FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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Vol. 42 (No. 1)
JANUARY–FEBRUARY 1977

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INTERREGIONAL COOPERATIVE RESEARCH IN FRUIT TREE VIRUSES AND ASPECTS OF CONTROL MEASURES: PRESENT AND FUTURE[1]

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A few commercial nurseries conduct virus indexing programs in regard to their propagating stocks and also maintain nuclear stock blocks. Individual State Experiment Stations as well have for several years cooperated in certification programs with commercial nurseries in regard to Prunus tree fruit nursery plants. There is, however, at the present no general U.S. recognized certification or regulatory program for distribution of virus-indexed or virus-free apple nursery stocks. In this respect, the U.S. orchardist is not as fortunate as his European counterpart in receiving reliable virus-free materials. The European distribution of virus-free material, handled through regulated programs, involving both research and inspection agencies, results in great volumes of clean budwood from the initial source which is built up and released to the industry by the cooperating nurseries. Part of the problem in the U.S. in not duplicating this accomplishment is the reluctance of the American growers to set up a uniform, regulated approach for handling virus-indexed trees. Also, because of our numerous and separate fruit growing areas, there tends to be a larger diversity in apple cultivars due to the different climatical aspects, growing seasons, temperature limiting factors, other pressing disease pathogens, soil types, processing requirements and changing consumer demands, each one a critical factor to specific area growers. In addition to this, there is a rapid development of patented selections being offered to the trade.

In spite of these handicaps, there has been considerable progress in obtaining and using virus-clean apple trees and we must realize that it is only 5 years since the first introduction and distribution of the IR-2 program's virus-free apple stocks began. We are just beginning to realize that our research findings and dissemination of this knowledge, which has led to increased quarantine interest in regard to the import of pome fruit tree material, signifies that the U.S. itself must also establish certification criteria and procedures in order to export it's own nursery material to meet the expanding world competition.

There is little or no control on the shipping of virus-infected apple budwood or treesthroughout the United States. This has in the past led to a high incidence and spread of latent viruses, particularly in cases where new cultivars have been desired quickly, in large amounts, and have been put on older, sometimes infected stock trees for a fast buildup of material. Exchange of nursery stocks among regions and nursery suppliers, without detailed information as to original source and disease status, also helps to increase the problem.

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[1]Part I appeared in Nov.-Dec., 1976 issue of Fruit Notes

With few exceptions, you pay your money and take your chances in regard to infection with viruses when you purchase tree stocks. Progress is being made when nurseries start from original clean source materials, but it will take several years until large numbers are built up, particularly with patented varieties. In addition, grower reluctance to pay premiums for certified virus-free trees delays the cleanup of U.S. material. This is due to the extra time and effort it takes to certify and maintain a virus-free program by the fruit tree industry.

Until the purchaser demands and is willing to pay for trees certified and indexed as to trueness to name and freedom from virus, he has only the reputation of the seller and nursery to fall back on.

Problems with stock-scion incompatibilities like the presently looming brown-line-decline syndrome with some East Malling types are suspected to be pathogenic in nature and may be the result of a combination of viral or mycoplasmal pathogens.

The relationship of stock-scion in regard to known clean materials is particularly important. It is not good to use virus-clean materials in one of the components while the virus content of the other is unknown. One may contain a latent or "hidden" virus that may damage the other clean component. This was well pointed out in the decline of Virginia Crab resulting in stem-pitting of the latter hardy stock material. Both parts of a two part tree must receive a clean bill of health to receive potential benefits of either of the components. In addition, as pointed out by van Oosten, the use of virus-free bud sources is only one of the ingredients of a healthy industry. Equally important is the careful attention shown to non-viral aspects of tree selections. Factors such as fruit finish, trueness to name, stability of the germplasm and a history of the susceptibility of the selection to known apple virus infections are other important and desirable facts. Given this information, the grower has a better guarantee of what the potential of his purchased trees will be in his future orchards. In today's competitive markets, with increasing production costs, all factors that can be ascertained should be made available to the orchardist especially in regard to purchasing his basic ingredient, his trees.

Tests at the Maine Station have demonstrated that considerable differences in regard to fruit finishing characteristics occur in selections of Golden Delicious even though they are free from virus infection. Some virus-free selections produce badly russeted fruit year after year compared to others which develop good fruit finish when growing side by side in the same orchard and receiving identical production practices. (Table 1)

Table 1. Non-viral fruit russet in selected clones of Golden Delicious, in lbs per bushel.

	Clone C			Clone H		
	Russeted			Russeted		
Tree	Heavy	Light	Clean	Heavy	Light	Clean
1	3.5	7.9	3.4*	2.4	4.9	28.5
2	8.0	21.0	7.6	2.3	17.3	16.5
3	22.6	11.4	1.9	.0	8.7	27.7
4	15.5	11.7	1.5	6.2	17.0	12.5
5	23.7	11.3	.0	2.2	13.9	20.5
6	13.5	21.6	2.3	.9	7.4	24.8
7	18.1	14.6	1.0	.2	12.2	23.9
8	7.2	3.5	.0*	5.9	17.2	9.8
9	10.7	15.6	10.7	2.6	13.2	20.2
10	2.4	17.8	18.9	2.7	13.7	13.2

*Less than a bushel

Both clones could be marketed as virus-free Golden Delicious. It goes without saying that good "seed" produces better crops than poor "seed." A successful potato farmer insists on knowing the disease rating and potential of his propagative seed and knows what the odds are of planting poor seed. It is paradoxical that apple trees are bought and planted for future envisioned high-yielding crops often without knowing their possible inherent faults or capabilities or virus content simply because there is no "pedigree" or labeling system to prevent this from occurring. Somehow a standard system has to be developed to insure that superior germ plasm is protected from viral reinfection as well as to insure that the grower receives specific information certifying that the product he receives is the quality product the nursery originally started with.

Progress has recently been made in reducing certain yellows diseases of fruit trees originally thought to be viral in nature but now known to be caused by mycoplasmal pathogens (ultramicroscopic bodies contained in phloem cells and transmitted by leafhoppers). There are also similar sized rickettsial and bacterial type pathogens transmitted by leafhoppers that affect woody plants. Fruit trees infected with these pathogens respond to antibiotic injections and disease symptoms are frequently arrested. Such controls are only stop-gap measures as they do not entirely eliminate infections and must be repeated. With viral infections there are not even stop-gap chemicals and a tree once infected in the orchard or infected when planted stays infected for the life of the tree. It is true that the possibility of reinfection with a virus may occur with insects as in other plants; however, to date, this has not been shown to happen with the apple virus entities. We still do not know what relationship the so-called latent and seemingly inocuous apple viruses have to other plants and should not continue to spread these around in infected budwood sources.

Tools to handle virus-free superior propagative material are available. What is needed is an industry-wide cooperative program establishing checks and controls backed up by regulation and inspection measures to insure quality of product from the originator to the purchaser with proper certification and identification of tree material. It should be handled by industry so as to keep it flexible and receptive to changes as they are needed, particularly with the patented scion and new stock selections, since these must be controlled by the patent holder. We have the expertise and the knowhow, all we need is the initiation of a system.

In conclusion, as one old career orchardist was heard to say, "It takes a lot of Saturday nights without a paycheck before a newly planted orchard starts to show a profit." The first and most important aspect of this orcharding business is what you put into that hole in the ground as the basic investment to live with, grow with and build upon.

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WHEN SHOULD AN EXISTING ORCHARD BE REPLACED

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One of the questions confronting an apple producer is that of the optimal replacement period. Should the old orchard (or some portion with trees of the same age) be torn out and replaced now or at some time in the future? This question has become increasingly important because of the trend to compact trees and higher density plantings.

A difficulty, of course, relates to the fact that a new planting takes several years to attain production and thus a direct comparison of net income from the old orchard as compared to the new orchard is not possible. Perrin and Proctor (1974) have outlined a procedure to be used in making such a decision which takes into account net income flows over the life of the orchard.[1]

[1] R.K. Perrin and E.A. Proctor, "The Economics of Replacing Apple Trees - A Guide for Producer Decision Making", Economics Information Report No. 36, Department of Economics, North Carolina State University at Raleigh, February, 1974.

The technique involves three steps: First, annual net returns per year over the life of the new orchard are discounted to obtain the net present value of the orchard.[2] Second, the net present value obtained in step one is amortized over the life of the orchard to obtain an "annualized" net income. Third, the "annualized" net income from step two is compared with the anticipated net income for the next year from the existing orchard. If the "annualized" net income from the proposed new orchard exceeds the anticipated net income for the next year from the old orchard, the old orchard should be replaced.[3]

A simple example may be helpful. The following table presents the life cycle cash flow for Red Delicious apples sold on the fresh market.

Table 1. Life Cycle Cash Flow Per Acre (With Projected Price Increases at 2.9 Cents Per Bushel Per Year)

Age of Orchard	Net Cash Income	Age of Orchard	Net Cash Income	Age of Orchard	Net Cash Income
1	$ -651	11	$1,277	21	$1,477
2	-174	12	1,360	22	1,490
3	-175	13	1,433	23	1,469
4	-62	14	1,446	24	1,451
5	205	15	1,459	25	1,432
6	515	16	1,462	26	1,413
7	847	17	1,465	27	1,394
8	1,033	18	1,467	28	1,350
9	1,113	19	1,469	29	1,310
10	1,194	20	1,471	30	1,269

The present value formula with uneven income streams is as follows:

$$PV = \frac{R_1}{(1+i)} + \frac{R_2}{(1+i)^2} + \cdots \frac{R_n}{(1+i)^n}$$

where R_1 to R_n = the annual net returns in each year
i = the appropriate interest rate

[2] Calculating the present value of a future return is the reverse of compounding interest. If we compound 95 cents at 5-1/4 percent simple interest, we have one dollar at the end of the year. Therefore, the present value of one dollar received one year from now, given a 5-1/4 percent interest rate is 95 cents.

[3] The following costs are not considered since they are irrelevant to the replacement decision: all fixed costs for equipment and buildings and land charges.

Inserting the numbers from Table 1 into the formula yields the following (the full series is not presented for reasons of brevity):

$$PV = \frac{(-651)}{(1+.10)} + \frac{(-174)}{(1+.10)^2} + \frac{(-175)}{(1+.10)^3} + \frac{(-62)}{(1+.10)^4} + \frac{(205)}{(1+.10)^5} + \frac{(515)}{(1+.10)^6} + \cdots$$

$$+ \frac{(1,269)}{(1+.10)^{30}}$$

$$= \$6,364$$

For the above table, the present value of the cash flow over 30 years with an assumed rate of 10 percent is $6,364.00.

The annualized value formula is as follows:

$$A + PV \times \left[\frac{i}{1 - \frac{1}{(1+i)^{30}}} \right]$$

where:
PV = present value
i = the interest rate

Using the present value computed above and an interest rate of 10 percent, the formula becomes

$$A = \$6,364 \left[\frac{.10}{1 - \frac{1}{(1+.10)^{30}}} \right]$$

$$= \$640$$

Thus, if the interest rate used is 10 percent the above formula yields an annualized net income of $640.00. If the existing orchard yields a return net of cash expenses less than this amount, it should be replaced.

Unfortunately, although this decision criteria has the appearance of a "rule of thumb"[4] it has many difficulties. Obviously, the technique requires a large amount of data. Some standardized yield pattern over time must be assumed and prices estimated for a large number of years in the future. The potential errors in the

[4] Rules of thumb are difficult to attain except in rather simple decision situations. They almost always assume a number of factors to remain constant and, as a consequence, often are in error.

future are, however, damped considerably by the discounting technique itself. That is, the effect on the present value of an error of 50 percent in net income in the 27th year will be relatively small.

A reasonable manager will also consider the fact that the net return in a given year from an existing orchard can be highly variable due to the random effects of weather on yield as well as price. Therefore, the blind application of the $640 criterion might well be wrong.

In summary: A theoretical decision model does exist for replacement of orchards. The orchardist may use the procedure as a technique to obtain more information concerning such a decision. This knowledge together with other considerations form the total bank of information the manager uses in exercising his judgment in the decision.

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CLEANING THE WEED SPRAYER

Cleaning the weed spray between sprayings will preserve the equipment, help insure uniform spray coverage, and prevent the chance mixing of incompatible chemicals, or applying traces of the wrong chemical. Below are suggestions for cleaning weed sprayers that appeared in Special Circular 81 entitled "Weed Control Sprayers: Calibration and Maintenance" and published by The Penn. State Univ. Extension Service, University Park, Pennsylvania.

"After each day's use, thoroughly flush with water, both inside and out to prevent accumulation of chemicals.

"Choose your cleaning area with great care. It is important to discharge the cleaning water where it will not contaminate water supplies, streams, crops, or injure other plants, and where puddles will not be accessible to children, livestock, pets or wildlife.

"When you change chemicals, or finish spraying for the season, clean the sprayer thoroughly both inside and out.

"The following steps are suggested for thorough cleaning:

1. Hose down the inside of the tank completely, filling it half full of water. Then flush out the cleaning water through the nozzles by operating the sprayer.

2. Repeat the procedure in step 1.

3. Remove nozzle tips and screens. Clean them in kerosene or detergent solution, using a soft brush. Do not use a knife, wire, or other hard material to clean nozzle tips. The finely-machined surfaces of the tips can be easily damaged, causing distortion of the spray pattern and an increased rate of application.

4. Fill the tank about half full of water and add about 1 pound of detergent for every 50 gallons of water.

5. Operate the pump to circulate the detergent solution through the sprayer for about 1/2 hour, then flush it out through the boom.

If you have used 2,4-D or an organophosphorous insecticide, before doing step 6, follow these additional procedures:

a. Replace the screens and nozzle tips.
b. Fill the tank about half full of water and add 1 pint of ammonia for every 25 gallons of water.
c. Operate the pump to circulate the ammonia solution through the sprayer for about 5 minutes, and discharge a small amount through the boom and nozzles.
d. Keep remaining solution in the sprayer overnight.
e. In the morning, flush out all the ammonia solution through the nozzles by operating the sprayer.

6. Fill the tank about half full of clean water while hosing down both the inside and outside, then flush out through the boom.

"When finished with the sprayer for the season, remove and store the nozzle tips, strainers and screens in light oil. Store the sprayer in a clean, dry shed. If the pump cannot be drained completely, store where it cannot freeze."

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A SUBSTANCE THAT DETERS EGGLAYING BY APPLE MAGGOT FLIES

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In the preceding 2 issues of Fruit Notes, I have discussed how apple maggot flies locate food, mates, and egglaying sites and how this information can be put to practical use in developing traps for monitoring and (in small orchards) possibly even controlling maggot fly populations. In this article, I will discuss a unique sort of behavior engaged in by the apple maggot and its close relatives just after egglaying. The fly-originating chemicals associated with this behavior offer promise as a new means of controlling the apple maggot without insecticides in large orchards.

Egglaying by apple maggot females is accomplished when the female arrives on a susceptible fruit, raises up on its legs, bores with its ovipositor through the skin of the fruit into the flesh, and deposits a single egg. The ovipositor is a needle-like protrusion from the posterior of the abdomen through which the egg is passed into the fruit. Following egg deposition, the female withdraws its ovipositor from the fruit, and then proceeds to circle around the fruit for about 30 seconds, dragging its fully-extended ovipositor on the fruit surface behind itself. After this, the female cleans its ovipositor for a few seconds and then flies off the fruit.

About 5 years ago, I became very curious as to why the females engaged in this rather elaborate behavior of ovipositor-dragging. Actually, my observations of maggot fly oviposition in nature revealed that only about half the cases in which females were seen attempting to bore into a fruit culminated in ovipositor dragging while the other half did not. When I examined the fruit, I found that among females which did drag their ovipositors after attempting boring, 90% had in fact deposited an egg. On the other hand, among females which did not drag their ovipositor after attempted boring, only 2% had deposited an egg. Thus, there was a clear positive relation between egglaying and dragging the ovipositor afterward. This suggested that the act of ovipositor dragging might be a mechanism for marking the fruit with some sort of substance to signify the presence of an egg.

I investigated this possibility in a Wisconsin sour cherry orchard heavily infested by apple maggot flies, which attack sour cherries in that state. I held a sour cherry by a thin wire attached to the stem, brought the cherry to within a few inches of a female on a cherry tree, and waited for the female to fly onto the cherry. Two types of cherries were offered: (1) a clean cherry never visited or infested by an apple maggot, and (2) a cherry in which another apple maggot female had just laid an egg and dragged her ovipositor. It turned out that 62% of the females that landed on the first type of cherry attempted egglaying, while 0% arriving on the second type attempted egglaying. Clearly, there was some sort of deterrent to repeated egglaying associated with the second type of cherry.

The question now arose as to whether this egglaying deterrent originated from the eggs, the flies, or the fruit. To answer this question, I offered the females 4 types of cherries: (1) a cherry in which a female had laid an egg but was not allowed to drag her ovipositor afterward, (2) a cherry with a pin prick, and the exuding fruit juice spread over the fruit surface afterward, (3) a cherry never visited by any flies, and (4) a cherry in which no egg was laid, but on which a female (transferred there from another cherry) had dragged her ovipositor. The results showed that 60-65% of females that arrived on each of the first 3 types of cherries attempted egglaying compared with 0% that arrived on the fourth type.

This was strong evidence that some sort of substance (which we will call a fruit marking pheromone), secreted from the ovipositor of a female during ovipositor dragging, was preventing other females from attempting to lay an egg.

Of what advantage is it to the flies to deposit such a marking pheromone? Examination of hundreds of fruits by myself and other investigators has shown that usually only 1 maggot larva per fruit can survive to maturity if the fruit is small, 5/8 inch or less in diameter. Hawthorne fruit, the original native host of the apple maggot, and sour cherries do not usually exceed this size. There simply isn't enough food or space in such fruits for more than one larva to develop. By depositing fruit marking pheromone following egglaying, a female is in essence saying to other females arriving afterwards, "Don't bother to lay an egg here. If you do, you'll be wasting your energy and your egg. There's only room for 1 larva here, and the larva from my egg already has a head start and would outcompete the larva from any egg you might lay. You're better off if you leave this fruit and look for a different one that isn't marked with pheromone and therefore doesn't already contain an egg." Apples, which the apple maggot began to infest about 110 years ago, are of course much bigger than hawthorne fruit or cherries and can support as many as 15-20 larvae to maturity. Therefore, 15-20 females can lay eggs in and deposit marking pheromone on apples before the pheromone begins to become a deterrent to further egglaying.

During the past 4 years, I (alone, or in conjunction with Drs. Volker Moericke of Bonn, West Germany and Harvey Reissig of Geneva, New York) have continued to explore various properties of this fruit marking pheromone. We have found that if pheromone-marked fruit is kept under dry conditions at normal summer temperatures, the pheromone is remarkably stable and is nearly as effective in preventing egglaying 2 weeks after its deposition as 0 hours after. Surprisingly, the pheromone has proven to be water-soluble, and can be partially washed away by rainfall. This is not necessarily a disadvantage to us, however. For example, we have been able to swish marked fruit in a container of water, spray the pheromone-water solution onto clean fruit in laboratory cages, and to a substantial degree prevent maggot fly egglaying in this fruit. If combined with an effective spreader-sticking agent, this pheromone should be able to survive considerable rainfall and remain effective under a variety of outdoor weather conditions.

Recently, we have found this same sort of pheromone to exist in all 6 of the close relatives of the apple maggot that we have examined. These include the blueberry maggot, black cherry fruit fly, eastern cherry fruit fly, and western cherry fruit fly. Drs. Byron Katsoyannos and Ernest Boller of Wadenswill, Switzerland have also recently found it to occur in the European cherry fruit fly, the worst pest of cherries in Switzerland. This past year, these workers collected marking pheromone deposited after about 1 million cherry fly egg layings in fruit in laboratory cages. They swished this fruit in water, and sprayed 10 cherry trees in nature with 2 applications of the pheromone-water solution. The results were extremely encouraging: only 6% of the pheromone-sprayed cherries had any cherry maggot eggs or larvae, compared with 100% maggot infestations of adjacent unsprayed cherries.

In the past 2 months, Reggie Webster and I have discovered that the fruit marking pheromone of the apple maggot acts not only as an egglaying deterrent to maggot flies but acts also as a chemical signal to *Opius lectus*, a parasite of the maggot eggs. The pheromone arrests the parasite females, and elicits a strong degree of searching behavior for maggot eggs. Parasites encountering fruits sprayed with marking pheromone are therefore likely to remain in the area of the pheromone-sprayed tree for a longer time and effectively search out any maggot eggs that might be in the fruit.

The task facing us now is the chemical identification and synthesis of the marking pheromone. This will require the expertise and equipment of an accomplished pheromone chemist, which are few in number. We hope in the near future to interest one of them in tackling this challenging pheromone. If some day the pheromone can in fact be obtained at reasonable cost, then the pheromone, combined with an effective spreader-sticker, could be sprayed onto our apple trees to prevent maggot fly egglaying. The deterred females, which we know move about frequently, might then be captured out by baited yellow rectangles and/or baited red spheres hung in specific trap trees. Native or released *Opius lectus* female parasites would be retained in the area by the presence of the pheromone. Thereby, an integrated approach to apple maggot management, combining deterrents, attractants, and parasites, could hopefully be achieved.

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Establishment and Management of Compact Apple Trees

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Part 2

Rootstocks

Commercial interest in size-control rootstocks developed in the early 1950's in Massachusetts. Presently, those in most common use are the clonally propagated Malling (M.) and Malling-Merton (MM) rootstocks. The degree of dwarfing induced by these rootstocks is shown in Table 9. A description of these rootstocks and seedlings follows as well as a summary in Table 10 of the characteristics of the common and less commonly planted rootstocks.

Table 9. Apple rootstocks presently used in Massachusetts and their relative degree of dwarfing.

Apple rootstock	Dwarfing (%) of seedling trees[z]
M.9	30–50
M.26	45–60
M.7	55–75
MM 106	75–90
MM 111	80–90
Seedlings	100

[z]Degree of dwarfing will vary with variety and soil type.

M.9. This is a true dwarf rootstock (Table 9) and can be useful for specialized orchard culture by commercial growers. It is a century old, thus well known. This rootstock has a brittle root system which means each tree will need to be supported by a post or by a trellis. It is a very suitable rootstock for high density plantings. Interest in this rootstock is increasing for use in "pick-your-own" orchards. On a good site, with good soil and management, cultivars on M.9 can be productive.

Virus-tested M.9 rootstocks (free of all known viruses) are becoming available. Preliminary data from the Netherlands show that: (a) cultivars on virus-tested M.9 rootstocks grow more vigorously than those on virus-infected M.9's; (b) virus tested trees usually produce larger yields than virus-infected trees; (c) the yield efficiency (pounds of fruit/unit of growth) of the virus-tested trees is equal to or higher than virus-infected trees; and (d) fruit quality is also usually better for the virus-tested trees. The stronger growth of virus-tested trees could be advantageous on poorer soil but a disadvantage for high density plantings on strong soils.

Cultivars on M.9 are well suited for trellising or the slender spindle type of training with a single post parallel to the trunk for support. Apple varieties differ in vigor on M.9 with weaker growing types like Idared, Empire, Golden Delicious, and probably MacSpur easier to train as slender-spindles than Red Delicious, McIntosh or Cortland. Slender-spindle trees will be described elsewhere.

M.26. This is one of the new clones from East Malling from a cross of M.16 and M.9 and introduced to the U.S.A. about 1958. Its roots are brittle like the M.9 but trees on this rootstock have better anchorage. *Whether or not trees on M.26 are going to require support is still questionable.* At present, we have found temporary support necessary on windy sites and when nursery stock quality was poor.

An overgrowth of M.26 forms below the graft union and burr knots (adventitious roots) form on the stock. It does not sucker as much as M.7. Trees on M.26 produce earlier than those of M.7 and it propagates well in stool beds. It is not resistant to wooly aphids or to collar rot. It is reported to be very winter hardy. M.26 requires well-drained soil for optimum performance.

M.26 is gaining popularity in Massachusetts orchards but many questions about this roostock remain unanswered: anchorage, soil requirements, whether loss from fireblight will be a problem, and scion/rootstock effects on growth and fruiting. Therefore, *it is suggested only for trial.* We have observed no serious problems but our experience is limited to 6 years.

M.26 looks very promising in Michigan. They have lost a few trees in commercial plantings, but these have been on low, wet heavy soils. Michigan reports that M.26 will support a free standing tree. To the contrary, researchers in western New York are rather "cool" toward M.26 because of its susceptibility to fireblight and its sensitivity to "wet feet." It requires a well-drained sandy, loamy soil without the tendency to drought (Table 8).

M.7 is the best stock we have to give a semi-swarf tree. Twenty years of commercial experience with M.7 has proven its reliability under our conditions. Cultivars on this rootstock come in bearing early and continue to produce good annual crops. M.7 is not without its faults—it produces suckers from the roots, it tends to lean, particularly when budded to Red Delicious, and it is susceptible to wooly aphids.

Table 10. Summary of rootstock characteristics
(Letters A-E denote estimate of value: A = excellent; E = poor)

Rootstock	Early bearing	Productivity	Anchorage	Collar Rot Resistance	Tolerance to: Wet soil	Dryness	Low T°	Remarks and Recommendations
Highly vigorous—90 to 100% standard								
Seedling	D	C	A	C-	C	B-	C	Use now limited.
M.13	C-	B	B	C	A-	C	C+	Does well on wet soils.
Robusta 5	B	B+	A	B	B	C	A+[y]	Tolerates heavy soils.
Medium vigor range—60 to 85% of standard								
MM104	B	A	C	E	E	B	C-	Very susceptible to collar rot.
M.2	B	B	B	B	C	B	C+	Never very popular.
M 106	A	A	B	C-	C+	B	B-	Avoid poorly drained soils.
M.7	A	B-	C	B-	C	B	C-	Suckers.
MM 111	C-	B+	B+	B	C	A	B	Popular with M.9 interstem.
Antonovka	B	B+	A	A+	?	?	A	Inadequately tested in U.S.A.
Alnarp 2	A	B+	A	?	?	?	A	Inadequately tested in U.S.A.
Half-size and smaller								
M.9	A+	A+	D	A+	D	C	B	Attractive to mice.
M.26	A+	A+	C-	C-	C-	C	A	Fire blight susceptibility.

[y]Reported as not being hardy where there are mild periods during winter because it has a very short rest period.

Trees on M.7 need to be budded 8 to 10 inches high in the nursery so that the trees can be planted deeper in the orchard. Deeper planting provides better anchorage and reduces suckering. M.7 produces a tap root, thus trees on this rootstock should be planted on deep, well-drained soils. In spite of higher budding, providing temporary basal support by means of 3-foot long hardwood stakes driven 2 feet into the ground is advisable for Red Delicious and for all cultivars on windy sites.

MM 106 has some good characteristics and some believe these outweigh its weaknesses when budded on semi-vigorous cultivars (Idared, Empire, or spur-types) and planted on light loam soils. Trees on this rootstock come into production early. MM 106 also has a strong well-balanced root system, therefore, anchorage is not a problem. It is sucker-free and resistant to wooly aphids.

Our Massachusetts orchards frequently have localized wet areas and in these areas we lose trees on MM 106. Furthermore, MM 106 produces large trees with such cultivars as McIntosh. Loss of trees on MM 106 is commonly attributed to collar rot but may be more directly related to winter injury at the crown, soil management, or soil drainage. (Trees on MM 106 are slow to mature in the fall and the trunk tissue near ground level, which is the MM 106 portion of the tree, is late maturing and thus more susceptible to low temperatures in early winter than the other above-ground portions of the tree.)

MM 111. A good rootstock for sandy loam soils because it is more drought-tolerant than other size-control rootstocks. It is more vigorous than MM 106, thus it is of no value to orchardists desiring to increase tree numbers per acre. Currently, MM 111 is being used as the understock for interstem trees because it produces well anchored trees. It is intermediate in winter hardiness.

Seedling. These formerly constituted the bulk of the rootstock material used for apple trees. No two seedling rootstocks are identical in genetic makeup. Trees on seedling rootstocks are well-anchored and more tolerant to unfavorable soil conditions than many M. and MM rootstocks. Trees on seedling rootstocks are slower to come into production than those on size-control rootstocks. Seedling rootstocks will produce trees 25 to 30 feet or more in height without restrictive pruning. Trees on seedling roots are inefficient because tree centers are unproductive or produce poor quality fruit due to inadequate sunlight. Presently, seedlings are used mainly as the understock for spur-type trees and interstem trees.

Interstem Trees

The interstem tree ordinarily consists of: the understock, the interstem, and the scion variety (Fig. 2A). Interstem trees cost more, and they are usually only available by contracting two years in advance. The scheme most often practiced by the nurseryman is to bench-graft the interstem (M.9) onto the chosen rootstock (usually MM 106 or MM 111), plant this tree in the nursery and bud on to it the scion variety in

August.

Trees consisting of four parts denoted as "C" series interstem dwarf apple trees are available from a nursery in Missouri. These have a seedling root, K-14 winter hardy trunk, a dwarfing interstem (C-6 or C-52) and the fourth part of this tree is the desired cultivar (Fig. 2B). The nursery reports that standard cultivars with C-6 produce trees about half size of standards on seedling roots. The interstem C-52 produces trees about two-thirds to three-quarters the size of the cultivar on seedling roots. Combining the spur-type cultivars with the C-6 and C-52 interstems reportedly produces earlier bearing, heavier yielding, and smaller trees than if standard type cultivars are used. Our experience with the "C" series in Massachusetts is limited.

There is an active interest in interstem trees with M.9 interpiece because of the desire for small trees that do not require support. Tree size should be intermediate between that produced by M.9 and M.7 rootstocks. It is suggested that the M.9 interstem should be at least 6 inches long and positioned on the stem of the understock at least 12 inches from the top of the roots to permit deeper planting.

Interstem trees are *suggested for trial.*

Orchard Design

Tree density defined. Terminology and planting distances used vary among researchers with compact apple trees. Below is shown the names we have chosen for this publication, the tree number in each density, and the rootstock and interstem combinations that can be utilized in each density.

Density	*Number of trees/A*	*Rootstock and interstem combinations that can be utilized in each density*[z]
Low	Less than 114	Seedling, MM 111, MM 106, Alnarp 2, M.13, C-52/K-14/seedling, M.7.
Medium	115 to 249	MM 106, M.7, C-52/K-14/seedling, C-6/K-14/seedling, M.9/seedling, M.9/Alnarp 2, M.9/MM 111, M.9/MM 106, M.26.
High	250 or more	M.9

[z]Cultivar vigor and soil type are factors influencing tree spacing.

Tree spacing. We cannot make firm recommendations on planting distances because our experience is too limited. Furthermore, the number of variables affecting tree size are great—orchard site, soil, severity of pruning, nutrition and tree training among others. However, as a guide we have suggested in Table 11, planting distances that seem reasonable minimum spacings for our conditions in Massachusetts. Similar tree spacings are given for both medium and low vigor cultivars which reflects our lack of experience with the spacing requirements of various cultivar-rootstock combinations. However, we have 20 years of commercial experience with M.7 and *strongly believe* that without restrictive pruning, 16 ft. x 24 ft. should be considered the minimum spacing of a permanent planting of vigorous cultivars on this rootstock and that on some soils 20 ft. x 30 ft. spacing is not too wide.

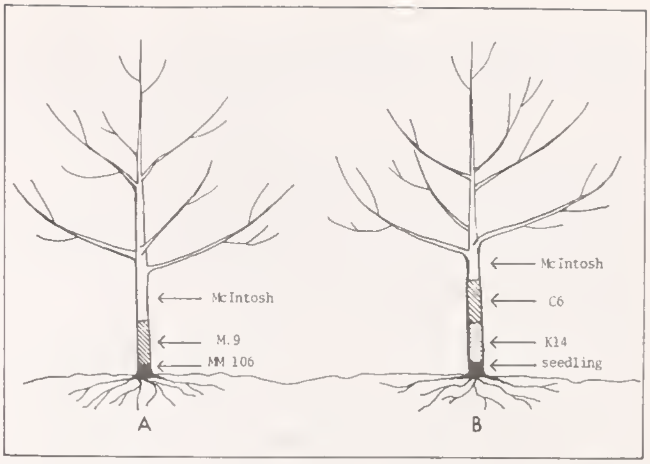

Fig. 2. Interstem trees. (A) is a 3-piece tree with an MM 106 understock, M.9 interstem, and McIntosh as the cultivar. (B) is a 4-piece tree with a seedling understock, K-14 winter-hardy trunk, C-6 dwarfing interstem, and McIntosh as the cultivar.

We have allotted an 8 ft. alley for orchard travel and harvest operations. If you like a 7 ft. alley, decrease the spacings between the rows by l ft. (for example, a 16 ft. x 24 ft. spacing to 16 ft. x 23 ft.).

It cannot be overemphasized that as planting density increases, it becomes even more important that soil, cultivar and rootstock be correctly matched. When deciding on what density to plant, consider the following factors: (1) the characteristics of the site and soil—windy, poorly drained soil, etc.; (2) cultivar being planted—vigorous, spur-type, etc.; (3) time available for tree training and pruning; and (4) method of marketing—"pick-your-own," processing, or fresh use.

Low density tree planting. Usually allows for full tree development with a minimum of pruning to restrict tree spread. It requires the least investment per acre while production costs are below those of orchards on seedling rootstock. Massachusetts growers should consider low density plantings when the cultivar is a vigorous-growing (McIntosh and Delicious) standard-type tree and the rootstock is M.7 or MM 106 because it is difficult to restrict the size of these trees. Plantings of these cultivars on these rootstocks spaced 10 x 18 feet, 15 x 20 feet, or 20 x 20 feet have become so dense that growers have been forced to remove trees while the orchards were still relatively young.

Medium density tree planting. This density will require more careful attention to training and pruning trees than with low density planting to prevent tree crowding and maintain fruit quality. It is essential to maintain conical-shaped trees

(Christmas tree shape). The higher investment per acre in comparison to low density plantings (Table 1) should be offset by earlier, higher yields. Medium density plantings involve free standing trees—MM 106, M.7, M.26, and interstem trees. *However,* more experience is needed before we can be sure of the stability of trees on M.26 without support.

The trees are smaller than in the low density planting, easier and less costly to spray, and a higher percentage of the leaf area is exposed to sunlight which is essential for flower bud formation and high fruit quality.

High density tree planting. This type of planting will require the use of M.9 rootstock with the tree individually staked or supported by a trellis. Thus cost of establishment is extremely high (Table 1). Adjustments in orchard size and/or management procedures will be necessary if sizeable acreage of high densities is planted by the established grower because of the careful attention needed in growing the trees and containing them within their allotted space. Few soils in Massachusetts are suitable for trees on M.9 without providing supplemental water.

In the Netherlands, where all modern plantings are on M.9, there is a rule of thumb that states that orchard size should be governed by the number of skilled pruners on the farm. An apple orchard of 20 to 25 acres is considered large in the Netherlands and the grower sells his fruit through an auction, jumble-packed in wooden crates. To the contrary, the average Massachusetts grower has 50 or more acres, grades and packs his fruit into bags, cell count cartons or trays, and in many instances retails part of the crop. Time is such a limiting factor that many orchardists are forced to hire custom pruners to prune their bearing orchards.

Orientation of tree rows. North-south orientation of tree rows is preferred because it favors maximum exposure of the leaves and fruit to sunlight. However, frequently the topography of the land and orchard boundaries dictate the directions in which the tree rows will extend.

When designing the orchard, allow for service roads and sufficient space at the ends of rows for equipment maneuverability.

Pollination. Most apple cultivars are self-unfruitful and require cross-pollination to set a commercial crop. In selecting a cross-pollinating cultivar, the following factors should be considered: (1) Age when it begins to flower, (2) season of bloom, (3) viability of pollen produced, (4) tendency to flower annually, (5) cross-incompatibilities, and (6) adaptability and value of the cultivar to the region.

Table 12 lists some of the cultivars grown in Massachusetts according to their season of bloom. These are generally suitable cross-pollinizers for each other; several exceptions are noted. These cultivars do not always bloom in the same relation one to another each year. During years when the pre-bloom temperatures are high, all cultivars are apt to bloom at about the same time; when the pre-bloom temperatures are low, the bloom is late and 7 or more days may elapse between the early- and late-blooming cultivars. Bloom periods of those cultivars listed in the early- and mid-season groups should overlap sufficiently for suitable cross-pollination in most seasons; the same would be true for those cultivars in the mid-season and late categories. It would be

Table 11. Suggested minimum planting distances for various apple cultivar/rootstock combinations.[z]

Rootstock or interstem combination	Tree spacing (ft) and trees/acre (in parentheses) for: Vigorous cultivars[y]	Medium vigor and low-vigor cultivars[x]
M.9 or M.9A	8 x 16 (340)	6 x 14 (518)
M.26	14 x 22 (141)	12 x 20 (181)
M.9/MM 106	12 x 20 (181)	10 x 18 (242)
M.9/MM 111	14 x 22 (141)	12 x 20 (181)
M.9/Alnarp 2	15 x 23 (126)	13 x 21 (159)
M.9/seedling	15 x 23 (126)	13 x 21 (159)
C-6/K-14/seedling	15 x 23 (126)	13 x 21 (159)
C-52/K-14/seedling	16 x 24 (113)	14 x 22 (141)
M.7 or M.7A	16 x 24 (113)	14 x 22 (141)
MM 106	18 x 26 (93)	16 x 24 (113)
MM 111	20 x 28 (77)	18 x 26 (93)

[z]Increase spacings by 2 feet on heavy soils.

[y]McIntosh, Delicious, Cortland, Macoun, Puritan, Spartan.

[x]Most spur-type McIntosh, spur-type Delicious, Paulared, Tydeman's Early, and Jerseymac have medium vigor. Golden Delicious, Idared, Empire, MacSpur, and Rome are cultivars with low vigor.

Table 12. **Approximate bloom period of apple cultivars producing viable pollen for cross-pollination.[z]**

Early	Midseason	Late
Empire	Cortland[y]	Macoun
Jerseymac	Delicious[x]	Melrose[x]
Julyred	Early McIntosh[y]	Northern Spy, Red Spy
Lodi	Golden Delicious	Rome, Gallia
McIntosh	Idared	
Niagara	Spartan	
Paulared	Spencer	
Puritan		
Tydeman		

[z] Bud sports or strains of an apple cultivar are not cross fruitful with each other or the parent cultivar even though they have viable pollen and functional ovules. Examples: Delicious strains such as Richared, Starking, Red Prince and Starkrimson will not pollinate Delicious or each other and vice versa.

[y] Cortland and Early McIntosh are cross-incompatible but are suitable pollinizers for other cultivars.

[x] Melrose and Delicious are said to be cross-incompatible. Both are suitable pollinizers for other cultivars.

The cultivars listed below are triploids; they do not produce viable pollen and are ineffective in cross-pollination.

Early	Midseason	Late
Gravenstein	Baldwin	Spigold
	Mutsu	
	Rhode Island Greening	

unwise to rely on early blooming cultivars to cross-pollinate a late-blooming cultivar or vice-versa.

One should not rely entirely on strongly biennial cultivars such as Early McIntosh as cross-pollinizers for annual cultivars such as Cortland, Delicious and McIntosh. When a strongly biennial cultivar fails to bloom, there is no suitable pollen to cross-pollinate the usual annual flowering cultivar. Hence, the annual cultivar will fail to set a commercial crop in alternate years and tends to become biennial, also.

In low density plantings, the pollinating cultivar may be set either in solid rows or interplanted with the main cultivar. The former is preferred because interplanting with the main cultivar can create problems in spraying and be an inconvenience in harvesting. When the pollinator cultivar is set in solid rows, alternate 1 or 2 rows of the pollinator with 4 rows of the main cultivar. Where interplanting is used, every third tree in every third row should be a pollinator cultivar.

Early McIntosh and Golden Delicious are probably partially self-fruitful and it is advisable to set them in solid rows with fewer pollinating rows than with other varieties to reduce the tendency of oversetting and for convenience of spraying. To the contrary, Cortland, McIntosh and particularly Delicious require a high proportion of pollinators, particularly on sites where poor pollinating weather is apt to occur rather frequently.

It is well documented that foraging bees tend to work up and down rows rather than across rows. When trees are planted at low densities and the trees are not crowded in the row, the bees will move between trees somewhat independently of the row. However, medium and high density plantings may eventually have little space between trees in the row, thus forming virtually a solid hedgerow. As a result, the distribution of pollenizer pollen across one or more rows may be seriously limited because of movement of the bees along the hedgerows instead of between adjacent rows. *Thus, it may be advisable that every fourth tree in every row be a pollinator cultivar.*

Orchardists almost invariably rely on honey bees for pollen dispersal, and they usually do this by renting colonies from beekeepers. We suggest that one, but preferably two colonies per acre be brought into the orchard at the time of 10% bloom. The hives may be arranged singly or in groups of 4 in various locations. Grouping is superior because colonies competing with each other increase bee activity. Bees can "set a crop" in 2 good flying days (temperature about 65° F and partial sun). After full bloom, bees should be removed as soon as possible so that you can continue your spray program.

Soil Preparation

Frequently, hay fields and pastures with reasonably good fertility, can be planted to trees without extensive land preparation. While it is generally true that newly-set fruit trees do very poorly in a heavy grass sod, it is possible to obtain growth equal to that obtained under cultivation by the use of herbicides.

Hay fields, and especially pastures, frequently have low fertility. Fertility can be increased by applying 500 to 600 pounds of a complete fertilizer such as 10-10-10 and by application of sufficient high magnesium lime or a high calcium lime. A soil pH of 6.0 to 6.5 is desired for orchards. Soils which have not had frequent applications of lime will require 2 or more tons of lime per acre. (It is always advisable to have the soil tested to determine its pH and lime requirements. Information on taking soil samples and where to send them for analysis can be obtained from your County Extension Office.)

Paraquat (an herbicide) can be applied in 4 to 6 foot wide strips along the tree rows the year prior to planting or after planting to control grasses and broadleaf weeds. Residual herbicides should not be used for preplanting weed control because the trees planted in the treated soil may be killed. When paraquat is used the year of planting, *the spray must not hit the wood of the tree,* otherwise injury may occur. Information on herbicide usage can be obtained from your County Extension Service.

On newly cleared land and soils which are low in fertility and are not too stony or likely to erode badly, it is advisable to build up the soil by seeding and plowing or disking under cover crops before planting trees. Spring oats, buckwheat, or millet can be sown as the summer cover crop and spring oats for the winter cover crop. This is an opportune time to apply lime because it can be incorporated into the soil during the disking of the cover crops.

When the trees are planted, a mixture of grass seed and oats can be sown. During the summer, the oats can be cut and let lie or be raked around the trees for mulch.

On a fairly level site which is not subjected to serious erosion, it may be possible to interplant with low growing crops such as pumpkins, for "pick-your-own" or roadside stand sales. These crops can be grown for a few years to help defray the cost of caring for the young trees until they come into production. The rows of the cultivated crops should not be planted so close to the tree rows that they interfere with growth of the young trees. Intercrops in a young orchard should be considered as a temporary enterprise and they should be discontinued just as soon as they interfere with tree growth and care.

Mapping the Orchard

Once the decisions are made concerning cultivars, rootstocks, and planting distances, the orchard design should be drawn to scale on paper. Be sure to map the location of the drainage system, wet spots, and changes in soil type.

After planting, record any changes in original planting plan, and record the date of planting, name and address of nursery supplying the trees, weather conditions at time of planting, and other information of value.

Staking the Field

A base line (the first row) is laid out on one side of the field parallel with an adjacent row of trees in an existing orchard, a fence, or a road. Stakes are placed along this line where the trees are to be planted. (*When* staking the field be sure to allow sufficient room along the edges of the orchard for equipment maneuverability.) Now establish several rows of stakes at the spacing desired for the alley between trees at right angles to this row (Fig. 3). Right angles can be determined with a measuring tape and stakes using the carpenter's square method in which 9 ft. x 12 ft. x 15 ft. or 12 ft. x 16 ft. x 20 ft. are the lengths of the sides of the right-angled triangle. A right triangle can be constructed out of wood strips if desired. Now that the stakes are in place, the remainder of the orchard can be staked by "sighting-in" on the stakes and with the tape measure.

When staking the field only 1 or 2 months prior to planting, a couple of handfuls of lime can serve as an alternative to staking each tree location.

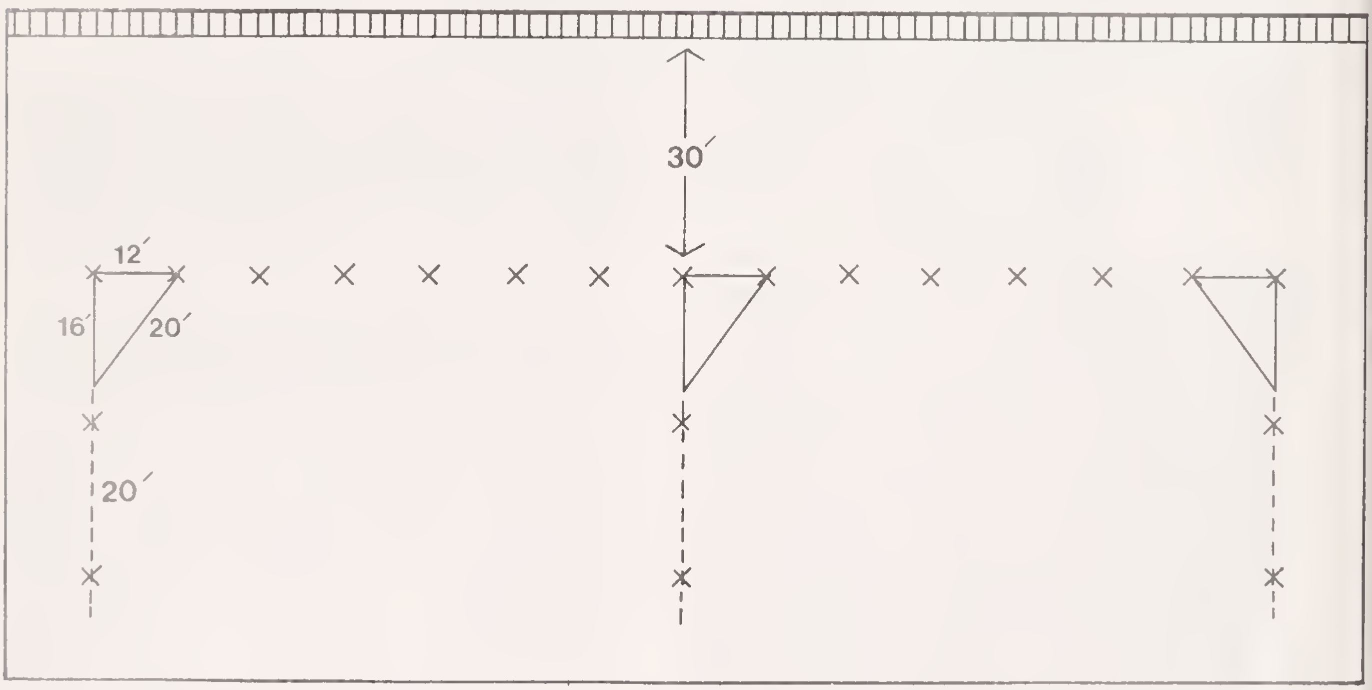

Fig. 3. A method of staking the orchard before planting. In this planting, the first row is laid out 30 feet from an existing fence and the location of the trees in the row staked (12 feet apart in the row). Right angles are determined at both ends and the middle of the first row with a 12 ft. x 16 ft. x 20 ft. right triangle. By stretching a measuring tape along the 16 ft. side of the right triangle, the location of the trees can be staked. The rows are 20 feet apart.

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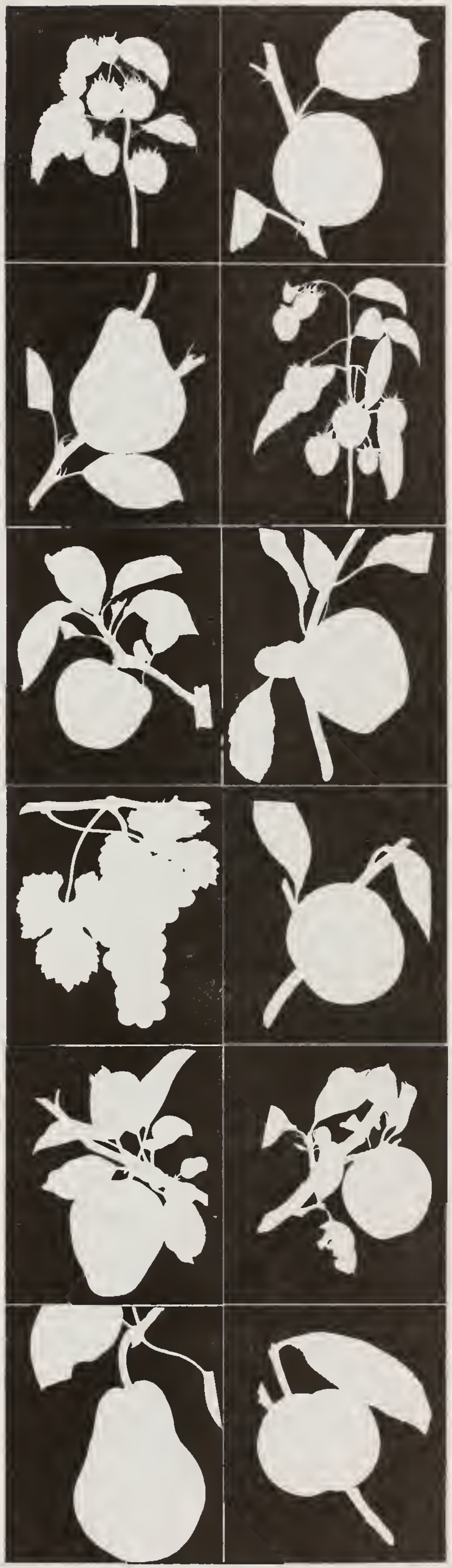
FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE



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MARCH/APRIL 1977

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THE USE OF A PRESSURE TESTER TO MEASURE FIRMNESS OF APPLES

William J. Bramlage
Department of Plant and Soil Sciences

Firmness of apples is used worldwide as a measure of ripeness and "condition" of the fruit. The most widely used instrument for firmness measurement is the Magness-Taylor pressure-tester (devised in 1925), although the Effegi tester (developed recently in Italy) has met some acceptance due to its compact size and convenience. Tests comparing the Magness-Taylor with the Effegi indicate that readings of the 2 instruments are quite comparable, and I shall assume that what is said in this article about use of a Magness-Taylor is equally true about use of an Effegi tester.

With its worldwide and longstanding use, and the importance of its measurements, one may assume that the Magness-Taylor is used in a standard way and that readings by different users are closely comparable. Not so! There is no standard technique and readings are often grossly variable among users of the instrument. In 1 test in Geneva, New York, it was found that professional users of a Magness-Taylor varied as much as 3 to 4 lbs in the readings they obtained on the same lots of apples! Following an informal discussion at a meeting in December, 1975, where it was evident that use of pressure testers differed widely, 10 Northeastern post-harvest horticulturists[1] agreed to gather data on factors that can influence pressure test determinations, in hopes of standardizing a technique. The results of this collaborative effort, coordinated by Dr. G.D. Blanpied of Cornell University, are summarized here.

<u>The Magness-Taylor pressure tester</u>: The instrument itself may be a cause of erroneous readings. First, there are 2 sizes of plunger "heads" that might be used. For apples, the larger one, with a diameter of 7/16 inch, is always used; the smaller, 5/16 inch head is for use on pears, which are much harder than apples until nearly ripe. A second problem is that the instrument may not be calibrated. Calibration is relatively simple and should be checked regularly. To calibrate, place the plunger on an accurate scale and press down slowly until the scale registers a weight that occurs on the pressure tester scale. Check this weight against the recorded reading on the pressure tester. Several different points on the scale should be tested in this manner. If the readings on the scale and on the tester do not correspond, the readings on apples you obtain with the tester should be adjusted accordingly, or better, the spring in the pressure tester should be replaced or the instrument sent to the factory for re-calibration, if necessary. A rusty spring should always be replaced.

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[1]Collaborators were: G.D. Blanpied, Cornell Univ.; D.H. Dewey, Mich.State Univ.; R.E. Hardenburg and A.Watada, USDA, Beltsville, Md.; M. Ingle, W.Va. Univ.; R. LaBelle & L. Massey, Geneva, N.Y.; G. Mattus, V.P.I and S.U., Blacksburg,Va.; W. Stiles, Univ. of Me. and W.J. Bramlage.

Choosing a sample for testing: The user should consciously and carefully choose the fruits that will be tested, knowing the factors that may influence the readings.

A. If you are testing in the orchard, it is likely that fruit from the outside of the tree will test firmer than those toward the inside of the tree.

B. Fruit size is a very important factor. In general, the larger the fruit, the softer it will be. Sometimes a 1/4 inch difference in diameter can make a 1 or 2 lb difference in the pressure test! Following years of careful record-keeping, Dr. George Mattus suggests that you not vary more than 1/4 inch in diameter among the fruit you test. Obviously, some kind of sizing device is therefore necessary in choosing a sample. Further, you should test a size that is representative of the majority of the crop, and specify the size you are testing. You cannot accurately compare firmness of lots of fruit if you sample 3-inch fruit in one lot and 2-1/4 inch fruit in the other.

C. The temperature of the fruit can have a small but sometimes significant influence on pressure tests. Firmness tends to be slightly less when apples are warm than when they are cold. This is not nearly as important a point as is the size of the fruit, but for maximum accuracy, the user should be consistent about testing either warm fruits or cold fruits.

D. A very important but controversial question is: How many fruits should you test, and how many times should you test each fruit? Obviously, 1 fruit is not sufficient, and the more fruits you test, the more accurate will be the average pressure reading. But, between these 2 indisputable points there is little agreement. Many people test only once per fruit, but many others test twice -- once on each of the opposite sides (usually blush and green sides). Some people may even test as many as 4 points on an apple. (Is 1 apple tested on 2 opposite sides equal to 2 apples tested on 1 side? Probably not.) How many different fruits should you test? Most people agree that 10 fruits from a given lot is probably minimal for accuracy, but may prefer 20 to 25 fruits to reduce error. If only 10 are tested, they should probably each be tested on 2 opposite sides. I personally prefer testing 20 apples once on a designated (green or blush) side. The significant point here is, however, that a large enough sample must be tested to overcome the variation within the population of fruits being sampled. If large variation exists, a large sample size is required.

Making the test: Having calibrated the pressure tester and carefully chosen a sample, how should you test the fruits? First, you should recognize that the fruit is not of uniform firmness. Generally, the blush side is firmer than the green side. This difference may be as much as 1 lb of pressure. Therefore, either consistently test the blush side, knowing it is firmer, or the green side, knowing it is softer, or else test both the blush and the green sides and average the readings.

Since the skin badly distorts a pressure test on an apple, it must be removed from the area to be tested. The depth of the cut removing this skin influences the reading: the deeper the cut, the higher the reading. Dr. Robert Hardenburg suggests use of a potato peeler (stainless steel to avoid rusting) for quick, shallow, consistent cuts. These cuts should be made at a point half way between the stem and calyx ends of the fruit. Never test a bruised area.

For testing, the fruit should be placed on a hard surface (e.g., table top) rather than being hand-held. The plunger should be inserted to the line inscribed on the plunger. Testing only to the "yield point" of the fruit tissue (i.e., when it "gives") produces an erroneously low reading, and going beyond the line gives a high reading. However, the most critical feature of testing is the speed of applying the force. The faster you apply the pressure, the higher will be the reading. The proper speed is about 2 seconds, and to regulate your speed it is suggested that you say to yourself, "1001, 1002, as you insert the plunger into the fruit. This may sound childish, but it is extremely critical as can be seen simply by applying force at different speeds during calibration. The user needs to frequently check himself during testing to make sure he is testing at the proper speed. Applying pressure too fast is probably the greatest source of false readings by users of the pressure tester.

Having tested the fruit, how do you read the scale? Some read it to the nearest whole lb., others to the nearest 1/2 lb., and some may even read to the nearest 1/10 lb. It seems clear that reading to the nearest 1/2 lb. is sufficient, and if your sample size is reasonably large, the nearest 1 lb. is satisfactory. Again my preference is to the nearest 1/2 lb.

With an accurate instrument, careful sampling, and precise testing, you should obtain a quite accurate firmness measurement of the fruits. But this accurate measurement still may not truly represent the "condition" of the apple. Some sources of error are the following.

A. Nitrogen (N) level of the fruit: Increasing the N level in apples may reduce firmness of apples more than it affects postharvest "condition" of them if the apples were at the threshold of N-deficiency before treatment. Thus, you may misjudge "condition" by comparing lots of widely varying N levels.

B. Watercore: The more watercore in a fruit, the firmer it may pressure test, even though increasing watercore indicates increasing fruit maturity. Pressure tests may indicate very little about "condition" of watercored apples.

C. Water loss: If apples are losing water rapidly, they may "soften" due to loss of turgor, i.e., wilting. This soften- does not represent what is usually regarded as "loss of condition."

There are probably other complicating factors, also, but these examples illustrate the importance of observing the fruit you are testing, recognizing symptoms of complicating conditions, and being careful about how you interpret the results of pressure tests.

With the importance of firmness in the acceptability of apples, and the ease of using pressure testers, these instruments seem certain to remain as key determinants of apple quality in the foreseeable future. Yet, it is shocking to see how erratically these devices are used. At present, a term, like "10-lb McIntosh" may actually mean little to anyone but the person who tested the fruit; these same apples may test 12 lbs. to another person, and 8 lbs to still a third person. Yet, McIntosh apples truly testing 12 lbs. of pressure have grossly different potential than ones truly testing 8 lbs. If we are going to use firmness as a meaningful guide to apple quality, we all need to re-examine our testing procedures, and do our utmost to standardize them so that our determinations can become more comparable and our interpretation can be more accurate. Here is a problem that can be overcome with good judgement and little or no expense.

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APPLE TREES ON M.26

William J. Lord
Department of Plant and Soil Sciences

Observations this past year show that the vigor of non-bearing trees on M.26 is variable. (Assuming that all the trees are on M.26.) Trees of the same variety , within a block, may be extremely variable in some orchards with some weak and/or difficult to train. This may mean that trees of M.26 react more to unfavorable growing conditions than those on more vigorous size-control rootstocks.

Roger Young, Kearneysville, West Virginia, reported at the 19th Conference of the International Dwarf Fruit Tree Association on March, 1976, that leaning in a test orchard of the trunk or leader (central leader not being upright) of trees on M.26 was a problem especially with 'Stayman', 'Rome','Winesap', and 'Jonathan' cultivars. Non-bearing 'Red Prince Delicious' planted at our Research Center in 1971 or 1972 have developed leaning. The leaning appears to be caused by something other than poor anchorage. In other orchards, poor anchorage appears to be a problem. Trees that were provided either no support or a short stake for support at planting, now require an 8-foot stake for support in some instances. This was not due to early, heavy cropping. Whether or not the stakes can be temporary or needed permanently is not known.

We need a free-standing tree smaller than that produced by M.7. But I'm beginning to wonder if M.26 is the answer for some orchards. Approximately 8% of the trees in Massachusetts on size-control rootstocks are on M.26. Thus, in several years we can better evaluate M.26.

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MITE PREDATOR STUDIES IN MASSACHUSETTS APPLE ORCHARDS IN 1976

Robert G. Hislop and Ronald J. Prokopy
Department of Entomology

In several 1976 issues of Fruit Notes, we described certain techniques developed by researchers in other apple growing regions of North America to reduce spraying for apple insects and mites without sacrificing fruit quality or quantity. These accomplishments were made possible by careful monitoring of insect populations in the orchard, and selection of orchard sprays to which mite predators were resistant. In this issue of Fruit Notes, we will describe work we have been doing this past year toward a similar goal of reduced spraying for mites in Massachusetts apple orchards.

Our study is long term and its objectives twofold: (1) to determine which species of mite predators occur naturally on wild or unsprayed abandoned apple trees, and (2) to determine if any of these predators occur or thrive in commercial orchards. This should provide some indication as to which types of spray programs are conducive to the buildup of these beneficial predators in our orchards.

We knew at the beginning of our study that *Amblyseius fallacis*, a predatory mite known to play a key role in the suppression of red and two spotted spider mites in some commercial apple orchards in the midwest and southeast, also occurs in some northeastern states. Several of its habits are well known, such as remaining in the ground cover until July, when it moves up into the tree canopy to feed on plant feeding mites. Here it is exposed to the constant onslaught of cover sprays directed against principal insect pests.

Because of this exposure, A. fallacis eventually developed resistance to certain organophosphorous insecticides. Portions of our orchard survey, described below, were undertaken in hopes of discovering this particular predator in Massachusetts orchards.

Last spring, we began intensive tri-weekly sampling of mite populations from March through October in the orchard at the Belchertown Research Center, and in 6 commercial and 3 abandoned orchards in 3 different locations across the state. In the Belchertown orchard, each of the materials Zolone*, Guthion*, Imidan*, and Sevin* were regularly applied by airblast sprayer to each of 3 groups of trees, with 3 groups left unsprayed for comparison. Among the commercial orchards, 3 used one type of spray program, while the other 3 used a different program. In each orchard, samples were taken of the ground cover under the trees, bark, and leaves of 3 'Red Delicious' and 3 'McIntosh' trees. The ground cover and bark were sampled to determine if mite predators, especially A. fallacis, existed in these habitats at different times of the season.

Bark and ground cover samples were placed in funnels under heat lamps which forced mites out of the samples into jars of preservative placed at the bottom. Leaf samples were brushed in a mite brushing machine, the mites landing on glass discs on which they could be readily observed. All mites were counted, including red and two-spotted spider mites, tiny apple rust mites, and predatory mites and insects.

We also sampled the leaves of 20 other commercial orchards from which we had obtained the spray history. This sampling was conducted only once--at the peak of the mite season in August.

Our results to date reveal arboreal mite predators to be widely distributed in Massachusetts apple orchards. However, Stethorus punctum, the black lady beetle important in Pennsylvania apple orchards, and Typhlodromus pyri, the predatory mite important in Western New York, were not found in our survey. The situation in abandoned orchards was quite different from commercial ones. In commercial orchards, fewer kinds of mite predators were found, the predominant species being A. fallacis. This predator was seldom encountered in abandoned orchards. Red and two-spotted mites were virtually absent in abandoned orchards, which is not surprising in view of the high predator populations found there. Growth of these populations was likely aided by high abundance of one of their food sources, the apple rust mite.

In many commercial orchards where the spray program included repeated applications of Zolone* and/or Benlate*-glyodin combination arboreal mite predators were scarce or totally absent. It appears that one or all 3 of these materials may have been toxic or repellent to the predators. In such orchards, the two-spotted spider mit

*Trade name

was the principal mite pest and miticides were applied repeatedly (2-4 applications) for its control. Two-spotted populations first appeared in early June, increasing thereafter until miticides were applied in July and August.

In commercial orchards where the above materials were not used, arboreal mite predators, particularly A. fallacis, were present in numbers sufficient to exert some suppressive effect on the spider mites. In most such orchards, the predominant mite pest was the European red mite. In 2 of the intensively studied orchards, populations of red mite peaked in late June in one orchard and late July in the other. In each case, only one miticide application was needed. A. fallacis (which appears to be only slightly susceptible to the principal miticides used in all sample orchards: Plictran* and Omite*) first appeared in the trees in July and increased thereafter in apparent response to increasing European red mite populations. The miticides undoubtedly eliminated part of A. fallacis' food source but apple rust mites were present in sufficient numbers to provide alternate food. In the third orchard studied intensively, spider mites never reached numbers high enough to cause damage and no miticide was needed.

None of the arboreal mite predators, including A. fallacis, appeared in the bark samples, suggesting wind dispersal as the primary means of their getting into the tree. The ground cover samples are still being analyzed. When completed, this analysis should tell us more about the early season habits of these mite predators.

We are encouraged by the wide distribution of certain arboreal mite predators such as A. fallacis in Massachusetts apple orchards. However, results to date tend to confirm our suspicion that these important predators either cannot survive or are repelled in orchards sprayed with certain insecticides and/or fungicides. This is of immediate economic importance to the grower, and may have serious long-term consequences as well. For example, if spider mites ever become resistant to all available miticides (which is a possibility), orchardists using these materials will almost certainly have little protection against spider mite buildup. In orchards where the buildup of mite predators is not discouraged, it is likely that miticide usage can be reduced in most cases.

During the next two years, we will be continuing our field and laboratory studies so that we may more fully comprehend the potentail of natural enemies, particularly mite predators, in the suppression of red and two-spotted spider mites in our commercial orchards.

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POMOLOGICAL PARAGRAPHS

Selecting the best spacing for the variety, rootstock and soil. We can try, but I believe that one cannot accurately select the best spacing for the variety, rootstock, and soil under our conditions. To do this, one may have to use several rootstocks in the same row because of the variable nature of our soils. Even then, it would be guess work. Personally, if I make an error, I prefer that the spacing be too wide rather than too close. I believe that the average Massachusetts apple grower who stores and grades his own fruit hasn't the time nor money to fight trees too closely spaced for their natural vigor.

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Early heavy cropping. This is not always desirable when trees are planted at wide spacings. Early, heavy cropping may stunt the tree. This has been observed in a row of Cortland on M.26 with the severity of stunting varying considerably within the row. Therefore, we may find that in some instances heading back cuts on the extension growth of the central leader and on shoots of the scaffold (framework) branches is desirable. This procedure will stiffen the central leader and scaffold branches, promote growth, and delay fruiting. An alternate to heading cuts is defruiting.

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Establishment and Management of Compact Apple Trees

William J. Lord and Joseph Costante
University of Massachusetts

Part 3

Purchasing Trees

Quality trees are the foundation of a successful orchard; anything less is a gamble. Thus, the following points are worthy of mention.

1. Plan ahead (a year or two is best), thereby making it possible to plant the trees you want when you want them.
2. Tree quality rather than price should be the major consideration. One-year-old trees, 4 to 6 feet in height and at least 5/8 inches in diameter usually grow faster than lower grades.
3. Insist on 1-year-old branched trees or whips budded 14 to 16 inches above the bottom of the rootstock. Trees budded lower than this may have to be staked.
4. We suggest purchasing from nurseries that dig their trees in the fall and store them.
5. Don't accept second best even if it means waiting a year or more for quality trees on the desired rootstocks and/or of the desired cultivar. The time waiting usually can be well spent on site preparation.
6. When ordering interstem trees be sure to specify a 6 to 7 inch dwarfing stem piece grafted on a 7 to 10 inch long understock. Degree of dwarfing varies with interstem length—the longer the interstem, the greater the dwarfing.

Care of Trees on Arrival From the Nursery

Check the trees to determine if tree count and cultivar/rootstock and size agrees with order and to determine if injury to the trees might have occurred in handling and shipping. Do this where it is cool and the roots will not dry out.

If planting conditions are not suitable, open the bundles of trees and store them in a cool, well-ventiled area and be sure the roots are kept moist, *or* heal them in a shady area, *or* cover the roots with wet soil, peat or sawdust in an open shed. **DO NOT** store trees with apples or where they have been stored. It is possible that residual ethylene in the storage atmosphere might break dormancy of the trees and when planted they may fail to grow properly or even die. Pear trees are especially sensitive to injury.

All photographs in this and subsequent parts by Louis J. Musante.

Time of Planting

Fall planting of apple trees is not recommended for Massachusetts because there is too much risk of winter injury to the trees. The trees should be planted in the spring as soon as the frost is out of the ground and the soil easily worked. Most years, planting can commence in late April, thus the target for receiving trees from the nursery should be April 15. Late planting is a frequent cause of unsatisfactory tree growth.

Planting

The soil should be in a good workable condition at planting. Do not plant in a wet "soggy" soil. The hole for the tree should be large enough to take in the entire root system. It is important to dig the holes the right depth because if dug too deep the tree may settle after planting and the graft union will be below ground. To the contrary, the hole should be deep and wide enough so that the roots will rest on the bottom without having to "pin-them-down" with soil. Plant the trees in good loam soil. When the hole is hand-dug, place the top soil on one side and the subsoil on the other side. This will enable you to place the top soil around the roots when setting the tree. Putting 2 to 3 pounds of high calcium lime on the soil scheduled to be returned to the planting hole may improve the calcium level of the trees for 2 or 3 years. Haul in some rich soil if the soil is not good. A half bushel of good soil with 2 to 3 pounds of high calcium lime mixed with it will help the trees off to a good start.

Planting holes are most frequently dug with tractor mounted augers. A 9-inch auger is suitable for trees on M.9 rootstock. However, a 12-inch auger is needed when the post for supporting the tree is going to be placed in the planting hole. A 2-foot auger or backhoe is best on a poorly prepared soil and for trees on rootstocks other than M.9.

Soaking the tree roots in water for 12 to 18 hours prior to planting is a good practice. During planting, keep the roots moist by covering them with wet burlap or canvas or keep them in water to prevent drying. At planting, the broken roots should be removed and the trees set in the holes so that the largest roots, and if possible, the heaviest branched side is toward the prevailing wind. Plant the tree with a slight slant in the same direction. When planting on dwarfing rootstock, the graft union after tree settling should be 2 inches above ground line. Allow an additional 2 inches at planting for tree settling.

After planting, the soil should be thoroughly tamped around the roots so they will be in contact with wet soil. It is not necessary to water trees unless it is extremely dry prior to and after planting.

Opinions differ concerning the planting depth of 3-piece interstem trees. Some suggest that these trees should be planted with the lower graft union 2 inches above ground. Other individuals suggest deeper planting with the top of the interstem 2 inches above the ground. We have tried both methods and have observed that when the rootstock portion is less than 7 inches in length, shallow rooting can be expected when the trees are planted with the lower graft union 2 inches above the ground. The trees may be less vigorous than those planted deeper (the top of the interstem 2 inches above the ground) and frequently require support.

Four-piece trees can be planted 12 inches or more in depth because the trees of this type may average 20 inches in length between the scion union and the top of the roots. However, the trees should not be planted too deeply to prevent scion rooting.

Placement of sand or gravel around the tree base after planting will help stabilize the tree. It also helps to keep the area dry and thus reduces the danger of collar rot. Do not remove soil from around the trunk, place the gravel or sand on top of the soil. (The trees will not scion root in these materials.) When the wind causes the trunk to sway, the gravel will trickle down and around the trunk, thus helping to stabilize the tree. Also, this will prevent the formation of an open area around the trunk where water will collect and contribute to crown disorders.

Supporting Trees

Tree support is now accepted as a standard procedure in apple growing. The need for tree support is dependent on rootstock, cultivar, soil type, and site. For example, all trees on M.9 need support. Delicious on M.7 need support whereas McIntosh on this rootstock is generally well-anchored on deep, well-drained soils. On windy sites, it may be advantageous to provide at least temporary support for all trees on M.26 and M.7 rootstocks. Support methods include: (a) temporary basal support which is practiced so that the tree can establish a strong lateral root system; (b) permanent support by posts; and (c) permanent support by a trellis.

Temporary support. This can be provided with a 3-foot long hardwood stake driven 2 feet into the ground next to the trunk at planting time. Plastic ties, nylon ties or wire can be used to fasten the tree to the post. When wire is used, the wire around the tree should be covered by a section of inner tube, a section of plastic hose, or cloth to prevent tree injury. Temporary support may be necessary for the first 5 or 6 growing seasons.

Permanent post. Pentachlorophenol-treated (penta-treated) or creosote-treated posts are used for trees on M.9 rootstocks. These should be allowed to weather for a year before use because of possible injury to the trees by the creosote or penta. The posts should be 8 to 8½ feet in length, at least 2 to 2½ inches in diameter at the base, and set 1½ to 2 feet in the ground (Fig. 4). Soon after planting,

Fig. 4. A planting of trees on M.9 rootstocks after 3 growing seasons. The trees are individually supported by an 8-foot post set 2 feet in the ground.

Fig. 5. In this orchard, the end posts are stabilized with a wire extending from the posts to an anchor bolt.

Fig. 6. End post of trellis using monofilament. A hole was bored in the end post for the insertion of the "feed through" device for the monofilament. The "feed through" device secures the monofilament and eliminates the need of stapling the monofilament.

plastic or nylon ties should be looped in a figure 8 around the tree and post at about 2-foot height to provide tree support. In older plantings, 3 to 5 of these ties are used per post for tree support and to keep the leaders vertical.

Trellis. Training apple trees to a trellis is quite similar to training grape vines to the Kniffin system. The trees are supported on trellises of 8 to 9-foot long preservative-treated posts set 2 to 2½ feet in the ground and perhaps spaced 24 feet apart in the row. The end posts are stabilized with a wire extending from about the height of the top wire of the trellis to an anchor bolt (Fig. 5) or to a "dead-man" buried 3½ to 4 feet deep and 4 to 5 feet from the post. No. 9 galvanized wires or plastic wires stapled to the posts or passed through the interior of the posts complete the trellis (Fig. 6). The bottom wire generally is 2 feet above the ground, while the others are spaced 12 to 18 inches apart above it depending upon the height of the posts (Fig. 7).

Care of Trees the First Year

Heading the newly planted tree. It is difficult to find agreement on this very important phase of tree training. No. 1 trees of non-spur types (standard types) frequently are headed at 30 to 36 inches or not at all if planted early. Spur-type trees which don't branch as readily as standard types are generally headed at 28 to 30 inches. Heading spur-type trees rather severely should promote branch development which might otherwise be inadequate in number. (The lower the tree is headed, the greater the number and length of the branches.) Regardless of heading height, both spur and standard types (non-spur) may still fail to produce a sufficient number of branches the first year in the orchard. As long as leaf size and color are good, the trees should develop good lateral branching the second season.

When newly planted trees are not headed severely enough, they usually develop branches that are too high. The next pruning season, the trees may have to be headed again to induce branching between the height of 20 to 30 inches above ground level (the desired height of the lower permanent branches). Thus a year is lost.

Pruning in the planting season. As a rule, *all desirable branches on the tree at planting* should be left unpruned. An exception to the rule would be when a tree has one large branch. This should be removed because it may cause one-sided branch development on the tree by inhibiting the growth of

Fig. 7. Tree being trained on a trellis. In this orchard, the posts are set 22 feet apart. The bottom wire is 2 feet from the ground with 2 wires above spaced 22 to 24 inches apart. The depression at the base of the trees should be filled in with soil, sand, or gravel to prevent accumulation of water.

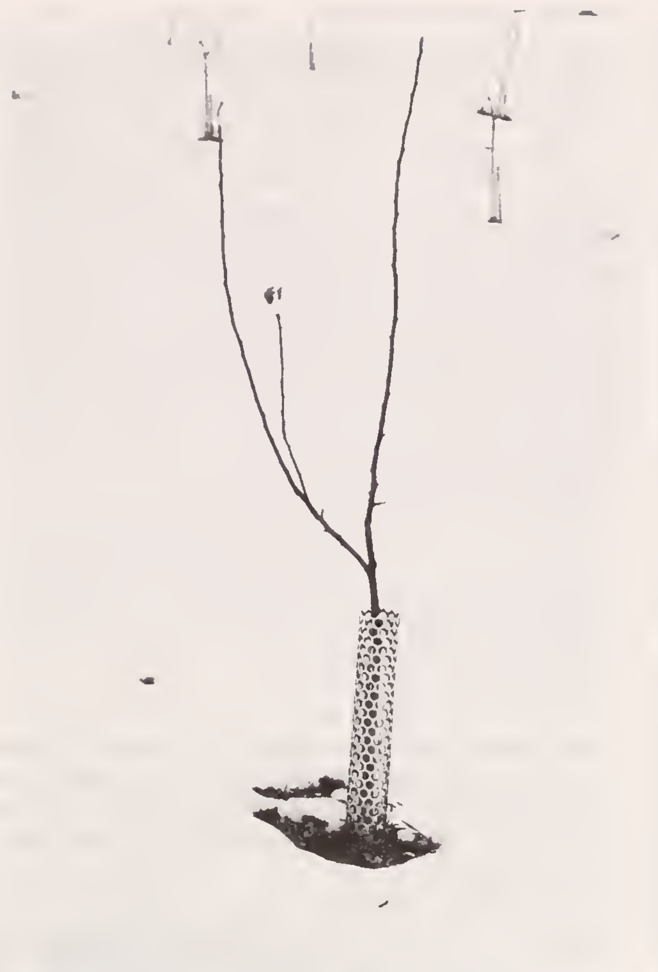

Fig. 8. McIntosh on M.26 after one growing season. This tree had one strong branch at planting that should have been removed. It now competes with the leader of the tree. It should be removed and the leader headed at 28 to 30 inches to stimulate branch development. Fig. 9 shows the same tree after pruning.

Fig. 9. The same tree as in Fig. 8 after pruning.

other branches or it may compete with the leader (Figs. 8 and 9).

Pest control. An essential for optimum growth in compact orchards is adequate pest control. Too often, young plantings are sprayed inadequately because of the practice of applying what is left in the tank after spraying bearing orchards. This is an unwise practice considering the high cost of establishing orchards and the need of early returns on the investment. Growers with substantial acreage of young plantings may find smaller and less expensive spray equipment than commonly used in older trees a good investment.

The most common pest problems in young apple orchards in Massachusetts are scab, sucking and chewing insects, and tree borers. Generally, for the first 3 years, 7 to 10 sprays annually are required to control these pests. The entire tree should be sprayed including the trunk. It is well to remember this when selecting mouse guards because some types inhibit good spray coverage as well as sunlight and air movement.

Young plantings can be sprayed on an alternate row basis (spraying every second or third row and then reversing the order of travel the next spray). The first growing season of the planting, the dosage rate per 100 gallons can be 25% of that recommended for bearing trees. The dosage rate should be increased annually and by the fourth growing season, a full dosage rate and spray schedule is recommended.

For information concerning pest control, contact your County Extension Office. Pest control charts are revised annually.

Fertilization. Lime but not fertilizer or manures can be put in the planting hole with the roots. Lime can be added by throwing 2 to 3 pounds of high calcium (Ca) lime on the soil destined to be returned to the planting hole. A nitrogen (N) fertilizer, a complete fertilizer, or one containing N, potassium (K_2O) and minor elements, should be applied after a rain has firmed the soil around the roots of the newly planted tree. Fertilize at the rate of 1/4 to 1/3 pound of ammonium nitrate (33% N) or its equivalent by spreading lightly in a wide circle around the tree (8 to 12 inches from the tree trunk). Calcium nitrate is gradually replacing ammonium nitrate as the common source of nitrogenous fertilizer because of low Ca levels in Massachusetts apple orchards.

Chemical weed control. Paraquat can be applied anytime during the growing season under newly planted trees and dichlobenil is safely applied in the late fall or early winter at the end of the growing season. Apply paraquat at the rate of 1 quart plus spreader per acre in mid-May and again in mid-July *taking necessary precaution against hitting the tree with the direct spray or spray drift.* Drift can be a major problem when applying herbicide sprays. To reduce this problem, you can use a foaming agent (adjuvant) with the spray, avoid spraying when the wind is greater than 5 miles per hour, avoid high pressures, and use nozzles that produce coarse sprays with a minimum of fine droplets. A flooding flat nozzle is particularly good for drift control and is designed to operate at 15 to 20 psi.

Dichlobenil (Casoron*) should be applied at the rate of 100 to 150 pounds of 4% granular per acre. Its use is described elsewhere in this publication.

Guards for mouse protection. Encirclement of tree bases with hardware cloth guards to prevent mouse injury has been a standard practice for many years. Hardware cloth must have 3 or 4 wires to the inch to be mouse-proof. The guards should be 6 inches in diameter and 18 inches in height. They should be set in the ground on top of the tree's root crown. Hardware cloth is expensive and has to be cut to the desired dimensions.

Plastic-lined mouse guards can be purchased precut from a local distributor. They are cut to form a circle 3 inches in diameter and 18 inches in height or a 6 inch circle with 10 inch height.

Plastic mouse guards have become popular the last several years because they are more economical than hardware cloth or plastic-lined mouse guards. However, they shelter insects and should be examined annually for constriction of trunk growth.

Pruning

At this point, it is well to recognize the fact that pruning procedures cannot be fully and accurately described. Furthermore, no two trees, which appear similar at planting time, grow alike even when subjected to similar pruning and training procedures. Cultivars differ in growth characteristics and their response to pruning. Lastly, rootstocks, soil and growing conditions influence tree vigor and pruning and training requirements of trees. At best, all we can do is discuss the basic principles for training and pruning and you will have to learn the finer details by experience.

We suggest training and pruning trees to obtain and maintain a conical shape (Christmas tree shape) because this form allows better penetration of sunlight into the trees and light distribution along the sides of trees. A conical tree shape is only possible with a central leader tree and only possible by removing and/or shortening the strong branches in the upper part of the tree and retaining the shorter, weaker branches. Presently, many trees in our orchards have large branches in the upper third of the trees which inhibit light penetration into the lower section of the trees.

In the past, the main objective of pruning an apple tree was to produce a large percentage of Extra Fancy apples at lower costs. This is still the prime objective but many growers are now attempting to obtain the benefits of early, heavy production by closer spacings of compact trees. As a result, the problem has arisen of trying to contain the trees within their allotted spacings especially when the cultivar-rootstock-soil has not been properly matched.

Training and pruning of trees becomes increasingly important as planting density increases. Growers lacking time to do detailed pruning and training, as being suggested for medium and high density plantings, would do well to establish only low density plantings. Such a planting system is relatively easy to manage and not so sensitive to variations in soil conditions, errors in pruning, and other management procedures as are medium and high density plantings.[7]

Season to prune. Commercial growers commence pruning some types of fruit trees in January, but home orchardists, because of limited tree numbers, can wait until the arrival of milder weather. Pruning may be done through the blossoming period but late March or April is preferred. Water sprouts on apple trees should be removed in mid-summer and dead or diseased branches can be removed whenever they are present.

Pruning systems. It appears logical to suggest the following pruning systems, based on orchard density, for Massachusetts orchards.

1. Low density orchards: minimal containment of tree spread and height.
2. Low density orchards: containment of tree height.
3. Medium density orchards: containment of tree spread and height.
4. High density orchards: staked or trellised.

Pruning low-density orchards with minimal containment of tree spread and height. This system involves pruning techniques used in the past and described in countless pruning bulletins. The tree has a central leader and pruning involves: (1) the selection of desirable scaffold limbs; (2) the removal of undesirable limbs to eliminate whorls of branches and thus permitting only one branch to develop at a given level as shown in Fig. 10A; (3) maintaining the dominance of the leader by suppressing or removal of competing leaders; (4) restricting too rapid development of certain scaffold limbs by heading-back to an outward growing horizontal shoot or branch; and (5) on bearing trees, the elimination

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[7] Growers may be able to increase production per man hour and per acre without the problems encountered with vigorous cultivars on semi-dwarf rootstocks at close spacings if M.26 and interstem trees prove reliable under our conditions.

of those tree parts which tend to bear fruit of poor size and color.

Limb positioning (described elsewhere in this publication) is a very important practice on cultivars, such as Red Delicious, which possess the inherent tendency to develop narrow crotches.

The "novice" fruit grower should purchase (fee 25 cents) Leaflet No. 290 entitled "Pruning Fruit Trees in the Home Orchard" from the Bulletin Center, Stockbridge Hall, University of Massachusetts, Amherst. This leaflet contains illustrations, photographs, and discussions which will increase the reader's understanding of basic pruning techniques.

Pruning low density orchards with containment of tree height. Many growers would like to restrict tree height to about 12 feet even in low density orchards. The central leader and branch development on the central leader in the upper portion of the tree requires considerable attention in order to accomplish this goal. The following training and pruning procedures for restriction of tree height is *suggested for trial.* These procedures involve the development of branches in layers on the central leader and heading the central leader annually (Fig. 10B) *but not heading* the past season's growth on scaffold limbs as shown in this figure. *Tree height can also be restricted by using pruning procedures described under the previous heading and by annual heading of the central leader as described below.*

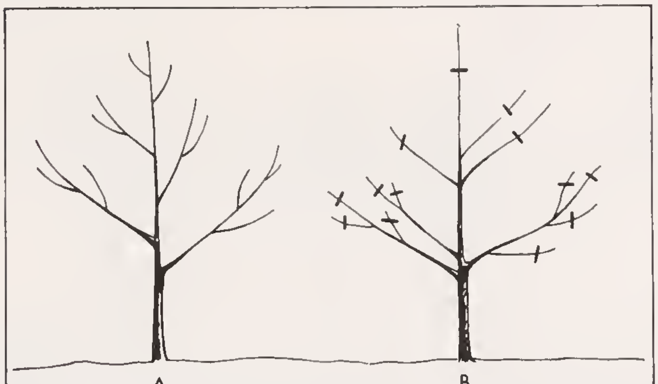

Fig. 10A. Two year old tree being pruned by standard pruning procedures. The lowest limb should be 18 to 20 inches from the ground, all others spaced 4 to 8 inches apart vertically on the trunk and each one about 90° around the trunk from the one below it.

Fig. 10B. Two year old tree being pruned as suggested by the USDA. It has 2 layers of limbs. The leader will be headed annually [heavy marks (—) indicate heading cuts]. The one year old wood on the branches is headed annually until branches on which this wood is borne start to fruit.

First dormant season.

1. Select central leader and remove branches competing with it (Figs 11 and 12). (This could have been done in June of the first growing season.) See Fig. 13.
2. Head the central leader by removing ¼ to ½ of its past season's growth (Fig. 12).
   a. When heading[8] leader of a weak tree or one with no lateral branching, be aware that the first level of branches should be developed within the vertical spacing of approximately 18 to 30 inches from ground level.
   b. If the leader and lateral branch development is poor, head it regardless, developing both the first and possibly some of the second level of branches the following year.
3. Select lateral branches (3 to 5 if possible), well-spaced vertically around the trunk for the first level of permanent branches at the base of the leader. (These branches could have been positioned with spring-type clothespins during the first growing season.) Fig. 14 shows the use of clothespins to position branches.
   a. If only one branch has developed or the branches are too high or low, remove them and start over.
   b. If branches have developed on only one side, do the same.
4. Branches lower than 18 to 20 inches from the ground should be removed.

Second dormant season.

1. A well-grown tree will have branches on 2 and 3 year old wood. However, most trees will not make sufficient growth to make possible the selection of a second level of branches 20 to 24 inches above the lower level of branches at the base of the central leader.
2. Remove all shoots competing with the previous summer's extension growth of the central leader. (This could have been done in June of the previous growing season. Also, it may have been possible to retain some of these competing shoots if they had been positioned with spring-type clothespins during the previous growing season.)
3. Head the central leader by removing ¼ to ½ of its past season's growth depending on tree vigor and the presence or absence of lateral branches on the previous summer's extension growth of the central leader.
4. Remove all branches along the central leader for a distance of 20 to 24 inches between the uppermost branch of the first layer of permanent branches and the top of the leader. (This could have been done during the

[8]Heading—usually refers to cuts made into current season's shoots or 1-year-old shoots. Only part of this wood is removed, leaving part of the same age wood on the tree.

Fig. 11. Jerseymac on MM 106 after one growing season. The tree developed wide-angled lateral branches. It is necessary to select one of the 3 upright branches as the central leader and head the central leader. Fig. 12 shows the same tree after pruning.

Fig. 12. The same tree as in Fig. 11 after pruning.

previous growing season.)

5. A few trees will have lateral branches on the previous summer's extension growth of the central leader. On these trees, it will be possible to select laterals for the second layer of branches. Select 3 or 4 lateral branches for this second layer allowing several inches vertical spacing between branches. Remove excess branches.
6. Continue the selection of the first level of scaffold branches at the base of the leader. Three to five branches are needed. These should be well-spaced vertically around the trunk and the lowest limb 18 to 20 inches from the ground.
7. Position the branches at the first level to an angle of 45° with wire or wood spreaders described elsewhere in this publication. Those that developed the previous growing season could have been positioned at that time with spring-type clothespins.
8. Remove upright shoots (watersprouts) that may have developed on the branches at the first level, branches growing towards the center of the tree, downward, or competing with the selected, permanent scaffold branches.
9. Heading of branches may be required on some cultivars to stiffen them and on spur-types to force lateral branching.

Third dormant season

1. A well-grown tree now has 2 distinct layers of branches (the first at the base of the central leader and the second 20 to 24 inches above the first layer) and possibly the beginning of a third layer on the previous season's extension growth of the central leader.
2. The previous summer's extension growth of the central leader is pruned and competing shoots removed as de-

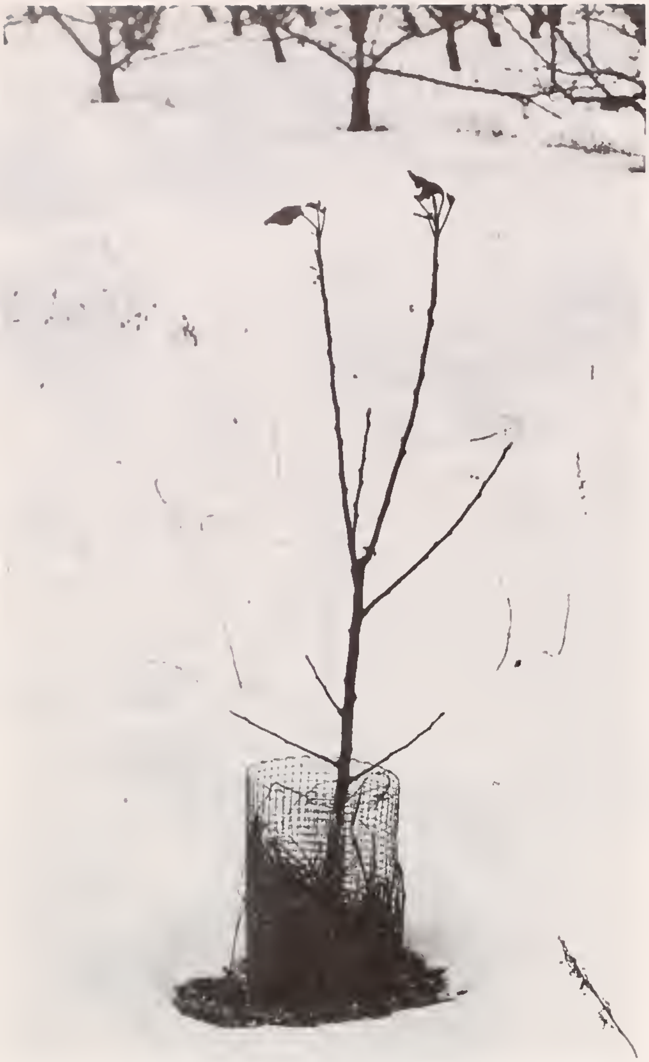

Fig. 13. A hormone is synthesized in the growing points of the branches in the upper parts of the tree and translocated downward. (The greater the amount of hormone, the wider the branch angles.) Therefore, crotch angles are relatively narrow in the branches highest on the trunk where little or no hormone reaches them from growing point above, and they are progressively wider toward the base of the tree as shown in this figure. Furthermore, the smaller the supply of hormone, the greater the growth. This is why the greatest growth was made by the uppermost branches of the tree shown in this figure.

scribed for the second dormant season.

3. Select 3 or 4 lateral branches, if they are present, on the previous season's extension growth of the central leader for the third level of branches. These should be 18 to 20 inches above the second level of branches.
4. Continue the selection of the second level of scaffold branches (20 to 24 inches above the first level). Three or four are needed and should be well-spaced vertically (3 to 4 inch spacing) and the branches not directly above one another.
5. Position the branches at the second level to an angle of 45°.
6. Prune the scaffold branches in the first layer at the base of the leader as described for the second dormant season.

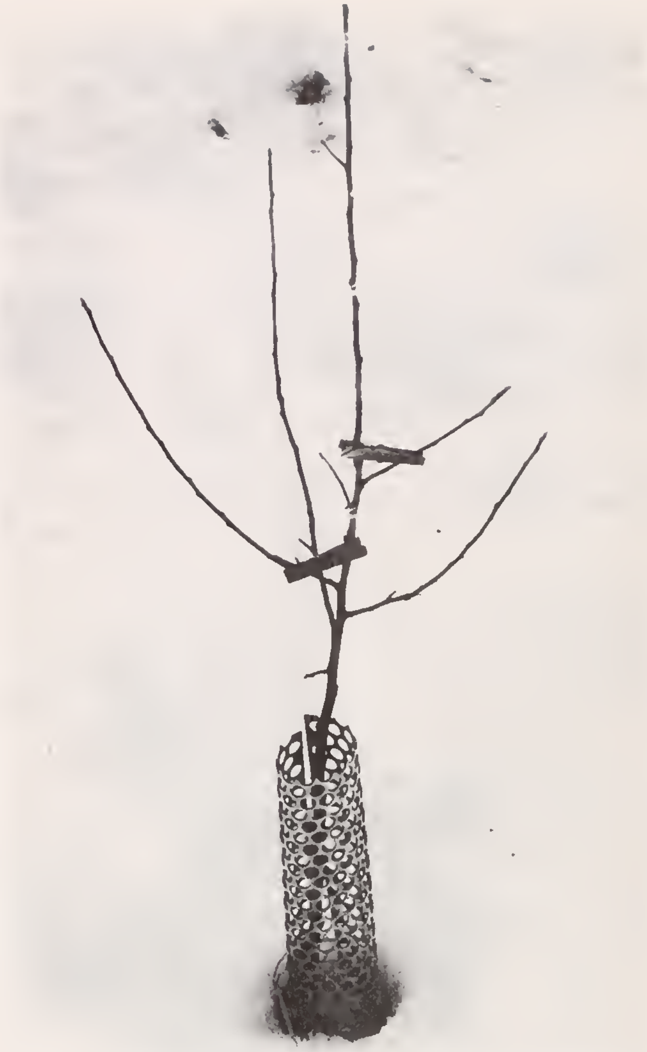

Fig. 14. Spring-type clothespins used on lateral shoots the first growing season to position branches. The clothespins could have been removed after 2 or 3 weeks. Note the plastic-lined mouse guard. The gap at the bottom of the guard makes it ineffective for mouse protection.

Fourth dormant season.

1. At this time, scaffold branches should be well distributed along the central leader in layers. There should be 3 distinct layers on well-grown trees and the start of a fourth layer, depending on how well the tree has grown.
2. The one-year-old and two-year-old sections of the

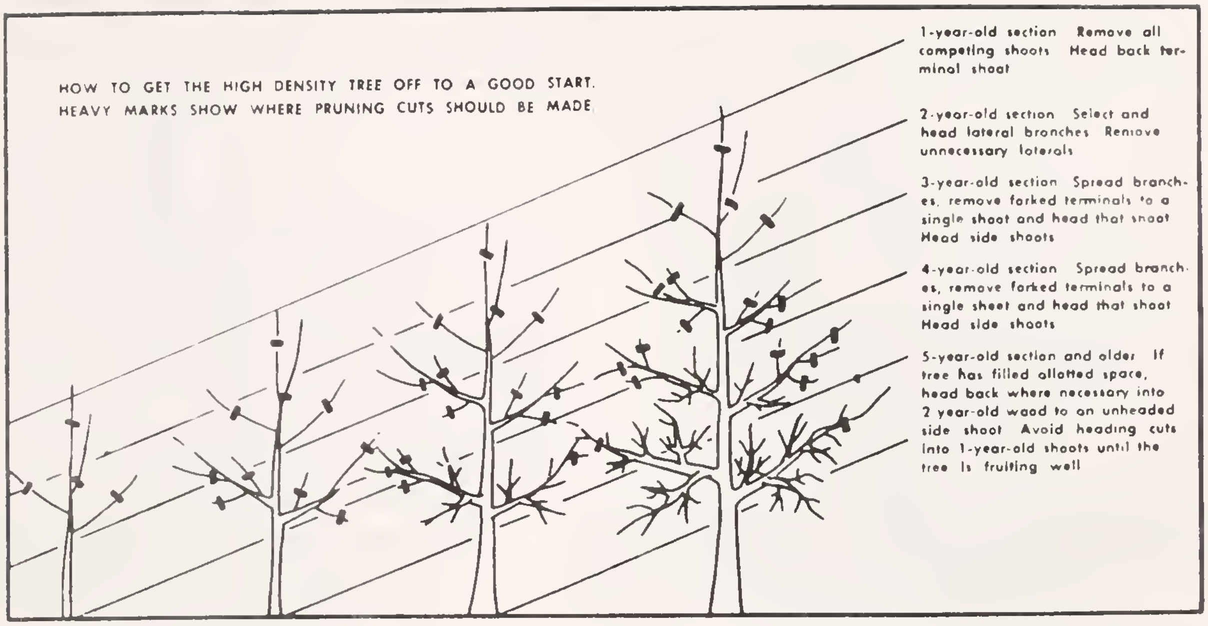

Fig. 15. A diagram of the "constructive training" program suggested by Dr. D.R. Heinicke in USDA *Agriculture Handbook No. 458* entitled "High Density Apple Orchards—Planning, Training and Pruning." (Reproduced with permission of the author.)

central leader should be pruned as in the third dormant season—heading the extension growth, removal of competing lateral shoots, selection of branches for the third level, and positioning of branches in the third level.

3. The framework of the 2 lower levels of branches has been established. Remove only water sprouts and those branches which are growing toward the center of the tree, or are competing with permanent scaffold branches. *Excessive pruning invigorates growth and delays formation of fruit buds.*

Care beyond the fourth year.

1. Prune to maintain the conical shape with short, weak branches in top of the tree.
2. Head the central leader annually. If it gets too vigorous, cutting into 2-year-old or older wood may be necessary. The central leader above the cropping area should not carry too many branches.
3. Try to develop new branches in the tree instead of attempting to invigorate old wood.
   a. Water sprouts that are growing in the direction of a vacant area can be kept to fill that section with bearing wood or as replacements for older bearing branches. Positioning of these water sprouts would be beneficial in many instances.
   b. An occasional new shoot, growing at an angle from a branch, can be retained to provide new bearing wood for the future.
4. Cut all dead and diseased wood, all branches that have a tendency to grow inward toward the tree's center, and all water sprouts that are growing straight up, whether in the center of the tree or from the upper surface of side branches.
5. Drooping shaded wood that has become weak and unproductive should be removed.
6. Where two branches are growing so close together that one shades the other, the less desirable branch should be removed.
7. All suckers at the base of the tree should be removed.

Pruning medium density orchards. A training and pruning system for medium density orchards is described in *Agriculture Handbook No. 458* published by the USDA.[9] We have no experience with this system in Massachusetts but since there is grower interest in it we have attempted to describe it below. The training and pruning procedures suggested in *Agriculture Handbook No. 458* (See Fig. 15) *may be most suitable for spur-type trees which branch less readily than standard types.*

Planting time.

1. Head trees at about 28 to 30 inches.

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[9]*Agriculture Handbook No. 458* published in 1975 by the USDA and entitled "High Density Apple Orchards—Planning, Training and Pruning." You can purchase this publication for 65 cents a copy from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.

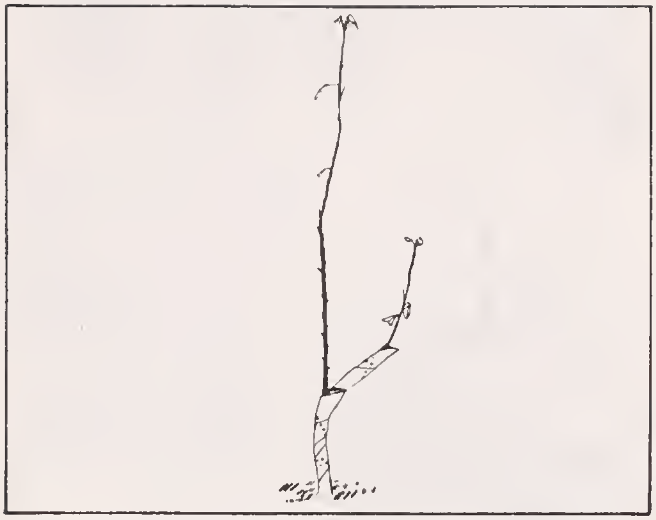

Fig. 16. Mac Spur on M.26 after 1 growing season. Since only one branch developed at a low level (less than 18 inches from ground), it should be removed and the tree headed again at 30 inches.

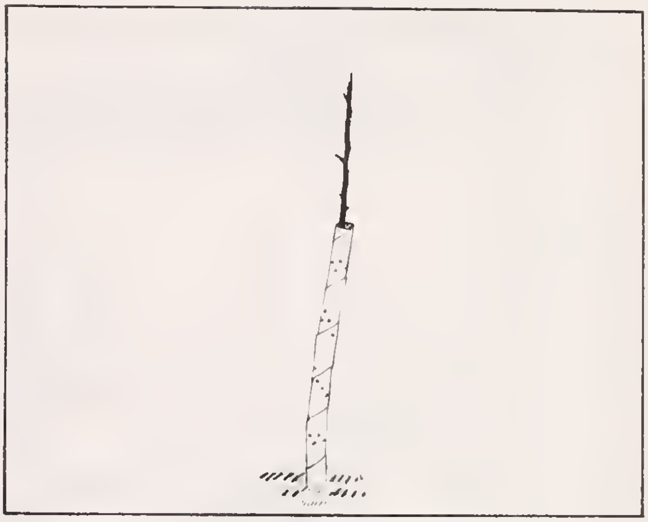

Fig. 17. Same tree as in Fig. 16 after pruning. For those with "courage" trunk renewal is a method of getting weak trees to grow properly. This involves cutting back the tree to a few buds to develop a new trunk.

First growing season.

1. When shoots average 3 to 6 inches in length:
   a. Select central leader plus 3 to 5 potential branches and remove all other shoots.
   b. Remove shoot growth lower than 18 inches from ground.

First dormant season.

1. Tree is now composed of new terminal shoot growth (one-year-old section of tree) and the original whip with lateral shoots (two-year-old section of tree).
2. Select the central leader and remove all competing shoots.
3. Head the central leader by removing ¼ to ½ of its past season's growth. Head it to induce branching that will be 18 to 24 inches above the branches at the base of the leader.
   a. If leader development is poor, head it regardless so that a strong leader will develop which can be headed at an adequate height the following year.
4. Select 3 to 5 lateral branches, well-spaced vertically around the trunk for the first level of permanent branches at the base of the leader on the two-year-old section of the tree.
   a. If only one branch has developed or the branches are too high or low, remove them and start over (Figs. 16 and 17).
   b. If branches have developed on only one side of the tree, do the same.
5. Head each branch by removing ¼ of the past season's growth. This will keep the branches vegetative, stiffened and encourage development of lateral side shoots (Fig. 18).

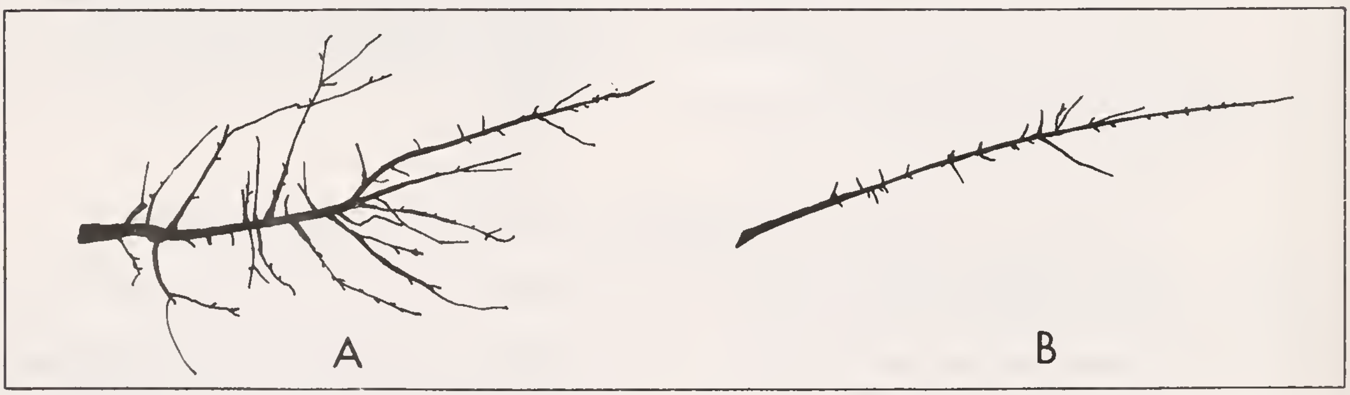

Fig. 18. Heading cuts as advocated by the USDA induces lateral branching as illustrated in (A). Branches of this type have greater fruiting potential than the unheaded branch shown in (B). Heading cuts to induce lateral branching may not be essential on non-spur type trees. (Redrawn with the permission of Don R. Heinicke.)

Second growing season.

1. When current season's growth is 3 to 6 inches long, remove those shoots competing with the terminal branch extension and the central leader.

Second dormant season.

1. Tree now composed of 1, 2 and 3-year-old sections with one or two levels of branches (Fig. 10B).
2. The 1 and 2-year-old sections are pruned the same as the first dormant season. This consists of removing shoots competing with extension growth of the leader and selecting 3 to 5 lateral shoots to form the second level of branches on the central leader. The second level should be 18 to 24 inches above the first level at the base of the leader. Head the leader and lateral shoots (branches) by removing ½ and ¼ of their past season's growth, respectively.
3. In the 3-year-old section:
   a. Position branches to open areas and spread to a 45° angle before pruning.
   b. Thin excess shoot growth and maintain 3 to 5 lateral branches in the lower or first level.
   c. Prune the lateral branches as if each were a central leader tree.
      1. Single out terminal shoot and remove competing shoots.
      2. Head terminal shoot by removing ¼ of its current season's growth.
      3. Thin[10] vigorous shoots growing upright on the branch.
      4. Head side shoots of the branch by removing ¼ or less of the current season's growth. This won't be necessary with some cultivars.

Third growing season.

1. Remove shoots the same as in the second growing season. In addition, remove all vigorous upright shoots developing on lateral branches.

Third dormant season.

1. The tree now is composed of 1, 2, 3, and 4-year-old sections with 2 or 3 levels of branches.
2. The 1, 2, and 3-year-old sections are handled as described before. Be sure to allow adequate space between limbs developing one above the other.
3. Some of the headed shoots on the 3-year-old section will have lateral shoots develop below the point of heading. If too many develop, remove some (thinning cuts), keeping those more horizontally positioned.
4. Do as little pruning as possible in the 3-year-old section of the tree. *The leader is the only terminal requiring heading each year.*
5. In the 4-year-old section, reduce the number of heading cuts:
   a. Remove all shoots competing with terminal growth.
   b. With regard to shoots developing on the branches: remove over-vigorous ones, head lightly some with moderate vigor, and leave the rest of moderate and weak vigor shoots unheaded.
   c. Where side shoots were headed the year before, cut (thin) into 2-year-old wood to a weak side shoot or a bud, removing the vigorous terminal growth.
6. Fruiting should be confined to the 4-year-old section.

Fourth growing season.

1. Remove fruit from central leader and ends of branches to maintain tree form (may be necessary in third season for some cultivars). Follow procedures practiced in the third growing season.

Fourth dormant season.

1. Tree is now composed of 1, 2, 3, 4, and 5-year-old sections with two to four levels of branches depending upon how well the tree has grown.
2. Encourage fruiting rather than growth, so, do as little pruning as possible.
3. If possible, avoid heading into 1-year-old wood in sections where fruiting is to be encouraged.
4. In 5-year-old section:
   a. If tree has filled allotted space, head back where necessary into 2-year-old wood to an unheaded side branch.
   b. Avoid heading cuts into 1-year-old wood *until* the tree is fruiting well.

Care beyond the fourth year.

1. Keep a vegetative terminal shoot on the central leader. It may be necessary to cut back into the older wood to renew the terminal shoot.
2. Make mainly thinning cuts by removing an entire branch or cutting back into older wood to a side shoot (1-year-old wood) or branch.
3. Follow procedures 4 to 9 as outlined in section entitled "care beyond the fourth year" for low density orchard with containment of tree height.
4. Cultivars, such as Cortland and Golden Delicious with flexible wood, often need to be headed back to

[10]Thinning refers to the removal of branches in a portion of the tree or throughout the tree to reduce competition between limbs and permit greater light and spray penetration.

a more horizontally growing branch near the trunk. Branches of Cortland tend to droop and this cultivar has a tendency to lose its dominant central leader. Thus, particular attention must be given to keeping the leader dominant. McIntosh and Jerseymac should present no serious problem if well trained during the first 4 years. Cultivars, like Delicious, Early McIntosh, and Macoun, need limb positioning because they are inclined to develop strong upright limbs.

Pruning high density orchards with trees staked. Trees on M.9 are frequently trained as slender spindles in Europe and in western New York State. Tree shape is conical having a permanent frame of branches at the base of the leader, and, above this frame, short fruiting branches arranged around a vertical leader which is supported by a post. The size of the permanent frame of branches depends on the planting distance, being larger the greater the planting distance.

High tree numbers per acre using M.9 as the rootstock is only possible with weak (small) frames. Therefore, pruning is minimized in the early life of the tree to encourage early cropping. On bearing trees, vigorous branches are completely removed to maintain low vigor on the trees. Thus, the combination of M.9 rootstock, minimum pruning, early bearing, and the removal of vigorous branches all contribute to weak growth and permits close tree spacings.

The following procedures are suggested for training trees as slender-spindles and are for trial only. Undoubtedly, experience will prove us wrong on some procedures.

Planting time.

Head McIntosh trees and other vigorous varieties at 36 inches—a weak growing variety should be headed at 30-32 inches. Remove all branches lower than 16 inches from the ground. Other branches are best left unpruned except if they are badly placed, for instance all are on one side of the stem or where there is only a single vigorous branch. When all the branches are on one side of the stem they should be thinned out. If there is only a single, vigorous branch, it should be removed to avoid lopsided development of the tree.

First growing season.

When the extension shoots at the top of the tree are 6 to 8 inches long, remove the upper-most extension shoots (generally 2) and leave a weak upright growing lateral for the leader. Spread branches with spring-type clothespins.

First dormant season.

1. In developing the slender-spindle, the goal should always be to weaken the growth in the top of the tree and encourage the production of fruiting branches. Thus, remove the strong vertical leader and use a weaker competitor lateral as the new leader if not done the first summer. The branch selected is not necessarily the first one below the leader, especially if the first lateral branch is growing very strongly. Similarly, if vigor in the lower part of the tree is weak, it is best to cut back to a lower upright-growing lateral to stimulate growth of the laterals for the lower frame. When there is no suitable lateral to serve as a replacement leader, it will be necessary to retain the central leader. It should be pruned back only if the overall tree is weak. Any competing lateral immediately beneath the central leader should be spread or removed.
2. If desirable branches fail to develop 24 to 36 inches above the ground, reduce the height of the leader by 10 to 12 inches. Cut at a vertical 1-year-old shoot suitable as a new leader. This is necessary to encourage formation of strong lower branches.
3. Four or five strong wide-angled branches are needed in the lower 1/3 to 1/2 of the tree. However, it is better to have too many than too few. The extra ones can be removed later.
4. Branches lower than 24 inches should be removed.

Second dormant season.

1. Again remove the strong vertical leader and use a weaker competitor as the new leader. If the leader is too vigorous, cut back to a vertical 2-year-old branch (Figs. 19 and 20). *The procedures of removing the strong leader will give a zig-zag growth pattern to the central leader and reduce its vigor.*
2. When limb positioning is necessary, perform this procedure at this time.

Third dormant season.

1. Repeat the procedure followed the second dormant season.
2. Remove, don't head back, vigorous branches in the upper part of the tree. This is necessary for the maintenance of a conical-shaped tree. Therefore, the branches in the upper 1/2 of the tree must be shorter and weaker than the permanent branches at the base of the leader. Secondly, heading-back scaffold branches, rather than their complete removal, will stimulate undesirable lateral and vertical growth.
3. Limb positioning is best avoided by retaining only the weakest shoots toward the top of the tree. All pruning should be directed toward reducing the vigor in the upper part of the tree and avoiding heavy growth.[11]

Fourth dormant season.

1. The top of the tree should be cut back to a 2 or more year old side branch and not, as in previous years, to

[11] Summer pruning (after growth stops) is the preferred time to make thinning cuts because less stimulation of growth follows pruning at this time. However, avoid all unnecessary pruning until the tree is in heavy production.

Fig. 19. McIntosh on M.9 after 3 growing seasons in the orchard. The central leader should be headed to a competitive lateral. Repeated replacement of the central leader by a weaker competitive lateral should weaken the growth in the upper part of the tree. Fig. 20 shows the same tree after pruning.

Fig. 20. The same tree as in Fig. 19 after pruning.

a 1-year-old shoot. Cutting back to a 1-year-old shoot should be done only when the shoot is weak and wide angled, otherwise the growth of the top may become too vigorous.

2. Strong growing branches 1-year-old and older toward the top of the tree should be selectively pruned. This is necessary if vegetative growth and fruit quality in the lower parts of the tree are to be maintained.
3. At this time, it may be necessary to remove some branches at the base of the leader, depending upon its vigor, because loss of the dominance of the central leader is possible if a balance is not maintained.
4. Continue to maintain the conical tree form.

Pruning fifth year and thereafter.

1. Pruning will be similar to the fourth year.
2. Do branch renewal by complete removal of excess branches. Leave a short stub when removing the branch since this encourages the growth of a replacement branch. However, branch replacement may be more successful on the upper portion of the leader than on its basal portion.
3. Maintain a conical tree form.
4. On weak growing varieties like Golden Delicious, thin wood pruning is necessary to attain fruit size. Cortland, which bears much fruit terminally, will require numerous small cuts to remove the excess of twiggy growth which develops toward the outside of the tree. On McIntosh and Delicious, it will be necessary to prune much vigorous wood growing above a horizontal position. However, whenever possible, remove just the drooping wood because undesirable upright growth will develop.

Pruning high density orchards on trellis. Trellises for supporting apple trees differ throughout the world as does training methods employed for trellised-trees. We described a trellis of 4 wires in the section on "supporting trees." A trellis may be constructed to accommodate 3 to 6 wires and the top wire may be 6½ to 10 feet above the ground. The height of the top wire is determined by the harvesting method. In Massachusetts all picking from trellised-trees is done from the ground, thus the top wire is 6 to 7 feet from the ground. In other areas, the height of the tree wall on trellis may be 12 feet and the fruit are picked from platforms or short ladders.

Erection of the trellis is expensive. Your County Extension Service can supply you with names of local growers who have trellises. You should visit these growers to obtain ideas on construction and training of trees on trellises. Also, your County Extension Service can supply you with names and addresses of individuals to write in other areas to obtain information on trellising. Perhaps the most costly error in trellising is insufficient spacing between rows because of the permanency of the trellis.

The trellis can be constructed in stages over the first 3 years after establishment of the trees or totally at a convenient time. However, the posts and the bottom wire should be in place soon after planting to support the developing lateral branches and the central leader. A variety of systems can be used to train trees to a trellis (Fig. 21). Our experience is too limited to judge which system or systems are best. However, a simple system for a 4-wire trellis involves training 8 limbs per tree to the trellis—4 on each side of the main leader—by twisting the limbs around the wire 1 or 2 turns. Spring-type clothespins, plastic ties, nylon ties, or baling twine can be used to hold the branches in place.

At planting, head the trees 17 to 18 inches above the ground to induce branching below the first wire. Two branches are selected during the growing season and these plus the extension growth of the central leader are tied to the bottom wire. To prevent restriction of growth, do not bend the branch downward to a level that is lower than its point of attachment to the trunk. The branch is in the best position when it originates several inches below the wire to which it will be tied. All but the 2 selected branches are removed in order to maintain a dominant central leader.

Pruning in the succeeding years of training will be similar until the tree has 8 limbs trained to the trellis—4 on each side of the main leader. When the central leader extends higher than the top wire, it can be bent in one direction and tied to the top wire or be removed just below the top wire.

Each year, shoots will arise from the tied branches; some should be (a) removed to allow better light penetration into the tree; (b) others should be bent and tied to the wires; (c) others should be headed back to maintain tree width in the row to 3-4 feet; and (d) others should be used as replacements for older branches that have become low in vigor.

Snow and ice may cause limb breakage on trellised trees some winters.

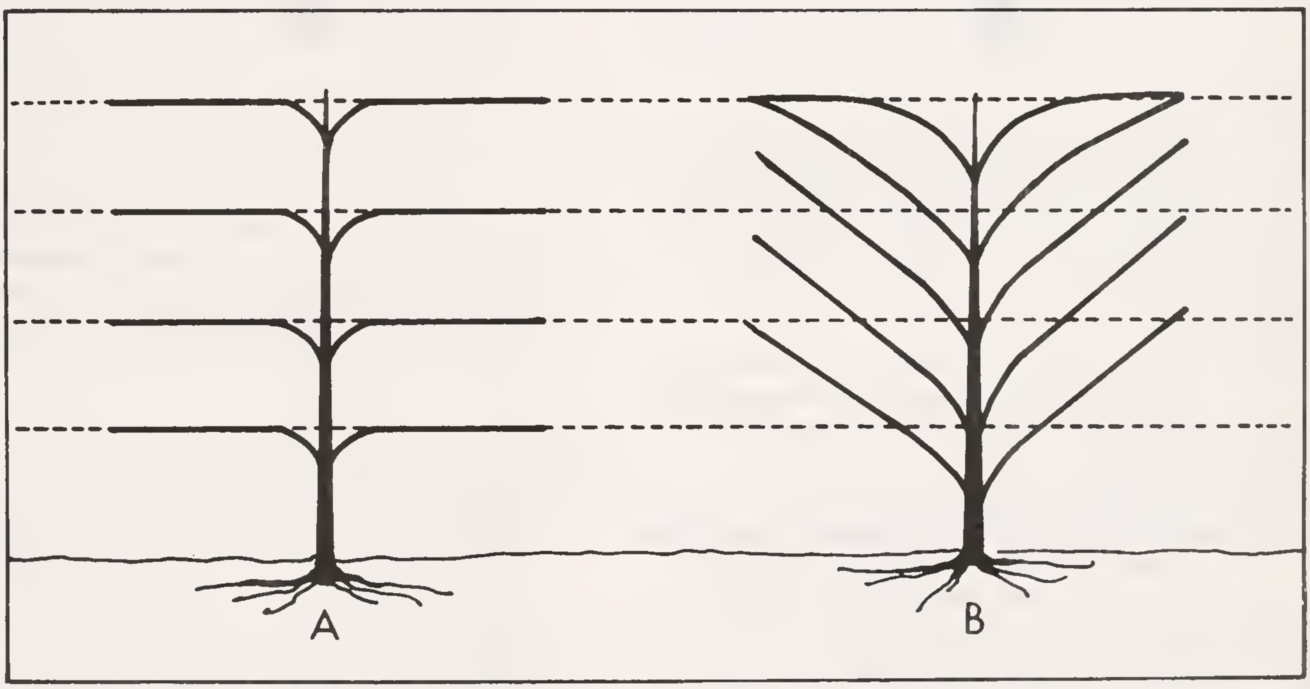

Fig. 21. Apple trees can be trained as palmettes with horizontal branches (A) or palmettes with oblique branches (B) and by other systems.

Cooperative Extension Service
University of Massachusetts
Amherst, Massachusetts
R. S. Whaley
Director
Cooperative Agricultural Extension Work
Acts of May 8 and June 30, 1914

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 42 (No. 3)
MAY/JUNE 1977

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SUGGESTIONS FOR FERTILIZATION OF APPLE TREES IN 1977

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Department of Plant and Soil Sciences

It should be recognized from the start that it is not possible to give specific suggestions for fertilization in an article of this nature. Therefore, the suggestions below merely serve as a guide to the fruit grower for determining the fertilizer program in his orchard. It is well to remember that foliar applications of nutrients are merely supplements to soil applications.

The 1977 fertilizer program will require more than usual consideration because of winter injury to the trunks of McIntosh trees and some Delicious trees in January, 1976, and due to variable fruit set this past summer.

The bark on the winter-injured tree trunks in some instances split but more generally just pulled away from the wood. Fortunately, most growers became aware of the injury in March and April and stapled or tacked the bark to the wood. Although the damage was repaired, this past fall the leaves on many of the winter-injured trees were light green or reddish in color in comparison to those on non-injured trees. Since the trees have been weakened, it is suggested that trees severely winter injured in 1976 be sprayed in 1977 with urea (5 pounds/100 gallons) at about first cover. Apply as a separate application.

Fruit set was variable in 1976 with a light crop of McIntosh in some orchards and a large crop of Delicious in many orchards. Regarding this, it is well to remember that the bloom and the early vegetative growth in 1977 will be made largely at the expense of stored foods. Trees which had only a partial crop in 1976 should have a considerable reserve of nitrogen (N) available for utilization this spring. Therefore, one should reduce N applications in those blocks that had a light crop in 1976. To the contrary, trees that had a heavy crop in 1976 and/or those that had winter injury, may be low in available N for utilization this spring.

Nitrogen (N). The best guide to N needs of your trees is leaf analysis combined with observations of tree vigor, fruit set, and fruit color. Growers definitely are using less N on McIntosh than in the past because we need medium-sized, well-colored apples with long storage life. Some growers have now omitted N in mature McIntosh blocks for 5 to 8 years with no apparent harmful effects.

Young vigorous trees are troublesome when they start bearing a crop because of excessively large, poorly colored fruit and poor keepability of fruit in storage. The reduction or omission of N is frequently essential. This proceedure plus limb positioning (spreading) may be needed on vigorous young Delicious trees to encourage bloom and fruit set.

Apply sufficient N to keep bearing Delicious trees vigorous. N levels of 2.2 - 2.4% in bearing Delicious trees are probably satisfactory because it is necessary to keep the tree vigorous in order to produce large-sized fruits. Furthermore, obtaining sufficient red color on the newer strains of Delicious is not a problem.

The N requirement can be met by applying calcium nitrate, ammonium nitrate or urea sources of fertilizer N or a "complete" fertilizer. (Growers concerned about bitter pit and/or cork spot may wish to rely on calcium nitrate as the source of N.) However, the phosphorous (P) in the complete fertilizer is not needed in our orchards. Therefore, purchase a prepared mix that contains no P or purchase an N and a K fertilizer and mix them prior to application or apply them separately.

<u>Potassium (K)</u>: The K requirements of apple trees with a large crop are high because the fruit utilizes about 3 times as much K as N. Since the quantity of K stored by the tree is extremely small, it seems important to supply adequate K this spring on trees that had heavy fruit set in 1976.

The requirements of apple trees for K (expressed as K_2O) based on potential yields are as follows: (a) less than 15 bu: 1.3 lbs/tree; (b) 15 to 25 bu: 1.3-2.7 lbs/tree; and (c) more than 25 bu: 2.7-4.3 lbs/tree. It is necessary, however, to maintain a balance among the essential nutrients for apple trees. For example, excessive levels of K can reduce both leaf and fruit Ca. <u>Therefore, we strongly urge that you participate in our leaf analysis program to more accurately determine the K needs of your apple trees.</u>

<u>Calcium (Ca)</u>: It is very difficult to increase Ca content of apple trees and fruit. Although foliar sprays of Ca solutions have been shown to reduce bitter pit, they have not eliminated it. A major problem is that Ca in the soil moves very slowly into the tree and most of it is quickly tied up in an insoluble form. We suggest, the following measures to increase Ca content of apple leaves and fruits.

A. Continue to apply 3 tons of limestone per acre every 2 to 3 years. Where high magnesium lime was used in the last application, the use of a more soluble high Ca, low Mg lime (5-7% MgO) will act more rapidly and will provide more Ca.

B. Use calcium nitrate as the source of nitrogenous fertilizer. Calcium nitrate increases the level of soluble soil Ca more quickly, increases the downward movement of Ca and raises the pH of the soil.

C. Apply foliar sprays of calcium chloride ($CaCl_2$) starting about 3 weeks after petal fall and repeat at 2-week intervals, totalling 6 to 8 applications. Apply 6 to 8 pounds $CaCl_2$/acre/spray until mid-July. After mid-July, apply 12 to 18 pounds /acre/spray. Sprays may be applied dilute or on a trial basis up to 6X concentration. Preliminary observations indicate that $CaCl_2$ can be added to the cover sprays of pesticides. However, growers desiring to combine $CaCl_2$ with their cover sprays should do it on a trial basis only. When combining with cover sprays, add $CaCl_2$ last to the spray tank. If weather conditions permit going over 14 days without a cover spray, use $CaCl_2$ spray alone. If foliar injury from $CaCl_2$ occurs, don't apply again until after substantial rainfall (an inch or more). Do not mix $CaCl_2$ and Solubor* in sprays.

Magnesium (Mg): The requirements of trees for this element can best be met by maintaining an adequate dolomitic liming program. Since it takes years before lime is effective in correcting Mg deficiency, Epsom salt sprays can be used to help correct the condition. Apply 2 to 3 sprays at the rate of 15 to 20 lbs per 100 gallons of water at the time of calyx, first cover and second cover sprays. To avoid possible incompatibilities, the Epsom salt sprays should not be combined with the regular pesticide sprays. Don't apply Epsom salts or a lime high in Mg unless leaf analysis or visual observation indicate low Mg levels. Mg can suppress Ca!

Boron (B): This element can be supplied to apple trees either by foliar or soil applications. Use the most economical and convenient method. However, it is safest to apply all elements as a fertilizer except in emergency situations.

Soil applications of boron (B) should be applied to orchards every 3 years. The rates of application per tree vary with age and size. In low density orchards, apply 1/4 pound of borax (11.1% actual B) or its equivalent under young trees coming into bearing, 1/2 to 3/4 pound to medium age and size trees and 3/4 to 1 pound to large or mature trees. Be sure to note the percent actual B in the fertilizer being used to supply this element. B containing fertilizers vary from approximately 11 to 21% actual B.

In medium and high density orchards (115 trees/acre or higher), it might be best to apply B on an acre basis. We suggest the following rates per acre of borax (11.1% actual B) or its equivalent: (a) trees 4 to 7 years of age - 12 lbs; (b) trees 8 to 15 years of age - 12 to 24 lbs; and (c) trees 16 to 30 years of age - 24 to 48 lbs.

When the soil application of B is followed by a wet spring, it may be advisable to apply 2 foliar applications of B the following year.

*Trade name

Many growers now rely on annual foliar applications of B. The usual practice is to add Solubor* to the first 2 cover sprays. Fertilizer grades of borax may contain grit and should not be used in a sprayer. Mature trees should receive 4 pounds of Solubor* per acre each year. Consequently, the goal is to apply about 2 pounds per acre in each of the 2 applications. For young orchards, the addition of 1/2 pound of Solubor* per 100 gallons (dilute basis) to the first 2 cover sprays meets the B requirement of these trees. Reports of New York State indicate that sprays can be concentrated up to 8X with satisfactory results.

Leaf samples from orchards treated with Solubor* have indicated adequate leaf boron levels but the fruit was deficient in this element. Whether or not B applied as a fertilizer more adequately meets the B requirement of apples than foliar-applied B is not known by us.

Manganese (Mn): This element is deficient in some apple orchards. Apple leaves having Mn deficiency have interveinal fading of chlorophyll with the veins remaining green. The use of manganese-zinc fungicides may be of value in orchards low in Mn or zinc or both elements.

Zinc (Zn): Based on optimum levels of Zn established by some states, some of our orchards are low in this element. Massachusetts growers have not used zinc sulfate sprays applied at the "green-tip" stage of bud development to increase zinc levels but some use manganese-zinc containing fungicides. These appear to be increasing Zn levels in our orchards.

*Trade name

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A ONE-TWO PUNCH FOR WEEDS IN STRAWBERRIES

Dominic A. Marini
Southeast Regional Fruit and Vegetable Specialist

To minimize weed problems in new strawberry beds, some growers are utilizing a one-two punch of DCPA (Dacthal*) followed by Chloroxuron (Norex* or Tenoran*) with excellent results. DCPA is applied at transplanting. When DCPA begins to lose its effectiveness, after 6 to 8 weeks, chloroxuron is applied when broadleaf weeds are less than 2 inches tall. Where galinsoga is a problem, it should be applied before the weed exceeds 3/4 of an inch.

DCPA and chloroxuron complement each other nicely. DCPA controls annual grasses, and some broadleaf weeds including lambs

*Trade name

quarters, chickweed and purslane, while chloroxuron controls most broadleaf weeds including galinsoga, but is weak on grasses. While DCPA must be applied pre-emergence to weeds in order to be effective, chloroxuron may be applied either pre- or post-emergence.

For best results with DCPA, it should be applied to smooth moist, clod-free soil before or immediately after setting plants and before weeds germinate. From 1/2 to 1 inch of water from rain or irrigation should follow within 1 week of application. Where irrigation is not available, shallow pre-plant incorporation works the chemical into the soil reducing the risk of failure because of lack of moisture to move it into contact with germinating weed seeds. Since chloroxuron kills germinated weeds up to 2 inches tall, moisture is not so critical for it to be effective.

Where this one-two punch is employed effectively, cultivation is reduced to a minimum. However, on soils that tend to pack after heavy rains, most growers cultivate to loosen the soil when plants start producing runners to facilitate their rooting. At this time, DCPA may be applied again pre-emergence followed by an early post-emergence application of chloroxuron, or chloroxuron may be applied without DCPA either pre- or post-emergence. Application of chloroxuron within a week of DCPA is not advisable in hot weather since injury may occur when temperatures exceed 85°F.

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REASONS FOR DEFORMED STRAWBERRY FRUITS

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Too frequently, strawberry growers find misshapen or deformed berries in their fruiting fields. These berries are sometimes referred to by such names as "nubbins" or "catfaced fruit." By the time this condition is observed, it is too late to do anything to correct the problem.

The strawberry fruit develops as a result of fertilization of the pistils on the blossom. A flower may have several hundred pistils and if fertilized, each pistil will develop into a seed, botanically called an achene. The edible part of the strawberry is mainly enlarged stem tissue. The primary blossoms have more pistils and develop into larger fruit than the later flowers of the inflorescence. The later flowers, called secondary, tertiary and quaternary blossoms, usually have progressively fewer pistils and thus the fruit developing from the tertiary and particularly from the quaternary flowers are small, or maybe nubbins.

A perfectly shaped strawberry fruit requires pollination, fertilization and subsequent seed development of each pistil in the blossom. When conditions are less than optimum for these processes, deformed berries can occur, the degree of deformity being related to the number of achenes that do not form.

Present day strawberry varieties are self-fruitful and do not require cross-pollination but there must be transfer of pollen from the anthers to the stigmas of the pistils. Insects, primarily honey bees and solitary bees, are necessary for this transfer since wind, rain, or gravity will not provide adequate pollination.

In a pollination study in which we caged plots of 'Catskill' strawberries to exclude bees, very few fruits developed and those that did were severely deformed. Blossoms in the uncovered plots pollinated by bees and those that were hand pollinated inside the covers, developed into normal berries. Berries in screened plots that allowed rain penetration and air movement were no better than those in the plots covered with polyethylene cages. This study showed that adequate bee activity is necessary in commercial plantings for high yields of well-formed berries. Thus, improper timing of insecticides may result in catfaced berries due to the killing of pollinating insects.

Frost injury may also deform fruit. The pistils are the most frost susceptible part of the blossom. When all the pistils are killed by frost, the fruit will not form. A light frost may kill some of the pistils which results in a percentage of deformed berries.

Insect damage, especially that of the tarnished plant bug, is probably the most common cause of deformed berries. The tarnished plant bug feeds on blossoms and developing berries causing the berries to be misshapen and if not controlled, heavy losses may occur. In a field study of tarnished plant bug injury at the University of Vermont in 1975, unsprayed plots produced 10 to 60% less fruit than those sprayed with an insecticide just before bloom. The yield reduction was due to less fruit because of blossom injury by the tarnished plant bugs and the presence of small deformed berries. Differences among varieties occurred, with 'Midway' being injured less severely than the other varieties in the trial (Table 1).

Table 1. Average weight (gms) of strawberries harvested from sprayed and unsprayed plots, University of Vermont, 1975.

Variety	Sprayed (gms)	Unsprayed (gms)	Size reduction (%)
"Raritan'	9.2	6.6	28
'Sparkle'	8.0	5.6	30
'Midway'	7.6	7.4	3
'Redcoat'	7.5	5.5	27
'Catskill'	7.3	5.0	32

WHY IRRIGATION FOR STRAWBERRIES?

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Irrigation is an important management tool for growers interested in obtaining consistent high yields of quality strawberries. Strawberries can be a very productive and profitable crop with potential yields as high as 18,000 quarts per acre. However, to obtain such yields, careful attention to all cultural practices is required, including maintaining an adequate moisture supply. Ample moisture is essential for optimum fruit size and high yields, and there are periods during every season when irrigation is necessary on both the non-bearing and bearing bed. Economic studies have shown that returns from irrigation are higher with strawberries than with other crops.

Strawberries are shallow-rooted, with the greatest concentration of roots in the top 4 to 6 inches of soil and most of the plant's moisture is obtained from the top 12 inches. The plants require about one inch of water per week for optimum growth, from the time plants are set until the crop is harvested.

Moisture is needed when the plants are set so that they can become established quickly, make rapid growth, and start producing runners early. It is necessary to enhance rooting of runners and to produce large plants with multiple crowns. Moisture is critical during August and September when fruit buds for the following year's crop develop within the crown. In the bearing year, adequate moisture is essential for maximum fruit set and to produce large berries. If a bearing bed is to be carried over for another year, moisture is necessary after mowing or renovating.

Irrigation is useful in other phases of strawberry production management besides supplementing rainfall. Frost protection is one of these. Hardly a spring goes by when strawberry crops do not suffer some frost losses. Some blossoms are killed outright, while others produce small, deformed, worthless fruit or "nubbins." Most frost damage occurs to open blossoms, but unopened buds can be damaged by low temperatures before bloom or before emerging from the crown.

Most investigators report that strawberry crops can be protected from temperatures as low as 22°F, while a recent article in American Fruit Grower states that irrigation saved a high percentage of the bloom at 15°F.

Growers report using irrigation on as many as 18 nights during a season for frost protection. As little as 50 gallons per acre per minute or 1/10 inch per hour will provide frost protection. Irrigation should start at 33 or 34°F before freezing begins and should continue until the ice has melted and the temperature has risen above freezing. A single 1/8 or 3/16 inch nozzle per sprinkler head will deliver enough water to protect the crop.

Irrigation also can be used to improve the performance of herbicides and fertilizers. Pre-emergence herbicides kill germinating weed seeds, but in order to do so, they must come in contact with the seeds. From 1/2 to 1 inch of moisture is necessary within a week after the herbicide application from the surface to move the chemical into the soil to contact the germinating weed seeds. Moisture is also required to dissolve fertilizer applied as sidedressing and move it down into the root zone of the strawberry plants.

As with other tools, irrigation must be used properly for maximum benefits. When used to supply moisture, irrigation should be applied before wilting begins, so that plant growth will not be interrupted. It should not be over-applied on fruiting beds or soft fruit or fruit rots may result. Overwatering can cause waterlogged soil and root injury, and may also leach nitrogen from the soil. But properly used, irrigation can help to insure consistent high yields of good quality strawberries here in New England, where adequate, timely rainfall is so unreliable and losses from spring frosts a likely possibility.

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"ALTERNATE ROW SPRAYING FOR APPLE PESTS"

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Department of Entomology

In the last issue of "Fruit Notes", we discussed the findings of our 1976 studies on mite predators in Massachusetts apple orchards. We presented information suggesting that some Massachusetts growers having substantial numbers of mite predators needed to use fewer miticide sprays than other growers having few mite predators. Usage of certain insecticide and/or fungicide materials was apparently harmful to the predators in some orchards. We suggested that growers could reduce miticide usage by employing only those insecticides and fungicides to which the mite predators seemed partially or fully tolerant or resistant.

In this article, we discuss our 1976 findings on another potentially useful method for reducing the amount of pesticide in Massachusetts orchards: alternate middle of row spraying.

The alternate middle row spray treatment involves spraying alternate halves of each tree on alternate spray dates instead of both halves on all spray dates. For example, in applying the first cover spray, the sprayer would be driven up the middle between tree rows A and B and return down the middle between rows C and D, skipping the middle between rows B and C. For the second cover spray, the sprayer would be driven up the middle between rows B and C, down the middle between rows D and F, and so forth. If this pattern were followed

We conclude from this first year of experimentation that an alternate middle row spray program in Massachusetts shows promise of effectively controlling the major pests that attack the fruit, even in the face of potentially damaging pest pressure. This effectiveness may stem in part from the adults of these pests moving around the trees with sufficient regularity to contact the sprayed portion. On the other hand, this program seems to be less effective (though still possibly adequately so) against mites and aphids, whose mobility is very limited. Keeping the tree well pruned and the center open should enhance the effectiveness of this program against all pests, particularly mites and aphids.

In summary, at least 2 more years of field research are necessary before we will be in a position to make any firm recommendations as to the cost-benefit value of alternate middle row spray programs in Massachusetts. But the results of this first year of research are encouraging.

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with every spray application, it would save 50% of the spray costs. Richard Moore has done extensive research on this approach in southern Connecticut, with very encouraging results. However, the complex and the density of apple pests in southern Connecticut is not the same as in Massachusetts. Hence, we needed to evaluate this approach under our own conditions.

In 1976 we compared alternate with every middle row spray treatments in a 4-acre block in each of 3 commercial apple orchards in western, central and eastern Massachusetts. Each block was divided into 2 plots: one receiving the alternate row program on each spray date from pink through last cover; the other receiving the every row program. Each grower used an air blast sprayer at 4X. He followed his normal spray schedule, and used his own selection of pesticides. All trees were full grown -- some on M-7 rootstock; others on standard. The centers of the trees were fairly well open in all blocks.

To determine the extent of insect pest pressure, we hung traps in each plot for monitoring codling moth adults and apple maggot flies (see Fruit Notes 41(1):4 and 41(6):7 for information on trap construction). We caught the following average numbers/trap/trapping week for all orchards combined: alternate row plot -- codling moth = 6.0, apple maggot = 1.9; every row plot -- codling moth = 6.5, apple maggot = 1.8. Researchers in other states have found that when codling moth abundance exceeds 2/trap/week and apple maggot abundance 1/trap/week, then fruit injury from these pests is very likely to occur unless spray is applied. Thus, potentially damaging numbers of both these pests existed in both the alternate and every row plots. To determine the actual degree of fruit injury caused by these and other pests as well as the abundance of mites and aphids on leaves, we examined 60 fruit and 60 leaves/tree on each of 6 trees in each plot in each block every 3 weeks from May until harvest.

The results (in the Table below) show that an average of 2.7% of the fruit in the every row plots was injured by insects compared with 2.8% in the alternate row plots. None of the sampled fruit in each plot was injured by codling moth, and only 0.1% in each plot by apple maggot. Plum curculio and European apple sawfly caused 0.2-0.4% injury in each plot whereas plant bugs caused the most injury: 2.0 -- 2.1%. Aphids and mites, however, were 60 to 70% more abundant in the alternate row plots than in the every row areas. No apple scab was observed on any of the leaves or fruits examined, but some may have escaped our notice.

	% fruit infested							% leaves infested	
Treatment	Codling Moth	Apple Maggot	Plum Curculio	Apple Sawfly	Plant Bugs	Other	Total	Aphids	Mites
Alternate row	0	0.1	0.2	0.4	2.1	0	2.8	2.2	19.1
Every row	0	0.1	0.3	0.3	2.0	0	2.7	1.4	11.3

Establishment and Management of Compact Apple Trees

William J. Lord and Joseph Costante
University of Massachusetts

Part 4

Limb Positioning

Method of limb positioning. Limbs can be positioned mechanically using spreaders or tie downs. Cultivars like Delicious, Paulared and Macoun require limb positioning more than McIntosh and Cortland (Fig. 22).

Types of spreaders. A wide variety of spreaders are used: spring-type clothespins, toothpicks, sharpened stiff wires or welding rods, notched laths, or wooden sticks with a sharpened nail in each end.

Spring-type clothespins or toothpicks are used on succulent shoots. Clothespins are preferred because they can be applied more quickly than toothpicks which need to be sharpened and can be blown off the tree.

Wire or wooden spreaders are preferred on 1-year-old wood and older. Wire spreaders are generally no more than 10 to 12 inches long, otherwise they may bend under pressure. These can be purchased or made from 8-gage wire and cut to various lengths. When making the wire spreaders, cut them at a sharp angle with the point on each end on the same side of the spreader. Spray painting the spreaders will make them easier to find if dropped during placement or if dislodged after placement.

Softwood sticks 3/4 x 3/4 inche or 1 by 1 inch and cut at various lengths are suggested for larger, stiffer branches. Regular box nails (8 or 10 penny) are driven into ends of the sticks and then the nail heads are cut at a sharp angle forming a point. Additional sharpening with an emery wheel will expedite placement and reduce limb damage.

Tie-downs can be used when branches have become too long or stiff for spreaders. Materials for tying down the limbs, such as baling twine, are cheaper than spreaders, but the labor involved in positioning the limbs is greater. When the twine is attached to a metal clip or wooden peg in the soil, they may also cause inconvenience.

Time of limb positioning. Spring-type clothespins or toothpicks are used when succulent shoots suitable for permanent branches are 4 to 8 inches long. *The limbs will become fixed in the spread position in about 2 weeks.* The spreading procedure should be repeated on other limbs within 3 to 4 weeks using the clothespins attached in mid-June and others if necessary. **DO NOT** spread the limbs too flat; spread to a 45° to 60° angle from the central leader *(a 90° angle from the central leader would mean the limb is horizontal to the ground).* Spur-type trees need clothespinning more than the standard type cultivars.

Fig. 22. Richared Delicious on MM 106 showing excessive vegetative growth and the lack of limb positioning.

Limb positioning with the wire or wood spreaders can be done at any season of the year, but is best used during the dormant season. The basic design of the tree is easily determined during the dormant season and thus decisions are easier to make concerning the need of spreading. Limbs that are too crowded can be saved by spreading; perhaps the greatest benefit of spreading is the omission of pruning (Fig. 23).

Fig. 23. The best control of vegetative growth can be obtained by combining minimal pruning and limb positioning.

Tree Nutrition

Fertilizer, either nitrogen (N) alone, a complete fertilizer, or a fertilizer containing N and potassium (K_2O) and minor elements, should be applied 3 to 4 weeks prior to bloom and at a rate of 1/4 pound of ammonium nitrate or its equivalent for each year of age.

Reduce or omit N on young, vigorous McIntosh trees when they start to bear fruit, if the trees appear very vigorous, to avoid excessively large, poorly colored apples. With this cultivar and all other cultivars, start participating in the Leaf Analysis Program when the trees start to fruit in order to determine the fertilizer requirements of the trees. (Information concerning the Leaf Analysis Program and specific details on orchard fertilization can be obtained from your County Extension Service.)

Boron deficiency is more apt to be a problem with young than older bearing trees. Therefore, boron should be applied as a ground application or a foliar spray once the trees commence to fruit if this element is not already present in sufficient amounts in the fertilizer being applied annually. Excessive N levels are particularly disastrous with bearing McIntosh trees and low Ca levels are a problem in all Massachusetts apple orchards.

Once every 3 years, take soil samples and send them to the West Experiment Station, University of Massachusetts, Amherst, for determination of soil pH and lime requirements. Directions for taking soil samples can be obtained from your County Extension Service.

Weed Control

Chemicals (herbicides) are frequently used to control grasses and broadleaf weeds under apple trees. Herbicides should be used in such a manner that they provide early-season control of weeds, but not necessarily control for the entire season. Regrowth of weeds in August and September can be advantageous for the following reasons:

(1) The weed regrowth will help slow down growth of vigorously growing trees and thereby lessen the chance of winter injury.

(2) The weeds will provide some protection to the tree roots against low temperature injury.

(3) They will reduce soil erosion.

The current recommendations for their use under apple trees can be obtained from your County Extension Service. In addition to chemical weed control, sand or gravel can be applied around the base of trees to reduce weed growth and/or an area in the vicinity of the trunk can be cleared of weeds in the late fall.

Calibration of sprayer with tractor-mounted boom. The sprayer can be calibrated by making a trial run over some known area. (One acre contains 43,560 square feet. When spraying a 4-foot swath, you must travel 10,890 feet to treat an area equivalent to an acre.) The easy way to calibrate the sprayer is to fill the tank completely or to some other known level, spray 1/10 of an acre (1090 feet x 4 feet) and then accurately measure how much water is required to refill the tank to the previous level. Multiply the gallons used by 10 to get the gallonage per acre. If for example, the sprayer delivered 60 gallons per acre and the herbicide is used at a 4-pound per acre rate, 4 pounds of the herbicide should be added for every 60 gallons of water in the spray tank.

Calibration of granular herbicide applicator. Granular applicators must be calibrated with the herbicide actually being applied. The best way to calibrate is to operate the applicator over a known area such as 1/100 of an acre (436 sq. ft.). You must catch dichlobenil* while operating over the known area and weigh it. The usual way is to disconnect the spinner and to collect the output from the applicator in a bag or bucket. Weigh the dichlobenil very carefully because the amount collected is quite small.

When using a hand-operated granular applicator, fill with a known weight of dichlobenil*, operate the applicator over a known area, and then weight the herbicide remaining in

*The only granular herbicide in common use.

Table 13. The number of trees that can be ground-sprayed with 100 gallons or 1 gallon of spray mixture when applied at the rate of 100 gallons per acre and spraying around the tree trunk the stated number of feet.

Distance sprayed from middle of the trunk	No. trees/100 gals.		Approx. no. trees/gal.	
	Calculated as a square	Calculated as a circle	Calculated as a square	Calculated as a circle
3 feet	1210	1539	12	15
4 feet	681	868	7	9
5 feet	436	555	4	6
6 feet	303	385	3	4
7 feet	222	283	2	3

Table 14. Ounces of dichlobenil required per tree when applying this herbicide by hand.

Area treated around the base	Ounces of dichlobenil G-4	
	At rate of 100 lb/A	At rate of 150 lb/A
Square area		
6 ft. x 6 ft.	1.3	2.0
8 ft. x 8 ft.	2.4	3.5
10 ft. x 10 ft.	3.7	5.5
12 ft. x 12 ft.	5.3	7.9
14 ft. x 14 ft.	7.2	10.8
Circular area		
6 ft. diameter	1.0	1.6
8 ft. diameter	1.8	2.8
10 ft. diameter	2.9	4.3
12 ft. diameter	4.2	6.2
14 ft. diameter	5.7	8.5

the applicator.

Calibration of a handgun on a hydraulic sprayer or a compressed air knapsack sprayer. When applying the herbicide with a handgun and to a limited area around each tree, calibration is relatively simple. First, determine how long it takes to deliver one gallon of spray. Then choose from Table 13 the plot size to be sprayed and note the number of plots that a gallon will cover. Finally, determine the length of time to spray one plot.

Example: (a) The hand gun delivered 1 gal. in 63 seconds.

(b) The distance sprayed from the middle of the trunk will be 4 feet. When calculated as a circle, 1 gal. will spray 9 areas of this size.

(c) Seconds to deliver 1 gal./Trees per gal. = 63/9 = 7 seconds/tree.

(d) The data show that each plot should be sprayed in 7 seconds.

Applying dichlobenil by hand. Some growers apply dichlobenil by hand on an individual tree basis. Table 14 above indicates the ounces of dichlobenil to apply per tree based on area to be treated. For example, if you plan to apply dichlobenil at the rate of 100 pounds per acre and to treat a circular area of 6-foot diameter under each tree, one ounce of dichlobenil should be applied under each tree.

Mouse Control

Three general methods of bait application for mouse control are available: hand trail baiting; mechanical trail baiting; and broadcast baiting. *Hand trail baiting,* placement of zinc phosphide-treated grain baits in natural mouse trails and burrows, gives excellent control of both meadow and pine mice but is slow and tedious especially when mice are not abundant or surface signs of pine mice are obscure.

Treat 2 to 4 spots with teaspoonful quantities of bait around the dripline of each tree. Pay particular attention to low areas, rock outcrops, fence rows and orchard borders. Bait should be placed near holes to underground burrows or in active runways and under vegetation or artificial covers. Apply at the rate of 2 to 3 pounds per acre. For pine mice, bait should be applied to holes and burrows for best results.

Mechanical trail baiting. A tractor-drawn trail-building machine constructs artificial runs in which bait is distributed. If properly done, 95% of meadow mice and 80% control of pine mice can be expected by the trail builder method. A trailbuilder should be operated so that the trail made by the machine is just inside the drip line on both sides of the trees. Apply at the rate of 2 to 3 pounds per acre. Check machine accuracy for proper operation.

Broadcast application of bait by hand, cyclone seeder or aircraft will provide control of meadow mice but control of pine mice may not be adequate. Broadcast application by tractor-drawn equipment is rapid but more bait is used than with hand or mechanical trail baiting. Broadcast methods give poor control when the ground cover is very dense, including a heavy mat of leaves, as the bait fails to penetrate into the mouse runways. Apply the zinc-phosphate-treated baits at the rate of 6 to 10 pounds per acre.

Choose a period, immediately after harvest, of the least human activity in the orchard and warm, clear weather for applying the baits. This is the period when mice will be most active and most apt to consume the applied baits. A thorough and conscientious job is essential for good mouse control.

NOTE: Before applying any toxic baits, a permit must be obtained for bait application from: Massachusetts Division of Fisheries and Game, 100 Cambridge Street, Boston, Massachusetts 02202. Pesticide regulations are always subject to change, therefore, always contact your local County Extension Service for the latest information on rodenticide and pesticide usage.

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 42 (No. 4)
JULY–AUGUST 1977

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CONSIDERATIONS IN ATTEMPTING TO IMPROVE[1] THE CALCIUM CONTENT OF APPLES

Heather A. Betts[2] and William J. Bramlage
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Apples are subject to many diseases and physiological disorders after harvest, all of which must be controlled to provide a product acceptable to consumers. The mineral nutrient composition of fruit at harvest greatly influences the occurrence of these problems, and it is now widely recognized that calcium (Ca) content is a key factor. Low Ca levels are implicated in development of corking disorders such as bitter pit, cork spot, and Jonathan spot, both before and after harvest. In addition, watercore, internal breakdown, low temperature breakdown, lenticel breakdown, scald, and rot may be intensified when fruit Ca levels are low. From among these problems, bitter pit and internal breakdown have been most extensively studied for their relationship to Ca nutrition.

Bitter pit has long been recognized as a Ca-deficiency problem. It is influenced by many environmental, orchard management, and storage factors such as water stress, pruning, mineral balance, and time of picking, and many of these influences may actually be acting through modification of fruit Ca levels. Usually, the larger the fruit and the drier the growing season, the more bitter pit is found. Some success in reducing bitter pit has been obtained with calcium chloride ($CaCl_2$) and calcium nitrate ($Ca(NO_3)_2$ sprays 4 to 7 times during the growing season; $CaCl_2$ is usually the preferred material since $Ca(NO_3)_2$ adds nitrogen to the tree, which can intensify a Ca deficiency. Sprays typically reduce the incidence from 40% to 10% in 'Cox's Orange Pippin' apples in England. Since mobility of Ca in the apple tree is very low, the Ca must be applied directly to the fruit for the treatment to be successful. Ca dips after harvest have also been used to increase the Ca content and decrease bitter pit occurrence during storage.

Internal breakdown usually occurs after harvest and is often more prevalent in late-picked fruit. High relative humidity in storage accentuates the disorder. It develops as extreme softening of the tissues, with brown discoloration that can become dark-chocolate colored with time, and with the vacular bundles standing out prominently as dark-brown strands. Recent studies show that internal breakdown is greatly influenced by Ca nutrition. In England, Perring determined that 'Cox's Orange Pippin' apples containing greater than 4.5 mg Ca/100 g fresh weight of flesh will usually

[1]This is a review article. Our current suggestions for increasing Ca level in apple trees can be found in the May-June, 1977 issue of Fruit Notes.

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be free from breakdown during storage, whereas at 3 mg/100 g fresh weight the fruit is very likely to develop breakdown early in storage. In Canada, Lidster, et al. determined that nearly this same Ca level (4.5 mg/100 g) was required for maximum protection of 'Spartan' apples from breakdown in storage. Spraying and dipping apples with Ca solutions before storage have frequently been effective in reducing internal breakdown. One spray program raised the Ca level of the fruit from 3.7 to 5.4 mg Ca/100 g of fruit flesh, and correspondingly reduced the occurrence of breakdown in storage from 16% in the controls to 0% in the treated fruits. In Massachusetts, we have consistently found in recent years that in a given situation, greatest incidence of internal breakdown occurs in the apples with the lowest Ca content.

There is, therefore, strong reason for a fruit grower who is having difficulty maintaining fruit quality during storage, to be concerned about Ca nutrition of the fruit. Unfortunately, it is not easy to substantially increase Ca levels of apples. Ca is one of the most abundant minerals in most soils, yet fruit frequently contain inadequate amounts of this mineral. Apple tree roots do not readily take up Ca from the soil, and what they can take up is influenced by numerous soil conditions. Thus, lime and Ca fertilizers do not quickly or markedly increase Ca levels in apples.

Leaves seldom show Ca deficiency symptoms even though fruit may be severely deficient. What Ca is absorbed from the soil is transported very slowly within the tree, and what is transported is apparently directly by water use in the tree. Movement is largely within the xylem (the water transporting system). Early in the season, small apples are using large amounts of water, and relatively large amounts of Ca move to the fruit with this water. By mid-season, however, apples are using much less water and are also serving as a large depository for sugars and other organic nutrients coming from the leaves. These nutrients are moving through the phloem (the food transporting system), in which Ca is relatively immobile. Therefore, little Ca is transported to the fruit late in the season, since the fruit are being supplied largely by the phloem system. As a result, 90% of the apple's Ca may move in during the first 6 weeks after full bloom. When water stress occurs in the apple tree, water may be drawn from the fruit to the leaves, and simultaneously Ca may be withdrawn from the fruit. In this way, water stress may create or intensify Ca deficiency in the fruit.

The average Ca level in the fruit is considerably lower than that in the rest of the tree. Within the apple fruit itself there are large differences in the concentration of Ca. In the cortex (outer flesh) of mature apples, Ca concentration declines steadily from the stem end to the calyx (blossom) end, which is probably why bitter pit and internal breakdown usually begin to develop (and develop most intensively) at the calyx end of the apple. The apple peel has about 3 times more Ca in it than has the flesh. Because of this uneven distribution, Ca concentration is sometimes extremely low in the fruit tissues most sensitive to physiological disorders.

An understanding of these characteristics of Ca nutrition of apples is important in designing a program to improve fruit Ca levels. Much work has been done worldwide to increase Ca levels in apples. Soil treatments have been of little measureable benefit. Tree sprays of Ca salts such as $CaCl_2$ and $Ca(NO_3)_2$ have given some success in increasing Ca levels and reducing disorders. Their effectiveness usually increases with concentration of the salts in the spray mix and with the frequency of spraying. A common cause for unsatisfactory results is poor spray coverage; because of the low mobility of Ca to fruit within the tree, thorough and uniform coverage is essential. This problem may be intensified by application of Ca in concentrate sprays.

Postharvest dips have the advantage of being able to completely cover the fruit with solution. In England, researchers in one trial got similar control of bitter pit with a postharvest immersion for 1 minute in 0.05 M $Ca(NO_3)_2$ as with 4 summer sprays of the same solution. However, $CaCl_2$ again is considered to be a more effective salt for dips than $Ca(NO_3)_2$, at least in part because $Ca(NO_3)_2$ will support bacterial growth and leave an undesirable residue on fruit after storage. Other substances have been added to the dipping solution in order to increase the penetration of Ca into the fruit, with varying and often conflicting results. The most striking effects have been obtained by adding "thickeners" to the dipping solution. Mason and his colleagues in Canada have used arrowroot flour and the commercial thickener keltrol with great success. With 'McIntosh,' dips in 4% $CaCl_2$ plus keltrol almost tripled flesh Ca during storage, and significantly reduced the softening rate of the fruit during and following storage. These thickeners apparently cause much more Ca to adhere to the surface of the apple, from which it can be absorbed into the flesh later during storage.

Injury can result from excessively heavy treatments to increase Ca levels. Tree sprays can severely injure leaves, especially early in the season or in hot weather. Postharvest dips can cause injury to the surface of the fruits, usually appearing as a burn or as black spots at the calyx end of the fruits. In most cases, fruit inury is not serious, but in a report from New Zealand 23% of 'Cox's Orange Pippin' were injured by a 2.5% $CaCl_2$ dip.

As we learn more about the effects of mineral deficiencies on storage life and quality retention in fruit, it becomes increasingly important to develop strategies to overcome the deficiencies. Solutions will not be simple. Following a comprehensive study of factors related to storage breakdown of 'Spartan' apples in British

Columbia, Canada, Lidster, et al. concluded that: "The fruit and orchard profile for expected minimum breakdown incidence would be as follows: (1) high Ca content in apple flesh (minimum of 42.4 ppm fresh weight): (2) apple K (potassium) and B (boron) content to be less than 883 and 2.9 ppm, respectively; (3) small apple diameters [optimum diameter, 5.8 cm (approximately 2.30 inches)]; (4) low apple soluble solids (below 11.9%); (5) low to moderate tree vigor [terminal growth less than 46 cm (approximately 18 inches)]." These 5 factors accounted for 75% of the variation in breakdown among different samples, but that still left 25% to be accounted for by other factors.

It will be necessary for the grower to understand the complexity of the Ca problem in apples if the problem is to be successfully overcome. We have attempted in this brief review to outline the key features of the Ca problem, so that as growers look ahead to the coming season they can better understand why specific actions or conditions can or cannot be expected to influence the Ca levels of their fruit, and thereby influence the storage life and quality of next year's crop.

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2,4-D FOR PROBLEM WEEDS IN STRAWBERRIES

Dominic A. Marini
Southeast Regional Fruit and Vegetable Specialist

Broadleaf perennial weeds, such as dandelions, can be a serious problem when carrying over strawberry beds for 2 or more seasons. The commonly used strawberry herbicides do not control these perennial weeds and hand weeding of deep-rooted perennials is virtually impossible.

Dow Formula 40* formulation of 2,4-D is now registered for use on old or established strawberry beds for the control of many broadleaf weeds. In the 1977 chemical weed control chart for small fruits, we are suggesting for the control of broadleaf weeds, a single application of this herbicide applied right after mowing or renovating the harvested strawberry bed. It should not be used on new plantings. Furthermore, spring or fall applications of 2,4-D to established beds are not recommended because of the possible injury to fruit buds. The recommended rate is 1 to 1-1/2 quarts per acre in 25 to 50 gallons of water. For best results, 2,4-D should be applied during warm weather when weeds are young and making rapid growth.

Since many crops and ornamental plants are sensitive to only the slightest trace of 2,4-D, it should be applied under calm con-

*Trade name

ditions when there is no possibility of drift onto nearby plants. Tomatoes, grapes, and roses are particularly susceptible to injury. Applying a dilute spray using nozzles that deliver large, coarse droplets and low pressure reduces the possiblity of drift.

Clean the sprayer thoroughly after using it to apply 2,4-D because trace amounts of this herbicide can injure sensitive crops. In fact, it would be best not to use the same sprayer for other crops. If this is unavoidable, rinse thoroughly with clean water and then fill the tank with a solution of 1 part household ammonia to 99 parts water and allow it to remain for 24 hours. Then pump some of this solution through the system, drain, and rinse again. A quicker method is to fill the tank 1/3 full of water and add 1/4 pound of activated charcoal and 2 to 4 ounces of laundry detergent for each 10 gallons. Agitate the mixture and swirl it around in the tank for at least 2 minutes so that it reaches all parts of the tank. Pump some through the system, drain, and rinse with clean water.

Where broadleaf perennial weeds are a problem in established strawberry beds, 2,4-D can be useful for their control, but it must be used with extreme caution because of the possibility of injury from drift onto nearby sensitive plants and the need for removing every trace of it from application equipment.

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THE PLUM CURCULIO: AN INTRODUCTION AND SUMMARY OF PRELIMINARY FIELD OBSERVATIONS, 1976

Karen I. Hauschild and Ronald J. Prokopy
Department of Entomology

The plum curculio is one of the most serious pests of apples in Massachusetts. It is a native species, originally found on wild plums, crabapples, and hawthorn; however, with the past century, it has adapted to most tree fruits as they have become introduced from Europe. Here we outline the life history as known from the literature, and discuss some of the results of our first year (1976) of research studies.

Dr. Whitcomb, of the Waltham Experiment Station, conducted an extensive study of the biology of the plum curculio in Massachusetts in the 1920's. He found that in some years a few adult curculios arrive on apple trees as early as the pink stage. According to his study, feeding punctures can be found from the last week in May, while oviposition (egg-laying) occurs from late May to mid-July. Mating, he found, occurs prior to, or during the time when the adults arrive on the trees. Eggs hatch in about a week. Larvae then tunnel into, and feed on, the developing fruits for the next two to three weeks. Most of the larval-infested fruits drop to the ground, and there the larvae leave the fruits to pupate in the soil. Adult curculios emerge from the soil approximately one month after that. These emerging adults feed on late apple varieties or leaves and then overwinter, unmated, in or near orchards. There is only one generation of curculios in Massachusetts.

Damage caused by the plum curculio is of several different types. Early in the season, curculios feed on and lay eggs in young fruits. These fruits are then scarred with surface wounds. Small round holes are the result of feeding punctures, while crescent-shaped yellowish scabs are the result of egg-laying activities. The most important injury is larval tunneling inside the fruits and the correspondent fruit drop. Feeding scars of the adults in the fall and adult feeding damage on blossoms in the spring are other types of injury.

Controlling this pest has been a frequently difficult as well as expensive task, even with modern insecticide sprays. Researchers in other states are working on alternatives to chemical control of the plum curculio, but to date no practical means of control other than insecticides have been developed. A reduction in the number of chemical sprays against the curculio would not only save growers' money, but in addition would postpone the onset of possible pesticide resistance, and decrease pesticide contamination in the environment. Beneficial insects such as pollinators, predators, and parasites would also undoubtedly benefit from reduced numbers of insecticide sprays.

One of the purposes of our plum curculio project here in the Department of Entomology is to study the activities of the adults to determine whether there is any behavioral trait which could be used in the development of a curculio trap. Although some aspects of the biology and life cycle of the curculio are reasonably well understood, there is little information on its behavior. A trapping device such as is used for apple maggot or lepidopterous pests (for example, the codling moth) would (coupled with information on how many curculios an orchard could tolerate without affecting crop quality or yield) aid the grower in determining whether and when he should use insecticides against the curculio. It also is possible that such a trapping device could be used as a direct control measure -- that is, the trap itself could be effective in controlling adult curculios, especially where only small populations were present.

The major study that was conducted last summer involved spending many hours observing the behavior of adult curculios on apple and plum trees located on Orchard Hill on the UMass campus. The purpose of this study was to obtain some understanding of the curculios' behavior. Observations were made at varying time intervals from 8:00 A.M. to 9:00 P.M. on warm, sunny days. Once we had located a curculio we watched that insect until it moved out of sight.

From these observations, we found that the main activities of adult curculios were:

1. Exploration - moving about a tree in search of food, ovipositional or resting sites.

2. Defense or camouflage behavior (These insects are very sensitive to noises or other disturbances.)

3. Resting

4. Feeding

5. Ovipositing (egg-laying)

An adult curculio appears to have little recognition of places it or other curculios had previously visited, as individuals spent considerable time re-exploring the same areas. Curculios were rarely observed flying, spending most of their exploratory time crawling. It appeared that they were able to distinguish fruits from twigs and foliage only upon direct contact, and not by distance vision or smell. In terms of egg laying behavior, females spent several moments "drumming" their antennae and tarsi (feet) on the fruit before they would attempt to lay eggs.

These observations would suggest that curculio behavior is rather complex, and for this reason it will take considerable time to discover what methods curculios use to find their host trees, food and mates. It appears that this insect has comparatively little dependence on vision. For this reason, we doubt that a trap employing only visual stimuli would be very effective. Also, since within-tree flight appears to be of minor importance, traps aiming to capture curculios flying within trees would likewise probably not be very effective. Traps based on insect flight to visual stimuli are relatively easy and quick to develop and use, and we have indeed experienced some success with such traps for tarnished plant bug, sawfly and apple maggot.

We are closer to an understanding of plum curculio behavior than we were a year ago. However, many further long term studies on the behavior of adult plum curculios will have to be carried out to uncover some behavioral trait which would lend itself to an effective, efficient and reliable trapping device.

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CO_2 TREATMENTS FOR 'McINTOSH' AT THE BEGINNING OF CA STORAGE

William J. Bramlage
Department of Plant and Soil Sciences

Perhaps you have read about the CO_2 treatments that are being used in Washington to slow down softening of 'Golden Delicious' apples in CA storage. This procedure has gotten a lot of publicity and is working very well in commercial storages in that state. If you have read any of these reports, you have surely wondered if the same treatment will work on 'McIntosh'. So have we, and in earlier Fruit Notes articles (Sept-Oct, 1973 and Sept-Oct, 1975) we reported results of our preliminary studies with this procedure. In 1975, we also reported that a large-scale test was to be conducted to determine the feasibility of this "CO_2 pretreatment" of 'McIntosh'. This test has now been completed and its findings can be reported.

The 'Golden Delicious' treatment simply consists of raising the CO_2 level in the storage to 15% during the first 8 to 10 days of CA storage, then scrubbing it down to the normal CO_2 level for CA storage. It results in much slower softening of the apples and allows the growers to market crisp fruit into late spring and early summer. In preliminary tests with 'McIntosh', both in Massachusetts and in other areas where this variety is important, the trials indicated that softening of 'McIntosh' could also be slowed down by CO_2 pretreatment, but that there was considerable danger of CO_2 injury from the treatment. To evaluate as broadly as possible the potential benefit and potential danger from such a treatment, a cooperative study was made at 5 locations where 'McIntosh' is an important variety: Massachusetts, New York, Michigan, Ontario, and British Columbia.

At all 5 locations, a treatment that had appeared in preliminary tests to be about optimum for 'McIntosh' was tested. It consisted of harvesting the apples at peak time for CA storage, quickly cooling them to 38°F, and as quickly as possible sealing them in CA where CO_2 was brought to 12%. This 12% CO_2 atmosphere was maintained for 2 weeks and then the apples were put under normal CA conditions of 5% CO_2 and 3% O_2. The samples were kept in CA for up to 8 months before being compared with other CA samples that had not received the 12% CO_2 pretreatment.

Besides conducting this test of what was believed to be about the best treatment for 'McIntosh', each participant tested the effects of 1 or more of the following factors that might influence response to the CO_2 treatment: harvest date; delaying treatment after harvest; slow cooling during treatment; temperature, humidity, and O_2 level during treatment; increased CO_2 concentration; and, increased length of the CO_2 treatment.

The results from these tests clearly demonstrated that the CO_2 pretreatment can delay softening of 'McIntosh' in CA storage. At every location, treating them with 12% CO_2 for 2 weeks produced apples that were 1 to 2 lbs firmer than untreated CA samples after 4 to 6 months in storage. However, the effect gradually wore off; after a week at room temperature these differences had largely disappeared, and after 7 to 8 months of storage even the fruit right out of storage showed only small differences. Nevertheless, these differences would be well worth the treatment if no problems arose from the treatment.

But there are problems! Both external CO_2 injury (a scald-like burn) and internal CO_2 injury (a form of internal breakdown) developed. The extent of these injuries was variable among locations; external injury occurred everywhere except in Michigan, and internal injury was distinct only in British Columbia. However, the problems were sometimes overwhelming; in British Columbia, 43% of the fruit had external injury, and 53% had internal injury, and in New York 30 to 35% of the apples had external injury. In Massachusetts, we've found the extent of injury to vary from year to year, sometimes not occurring at all and in other years occurring to a serious extent. We also find different samples varying greatly in the amount of injury that they develop from the same treatment. Just as it was obvious in these tests that the CO_2 treatment can delay softening of 'McIntosh', it was also obvious that the treatment has the potential of causing very serious damage to the stored apples.

What about other factors that might influence results? We found that increasing the CO_2 level from 12% up to 15% resulted in a bit more fruit firmness after storage, and that increasing treatment time from 2 weeks to as much as 6 weeks did likewise. However, both of these modifications increased the amount of CO_2 injury as well as increasing firmness of the apples. Harvesting the fruit 1 week earlier than peak time increased treatment benefit, but again it also increased the amount of injury. Harvesting 1 week later than peak time reduced benefit from the treatment. Treating the apples at 32°F rather than at 38° reduced both benefit and injury. In tests in New York, treatment was begun when the apples were still warm (55°) and they were cooled to 38° during the 2-week treatment; the CO_2 treatment was of no value in delaying softening of these warm fruit. In Michigan, apples were kept at 70°F for a week, or at 32° for 1 or 2 weeks, before they were treated; any delay reduced treatment benefit, and 1 week at 70° eliminated any benefit. The O_2 level and the humidity in the storage during the CO_2 treatment had no effect on the delay in softening brought about by the CO_2 pretreatment.

It was rather clear from the results of these tests that raising the CO_2 level to 12% for 2 weeks at the beginning of CA storage has no magic effect on the apples; it simply slows down their rate of ripening even more than CA alone does. Anything that increases ripeness (late harvest, slow cooling, delayed treatment, etc.) before treatment takes away from the benefit obtained from the treatment. Benefit from treatment is increased when less ripe apples are treated. However, factors that increased the ability of the treatment to delay ripening and softening also increased their susceptibility to CO_2 injury. The only exception to this was storage humidity. We found that by not humidifying the storage until after the CO_2 treatment, injury was reduced but firmness was not. Later tests in British Columbia support this finding. However, it remains to be determined if this technique is practical, and if it produces new problems.

After examining the results of these tests, it was the unanimous conclusion of those who participated in them that for 'McIntosh', the possible benefits to be gained from the CO_2 pretreatment did not outweigh the possible losses that might result from CO_2 injuries. Unfortunately, 'McIntosh' seems to be more sensitive to CO_2 than are 'Golden Delicious' in Washington. Unless a way can be found to reduce the risk of injury without reducing the delay of softening, CO_2 pretreatment of 'McIntosh' cannot be recommended for commercial practice.

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol 42 (No. 5)
SEPTEMBER/OCTOBER 1977

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THE NATIONAL CONTROLLED ATMOSPHERE RESEARCH CONFERENCE

William J. Bramlage
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On April 5-7, 1977, a National Controlled Atmosphere Research Conference was held at Michigan State University, bringing together nearly 100 persons with professional interests in controlled atmosphere storage of various commodities. The last such conference was held in 1969, and the main objective of this meeting was to review the changes that have occurred since then. The focal points of the meeting were the consideration of new techniques and new problems, and an update on our knowledge of the responses of different commodities to CA. The full proceedings of the Conference will be available soon, but in this article I will touch on the points that may be of most interest to our readers.

Storage construction. Probably the biggest concern today with storage construction, is the problem of how to fireproof polyurethane satisfactorily. Flame retardants have been of limited value, and some of the approaches that are being taken either are not practical in a storage or are of unproven durability. Several speakers concluded that the most reliable way to fireproof urethane is to cover it with one-half inch of cement mortar. Mr. Keith Clarke, of Vineland, Ontario suggested that at a minimum, a urethane-sealed storage should be dealt with as a highly flammable structure: Treat it as a farmer does his haymow, he suggested. Some storages have burned because their owners were using them as workshops!

Construction methods were discussed by Mr. D.L. Hunter of Yakima, Washington. Of considerable interest today is how to conserve energy in the storage. He pointed out that large rooms (e.g., 40,000 bu capacity) are most efficient, as are large capacity refrigeration units. However, large units give you less air movement per unit. One common mistake in storage is to put fans in front of cooling coils. This arrangement adds the heat from the fan to the room air.

Mr. Hunter also described the use of a rubber gas seal that can be sprayed on behind the insulation. Rubber gas seals have been very successful where they have been applied carefully. The first storage to use this material was built in 1969 in Kelowna, British Columbia; this storage has been expanded three times since then, always with the rubber vapor barrier, and over a million bushels of apples are now stored in it. The operator of this storage was at the Conference and verified the successful use of this gas seal.

Storage operation. Since a storage operator can choose from a long list of scrubbbing techniques, a common question is: Which is best? Lime boxes are not used in many areas, partly because they are considered to be a nuisance, but they are very effective. We have been urging growers not to put lime in the storage because it keeps the CO_2 level so low that the CO_2 is not providing its maximum effect in delaying ripening of the fruit in storage. However, tests in New York showed no adverse effect on the fruit from having lime in the room. This technique of course provides protection from CO_2 injury, but you must consider that it displaces some fruit. Dr. G.D. Blanpied, of Cornell University, compared data on costs for various scrubbing systems. Water scrubbers are very effective, but corrosion of bearings, motors, and switches from the brine raises operating costs. This can be avoided by having a separate water scrubbing system, which costs more to install but which saves money in the long run. Surprisingly, Dr. Blanpied's analyses indicated that in the long run the least expensive scrubbing system may be the commercial scrubbing devices that use charcoal as CO_2 adsorbant. While they are expensive to purchase and install, their operating expenses are very small and they have a long operating "life."

Another operation technique of considerable interest is the possible use of high-CO_2 treatments at the beginning of CA storage. This question will be considered in a separate article.

Commodity responses to CA storage. In the U.S., about 38% of the apple crop is stored in CA. In the Northeast, the percentage is much higher than this and has probably reached its peak, but in the Southeast and Midwest --- the "growth areas" for CA storage of apples --- only a small percentage of the crop is stored in CA. The question we can now ask is, what about storing commodities other than apples? In the West, many pears are stored in CA, but in the East a greater susceptibility to CO_2 injury almost rules out CA storage of pears. Progress is being made in developing techniques for CA storage of peaches and nectarines, but there is no commercial application yet. Sweet cherries may be stored in CA, but there is little evidence that it is better than storage in air if good temperature control is maintained (29-30°F is optimum). Avocados are being successfully stored commercially in Florida, but the potential for development is limited. Much effort has gone into tests for CA storage of citrus, but without success.

Vegetables are extensively transported in CA-equipped trucks and vans. One of these systems ("Transfresh") ships 5 million pounds of foodstuffs per week, mostly by truck, and another ("Sea-land") is involved primarily in ocean transport. However, these are short-term treatments aimed specifically at transportation problems. Long-term storage of vegetables in CA has not proven feasible. There is often interest in storing tomatoes in CA, but this is very dangerous because tomatoes can easily be injured by a storage environment. Root crops (carrots, beets, potatoes, etc.) have been extensively tested and simply are not suited to CA storage. Frequent mention is made of CA storage for flowers, but laboratory successes are very difficult to put into commercial practice, due in part to the vast number of flower species, varieties, and growing conditions that can all influence storage responses.

On the national scene CA storage is moving into some new areas. Some excellent results have been obtained from nut and grain tests with CA, and commercial storage is now practiced. The object here is mainly to control insects. Also, use of CA during transit of meat is growing rapidly, and 40% of the "Transfresh" shipments are with meat. In this case, the object is mainly to control bacteria growth and discoloration of the meat.

To the Northeast storage operator, however, it is evident that CA storage today is still an apple industry.

Hypobaric storage. During the past 10 years, a new concept in storage has emerged. It is called "hypobaric storage", "low pressure storage," or simply "LPS." This approach involves storing produce under a strong vacuum, which removes gases (like the ripening ethylene) from the produce almost as fast as they are formed. It also greatly reduces the amount of oxygen they are receiving, and removes CO_2 as fast as it forms. This type of storage has produced some remarkable results with storage of many commodities, including apples and pears. 'McIntosh' apples in March are said to taste like they were just harvested.

There are many engineering problems involved with applying the technique. It would require whole new approaches to storage construction. Tests with this new storage method have now been made on small scales in a number of different places, and results were critically evaluated at this Conference. It seems clear that LPS can work, and work well, on a number of crops. Grumman Allied Industries, Inc. (basically, an aerospace industry) is developing 40-foot long units for transporting produce in LPS, but they are still experiencing technical problems. Even when it becomes technically feasible to commercially build and operate LPS systems, they will be expensive. How economically competitive LPS will be with CA remains to be determined. The recurring theme of reports given on the use of LPS was that the spectacular effects first reported for this system led to expectations that were too great. More realistic assessments now state cautious optimism that LPS will take its place in post-harvest horticulture, but that CA and other systems now being used have not been made obsolete.

Summary. This 1977 National CA Research Conference brought together a great deal of knowledge, and some controversy, about the use of CA in today's horticultural industry. Proceedings of this Conference should be of interest and value to everyone involved in CA storage. We will inform you in Fruit Notes how to obtain copies when they are published.

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MONITORING TRAPS FOR BLUEBERRY MAGGOT FLIES

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Department of Entomology

The blueberry maggot, Rhagoletis mendax, is generally considered the most important insect pest of commercially grown highbush blueberries in the eastern and mid-western United States. The adults look identical to apple maggot adults, but are a different species. They emerge from overwintering cocoons about the time earliest-ripening berries are turning reddish blue. They feed for about 10 days—principally on insect honeydew on foliage, mate, and then commence laying eggs into the berries. The eggs hatch in about 4 days, and the larvae (maggots) feed for about 2 weeks on the flesh of the berry, causing it to rot. Infested berries may look in fine condition on the outside but be soft and mushy inside. When no measures are taken to prevent injury, 50% or more of ripe berries may be maggot infested.

The standard method of controlling the blueberry maggot is application of 3-5 insecticide treatments against the adults. At present, the treatment schedule followed by most growers is a type designed to prevent any possible maggot injury, irrespective of whether or not maggot flies are actually present. If there were a method available for accurately assessing fly abundance in the plantation and eventually relating fly density to level of larval infestation, then the decision as to whether or not insecticide should be applied could be made on a firm cost-benefit basis. Unnecessary and uneconomical sprays could be eliminated, resulting in (a) monetary savings to the grower, (b) less pesticide residue on and in the fruit and in the environment, (c) less selective pressure for rapid development of maggot fly resistance to insecticides, and (d) greater opportunity for natural enemy buildup. Until now, no effective method for assessing blueberry maggot fly abundance has been available.

In 1976 and 1977, we studied the reactions of blueberry maggot flies to visual and combined visual-odor stimuli. When we tested their responses to 6 x 8 inch painted cardboard rectangles

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[1] Graduate Student in Department of Plant and Soil Sciences

hung from highbush blueberry branches, we found that the flies were more attracted to yellow enamel ones than to enamel green, blue, orange, red, white, gray, black, aluminum foil, or clear Plexiglas ones. We then found that the maggot flies were even more attracted to daylight fluorescent yellow rectangles than to enamel yellow ones. These color responses of blueberry maggot flies were virtually identical to the color responses of apple maggot flies in earlier tests (see Sept.-Oct., 1976 issue of Fruit Notes). We believe that the reason the flies are so attracted to bright yellow color is because they perceive yellow as if it were super-bright or super-intense foliage on which to find food.

In another test, we hung 1.3 and 3-inch diameter red spheres and found the blueberry maggot flies highly attracted to both, but especially to the 3-inch ones. This is very similar to our findings on apple fly response to red spheres (see Nov.-Dec., 1976 issue of Fruit Notes). We believe that the reason the flies are so attracted to 3-inch red spheres is because they perceive such spheres as if they were super-large blueberries on which to find mates or lay eggs.

We then coated 6 of the 6 x 8 inch daylight fluorescent yellow rectangles and 6 of the 3-inch red spheres with Bird Tanglefoot (a clear sticky substance that captures and holds arriving flies) and hung them from highbush blueberry branches in a plantation in Munson, Mass. from July 13 to August 11. We caught a total of 1547 blueberry maggot flies on the rectangles and 3309 on the spheres. When ammonium acetate crystals (an odoriferous bait attracting food-seeking flies) was added to a second set of 6 yellow rectangles, 2206 maggot flies were captured. This was more than on the unbaited yellow rectangles, but fewer than on the unbaited spheres.

These findings indicate the sticky-coated daylight fluorescent yellow rectangles and 3-inch red spheres are effective traps for capturing large numbers of blueberry maggot flies. Hence, they can be profitably employed to monitor maggot fly population levels and activities in commercial plantings. Their use will aid in better timing of maggot fly sprays, and avoidance of unnecessary applications when no maggot flies are present.

Proper positioning of the traps is critical to their fly-capturing effectiveness. They must be hung so that the flies can clearly see them. Therefore, all foliage, twigs, and berries within 8-12 inches of all sides of each trap should be removed. But beyond this distance, there should be as much fruit and foliage as possible (especially below and to the sides) to attract flies into the general area. Although we have not yet established any firm relationship between maggot fly trap captures and fruit infestation levels, we would suggest that capture of 5 flies per trap per week may warrant insecticide treatment on highbush berries grown for the fresh market. At least 1 trap per acre should be employed. Berries grown for processing may require treatment when fewer than 5 flies per trap per week are captured.

Where can the traps be purchased? Sticky-coated, ammonium-acetate-baited fluorescent yellow rectangles can be bought from Zoecon Corporation, 975 California Avenue, Palo Alto, California 94304, at a cost of about $1.00 each. Each rectangle will probably need replacing with a new one at mid-season owing to accumulation of large numbers of other large insects which may cover up and obscure the smaller maggot flies on the trap. Sticky-coated 3-inch red spheres, likewise baited with ammonium acetate, may be purchased for about $1.00 each from New England Insect Traps, Box 301, North Amherst, Mass. 01059. Such spheres are quite selective, capturing relatively few other insects. They will last many seasons and require coating with Tanglefoot only at the beginning of the season and perhaps again after a series of heavy rains. Whichever type of trap you choose to use, it should, over the long term, pay you dividends in reduced spray costs for this insect.

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POMOLOGICAL PARAGRAPH

Ethephon's use to promote early-ripening of McIntosh. Our suggestions for ethephon use on McIntosh are based on 3 time periods for sale of ethephon-treated fruit --- prior to normal harvest time (Labor Day or shortly after), during normal harvest, and after several months of storage. To have well-colored McIntosh by Labor Day, we suggest applying ethephon at 2/3 to 1 pint plus 20 ppm 2,4,5-TP 8 to 12 days prior to anticipated harvest. These suggestions have worked well at our Horticultural Research Center. In 1975, we applied 1 pint of ethephon plus 20 ppm 2,4,5-TP with an airblast sprayer on August 27 and had adequate color for harvesting by September 2. In 1976, we applied the same mixture on August 16, and harvested the fruit August 26.

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SOME DETAILS TO CONSIDER WHEN HARVESTING AND STORING APPLES

F.W. Southwick
Department of Plant and Soil Sciences

Pre-Harvest Conditions

1. Abnormally high temperatures during the few weeks prior to harvest tend to make most apple varieties more susceptible to storage scald in both regular and CA storage.

2. Preharvest drop tends to be most severe when: (a) hot weather prevails; (b) trees have a large crop; (c) foliage is damaged by drought, frost, insects and diseases; (d) trees are deficient in boron, magnesium and potassium; and (e) trees have a high nitrogen level.

3. The preharvest drop control materials NAA and 2,4,5-TP are effective when applied before damage to the foliage occurs - not afterward.

4. Apples continue to increase in size as long as they remain attached to the tree. A significant increase in total bushels harvested is possible by delaying harvest whenever such action suits your marketing strategy. Of course, preharvest drop control, fruit maturity and susceptibility to various fruit disorders must be kept in mind.

Harvest

1. There is no single optimum maturity date for a variety during the picking season for fruit to be sold throughout a 9-month marketing period. For example, the desired maturity of apples for immediate post-harvest sale may be much more advanced than for regular or CA storage.

2. McIntosh for CA storage should range in flesh firmness from 15-17 pounds and possess at least 50 percent red color. Such fruit will be less susceptible to storage scald and be in a firmer, juicier condition in April and May than more mature, later picked apples. However, McIntosh placed in regular storage (until January or February) will develop less scald when the fruit is more mature at later picking dates. With other varieties, the less mature fruit is invariably more susceptible to scald regardless of whether it is held in regular or CA storage.

3. Immature fruit of all varieties is subject to more bitter pit, shriveling, and brown core during storage than more mature apples.

4. Overmature fruit is more susceptible to water core, internal breakdown, flesh softening and rots than less mature fruit either prior to harvest or during storage.

5. Avoid excessively large fruit of a given variety when selecting apples for long-term storage. Such fruit have much poorer keeping quality than smaller sizes. Usually fruit from light bearing older trees and from very young trees are often unsuited for CA storage because of their large size.

6. Alar-85*-treated McIntosh scheduled for storage should be harvested at the same time as untreated fruit even though the Alar-85-sprayed fruit may be a pound or two firmer than similar apples which have received no Alar-85. Most of the flesh firmness advantage Alar-85-sprayed fruit possesses at harvest is lost during the first few months of storage. The prime value of Alar-85 on bearing McIntosh trees is to provide superior preharvest drop control during the latter part of their picking season rather than serve this purpose when McIntosh for CA storage should be harvested (early part of the picking season). The magnitude of preharvest drop is often relatively minor early in the McIntosh harvest season and can be controlled quite well with NAA (naphthaleneacetic acid).

7. Late varieties which may be frozen on the trees should never be harvested until the fruit thaws completely. Harvesting frozen fruit will result in visible injury at points where they are grasped by pickers and wherever they come into forceful contact with other fruit in picking or storage containers. Apples which have been frozen can be expected to have hastened flesh softening (even if no visible injury is present after thawing) and a shortened storage life. The lower the freezing point between 22^{o} and 28^{o}F, the greater the potential loss of flesh firmness. Dispose of such fruit as rapidly as possible. If the fruit temperature falls below 22^{o}F, visible injury to the fruit tissue can be expected once thawing takes place.

8. All varieties subject to storage scald should be treated prior to storage with a suitable inhibitor if they are to be stored beyond early January. Suggestions for prestorage treatments to control storage scald and decay organ-

*Trade name

isms can be obtained from your Regional Fruit Specialists.

9. Harvested fruit should be moved into storage no later than 12 to 24 hours after picking. Long delays between harvesting and storage result in greater susceptibility of CA McIntosh to scald, other senescence disorders, and loss of flesh firmness.

Storage

1. Ideally, apples placed in storage should be cooled from field temperatures to 32°F within 24-36 hours. Rapid cooling of apples following harvest is of major importance in maximizing their marketable life. Rapid removal of the field heat from fruit stored in bins or boxes requires recognition and understanding of proper stacking procedures to obtain the best possible rate of heat exchange from fruit in the center of these containers to the cooling unit. If an extended period is required to reduce the temperature to 32°F, one can expect a much more rapid deterioration of the fruit from senescence disorders and loss of flesh firmness than would result following fast cooling to 32°F.

2. When apples are placed in CA storage, we recommend a delay in sealing the room until the fruit is cooled to 32°F even though the CA room (as for McIntosh) will be held at 38°F after the room is sealed. However, complete loading and proper cooling of an individual CA room should be accomplished in about 2 weeks. Any extension of this period, particularly for McIntosh, may result in a substantial increase in their storage scald susceptibility. Generally, CA storage tends to reduce the scald susceptibility of McIntosh as compared to similar fruit held in regular storage. However, delaying the sealing and CA atmosphere development for 3 to 5 weeks beyond the time McIntosh are initially loaded into a room may make this variety about as susceptible to scald as similar fruit placed in regular cold storage. Of course, if long periods of time are required before a CA room for McIntosh can be sealed, the application of a scald inhibitor is essential.

3. Since questions are frequently asked concerning the atmosphere and temperature requirement for CA storage of apples, the following table represents our present recommendations.

Variety	Carbon dioxide (Percent)	Oxygen (Percent)	Temperature (Degrees F)
Cortland*	5	3	38
Macoun	5	3	38
McIntosh	5	3	38
Baldwin	2	3	32
Cortland*	2	3	32
Delicious	2	3	32
Empire	2	3	32
Golden Delicious	2	3	32
Idared	2	3	32
Northern Spy	2	3	32
Rome Beauty	2	3	32
Spartan	2	3	32

*Cortland may be stored at either CA atmospheres and temperatures listed.

Varieties with the same CA atmosphere and temperature requirements can be stored together providing the room can be fully loaded, cooled and ready for sealing in approximately 2 weeks.

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 42 (No.6)
NOVEMBER–DECEMBER 1977

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NEW ENGLAND FRUIT MEETINGS AND TRADE SHOW

The New England Fruit Meetings and Trade Show will be held at the New Hampshire Highway Hotel, Concord, New Hampshire. The meetings are scheduled for January 4 and 5, 1978.

The hotel is accessible from all major highways. Routes 3 and 93, which lead to Concord, are accessible from anywhere in Massachusetts. Persons coming from Western Massachusetts and Southern Vermont may find the most convenient route to be Routes 9 or 10 to Keene, New Hampshire, and then Routes 9 and US 202, 89 and 93 to the Highway Hotel.

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MULCHING STRAWBERRIES FOR WINTER PROTECTION

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Winter injury is often one of the most limiting factors for strawberry production in northern regions. Although most New England growers mulch their plants in the fall to prevent winter injury, it may still occur, especially when snow-cover is lacking. Nevertheless, growers recognize the value of mulch but are often unsure when to apply it and how much to use. A brief review of the physiological changes occurring in strawberry plants during the fall may help eliminate some of the confusion.

Plants generally develop hardiness in response to fall environmental conditions. Strawberries cease growing and enter rest in late-summer and early-fall as daylength and temperatures decrease. During this time, sugars accumulate in the leaves and roots, leaves become less upright, and red color may develop in petioles and leaves. Hardiness increases significantly after exposure to several frosts, but may be reduced by subsequent warm weather. Cool weather is then needed to regain the lost hardiness. Strawberries usually continue to harden into mid-winter.

Because hardening conditions are not the same each fall, the rate of hardiness development and the degree of hardiness attained differs from year to year. If mulch is applied before near freezing temperatures occur, plants often fail to harden sufficiently, and may be injured more severely than unmulched plants. Therefore, mulch should not be applied according to the calendar date, but on the basis of fall weather conditions. Researchers in Minnesota (1) found plants mulched in early October were killed when exposed to 27°F, while those mulched in early November survived 18°F. Although the critical temperature varies with the variety, well-hardened plants may be severely injured or killed when exposed to 10°F, while blossom primordia in the crowns may be injured at 25°F. A good rule to follow is to mulch after several days of near-freezing temperatures, but prior to severe cold.

Many materials are used for mulch. They should be free of weed seed, and be loose and light so as not to mat down, but heavy enough so that it will not blow away. Canadian researchers (2) found straw provided better protection than sawdust or wood chips. Marsh hay appears to be as effective as straw. Both of these materials lose much of their insulative properties when they become wet, ice-filled, or matted down.

We have monitored strawberry crown temperatures under several mulching treatments (Table 1).

Table 1. Minimum air temperatures, minimum temperatures of strawberry crowns of mulched and unmulched plants, and snow depth. Data were collected in 1966 and 1975.

Air temp. (°F)	Snow depth (inches)	Straw mulch (tons/A)	Crown temp. (°F)
	1975		
-6	8	3	27
-6	8	6	27
-6	8	0	24
-6	0	0	3
	1966		
-18	0	6	20
-18	0	0	5
-12	7	6	25
-12	7	0	22

With an air temperature of -6°F, plant crown temperature was 27°F under both 3 and 6 tons of straw/A, with 8 inches of snow cover. Plants with 8 inches of snow but which were not mulched had crown temperature of 24°F. Plants that were not mulched and lacked snow cover were at 3°F, which is below the critical temperature for strawberry plants. Crown temperatures are influenced by the present temperature as well as the temperature of several previous days. For example: in 1975, there were 5 consecutive days when the temperature fell below 15°F. The next day was -6°F and at that time the crown temperatures were 3°F. In 1966, however, several warm days followed by a temperature of -18°F produced a higher crown temperature of 5°F.

The data in Table 1 suggest that mulch provides little additional protection when plants are covered with 7 inches or more of snow. When snow cover is lacking, however, 6 tons of straw per acre may provide up to 15°F protection. Mulching at rates greater than 3 tons/A would probably add little protection especially in areas where snow cover is reliable.

LITERATURE CITED

1. Brierley, W.G. and R.H. Landon. 1944. Winter behavior of strawberry plants. Minn. Agr. Exp. Sta. Bul. 375.

2. Collins, W.B. 1966. Effects of winter mulches on strawberry yields. Proc. Am. Soc. Hort. Sci. 89:331-335.

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PROCEEDINGS OF THE NATIONAL CONTROLLED ATMOSPHERE RESEARCH CONFERENCE

In the Sept.-Oct., 1977, issue of Fruit Notes, we presented some of the points discussed at the National Controlled Atmosphere Research Conference held in April, 1977. The full proceedings of the conference are now available. They consist of 300 pages of information on CA and hypobaric storage structures and equipment, transport research and applications, quality maintenance, prestorage treatments with CO_2, atmosphere modification, and insect and disease control during storage. It concludes with specific requirements and recommendations for transport and storage of individual crops.

These proceedings are available for $8.00, postage paid, for U.S. and Canadian delivery, and $9.00, postage paid, for overseas delivery. Please request Horticultural Report No. 28, and enclose a check or money order written to the order of Michigan State University. However, this order should be sent to the Department of Horticulture, Michigan State University, East Lansing, Michigan 48824.

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A VISITOR'S VIEW OF THE APPLE INDUSTRY IN BRITISH COLUMBIA

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The major fruit growing area in British Columbia is centered in a narrow band in the Okanogan Valley extending from the Washington State border north about 100 miles. Orchards in general are quite small and many growers depend upon apple production as a supplement to other income. Expansion of the industry will be limited because most good sites are now in production and orchards established further north are likely to be damaged by periodic winter freezes.

There are about 33,000 acres of fruit trees in British Columbia, with 25,000 of these being planted to apples. Apple production generally ranges between 9 and 10 million bushels. Approximately 40% of the apples are Delicious, 30% McIntosh, 10% each of Golden Delicious and Spartan and the remaining 10% miscellaneous varieties. The acreage of Spartan is not expected to increase due to a serious problem with internal breakdown in storage. There are relatively few old orchards due to freezes during the past 10-12 years. This has made possible the replacement of these older orchards with more acceptable varieties and strains.

Most fruit growers are planting trees on size-controlling rootstocks. One of the most important factors when choosing a rootstock in British Columbia is its susceptibility to collar rot. Many of the commonly-planted rootstocks in Massachusetts, including M.7 and M.106, are too susceptible to collar rot to be planted extensively. However, the vigorous rootstock M.4 has been used successfully because of its resistance to the disease. Recently, M.26 has become popular because it induces early bearing, partial dwarfing, and has resistance to collar rot. Under British Columbia conditions, it produces a tree similar to or slightly smaller than one on M.7.

Orchards in British Columbia are being planted heavily to spur-type McIntosh and Delicious. It was estimated that for every non-spur McIntosh being planted there were 10 spur-type McIntosh going into the ground.

Tree spacing in British Columbia is generally closer than that presently suggested in Massachusetts. A number of growers have planted spur McIntosh 8 x 18 ft or spur Delicious 10 x 20 ft on M.4 roots, with the intention of removing every other tree when the trees begin to crowd. However, a poor orchard often results because tree removal is delayed and the lower limbs become weak.

The fertilizer program followed in British Columbia differs in many respects from that in Massachusetts. All orchards are deficient in boron (B). A lack of B can result in poor tree growth and a light crop of misshapen fruit. It is recommended that broadcast applications of B be made every third year in early August. However, many growers apply B solely in the spring as a spray application.

B deficiency appeared in many British Columbia orchards in 1977. In many cases, the injury was severe enough to reduce the crop. This situation occurred, in most instances, in orchards where no late-fall irrigation was applied and where the grower had not applied B to the soil for many years because of primary reliance on a summer spray application of B.

Generally, annual applications of nitrogen (N) are made. Growers are steadily changing from the use of ammonium nitrate to urea. In many instances, N applications are split, with half being applied in November and the remainder being spread in the spring. Calcium, zinc and magnesium may also be deficient and require application in British Columbia orchards.

Both pesticides and plant growth regulators are applied with sprayers delivering about 50 gal/acre. Most growers do not have spray equipment to make dilute applications.

Chemical thinning of apples, including McIntosh, is often done with dinitro materials (Elgetol*). This is applied during the full bloom period. Elgetol* acts by burning the stigmas of unpollinated flowers and thus reducing the number of fruit that set. If the weather turns excessively moist or cool during the first 4 days after the spray application, serious overthinning and leaf burning may occur. Sevin* is not used as a thinner because of its detrimental effects on the predator mite population. Consequently, the thinning results I saw in British Columbia on McIntosh were much poorer than we would expect to have in Massachusetts. Often there was overthinning of the bottom limbs and clustered fruit at the top of the tree. Clusters of fruit were generally broken up by hand-thinning after June drop.

The major stop-drop compound used on McIntosh is 2,4,5-TP. Very serious carryover effects of 2,4,5-TP showed up in the spring of 1977 from applications made late in the summer of 1976. Delayed foliation at shoot tips, small leaf size, and reduced fruit set and fruit size were all symptoms of the carryover effects. This problem was serious enough to reduce the McIntosh crop in British Columbia in 1977. The problem may have been particularly severe in 1977 because the application of 2,4,5-TP in 1976 was made prior to and during a period of very hot weather, and also because the 2,4,5-TP was applied as a concentrate spray. Alar-85* is normally not used as a stop-drop material and NAA apparently is not effective enough.

Approximately 300,000 boxes of McIntosh each year are treated with ethephon to advance ripening for sale of these fruit soon after harvest. It is recommended that both NAA and 2,4,5-TP be included with the ethephon and that these chemicals be preceded by an application of Alar-85* in mid-summer.

Growers are experiencing increasing problems in establishing trees on old sites. It now is recognized that the poor growth is due to soil acidity where trees previously grew. Lime has not been added routinely in the past because the fruit-growing area is arid and thus the soil has had a pH of 7.0 or greater. In existing

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*Trade name

orchards, soil pH between the rows may still be near neutral. However, in the soil within rows the pH may be well below 5.0. It is now recommended that lime be added in the rows of an older orchard before it is removed. Using this method, the lime may be added more precisely in the areas that require lime and not in the areas between rows that do not require pH adjustment.

In conclusion, it was interesting to observe the innovations and contrasts of 'McIntosh' culture in an area where orchards are generally small and the weather during the growing season is dry and sunny. Growers in British Columbia have cultural problems but they are in many instances different from the ones in Massachusetts.

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APPLE APHID CONTROL THROUGH NATURAL ENEMIES

Roger G. Adams, Jr. and Ronald J. Prokopy
Department of Entomology

Aphids are small soft-bodied, pear-shaped insects that may be either winged or wingless. They may cause considerable injury to apple and are most easily recognized by the presence of a pair of tube-shaped structures known as cornicles at the end of their abdomens. In this article, we discuss the apple aphid *Aphis pomi* and its natural enemies in Western Massachusetts apple orchards. We focus in particular on our research on the ecology of its major predator, a midge. We conclude with new findings on spray materials which are least toxic to the midges and allow their build-up.

The apple aphid, formerly known as the green apple aphid, may be found in dense colonies on apple throughout the growing season. Serious losses may result in commercial orchards if populations are not suppressed. Apple aphid injury may be caused in a number of ways. Feeding on fruits may result in the production of "aphis apples," while foliar feeding may result in leaf curling and stunting of terminal growth. Aphid excretion of honeydew (a sticky, sugary waste product visible as clear spots about 1/16 inch in diameter on leaf and fruit surfaces) and subsequent growth of blackish sooty mold fungus on the honeydew can result in reduced photosynthetic activity of leaves and contamination of fruit. Recent evidence that the apple aphid can artificially transmit the organism causing fire blight in apples could lower the economic threshold level for this pest. Currently, several sprays are required in local orchards to assure successful control. One of the aims of our apple pest management program is reduction in spray applications without increased aphid injury. To achieve this aim, we are hopeful that aphid natural enemies will play a greater role in aphid control than they now do.

The most frequently reported natural enemies of aphids are lady beetles, lacewing larvae, syrphid fly larvae, and anthocorid bugs. However, while studying the natural enemy complex of the apple aphid in a Western Massachusetts apple orchard, we found quite a different species to be the dominant predator: the larval stage of a cecidomyiid midge by the name of *Aphidoletes aphidimyza*.

The adult midge is a small delicate, fly-like insect which can lay up to 100 eggs in aphid colonies. The eggs are tiny and orange, resembling particles of paprika. They hatch into larvae in about 3 days. The larvae are small (about 1/10 inch long), bright orange colored maggots that feed on many species of aphids. Larval development is completed in 7 to 10 days, at which time they drop to the soil to form cocoons. The complete life cycle from egg to adult usually takes about 3 weeks. The species overwinters in the soil as a larva within a cocoon.

Population densities of the apple aphid and its natural enemies were recorded from 1974 through 1976 in an unsprayed section of an apple orchard at the Belchertown Fruit Research Center. Throughout the study period, the cecidomyiid was by far the most abundant predator found. A total of 1902 individuals appeared on sampled foliage. Syrphids were next most common, with 177 individuals found. Lacewing larvae, lady beetles, and anthocorids appeared only occasionally.

The cecidomyiid was responsible for high apple aphid mortality and dramatic aphid population reductions. Apple terminals were caged with various aphid to cecidomyiid density ratios to study the feeding behavior of the larvae. In every case, those aphid colonies caged with cecidomyiids were either reduced or decimated within 12 days. The overall mean number of aphids killed per cecidomyiid during its larval development was 28, ranging from 4 to 65, depending on predator and prey abundance. During feeding, cecidomyiid larvae paralyze aphids by injecting salivary toxins. Since there is no struggle by the aphid, killed aphids appear as shrivelled, blackish bodies with the mouthparts still anchored in the leaf.

Our studies showed that predaceous cecidomyiids appear in Western Massachusetts apple orchards in mid-June. However, by early June, apple aphid populations have already reached injurious levels in some orchards. Therefore, despite control of summer apple aphid populations by the cecidomyiid, it appears too late in the season to prevent damage due to early-season aphid activities.

Why don't cecidomyiids appear until mid-June? Where do they overwinter - within or outside the orchard? To find answers to these questions, emergence cage studies were conducted during the spring of 1976. Tent-like cages, containing yellow sticky traps used to capture emerging cecidomyiid adults, were placed in the Belchertown orchard under leaves which harbored cecidomyiid larvae the previous fall. On June 11, 4 cecidomyiid adults were captured within such cages. Thus, a portion, if not the majority, of the cecidomyiid population overwintered within the apple orchard, but adults did not emerge until mid-June. This last finding agrees with the observed first appearance of cecidomyiid eggs on foliage sampled in previous years. Therefore, due to the lack of biological synchrony between predator and prey, the cecidomyiid is unable to prevent early season aphid damage. The cecidomyiid is still in the soil in the cocoon stage while early damage is occurring.

For season-long control, apple aphid populations need to be maintained below economic threshold levels until the cecidomyiid predator arrives to control summer aphid populations. We believe that the economic threshold level of the apple aphid (that is, the point at which some remedial action should be taken) is approximately 50 apple aphids per terminal leaf.

Drs. Madsen, Peters, and Vakenti of the Summerland Research Station in British Columbia were able to reduce the number of sprays needed to obtain apple aphid control by monitoring aphid populations. Their results are presented in an article entitled "Pest Management: Experience in Six British Columbia Apple Orchards," which appeared in the August, 1975 issue of the Canadian Entomologist. Sprays were recommended when 50 per cent of the leaves sampled were aphid infested.

Pesticide sprays have been shown to have a detrimental effect on many natural enemies of pests. For example, syrphid flies are abundant in late May and June in many commercial orchards. They lay oval, white eggs about 1/16 of an inch long on apple foliage in or near aphid colonies. The eggs hatch into grayish-white larvae which are ferocious aphid predators. However, syrphids are often though not always, killed by pesticide sprays. Further studies are needed to determine which materials allow syrphid survival.

We are currently in the process of studying the toxicity of orchard pesticides to the predaceous cecidomyiid to determine its susceptibility, tolerance, or resistance to some of the more recommended materials. Cecidomyiid eggs collected from the Belchertown orchard were placed on adhesive tape affixed to glass slides. The slides were dipped for 5 seconds in chemicals mixed with water at dosages equivalent to 1X concentration in an orchard sprayer. Each chemical was replicated 5 times with 10 eggs per replicate. Egg mortality was determined 72 hours after treatment. Toxicity of pesticides to young larvae hatching from treated eggs (early larval mortality) was determined by counting the dead larvae on microslides 72 hours after treatment. Toxicity to late instar larvae was determined by immersing third and fourth instar larvae in pesticide mixtures for 10 seconds. Mortality was checked 96 hours after treatment.

Table 1. Laboratory toxicity of orchard pesticides to eggs and larvae of the predaceous cecidomyiid, *Aphidoletes aphidimyza*.

Pesticide	Dosage/100 gal spray	% egg mortality	% early larval mortality	% late larval mortality
Imidan 50 WP	1-1/2 lbs	8	24	18
Guthion 50 WP	5/8 lb	86	14	18
Guthion 50 WP (Fitchburg)	5/8 lb	6	38	6
Sevin 50 WP	1 lb	72	21	--
Zolone 3 EC	1-1/2 pts	4	0	10
Thiodan 50 WP	1 lb	6	29	46
Systox 6 EC	5 ozs	8	57	32
Phosphamidon 8 EC	1/4 pt	34	27	16
Plictran 50 WP	5 ozs	14	0	12
Omite 30 WP	1-1/2 lbs	6	2	--
Thiram 50 WP	2 lbs	6	0	8
Captan 50 WP	1 lb	8	2	6
Glyphosate 4 EC	4 qts	-	-	10
Check	---	4	6	8
Check (Fitchburg)	---	5	0	3

Per cent mortality was generally low with the exception of the Guthion (Belchertown population) and Sevin treatments, where 86% and 72% of the eggs, respectively, failed to hatch. Phosphamidon was moderately toxic to *Aphidoletes* eggs. In contrast to the high toxicity of Guthion to *Aphidoletes* eggs collected from Belchertown, mortality of eggs collected from a commercial apple orchard at Marshall Farm in Fitchburg, MA and treated with Guthion was very low (6%). Thus, differential Guthion resistance appears to exist in Aphidoletes populations collected from 2 areas of the state. The Marshall Farm apple orchard in Fitchburg has received 7 to 8 Guthion treatments annually for 7 years at the dosage rate of 1/2 lb/100 gal. The section of the Belchertown apple orchard from which Aphidoletes eggs were collected for use in toxicity tests had not received insecticide or miticide treatments for 6 years.

A few materials that were of low toxicity to *Aphidoletes* eggs were moderately or highly toxic to young larvae hatching from treated eggs. Such early larval mortality was highest (57%) for Systox treatments, while Imidan, Thiodan, and Guthion (Fitchburg) were of moderate toxicity (24 to 38%) to young larvae.

Thiodan was found to be most toxic (46% mortality) to late instar larvae while Systox was of moderate toxicity (32%). The fungicides Captan and Thiram, the miticides Plictran and Omite, and the herbicide Glyphosate were all of low toxicity to *Aphidoletes* eggs and larvae.

These results show that Guthion, Systox, and Sevin had very detrimental effects on the predaceous cecidomyiids from Belchertown. Phosphamidon treatments were moderately toxic to *Aphidoletes* eggs and young larvae hatching from treated eggs, thus resulting in overall high mortality. Zolone was the only insecticide tested that had little effect on the eggs and young larvae of Belchertown cecidomyiids. However, Zolone has been found to be very highly toxic to the most important mite predator in Massachusetts, *Amblyseius fallacis* (Robert Hislop, personal communication) (see March-April, 1977 issue of *Fruit Notes* for more information on this mite predator). Thiodan and Imidan were moderately toxic to Belchertown cecidomyiids and, according to recent lab tests by Robert Hislop, of rather low toxicity to *A. fallacis*. Therefore, Imidan should be the broad-spectrum insecticide of choice and Thiodan the aphicide of choice if one desires good insect and aphid control while allowing at least moderate survival and build-up of our most important aphid and mite predators. The more abundant these predators, the fewer pesticide applications that are needed.

We emphasize that these findings are based on tests of a single population of cecidomyiids which has its own unique genetic structure and has been exposed over the years to a certain array of pesticides. The genetic structure and pesticide exposure history of cecidomyiids undoubtedly varies from orchard to orchard. Indeed there is some indication from our field observations that cecidomyiid populations in certain commercial orchards in Massachusetts may be more tolerant of Guthion treatments that Belchertown populations. We are currently studying this aspect.

In conclusion, we reiterate that the more abundant the aphid predators, the fewer aphicide applications that are needed.

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TRENDS OF MICHIGAN TREE FRUIT INDUSTRY

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Michigan State University
Part I.

Composition of the Industry

Michigan's fruit industry includes about 66,000 acres (A) of apple, 41,000 A tart cherry, 13,600 A sweet cherry, 18,000 A peach, 8,000 A plum and 6,500 A pear. Pear acreage has declined rapidly because of pear psylla and fireblight control problems, low yields, and declining markets. Peach acreage has also decreased because of winter injury, valsa canker, X-disease, lack of satisfactory chemical fruit thinning compounds, and need for seasonal labor for pruning and multiple selective harvesting. The future of the sweet cherry industry is uncertain. About two-thirds of the crop is brined for maraschino cherries and the future of this market depends on development of a satisfactory alternative to the dye that was recently banned for artificially coloring maraschino cherries. Many Michigan orchardists grow small acreages of plums because they are relatively easy to produce and can be readily machine-harvested with cherry harvesting equipment. About two-thirds of the crop is processed.

Michigan produces two-thirds of the nation's sour cherry crop and this crop continues to increase in importance. Several major changes in this industry offer it an optimistic future. The crop is mechanically harvested, eliminating a major harvest labor concern. Expanded grower processing provides the producer increased control over the marketing of his product. The industry has marketing legislation to provide for diversion or "set-aside" in surplus years for market stability, and has a promotion program to encourage market expansion. The industry has some production and marketing problems but appears to have a very stable future in Michigan.

With 66,000 A, apples are the largest tree fruit crop in Michigan. In the most recent tree survey (1973), the 5 leading varieties were Delicious (24%), Jonathan (22%), McIntosh (11%), Golden Delicious (10%) and Northern Spy (8%). About 80% of the state's apple acreage was on seedling rootstocks and 20% on size-control rootstocks. Approximately 14% of the acreage was planted between 1968-1972 and two-thirds of these trees were on size-control rootstocks.

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[1]Presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association on July 13, 1977.

The 1973 tree census data indicated that Delicious should replace Jonathan as the major apple variety. However, much will depend upon the performance of this variety on size-control rootstocks, since 72% of the Delicious non-bearing acreage in 1973 was on these types of rootstocks. Delicious is extremely vulnerable to frost and fruit set is frequently poor.

McIntosh has been one of Michigan's leading apple varieties for many years, but non-bearing trees represented a very low percent of the total McIntosh trees in 1973. This fact plus anticipated tree removals indicate that McIntosh production in Michigan will decline in the future. The fruit are easily bruised during harvest and many growers experience difficulty obtaining adequate red color on this variety. Recent plantings have been primarily spur-type McIntosh.

Northern Spy is not being planted heavily. It is very slow to come into production and is grown primarily for the processing market. Growers are more interested in dual purpose apple varieties and summer varieties. Idared is becoming very popular, since it bears at an early age, has a semi-spur type growth habit, produces large attractive fruit which have excellent packout, and stores well. It has returned a premium to Michigan growers during late-season marketing periods.

We anticipate an increased production of summer apple varieties because young-bearing trees and non-bearing trees represented a very high percentage of the total for summer varieties in Michigan orchards in 1973. Paulared and Jerseymac predominate in recent plantings of summer varieties.

Irrigation

Young trees have limited root development and are readily stunted by prolonged drought conditions. Thus, many orchardists have found that trickle irrigation is beneficial in young plantings. Dr. A.L. Kenworthy, in our Department of Horticulture, has also obtained some interesting results applying nitrogen (N) through the trickle system. He cooperated with 2 commercial orchardists in northern Michigan and applied N in 4 applications at weekly intervals during June. The treatments consisted of N applied at the same rate used by the growers when applying a ground application in late fall or early spring, and at rates equal to 50 or 25% of the grower rate. Ammonium nitrate or urea was used depending on the grower's preference. He found no significant differences in leaf N among the 3 N rates applied through the trickle irrigation and the ground application applied by the growers. Half as much nitrogen applied through the trickle irrigation system appeared as effective as the grower's soil application. No yield differences have been observed.

The drought in the summer and fall of 1976 markedly affected Michigan's 1976 apple crop. In a number of orchards fruit did not mature uniformly on the trees suffering from severe moisture stress, with those around the periphery of the tree ripening earlier than fruit in the interior of the tree. This phenomenon was not as pronounced in irrigated orchards.

Harvest

Market demands for larger, redder apples increases the hazard of internal breakdown of Jonathan fruit. Control of internal breakdown is now achieved by a pre-storage water dip or drench treatment with a 4% calcium chloride solution. Unfortunately, calcium chloride is corrosive to most metals; thus, application equipment must be cleaned after use. Corrosion of nails or other bin fasteners also can be a problem. A fungicide is added to the calcium chloride solution to control storage rots. The solution can be utilized until it becomes excessively contaminated with accumulated soil or debris.

For many years, Michigan growers obtained adequate scald control on stored fruit by using DPA at 1000 ppm. In recent years, it has been necessary to increase the rate to 2000 ppm except for Jonathan, Idared and late-picked Rome Beauty, for which 1000 ppm appears to give adequate scald control.

Storage scald is controlled best when fruit is treated at normal orchard temperatures within a day or so after harvest. Cold fruit directly from the orchard or from storage for up to 2 weeks after harvest can be effectively treated for scald control but the maximum concentration of DPA must be applied. The chemical becomes less effective as the treatment is delayed but it is better to make a late application of the material to apples intended for long term storage than not to treat at all. A fungicide, either thiabendazole (TBZ) or benomyl, is added to the scald inhibitor solution to prevent widespread development of blue mold, soft rot and gray mold diseases on apples during subsequent storage and handling.

Ethylene is a gaseous plant hormone that causes fruits to ripen. It is produced at a constant low rate during the last few weeks of growth and development of immature fruit. The ethylene production rate abruptly increases immediately preceding the onset of ripening, causing the internal atmosphere ethylene concentration to increase from about 0.1 ppm to 10 to 100 ppm over the course of several days.

Dr. D.R. Dilley has developed a colorimetric technique that enables storage operators to detect high ethylene levels in fruits as they begin to ripen. About 20 fruits are placed in a 10 liter dessicator, which is then filled with water. A vacuum is applied for about 5 minutes to withdraw gas from within the fruit. A sample of this gas, which collects in the head space of the desiccator, is introduced into an ethylene indicator tube which changes color from yellow to blue-green as the chemical indicator reacts with ethylene. A 200 ml. gas sample is tested.

Fruit testing about 0.5 ppm of ethylene or less is utilized for longest term storage. Apples testing about 2.5 ppm or less are considered satisfactory for mid-term CA and those testing greater than 5 ppm are used for short-term storage. Making such prestorage ethylene analysis and storing fruit accordingly has markedly improved the fruit firmness situation for one of our major long-term storage operators.

Marketing

A unique experience to Michigan fruit growers in the last few years is a marketing and bargaining bill known as Public Act 344. This state legislation provides for the establishment of a grower marketing organization possessing exclusive marketing control over a fruit crop when 51% of the growers of a specified marketing unit request certification to be the marketing agency for that commodity. The legislation pertains to marketing of produce for processing, not fresh market outlets. Processors, desiring to purchase the product of the grower marketing organization, must bargain with the organization on price and other terms relative to marketing of the grower's produce. All growers pay a fee, deducted by the processor, to the association for its bargaining services. The constitutionality of the legislation is being challenged in Michigan courts and growers have varying opinions about it. It has disrupted some long established grower-processor relationships. In 1976, bargaining returned more money to the Michigan producer of processed apples than that returned to growers in other competing areas in the eastern part of the country. There are some problems to be resolved in the marketing procedures but the other states are closely observing the performance of PA 344 in Michigan to determine if similar marketing legislation has merit for their respective areas.

Expansion of farm marketing through pick-your-own and retail farm markets has increased and been important to the success of many orchardists in recent years. It is more intensive in southeastern Michigan near the metropolitan Detroit area. However, it is being performed very successfully by many enterprising fruit growers throughout Michigan.

(Will be continued in the January-February, 1978 issue)

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FRUIT NOTES INDEX FOR 1977

(This index of major articles has been prepared for those who keep a file of Fruit Notes. The number in parenthesis indicates the pages on which the item appears.)

All pesticides listed in this publication are registered and cleared for suggested uses according to Federal registrations and State laws and regulations in effect on the date of this publication.

When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials.

NOTICE: THE USER OF THIS INFORMATION ASSUMES ALL RISKS FOR PERSONAL INJURY OR PROPERTY DAMAGE.

WARNING: PESTICIDES ARE POISONOUS. READ AND FOLLOW ALL DIRECTIONS AND SAFETY PRECAUTIONS ON LABELS. HANDLE CAREFULLY AND STORE IN ORIGINAL LABELED CONTAINERS OUT OF REACH OF CHILDREN, PETS AND LIVESTOCK. DISPOSE OF EMPTY CONTAINERS RIGHT AWAY, IN A SAFE MANNER AND PLACE. DO NOT CONTAMINATE FORAGE, STREAMS AND PONDS.

Cooperative Extension Service
University of Massachusetts
Amherst, Massachusetts
R. S. Whaley
Director
Cooperative Agricultural Extension Work
Acts of May 8 and June 30, 1914

DR. WM. J. LORD FN
PLANT & SOIL SCIENCES
FRENCH HALL

01002

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 43 (No. 1)
JANUARY / FEBRUARY 1978

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VARIETIES OF PEACHES FOR MASSACHUSETTS

J.F. Anderson
Department of Plant and Soil Sciences

Variety	Recommended for	Flesh color	Approximate harvest date*
Erly-Red-Fre	C & H	W	-42
Garnet Beauty	T	Y	-41
Brighton	T	Y	-41
Sunhaven	C & H	Y	-40
Harbelle	T	Y	-38
Jerseyland	C & H	Y	-32
Reliance	H	Y	-32
Raritan Rose	C & H	W	-30
Redhaven	C & H	Y	-28
Harken	T	Y	-25
Harbrite	T	Y	-25
Triogem	C & H	Y	-23
Sunhigh	C	Y	-18
Richhaven	C & H	Y	-16
Canadian Harmony	T	Y	-12
Cresthaven	C & H	Y	- 7
Elberta	C	Y	0
Jerseyqueen	T	Y	+ 3

C - Commercial H - Home garden T - Trial
Varieties so marked are not necessarily equally adapted to all sections of the state.
Y - Yellow flesh * - Days before or + after Elberta
W - White flesh about 9/15

Variety Notes

Erly-Red-Fre An attractive, white-fleshed, freestone peach of medium to large size. The flavor is excellent. The tree is vigorous and above average in bud hardiness.

Garnet Beauty* A bud sport of Redhaven. Resembles Redhaven in color and texture. It is a semi-clingstone. The tree is vigorous, productive and hardy.

Brighton* An attractive, high-quality, yellow-fleshed peach. The fruit is roundish, uniformly medium in size and highly colored. The flesh is medium firm, juicy, with very good flavor. The pit is semi-cling. The tree is vigorous, productive and medium-hardy.

*Recommended for trial on basis of performance in other areas.

Sunhaven An attractive, highly colored peach of good quality. The fruit is variable in size, medium to large. The tree is productive and above average in bud hardiness.

Harbelle* The fruit is large, attractive, with deep yellow ground color and a bright red blush. Flesh is a rich yellow, medium in firmness, of good quality. The stone is semi-free. The tree is productive and medium in vigor and bud hardiness.

Jerseyland A large, firm, juicy, freestone and of good flavor. The tree is large, upright and very productive. Bud hardiness is above average.

Reliance A medium-sized, roundish, yellow-fleshed freestone peach of fair to good flavor. Reliance is recommended as a very hardy variety for the home fruit planting.

Raritan Rose The fruit is large, round, attractive. The flesh is white, firm, and juicy. The tree is large, upright-spreading and productive. Bud hardiness is above average.

Redhaven The medium-sized fruit is highly colored, attractive and has firm flesh and fair flavor. The tree is very productive and requires heavy thinning.

Harken* A large, attractive, yellow-fleshed peach. The flesh is firm, juicy, of good quality and the stone is free. The tree is said to be vigorous, productive, and equal to Redhaven in bud hardiness.

Harbrite* A large, attractive, yellow-fleshed peach. The flesh is medium-firm, juicy and of good flavor. The stone is free. The tree is said to be very productive, hardy and moderately vigorous.

Triogem The fruit is medium to large and well-colored. The flesh is smooth, firm and has a very good flavor. The tree is medium to large, fairly vigorous and productive. The buds are of average hardiness.

Sunhigh A large, highly colored, freestone with firm flesh and excellent flavor. The tree is medium in size, productive and susceptible to bacterial spot.

Richhaven A large, attractive, highly colored freestone of very good quality. The tree is large, vigorous and productive. Bud hardiness is above average.

Canadian Harmony* A large, highly-colored, yellow-fleshed peach. The flesh is firm, juicy and of good flavor. The tree is vigorous, productive, and about equal to Redhaven in bud hardiness.

Cresthaven* A large, oblate-shaped peach with a dark-red blush. The bright yellow flesh is firm, juicy and slightly fibrous, there is some red at the pit. The flavor is very good. The tree is vigorous, productive and medium in hardiness.

Elberta The fruit is large, fairly attractive and a freestone. Flesh is firm, juicy and has fair flavor. The tree is large, vigorous and productive. The tree has wide soil and climatic adaptibility.

Jerseyqueen A large, attractive, oval-shaped peach. The flesh is yellow, firm and very good in flavor. The stone is free. Jerseyqueen is moderate in bud hardiness.

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TRENDS OF MICHIGAN TREE FRUIT INDUSTRY (PART II)[1]

Jerome Hull, Jr.
Department of Horticulture
Michigan State University

Rootstocks

Trees on dwarfing rootstocks have been planted extensively by Michigan apple growers in recent years. Nevertheless, clonal rootstocks have not solved all of our apple production problems. In fact they have introduced additional problems.

Clonal rootstocks used initially were M.2 and M.7. M.2 tended to be too vigorous and M.7 develops suckers from the rootstock and gives poor anchorage to the more vigorous varieties, notably Delicious.

MM 106 and MM 111 were popular rootstocks when they became available in the early 60's. MM 106 is a very productive and precocious rootstock but often produces a larger tree than anticipated, particularly with McIntosh and Paulared varieties. It also has been sensitive to cold injury and collar rot, particularly when planted on poorly drained soils or on some of Michigan's heavier textured soils. MM 111 has not been as dwarfing as desired and has been slow to initiate bearing on young trees.

M.9, popular for high density plantings, is not well adapted to Michigan's light textured orchard soils. Trees on this rootstock are readily stunted by drought and weed competition. The

[1]Part II of talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association on July 13, 1977.

stunted trees fruit early and fail to produce adequate vegetative growth for ample bearing surface.

Many orchardists are now planting trees on M 26, about which we have little experience or knowledge. There is also much renewed interest in M.7 budded higher than in older plantings on this rootstock, to enable deep planting for better anchorage.

MSU has developed several new apple rootstocks from seed of open pollinated trees of the Malling 1 through 16, Alnarp 2 and Robusta 5. These have been named the MAC (Michigan Apple Clone) series. The more dwarfing. well-anchored clones are MAC 1,4,9,10, 25,39 and 46. MAC 9 is the most dwarfing, producing trees slightly larger than M.9 but with better anchorage. Trees on these rootstocks will soon be under evaluation in commercial orchards.

Research and grower experience with apple trees on clonal rootstocks indicates such plantings should be placed on the most desirable fruit sites. Because the trees are smaller, bloom is much more susceptible to frost injury.

Orchardists have learned that trees on clonal rootstocks require excellent management practices if tree performance is to equal grower expectations. This includes site selection, soil preparation, planting techniques, weed control, soil and moisture management and early training. Some growers have erred and planted trees too close together, resulting in crowding before trees begin to produce fruit. This has prompted interest in transplanting of established trees and in summer pruning.

Frost Control

High density plantings on size-control rootstocks have accentuated the concern for ideal planting sites for apple orchards because the smaller tree is much more vulnerable to spring frosts. Growers with less than ideal sites often find it necessary to consider some method of frost control in high-density plantings. Frost protection with oil and propane gas has become very expensive. Overtree sprinkling has been demonstrated to be an effective way of preventing frost injury. This technique along with wind machines and helicopters, may become more popular in the future with orchardists requiring occasional frost protection. Research with a foliar application of rhizobitoxin suggests it may delay bloom several days to minimize frost injury.

Tree Management

Spur-type Delicious are very popular in both clonal and seedling rootstock plantings. Unfortunately, these trees have not always performed to grower expectation. The primary cause for disappointment probably has been management rather than rootstock, tree density, or a choice of strain.

Early training of young trees to prevent development of vigorous upright growth is important as a means of encouraging early fruiting. Spring-type clothespins can be attached to the leader above lateral shoots to force the laterals to grow more horizontally. (The snap portion of the clothespin is attached to the trunk when new lateral branches are 3 to 5 inches in length.) The clothespins are left in place 3 to 4 weeks. An apple picking bag is an excellent container for carrying clothespins when you place them in the trees or remove them later in the season. Round toothpicks can also be used on succulent lateral shoots for the same purpose. They are less expensive than clothespins but take more time to position in the trees. Either technique promotes development of wide-angle scaffold branches.

Many trees require branch spreading the second season. Wire spreaders 6 to 8 inches in length and cut with a sharp point on each end work well on upright growing branches in the second season. If additional spreading is required in subsequent years, wooden spreaders should be used. Orchardists use either wooden spreaders with nails inserted in each end of the spreader or wooden slats with V cuts in each end. Scrap lumber, sawed into varying lengths with <u>deep</u> V cuts in each end, work satisfactorily. Wooden spreaders with shallow V cuts are difficult to anchor in the tree and tend to slip along the scaffold and the leader.

Delicious is not the only variety that requires this detailed training. Paulared, a popular and heavily-planted summer variety, requires scaffold spreading over several years. Early spreading is particularly beneficial with this variety as established scaffolds split readily at the point of attachment to the leader during spreading in subsequent seasons with wooden spreaders.

Our experience with Paulared indicates that it is a rather vigorous variety and trees propagated on MM 106 tend to make fairly large trees. We also note a tendency towards biennial bearing. Fortunately, chemical thinning seems to overcome this difficulty. An application of 50 ppm NAD at petal fall or 7.5 ppm of NAA about 10 days after bloom has provided acceptable chemical thinning of young Paulared trees.

When planting trees on the less vigorous rootstocks (M.9 and M.26), we usually head the trees at 24 to 30 inches to encourage scaffold formation at the desired heighth on the trunk. Orchardists heading these trees at 30 to 36 inches often fail to obtain scaffold development within 2 feet of the soil surface and have "top-heavy" trees. Removal of the shoots just beneath the apical bud is an effective method of preventing formation of vigorous competing scaffolds. Establishment of such vigorous scaffolds makes it very difficult to maintain small tree stature.

Growers observe that leaving more than the usual number of scaffolds on Starkrimson Delicious results in more consistant annual production.

Summer Pruning

Interest in summer pruning has increased as orchardists have experienced difficulties with excessive tree vigor in high density plantings.

Summer pruning of fruit trees means different practices to different people.

Some orchardists consider summer pruning to be nothing more than removal of water sprouts, which are removed by hand or with pruning equipment in mid-season. This pruning removes the vigorous upright current season's shoots developing on the scaffolds and interior of the tree, especially in the vicinity of large pruning cuts that were made during dormant pruning.

Some clonal rootstocks and some of the interstem trees tend to grow numerous suckers from the rootstock. Orchardists who prune these off during the summer often refer to the practice as summer pruning.

Occasionally, an orchardist will perform dormant season-type pruning during the growing season. This involves moderate to heavy pruning with selective branch removal, including heavy cuts. Apple trees subjected to such pruning in June can be severely weakened or stunted and fruit may fail to grow to optimum size. Flowerbud initiation may be reduced and there is the possibility of temporarily throwing the tree out of production.

Summer hedging is the summer pruning concept of a few orchardists, but it has presented some problems. Initially, summer hedging was done in mid-season after the initial flush of growth. Regrowth occurred the same season in the vicinity of the pruning cuts resulting in development of "crows feet" type growth on the tree's periphery. Excessive shading in the tree's interior occurred. When summer hedging is delayed, less regrowth occurs, thus the most successful summer hedging of apples is normally performed in mid-August. Follow-up dormant pruning is also necessary but this consists of numerous fine cuts, thinning out the growth around the periphery of the tree plus removal of large branches causing crowding.

Summer pruning of young, vigorous, closely-planted apple trees that are crowding has consisted of selective heading-back and selective removal of shoots to reduce tree vigor. Upright vigorous shoots originating on the main scaffolds are removed. Cutting to a lateral or to an apple is most dwarfing. Delaying this pruning until August results in less difficulty with regrowth whereas if performed in June or early July, regrowth beneath the cut usually occurs, especially if pruning stubs remain.

Summer pruning to control tree size of bearing trees can affect shoot growth and flowerbud development. Shoots are usually pruned back to an apple and non-fruiting limbs are thinned out by cutting to a lateral branch. Suckers and upright growth are removed. Improved fruit color results and stronger flower buds develop in the interior area of the tree. Some orchardists leave about two inches of the current season's growth. Buds on this basal stub often regrow if cuts are made before August.

Peach trees respond more favorably to summer pruning than do apple trees. Pruning is usually delayed at least until bloom. Pruning cuts heal more readily when performed at this time of the year and the seasonal application of fungicides helps to reduce canker difficulties. Pruning at this time of the year also accomplishes some fruit thinning. This pruning is best described as dormant season-type pruning performed in early summer.

Summer hedging of peach trees has some advantages. The hedgerow concept of peach culture being researched at Purdue University involves summer pruning to dwarf the tree. Some Michigan orchardists have practiced mechanical topping of peach trees not trained to a hedgerow. The trees are mechanically topped and sometimes hedged in late July to control tree height and to admit light into the tree. There is very little regrowth the same season. Growth in the top of the trees the following season is less vigorous than that normally experienced with dormant-season hedging. Some vibration of the tree occurs during mechanical hedging and the nearer to harvest the practice is performed, the more fruit is shaken from the tree. Experience suggests that the tree should be very vigorous before being subjected to hedging.

Mechanical topping and hedging stiffens the scaffold branches and more growth occurs in the lower part of the tree. Admitting light to the interior of the tree has made possible the retention of more fine wood over a longer period of time. After several years, one peach grower had to thin-out the bottom area of the topped trees to enable pickers to reach fruit in the lower interior of the tree during harvest.

Peach trees subjected to severe early-season summer hedging have sometimes been severely winter-injured the following winter if extreme winter temperatures occur.

(Will be continued in the March-April, 1978 issue)

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POMOLOGICAL PARAGRAPH

<u>Supplies for trellising apple trees or growing them as slender spindles</u>. Dr. Loren D. Tukey, 103 Tyson Building, University Park, Pa. 16802, has compiled a listing of commercial suppliers of materials used in training trees on trellises or as slender spindles. You can obtain a copy of this list from Dr. Tukey.

SHELF LIFE OF PESTICIDES IN COMMON USE BY FRUIT GROWERS

Jeffrey Carlson
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Fruit growers frequently ask how long pesticides can be stored and still be effective. To answer this question, we have obtained information on 10 fruit pesticides in common use by consulting the manufacturers of these chemicals. The information below can give only a general idea of the shelf life as it is ultimately determined by conditions of storage, as well as chemical stability. The following storage conditions should be observed, also, please consult the label for any specific conditions for particular chemicals.

1. Store pesticides in a dry, well-ventilated place at temperatures above freezing.

2. Always keep a pesticide in its original container and make sure it is tightly sealed.

3. Store granular or powdered materials above the ground to avoid dampness.

4. Keep the temperature under 100°F if storing volatile compounds.

5. Keep volatile herbicides separate from other pesticides to avoid contamination.

6. Keep an accurate inventory of the stored chemicals. It is to your benefit to use up the pesticides that you've purchased as soon as possible. Don't forget about them in the back room. Rotate stock; use older materials first!

Common Name (Trade Name)	Shelf Life	Comments
phosmet,WP (Imidan)	2-3 years	Good stability under normal storage conditions.
dodine,WP (Cyprex)	2-3 years	Could be stored up to 5 years provided container is tightly closed and the room is kept cool and dry.
azinphos-methyl,WP (Guthion)	2 years	Under normal storage conditions.
thiram,WP (Thylate)	4 years	If kept dry, package is sealed tightly, and is stored at temperature under 100°F.

Common Name (Trade Name)	Shelf Life	Comments
simazine,WP (Princep)	Indefinite	Has been stored as long as 9 years under good conditions.
ammonium sulfamate, soluble salt (Ammate X)	At least 2 years	No low temperature limit but keep dry and under 100°F.
carbaryl,WP (Sevin)	several years	Wettable powder formulations have been stored up to 5 years without loss of effectiveness. Settling may occur in flowable formulations. It is important to shake the container in order to re-suspend components before using.
captan,WP	3 years	Under normal storage.
paraquat, liquid (Paraquat CL)	Indefinite	Extremely stable, no problems with storage.
captafol, flowable (Difolatan)	at least 3 years	After 2 years will tend to settle, needs good agitation.

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EUROPEAN APPLE SAWFLY: BIOLOGY AND DEVELOPMENT OF AN ADULT MONITORING TRAP

Elizabeth D. Owens and Ronald J. Prokopy
Department of Entomology

One of Massachusetts' more serious apple insect pests, the European Apple Sawfly (EAS), is a recent invader of North America. It was first discovered on Long Island in 1939, and may have been introduced there in the cocoon stage in root balls of ornamental crab apple trees imported from Europe. Since its introduction, it has spread through many of the fruit growing areas of the Northeast and is particularly troublesome in the New England states.

EAS adults first appear in apple orchards during full pink. The small, inconspicuous, wasp-like insect is not often observed by orchardists. When seen among the open flowers, it appears little different from other small insect pollinators, being dark-bodied with a yellowish head and underside, and having clear wings.

It is during bloom that female EAS deposit their small white eggs in the developing fruit. The egg-laying scar appears as a tiny brownish spot near the top of the caylx cup. The larvae hatch in about 10 days, with the first visible larval feeding damage being a small dark brown trail tunneled near the surface of the fruit. As a sawfly larva develops, it takes on the appearance of a dark-headed white caterpillar which migrates from fruit to fruit, tunneling directly to the core and feeding. Later larval damage is characterized by large masses of dark-colored frass at the feeding tunnel entrances. Most EAS-damaged fruit is lost during June drop. However, some remain on the tree and appear at harvest scarred with long yellowish scabs originating at the caylx and winding around the fruit surface.

It takes about 3 weeks and 4 to 5 fruits for a sawfly larva to mature. It then drops to the soil where it forms a cocoon, remaining in that state until adult emergence the following spring. Thus, there is only one generation annually.

Most commercial apple orchards do not have a population of sawflies arising from within the orchard, the reason being that standard pesticide spray programs include a petal fall spray which, if applied at the appropriate time, kills most or all of the larvae. However, since most New England orchards are surrounded by areas dotted with wild or abandoned apple trees, there is a continued threat of invasion by sawfly adults migrating in from the outside. To improve the orchardist's ability to determine if EAS is active in his orchard and, if so, to aid in the appropriate timing of spray applications against sawfly, we initiated the following research aimed at development of an effective and convenient trap for monitoring EAS adult population levels.

First, we spent many hours observing EAS adult activity in abandoned apple trees. Females were watched as they flew about blossoming trees on warm sunny days in May. We observed them feeding on pollen in open or partially opened blossoms and laying eggs in the caylx cup. Most adults were seen to land near or directly on the blossoms. This information led us to study (with the aid of a spectrophotometer) the visual reflectance pattern of apple blossom parts and to field test white surfaces that might prove to be effective blossom mimics.

In our first experiment, conducted in an abandoned orchard, we compared 6 x 8 inch rectangles hung vertically from apple tree branches and coated with the following colors of enamel paint: white, gray, black, yellow, green, blue, orange, or red. Clear plexiglas and aluminum-foil-covered rectangles were also tested. All traps were coated with a thin layer of Bird Tanglefoot*, a clear sticky substance that captures alighting insects. The results (Table 1) show that more EAS were captured on the white rectangles than any others tested. The fact that white captured

*Trade name

more than clear plexiglas (= a neutral surface) indicates that EAS captures on white were the result of positive attraction and not simply random collision.

Table 1. Comparative captures of EAS adults on rectangles of various colors. 7 replicates.

Rectangle	Total No.EAS adults captured
White	61
Gray	25
Clear plexiglas	18
Yellow	3
Aluminum foil	1
Black	1
Red	1
Green	0
Orange	0

Spectrophotometer analysis of light reflected from apple blossom petals and all other blossom parts (stamen, pistal, etc.) showed all flower parts to be high in reflectance at wavelengths from 400-650 nm, and very low in reflectance in the ultra-violet part of the spectrum (300-400 nm). The human visible spectrum is 400-700 nm; the insect visible spectrum is 300-650 nm.

In our second test, we therefore compared 5 types of white rectangles: zinc oxide, Day Glo primer, white enamel, lead oxide, and Zoecon pre-dyed white cardboard. The first three were low in ultra-violet reflectance (as were apple blossoms) and the last two were high in UV reflectance (unlike the blossoms).

The results (Table 2) showed that zinc white, which most closely mimics apple blossoms in color reflectance pattern, captured the most EAS. Day Glo and enamel whites captured nearly as many EAS as the zinc white, but Zoecon and lead white, which were poor mimics of apple blossom reflectance patterns, were not at all attractive to EAS. These results indicate that sticky-coated rectangles coated with either zinc oxide white or Day Glo primer white could be used to monitor EAS activity.

Table 2. Comparative captures of EAS adults on rectangles of various white surfaces. 10 replicates.

Rectangle	Total No. EAS adults captured
Zinc white	90
Day Glo primer	62
White enamel	49
Zoecon white	3
Lead white	0

Although further work is necessary to determine the optimum shape and placement of the traps, our research to date has resulted in an effective and convenient monitoring trap for adult EAS during apple bloom. Because most orchardists use domestic honeybees for pollination, it should be noted that the rectangular zinc white or Day Glo primer white traps were not very attractive to bees. In the next issue of Fruit Notes, we will discuss our research showing that such white traps are also effective for monitoring tarnished plant bug adult populations in apple orchards.

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Cooperative Extension Service
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FRUIT NOTES

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EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 43 (No. 2)
MARCH / APRIL 1978

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VARIETIES OF RASPBERRIES AND BLACKBERRIES
FOR MASSACHUSETTS

James F. Anderson
Department of Plant and Soil Sciences

Variety	Type	Recommended for	Harvesting Season
Gatineau	Red	C & H	Very early
Heritage	"	T	Very early
Madawaska	"	C & H	Early
Taylor	"	C limited	Midseason
Latham	"	C & H	Midseason
Sumner	"	C & H	Late
Heritage	"	C & H	Late Sept.
Clyde	Purple	H	Late
Brandywine	"	T	Late
Bristol	Black	H	Early

T = Trial   H = Home garden   C = Commercial
Varieties so marked are not necessarily equally adapted to all sections of the state.
*It is recommended that only Registered or Certified plant stock be used in establishing new raspberry plantings.

Variety Notes

Gatineau — The fruit is large, firm, good quality and moderately attractive. The plant is vigorous, productive and moderately winter hardy.

Heritage — Most often grown for the fall crop only. The summer crop is said to be moderate in production and the fruits slightly smaller than those produced in the fall.

Madawaska — Produces large, firm fruit of good quality and medium red color. The plant is vigorous, productive and winter hardy. It is susceptible to spurblight.

Taylor — Has been grown successfully on a commercial scale in the high elevations of Worcester and Franklin counties. Where it remains free of virus, the plants are tall, vigorous, hardy and productive and the fruits large, firm and have very good flavor.

Latham — The fruit is of good size, bright red in color and of average firmness and flavor. The plants are vigorous, productive and hardy when spurblight is controlled. Latham is susceptible to spurblight.

Sumner	The fruit is medium to large size, firm, and have very good flavor. The plants are hardy, vigorous and productive. Appears adapted to heavier soils.
Heritage	The berries of the fall crop are medium-sized, very firm, coherent, attractive and of very good flavor. The plants are vigorous and productive.
Clyde	A large fruited purple raspberry. The berries are attractive, firm, tart, and good in quality. The plants are very vigorous, hardy and productive. Clyde is most suitable for culinary use.
Brandywine	A new introduction from New York. The berries are said to be large, round, reddish-purple, firm, coherent, tart but of good quality. The plants are very vigorous and productive. Said to make a fine flavored jam.
Bristol	Black raspberries are not generally satisfactory in Massachusetts because of their great susceptibility to virus diseases. Bristol is one of the more desirable varieties. It produces large attractive, firm berries of good quality. The plants are vigorous, and productive as long as they remain free from virus diseases.

Blackberry Varieties

Darrow	The plants are hardy, vigorous and productive. The berries are large, firm, attractive and have good flavor.

Trailing types, such as Boysenberry, Loganberry and Youngberry are not sufficiently winter hardy and productive in most parts of the state. However, the Boysenberry has been reported as reasonably satisfactory in a few locations.

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POMOLOGICAL PARAGRAPH

Publication Available. Bulletin No. C-102 entitled "Establishment and Management of Compact Apple Trees" is available for 75 cents from The Bulletin Center, Cottage A, Thatcher Way, University of Massachusetts, Amherst, Mass. 01003. Make check or money order payable to the Massachusetts Cooperative Extension Service and send it to the address given above. This publication has under one cover the information on establishment and management of compact apple trees that appeared in serial form in *Fruit Notes* during 1976 and 1977.

PARTIAL BUDGETING OF MANAGEMENT ALTERNATIVES FOR FRUIT GROWERS

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Introduction

Fruit growers must make many decisions of both a short-term or long run nature. These decisions can range from those involving replacement of blocks or choice of varieties (which are very long run in nature) or those such as selecting a spray program, deciding on the size of a picking crew and purchase of packaging materials (which are short run in impact). Decisions can be of significant magnitude in a monetary sense or relatively insignificant. It is obvious that as the magnitude of financial committment increases, the attention paid to the consequences of such a decision on profitability should also increase.

The most important function of management is the planning and evaluation of the alternative courses of action that can be taken. The decision-making function is the true meaning of management. Thus, it is important that a manager become fully knowledgeable with the concepts of costs, revenues, and profits. He also must have a decision-making framework or "procedure" that he can follow in developing and analyzing his data so that the profitability of a course of action can be established. It should be clear that the exercise is one of planning or anticipating future events. This means that the manager must make some assumptions or projections with regard to expected future prices, costs, yields, and the like. It also means that if these projections turn out to be in error, then the decision made may also be in error. Thus, the importance of good information from records, farm research, or other sources should be obvious.

Budgeting as a Tool for Decision Making

Budgeting is the pencil and paper testing of the consequences of a decision before actually making it. It consists of projecting the costs and returns resulting from a course of action into the future and thus calculating the probable effects on net earnings.

Since few managers will knowingly make a decision that is shown to be unprofitable, it is important that a manager have the best information available and that he knows how to use this information to assist him in assessing the profitability of the decision.

The technique to be described and illustrated here is that of partial budgeting. It is the most easily understood and most widely applicable of all of the economic decision making tools. Some of the other advantages are as follows:

1. Budgeting is adaptable to individual farm situations.

2. Budgeting is a framework for dealing with prices, costs and yields and can be used to analyze the effects of changes in any of these economic variables.

3. Budgets can be adjusted to reflect the differences in managerial ability.

4. Budgeting enables the comparison between alternatives.

5. Budgeting can be used to analyze the impact of a specific adjustment (partial budgeting) or changes affecting the entire business (complete budgeting).

Budgeting Applied to an Orchard Situation

Before budgeting begins, it is necessary to select the alternatives for which budgeting is to be conducted. In the hypothetical example illustrated in this paper, we wish to evaluate the economic consequences of full row spraying for pest control versus alternate row spraying. This is an excellent example of a decision where partial budgeting is appropriate.

Partial budgeting is used when considering a change in only one aspect of the operation. The focus is on only those things that will change as a result of the decision. Thus, the information needs are identified as those changes. Identifying the nature of the changes that will occur is the first step. In the problem of evaluating the impact of alternative row spraying, we can identify the following factors:

(1) Spray materials

(2) Tractor and sprayer time

(3) Labor time

(4) Fruit damage

(5) Yield

There may be other factors that could be relevant but are non-quantifiable or involve information that is not available. For example, reduced soil compaction may be beneficial while increased mite or aphid populations may have a long run negative impact on vigor and yield. However, at present information is lacking on these impacts and one must, therefore, assume they have no effect.

"Quantifying the Effects of the Alternative"

The next step in the analysis requires the estimation or projection of the magnitude of the effects on each of the factors. This step can be illustrated by the following set of questions:

1. How much less spray materials would be needed?

2. How much less sprayer and tractor time is needed?

3. What reduction in labor would result?

4. How much more insect damage on fruit would there be?

5. What would be the effect on yield?

Finding the answers to these questions is not easy. The best and most accurate answers would be based on personal experience in one's own orchard under the specific conditions of that orchard. However, this would imply the conduct of experiments by the orchardist over some period of time, which could be a risk. Another source of information is the experience of other orchardists who may have adopted the practice. While such information is often valid and accurate, it is equally often in error. The particular circumstances may not be the same, other factors may have influenced the results, and poor records or memory may yield erroneous or false information. A third source of information is the research results provided by the Agricultural Experiment Stations and Extension Services. These results are nearly always from controlled situations with close monitoring and collection of data. Every effort is made to ensure that the results are valid and accurate. In many cases decisions must be based on information from all three sources, i.e., individual rates of spray application and other practices and either experience of others or research results on effects on quality and yields.

Assuming such information is available, the following illustrates how these data might be organized for further analysis:

Resource Use for Alternate Spray Methods 1 Acre Block

	Full Row	Alternate Row	Difference
Spray Materials ($)	$120	$60	-$60
Tractor & Sprayer Time (hrs)	3	1.75	-1.25 hrs.
Labor Time (hrs)	3	1.75	-1.25 hrs.
Fruit Damage (%)	2	3	+1%
Yield (bu.)	250	250	0

"Converting the Data to Economic Terms"

The next step in the analysis is to convert these data to economic terms. This involves putting prices or values on each of the factors. Below is a table with assumed prices for each factor and the computation of the added or reduced costs.

Factor	Unit Value	No. of Units	Total Cost
Spray Materials	--	--	$60.00
Tractor & Sprayer Time	$5/hr.	1.25 hrs.	6.25
Labor Time	$3/hr.	1.25 hrs.	3.75
Damaged Fruit	-$4/bu.	2.50 bu.	10.00

"The Partial Budget and Profitability Determination"

The final step is to compile the economic data in the partial budget. The usual format for the partial budget is as follows:

Added Returns: (A) ____________	Reduced Returns: (C) ____________
Reduced Costs: (B) ____________	Added Costs: (D) ____________
(A) + (B) = (E) ____________	(C) + (D) = (F) ____________

If (E) is greater than (F) then decision is profitable.

If (E) is less than (F) then decision is unprofitable.

In the example at hand there are no added returns (A) or added costs (D). The only categories of relevance are reduced costs (B) and reduced returns (C). Therefore, the profitability relation reduces to the comparison of (B) and (C). If (B) exceeds (C) the alternative is profitable.

The values comprising reduced costs (B) are:

Spray materials	$60.00
Tractor and sprayer	6.25
Labor	3.75
Total (B)	$70.00

The only value appearing in (C), reduced returns, is a reduction in the value of fruit of $10.

The value of (B) exceeds (C) by $60 which is the indicated increase in profit per acre which would result from the adoption of the alternate row spraying method.

"Determination of the Economic Parameters"

The above procedure is quite simple in concept and application but it avoids the issue of how some of the economic parameters are obtained. Specifically, the entire question of how equipment costs are estimated and placed on an hourly basis is not treated. Two classes of costs are involved: (1) fixed or "ownership" costs and (2) variable costs. The ownership costs include depreciation, interest on investment, taxes, insurance, and repairs. Variable costs include fuel and lubrication. Ownership costs are essentially a given value for a year and do not vary with acreage while variable costs are directly proportional to use.

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POMOLOGICAL PARAGRAPH

Apple Production Costs in Pennsylvania in 1975 were found to be $679.68 per acre, according to a study made in Adams and Franklin Counties by B. Wayne Kelly, Farm Management Extension Specialist at Pennsylvania State University. Harvesting costs were $196.37/acre for an average yield of 402 bu/acre, giving a cost harvested at $2.18/bu. Spraying materials were $91.44, and all labor (less harvesting) was $212.70/acre. In Western Michigan, a study by Myron Kelsey, Agricultural Economist at Michigan State, indicated that production costs for a semi-dwarf planting were $518.22/acre and harvesting costs, $236.19/acre for a yield of 400 bu/acre, giving a cost harvested at $1.88/bu. Spray materials were $97.49/acre, and all labor (less harvesting) was $133.27. Although the studies were not completely comparable (differing somewhat in values and charges), their results are surprisingly close. -- L. D. Tukey, Penn State, Horticultural Reviews. 26 (No. 2). 1977.

TRENDS OF MICHIGAN TREE FRUIT INDUSTRY (PART III)[1]

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Nematodes and Soil Fumigation

Parasitic nematodes have become of increased concern to Michigan fruit growers. Many orchards are planted on light-textured soils and on these soils damaging nematode populations are being detected in an increasing number of young orchards and orchard sites. Peach trees are most susceptible to nematode injury in Michigan. However, cherry trees also are susceptible and nematodes can be a problem in apple and pear plantings, especially in orchard replantings.

The root-lesion nematode is of primary concern, although the dagger, rootknot and lance nematodes may also be present. The usual nematode damage symptoms are stunted trees with poor vigor. Nematode numbers vary within a field; therefore, tree vigor on the site is variable.

Some feeding nematodes will induce gall formations on plant roots. Root cells destroyed by nematode-feeding become dark discolored areas in the root system. These root-lesions increase with continued feeding and secondary invasion by other soil microorganisms occurs. Some nematodes feed on young roots and alter the traditional root branching structure. They may also devitalize or kill roottips.

Soil fumigation prior to planting on old orchard sites is often essential to produce vigorous healthy orchards. Thus, a laboratory analysis of soil and root tissue is suggested to detect nematode problems. The soil and root samples are usually collected about 2 months after the initiation of tree growth in the spring and before frost in the fall (usually mid-July to mid-September).

Many fruit crops respond to soil fumigation with nematicides. This is readily apparent by improved tree growth. A long-term study in New York has demonstrated a definite financial advantage from fumigating an apple orchard. In Michigan, increased growth and winter survival of young peach trees has occurred following fumigation. Furthermore, fumigation also seems to be associated with improved weed control in new fruit plantings.

Nematode control is not simple. Proper soil preparation prior to soil fumigation is essential for maximum nematode control. The soil must be cultivated to promote thorough decomposition of previous

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[1] Part III of Talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association on July 13, 1977.

crop debris because undecayed roots harbor nematodes, protect them from the fumigant, and interfere with fumigant application. It should be in excellent tilth and soil moisture should approach that desirable for seeding. Dry soils permit rapid escape of fumigants whereas dispersion of fumigants in excessively wet soil is poor. Fumigants do not volatilize and disperse properly at soil temperatures below 50°F and escape too rapidly from soils when the temperature is above 80°F. Spring treatment usually delays planting so late summer or early autumn is usually best for the application of soil fumigants in Michigan.

Soil fumigation is the primary treatment being utilized by Michigan orchardists. The fumigant is chiseled 6-10 inches deep into the soil with the chisels space 8-10 inches apart along the tool bar. The soil is smoothed with a drag or cultipacker immediately after application to prevent the chemical from escaping. The most widely utilized soil fumigants are Vorlex*, DowFume W-85*, Telone* and Shell D-D*. Methyl Bromide also has been utilized to treat individual tree sites with an injecting soil auger in the fall prior to planting. When fumigating orchardists normally treat a 7-foot strip where the tree row will be located rather than treating the entire field.

Research with granular nematicides applied with fertilizer applicators and rotatilled into the soil is encouraging. There also is much interest in foliar application of nematicides. Vydate-L* is a foliar nematicide that can be applied to non-bearing trees. However, 2 to 3 applications per year are necessary. Furthermore, we do not consider it an alternative to soil fumigation, although yearly applications until a tree comes into bearing may help suppress nematode difficulties.

Nemagon* or Fumazone* can be applied as a post-plant row application. It must be chiseled into the soil about 8 inches deep along the tree row. However, it is usually a less effective method than pre-plant soil fumigation.

Orchard Replant Problems

Another difficulty encountered in establishing fruit plantings is frequently referred to as the Specific Apple Replant Disease. This is observed where an apple orchard is replanted to apples. Young trees planted where the old trees stood may make poor growth, thus tree growth on the site is variable.

A specific disease has been identified as the cause of this difficulty in cherry, and work continues to identify the difficulty in Apple. Chloropicrin is beneficial as a soil treatment for the Specific Apple Replant Disease. The Dutch have found that using a potting mixture in the planting hole is useful in preventing poor vigor because of the disease.

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* Trade name

The use of beneficial bacteria to promote establishment and growth of young trees is a new area of research. Spectacular biological control of crown gall, caused by the bacteria _Agrobacterium tumefaciens_, has prevented the stunting and poor growth associated with the gall formation on crown gall-infected trees. An organism from New Zealand has been reported by the USDA and plant pathologists at Agricultural Experiment Stations to promote favorable growth of fruit trees. Dr. A. Jones, MSU plant pathologist, is using New Zealand bacteria _Agrobacter radiobacter_ (isolate #84) to inoculate tree roots by dipping at planting time as well as inoculating the soil in an attempt to promote growth of young fruit trees in Michigan by preventing crown gall infection.

The exact mechanism of activity by the organism is not known. Some pathologists believe the isolate occupies sites on the plants and thus prevents other pathogenic bacteria from invading the plant root system.

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TARNISHED PLANT BUG ON APPLE: DAMAGE AND MONITORING TRAPS

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The tarnished plant bug (TPB) is among the 5 most injurious insect pests of apple fruit in Massachusetts orchards.

From the published literature, we know that TPB adults overwinter under duff in hedgerows. During the first warm days of Spring, they begin flying into apple orchards. There, an adult seeks out a developing flower bud, inserts its beak into the bud, and sucks up plant sap. After the beak has been removed, sap oozes from the puncture, sometimes forming a large, readily visible droplet. The overwintering adults continue to feed in this manner until they die, usually by the time of the first cover spray. The adults rarely lay eggs in apple trees but rather in legumes and other ground cover plants. Indeed, some of our preliminary findings suggest that a large amount of vetch, alfalfa, a clover in or near the orchard may encourage substantial buildup of TPB populations. The eggs hatch into nymphs, which then give rise to second generation adults. The nymphs do not feed on apple. Neither, apparently, do the second and third generation adults -- at least not to the extent of causing noticeable injury.

Research on TPB was initiated in 1976 because we wanted to learn more about this insect. Our goals were three-fold: (1) to determine what types of apple injury result from TPB feeding, and when these injuries are initiated; (2) to develop some sort of simple, effective monitoring method for estimating the size of TPB populations in apple trees; and (3) to accurately relate the numbers of TPB sampled by this method to the amount of TPB injury. We hoped we could eventually construct an index or chart which would indicate to the grower that if X number of TPB adults were taken in the samples, then X amount of TPB injury could be expected. Based upon the intended market for the fruit, and therefore the amount of TPB injury the grower felt he could tolerate, the grower could then decide if it was worthwhile to spray a pesticide against TPBs. In this article, we report on our progress to date toward these goals.

To study the nature and occurrence of TPB injury, we first constructed a large number of cages made of plastic and cloth. In an unsprayed section of orchard at the Horticultural Research Center, each cage was positioned to completely surround 6-7 developing flower buds on a branch. We introduced one TPB adult into each of 6 cages and sealed the ends to prevent escape. The cagings began on April 12, 1977, the day the first TPB adult was found in the orchard. The buds were at green tip. The TPBs remained in the cages for 4 days, after which they were removed and the cages resealed to prevent further entry of insects. We repeated this procedure with TPBs in new cages every 4-5 days until July 1 (the cages were opened for 4 days at bloom for pollination). Using this procedure, we could correlate the stage at which developing apple flower buds were exposed to TPBs with the nature and amount of ensuing injury.

The data in Table 1 reveal that feeding by caged TPBs on apple flower buds at the green tip and half inch green stages caused a substantial amount of bud abscission. No detectable bud abscission resulted from TPB feeding initiated at tight cluster or afterward.

TABLE 1

Time of initiation of injury by TPB adults in cages	Average number of flowers per cluster at full bloom	% decrease compared with check
Green tip	3.1	31%
Half inch green	3.7	18%
Tight cluster onward	4.5	0%
Check (cages without TPBs)	4.5	---

Most years abscission resulting from early season TPB feeding would not be an important economic consideration. However, in off-bearing years, years of severe frost damage, or poor pollination, this bud abscission could be important.

The data in Table 2 reveal that feeding by caged TPBs on buds, blossoms, and fruit from mid-pink to petal fall caused dimples in a large percentage of the apples at harvest. Most of the dimples were near the calyx. Many were deep, but some were shallow and surrounded by a small (1/16" - 1/4") tan-colored scab. Only a small percentage of dimpled fruit resulted from TPB feeding from green tip to early pink and from first cover or later.

TABLE 2

Time of initiation of injury by TPB adults in cages	% Dimpled fruit at harvest
Green tip to early pink	12%
Mid-pink to petal fall	47%
First cover or later	9%
Check (cages without TPBs)	0%

The economic consequences of dimpling injury caused by TPB feeding vary from grower to grower according to the intended market of the fruit and the severity of dimpling. When you come right down to it, the dimples are purely cosmetic injuries and affect only the appearance of the fruit. In no way do the dimples affect the eating or keeping quality of the fruit, as do injuries by apple maggot, plum curculio, and codling moth. Most Massachusetts growers with whom we have spoken feel they can tolerate 1-3% of lightly dimpled fruit in their cartons of U.S. Fancy or better fruit. Moderately or heavily dimpled fruit is usually culled.

Our next goal was to develop a method for monitoring the abundance of TPB adults on trees throughout the period when they could cause injury: silver tip through petal fall. In many crops where TPB is a pest (e.g. alfalfa, sugarbeets), TPB abundance can be readily and rather accurately monitored by collecting TPB in sweeps with an insect net. This method is not useful for collecting TPBs on the woody twigs and branches of fruit trees, however.

Because plant bugs are rather closely related to aphids, we suspected that plant bug adults, like aphid adults, might use visual cues to guide them to their host plants and feeding sites. Our approach was similar to that which we used in developing a method of monitoring European apple sawfly populations in apple orchards (see Fruit Notes 43(1):9-12). Using a spectrophotometer (an instrument which records the wavelengths of light reflected from surfaces), we measured the spectral reflectance pattern of the surface of all apple structures susceptible to TPB feeding injury. We also measured the spectral reflectance pattern of surfaces to which we had applied various enamel paints. By so doing, we were able to select particular painted surfaces which closely mimicked the reflectance patterns of apple structure. The only structure which we could not mimic was the pink tissue of developing blossoms, which had a reflectance pattern unlike that of pink, red, or any other paint. We then applied the paints to 6x8 inch cardboard rectangles, coated the rectangles with a clear sticky substance (formerly known as "Bird Tanglefoot" but now called "Tangletrap") to capture alighting TPBs, and hung the rectangles by wire from low apple tree branches at knee to waist height.

The results of this test showed that TPB adults alighted in greatest numbers on white, clear Plexiglas, and yellow rectangles, and in lesser numbers on gray, green, blue, red, orange, and black rectangles (table 3).

TABLE 3

Color of Rectangle	No. TPB adults captured	Color of Rectangle	No. TPB adults captured
White	131	Blue	39
Clear Plexiglas	129	Red	34
Yellow	109	Black	31
Gray	96	Orange	27
Green	71		

The white paint reflected light in the same general pattern as bud scales, newly unfolding leaves, the calyx cup, and mature blossom petals. The intensity of reflection from the white was greater than from bud scales, etc., hence giving it the appearance of very bright bud scales, etc. The yellow paint reflected light in the general pattern of maturing leaves, but likewise, at greater intensity. The fact that clear Plexiglas captured just as many TPBs as the white and yellow rectangle suggests that TPBs were not actually attracted by the white and yellow surfaces. Rather, it appears that TPBs were repelled by colors such as red, orange, and black, which have reflectance patterns similar to those of twigs and bark, upon which TPBs do not feed.

Additional tests revealed that like sawfly adults, TPB adults discriminate between different types of white surfaces. No apple structures reflect an appreciable amount of ultra-violet (UV) light. Consistent with this was our finding that TPBs readily alighted on white-painted rectangles reflecting a low amount of UV, but were repelled by white-painted rectangles reflecting moderate or substantial UV. Although to the human eye, UV and non-UV reflecting white paints are indistinguishable, to the eye of TPB, they obviously are distinguishable. As things have turned out, the same low-UV-reflecting titanium or zinc oxide white-painted rectangle traps that have proven so attractive to sawfly adults (Fruit Notes 43(1):9-12) are also the most effective for TPB adults.

Next, we compared this sticky-coated white rectangle trap with other methods of monitoring TPB adults in orchards. Each week from silver tip to petal fall, we examined 25 developing flower buds on each of 12 unsprayed apple trees at Belchertown for evidence of TPB injury. At the same time, we counted the number of TPB adults seen on the 25 buds, and the number collected after making 25 sweeps of the ground cover foliage under each tree with an insect net. Counts also were made of the number of TPB adults captured weekly on a white rectangle trap hung in each tree.

We found that the number of TPBs captured on the traps each week corresponded very closely to the amount of TPB injury that week. Thus, in weeks where few TPBs were captured, little new injury had occurred. In weeks of substantial TPB captures, substantial new injury had occurred. On the other hand, our counts of TPB numbers observed directly on the buds or taken in net sweeps bore no relation to the level of new TPB injury for the week.

Our assessment of the occurrence of TPB injury in this test was not as accurate as we would have liked, because whenever it rained, the characteristic droplet of plant sap oozing from the puncture hole was washed away. In such circumstances, many injured buds could be discerned only with the aid of a hand lens to reveal the microscopic puncture. This suggests that in a "normal" Massachusetts spring, with rainfall once or twice a week, grower reliance on visual examination of buds for presence of oozing plant sap as the sole indicator of TPB injury could be highly misleading. Our experiments indicate that use of the white rectangle traps is a much more reliable method.

Beginning in 1978, we plan extensive studies to relate numbers of TPB captured on the white traps to level of TPB injury. Development of an accurate trap capture:injury index of TPB should be of real value to growers in making decisions about the need to apply a pesticide spray against TPB. But even in the intervening years before refinement of the index, the white rectangle traps should be useful to those apple growers having a perennial TPB problem: the traps will function as a reliable indicator of the first appearance in the spring of active TPB adults in the orchard. They should also be useful to peach growers for this same purpose.

These white traps, which also effectively serve to monitor sawfly adult activity, can now be purchased from: New England Insect Traps, Colrain, Massachusetts 01340.

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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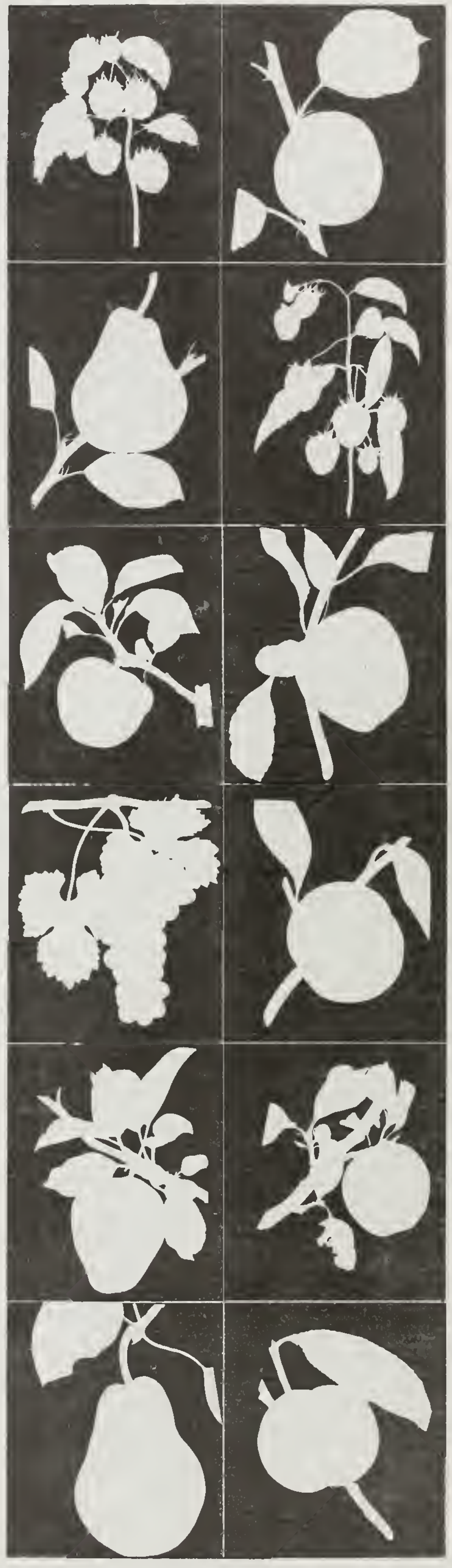

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APPLE POLLINATION COMMENTS

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To set fruit, apples must be cross-pollinated. McIntosh pollen will not grow on a McIntosh flower's female parts; the pollen must come from another apple variety. This is true with most apple varieties. Many insects may carry pollen from one apple flower to another and oftentimes flies, wasps and solitary bees are important in cross-pollination. When one has only a few acres of fruit, there are usually enough insects in the vicinity to do the job. In most years, if eight percent of the flowers on a tree set fruit, one has an adequate set for a crop.

In larger orchards, those with five, ten or more acres, there are usually too few insects available to accomplish cross-pollination. This is especially true in those years when we have cool, cloudy damp weather during bloom. Large orchards need to have colonies of bees moved in to insure pollination.

The wholesale price of honey has tripled since 1971. The retail price for a pound of table honey has moved from 45¢ to 99¢ to $1.30. Many beekeepers are reluctant to move bees into orchards because they fear their colonies may swarm. Swarming weakens a colony and the beekeeper may lose his honey crop. Beekeepers who are renting bees for apple pollination are charging more than ever before and it is important that growers get the most from rented bees. There are several very simple rules to follow.

Where to Place Colonies

Honey bee colonies should be placed where they receive a maximum of sunlight. The entrances should face east or south. We prefer to see colonies on land which has a slight slope to the east or south. If the colonies have some protection from prevailing winds, more bees will fly than if they do not. Never place colonies under trees where they will be shaded. Sunlight warms the hives and encourages more bees to take flight.

How Large A Colony to Rent

It appears the price for rented colonies in New York State for apple pollination this year will vary between $15 and $35 per colony. One must not expect that colonies rented for $15 or less will contain as many bees as do those which command a higher price.

We recommend that colonies for apple pollination be in at least two boxes (supers). We recommend the bees have brood in six frames in each colony. Having brood in six frames is not the same as having six frames full of brood. A brood nest is more or less the shape of a ball. When there are six frames with brood, the outer frames may not be too full. It is nearly impossible to count the number of bees in a hive, but one can count the number of frames which contain brood.

If there is brood in six frames, the colony will contain about 25,000 bees, perhaps more, and be in excellent condition for apple pollination. Colonies which have brood in six frames at the outset of bloom may swarm if the bees are kept in the orchards too long. For this reason, some beekeepers are reluctant to rent colonies which are this populous.

Colonies Should be Grouped

We recommend that colonies be placed in groups of three to five within the orchard. By grouping colonies in this manner, the apple grower can select the better locations for bees, spots where the colonies will receive a maximum amount of sunlight throughout the day. This also allows one to select those spots which are drier and which are protected from the prevailing winds. Again, one wants to encourage as much flight as possible.

Dry Bottomboards

Colonies of honey bees which have wet bottomboards will send fewer bees to the field than those which have dry bottomboards. Wet bottomboards tend to cool the colony and more bees are required to keep the brood nest warm.

We recommend that apple growers place pallets, old tires, cinder blocks or slabwood in the orchard on which colonies may be set. This practice will work to the advantage of both the fruit grower and the beekeeper.

If the colonies of bees are six to eight inches off the ground, there will be less problem with grass blocking the entrances and hindering flight. Grass may prevent the sun's hitting the colony entrance and delay flight in the morning. A piece of tarpaper tucked under the front of the colony and extending outwards will serve to keep the grass from growing and blocking colony entrances.

Dandelions, Yellow Rocket and Apples

Dandelions, yellow rocket and apples all produce nectar which contains about 40 percent sugar. Thus, all three of these plants have flowers which are about equally attractive to honeybees. Dandelions produce more nectar in the morning than they do in the afternoon and so there will be fewer bees visiting dandelions in the afternoon. Apples appear to produce nectar about equally all day as does yellow rocket. The best way to get rid of dandelions and yellow rocket is to use a weed killer. Mowing these competing plants will help, but it is expensive.

If there are a large number of dandelions and yellow rocket plants in flower in or near the orchard, one needs additional bees.

At the present time, we have no method of discouraging bees from visiting these weed plants.

Fresh Water

Honey bees use large quantities of water to dilute the honey which they feed to their young. Bees may collect water from wheel ruts and depressions in the orchard. These may contain an accumulation of pesticides. If the bees have fresh, clean water, fewer will die. Beekeepers who rent bees for apple pollination expect to lose a small number of their bees because of pesticides and they adjust the rent price of their colonies accordingly. The grower who provides fresh water for honey bee colonies will benefit.

Hand-Collected Pollen

A small number of apple growers in New York State buy hand-collected apple pollen, take it to the orchard and play "little Miss Honey Bee." Hand-collected pollen may be applied to the female parts of a flower with a brush. Little pollen, if any, gets where it is needed when it is dropped from an airplane or shot into a tree from a shotgun shell. While this may be fun, it is a waste of time and money. There is nothing mysterious about cross-pollination. It involves the transfer of pollen from one apple variety to another apple variety.

Honey bees can cross-pollinate apples easily, quickly and at a reasonable cost if they are given the proper management and if the orchard is properly interplanted with varieties which have pollen which will cross-pollinate each other. Neither hand-collected pollen or pollen moved by bees will grow unless the temperature is sufficiently high.

Hedgerowing is a Special Problem

Nearly all orchards planted today follow the same scheme. The apples are grown on dwarf rootstock and planted in hedgerows.

A wind of about 12 miles per hour stops bee flight. A wind of only a few miles per hour will slow bee flight and oftentimes discourage bees from flying over the tops of hedgerows. We know from experience that bees prefer to fly up and down the sides of rows. Planting pollenizing varieties in the row is important because there must be an exchange of pollen to set fruit.

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POMOLOGICAL PARAGRAPH

<u>Foliage sprays containing nitrogen for fertilizing peaches.</u> Peach trees frequently have small pale green leaves, or yellow leaves with red flecks that develop into a mild "shothole" condition. These are symptoms of nitrogen (N) deficiency caused either by cold weather

in the spring or by failing to apply N by mid-April. These symptoms were present in many of our peach orchards in May and early June of 1977. Some growers asked if urea sprays would benefit growth. Unfortunately, foliar sprays of N to peach trees are ineffective. Peach leaves do not absorb N as efficiently as do apple leaves.

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FACTORS AFFECTING SHAPE OF APPLES AND INCREASING THEIR LENGTH WITH PROMALIN*

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Shape of apples is known to be influenced by both climatic and non-climatic factors. The elongated shape and the 5 lobes at the calyx end of Delicious apples are particularly distinctive; thus, there is interest in studying the factors influencing their shape and the possibility of modifying that shape by chemical means.

Climatic Factors

Delicious grown in Massachusetts are longer some years than others and within a given year their shape will vary considerably among orchards. Shape of apples depends on cell division and cell elongation, both of which occur within 3 to 4 weeks after bloom, and is governed by growth hormones in the tree.

In 1914 J. R. Shaw in Massachusetts reported on the relationship between shape of Ben Davis and Baldwin apples and the temperature following bloom; the cooler the temperature, the more elongated the apple. He concluded that during the post-bloom period, temperature variations between the 6th and 16th day after full bloom fitted the observed variations in shape more closely than during any other period.

Non-climatic Factors

As most growers know, distribution of seeds in fruit influences shape. Apples with small numbers of seeds are frequently lopsided, with the less fleshy side being the one lacking seeds. M.N. Westwood and L.T. Blaney, in Oregon, found that rootstocks, crop density, cluster position, and strain can also influence fruit shape (Non-climatic factors affecting the shape of apple fruits. Nature 200:802-803, 1963). In studies with Delicious, fruit from trees on M.1, M.2, M.16 and seedling roots were longer than those harvested from trees on M.9, M.4 and M.7. Both crop load and fruit location affected the shape of Golden Delicious. Those from trees with a light crop (whether the result of heavy thinning or light bloom) were longer than fruit from trees with a heavy crop. The "king" fruit were longer than side-bloom fruit. Fruit shape differed significantly among the 3 Delicious strains studied, with those from the "regular" Delicious trees being flatter than those from

*Trade Name

Starking and Starkrimson strains.

Fruit Shape Alterated by Growth Regulators

M.W. Williams and E.A. Stahly, in Washington, found that applications of cytokinins and gibberellins, alone and in combination, to Delicious apples just after full bloom affected fruit shape by increasing their length. (Effect of cytokinins and gibberellins on shape of 'Delicious' apple fruits. Jour. Amer. Soc. Hort. Sci. 94: 17-19, 1969). Cytokinin-treated fruits were longer than normal with prominent, well-developed calyx lobes, whereas those treated with gibberellins were merely longer. They postulated that the influences of temperature, crop size, and fruit location in the cluster on fruit shape were very likely related to their effects on the levels of gibberellins, cytokinins and other naturally occurring growth regulators in the developing fruits.

Fruits can become flatter by application of Alar-85*. Because of this undesirable response plus possible fruit size suppression on Delicious we prefer using 2, 4, 5 - TP for preharvest crop control rather than Alar-85. Williams in 1975 (Carry over effect of ethephon on fruit shape of 'Delicious' apples. HortScience 10: 523-4) reported that ethephon applied to Delicious apples before harvest to improve fruit quality also can flatten fruit the following year if applied to trees of medium to low vigor.

Promalin to Lengthen Delicious

Promalin, a plant growth regulator formulation containing gibberellins and cytokinin, when tried in several areas of the United States, has lengthened Delicious apples, increased their weight, and improved development of the calyx lobes. We have conducted limited tests with Promalin because of grower interest in increasing the "typiness" of Delicious and the possibility of increasing yields due to increased volume of the fruit.

In 1975, 1 pint of Promalin/per 100 gallons of water applied at late petal fall at our Horticultural Research Center did not increase the "typiness" of Richared Delicious apples. We enlarged our trials in 1976 and added surface active agents glyodin and Triton B-1956 to 2 of the treatments (see Table 1 on the next page).

Fruit set was not influenced by the treatments. However, the length of the Delicious as indicated by the L/D ratio was increased by the 1/2 pint of Promalin when applied with glyodin or Triton B-1956, and also by 1 pint of Promalin; the higher the L/D ratio the longer the apple -- a "typey" Delicious will have a L/D ratio of 1.00 or greater.

It is of interest to note that although Promalin increased the length of the Delicious the difference could not be detected by visual observation before harvest but could be seen on the harvested

*Trade Name

fruit. Furthermore, neither the fruit size nor total yield was influenced by the treatments (Table 1).

Table 1. Effects of Promalin, applied at 125 gal/A when petals on king blossoms started to fall, on Richared Delicious apples, 1976.

Treatment (rate/100 gals)	Fruit set (per cm. limb circ)	L/D ratio[z]	Fruit wt (gms)	Yield (bu/tre
1. Check	5.3a	0.98b	190ab	12.2a
2. Promalin, 1/2 pt	6.0a	0.99ab	175c	13.6a
3. Promalin, 1/2 pt + glyodin, 1 pt	5.0a	1.01a	195a	13.8a
4. Promalin, 1/2 pt + Triton, 1/4 pt	5.7a	1.01a	185abc	14.8a
5. Promalin, 1 pt	6.6a	1.02a	181bc	15.2a

[z]L/D = Length/diameter ratio

A trial was also conducted in a grower's orchard in 1976, with 1/2 pint or 1 pint of Promalin applied when the petals on the "king" blossoms on Starkrimson Delicious started to fall. The results were similar to those reported in Table 1. Measurements of the L/D ratios of the harvested fruit indicated that the Promalin-treated fruit were longer than those from the check trees, but this increase in length was not evident by visual observations of the fruit while on the tree nor was there any significant increase in fruit weight or yield.

In 1977, Promalin at 1 pint per 100 gallons of water plus 1 pint of glyodin was applied at full bloom or calyx of Starkrimson Delicious at the rate of approximately 150 gallons per acre. The full bloom application was not effective whereas the fruit from trees sprayed at calyx were heavier and longer. However, the difference as in 1976 was too slight to be noticeable on the tree.

Summary

Both climatic and non-climatic factors can influence the "typiness" of Delicious apples. Our most-typey Delicious are produced in orchards on high elevations where post-bloom temperatures are apt to be cooler than at lower elevations. However, temperatures are not always favorable even at higher elevations and there are growers interested in giving "mother nature" a boost by using Promalin. Our trials with Promalin are very limited and more work is needed to determine the influences of temperature. However, it does appear that a consistent favorable response from a Promalin spray may not be likely.

A number of growers purchased Promalin last year but for one reason or another did not apply it. We certainly do not want to discourage Promalin use in 1978 because we need to determine its possible usefulness under our conditions.

Our only suggestions concerning Promalin use other than following the directions on the label are to add to the spray mixture a surface active agent such as glyodin and to apply on a day when temperatures are 60° or higher.

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NUTRITIONAL PROBLEMS AND SUGGESTIONS FOR FERTILIZATION OF APPLE TREES IN 1978[1]

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It should be recognized from the start that it is not possible to give specific suggestions for fertilization in an article of this nature. Therefore, the suggestions below merely serve as a guide to the fruit grower for determining the fertilizer program in his orchard. It is well to remember that foliar applications are merely supplements to soil applications.

Nitrogen (N): The trees severely winter injured in 1976 did not recover as well as hoped in 1977 in spite of the supplemental urea sprays. Some of these trees probably should receive an urea spray (5 pounds/100 gallons) at about first cover in May. Apply as a separate application.

Most orchards had only a medium-sized crop in 1977 while some blocks of Delicious either had no crop or a light crop due to frost. Trees which had no crop, or just a partial crop, in 1977 should receive little or no N in 1978. To the contrary, trees that had a large crop in 1977 may be low in available N for utilization this spring.

The best guide to N needs of your trees is leaf analysis combined with observations of tree vigor, fruit set, and fruit

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[1] Unless stated otherwise all photographs are by Louis Musante, Audio Visual Dept. University of Massachusetts.

color. Growers definitely are using less N on McIntosh than in the past because we need medium-sized, well-colored apples with long storage life. Some growers have not omitted N in mature McIntosh blocks for 5 to 8 years with no apparent harmful effects.

Young vigorous trees are troublesome when they start bearing a crop because of excessively large, poorly colored fruit and poor keepability of fruit in storage. The reduction or omission of N is frequently essential. This procedure plus limb positioning (spreading) is needed on vigorous young Delicious trees to encourage bloom and fruit set.

Apply sufficient N to keep bearing Delicious trees vigorous. N levels of 2.2 - 2.4% in bearing Delicious trees are probably satisfactory because it is necessary to keep the tree vigorous in order to produce large-sized fruits. Furthermore, obtaining sufficient red color on the newer strains of Delicious is not a problem.

The N requirement can be met by applying calcium nitrate, ammonium nitrate or urea sources of fertilizer N or a "complete" fertilizer. (Growers concerned about bitter pit and/or cork spot may wish to rely on calcium nitrate as the source of N.) However, the phosphorous (P) in the complete fertilizer is not needed in our orchards. Therefore, purchase a prepared mix that contains no P or purchase an N and a K fertilizer and mix them prior to application or apply them separately. Some growers apply the K fertilizer in the fall and the N fertilizer in the spring.

<u>Potassium (K):</u> The K requirements of apple trees with a large crop are high because the fruit utilizes about 3 times as much K as N. Since the quantity of K stored by the tree is extremely small, it seems important to supply adequate K this spring on trees that had heavy fruit set in 1977.

The requirements of apple trees for K (expressed as K_2O) based on potential yields are as follows: (a) less than 15 bu: 1.3 lbs/tree; (b) 15 to 25 bu: 1.3-2.7 lbs/tree; and (c) more than 25 bu: 2.7-4.3 lbs/tree. It is necessary, however, to maintain a balance among the essential nutrients for apple trees. For example, excessive levels of K can reduce both leaf and fruit Ca. <u>Therefore, we strongly urge that you participate in our leaf analysis program to more accurately determine the K needs of your apple trees</u>.

<u>Calcium (Ca)</u>: Cork spot and bitter pit, which are visual evidence of low Ca levels in apples, was more prevalent than usual on Delicious during the 1977-78 storage season.

The Delicious on the left in the following photograph shows bitter pit and the one on the right has cork spot. Bitter pit is most frequently associated with the calyx end of the apple and its severity

(Photograph by Russell Mariz, Photo Center, UMass.)

will increase in storage. Cork spot is not localized and will appear anywhere on the apple. The spots are more pronounced than bitter pit, being much deeper and wider. In some cases the cork spot resembles the inner cone of a miniature volcano, with the depressed skin area containing green or dark red pigment. Cork spot does not increase in severity in storage.

Cortland continued to be troublesome in some orchards because of its susceptability to bitter pit, and a few orchardists were concerned this fall about this disorder on McIntosh.

It is very difficult to increase Ca content of apple trees and fruit. Although foliar sprays of Ca solutions have been shown to reduce bitter pit, they have not eliminated it. A major problem is that Ca in the soil moves very slowly into the tree and most of it is quickly tied up in an insoluble form. We suggest the following measures to increase Ca content of apple leaves and fruits.

A. Continue to apply 3 tons of limestone per acre every 2 to 3 years. Where high magnesium lime was used in the last application, the use of a more soluble high Ca, low Mg lime (5-7% MgO) will act more rapidly and will provide more Ca.

B. Use calcium nitrate as the source of nitrogenous fertilizer. Calcium nitrate increases the level of soluble soil Ca more quickly, increases the downward movement of Ca and raises the pH of the soil.

C. Apply foliar sprays of calcium chloride ($CaCl_2$) starting about 3 weeks after petal fall and repeat at 2-week intervals, totalling 6 to 8 applications. Apply 6 to 8 pounds $CaCl_2$/acre/spray until mid-July. After mid-July, apply 10 pounds/acre/spray. Sprays may be applied dilute or on a trial basis up to 6X concentration. Growers desiring to combine $CaCl_2$ with their cover sprays should do it on a trial basis only. When combining with cover sprays, add $CaCl_2$ last to the spray tank. If weather conditions permit going over 14 days without a cover spray, use $CaCl_2$ spray alone. CAUTION: DURING DROUGHT DO NOT APPLY A SECOND FOLIAR $CaCl_2$ APPLICATION UNTIL AN INCH OR MORE OR RAIN FALLS. Do not mix $CaCl_2$ and Solubor* in sprays.

Foliar injury usually is worse on McIntosh than Delicious. There is some evidence that the combination of guthion and $CaCl_2$ may increase foliar burn. Foliar injury was more severe from dilute sprays than when applied at 6X at the Horticultural Research Center in 1976 but the opposite occurred in 1977. This appears to indicate the $CaCl_2$ injury varies with season because of such factors as rainfall and temperature.

Magnesium (Mg): Deficiency symptoms of Mg (Figure 2) are not as prevalent as in the past but this important element should not be forgotten in our anxiety to increase Ca levels.

Pictured on the left is Mg deficiency symptoms on pear leaves; the symptoms on apple are similar. Deficiency symptoms are characterized by necrotic (brown) areas between the veins. The older, basal leaves on shoots and spurs are usually affected first, and as the season progresses the injury symptoms appear on the younger leaves. By late summer, the shoots on which the leaves show Mg deficiency may be defoliated except for a few leaves near their terminals. Mg deficiency increases fruit drop at harvest.

The requirements of trees for Mg can best be met by maintaining an adequate dolomitic liming program. Since it takes years before lime is effective in correcting Mg deficiency, Epsom salt sprays can be used to help correct the condition. Apply 2 to 3 sprays at the rate of 15 to 20 lbs per 100 gallons of water at the time of calyx, first cover and second cover sprays. To avoid possible incompatibilities, the Epsom salt sprays should not be combined with the regular pesticide sprays. Don't apply Epsom salts or a lime high in Mg unless leaf analysis or visual observation indicates low Mg levels. Mg can supress Ca!

Boron (B): Toxicity symptoms of this element were observed in a few orchards in 1977. They occurred on bearing trees sprayed with a foliar application of B and on trees fertilized with B the year of planting. The picture on the following page shows typical foliar symptoms of B toxicity. The symptoms are characterized by loss of chlorophyll (green coloration) from along the midrib and larger lateral veins. The symptoms are first apparent at the

*Trade Name

base of the leaf blade. In severe cases, loss of chlorophyll is more extensive than shown in the picture; marginal leaf scorch develops, leaves absciss, and wood injury can occur.

B deficiency is more common than B toxicity. The most common symptom of B deficiency is found in the fruit being characterized by brown, round or irregular shaped lesions of about 1/4 inch diameter. The dead cell masses become dry, hard and corky before harvest. Fruit affected with the disorder will have a pebbled surface (particularly noticeable on Cortland), open calyx, and abnormally dark color as they mature. However, frequently the first recognition of the problem is excessive preharvest drop.

B can be supplied to apple trees either by foliar or soil applications. Use the most economical and convenient method. <u>However, it is safest to apply all elements as a fertilizer except in emergency situations</u>.

Soil applications of boron should be applied to orchards every 3 years. The rates of application per tree vary with tree age and size. In low density orchards, apply 1/4 pound of borax (11.1% actual B) or its equivalent under <u>young trees coming into bearing</u>, 1/2 to 3/4 pound to medium age and size trees and 3/4 to 1 pound to large or mature trees. <u>Be sure to note the percent actual B in the fertilizer being used to supply this element.</u> B containing fertilizers vary from approximately 11 to 21% actual B.

In medium and high density orchards (115 trees/acre or higher), it might be best to apply B on an acre basis. We suggest the following rates per acre of borax (11.1% actual B) or its equivalent: (a) trees 4 to 7 years of age - 12 lbs; (b) trees 8 to 15 years of age - 12 to 24 lbs; and (c) trees 16 to 30 years of age - 24 to 48 lbs.

When the soil application of B is followed by a wet spring, it may be advisable to apply 2 foliar applications of B the following year.

Many growers now rely on annual foliar applications of B. The usual practice is to add Solubor to the first 2 cover sprays. Fertilizer grades of borax may contain grit and should not be used in a sprayer. Mature trees should receive 4 pounds of Solubor per acre each year. Consequently, the goal is to apply about 2 pounds per acre in each of the 2 applications. For young orchards, the addition of 1/2 pound of Solubor per 100 gallons (dilute basis) to the first 2 cover sprays meets the B requirement of these trees. Reports of New York State indicate that sprays can be concentrated up to 8X with satisfactory results.

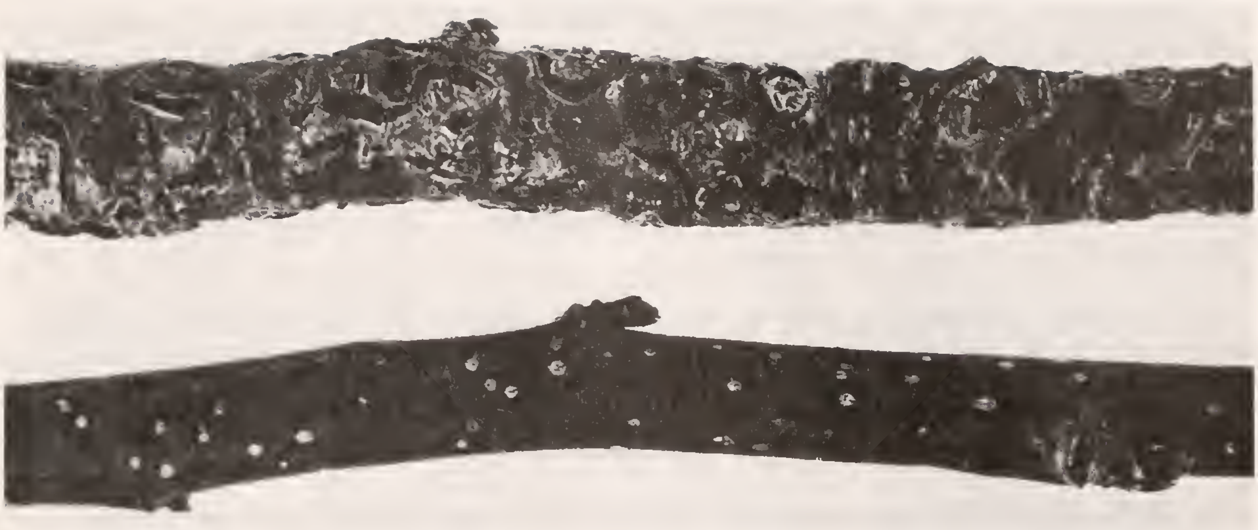
Leaf samples from orchards treated with Solubor have indicated adequate leaf boron levels but the fruit was deficient in this element. Whether or not B applied as a fertilizer more adequately meets the B requirement of apples than foliar-applied B is not known by us.

Manganese (Mn): The element was deficient in several orchards last summer. As shown in the photograph below apple leaves having Mn deficiency have interveinal fading of chlorophyll with the veins remaining green. In the past we have analyzed McIntosh apple leaves from trees showing Mn deficiency and found the leaf of this element

to be 9 to 14 ppm. Mn levels of this magnitude are critically low in comparison to the desired standard of 50-100 ppm set by other states for apple trees. Mn deficiency should be corrected on trees showing considerable foliage damage. Although we haven't definite proof, Mn deficiency appeared to be associated with excessive fruit drop on a few trees in one orchard in 1977. Mn deficiency can be corrected by foliar applications of manganese sulfate or of a fungicide containing Mn. Apply manganese sulfate at about first cover at the rate of 3 lbs per 100 gallons of water. If using a Mn-containing fungicide, 2 or 3 applications are necessary with timings about petal fall, first and second cover.

Mn toxicity is implicated with the problem of "apple measles" shown in the photograph on the following page. The twig from Delicious at the top of the photograph shows severe symptoms of measles while the twig below has normal bark. Measles can severely injure or kill young Delicious trees. An over-application of a dormant-oil spray can induce symptoms similar to that shown in the photograph.

Our only solution to the apple measle problem is raising the soil pH to 6.0-6.5. Apply lime, if needed, before planting and add 2-3 lbs of lime to the planting hole.



Zinc (Zn): Based on optimum levels of Zn established by some states, some of our orchards are low in this element. Massachusetts growers have not used zinc sulfate sprays applied at the "green tip" stage of bud development to increase zinc levels but some use manganese-zinc containing fungicides. These appear to be increasing Zn levels in our orchards.

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NAPHTHALENEACETIC ACID (NAA) FOR TREE TRAINING

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It was reported in 1977 that 1% NAA in latex paint is an excellent tree training aid when applied as a painted band around the stem of newly-planted apple trees (after heading) to cover the second, third, and fourth buds. The first bud below the heading cut, which was not painted, became a vigorous central leader. This treatment eliminated the cluster of vigorous shoots in the top of the trees which compete with the central leader and increase the number of favorably positioned branches on the newly-planted trees, and improved crotch angles of these branches. If for some reason the bud selected for the central leader died, a strong leader reportedly developed from the NAA-treated area. Basically, the suggested NAA treatment is a replacement for the current training procedures which involve removal by hand, in June, of growth that is in competition with the shoot favored as a central leader.

Directions for use indicated that the 1% NAA in latex paint should be applied after heading the newly-planted tree to the desired height but before growth begins. The treatment is not effective if made after start of growth.

Last summer, we compared the NAA tree training technique on Marshall McIntosh, Macoun, and Redspur Delicious with removal of buds 2, 3, and 4 immediately after planting (disbudding) or removal of shoots competing with the central leader in mid-June. The Marshall McIntosh and Redspur Delicious were headed at 36 and 30 inches, and the Macouns at 30 inch height. All treatments were replicated at least 16 times.

The NAA treatment was a complete disaster in the 3 orchards. The first bud below the heading cut, which was supposed to develop into the leader, was with only one exception either severely stunted or killed. When the bud selected for the central leader died, no strong leader developed from the NAA-treated area.

Crotch angles were affected only on the Redspur Delicious (Table 1). The trees receiving the NAA treatment and those on which the competing shoots were removed in mid-June, had wider crotch angles than the disbudded trees for each heading height.

Table 1. Effect of NAA application, removal of competing shoots in mid-June, and disbudding on crotch angles.

Treatment and heading height	Cultivar: Marshall McIntosh	Redspur Delicious	Macoun
	Avg. crotch angle (degrees)[z]		
NAA, 36 in	70a	60a	
NAA, 30 in	67a	53bc	60a
Shoots removed, 36 in	69a	56ab	--
Shoots removed, 30 in	68a	56ab	59a
Disbudding, 36 in	66a	50c	--
Disbudding, 30 in	67a	44d	55a

[z] Mean separation in columns by Duncan's multiple range test, 5% level.

We do not know why the results with NAA were so unfavorable although we believe the concentration was too high. However, it is obvious that Massachusetts growers should not use NAA for tree training until further experimentation shows the procedure to be reliable.

Even if the NAA tree-training technique is proven to be reliable, it has at least 3 obvious drawbacks. Spring is an extremely busy season and chances are great that the NAA will not be applied. Secondly, the treatment must be applied before growth starts. And lastly, frequently a better choice of a leader can be made in mid-June and this job can be combined with limb spreading with clothes pins. Thus, at present, we still suggest the standard procedures of leader selection. This involves selection of the uppermost shoot on the windward side of the newly-planted tree when shoot growth is 6 to 8 inches in length. Shoots competing with the selected leader should be rubbed or pruned off for a distance of approximately 6 inches down the stem.

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ALTERNATE VS. EVERY MIDDLE SPRAYING FOR APPLE PESTS IN 1977

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Earlier, we reported our 1976 findings on the comparative effectiveness of alternate vs. every middle spray treatments in 3 commercial orchards (see Fruit Notes 42(3):8-10). In this article, we report on our 1977 findings, and include a cost-benefit treatment comparison for one of the orchards.

The alternate middle treatment involves spraying alternate halves of each tree on alternate spray dates instead of both halves on all spray dates. For example, in applying the first cover spray, the sprayer would be driven up the middle between tree rows A and B and return down the middle between rows C and D, skipping the middle between rows B and C. For the second cover spray, the sprayer would be driven up the middle between rows B and C, down the middle between rows D and E, and so forth. If this pattern were followed with every spray application, it would save 50% of the spray material costs.

In 1977, we compared alternate with every middle spray treatments in the same 4-acre blocks in the same 3 orchards as in 1976. Each block was divided into 2 plots: one receiving the alternate middle program on each spray date from pink (or petal fall) through last cover; the other receiving the every middle program. Each grower used an air blast sprayer at 4X. He followed his normal spray schedule, and used his own selection of pesticides. All trees were full grown - some on M.7 rootstock, others on standard. The centers of the trees were fairly well pruned in all blocks.

To determine the extent of pest pressure, we hung traps in each plot for monitoring tarnished plant bug adults, codling moth and redbanded leafroller adults, and apple maggot flies (see Fruit Notes 41(1):3-4; 41(6):6-9; and 43(2):10-14 for information on construction of each trap type). We caught the following average numbers/trap in each plot:

Treatment	Orchard	Tarnished Plant Bug Trap (unbaited white rectangles)	Zoecon pheromone traps: Codling Moth	Zoecon pheromone traps: Redbanded leafroller	Apple maggot trap (unbaited red sphere)
Every middle	A	1.3	56	110	7.0
	B	5.0	44	120	3.0
	C	5.7	127	205	5.7
	Average	4.0	76	145	5.2
Alternate middle	A	1.0	51	185	2.7
	B	13.0	76	111	14.5
	C	9.3	75	157	11.7
	Average	7.8	67	151	9.7

Researchers in New York believe that when cumulative codling moth captures/trap reach 15-20 and apple maggot captures/trap reach 1, fruit injury is likely to occur unless insecticide is applied. A relation between plant bug or leafroller captures and need for spraying has not yet been established, but substantial numbers of each were trapped. Overall, the trap data show that pest pressure was considerable in both the every and alternate middle plots.

To determine the actual amount of fruit injury caused by these and other pests and to determine spider mite and aphid abundance on leaves, we examined 60 fruits and 60 leaves/tree on each of 6 trees in each plot in each block every 3 weeks from mid-April until harvest. The results are given here:

	Spraying every middle in orchard:				Spraying alternate middles in orchard:			
	A	B	C	Avg.	A	B	C	Avg.
% leaves infested with:								
Mites	6.0	15.2	6.1	9.1	20.6	16.7	2.1	13.1
Aphids	1.7	2.9	2.2	2.6	0.8	3.2	1.3	1.8
% fruit injured by:								
Plant bug	0.3	1.9	1.3	1.2	0.3	2.9	1.5	1.6
Curculio	0	0.4	0	0.1	0.2	1.2	0.3	0.6
Sawfly	0	0.1	0.3	0.1	0	0.6	0.1	0.2
Green Fruitworm	0	0.1	0.1	0.1	0	0.3	0	0.1
All other insects	0	0	0	0	0	0	0	0
Total 1977	0.3	2.6	1.7	1.5	0.5	5.1	2.0	2.5
Total 1976	0.9	5.8	1.6	2.8	1.7	5.2	1.9	2.9

The results show that for all orchards combined, an average of 1.5% of the fruit in the every middle plots was injured by insects vs. 2.5% fruit injury in the alternate middle plots. Compared with 1976, the 1977 results show 14% less fruit injury in the alternate middle plots and 46% less in the every middle plots. Most of the 1977 difference between alternate and every middle plots was attributable to Orchard B, where the presence of abandoned trees nearer the alternate middle plot resulted in heavier insect pressure on that plot.

As in 1976, plant bugs caused the most fruit injury. Their damage was slightly greater in the alternate than every middle treatment. However, because plant bug damage on a ripe fruit appears as a purely cosmetic injury, and does not affect the eating quality of the fruit, most growers cull only about 50% of plant bug injured fruits. The next most injurious insect was plum curculio. It was the only fruit insect to cause greater injury in the alternate middle than the every middle plot in each orchard. Apple sawfly and green fruitworm caused slight injury, while no fruits in any plots were found damaged by codling moth, apple maggot, or redbanded leafroller.

In contrast to 1976, aphids were, on the average, slightly more abundant in the every middle than alternate middle plots. As in 1976, spider mites were, on the average, slightly more abundant in the alternate middle than every middle plots.

Some apple scab was observed in each block, but did not appear to occur in any greater amount in the alternate middle plots.

A cost-benefit analysis of the every vs. alternate middle treatments in Orchard C was conducted by students in a graduate insect pest management class at UMASS (see Fruit Notes 43(2):3-7). The results are summarized here:

	Dollar Costs/Acre		
	Every Middle	Alternate Middle	Difference
Spray materials*	135.70	67.85	-67.85
Labor (at $3/hr)	10.50	5.25	- 5.25
Fuel, oil, filters, etc.	5.00	2.50	- 2.50
Value of fruit loss owing to insect & disease injury**	32.72	44.72	+12.00
Cost reduction from alternate middle program***			-63.60

(Since a reduction in net costs is the same as an increase in returns, the value of $63.60 should be regarded as an increase in net returns.)

* Includes cost of all insecticide, miticide, and fungicide materials.

** Fruit yield was sampled on randomly selected trees and found to be equal in the alternate and every middle plots. Total yield estimated at 750 bushels/acre in each plot. Only 0.18% and 0.06% diseased fruits appeared in the 3360 fruits sampled at harvest in the alternate and every middle plots, respectively Fifty percent of the fruits injured by plant bugs plus all fruits injured by other insects were considered as culls. Total bushels of culls per acre were 8.18 and 11.18 for the every and alternate middle plots, respectively. Culls were given an average value of $2/bushel (combination of #2 fruit and cider apples). All undamaged fruit was given a value of $6/bushel.

*** The analysis does not include possible additional costs (if any) of grading out the greater number of insect- and disease-injured fruits (11.18 - 8.18 = 3.0 bushels/acre) from the alternate middle plots.

The results show that grower C realized a net profit of $63.60 more per acre from the alternate middle than the every middle plot. An additional benefit was that the grower could spray the alternate middle plot in about half the time as the every middle plot. This allowed him to respond more rapidly to conditions calling for immediate pesticide application.

We conclude from our first 2 years of experimentation that an alternate middle spray program in Massachusetts shows promise of effectively controlling most of the major insect pests that attack the fruit. To date, it has proven just as effective as an every middle program against those pests which are highly mobile, and hence make frequent contact with the sprayed portion of the tree: codling moth, redbanded leafroller, and apple maggot. In some situations, the alternate middle program may be slightly less effective against a pest like plum curculio, whose mobility within the tree is quite restricted (see Fruit Notes 42(4):5-7). Where such is the case, every middle treatments for the petal fall and first cover sprays would be advisable. The alternate middle program's effectiveness against spider mites and aphids may depend on the type of pesticides employed. On the one hand, spider mites and aphids are not very mobile. On the other hand, if not killed by toxic orchard pesticides, predators are capable of effectively suppressing spider mites and aphids below damaging levels (see Fruit Notes 42(2):5-7 and 42(6):6-10).

In summary, our findings to date show that the alternate middle spray program can result in greatly reduced pesticide usage, effective pest control, and a greater net profit to the grower. For those growers interested in trying out the program, we would suggest starting with a one or two-acre block to see how the program works with your particular type of sprayer and trees, and under your particular local insect, mite, and disease conditions. We would advise against submitting large acreage to this program until you (and we) learn more about the program's long-term effectiveness and possible shortcomings. For example, we need much more information on its effectiveness against plum curculio and apple diseases. Present knowledge suggests that the program works best where the trees are well pruned (open centers) and spaced at recommended intervals (not wider).

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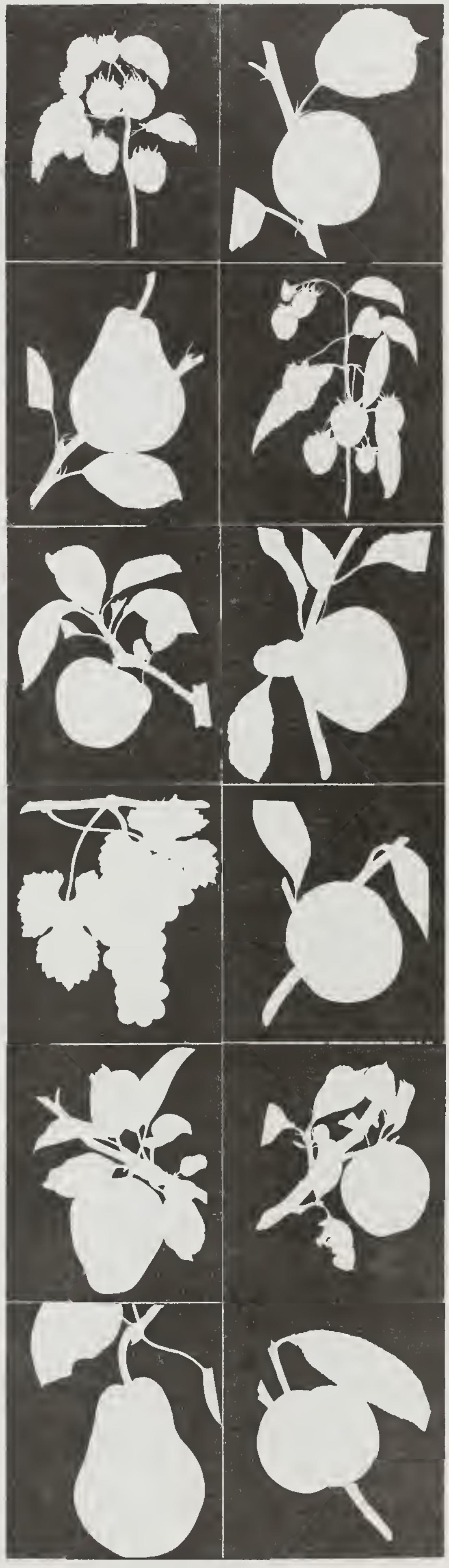

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol 43. (No. 4)
JULY/AUGUST 1978

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FACTORS AFFECTING NUTRIENT CONTENT OF APPLE FOLIAGE

William J. Lord
Department of Plant and Soil Sciences

Crop size can have a considerable effect on the quantity of several elements in apple foliage. Leaves from a tree with a large crop will contain more nitrogen (N) and less potassium (K) than leaves from a tree with a light crop. Leaves from a light-crop tree may contain 0.2 to 0.3% less N than when the same tree has a full crop. Leaves may decline as much as 0.4% K in a heavy-crop year. Calcium (Ca) follows the same trend as N and exhibits about the same difference as N in leaf content between the light- and heavy-crop years. Leaf magnesium (Mg) is slightly higher in a heavy-crop than in a light-crop year. Crop size has little, if any, effect on leaf phosphorus (P).

The amount of one element may affect the amounts of other elements in the leaf. For example, leaves which are relatively high in N tend to have lower levels of K and P and higher levels of Mg and Ca than leaves from trees which have a low to medium level of N. High levels of K may depress leaf Mg and Ca, particularly if the soil supply of Mg and Ca are low. However, moderate levels of K do not seriously depress Mg as long as there is an adequate level of Mg.

Another factor which may influence the leaf content of some elements is soil moisture or rainfall. Leaf K is generally lower in dry growing seasons than in years with adequate soil moisture. Mg is generally lower in years which have above normal rainfall during the early part of the growing season. The magnitude of the change in leaf content caused by seasonal rainfall will depend upon the relative wetness or dryness of the season and the supply of nutrients in the soil. If the soil is so wet or so dry that development of new roots is prevented, the leaf content of essential elements could be reduced.

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POMOLOGICAL PARAGRAPH

<u>Use of ethephon to promote color and ripening of apples in Massachusetts</u>. Our suggestions for use of ethephon for promoting uniform ripening and red color of apples have not changed from last year. These suggestions were published in <u>Fruit Notes</u> 40 (No. 4): July/August, 1975. Those who do not keep back issues of <u>Fruit Notes</u> can obtain a copy of the suggestions on ethephon usage from your Regional Fruit Specialist.

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LATE SUMMER FERTILIZATION OF STRAWBERRIES

William J. Lord
Department of Plant and Soil Sciences

In Massachusetts, the June-bearing varieties of strawberries initiate their flower buds in the fall. If conditions are favorable, many varieties produce several flower buds in each strawberry crown and consequently produce several inflorescences per plant. The extent of flower bud development seems to be influenced by the supply of available nutrients, particularly nitrogen.

A number of experiments have indicated an advantage of building up the nitrogen supply in the fall from the standpoint of increased flower bud formation. However, factors such as earliness of runner plant rooting, quality of plants, soil moisture, and pest and weed control may have more effect on plant productivity than the fertilizer applications.

A recent study in Minnesota showed that nutrition can affect winter-hardiness of 'Redcoat' strawberry plants. In this study 'Redcoat' strawberry plants deficient in nitrates, phosphorous, and potassium received fertilizer treatments in late-August. Artificial freezing tests were conducted on the plants at the onset of their acclimation to cold weather, and in mid-winter with fully hardened plants. Plants fertilized with a complete fertilizer of 1:1:1; 2:2:2, 1:1:2, or 1:2:1 ratio made better recovery from the early and mid-season artificial freezing tests than the non-fertilized plants and those that received a fertilizer with a 1:0:0, 2:0:0 or 1:1:4 ratio.

Winter injury to strawberry plants is of frequent occurrence in Massachusetts, thus it may be worthwhile to fall fertilize* with a complete fertilizer rather than one containing nitrogen alone, as has been suggested in the past if the plants lack vigor. We suggest applying a complete fertilizer (1:1:1, 1:1:2, or 1:2:1 ratio) at the rate of 30 pounds of actual nitrogen per acre.

A broadcast application of fertilizer at that time may damage the foliage unless precautions are taken. Apply on a clear day of low humidity and shake off any fertilizer adhering to the leaves, (a switch made from brush is convenient) or apply during a rain, to avoid burning of the foliage.

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* About late August.

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NEW HERBICIDE FOR BLUEBERRIES

Dominic A. Marini
Southeast Regional Fruit & Vegetable Specialist

Terbacil (Sinbar*) is now registered for the control of many annual and some perennial weeds in blueberries, and is included in the 1978 Weed Control Guide for Small Fruits. Some of the weeds mentioned on the label are crabgrass, fall panicum, foxtail, mustard, yellow rocket, purslane, ragweed, lambs quarters, chickweed, shepherdspurse, marestail, cinquefoil, hawkweed and quackgrass - also known as doggrass or witchgrass. As with other new materials, limited applications on a trial basis are suggested.

Terbacil is sold as a wettable powder that is mixed with water and applied as a spray. Continuous agitation is necessary to keep it in suspension for uniform application. It may be applied as a band along the row and under the bushes or as a complete broadcast application.

Plants should be established for at least one year before being treated with terbacil. It may be applied in the spring or after harvest in the fall before weeds emerge, or to weeds in the early seedling stage of growth. Apply at the rate of 2 pounds of the 80 percent wettable powder per acre on light soils, and 3 to 4 pounds on heavy soils. Do not use on gravelly soils with less than 1 percent organic matter or where roots are exposed. Avoid contact of fruit or foliage with spray or mist.

Blueberries may be planted in soil treated with Sinbar one year after the last application. Do no replant to other crops for 2 years, or injury may result.

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* Trade Name

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POMOLOGICAL PARAGRAPH

<u>When can the severity of russet on Golden Delicious be estimated?</u>
Dr. L. L. Creasy, Cornell University, Ithaca, New York, reported at the 122nd Annual Meeting of the New York State Horticultural Society that russet on Golden Delicious apples is present 30 days after petal fall, but the high pigment concentration on the fruit at this time makes it difficult to see. However, generally by mid-July russet is readily visible and the amount estimated at this time will not change through harvest.

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USE OF CREOSOTE TO PREVENT DEER DAMAGE IN ORCHARDS

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The white-tailed deer is highly prized by hunters who spend large sums of money annually in quest of "their" deer. However, the "Buck-law" in Massachusetts, enacted to increase deer population, has not found favor with farmers because deer feed on agricultural crops.

Deer favor fruit trees, especially apples, as a food source and cause considerable damage in some Massachusetts orchards. Both the female and male deer feed on apple trees during the winter months and the male deer injures trees with his horns. During the summer, deer feed on new shoot growth and developing fruit.

Fencing, the most effective means of keeping deer out of orchards, is expensive. Therefore, many growers use taste repellents to prevent deer damage. These are somewhat effective when sprayed on trees during the growing season and/or during the fall and winter months. Smell and noise repellents also have been tried in Massachusetts with limited success. Recently, it has been reported from Maryland that Tabasco Sauce is an effective taste repellent against deer and rodents.

Ben Tarnauskas, who operates an orchard on the Granville-Westfield town line, conceived the idea of using creosote as a deer repellent. Strips of felt approximately 3/4" x 6", with a wire attached to each strip, were dipped in creosote. (Felt weather stripping is an available and perhaps the most economical source of felt.) Ben attached one treated strip per tree on trees next to the woods. He observed that the deer avoided these trees and therefore he placed the creosote-treated strips in all young trees. The creosote has proved to be an effective repellent.

Other orchardists in Granville are now using creosote-treated felt strips in their orchards. Edward Roberts has placed 2000 strips near young trees (one strip/tree 30 inches above the ground) with excellent results. No feeding by deer has occurred in trees containing the strips this past year. Mr. Roberts retreats the strips with creosote in an oil can. He suggests "touching-up" the strips about every 3 weeks during the rainy periods of the growing season. (Once seems enough for the entire winter). This method saves on repellent and keeps the odor strong. <u>One caution</u>: creosote will burn apple tree leaves and bark. Therefore, the felt strip must be hung in such a manner that the excess creosote will not drip on foliage or wood. A safer method is to drive a 3/4-inch stick approximately 36 inches in length in the ground near the tree with the creosote strip wired to its top.

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INFLUENCE OF PESTICIDES ON SPIDER MITE AND PREDATOR ABUNDANCE IN MASSACHUSETTS APPLE ORCHARDS--1977 RESULTS

Robert G. Hislop, Charles Acker, and Ronald J. Prokopy
Department of Entomology, Fernald Hall

In the March-April, 1977, issue of _Fruit Notes_ we described the results of our 1976 research aimed at reduced spraying for spider mites in Massachusetts apple orchards. In 1977, we continued our search for natural enemies of mites and discovered that _Amblyseius fallacis_, our most important mite predator, was even more abundant and widespread than our 1976 survey suggested. Here, we discuss the results of our 1977 field work aimed at enhancing the buildup of this valuable predator in our orchards.

In June, 1977, we resumed the extensive spider mite (red mite and two-spotted mites) and predator sampling program begun in 1976 but concentrated on sampling only apple tree foliage. We sampled 4 commercial orchards (A, B, C, and D), located in 2 separate regions of the state, and 1 abandoned orchard. Two of the commercial orchards employed one type of spray program, the other 2, a different program. In addition, at the Horticultural Research Center at Belchertown, we applied either Imidan, Guthion, Zolone, or Benlate at biweekly intervals from petalfall to late August to 3 groups of trees, with 3 groups left unsprayed for comparison. All trees in the commercial and Belchertown orchards were sampled at biweekly intervals to determine spider mite and predator populations. The samples were collected, processed, and analyzed in the manner described in the 1977 issue of _Fruit Notes_.

Results in 1977 supported the 1976 results in that _A. fallacis_ was common only in certain commercial orchards. In the abandoned orchard its numbers were low but numerous other predator species kept red mites and two-spotted mites at very low levels.

In commercial orchards A and B, sprayed with combinations of Guthion, Zolone, Imidan, Benlate, Glyodin, and Captan, two-spotted mites reached 10.7 and 14.3 mites per leaf at peak abundance (Table 1) but red mites remained below damaging levels. Populations of _A. fallacis_ reached maximum levels of only 0.06 and 0.04 mites per leaf.

On the other hand, in commercial orchards C and D, sprayed with combinations of Guthion, Captan, and Cyprex, two-spotted mites were virtually absent. In orchard C, red mites remained at very low levels, in contrast to orchard D, where they reached a peak abundance of 36 mites per leaf (Table 1). _A. fallacis_ was relatively scarce in orchard C in comparison to orchard D, probably due to the low spider mite populations. In orchard D, predacious mites reached very high numbers, (5.4 mites per at peak abundance) but yet were unable to control the red mites. In addition to the large _A. fallacis_ populations in orchard D, there were 2 additional

TABLE 1. Abundance of spider mites and mite predators in commercial and abandoned orchards in 1977

	Number and type of pesticide sprays applied			Number of mites/leaf at peak abundance (July-August)				
Orchard	Insecticides	Fungicides	Miticides	Red Mites	Two-spotted Mites	Yellow Mites	*A. fallacis*	Other predacious mites
A	5 Guthion 50WP 2 Imidan 50WP 3 Zolone 3EC	9 Glyodin 30%EC 9 Benlate 50WP	1 Omite 30WP 1 Plictran 50WP	2.10	10.70	0.00	0.06	0.00
B	6 Imidan 50WP 2 Zolone 3EC	6 Glyodin 30%EC 6 Benlate 50WP 3 Captan 80WP	1 Plictran 50WP	0.40	14.30	0.00	0.04	0.00
C	8 Guthion 50WP	6 Captan 80WP 4 Cyprex 65WP	--------------	0.02	0.00	0.00	0.11	0.00
D	9 Guthion 50WP	9 Captan 80WP	--------------	36.00	0.00	3.80	1.61	0.00
Abandoned	-------------	------------	--------------	1.34	0.00	0.08	0.00	1.62

species of mite predators, called yellow mites, that are very slow and inefficient at locating and capturing red mite prey. These predators were considerably more abundant than _A. fallacis_, and it is very likely that they were interfering with _its_ performance.

In the abandoned orchard, two-spotted mites were totally absent, while red mites were always at low levels (Table 1). _A. fallacis_ was largely absent. However, other predacious mites _increased to_ 1.70 mites per leaf, which is a rather high level, but still considerably lower than predator levels in commercial orchard D. It appears that the fewer numbers of mite predators in the abandoned orchard were able to control red mites better than the larger number of predators in orchard D. This was probably because the different predator complex in the abandoned orchard was more efficient in controlling red mites.

At the Belchertown Research Center, two-spotted mites were in greatest abundance (causing severe leaf injury) and _A. fallacis_ in least abundance in the Zolone treated plot (Table 2). _However_, red mites remained below damaging levels in all plots. In the Guthion and Imidan plots, _A. fallacis_ populations were high, keeping two-spotted and red mites _well below_ damaging levels. _A. fallacis_ levels were also high in the Benlate plot but _failed to keep two_-spotted mites from reaching damaging levels (Table 2). This is likely due to certain characteristics of Benlate (see below) which adversely affect _A. fallacis_ populations. Yellow mites were absent from all plots.

The combined results from the commercial orchards and the Belchertown Research Center show that one or more of the materials Zolone, Benlate, and Glyodin have a toxic and/or other effect on populations of _A. fallacis_. In addition, our recent laboratory findings _confirm results from_ Michigan (Dr. B.A. Croft's laboratory), showing that Benlate, at orchard concentrations, severely reduces the number of eggs laid by _A. fallacis_. Growers using these materials (Table 1) needed more _miticide_ sprays, principally to control two-spotted mites, than growers spraying only Guthion, Imidan, Captan, and Cyprex. However, red mites can become a problem in some orchards (i.e. in orchard D) using the latter pesticides because the favorable environment may allow less efficient mite predators to increase and interfere with _A. fallacis_.

In the future, we plan further laboratory and field trials aimed at determining which pesticides are safest for _A. fallacis_ populations in our commercial orchards. This predator _can be of_ great assistance in suppressing harmful spider mites if its survival can be guaranteed. In the next issue of _Fruit Notes_, we will describe results of laboratory tests _aimed at determining_ the toxicity of a large variety of orchard pesticides to _A. fallacis_.

TABLE 2. Pesticides applied to apple trees at Belchertown Research Center in 1977.

Pesticide	Rate/100 Gal	Number of mites/leaf at peak abundance (July - August)		
		Red Mites	Two-spotted Mites	A. fallacis
Imidan 50wp	1.5 lb	7.50	2.70	1.48
Guthion 50wp	10 oz.	5.74	3.60	2.00
Zolone 3EC	1.5 pts	6.60	108.80	0.25
Benlate 50wp	6 oz.	8.00	17.50	1.47
Check	-----	3.70	1.74	2.14

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APPLE TREE RESPONSE TO SUMMER PRUNING

W. J. Lord and D. W. Greene
Department of Plant and Soil Sciences

Summer pruning has been practiced for centuries by European gardeners in order to restrict vegetative growth and to induce the formation of flowering spurs, but has not been widely applied in commercial fruit growing. Considerable research on summer pruning was conducted in the early 1900's, and it produced widely differing results depending on type of pruning, tree vigor, and cultivar. It is very difficult to evaluate the results of these experiments because these early reports generally described their experiments too vaguely or the treatments were not replicated, but it should be noted that in some of these trials summer pruning failed to suppress vegetative growth, to increase flowering, to induce early bearing, or to increase production. In some of these trials, the summer pruning procedure was similar to that practiced during the dormant season, whereas pruning as practiced by European gardeners to induce fruitfulness involved removal of a portion of the current-season shoot rather than removing whole branches or shoots. Despite all the differences, however, it was generally agreed that summer pruning restricted tree growth more than an equivalent amount of pruning during dormancy.

This flurry of research on summer pruning in the early part of the century led to the conclusion by some American pomologists that the results were too unpredictable and the practice too laborious to be of value in commercial orchards. But, now that we have greater density of plantings (trees per acre) than in the past, interest in vegetative growth control has been renewed. Furthermore, we have substantial acreage of trees on size-controlling rootstocks that are easier to prune because they are smaller, and we have mechanical pruning devices that make pruning quicker. Delicious, the major cultivar in the U.S., tends to make excessive growth and to be unfruitful, and therefore needs growth restriction. And still further, as we look for ways to improve the calcium nutrition of apples we see reports from Europe indicating that summer pruning can increase fruit calcium levels. There is, therefore, ample reason to re-examine the applicability of summer pruning to commercial fruit production.

What is Summer Pruning?

The term summer pruning alone means little and only tells the season of pruning. It may mean nothing more than the removal of water sprouts or performing dormant-type pruning during the growing season as a means of tree training. Summer pruning could mean making detailed cuts on current season's shoots throughout the tree, using hand-held pruning tools, to restrict vegetative growth and induce the formation of flower buds on young trees. It also could mean removal of current season's shoots and/or 1-year-old wood on the periphery of the bearing tree with hand-operated pruning tools or a mechanical pruning device to restrict tree growth or increase fruit calcium.

The object of our summer pruning investigations has been: (1) to determine the vegetative and fruiting responses of young Delicious and Cortland trees; and (2) to study its influence on quality of fruit from Cortland and McIntosh trees.

Definition of Terms

At this time a few terms used in this report should be defined to avoid confusion that otherwise might arise in regard to their meaning. Pinching will refer to the removal of only the tip of current season's shoots. Heading will be the term used when cutting current season's shoots back to 4 to 6 mature leaves. Stubbing as used here is to cut upright shoots on limbs about 1/4 to 1/2 inch above their base, thus leaving a short stub.

Axillary buds are borne in the axils of the leaves on current season's shoots. When a current season's shoot is pinched or headed, the axillary bud or buds directly below the pruning cut may produce growth; these are referred to as axillary spurs or shoots. We arbitrarily classified any growth less than 1 inch long but producing a whorl of leaves as being an axillary spur. When shoots produced more than an inch of extension growth they were classified as axillary shoots. The tip of an axillary spur will become either a leaf or flower bud. The terminal bud on an axillary shoot also will become either a leaf or flower bud.

Effect on Growth of Young Trees

Pruning while the shoots are still elongating tends to cause new shoots to start growth from the axillary buds below the pruning cuts. The amount of regrowth may show little correlation with severity of pruning. We have found that Red Prince Delicious produces more of this regrowth than Cortland. Tree vigor at time of pruning also is an important variable since the length of shoots at time of pruning is highly correlated with amount of regrowth, i.e., the longer the shoot, the greater the regrowth.

Pinching did not devitalize the trees in our studies, whereas heading restricted the size of vigorous trees. Considerable regrowth follows summer pruning of vigorous young trees in late-June through mid-July. However, if substantial leaf surface is removed at this time, regrowth does not compensate for the removed surface. July and early-August appear feasible times for restricting tree size by summer pruning, but regrowth may be less when pruning is done in early-August.

Pinching and heading cuts on vigorous Red Prince Delicious trees in early or mid-July frequently causes new shoots to start growth from 2 or more of the axillary buds below the pruning cuts. Thus, a proliferation of growing points occurs just as when trees are sheared with mechanical pruning devices during dormant season.

Whether the proliferation of growing points can be considered an unfavorable response in all cases remains to be proven. However, clearly unfavorable responses to summer pruning have occurred. On Cortland/7A trees, 18% of the shoots headed on July 18, 1976 were dead in 1977; death of headed shoots occurred less frequently following the July 1 and August 2 pruning dates. Many current season's shoots on Cortland/7A and Red Prince Delicious/26 stubbed in 1977 failed to produce regrowth. In 1978, 71% and 50% of the stubs were dead on the Cortland and Red Prince Delicious, respectively. Some flowering from axillary flower buds and spurs has occurred in September of the year of pruning. Summer-pruned trees also have shown a tendency to mature their wood later in the fall as evidenced by delayed leaf abscission, and this may lead to winter injury. Furthermore, Starkrimson trees that had been summer pruned by heading cuts in 1976 made more growth than the control trees in 1977; thus, the advantages of vegetative growth control in 1976 were lost in 1977 without follow-up summer pruning.

Effect on Formation of Flowering Spurs

We wanted to determine if stubbing, heading, or pinching current season's shoots in summer caused a flower bud to form immediately below the cut. Stubbing is preferred in some fruit growing areas because less regrowth is produced and thereby more chance for initiating flower buds than when a longer stub is left as with heading and pinching. Even though we stubbed shoots on Cortland/7A and Red Prince Delicious/26 on June 21, July 5, or July 19 many were not vigorous enough at time of pruning to produce an axillary flowering spur or shoot. As previously mentioned, many of the stubs failing to make regrowth in 1977 were dead in 1978.

Heading and pinching on Cortland/7A in 1976 and 1977 caused formation of some flowering axillary spurs or the development of axillary shoots with a terminal flower bud. Since Cortland normally produces some terminal flower buds, a terminal flower can form in spite of considerable extension growth of axillary shoots from the first leaf axil below the pruning cut. On Cortland we believe that summer pruning merely eliminated some potential flower buds and stimulated the formation of others since total bloom was not increased in either year following pruning.

Heading and pinching procedures failed to induce the formation of flowering spurs or shoots on Starkrimson Delicious/106 and Red Prince Delicious/106 in 1976 but were somewhat successful on Red Prince Delicious/106 and Red Prince Delicious/26 in 1977, probably because conditions were very favorable for flower bud initiation as evidenced by the snowball bloom in most orchards in 1978.

The Red Prince Delicious/106 made considerable regrowth from the 1st leaf axil following heading and pinching and no flower buds were initiated on this axillary growth. However, flower buds were initiated on axillary spurs or short shoots developing from the 2nd leaf axil below the pruning. In the case of the Red Prince Delicious/26, which had low to moderate vigor in 1977, flower bud initiation occurred on axillary spurs and shoots from both the 1st, and 2nd leaf axil. As with Cortland, total bloom was not increased in 1978 by the summer pruning. Furthermore, Red Prince Delicious/106 summer pruned by heading cuts both in 1976 and 1977 when they were in their 2nd and 3rd leaf had significantly less bloom in 1978 than the control trees.

Heading and pinching in late-June and early-July were most effective while pruning in mid-July or later had little effect on flower initiation (Table 1).

TABLE 1. Time of summer pruning and percentage of tagged axillary spurs or shoots that had terminal buds that bloomed the following year.

Time of pruning	Bloom, 1977 of Cortland buds %	Time of pruning	Bloom, 1978 of buds on: Cortland %	Del/106 %	Del/26 %
7/1/76	21.9 a	6/21/77	47.6 a	-------	25.1 a
7/15/76	3.3 b	7/5/77	42.7 a	14.2 a	13.4 b
8/2/76	1.4 b	7/19/77	15.7 b	2.1 b	4.1 b

Its Place in Massachusetts Apple Orchards

Performing dormant-type pruning during the summer has a place in young apple orchards as a means of tree training. However, summer pruning is laborious and certainly of doubtful value under Massachusetts conditions as a direct stimulus for flower bud initiation on axillary spurs and shoots. To the contrary, Dr. G. E. Stembridge at Clemson University, Clemson, South Carolina, obtained substantial flower bud initiation following stubbing of 4-year-old Delicious/106 in early summer, 1974. Furthermore, many of the axillary spurs and shoots produced by late summer pruning initiated flower buds in 1975. Stembridge stated in correspondence that he thought the extra flowers produced by summer pruning were relatively inconsequential to the productive capacity of the tree. A more important consequence of the summer pruning was the removal of unwanted vigor and better light penetration. In South Carolina, growing conditions are probably more favorable for flower bud initiation following summer pruning than in Massachusetts. To the contrary, the problem of controlling vigor is probably less acute in Massachusetts than in South Carolina.

Basically, Delicious is our only cultivar with which we have problems of adequate fruitfulness on young trees whereas tree crowding and low fruit Ca is a problem with different cultivars in many bearing orchards. Mid-July through early-August seems a suitable timing for summer pruning to restrict vegetative growth; when practiced to increase fruit Ca, early August may be best.

Many answers are needed concerning the responses of our major cultivars before we can suggest this procedure on other than a trial basis only. Summer pruning is very laborious when done with hand shears, thus one of the questions is, "Can it be performed with a mechanical tree hedger?".

It certainly is possible that Rome and Cortland, which produce part of their crop on 1-year-old wood, may not show favorable responses to summer pruning if a high percentage of current season's shoots are removed. Furthermore, we need to know the influence of summer pruning on sun scald of fruit, and fruit maturity and keepability in storage.

Research on summer pruning is being conducted in many fruit growing areas and many questions concerning the practice will be answered. Meanwhile, we urge caution to the growers currently experimenting with summer pruning.

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THE EFFECT OF SUMMER PRUNING OF McINTOSH APPLE TREES ON THE CALCIUM NUTRITION AND POSTHARVEST QUALITY OF THE APPLES

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As we have searched for methods to increase the amounts of calcium (Ca) in apples, we have become interested in the results from Europe indicating that late summer pruning can improve Ca nutrition of the fruit. It is logical to expect such a result from late-summer pruning, since vegetation and fruit are competing for what Ca is available within the tree, and vegetation is the much stronger competitor. Therefore, removing vegetation late enough so that regrowth does not occur should reduce much of the competition and allow more of the available Ca to move into the fruit.

But, will it work? To test the idea, we adopted the pruning technique of A. P. Preston in England, which he found to work under their conditions. This is a very severe pruning technique: <u>all</u> current-year shoots are removed to their <u>points of origin</u>. We applied this technique to 8 vigorous 12-year-old McIntosh trees on M.7 rootstock in 1975 and in 1976 within an experiment where we were testing various methods of raising the Ca level in the fruit. Pruning was done in early-August, 1 month before harvest, and resulted in no regrowth in that season.

The effects of the pruning on the quality of the fruit were outstanding. Ca content of the fruit at harvest in 1975 was 15% above that of fruit from trees that had not been summer-pruned. Due to reduced foliage, light penetration was much greater and the fruit were much redder at harvest; however, there was no sun-scald on them (although sun-scald did occur on Cortlands that were pruned in the same way). After storage in either regular storage to January, or in CA until mid-April, apples from the summer-pruned trees had much less bitter pit, breakdown, and rot.

In 1976, the same trees were again pruned in the same way. Again, the fruit were highly colored due to the excellent light penetration, but were not sun-scalded. In this second year, summer pruning increased fruit Ca by an amazing 60%, and after storage the quality of the fruit was outstanding: bitter pit and breakdown had been virtually eliminated, and the fruit were substantially firmer than ones from trees that were not summer pruned. Clearly, summer pruning had effectively increased the amount of Ca in the apples and had correspondingly improved their postharvest quality.

Should you consider using this pruning technique in your orchard? We do not think so; we do not believe that the Preston technique can be applied in New England without modification. We believe it is too severe a method of summer pruning for McIntosh in Massachusetts. Among our concerns is the fact that in 1976 the trees produced many blossoms at harvest time.

These results do, however, demonstrate that summer pruning may be an important method of coping with Ca deficiency in apples. We are now considering less severe pruning methods to see if we can find a technique that is compatible with our growing conditions, and yet will remove enough vegetation to significantly improve fruit Ca levels. An important point in considering summer pruning is to recognize that if pruning is done early and regrowth occurs, the new vegetation will increase the competition for available Ca; if substantial regrowth occurs, summer pruning may reduce the amount of Ca in the fruit, and worsen their storage problems.

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When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials.

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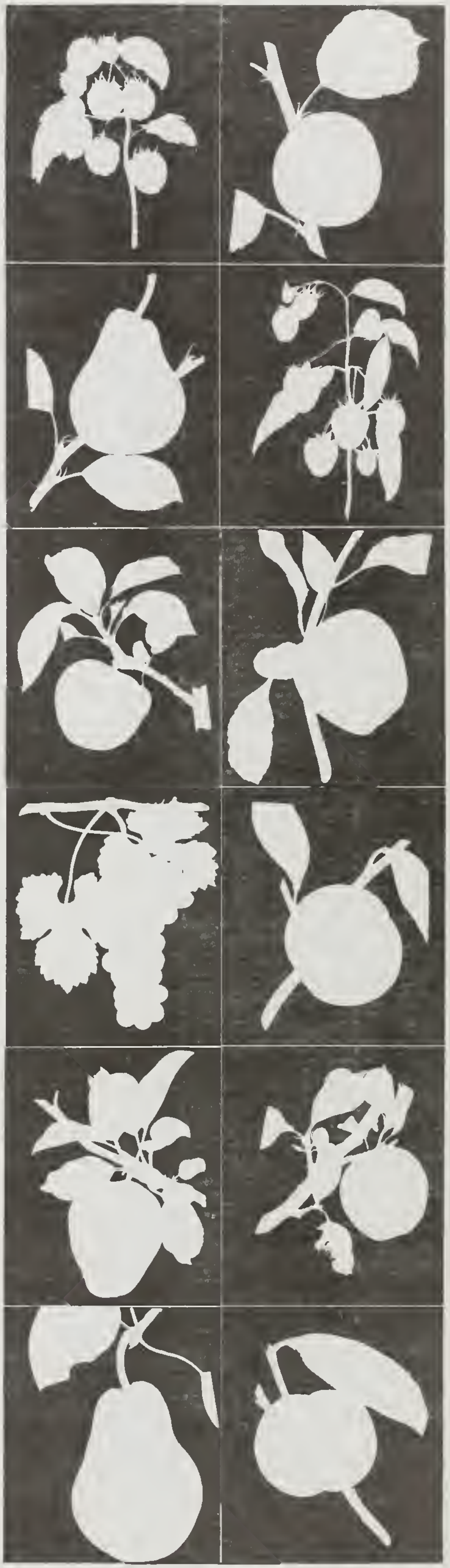
FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE



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SEPTEMBER/OCTOBER 1978

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NEW ENGLAND FRUIT MEETINGS AND TRADE SHOW, 1979

The New England Fruit Meetings and Trade Show, as in the past, will be held at the New Hampshire Highway Hotel, Concord, New Hampshire. The meetings are scheduled for January 10 and 11.

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HARVESTING AND STORING APPLES: A TIME FOR OBSERVING DETAILS

W. J. Bramlage
Department of Plant and Soil Sciences

The apple harvest season is a hectic time for a fruit grower. His attention is often focused on his harvest labor, and perhaps on his harvest sales operation. And, unfortunately, something may have to "give". Don't let it be your storage operation! Short-cuts or mistakes in September can mean disaster in April. If a grower is to market quality fruit in the Spring, he must pay attention to details in the Fall. Some comments follow on things to be watched.

Weather. Hot weather shortly before and during harvest is generally detrimental. It ripens fruit rapidly, leading to harvest of over-mature apples with shorter storage life. It results in poorer coloring, especially if night temperatures are high, and again leads to harvesting riper apples because it is necessary to wait for at least 33% red color. It increases susceptibility to scald, making effective scald treatments crucial. If it's hot during the harvest period, the hot apples increase the heat load going into a storage room. Unless ample refrigeration is available, it is best to allow these hot apples to cool overnight in the orchard, and bring them into storage early the next morning.

If the weather is cool during harvest, the prospects for high quality fruit in the Spring are much better. Nevertheless, there is need to get apples off the tree and into storage as quickly as possible. The riper the fruit at harvest, the shorter is its storage life.

With late varieties, freezing may occur. Apples freeze at about 28°F. If they freeze, do not pick or handle them until they are fully thawed. Physical contact will produce visible damage ("bruises") when they thaw. Unless the fruit temperature falls to about 22°F, apples will survive freezing; at about 22°F, lethal damage occurs and they show browning and breakdown soon after they thaw. If browning and breakdown do not show up soon after thawing, the apples have survived the freezing. However, any freezing causes softening and probably leads to faster deteriotiation during storage. If apples freeze, do not attempt to store them for long periods of time; dispose of them as quickly as possible.

Fruit maturity. Maturity is the stage of development at harvest. If too immature at harvest, fruit will never develop top quality flavor and may be more subject to shriveling, scald, bitterpit and browncore after harvest. If overmature, fruit will deteriorate quickly and be more subject to softening, breakdowns and rots.

How to identify maturity is a difficult question. Pressure test, color (especially undercolor), abscission, and flavor are helpful guides, but experience with your own fruit may be your best measure. Use of growth regulators has made this an even more difficult question. Alar* delays maturity, but not as much as many people think. Its phenomenal drop control capability and its delay of softening can be misleading. Do not delay harvest of Alar*-treated fruit; a significant amount of the firmness difference between Alar*-treated and untreated fruits will disappear rapidly during storage. Ethrel* hastens maturity, and despite our belief that Ethrel*-treated fruits can be stored if harvested at the right time, we think that it's hazardous to try to CA-store Ethrel*-treated apples commercially. The hormone-type Stop-drop sprays also promote maturation, and should be used with this understanding.

Further complicating the maturity problem is the use of red strains and dwarfing rootstocks. Since for marketing reasons harvesting is usually gauged by red color, the red strains are probably an advantage to proper storage management since less mature (and longer keeping) fruit may be harvested. However, among the strains of 'Delicious' it is well known that some red strains mature well ahead of others. Therefore, it cannot be assumed that red strains are just like the standard strains except for color; other criteria must also be watched. It is very likely that some rootstocks influence maturity, although this must yet be defined. Again, you cannot assume that fruits from dwarfing-rootstock trees are the same as those from seedling-rooted trees. You must watch these fruits closely.

Just when to harvest apples for maximum storage life is perhaps the most frustrating question to face. In Massachusetts, flesh firmness of at least 15 to 17 lbs (if Alar*-treated, 16 to 17 lbs) is considered essential for 'McIntosh' if they are to be stored in CA. If you are using a pressure-tester to gauge fruit maturity, be sure you are using it properly. (See: "The Use of a Pressure Tester to Measure Firmness of Apples". Fruit Notes, March/April, 1977). In Michigan, a simple test has been devised to measure the amount of ethylene gas being produced by apples as a means of determining whether they are suitable for long-term or for short-term storage, and it is being used commercially there, but we as yet have no personal experience with this test in Massachusetts.

Most of the problems due to harvesting slightly immature apples can be dealt with, and these fruit will have the potential for long storage. Most of the problems due to harvesting overmature apples

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* Trade Name

cannot be dealt with except by rapid disposal of them. It is better to pick a little too soon than a little too late. Overmaturity is perhaps the greatest source of storage problems.

Pre-storage operations. It is absolutely essential that apples be cooled quickly and thoroughly after harvest. Ideally, they should be cooled to 32°F within 24 to 36 hours, but in practice it is sufficient to completely cool them in 7 days. However, few growers have any idea what the temperature of their fruit actually is in storage. (Air temperature is a poor gauge of fruit temperature.) Some growers who have measured fruit temperature during storage with thermocouples have been shocked to learn how slowly they are cooling. Many refrigeration systems are designed to maintain temperatures after the apples are cool, and therefore do not have the capacity to rapidly cool large volumes of fruit. These rooms can only cool fruit adequately if they are loaded slowly and carefully. Use of bulk bins increases the cooling problem, since contact of moving cold air with the fruit is reduced. Furthermore, bins are often arranged in the storage without regard for air-flow patterns. Cold air must move over the surface of an apple if it is to cool quickly. Inadequate cooling is undoubtedly a major source of storage problems.

Varieties susceptible to scald should be treated with an inhibitor before storage if they are to be stored beyond early January. Postharvest dips are very effective if used properly. Diphenylamine, at 1000 ppm for McIntosh, 1000-1500 ppm for Delicious, and 2000 ppm for Cortland, is generally the preferred inhibitor except for Golden Delicious, but Ethoxyquin at 2700 ppm may also be used. Tests in New York indicate that liquid-concentrate DPA is more effective than wettable powder DPA, since it is more stable in suspension and less toxic to the fruit, although it requires addition of a defoaming agent. Surveys in New York revealed that many dip tanks contained considerably less inhibitor than recommended, due to dilution of solution by wet apples, removal of inhibitor on the surface of treated fruit, and breakdown of inhibitor in the dip tank. New York recommendations now suggest that when DPA dips are being replenished (brought back to volume), double-strength solution should be added to the tank, to compensate for this diminished concentration of the inhibitor.

If a postharvest dip is being used, it is wise to add a fungicide. A circular on "New England Suggestions for Postharvest Fruit Rot and Storage Scald Control" is available from your Regional Fruit Specialist. Benlate* has given excellent decay control on apples, but it should be noted that Benlate* seems to be unusually conducive to development of resistant strains of fungi. If Benlate* has been used during the growing season, there is a possibility that a resistant strain is present on the fruit. Furthermore, it is suggested that treated fruit be removed from the dipping area as quickly as feasible to avoid buildup of resistant spores. Much can be done to reduce storage decay problems by preharvest sanitation treatments; this was carefully described in Fruit Notes by Dr. C. J. Gilgut in 1972 (Fruit Notes, Sept.-Oct.:pp 2-7).

If a postharvest dip is used, calcium chloride ($CaCl_2$) may also be added to the solution. Adequate calcium levels in the fruit are essential for long storage life. If calcium treatments have not been applied during the season, or if significant amounts of cork or bitterpit are present in the fruit, 24 to 32 lbs of $CaCl_2$/100 gallons may be added to the dip solution. The calcium residue on the surface of the fruit will continue to enter the apples during storage, and can substantially reduce the development of fruit disorders.

Storage operations. CA rooms should be filled and sealed as quickly as the apples can be thoroughly cooled. The longer the fruit remain in air after harvest, the less benefit CA will have on them. It should be no more than 2 weeks between the time you start loading a room and when that room is sealed. However, to accomplish this, you must have sufficient refrigeration capacity in that room to remove the field heat, or else have a special room with extra cooling capacity in which you do the initial cooling of the fruit. If you must choose between thorough cooling and early sealing, choose thorough cooling. Don't overload your cooling capacity to get an early seal.

The exact temperature at which you store your fruit is a critical factor in determining how well they will keep. You must have a highly reliable, calibrated thermometer in the storage room, and you must store the fruit at the recommended temperature, not near it. A storage temperature that is only 1° or 2°F above the recommended temperature will significantly reduce the storage life of your fruit.

Traditionally, a relative humidity of 90 to 95% has been recommended for apple storages. It has been clearly shown in recent years that if the R.H. is very near 100%, apples are more subject to breakdown disorders; on the other hand, if R.H. is below 90% the apples will shrivel. However, we know of no storage that is equipped to monitor R.H., and doubt if very many storage operators ever measure R.H. (a sling psychrometer is a good tool for measuring humidity). In this situation, we feel that storages are more likely to have too low humidity than too high a humidity, since it is not easy to maintain an atmosphere close to 100% R.H. Therefore, we recommend that storage operators do everything possible to maintain as moist an atmosphere as possible in the storage.

For CA storage, our recommended conditions are the same as in recent years. McIntosh and Macoun should be stored at 3% O_2, 5% CO_2, and 38°F. Baldwin, Delicious, Empire, Golden Delicious, Idared, Northern Spy, Rome Beauty, and Spartan should be stored at 3% O_2, 2% CO_2, and 32°F. Cortland may be stored under either regime, but store best as part of the latter group of varieties.

Careful observations and record keeping do not end with attainment of the CA condition. Atmosphere and temperature should be monitored and recorded daily. If the O_2 falls below 3%, it should be brought back up immediately. Storage conditions should be watched closely and recorded. (The gas analyzer, the aspirator bulb, and all sample lines should have been carefully checked before sealing, and any indication of malfunction during storage should be checked-out immediately. Porous aspirator bulbs, which result in higher O_2 readings than actually exist in the room, have been responsible for severe low O_2 injury to fruit.) It is well to sample fruit periodically during the storage season. (See: "The Soft McIntosh Problem", Fruit Notes, Sept.-Oct. 1974: pp. 1-4)

Successful storage operation requires attention to details, from the beginning of harvest to the sale of the last apples. Any mistake or oversight can be disastrous, especially with the trend to longer storage periods: the longer apples are kept, the more important are the details. The successful operator should recognize a problem as it develops, and adjust his marketing practices accordingly. For example, if cooling in some fruits has been inadequate, these fruits should be disposed of as quickly as is feasible. Long-term storage should be attempted only with apples that have "everything going for them". Long-term CA does not correct mistakes; it only underlines them.

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BRUISING OF APPLES AFTER PACKING

W. J. Bramlage
Department of Plant and Soil Sciences

Dr. George Mattus has been conducting extensive studies in recent years on the condition of apples in the distribution centers and retail stores of Virginia. He has often observed a great deal of impact bruising on apples, indicating damage that is occurring during handling of the packed fruit. To determine some of the factors associated with this bruising and to try to find ways of reducing it, Dr. Mattus conducted a series of tests this Spring that produced some impressive results. Some of his findings are reported here.

In one series of tests, carefully harvested apples of 5 different cultivars were packed in fiber or foam trays, which were packed in cartons. Both 88- and 100-size packs were tested. In addition, 6 different cultivars were packed in 3-lb poly bags, which were placed in 12-bag cartons. Two different cartons for the bags were tested: 1 carton had 12 single cells, 1 for each bag, whereas the other carton had only 4 cells, so that 3 bags were packed in each cell -- 2 vertically and 1 horizontally.

Each carton was dropped once, from either a 6-inch or a 12-inch height. Injury to the fruit was tabulated and is shown in Table 1.

TABLE 1. BRUISING OF APPLES, PACKED IN TRAYS OR POLY BAGS, FOLLOWING A SINGLE DROP OF A CARTON.

Packing variable	Height of drop	DAMAGE TO FRUIT: % with bruises	No. of bruises per apple	Sq. cm. of bruised area per apple	% with cuts or punctures
		CARTONS CONTAINING TRAYS			
Type of Tray					
Fiber	6"	64	0.9	62	0
Foam	6"	52	0.7	42	0
Fiber	12"	70	1.0	116	0
Foam	12"	54	0.7	54	0
		BAG-MASTER CARTONS			
No. of Cells					
12	6"	68	1.1	109	2.9
4	6"	69	1.2	127	2.2
12	12"	77	1.4	223	3.5
4	12"	80	1.5	240	4.0

The results dramatically demonstrate the potential for damage to fruit after packing. A single 6-inch drop of a carton (measure it!) bruised over 50% of the fruit. Apples packed in foam trays bruised less than those packed in either fiber trays or poly bags. Apples packed in poly bags, rather than in trays, received more bruises from the drop, and these bruises were much larger than those on tray-packed fruit. In addition, the apples in poly bags received cuts and punctures from the drop, even the one from only a 6-inch height.

Interestingly, the 12-inch drop was not much worse on the fruit than the 6-inch drop. Also, it made little difference whether the poly bags were packed in 4-cell or 12-cell cartons.

In another series of tests, Golden Delicious apples in either fiber or foam trays were packed in a number of different ways to find out more about what influences bruising. In these tests, the cartons of apples taken directly out of cold storage were all dropped once from a 12-inch height.

Results are shown in Table 2. These tests showed that (1) more injury occurred in dry fiber trays than in moist fiber trays; (2) more injury occurred in shallow fiber trays than in deep-cell fiber trays; (3) damage to fruit packed in fiber trays can be reduced by individually wrapping apples in paper, padding the bottom of the carton, and especially by putting pads between layers; and (4) cold apples are more subject to bruising than are warm apples.

Clearly, the way apples are packed influences the amount of damage inflicted by impact upon the carton. However, the clearest message from these studies is: Don't drop cartons of apples!

TABLE 2. EFFECTS OF MODIFICATIONS OF TRAY PACKING ON BRUISING OF GOLDEN DELICIOUS APPLES AFTER DROPPING A CARTON OF 100-SIZE TRAYS 12 INCHES.

Packing variable	DAMAGE TO FRUIT		
	% with bruises	No. of bruises per apple	Sq. cm. of bruised area per apple
Dry fiber trays	83	1.7	210
Moist fiber trays	72	1.6	169
Foam trays	70	1.4	102
Deep-cell fiber trays	62	1.1	77
Dry fiber trays-- +			
paper wraps on all apples, <u>OR</u>	69	1.2	100
2 pads in bottom of carton, <u>OR</u>	72	1.2	98
filled paper pad on each layer, OR	59	0.8	41
Urethane sheet on each layer	57	0.9	93
Using 20°C apples	71	1.3	127

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CONTROLLED ATMOSPHERE STORAGE SAFETY PRECAUTIONS

G. D. Blanpied, Pomology Department
and
L. D. Baker, Agricultural Engineering Department
Cornell University

[Editors' Note: Earlier this year, a life was lost in the Hudson Valley Region of New York due to lack of precautions when entering a CA room. We urge that this article be prominently displayed so that a repeat of this tragedy may be avoided.]

Occasionally, someone must enter a CA storage to obtain fruit samples, to replace a broken fan belt, burned out motor, to check for plugged nozzles, or to make other equipment repairs. The atmosphere in the CA room probably contains less than 5% oxygen. Outside air is about 21% oxygen. Do you know what happens to you in a CA storage?

Symptoms of Asphyxia*

17% oxygen - candle is extinguished.

12-16% oxygen - breathing increased and pulse rate accelerated.

ability to maintain attention and to think clearly is diminished, but can be restored with effort.

muscular coordination for finer skilled movements is somewhat disturbed.

10-14% oxygen - consciousness continues, but judgement becomes faulty.

severe injuries (burns, bruises, broken bones) may cause no pain.

muscular efforts lead to rapid fatigue, may permanently injure the heart, and may induce fainting.

6-10% oxygen - nausea and vomiting may appear.

legs give way, person cannot walk, stand, or even crawl. This is often the first and only warning, and it comes too late. The person may realize he is dying, but he does not greatly care. It is all quite painless.

less than 6% oxygen	- loss of consciousness in 30-45 seconds if resting, sooner if active. breathing in gasps, followed by convulsive movements, then breathing stops. heart may continue beating a few minutes, then it stops.

REMEMBER: THE CA STORAGE CONTAINS LESS THAN 5% OXYGEN

To avoid problems, plan ahead.

Before Sealing the Room

(1) The manhole in the gastight door should be at least 24 x 30 inches high to accommodate a large person with breathing equipment strapped to his/her back.

(2) There should be a ladder inside the room, near the refrigeration unit. When loading the room, leave sufficient space to move and use the ladder around the equipment.

(3) Place a danger sign on each gastight door. "DANGER - OXYGEN TOO LOW FOR PEOPLE TO BREATHE" or other suitable warning should be printed on the sign using letters at least 1-1/2 inches high.

Entering a Sealed CA Room

If you have a New York State CA registration and need to break the seal before the end of the initial 90 day period, notify the New York Department of Agriculture and Markets in advance.

If you must go to a place in the CA room where you cannot be EASILY DRAGGED TO THE DOOR, open the room and vent with air until the oxygen is 21% before entering (see item 6 on next page).

If you need to enter a sealed CA room (one from which you can be easily drag-rescued) proceed as follows:

(1) Have at least 2 sets of tested breathing apparatus ready. If you don't own your own equipment, know where functional breathing equipment can be borrowed or rented. The breathing equipment should be fed with air (compressed or fan blown) not pure oxygen. The mask should be held in place with straps. Scuba diving equipment is dangerous to use because the mouthpiece may fall from your mouth if you fall.

(2) Check the breathing apparatus. Does it deliver air to the mask? Is the tank full of air? The two individuals using the equipment should put on the breathing equipment in normal air and use up a tank of air while doing routine tasks. They can then become accustomed to the apparatus, learn something about its limitations and hear the alarm when the air level in the tank is nearly exhausted. The tanks should then be refilled prior to use in the CA storage.

(3) Review the symptoms of asphyxia so you won't take any chances.

(4) Remove the window in the gastight door of the CA storage room.

(5) The repair person enters the CA room with breathing apparatus. The back-up person must keep the repair person in sight. If this can be achieved from outside the CA room, the back-up person should be ready to enter the CA room, but not use the air until necessary. The back-up person may need to enter the CA room to keep the repair person in sight. If both people are in the CA room and one person's warning bell rings to signal the tank is almost empty, then both people should exit the CA room. If one must climb the ladder, the second should stay on the floor. If both need to climb the ladder to maintain visual communication, drag-rescue cannot be accomplished. Open the room and vent with air.

(6) If you vent the CA room with air and then need to restore the CA atmosphere, but do not have access to an oxygen burner, you can flush out the oxygen with nitrogen gas. Order the nitrogen gas in the liquid form (large thermos bottles), in trailer truck cylinders, or in regular cylinders with a manifold. A tightly packed room will require about 2 cubic feet and a room with plenty of free air space will require about 3 cubic feet of nitrogen gas per bushel to lower the oxygen concentration from 21% to 5%. Use a garden hose to deliver the nitrogen gas to the intake of the blower in the CA room. Leave the porthole open to relieve pressure in the room.

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* The description of asphyxia was taken from Noxious Gases and the Principles of Respiration Influencing Their Action by Yandell Henterson & Howard W. Haggard. Reinhold Publishing Corp., 330 West 42nd Street, New York, N.Y.

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CHOKECHERRIES: HOW TO RECOGNIZE AND GET RID OF THEM

Georgene Moizuk Bramlage
Leverett, MA

The importance of being able to identify chokecherry trees is that they serve as alternate hosts for X-disease, a very destructive disease of peach, nectarine, sweet cherry, and tart cherry trees. If the leaves of a wild cherry tree turn red or yellow in July or August when the leaves of other trees are still green, this is evidence that the tree is an X-disease-infected chokecherry.

Control of X-disease of stone fruits demands control of choke-cherries. All chokecherry trees within at least 500 feet of any stone fruit trees or future stone fruit site should be completely eradicated. However, since neither the rum cherry nor the pin cherry harbors X-disease, these trees are perfectly harmless to stone fruit orchards. Illustrations and descriptions of these three kinds of cherry trees can be found below.

The easiest way for the "novice" to identify the cherry trees is by their fruit and fruiting habit. The fruit of the pin cherry is borne in an umbel.

The fruit of both the rum cherry and choke cherry is borne in a raceme

but the calyx cup persists on the fruit of the rum cherry.

Fig. 1

Fig. 1. The leaf shape of the rum cherry is long and narrow, and the serrations are dull and turn inward. The leaves are thick and shiny with dense, reddish brown pubescence (fuzz) along the back of the midrib. The glands on the leaf stem are either small and inconspicuous, or absent. The fruit is borne in a raceme and ripens in late summer. The calyx cup persists on the fruit. Rum cherry may grow into a tree up to 50 feet or more, and the bark on a two year old or older tree is dark brown to black, and the lenticels on the bark are small and numerous.

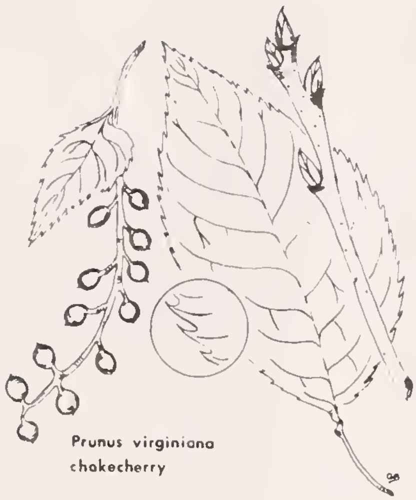

Fig. 2

Fig. 2. The leaf shape of the chokecherry is broad with the sharp saw-like teeth pointing outward. The leaves are fairly dull and thin when compared with the rum cherry, and there is little or no pubescence. The glands on the leaf stem are large and prominent, especially on large young leaves. The fruit is borne in a raceme and ripens in mid-summer before that of the rum cherry. The calyx cup does not persis on the fruit. Chokecherries are usually found as shrubs up to 15 feet tall with red-brown to dark brown bark, and only a few large lenticels on the shiny bark.

Fig. 3

Fig. 3. The leaf shape of the pin cherry is long, pointed, and narrow with the serrations small and fine, and sharply hooked. There is little or no pubescence (fuzz) on the backs of the leaves. The glands on the leaf stem are either small and inconspicuous, or absent. The fruit is borne in an umbel and ripens in mid-summer. Pin cherry may also grow into a tree up to 50 feet or more, and the bark on the older trees is distinctly reddish brown, and the lenticels on the bark are few and large.

Eradication

If you find that chokecherries are in the vicinity of your stone fruit trees, what is the best way to eradicate them? The chokecherry is difficult to kill due to its habit of sprouting freely from the roots. Cutting or mowing is not effective; it merely results in a thicket of sprouts which require further cutting. Satisfactory treatment requires use of a chemical agent that will be carried down to the roots and kill them, thus preventing further sprouting.

The suggested material for this is Ammate-X* (AMS), at the rate of 4 lbs per gallon of water. It may be applied as either

* Trade Name

a stump treatment or as a "frill" treatment. Stump treatment is the application of the chemical to freshly cut stumps, thoroughly drenching the entire stump surface. "Frill" treatment is done by making cuts above the ground around the tree, using an axe or hatchet in a downward motion to expose the "growing region" of the trunk, and to leave openings to hold the material. These cuts are then filled with the chemical. Frill treatment is a convenient and effective way to kill trees of larger diameter.

Eradication of chokecherry with Ammate-X* is effective any time of the year except when the ground is frozen, or when there is snow or water on the ground around the trees. However, when using this chemical, follow the instructions on the label carefully. For further information on brush control, you may obtain the "1978 New England Chemical Brush Control in Non-Food Crop Areas and in Christmas Tree Stands" circular from your Regional Specialist.

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MISCELLANEOUS INFORMATION ON ORCHARD MOUSE CONTROL

Edward R. Ladd
U. S. Department of the Interior
Fish and Wildlife Service

We have checked a few orchards for meadow mice and find the population is about the same as 1977. If it continues at this level, orchardists can expect a high level of tree damage this winter unless an adequate baiting program is performed.

The bait application should be made in October after harvest of the apple crop. Early application is usually not advisable since meadow mice continue to reproduce until Fall. Consequently, the mice that remain after an early bait application can easily regain their reduced numbers by Fall.

Meadow mice must have a dense cover of grass or other plants for their survival. Thus, close and complete mowing of the entire orchard will remove much of this needed cover and make the area less attractive to mice. Time the mowing so that it will make distribution of baits easier.

In addition to mowing and baiting it is advisable to perform these practices in buffer strips around as many tree blocks as possible. In the past few years there have been several instances where the outer rows of trees have received damage by mice in spite of a good baiting program within the orchard. In these cases, the mice may have moved in under snow cover from surrounding areas. Although a buffer strip is not totally effective, it does increase the travel distance for the mice and frequently will reduce damage from mice migrating into the orchard.

Assuming that a mid-winter thaw will occur, make plans to check those orchard areas known to have high mouse populations. Have sufficient bait available to hand treat those blocks that have mouse holes and runways in the snow. This spot treatment should reduce possible mid-winter tree damage.

Do not exceed label restrictions when baiting and distribute them carefully. Baits, when properly placed, should be in vegetation at soil level; this is where the mice are. Baits on bare ground or suspended in the vegetation are wasted and may be easily found by animals other than orchard mice.

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LABORATORY TOXICITY OF PESTICIDES AND GROWTH REGULATORS TO AMBLYSEIUS FALLACIS, AN IMPORTANT SPIDER MITE PREDATOR IN MASSACHUSETTS APPLE ORCHARDS

Robert G. Hislop, Charles Acker, Nancy Alves, and Ronald J. Prokopy
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In the last issue of Fruit Notes (July/August, 1978), we described results of 1977 studies aimed at determining the toxicity of orchard pesticides to field populations of Amblyseius fallacis, a key predator of red and two-spotted spider mites in Massachusetts apple orchards. Combined results from several commercial orchards and our Belchertown research plots demonstrated that application of orchard concentrations of Zolone, Benlate, and perhaps also Glyodin reduced populations of A. fallacis in the trees, resulting in spider mite outbreaks. On the other hand, use of Imidan, Guthion Captan, and Cyprex permitted buildup of A. fallacis, usually resulting in effective suppression of spider mites, especially two-spotted mites.

Here, we discuss results of laboratory tests, carried out in conjunction with our 1977 and current field trials, aimed at determining the direct and residual toxicities of pesticides to a strain of A. fallacis from the Bishop orchard in Shelburne.

Three principal experiments were performed: (A) toxicity tests of orchard materials at recommended field rates; (B) toxicity tests of principal pesticides (i.e. those in greatest use) at three different rates; and (C) tests of the influence of pesticide residues on the reproductive capability of A. fallacis.

Direct Toxicity of Spray Materials to *A. fallacis*

To determine the direct toxicity of orchard spray materials to A. fallacis, we used double-stick tape to affix adult females to microscope slides. The slides were then dipped into solutions of the spray materials, which included a variety of insecticides, miticides, fungicides, herbicides, and growth regulators. There were five replicates (18 mites per replicate) for each rate of each material. Control slides were dipped into water. Mortality of *A. fallacis* was determined at 48 hours after treatment.

Results with materials tested at recommended field rates are presented in Table 1. Materials with a toxicity of 70-100% are considered highly toxic, 30-70% moderately toxic, and 0-30% of low toxicity. Materials of high toxicity were: Zolone (both EC and WP), Systox, Sevin, Diazinon, Carzol, Paraquat, and Roundup. Materials of moderate toxicity were: Phosphamidon (4 oz. rate, and 1 oz. rate), Kelthane, Plictran, and Alar.

TABLE 1. TOXICITY OF ORCHARD SPRAY MATERIALS AT RECOMMENDED FIELD RATES TO *Amblyseius fallacis* (BISHOP STRAIN).

MATERIAL	RATE/ 100 GALS	MORTALITY (%)	TOXICITY RATING
INSECTICIDES			
Zolone (phosalone) 3EC	1.5 pts	100	High
Zolone (phosalone) 25WP	4.0 lbs	87	High
Systox (demeton) 6EC	3.0 oz	100	High
Sevin (carbaryl) 50WP	1.0 lb	100	High
Diazinon 50WP	1.0 lb	70	High
Phosphamidon (dimecron) 8EC	4.0 oz	46	Moderate
Phosphamidon (dimecron) 8EC	1.0 oz	32	Moderate
Thiodan (endosulfan) 50WP	1.0 lb	19	Low
Malathion 25WP	2.0 lbs	15	Low
Imidan (Phosmet) 50 WP	1.5 lbs	10	Low
Guthion (azinphosmethyl) 50WP	10.0 oz	10	Low
Methoxychlor 50WP	3.0 lbs	3	Low
MITICIDES			
Carzol (formetenate hydrochloride) 92SP	8.0 oz	85	High
Kelthane (dicofol) 35WP	1.3 lbs	56	Moderate
*Plictran (cyhexatin) 50 WP	6.0 oz	33	Moderate
Omite (propargite) 30WP	1.5 lbs	9	Low
Vendex 50WP	0.5 lb	8	Low
FUNGICIDES			
Glyodex WP	0.5 lb	28	Low
**Glyodin 30%EC	1.5 pts	21	Low
Dikar WP	1.5 lbs	15	Low
Benlate (benomyl) 50 WP	6.0 oz	15	Low
Thiram (thylate) 65WP	1.0 lb	12	Low

TABLE 1. (Continued)

MATERIAL	RATE/ 100 GALS	MORTALITY (%)	TOXICITY RATING
FUNGICIDES (cont'd)			
Phygon WP	0.5 lb	5	Low
Captan 50WP	2.0 lbs	9	Low
Ferbam 76WP	1.5 lbs	1	Low
Cyprex (dodine) 65WP	6.0 oz	12	Low
HERBICIDES			
Paraquat CL (paraquat) 2 lbs/gal	2.0 qts	100	High
Roundup (glyphosate) 2 lbs/gal	1.0 gal	100	High
Princep (simazine) 80WP	3.0 lbs	5	Low
GROWTH REGULATORS			
Alar-85 (deminozide) 85WP	1.0 lb	33	Moderate
Ethrel (ethephon) 21.6% liq	0.5 pt	6	Low
Fruitone-N (naphthaleneacetic acid) 1/4 lb = 10 ppm	10.0 ppm	9	Low
Amid-Thin W (naphthaleneacetamide) 1/4 lb = 25 ppm	25.0 ppm	0	Low
FOLIAR NUTRIENT SPRAY			
$CaCl_2$	3.0 lbs	14	Low

* Proved to be of low toxicity to Carlson orchard strain of _A. fallacis_.

** Proved to be of moderate toxicity to Carlson orchard strain of _A. fallacis_.

All of the other materials tested, including all fungicides and calcium chloride foliar nutrient spray, were of low toxicity. The high toxicity of Zolone 3EC contrasted with the low toxicity of Imidan and Guthion, thus supporting our 1977 field results. Glyodin was of low toxicity to this strain of _A. fallacis_, although additional results indicated that it was of moderate toxicity to the strain of _A. fallacis_ from the Carlson orchard in Harvard. Further field trials with Glyodin are currently in progress. Benlate was of low direct toxicity to this predator, although it had severe antireproductive effects (see below). Sprays highly toxic to A. fallacis are not recommended for use after bloom, and those with moderate toxicities of 40% or greater are not recommended for use after the first cover spray. Although most A. fallacis are still in the ground cover at the time of the first cover spray, even small amounts of highly toxic materials falling on the ground cover can severely injure them.

Results with principal orchard pesticides tested at three different concentrations are given in Table 2. Five of the materials (Imidan, Guthion, Cyprex, Captan, and Benlate) were of low toxicity to A. fallacis even at double the recommended field concentration. Zolone 3EC was highly toxic even at half the recommended field rate, while Glyodin 30% was moderately toxic at double the recommended field rate.

TABLE 2. TOXICITY OF PRINCIPAL ORCHARD PESTICIDES AT THREE DIFFERENT RATES (ONE-HALF, ONE, AND TWO TIMES THE RECOMMENDED RATE) TO *Amblyseius fallacis* (BISHOP STRAIN).

	MORTALITY (%)		
PESTICIDE	1/2 RECOMMENDED RATE	RECOMMENDED RATE*	TWICE RECOMMENDED RATE
Imidan (phosmet) 50WP	2	10	15
Guthion (azinphosmethyl) 50WP	4	10	12
Zolone (phosalone) 3EC	94	100	100
Benlate (benomyl) 50WP	7	15	14
Cyprex (dodine) 65WP	5	12	15
Captan 50WP	4	9	18
Glyodin 30%EC	5	21	48

* See Table 1.

Influence of Pesticides on Reproductive Capability of *A. fallacis*

To test the influence of pesticide residues on the reproductive capability of A. fallacis, adult females were placed on detached living bean leaves which had been previously dipped into a solution of pesticide at the recommended orchard rate and allowed to dry for 3 hours. We daily offered the predators two-spotted mites as food and counted their eggs over the succeeding 2-week period. (The two-spotted mites caused only slight damage to the leaves.) Each treatment, (including water-dipped check leaves) was replicated 14 times.

The results are given in Table 3. Five of the pesticides tested (Imidan, Guthion, Cyprex, Captan, and Glyodin) had little or no apparent effect on A. fallacis reproductive ability. However, the presence of Benlate residues totally destroyed the ability of of this predator to develop and/or deposit eggs. At the end of the two-week test period, not even a single predator mite regained reproductive capability. Therefore, we do not recommend use of Benlate after the first cover spray, when A. fallacis are entering the trees. Leaf residues of Zolone 3EC killed all A. fallacis, thus preventing successful completion of this test.

TABLE 3. INFLUENCE OF PESTICIDE RESIDUES ON Amblyseius fallacis REPRODUCTIVE CAPABILITY.

PESTICIDE*	AVERAGE NO. EGGS/A. fallacis FEMALE**	
	TREATED LEAVES	CHECK LEAVES
Imidan (phosmet) 50WP	17.5	20.7
Guthion (azinphosmethyl) 50WP	21.6	19.1
Zolone (phosalone) 3EC	dead	23.4
Benlate (benomyl) 50WP	0	22.6
Cyprex (dodine) 65WP	21.0	22.2
Captan 50WP	21.0	20.4
Glyodin 30%EC	19.8	21.5

* Applied at recommended orchard rate (see Table 1).

** 14-day egg totals.

Conclusions

The laboratory data presented here thus support our suggestions based on earlier field studies that certain orchard spray materials are harmful in different ways to populations of A. fallacis. For example, combined field and laboratory results clearly demonstrate that the directly toxic effects of Zolone (both EC and WP) and Sevin, and the indirectly toxic (antireproductive) effects of Benlate can have serious consequences to to populations of A. fallacis, thus creating spider mite outbreaks. Care should therefore be taken when deciding which orchard spray materials to use for sound pest management. In the future, we will continue our field and laboratory testing of the influence of orchard spray materials on population buildup of our principal mite predator, Amblyseius fallacis, in our apple orchards.

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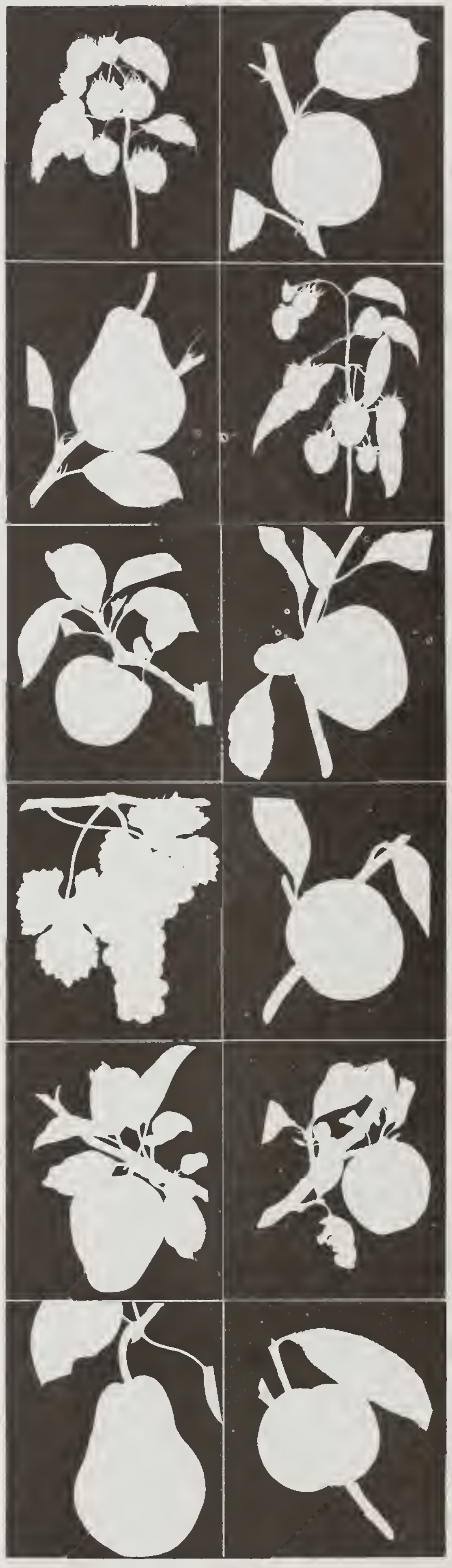

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 43 (No. 6)
NOVEMBER / DECEMBER 1978

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WINTER TRUNK INJURY TO APPLES

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In the spring and summer of 1976, many orchardists became aware of extensive winter injury to the trunks of apple trees. Winter cold injury has not appeared on such a large scale in Southern New England for many years. This article is written to review some of the current knowledge about cold injury and to relate it to the winter injury of 1975-76. In reviewing the literature it is apparent that we still lack a good understanding of cold injury and cold hardiness.

For many years, the standard way to study cold hardiness has been to collect samples of shoot, bark, or bud tissue at various times during the year, and expose it under controlled laboratory conditions to freezing temperatures. The resulting damage is then related to conditions that might influence cold hardiness. The researcher has only limited control over conditions under which the tree stood in the orchard. Every season is unique in its sunlight, temperature, rainfall, wind and snow conditions. Consequently, progress in relating cold hardiness to any single one of these, and other factors, is very slow.

Many studies of cold injury have led researchers to conclude that when low temperature causes direct injury to woody plant tissues it is either because ice has formed within the tissue cells, or because the tissue has dehydrated due to ice formation. Cells of living tissues contain protoplasm, the stuff that carries on basic life processes. A major constituent of protoplasm is water. If this water freezes to ice in the protoplasm, the protoplasm is destroyed and death is assured.

Woody plants that survive New England winters are able to avoid ice formation within the protoplasm as a result of a process known as acclimation. The acclimation process can be initiated by the shortening day length of August or September, and by temperatures below about 28°F. Only nongrowing (dormant) plants can acclimate, and become hardy to sub-freezing temperatures.

Just what changes occur during acclimation that make survival to freezing temperatures possible are still not known. It is known that the acclimation process takes time. Exposure of the plant to temperatures below about 28°F can, over a period of several days, result in hardiness to temperatures of near zero °F if other factors are favorable. Exposure, for a couple of weeks can result in maximum cold hardiness. But all tissues in a plant do not develop hardiness in the same way, or to the same degree. Dormant apple flower buds, for example, are hardy to 0°F long before trunk bark develops much cold resistance.

Other factors affect the acclimation process, so that resistance to very low temperatures does not always result from exposure to below freezing temperature. It is pretty well established that conditions which favor accumulation of carbohydrates in the bark and woody tissue also favor acclimation to low temperature. Maximum accumulation of carbohydrates depends on active photosynthetic activity in the whole tree for the whole growing season. Foliage diaease or injury, inadequate water or nutrition, shading, severe hail damage, or a growing season shortened by early frost will obviously limit photosynthetic production of carbohydrates: It is also recognized that a heavy fruit crop will draw off carbohydrates that would otherwise be available for storage in the tree tissues. There is some evidence also that chemicals produced by the crop seeds may directly inhibit cold acclimation.

Reports of cold hardiness studies indicate that we cannot assign any specific safe temperature minimum to a tree at any given time. Duration of exposure to the temperature minimum must be considered. Injury increases with the length of exposure to cold as the lethal temperature is approached. Also, repeated freezing and thawing has an amplifying effect on injury.

A given level of cold hardiness is subject to change toward less hardiness if the day or nighttime temperature gets much above freezing. Just how much hardiness is lost undoubtedly depends on length of exposure and how high the temperature goes, but these relationships have not been clarified. In peaches it appears that deacclimation (loss of the acclimated condition) is minimal during the rest period, but can take place very rapidly on exposure to a few hours of warm temperature any time after the rest period is completed. The rest period is usually completed in late January or early February in New England peaches.

Pruning in the fall or early winter makes trees more susceptible to cold injury. Again, an acceptable explanation of why this is so has not appeared. Early pruning was obviously a major contributing factor to the trunk injury in some orchards in the 1975-76 winter. At Storrs, the only trees to show trunk damage were those (18-year-old Jerseyred) that had been heavily pruned in late November and early December. No further pruning was done until early February. Comparable Jerseyred trees pruned similarly in February showed no damage. Injured trees lost 50-90% of the bark around the trunk in the spring of 1976. These observations indicate the damage must have occurred during December or January. December temperature went to zero or lower on two days; Christmas Eve (0°F) and Christmas Day (-1°F) at Storrs. In January, 4 subzero readings were recorded: -1° the 18th, -3° the 19th, -8° the 23rd, and -5° the 24th. In February the lowest minimum was +5° on the 3rd.

The fall of 1975 was unusual in that it remained quite warm through the middle of December. The lowest for November was 27°, and daytime highs were over 60° as late as the 21st and 22nd. December continued the warm trend with 61° Dec. 1st, and 60° the

15th. The only minimums through Dec. 15 that were below 20° were 15° and 18° early in the month.

After the 60° temperature of Dec. 15, there was a drop to 16° on Dec. 17, and minimums remained low for the next 9 days with readings of 20, 7, 6, 10, 17, 17, 0, -1, and 5°. The first snows came during this period, accumulating to 9" between Dec. 21 and 23. For the rest of December, January and February, temperature records show favorable conditions for acclimation. A high of 52° on Dec. 27 cooled gradually and single number temperatures did not appear again until January 5 and 6. During that 9 day period maximums did not go above 41°. By January 23, when the winter's lowest temperature (-8°) was recorded, trees should have been well acclimated. The temperature fluctuations during January were not great, nor as rapid as in December.

However, trunk injury was associated with pruning done as late as the 3rd week of January in some orchards. In most years, trees pruned in the second or third weeks of January do not suffer cold injury. Since January temperatures in 1976 were not unusual, it must be supposed that the injured trees were not as well acclimated as in most years. Non-pruned trees withstood subzero temperatures, but the hardiness-reducing effect of pruning was sufficient to raise their critical temperature level into the subzero temperatures experienced in January. Possibly injury would also have occurred on trees pruned in February if subzero temperatures had occurred in February.

The tree tissues that were injured at Storrs, and other orchards in Connecticut were the bark or cambium of the trunk and lower scaffold limbs. Bark separated from the wood in some cases, and remained attached in others. In both cases the bark died and decayed in the spring and summer. On some trees, bridges of live bark remained between dead areas, connecting across the injured zone. In Connecticut, these injured trees produced a normal crop in 1976, indicating that the conducting tissue of the wood was not seriously harmed. Completely girdled trees died during 1977, but some trees with very little connecting bark remained alive, and even looked pretty good except for crop.

Studies of cold hardiness have shown that bark and wood tissue of acclimated apple trees survive cold temperatures by two different mechanisms. Acclimated wood tissue is capable of a phenomenon called deep supercooling. Supercooled water in the protoplasm remains liquid even when its temperature is far below the normal freezing point. It is a phenomenon that can also be shown by pure water when small droplets are dispersed in a low-freezing-point liquid. Researchers suspect that in the woody stem or trunk tissue, protoplasmic water may be somehow isolated from ice nucleation that occurs outside the cell walls. A temperature is finally reached, however, at which this protoplasmic water (or the finely dispersed water droplets in a non-living system) will suddenly freeze to ice. This temperature is around -40°F for fully acclimated tissue or dispersed pure water. Apple trees do not survive where winter temperatures frequently drop below about -40° because below that temperature ice forms in the living wood cells, causing death.

Apple bark, cambium, and bud tissues, do not depend on deep supercooling. Investigations have shown that these tissues survive our winters by moving the freezable protoplasmic water outside the cells to sites where ice formation does no apparent damage. As the temperature drops below freezing, ice begins to develop in cracks in the bark, in intercellular spaces, and between bud scales. This creates a vapor pressure gradient favoring movement of protoplasmic water toward the ice. The protoplasm becomes dehydrated rather than freezing, but considerable dehydration does not harm acclimated tissue. Experimentally, apple bark, cambium, and bud tissues have been subjected to temperatures more than 100°F below zero without injury if the temperature drop is not too rapid. The ability of these tissues to survive is thought to be limited by the rate at which water can move out of the protoplasm when temperature drops.

If the temperature drops at a rate of degrees per <u>minute</u> these tissues can be injured by ice formation within the cells even when fully acclimated. Air temperature drop in nature is normally at rates of degrees per <u>hour</u>. The temperature fall on the morning of December 17, 1975 was about 10°F in 5 hours (2°F per hour) between 26° and 16°F.

If the bark and cambium had been fully acclimated on December 17, 1975, we would not expect that intracellular ice could have formed, in response to the 2° per hour temperature drop. On the other hand, the 60°F temperature of December 15 may have deacclimated the tissue. Then the tree would have had only 5 or 6 hours of exposure to temperatures below 28°F before the 16° temperature occurred. Recall that a period of <u>days or weeks</u> at sub-freezing temperature is needed to induce much acclimation.

Temperatures of bark and cambium tissues apparently do sometimes drop at rates faster than water can move out to safe freezing sites. It can happen in winter when air is calm and well below freezing, and the south, or southwest, side of the tree trunk is exposed to direct low angle sunshine. Tissue temperature can go to 70 or 80°F under these conditions. When the sunlight is suddenly cut off by shading, or sunset, the bark temperature returns to ambient air temperature very quickly. This sometimes results in bark or cambium kill on the south or southwest side of tree trunks. It can be prevented by applying a reflective white latex paint to the trunks.

Knowledge of the relative hardiness of different tissues at different times of the year can be helpful when trying to determine when injury might have occurred, if it is discovered much later. It has been shown that sapwood is the hardiest tissue in the early fall. But by midwinter, cambium is the hardiest tissue, bark tissue is slightly less hardy, and sapwood is least hardy.

Discovery of blackheart in the sapwood, without any bark or cambium injury would indicate severe midwinter cold. Many New England Baldwin trees have blackheart as a result of the extremely low temperatures of 1933-34. Finding injured cambium or bark but normal sapwood points to fall or early winter cold. Injury to both cambium and sapwood could result from unusually low temperature at any time in trees that were not well acclimated. Southwest trunk injury could also occur at any time in the winter months.

In summary, the factors that seem to have been most involved in the 1975-76 winter injury seen in Southern New England were: (1) a mild fall encouraged late growth activity, and discouraged acclimation; (2) warm temperature in mid-December may have deacclimated the tissue just prior to a period of low temperatures; (3) a very heavy 1975 crop load on some trees limited the development of cold hardiness; (4) pruning of trees prior to occurrence of critical temperatures reduced the trees' ability to withstand cold.

From the experience of 1975-76, and other winters, it should be reasonable to conclude that pruning before late February entails risk any year, but when conditions have not been favorable for development of cold acclimation by late December, early pruning is especially hazardous. Growers should learn to recognize seasons in which early pruning must be avoided. A suggested guide, until something better is developed, might be:

(1) Don't prune before Christmas, because mild temperatures are likely to occur before then that can deacclimate the trees.

(2) Keep a record of minimum and maximum temperatures, beginning November 1. Delay pruning until February if there have been 25 days with minimums of 28°F or lower by December 25.

(3) Don't prune within 10 days following maximums of 55°F or more that occur before Christmas.

(4) Leave for late February and March, the pruning of all trees that bore especially heavy crops and those that were weak or had reduced leaf surface for any reason.

Use of a guide such as this will not eliminate the possibility of injury due to unusual temperature extremes, but it should minimize the risk of cold injury that is associated with pruning.

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EVALUATION OF ALAR AND ETHREL ON THE COLD HARDINESS OF 'MCINTOSH' AND 'DELICIOUS' APPLE TREES

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It is well known that the development of cold hardiness in plants is primarily a function of the type or variety of plant and the weather conditions, especially temperature and day length, during the autumn. The degree of hardiness that a plant develops, however, may also be modified to a limited extent by other factors such as cultural practices or use of various plant growth regulators.

Although Alar and Ethrel are used as growth regulators in many apple orchards, we have little knowledge of whether or not their use influences the cold hardiness of the trees. The purpose of this investigation was to determine if the hardiness of bearing-age trees is either increased or decreased by their use.

The work was carried out over 2 seasons, from June, 1975 to March 1977, on 30 McIntosh and 30 Delicious trees located at the University of Vermont Horticultural Research Center. All trees were on M.7 rootstocks, approximately 25 years old, and uniformly vigorous.

Five McIntosh and 5 Delicious trees were used for each of 6 treatments. The treatments were: (1) unsprayed controls; (2) Alar at 2#/100 gal applied in early June; (3) Alar at 2#/100 gal applied in early August; (4) Ethrel at 2-1/2 pts/100 gal applied about 10 days prior to normal harvest; (5) the June Alar application plus the Ethrel application, and (6) the August Alar application plus the Ethrel application.

Terminal shoots collected at monthly intervals from August to March 1975-76 and again in 1976-77 were frozen in the laboratory to several different temperatures and the amount of injury occurring was measured by determining the electrolyte release from the injured cells.

As expected, the McIntosh shoots were injured less by freezing than were the Delicious shoots; however, very few significant differences in hardiness between the treated trees and controls were found with either variety. Slightly less injury occurred in both varieties at mid-winter of the first year when trees had been treated either in June or August with Alar. The same treatments brought about a slight increase in injury when the shoots were frozen in March. Ethrel appeared to have even less influence than Alar in altering the hardiness of apple shoots. Shoots of Ethrel-treated trees had slightly less injury than the controls when frozen in November, 1976, and slightly more injury when frozen in March.

Although statistical differences in shoot hardiness were occasionally detected as a result of the application of these materials, the differences were small and of little practical significance. Based on these 2 years' data, it appears that Alar and Ethrel had only limited and erratic effects in altering the cold hardiness of McIntosh or Delicious shoots, and the use of these materials probably does not significantly increase or decrease the possibility of low temperature injury, even though they do alter the physiology of the tree.

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QUINCE RUST ON APPLE

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Quince rust (caused by the fungus Gymnosporangium clavipes) appeared as a problem on Red Delicious in Massachusetts this past season. It was also present in the Hudson Valley area of New York. Generally, the disease is of little importance, but outbreaks can cause serious damage.

Quince rust shows on the fruit as a sunken, dark green, misshapen area near the calyx end. The disease often extends into the fruit, discoloring areas as far as the seed cavities. Fruit may also redden prematurely. The disease seldom affects apple leaves.

Quince rust is related to cedar apple rust. Both fungi require two hosts in order to reproduce. During July and August, infections on apples (or on related plants, such as quince, hawthorne, amelanchier or crabapple) produce spores. Wind blows these spores to the next host plant, the red cedar or native juniper, where infections are started. After 2 years, wet weather in May or June will release spores from the juniper and red cedar infections. These spores will infect apple or related plants, and the cycle repeats itself.

Removing red cedars and other junipers located within 2 miles of the orchard makes rust control much easier. Widening the juniper-free area to 4 or 5 miles can completely control rusts. However, in most cases, it is more practical to apply a fungicide. A grower should note that while some scab fungicides also provide good rust control (Dikar, manzate, polyram), other good scab fungicides do not control rust (benomyl, captafol, captan, dodine, glyodin). Other fungicides give good rust control, and fair to poor scab control (ferbam, Niacide-M, thiram, zineb)*. Fungicides to control quince rust and cedar apple rust should be applied from the time of pink buds to the third cover.

* A listing of the activity spectrums of apple fungicides is available from the Plant Pathology Department, Fernald Hall, University of Massachusetts, Amherst, MA 01003.

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SPIDER MITE SUBSTANCES INFLUENCING SEARCHING BEHAVIOR OF THE MITE PREDATOR, *Amblyseius fallacis*, ON APPLES

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In the preceding two issues of *Fruit Notes*, we described our laboratory and field results on effects of various orchard spray materials on the survival and reproduction of *Amblyseius fallacis*, the most important mite predator in Massachusetts commercial apple orchards. We observed that even in orchards using materials comparatively safe for *A. fallacis*, this predator's performance was often less effective against red mites than against two-spotted mites. We suggested that factors such as late-season competition from other predators might partially explain this difference. Furthe observations, however, suggested that this reduced effectiveness against red mites might also be due to particular early-season habits of *A. fallacis* which could possibly allow red mites to build up unchecked in the Spring and early Summer.

Adult *A. fallacis* females spend the Winter in orchard surface litter. In Spring, warming temperatures bring them out of their Winter shelters up into the ground cover vegetation where they feed on two-spotted mite prey. In early Summer, they invade the apple tree foliage in search of red and two-spotted mites. Because two-spotted mites (but not red mites which were introduced here from Europe) are believed to be the native prey of *A. fallacis*, we theorized that perhaps this predator had evolved certain capabilities allowing it to locate two-spotted mites more efficiently than red mites. If this were true, and *A. fallacis* could more readily locate two-spotted mite infestations, particularly in the orchard understory, then it would seem that *A. fallacis* might become preoccupied feeding on this host. Red mites could then escape predator detection while building up in the trees.

The purpose of this research described here was to examine the possible influence of physical and chemical substances deposited by red and two-spotted mites on the host searching behavior of *A. fallaci* As we will show, such behavior-influencing substances do in fact exist At the conclusion of thie article we outline how, in the future, spray applications of the synthetic equivalents of these substances to apple trees might enhance the ability of *A. fallacis* to better control red and two-spotted mites.

In our first experiment we allowed equal numbers of red and two-spotted spider mites to infest separate 1/2 inch diameter apple leaf discs for 2 days, after which all spider mite prey (including eggs) were removed. Each leaf disc was then placed in a simple, single choice observation chamber. We then placed a single starved _A. fallacis_ female at the edge of the chamber and allowed it to enter and leave the disc at will. Data and observations were recorded over a ten-minute time period. The results (Table 1) show that _A. fallacis_ females spent an average of 312 seconds per visit on discs having previous two-spotted mites compared with only 58 seconds per visit on discs having no previous prey (an approximate 5-fold difference) and 156 seconds per visit to discs having previous red mites (a 2-fold difference). These data strongly suggest that both species of spider mites deposit substance(s) that function to arrest host searching _A. fallacis_, and that the substance(s) deposited by two-spotted mites was more than twice as active as that deposited by red mites. In this experiment we noticed that a large amount of silk (a white thread-like material very similar to the sort of silk spun out by spiders) was left behind by the two-spotted mites. We suspected that this silk might be playing a role in the observed behavior of _A. fallacis_.

TABLE 1. FREQUENCY AND LENGTH OF VISITS BY _A. fallacis_ FEMALES TO APPLE LEAF DISCS HAVING PREVIOUS PREY. (20 replicates)

Previous prey	Avg. no. _A. fallacis_ visits per apple leaf disc	Avg. time (seconds) per visit on disc
Two-spotted Mites	1.5	312
European Red Mites	2.6	156
None (check	3.4	58

Therefore, in our second experiment, we examined the possible influence of two-spotted mite silk on the searching behavior of _A. fallacis_. We manually placed the silk spun by 50 two-spotted mites over a 24-hour period onto 1/2 inch diameter filter paper discs. Each disc was placed in the observation chamber with a single starved _A. fallacis_ female and data recorded as before.

The results (Table 2) show that host searching _A. fallacis_ females spent 142 seconds per visit on discs containing two-spotted mite silk, compared with 12 seconds per visit on discs having no silk (a 12-fold difference). This result strongly suggested that physical and/or chemical properties of two-spotted mite silk function to arrest host searching _A. fallacis_ females.

TABLE 2. FREQUENCY AND LENGTH OF VISITS BY A. fallacis FEMALES TO FILTER PAPER DISCS HAVING TWO-SPOTTED MITE SILK. (20 replicates)

Condition of disc	Avg. no. A. fallacis visits per disc	Avg. time (seconds) per visit on disc
With silk	3.5	142
Without silk	6.1	13

In our final experiment reported here, we examined the possible influence of solely chemical substance(s) deposited by two-spotted mites on the host searching behavior of A. fallacis. We placed two-spotted mites on 1/2 inch diameter filter paper discs for two days, after which all mites and eggs were removed. We then washed ten such discs in one or another of four different types of chemical solvents: water, methanol, chloroform, and hexane. The washings (= extracts) were then centrifuged at high speed to remove any physical substance such as silk, that might influence A. fallacis host searching behavior. We reapplied each extract to a series of fresh filter paper discs, each of which was dried and placed in the observation chamber with a single starved A. fallacis female. The searching behavior of the females was then recorded over a ten-minute period.

The results (Table 3) show that host-searching A. fallacis females visited discs treated with the methanol extract an average of 8.2 times, nearly three times more frequently than they visited control discs treated with solvent alone (= 3.3 visits). Although the average length of each visit was approximately equal on each disc type, the length of time between visits to discs treated with the methanol extract was only 34 seconds, less than 1/3 the time between visits to check discs (= 112 seconds). These data, coupled with our observations suggests that host-searching A. fallacis females were stimulated to repeatedly return to discs treated with methanol-extracted chemical substances deposited by two-spotted mite prey.

TABLE 3. FREQUENCY AND LENGTH OF VISITS AND RETURNS BY A. fallacis FEMALES TO FILTER PAPER DISCS TREATED WITH CHEMICAL EXTRACTS OF SURFACES PREVIOUSLY VISITED BY TWO-SPOTTED MITE PREY. (20 replicates)

Solvent	Avg. No. A. fallacis visits per disc		Average time (seconds) per visit on disc		Average time (seconds) between visits	
	Extract	Control	Extract	Control	Extract	Control
Chloroform	3.6	5.3	32	26	54	86
Hexane	4.1	3.9	16	24	118	80
Water	7.4	5.9	27	44	64	52
Methanol	8.2	3.3	28	31	34	112

We have thus discovered in these experiments two sorts of behavioral reactions of host searching _A. fallacis_ females while in the neighborhood of substances deposited by red and two-spotted mite prey: (1) stimulated searching activity in the vicinity of extracted chemical substance(s), and (2) arrestment in the presence of two-spotted mite silk. In nature, it is likely that such chemical substance(s) secreted by red and two-spotted mites, is utilized by _A. fallacis_ adults as a cue aiding in more rapid and better detection of nearby areas infested by prey. Contact with the physical structure of the silk of the prey slows down the host searching activity of _A. fallacis_ adults, arresting them in the immediate locale of an individual prey. These results also support our hypothesis that _A. fallacis_ could become preoccupied for relatively long time periods searching within areas of two-spotted mite infestations, thereby having the effect of preventing the predator from exploring new areas harboring other hosts such as red mites.

Chemical substances that are deposited by prey and that influence the host searching behavior of predators such as _A. fallacis_ are called "kairomones". Eventually, they could be of significant value to pest management programs. For example, if one were to identify and synthesize the kairomone secreted by two-spotted mites and spray it on apple trees together with artificial alternate food substances for _A. fallacis_, the result could possibly be greater retention of _A. fallacis_ on the apple foliage during times when natural prey densities are low. Such artificially maintained populations of _A. fallacis_ could function to "guard" against possible spider mite outbreaks.

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FRUIT NOTES INDEX FOR 1978

(This index of major articles has been prepared for those who keep a file of _Fruit Notes_. The number in parenthesis indicates the pages on which the item appears.)

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 44 (No. 1)
JANUARY / FEBRUARY 1979

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ERRATUM IN NOVEMBER/DECEMBER ISSUE

An error that should be corrected occurred on page 5 of the Nov./Dec. issue of Fruit Notes. Item 2 of the suggested pruning guide states "Delay pruning until February if there have been 25 days with minimums of 28°F or lower by December 25". This should have read "Delay pruning until February if there have not been 25 days with minimum of 28°F or lower by December 25".

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VARIETIES OF STRAWBERRIES FOR MASSACHUSETTS

James F. Anderson
Department of Plant and Soil Sciences

Varieties	Recommended for	Harvesting Season
Earlidawn	C	Very early
Darrow	T	Early
Earliglow	T	Early
Sunrise	C	Early
Midland	C & H	Early
Holiday	C	Early-midseason
Raritan	C & H	Midseason
Midway	C & H	Midseason
Catskill	C & H	Midseason
Redchief	C & H	Midseason
Guardian	C & H	Midseason
Garnet	C & H	Mid-late
Sparkle	C & H	Mid-late
Delite	T	Late
Vesper	C	Very late

T = Trial   H = Home garden   C = Commercial

Varieties so marked are not necessarily equally adapted to all sections of the state.

Variety Notes

Earlidawn — The fruits are of medium size and of fair to good flavor. The plants are productive and of moderate vigor. Earlidawn is not recommended where red stele is present.

Darrow — The fruits are medium to large, firm, glossy and have a deep red color. Primary berries tend to be rough. The plants are moderate in fruit production, vigor and runner production. Darrow is highly resistant to red stele and partially resistant to Verticillium wilt.

Earliglow — The fruits are medium to large, firm, have a uniform, symmetrical shape and medium to dark red color. The flavor is very good. The plants are productive, make a good bed and are highly resistant to red stele and Verticillium.

Sunrise — The berries are medium in size, glossy bright red, firm and have a symmetrical conic shape. The plants are vigorous, fair in production and resistant to red stele and Verticillium.

Midland — The berries are large, firm, dark red and have very good flavor. The early fruit tends to be coarse. Midland is susceptible to both red stele and Verticillium.

Holiday — The berries are large, attractive, glossy, medium to dark red, very firm and fair to good in flavor. The plants are vigorous, make a good bed and are productive. Holiday is susceptible to red stele but had partial resistance to Verticillium.

Raritan — The berries are very attractive, bright red, glossy, firm, medium to large and have very good flavor. The plants form a good bed and are productive. Raritan is susceptible to both red stele and Verticillium.

Midway — The berries are of good size, a deep red color, glossy and very good in flavor. The plants are vigorous, productive and resistant to red stele. Midway is susceptible to Verticillium.

Catskill — The berries are large, have a good strawberry flavor. The berries have a tender skin and rate only fair in firmness. The plants are very productive and are resistant to Verticillium but are susceptible to red stele.

Redchief — The berries are medium to large, attractive, firm and have good flavor. The plants are vigorous and productive. Redchief is highly resistant to red stele and intermediate in resistance to Verticillium.

Guardian — The berries are large, glossy and light red in color. The primary berries tend to be rough. The berries are firm and have good flavor. The plants are vigorous and productive. Guardian is highly resistant to both red stele and Verticillium.

Garnet — The berries are large, attractive, moderately firm and have good flavor. The plant is vigorous, forms a good bed and is productive. Garnet is susceptible to both red stele and Verticillium.

Sparkle — The berries are medium to large, firm, dark red and have very good flavor. Berry size tends to decline rapidly. The plants are vigorous, productive and have partial resistance to red stele but are susceptible to Verticillium.

Delite — The berries are medium to large, long conic to long wedge in shape, bright red, glossy, firm and have good flavor. The plants are vigorous, productive and are highly resistant to both red stele and Verticillium.

<u>Vesper</u> The berries are very large, attractive, moderate in firmness and good in flavor. The plants are vigorous and productive but are susceptible to both red stele and Verticillium.

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PRUNING MACSPURS

William J. Lord
Department of Plant and Soil Sciences

On bearing Macspur trees, it is common to find weak scaffold limbs with few lateral branches. Scaffold limbs of this type have small potential bearing area. Branching can be induced on these limbs with stubbing cuts into 2- or 3-year-old wood.

Figure 1 illustrates the response to such a stubbing cut. On this figure, the arrow points to where a branch on Macspur was stubbed during the previous dormant season. Note the vigorous upright growth during the following growing season that was stimulated by the cut. The branch in the upper-right-hand corner is one that possesses inadequate lateral branching.

During the dormant season following stubbing, the vigorous vegetative growth behind the stubbing cut, portrayed in Figure 1, should be selectively pruned leaving only those which have the potential to become horizontally-oriented lateral branches. This is illustrated in Figure 2.

<u>Don't</u> make stubbing cuts unless they are needed to induce branching, reduce the length of limb, or stiffen unheaded limbs, because it has been shown with Delicious that stubbing can convert fruiting spurs into non-fruitful, vigorous shoots.

Figure 1

Figure 2

****

Stub pruning. We haven't mentioned stub pruning since it was discussed in the February, 1964 issue of Fruit Notes. However, while pruning branches on the windward sides of Delicious trees planted on a windy site this past winter the practice was brought in mind. We know that branches on the windward side are apt to "hug" the leader until cropping holds them down. Leaving extra limbs on the windward side of trees on windy sites will help keep the branches more horizontal because of competition. However, to keep from restricting the central leader and/or inhibiting the development of desirable scaffold limbs, do stub pruning. Stub pruning involves reducing the length of undesirable limbs instead of removing them. Many of the stubbed branches will have to be removed or again restricted during the next pruning season.

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PRUNING PEACH TREES

William J. Lord
Department of Plant and Soil Sciences

Pruning peach trees correctly is one of the most important operations in peach growing because Valsa canker, winter injury, and limb breakage are problems associated with poor pruning practices.

Peach trees may be pruned as either open center or modified leader type trees. The open center system consists of 3 main scaffold limbs arising at approximately the same point on the trunk. The modified leader type tree has 3 to 5 branches vertically spaced 4 to 6 inches apart along the trunk, with the modified leader also carrying side branches. The writer prefers the modified leader type tree, the pruning of which is described below, because it is less time consuming to train during the formative period and in our experience, results in less limb breakage during periods of high winds. Following a windstorm in August, 1976, damage to open-center trees in one orchard was so severe that the grower had to remove them, whereas trees trained as modified central leader trees were retained.

Pruning at planting: A 1-year-old peach tree as it comes from the nursery normally has several side branches. After the tree is set, all branches within 18 inches of the ground should be removed. Any narrow-angled side branches should be cut off. Then, 3 or 4 branches which come out at wide angles, vertically spaced about 6 inches apart, should be saved for main scaffold branches. All other limbs should be cut off flush with the trunk. The leader should be cut back to the top-most side branch and the lateral branches should be cut back to short stubs, 2 to 4 inches long, with each containing 1 bud.

Pruning during the formative period: Delay pruning of both the young and bearing tree until late spring (near bud swell). After pruning, spray the trees with a fungicide before a rain occurs to help prevent or reduce damage from Valsa canker. (Information on fungicides for Valsa canker control can be obtained from your County Extension Service.) Since Valsa canker is frequently associated with poor pruning practices and winter injury, other control measures include avoiding or eliminating narrow crotches, making pruning cuts so as not to leave stubs, and avoiding late growth.

Pruning during the formative period consists of making the final selection of scaffold branches. These branches should be chosen after the first season's growth. Most will be the same branches that were selected originally, with some slight readjustments. Subsequent pruning should develop an open bowl-shaped tree by removing branches that tend to grow inward and those which are growing straight up through the center of the tree. Head back slightly only those selected scaffolds where growth has exceeded 30 inches with little or no branching. On scaffolds which have made less than 30 inches growth with several side branches, cut off all but 2 or 3 well-spaced side branches. Laterals on a scaffold branch which will grow out and slightly up from left and right are most desirable. Those which tend to grow towards the ground should be removed. All branches which arise from the trunk, other than scaffolds, should be removed.

From the second to the fourth year, cut off annually those branches which interfere with the growth of the scaffold limbs but avoid severe pruning, which will delay the time when the tree will start to produce a profitable crop.

Pruning bearing trees: When pruning bearing peach trees, keep in mind that peaches are borne laterally on shoots that grew the previous year. Therefore, the stimulation of 1-year shoot growth by fertilization and pruning is essential for maximum yields of fruit. On a vigorous 1-year shoot, usually 3 buds will be produced at each node. The 2 plump outside buds will be flower buds and the smaller bud in the center will be a leaf bud. On less vigorous shoots there may be but 1 flower bud and a leaf bud on a node.

In pruning a bearing tree the following branches should be removed:

1. Those which are broken or diseased.
2. Those which are slender and weak---especially on the inside of the tree.
3. Those which grow toward the center or straight up.
4. Those which grow downward so as to interfere with mowing or cultivating equipment.

After these branches are removed, it may be necessary to thin out a few of the more vigorous branches where they are too numerous. "Leggy" branches (those which grow out for a considerable distance without branching) need to be headed back in order to induce the development of side branches nearer the trunk. To overcome the peach tree's growth habit of producing bearing wood further and further from the trunk, retain a few young branches on the inner parts of the tree. These branches should be located so that they will subsequently replace older wood. To keep the tree at a convenient height, head back upright branches to an outward growing lateral branch when they reach a distance of approximately 8 feet from the ground.

Pruning Winter-Injured Trees: Peach trees may suffer winter injury from low temperatures by killing of the flower buds, and by killing of the wood. Under Massachusetts conditions, the critical winter temperature for the killing of flower buds is about -15°F. The exact temperature at which flower buds will be killed depends upon the variety, as some are more hardy than others. The extent of flower bud injury can be determined by cutting several buds and noting if they are black in the center. If all of the buds are killed, an opportunity is provided to reduce the proportion of old wood without affecting the crop since there would be no crop the following summer anyway. This will tend to stimulate the development of new growth nearer the trunk.

With more severe temperature (-20°F or lower) the wood may be injured in addition to the buds. This condition is indicated by the inside of a branch turning dark brown or black. When this condition exists, it is best not to prune the tree until after growth starts. Then, only weak shoots on the interior of the tree and dead branches should be removed since the tree will need every healthy leaf to help recover from the winter injury.

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CONTROL OF WATER SPROUTS AND SUCKERS WITH TREE-HOLD*

William J. Lord and Duane W. Greene
Department of Plant and Soil Sciences

Water sprouts, which generally are removed to maintain tree form and prevent shading, are particularly troublesome on standard-type Delicious and following heavy pruning. Unfortunately, their removal becomes more time consuming in succeeding seasons because of the proliferation from the stubs created by pruning. Sucker growth from the trunks and roots of mature seedling trees and in plantings of M.7 and M.7A is a serious problem in Massachusetts. Suckers are costly to remove, increase in number annually, provide mouse cover, and are a haven for insects and diseases.

We now have a 24-C State Registration for Special Local Needs for Tree-Hold Sprout Inhibitor A-112 (Amchem Products, Inc., Ambler, PA) for the control of water sprouts and suckers in apple and pear orchards in Massachusetts. This formulation contains 15.1% ethyl ester of naphthaleneacetic acid and is equivalent to 13.2% naphthaleneacetic acid by weight (1 lb/gal). This formulation must be diluted before use, with either water or white interior latex paint.

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* Trade Name

Tree-Hold diluted in a combination of water and water-base, interior-grade, white latex paint has given good control of water sprouts at our Horticultural Research Station in Belchertown. However, more experience is needed to determine its effectiveness when used alone or in combination with herbicides for the control of suckers because failure of Tree-Hold to control dense sucker growth under mature trees has been reported. Thus, we suggest the use of Tree-Hold on a trial basis only for sucker control.

Mixing for Water Sprout and Sucker Control

For the control of water sprouts use 10 fluid ounces (2/3 pt) of Tree-Hold and make up to a volume of 1 gallon with a combination of water and interior-grade latex paint. The latex paint "marks" the treated areas and makes the mixture more viscous, thus restricting the NAA to the treated area. It has been our experience that at least 4 pints of latex paint should be used in each gallon of treating solution. Be sure to use an interior-grade latex paint and one that does not contain a mildewcide.

For spraying suckers on a trial basis, mix 10 fluid ounces of Tree-Hold with sufficient water to make 1 gallon of spray mixture. Eight gallons of Tree-Hold are required for 100 gallons of spray.

Control of Water Sprouts

Prune water sprouts and then apply Tree-Hold mixture thoroughly over the cut surfaces. It can be applied with a paint brush or a small compressed air sprayer. We found that a 1-1/2 gallon compressed air sprayer with a 12-foot hose worked well, and that attaching a sponge to the nozzle was useful for swabbing the mixture on pruning cuts. The treatment can be applied anytime weather permits before growth starts in the Spring. Areas where pruning cuts have been made should be covered thoroughly, but drip on to other parts of the tree should be avoided. <u>The Tree-Hold mixture can kill buds</u>. <u>Be sure to follow the label</u>.

Control of Suckers

Prune the suckers during the dormant season. The Tree-Hold mixture can be sprayed on the stubs during the dormant season or when the new shoots from the suckers are 6 to 12 inches in height. <u>However, the most effective timing</u> is when the suckers are actively growing. Since the Tree-Hold mixture contains 10,000 ppm NAA, <u>the label restricts its use from bud swell through 4 weeks after petal fall</u> to eliminate the possibility of fruit thinning and leaf damage. Therefore, the Tree-Hold mixture should be sprayed in late-June to mid-July when the suckers are 6 to 12 inches in height. Coverage should be thorough.

The Tree-Hold mixture is too expensive to apply as a band application under the trees. Since the population of suckers is generally more dense near the trunk and very troublesome inside wire mouse guards, the spray may be limited to these areas using a compressed air sprayer, a weed sprayer with an air gun, or a weed sprayer and boom with a trunk-directed nozzle.

Maintain low spray pressure to avoid drift of the Tree-Hold mixture. Spray on tree trunks is of no concern but drift onto scaffold limbs will damage foliage and fruit. Although annual sprays of Tree-Hold mixture may be required, the number of suckers should be gradually reduced. It is of interest to note that researchers in New York State reported in 1978 that 3 consecutive annual applications of Tree-Hold has had no harmful effect on tree growth or productivity.

Summary

Tree-Hold Sprout Inhibitor A-112 is a useful chemical tool for the control of water sprouts and suckers in our apple orchards. We are reasonably sure of its effectiveness for water sprout control but need much more experience with its use on suckers. The new registration will allow growers to evaluate the effectiveness of Tree-Hold for sucker control under a variety of conditions. Grower experiences with Tree-Hold for sucker control will add to the information currently being obtained at our Horticultural Research Center and by James Williams, Regional Fruit Specialist in Northeastern Massachusetts.

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U.S. APPLE EXPORTERS EXPECT ANOTHER GOOD YEAR FOLLOWING RECORD SHOWING IN 1977/78[1]

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Foreign Agricultural Service
U.S. Department of Agriculture
Washington, D.C. 20250

After a banner 1977/78 season, U.S. apple exporters are preparing for another good year in 1978/79. More normal crops in major markets of Western Europe following shortfalls last season conceivably could keep U.S. apple exports from reaching the record sales of $66 million achieved in 1977/78 (July-June). But sales promise to be brisk as markets in Latin America, the Middle East, Far East, and other areas are developed further.

Another bumper U.S. crop -- estimated at 3.3 million metric tons, the same as last year's -- will allow ample supplies for export while intensifying pressure to sell abroad. Moreover, the crops are abundant in traditional exporting areas such as the Pacific Northwest, New England, and eastern New York State.

The status of the U.S. dollar also will have a bearing on U.S. trade. Prior to its recent strengthening, the U.S. dollar was declining against many currencies of the world. For instance, the

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1. Reprinted from November 13, 1978 issue of Foreign Agriculture with permission from the author.

British pound in mid-October 1978 was worth about $2.08, compared with about $1.85 a year earlier.

Given a landed duty-paid price of $12 per carton (42 lb) for both years, U.K. importers would have paid about £5.77 for U.S. apples in October 1978 -- some 11 percent less than a year earlier.

Some further examples of the prolonged deterioration in the value of one U.S. dollar vis-a-vis foreign currencies (as of October 27, 1978) include:

	October	
	1977	1978
Netherlands	f2.4	f1.9
Switzerland	F2.2	F1.5
West Germany	DM2.2	DM1.8
Norway	Nkr5.4	Nkr4.8
Singapore	S$2.4	S$2.1
Malaysia	M$2.4	M$2.1

Currently, it looks as if total U.S. apple exports in 1978/79 could add up close to last season's recent high of 7.9 million cartons. Exports in 1978/79 were well above the exceptionally good showing of the preceding season (1976/77), when 6.3 million cartons moved into foreign markets.

At the start of last season, U.S. apple shippers were faced with a very inviting situation. The important European producers were then reporting exceptionally small apple crops, which for all Europe amounted to only about 5 million tons, compared with 6.4 million in 1976. This meant that the United States had an excellent opportunity to help fill the vacuum on the Continent -- aided by a temporary reduction in the EC common external tariff on apples from 14 percent to 6 percent. Additionally, the area's leading producer, France, was not able to reach distant markets with the same intensity of former years.

As it turned out, France's apple crop in 1977 was down some 27 percent from the previous year to 1.2 million tons. This decline greatly limited the country's export potential while opening up new outlets for the United States in Europe, the Middle East, and other markets.

Despite loss of shipping time during the first of last season because of the dock strike on the east coast, U.S. apple exports went on to score a 25 percent gain in volume and a 57 percent increase in value over the 1976/77 levels. On a price per carton basis, export sales to all destinations averaged $8.42 per equivalent 42-pound carton, versus $6.71 per carton in 1976/77.

This is a far cry from the depressing prospects that confronted U.S. exporters in the 1960's and early 1970's. Around 1962, for

for instance, there were strong signs that the United States potentially could be squeezed out of the world apple market. Plantings in France and other nearby countries in Western and Eastern Europe had been exceptionally heavy, portending a future explosion in production.

Shortly after the mid-1960's, the explosion hit. Once-viable U.S. markets in the United Kingdom and Scandinavia collapsed. Prospects appeared bleak to impossible in Latin America and the Far East.

Canada -- like the United States a leading producer and exporter -- was plagued with similar problems. And, to compound the problem still further, Southern Hemisphere suppliers such as Australia and New Zealand began to eye the U.S. late winter through early summer market with greater interest. They also were having access problems in Western Europe.

Coinciding with these developments was burgeoning production in the United States of Red Delicious and other types.

U.S. exports during that time did fall considerably -- averaging about 2-2.5 million cartons in the late 1960's and early 1970's. However, a nucleus of grower-shippers simultaneously were searching for new markets and making quality improvements needed to compete.

Gradually, the situation improved, and today U.S. apple exporters are shipping reasonably large volumes to the Far East, Latin America, and the Middle East.

Last year's record showing capped this rebound, as most major markets came through with larger purchases than in 1976/77.

CANADA -- largest single market for U.S. apples -- was one of the exceptions to this generally upward trend and probably will show another slight decline in 1978/79. The current forecast: 2.4 million cartons, against 2.6 million shipped in 1977/78.

However, U.S. sales there last year were larger than expected, coming in just 300,000 cartons under the unusually high level of 1976/77.

The major limiting factors for 1978/79 will be the slightly larger Canadian crop and price gains resulting from the weakness of Canada's currency against the U.S. dollar. The Canadian dollar in October was worth slightly less than 85 U.S. cents, compared with 93 in August 1977.

In WESTERN EUROPE, U.S. shippers cannot expect to repeat their strong 1977/78 showing of 1.4 million cartons in view of the 22 percent gain estimated for apple production in 11 key countries there over the unusually low level of 1977. The current estimate for 1978/79 exports: 600,000 cartons, or some 15 percent above the 522,000 cartons shipped in 1976/77.

On the positive side, expected output still is some 4 percent below that of 1976, and crops in the key European producers -- France and Italy -- are off 4 percent and 19 percent, respectively, from 2 years ago. Italy's crop, in fact, is some 5 percent below the small outturn of 1977.

LATIN AMERICA (including the Caribbean and Mexico) should continue its gradual growth as a market for U.S. apples. Exports there in 1978/79 are forecast at 1.9 million to 2.0 million cartons, against 1.5 million last year. Shippers will probably at least equal last year's showing in Mexico and Venezuela -- which together take about half of all U.S. exports to the region -- and make further gains in Central America, the Caribbean, Colombia, and possibly Brazil.

In contrast to diminishing sales opportunities a few years ago, when France was encroaching on many traditional U.S. markets, Latin America recently has become an attractive outlet. U.S. shipments there last year rose 12 percent over the 1976/77 level.

In the FAR EAST AND PACIFIC -- a recent growth market that did not, however, participate in last year's advance -- sales are expected to exceed the 1.4 million cartons in 1977/78. A large crop in the U.S. Pacific Northwest means plentiful export supplies.

Hong Kong should continue to be a high-volume market, with any plus conditioned in part on currency relationships -- the Hong Kong dollar has been slightly weaker so far this year. Taiwan, Malaysia, and Singapore also look better than they did last season, when sales to Taiwan and Singapore fell significantly.

The region as a whole took 155,000 fewer cartons in 1977/78 than during the previous year. This was the first interruption in the steady upward trend in sales since 1970, when only 210,000 cartons were sold to the Far East.

Exports to the MIDDLE EAST -- which opened up abruptly last year in response to smaller exports from its traditional supplier, France -- should at least match the 1 million cartons of U.S. apples shipped in 1977/78.

France and Italy have long dominated this market and will probably try to reclaim their traditional shares. However, some trade sources predict that the United States will exceed last season's performance in this area by a significant margin.

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INTEGRATED MANAGEMENT OF APPLE PESTS IN MASSACHUSETTS - 1978 RESULTS: INSECTS

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In 1978, the United States Department of Agriculture Extension Service made monies available for the study of integrated pest management (IPM) on major crops grown in the United States. We applied for and received such a grant to study integrated management of apple pests in Massachusetts. Although apples rank 6th in economic importance of agricultural crops in this state, pesticide usage ranks highest.

Reduced spray programs have been discussed in previous issues of Fruit Notes [41(1), 41(2), 41(3), 42(3) and 43(3)]. The major objective of our IPM program was to utilize data obtained from trap captures of pest adults and other methods (such as sampling leaves for mites and observing leaf and fruit clusters for aphids and their predators) to better time, and hopefully decrease, the number of spray applications aimed against fruit and leaf pests while maintaining fruit quality.

METHODS

During the growing season of 1978, we scouted 24 orchards in the four major fruit growing counties (Middlesex, Worcester, Hampden and Franklin) in Massachusetts. Eight orchards were in the IPM program, wherein we told the growers when and what materials to spray. Eight were check orchards in which the growers sprayed their usual program with whatever materials they wished to use. Four were abandoned orchards which we used to observe presence and relative numbers of insect pests. Four were alternate-middle vs. every-middle spray orchards. (We will discuss the 1978 results of the alternate vs. every-middle program in the next issue of Fruit Notes.)

Every week 10 trees in a 10-acre block in each IPM and check orchard were scouted for beneficial and pest insects. We looked at 45 leaf clusters and 45 fruits from all parts of each tree for aphids, aphid predators, other leaf and fruit pests and any injury. Later in the season (from mid-June to harvest) we took leaf samples which we brought back to the lab and brushed for predator and leaf-feeding mites [see Fruit Notes 43(4)]. We also used visual traps to monitor tarnished plant bug and European apple sawfly adults in all orchards [see Fruit Notes 43(1) and 43(2)], pheromone (sex odor) traps for codling moth and leafrollers, and unbaited sticky red spheres, sticky red spheres baited with ammonium acetate (a food mimic), and Zoecon® AM Standard baited yellow rectangles for apple maggot flies [see Fruit Notes 41(5) and 41(6)]. In the IPM orchards, decisions

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1 We would like to thank Ted Bardinelli, Kevin Beswick, Victoria Ciarcia, Sylvia Cooley and Thomas Luippold for their assistance in this program, as well as the MFGA and participating fruit growers.

as to whether or not to spray were made on the basis of trap captures and visual observations of pest and predator insects. Decisions on all insecticide and aphicide applications were made in the orchard. Leaf samples for mites were brought back to the lab and processed. A decision on whether or not to spray for mites was made within 24 hours.

RESULTS

A summary of our 1978 results is given in Table 1 (see below). Average numbers of tarnished plant bug (TPB), European apple sawfly (EAS), apple maggot fly (AMF), codling moth (CM), redbanded leafroller (RBLR) and obliquebanded leafroller (OBLR) adults were higher in the 8 IPM orchards than in the 8 check orchards. But, in spite of these higher numbers, fruit injury levels at harvest (for all fruit-infesting insects) averaged 44% lower in the 8 IPM orchards (an average of 2.6% injury) than in the 8 check orchards (an average of 4.8% injury). At the same time, the 8 IPM orchards averaged 31% fewer insecticide sprays aimed at these pests. We attribute this decrease in injury to better timing and avoidance of unnecessary spray sppli-cations. In addition, the 8 IPM orchards averaged 27% fewer sprays than in the previous 2 years.

TABLE 1. Summary of Overall Results - IPM and Check Orchards

	Average Number/Trap						Average Fruit Injury	Average No.[z] Insecticide Sprays	
	TPB[y]	EAS[x]	AMF[w]	CM[v]	RBLR[u]	OBLR[t]		1978	1976,1977
8 IPM Orchards	6.0	5.3	8.5	122.6	166.0	5.5	2.6%	6.7	9.3
8 Check Orchards	4.5	4.3	5.7	89.9	98.5	4.5	4.8%	9.6	---
Difference	+33%	+23%	+47%	+36%	+18%	+22%	-44%	-31%	

[z] Does not include materials directed solely at aphids (e.g., endosulfan, phosphamidon).

[y] TPB = Tarnished Plant Bug

[x] EAS = European Apple Sawfly

[w] AMF = Apple Maggot Fly

[v] CM = Codling Moth

[u] RBLR = Redbanded Leafroller

[t] OBLR = Obliquebanded Leafroller

On the basis of these results, we've calculated (see Table 2) that with the average reduction in number of insecticide applications (3) in the IPM orchards, these growers saved between \$173.70 and \$322.50 (depending on material and rate) on insecticides alone in each 10-acre IPM block.

TABLE 2. Savings Attributable to Decreased Insecticide Usage[z] in IPM Orchards for the Two Most Commonly Used Materials. Comparisons Based on 3 Applications Saved.

Chemical	Cost[y]/Lb.	Rate/100 Gal.	Savings/A[x]	Savings/10-A Block	
				1 Applic.	3 Applic.
Guthion	\$4.30	1/2 lb.	\$ 8.60	\$ 86.00	\$258.00
		5/8 lb.	10.75	107.50	322.50
Imidan	\$1.93	3/4 lb.	5.79	57.90	173.70
		1 lb.	7.72	77.20	231.60
		1-1/4 lb.	9.65	96.50	289.50

z Does not include aphicide use, costs of labor, gasoline or equipment.

y Costante, J. 1978. Insecticide guide for control of major pests and cost comparison. Univ. of VT (mimeo).

x Based on 400 gal./A dilute for IPM orchards.

Table 3 gives a list of the major apple-infesting pests. This list was based on an on-tree harvest survey of 2,000 fruits per orchard (100 fruits per tree on each of 20 trees). In both the IPM and check orchards, TPB accounted for the greatest percentage of fruit injury. (However, we found no good relation between TPB trap captures and TPB injury levels at harvest.) In the IPM orchards, EAS ranked second in terms of injury level. (We found that EAS trap captures and EAS injury levels are highly related, and for this reason we will be able to even more accurately time and predict need for insecticide applications aimed against EAS next year.) In the check orchards, San José scale and green fruitworms caused more injury than EAS and other pests except plum curculio. We attribute better control of GFW in the IPM orchards to our careful monitoring of the presence of the larvae. In the IPM orchards, we attribute the excellent control of AMF with minimum insecticide usage to the information obtained from AMF captures on the unbaited spheres. Captures of AMF on these spheres were considerably greater and much better related with AMF injury to fruit at harvest than were captures on the baited spheres on Zoecon yellow rectangles. In one IPM orchard, no mature female AMF were captured until August 14, and few CM were captured. Based on our recommendations stemming from these trap captures, no insecticide was applied between June 6 and August 16. The result: no fruit injury whatsoever from AMF, CM, or any other fruit pest except early season TPB. We found almost no codling moth and leafroller injury on fruits at harvest in any of the other orchards.

TABLE 3. Major Pest Species and Average Injury Levels[z]. Numbers in Parentheses Indicate Relative Ranking of Injury Level.

Pest	IPM Orchards (8)	Check Orchards (8)
Tarnished Plant Bug	1.60% (1)	2.33% (1)
European Apple Sawfly	0.68% (2)	0.54% (4)
Plum Curculio	0.17% (3)	0.17% (5)
Apple Maggot Fly	0.13% (4)	0.08% (6)
San José Scale	0.03% (5)	0.96% (2)
Codling Moth	0.01% (6)	0 (8)
Leafrollers	0.01% (7)	0.05% (7)
Green Fruitworm	0 (8)	0.59% (3)
Other	0.01%	0

[z] Based on on-tree surveys of 2,000 fruit per orchard (or orchard block) at harvest (100 fruit on each of 20 trees).

The mite results in our IPM orchards were also encouraging. Our 8 IPM orchards averaged 1.2 miticide applications as compared with an average of 1.6 applications in the 8 check orchards, and at the same time had slightly more predator mites (Table 4). We attribute the slightly increased number of predator mites to selective use of pesticides in the IPM orchards. (We asked growers _not_ to use chemicals that had previously been shown to be toxic to mite predators [_Fruit Notes_ 43(5)]). In Orchard A (Table 5), which had a high number of predator mites (both _A. fallacis_ and yellow mites), no miticide application was needed this year. In Orchard B, in which an herbicide shown to be toxic to _A. fallacis_ was used, 3 miticide applications were needed. As the effects of selective use of pesticides non-toxic to predator mites take hold in IPM orchards in future years, we expect increasing predator buildup and gradually decreasing need for miticide application.

TABLE 4. Summary of 1978 IPM and Check Orchard Mite Results

Orchards	European Red Mites	Two-Spotted Mites	Predatory Mites		Avg. No. Treatments	
			A. fallacis	Yellow Mites	Oil	Miticides
8 IPM	2.1	5.3	0.07	0.01	0.8	1.2
8 Check	2.4	0.7	0.05	0.01	0.8	1.6

TABLE 5. Mite Results in 2 IPM Orchards in 1978

IPM Orchard	European Red Mites	Two-Spotted Mites	Predatory Mites		Avg. No. Treatments	
			A. fallacis	Yellow Mites	Oil	Miticides
A	0.2	0.03	0.06	0.07	1	0
B*	11.4	0.08	0.01	0	1	3

* Sprayed under trees with Ammate in June.

Our plans for 1979 include increasing the number of IPM orchards and the IPM acreage in each. (The number of check orchards to be scouted will probably decrease.) Since we have better predictive tools for monitoring EAS and AMF adults, our results next year should be even better. The combined efforts of Dr. William Manning and Ted Bardinelli of the Plant Pathology Department will also provide an IPM approach to disease control.

In conclusion, our integrated insect pest management program in 1978 resulted in substantial overall savings of grower money and time, through a reduced number of spray applications, and at the same time, resulted in very high quality fruit production.

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Cooperative Extension Service
University of Massachusetts
Amherst, Massachusetts
Ross S. Whaley
Director
Cooperative Agricultural Extension Work
Acts of May 8 and June 30, 1914

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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Vol. 44 (No. 2)
MARCH/APRIL 1979

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MONITORING APPLE MAGGOT FLIES, SAWFLIES, AND PLANT BUGS WITH VISUAL TRAPS

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Introduction

With the advent of integrated pest management programs in commercial apple orchards in Massachusetts and other apple-growing regions of the United States, there is increased emphasis on the ability of growers, orchard scouts, and extension agents to accurately monitor population levels of injurious apple insects and mites.

Certain pests, such as aphids, spider mites, leafhoppers, leafminers, and scale insects attack principally or exclusively the vegetative parts of the tree and can be tolerated in small or even moderate numbers without economic injury. Their population levels can be monitored with reasonable accuracy by direct visual examination of foliage or branches.

Other pests, such as green fruitworms and oblique-banded, red-banded, and fruit-tree leafrollers feed, as larvae, from the exterior of the fruit. While even a few larvae may cause economic injury, larval populations and the readily discernible injuries they cause, can be rather accurately monitored by direct visual examination of fruit.

Still other pests, such as tarnished plant bug, European apple sawfly, plum curculio, apple maggot, and codling moth, feed as adults or larvae on developing buds or fruit. They can not be tolerated in appreciable or even small numbers without economic injury. Except for plum curculio, their feeding and egglaying activities are rather difficult and tedious to accurately detect by direct observation. Populations of these pests are best monitored in the adult stage. The monitoring method must be sensitive, so that detection of very low population densities is possible, and pesticide application, if necessary, can be made before the occurrence of economically unacceptable feeding injury or egglaying.

In the 8 commercial apple orchards in our 1978 integrated pest management (IPM) program in Massachusetts, it was the latter 5 pests which accounted for nearly all of the insect injury on the 16,000 apples examined at harvest: 1.60% by plant bug, 0.68% by sawfly, 0.17% by plum curculio, 0.13% by apple maggot, and 0.01% by codling moth, with all remaining insect injury to the fruit totalling 0.05% (see Fruit Notes 44(1) for further in-information on the 1978 results of the apple IPM program in Massachusetts). This same sort of insect injury pattern is probably characteristic of several other eastern states as well.

During the past few years, we have been attempting to develop effective trapping devices for accurately monitoring adult population levels of plant bug, sawfly, apple maggot, and plum curculio.

Most entomologists who have sought to develop insect traps have been primarily interested in uncovering highly stimulating odors, such as sex pheromones, which can attract an insect from a considerable distance. In recent years, this approach has met with outstanding success. Witness the development of sex pheromone traps for male codling moths, leafrollers, fruitworms, and leafminers by Dr. Wendell Roelofs and colleagues at the New York State Agricultural Experiment Station at Geneva.

In many instances, however, sex pheromone traps are so powerful that they attract individuals from distances well beyond the borders of the orchard. Hence, it has often proven rather difficult to accurately relate pheromone trap captures in an orchard to the number of pest adults actually present within the orchard.

Our approach has been an attempt to uncover attractive <u>visual</u> stimuli. Such stimuli, when incorporated into a trap, would lure insects only from a distance of a few yards or less. Theoretically, therefore, visual traps would have the advantage of providing estimates of only those pest adult numbers actually present within the orchard.

Thus far, this approach has yielded 2 sorts of effective visual traps for apple maggot flies, one for European sawfly, and one for tarnished plant bug. Some of the research that led to the development of these visual traps has been outlined in recent issues of Fruit Notes: 41(5), 41(6), 43(1), and 43(2).

In this article, I tie together elements of our previously described findings and present new findings on the relationship of levels of trap captures to levels of injury caused by each pest.

Specific Ingredients of Our Approach

First, we make extensive direct observation of the movements of the adults on unsprayed apple trees to determine the frequency with which they visit the buds, flowers, leaves, branches, or fruit and to determine the nature of their activities (feeding, mating, egg-laying, resting) on each of these structures. Second, using an instrument called a spectrophotometer, we analyze the precise visual reflectance pattern (hue) of the most often visited tree structures. Third, we attempt to mimic these visual reflectance patterns with pigments or paints having the same type of reflectance pattern. Fourth, we apply these pigments or paints to objects whose shape and size is similar to that of the corresponding tree structures. Finally, the objects are coated with a clear sticky substance (such as Tangletrap*) which captures alighting insects, and are hung in apple trees to assess the responses of the adults.

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*Trade Name

Apple Maggot Flies

Apple maggot flies, prior to reaching sexual maturity, make frequent visits to apple tree leaves, where they feed on insect honeydew and other surface substances, and rest. After reaching sexual maturity, they make frequent visits to the fruit, where they mate and lay eggs. Visits to the twigs and branches are infrequent.

A green rectangle of medium size (6 x 9 inches) roughly mimics the hue reflectance pattern and form of clusters of apple foliage. While apple maggot flies will alight on such a green rectangle, they alight in much greater numbers on yellow rectangles, which have the same sort of hue reflectance pattern as apple leaves, but reflect light at a much higher intensity than leaves. It seems as though the flies perceive yellow rectangles as being super-bright or super-normal clusters of foliage. Daylight fluorescent yellow is an especially bright and attractive hue.

When baited with an odoriferous substance such as an ammonium acetate-protein hydrolysate combination (which apparently mimics the smell of insect honeydew), and coated with Tangletrap, daylight fluorescent yellow rectangles are excellent for monitoring populations of food-seeking flies.

A yellow or green 2-inch diameter sphere closely mimics the hue reflectance pattern, form, and size of a developing apple. While mature apple maggot flies readily alight on such spheres, they alight in considerably greater numbers on red, violet, and black spheres 3-5 inches in diameter. It seems as though these dark colored spheres, on the basis of greater contrast against the background, are more readily detectable by the flies than are the light colored ones -- much the same as humans can more easily locate red apples than yellow or green apples in a tree. Apparently the flies view large spheres as being super-large or super-normal apples. Our studies have shown, however, that if a sphere is overly large--for example, 12 inches diameter--it is less likely to be viewed as an apple and in fact attracts fewer flies than a 3 1/2-inch sphere.

When coated with Tangletrap, 3 1/2-inch diameter red spheres provide excellent traps for monitoring populations of apple maggot flies seeking mating and egglaying sites.

In 1978, we compared 6 x 9 inch odor-baited yellow rectangles (sold commercially as Pherocon AM Standard Traps by Zoecon Corp., Palo Alto, California) with 3 1/2-inch diameter dark red spheres coated with Tangletrap in 16 commercial and 4 abandoned Massachusetts apple orchards. Although early-season maggot fly captures in the abandoned orchards were slightly greater on the yellow rectangles than on the spheres, captures in the commercial orchards were consistently earlier and consistently greater in weekly and total numbers on the spheres than on the rectangles.

In commercial orchards, the great majority of apple maggot flies are immigrants, and apparently are more in search of mating and egglaying sites than in search of food. Hence, the greater effectiveness of the spheres for monitoring apple maggot flies in commercial orchards.

European Apple Sawflies

European apple sawfly adults make frequent visits to apple blossoms, where they feed on the pollen and lay eggs in the receptacles. Some mating and resting also occurs on the blossoms. They make comparatively few visits to the leaves and branches.

Certain white paints which reflect little or no light in the ultraviolet part of the spectrum closely mimic the hue reflectance pattern of apple petals, although they reflect at a higher intensity than the petals. Medium size rectangles (6 x 8-inches) coated with such paint plus Tangletrap attract and capture large numbers of sawfly adults. Evidently, the sawflies perceive the white rectangles as being super-bright or super-normal clusters of apple blossoms. However, not just any white surface will attract sawflies. For example, white paper, white cardboard, and lead white paints reflect considerable amounts of ultraviolet light, which, although not visible to humans is readily visible and in fact quite repulsive to sawflies. Fortunately, the white rectangles attract and capture few honeybees.

Tarnished Plant Bugs

Tarnished plant bug adults make frequent visits to apple buds and blossoms, where they feed. Less frequently, they visit leaves and branches, where they rest. Mating and egglaying seem to be rather infrequent on apple trees, principally occurring on ground cover vegetation.

Just as they mimic the hue reflectance pattern of apple blossom petals, certain non-ultraviolet-reflecting white paints also approximate the hue reflectance pattern of developing apple buds. As with sawflies, 6 x 8-inch rectangles coated with such paints plus Tangletrap capture considerable numbers of plant bug adults. However, our research indicates that plant bug adults are substantially less visually specific in orientation to the hue or form of apple tree structures than are apple maggot flies and sawflies. Hence, visual traps may ultimately prove of somewhat more limited value for precise monitoring of plant bug populations.

Where to Purchase Visual Traps

These visual traps for apple maggot flies, sawflies, and plant bugs can be purchased at modest cost from New England Insect Traps, Leyden RFD, Bernardston, MA 01337 ($1.25 per 3 1/2-inch red wooden sphere with accompanying Tangletrap; $1.00 per non-ultraviolet white cardboard rectangle, pre-coated with Tangletrap).

How to Position Visual Traps in Trees

Proper use of visual traps demands more careful attention to trap placement than is the case with sex pheromone traps. The visual traps, best hung from branches on the south side of apple trees at heights of 20-40 inches for plant bugs and 6-8 feet for sawflies and maggot flies, must be readily visible to insects approaching from any direction. It is advisable, therefore, to remove all foliage and fruit within 12 inches or so of the sides, top, and bottom of a trap. Beyond this distance, however, there should be as many buds, blossoms, leaves, or fruits as possible to attract insects into the general area. Presently, we are using one visual trap of each type per 2 acres of trees in our pest management orchards.

Relation Between Trap Captures and Insect Injury Levels

The ultimate proof of the usefulness of such visual traps lies, of course, in the accuracy with which trap captures estimate numbers of injury-causing adults actually present in the orchard. In 1978, we therefore made an attempt to establish indices relating levels of trap capture to levels of injury caused by each pest. We hung 6-10 traps of each type in each of 16 commercial orchards.

The results showed the following correlation values of trap captures with injury levels (+ 1.00 would be a perfect positive correlation, indicating a perfect relationship of trap captures to injury levels): (a) apple maggot captures on red spheres with apple maggot egg-laying stings, + 0.87 (b) sawfly captures on non-ultraviolet reflecting white rectangles with sawfly injury scars on mature fruit, + 0.82; and (c) plant bug captures on non-ultraviolet reflecting white rectangles with abscission of developing buds caused by plant bug feeding, + 0.67.

These high positive correlation values are very encouraging and suggest that prospects are good for establishing reliable indices relating visual trap captures to insect injury levels, and therefore for using visual trap captures as a basis for deciding if or when pesticide treatments against plant bugs, sawflies, and apple maggot flies are economically merited in a given block of trees. We hope that our studies during the next 2-3 years will refine and validate the initial indices obtained in 1978. Until then, the principal value of the visual traps will be in detection of the first appearance and the disappearance of these pest adults in orchards.

ROOTSTOCK TESTING ON AN INTERNATIONAL BASIS

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In the past, rootstock studies were uncoordinated efforts and results have varied from state to state with little chance of isolating the influences due to climate and soil differences. In 1976 the North Central Regional Cooperative Project NC-140 entitled "Scion/Rootstock and Interstem Effects on Apple Tree Growth and Fruiting" was initiated with the following objectives.

Objectives:

1. To evaluate the production efficiency of available and potentially useful rootstocks or interstems for fruit trees which are potentially precocious, dwarfing, free standing, easy to propagate and adapted over a wide range of climatic conditions in the North Central Region.

2. To determine the propagation practicability of new rootstocks and interstem material and ascertain the anatomical and physiological factors in graft unions that determine compatibility.

3. To ascertain the cause and prevention of the decline of new and existing rootstocks and interstems and evaluate the influence of various cultural practices on rootstock survival and performance.

Under Objective 1, a uniform interstem planting was established in 1976 in Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Missouri, Ohio, and Wisconsin, and a partial planting was established in Kentucky. 'Millerspur Delicious' and 'Empire',with 8-inch interstem of M.9 on either Antonovka, MM.111 or Ottawa 11 rootstock, are being evaluated.

Currently, NC-140 is being expanded so that a 1980 rootstock planting will be established by at least 20 cooperators in U.S.A. and Canada. At each location a planting of 'Redchief Delicious' (spur-type) on M.9, Ottawa 3, EMLA27, EMLA9, EMLA7, EMLA26, MAC9, MAC24, and OAR1 will be established. (The EMLA's are virus-free clones of M.9, M.7, etc., the MAC's are Michigan State apple clones, and the OAR1 is a clone introduced by Oregon State Agricultural Experiment Station.)

Other Cooperative Rootstock Plantings will be established later in the 1980's. Hopefully, our NC-140 project will prove to be a benefit to growers and apple tree nurserymen, since coordinated research should lead to clearer information about apple rootstock performance.

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TREATMENT OF GIRDLED FRUIT TREES

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Department of Plant and Soil Sciences

Girdling or partial girdling of fruit trees occurs annually in spite of orchard sanitation, poison baits and mechanical protectors, and may be particularly severe in years of heavy, persisting snowfall, as occurred during the winter of 1977-78. You can help prevent damage when snow acculates above the wire or plastic guards by tramping the snow to lower its height.

Determining the Treatment

1. Trees not worth saving should be removed and replaced.

2. If apple, pear or plum trees with injury above the graft union are only 1- or 2-years old, they can be cut below the girdled area. Shoots will then develop from the remaining stub. One of these can be selected during the following spring for a new tree. Be sure the selected shoot originates above the graft union. In case of interstem trees the shoot must originate above the interstock.

3. If apple or pear trees are 1-1/2 or 2 inches in diameter they can be cleft grafted. Cleft grafting is less likely to be successful on stone fruits.

4. Trunks of girdled apple, pear or plum trees more than 2 inches in diameter can be bridge grafted. Peach trees usually do not respond satisfactorily to bridge grafting.

5. When the roots of an apple tree are so badly injured that scions cannot be readily attached to them, inarching can be done.

6. Repair of girdled apple trees is complicated by planting of interstem trees. Girdling of the interstem portion, usually M.9 (it is reported that mice prefer M.9), means that when bridge grafting, cleft grafting or inarching is done part, if not all, of the dwarfing influence of the interstem will be lost. A solution to this problem is using scion wood and rootstocks from a stool bed of M.9 maintained on the farm.

Season for Repair Grafting

Repair grafting by bridging or inarching should be performed when the bark is slipping readily. Under Massachusetts growing conditions, the bark may not begin to slip readily until mid-April. Cleft grafting can be done earlier (March) since it is not necessary for the bark to slip. However, when the scions for bridge and cleft grafting or the nursery tree for inarching are kept dormant in storage, grafting can be successfully done even though the trees have made considerable growth.

Selection of Scion Wood for Bridge Grafting

It usually is necessary to obtain scions in advance of their use in order to have them dormant. Water sprouts or well-ripened one-year terminal growth make good scions for bridge grafting. Scions can vary in size from that of a lead pencil to one-half inch in diameter, the largest scions being used on larger wounds. Scions may be taken from the same tree or any other available compatible sort, but preferably from a winter hardy variety such as Cortland or McIntosh apple.

Trees for Inarching

Use dormant nursery trees 3 to 6 feet in height.

Mechanics of Repair Grafting

Farmers' Bulletin Number 1369 of the U.S. Department of Agriculture gives detailed instructions for bridge grafting and inarching. A limited supply of this publication is available at your County Extension Service. Also available from your County Extension Service is our publication on cleft grafting.

Grafting Compound

For the protection of grafting wounds, many growers now use asphalt emulsion instead of a grafting wax. It can be obtained from most distributors of farm and gardening supplies. Asphalt emulsion should be applied on the tip ends of the scions and the cut stub of the trunk when cleft grafting, and over the area where the scions or top of the inarched tree meets the stock of the girdled tree. Applying the emulsion on the injured section of the trunk is also advisable to prevent weathering.

The Number of Scions

The following are about the right number of scions for different sized trees:

(1) Tree 2 inches in diameter, 3 scions
(2) Tree 3 inches in diameter, 4 scions
(3) Tree 6 inches in diameter, 6 scions
(4) Tree 10 inches in diameter, 8 or 10 scions.

On partially girdled trees use a proportionate number of scions. A tree one-quarter or more girdled should be bridge grafted.

Care of Scions After Grafting

Inspect repaired trees periodically after grafting and recoat with grafting compound any areas where cracking has occurred. This phase in the process of bridge grafting and inarching is most apt to be neglected. Thus, the following procedure should increase the reliability of coverage. Place masking tape over the grafting compound-coated areas (where the scions or top of the inarch tree meet the stock of the girdled tree). Then, coat the masking tape with grafting compound.

The scions used for bridge grafting and the trees used for inarching must be kept from producing shoots. As buds on the scions swell, rub them off. When inarching, let 1 bud develop into a shoot, preferably the bud nearest to the graft. When you are sure the graft has "taken", it should be removed.

General Considerations

1. As soon as the injury is discovered, it may be possible to save some of the cambium layer cells (where new cells are produced in the trunk) by promptly applying the asphalt emulsion or grafting wax to the injured area.

2. Occasionally suckers are present or arise later from the area below the wounds. Suckers that extend above the wounded surface may be used as "inlay scions" at the top end.

3. Trees leaf out and often fruit the first season after the bark and cambium layer are destroyed around the tree trunk. However, the vigor of these completely girdled trees varies considerably. On some trees the foliage and fruit appear normal, on others, foliage may be light in color but fruit size normal, and on some other girdled trees, the foliage may be light in color and sparse, and the fruit small.

The reason why completely girdled trees leaf out and often fruit the first season after the bark and cambium layer are destroyed around the tree trunk is because water and other materials which are taken up by the roots from the soil pass up to the leaves through the wood. In the leaves the water and the carbon dioxide taken from the air by the leaves are united chemically, through the action of sunlight, into sugar. After the manufacture of the plant foods by the leaves, they move to other parts of the tree through the phloem which is found in the bark. When the phloem has been destroyed by girdling, this food cannot move to the roots. Roots will continue to grow and take up water and minerals only as long as their food supply holds out, and the above-ground portion will continue to grow only as long as it continues to receive water and minerals from the roots. Reserve food stored in the roots enable the roots to function for some time, often a year or 2, thus keeping the top of the tree alive. However, a completely girdled tree, unless repaired, will eventually die from starvation of the roots.

NUTRITIONAL PROBLEMS IN 1978 AND SUGGESTIONS FOR FERTILIZATION OF APPLE TREES IN 1979

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Prospects for a heavy bloom in 1979 are not too likely following the large crop in 1978. However, there are ample flower buds for a good crop in 1979 if weather is favorable at bloom.

The analysis of leaf samples from commercial orchards showed that potassium (K) and manganese (Mn) were deficient in some orchards in 1978, and boron (B) was generally low. Foliar calcium (Ca) levels were considerably higher than most years; nevertheless, bitter pit on Cortland was very prevalent in some orchards and we were surprised to find a serious amount of cork spot in some Red Delicious fruit, and Empire. With the above observations in mind, we present the following suggestions as a guide for fertilization in 1979.

<u>Nitrogen (N)</u>: Most orchards had a large crop in 1979, there, fore, the trees may be low in available N for utilization this spring. We suggest higher rates than normal of N this year unless the trees were excessively vigorous in 1978 or were heavily pruned this past winter.

<u>Potassium (K)</u>: K was low in many orchards and even deficient in some in 1978, probably due to the demand for this element by the large crop, or because the dry weather reduced its availability.

The leaf scorch symptoms of K deficiency may be confused with the leaf margin burn from calcium chloride sprays. However, unlike leaf burn from calcium chloride sprays, the scorch of leaf margins due to K deficiency progresses from the older leaves to the younger leaves of current season shoots as the season advances. The scorch may turn gray in color and leaf fall may occur late in the growing season.

The K requirements of apple trees with a large crop are high because the fruit utilizes about 3 times as much K as N. Since the quantity of K stored by the tree is extremely small, it seems important to supply adequate K this spring on trees that had heavy fruit set in 1978.

The requirements of apple trees for K (expressed as K_2O), based on potential yields, are as follows: (a) less than 15 bu. 1.3 lbs./tree; (b) 15 to 25 bu: 1.3 to 2.7 lbs./tree; and (c) more than 25 bu: 2.7 to 4.3 lbs./tree. It is necessary, however, to maintain a balance among the essential nutrients for apple trees. For example, excessive levels of K can reduce both leaf and fruit Ca. <u>Therefore, we strongly urge that you participate in our leaf analysis program to more accurately determine the K needs of your apple trees</u>.

Calcium (Ca): The use of calcium chloride ($CaCl_2$) sprays to increase the flesh Ca content of our apples is rapidly becoming a standard practice in commercial orchards. Our suggestions for their use in 1979 are as follow:

Apply foliar sprays of $CaCl_2$ starting about 3 weeks after petal fall and repeat at 2-week intervals, totalling 6 or 8 applications. Apply 6 to 8 pounds $CaCl_2$/acre/spray until mid-July. After mid-July, apply 10 pounds/acre/spray. Use a technical grade $CaCl_2$ such as Allied Chemical Flakes, 77-80% $CaCl_2$. Other brands may be equally suitable.

Experience in Massachusetts has shown that $CaCl_2$ can be combined with pesticide sprays. However, there is limited evidence that the combination of Guthion (azinphosmethyl) 50 WP and $CaCl_2$ may increase foliar burn. Do not mix $CaCl_2$ and Solubor sprays. Always dissolve the $CaCl_2$ in a pail of water and add this last and when the spray tank is nearly full.

Foliar $CaCl_2$ sprays may be applied dilute (300 gallons/acre) or up to 6x concentration (50 gallons/acre). In our tests, flesh calcium has been increased more by 6x concentration than by dilute. In 1977 the effectiveness of foliar $CaCl_2$ sprays at 6x and 10x was compared on McIntosh. The concentrations were equally effective for increasing flesh calcium, and foliar burn was not excessive.

$CaCl_2$ sprays can cause burn of leaf margins. Foliar injury usually is more serious on McIntosh than on Delicious. If foliar injury occurs, do not apply again until 1 inch of rain falls. Foliar burn was more severe from dilute sprays than when applied at 6x at the Horticultural Research Center in 1976, but the opposite occurred in 1977. This appears to indicate that $CaCl_2$ injury varies with season because of such factors as rainfall and temperature.

Boron (B): B can be supplied to apple trees either by foliar or soil applications. Use the most economical and convenient method. However, it is safest to apply all elements as a fertilizer except in emergency situations.

Soil applications of boron should be applied to orchards every 3 years. The rate of application per tree vary with tree age and size. In low density orchards, apply 1/4 pound of borax (11.1% actual B) or its equivalent under young trees coming into bearing, 1/2 to 3/4 pound to medium age and size trees and 3/4 to 1 pound to large or mature trees. Be sure to note the percent actual B in the fertilizer being used to supply this element. B- containing fertilizers vary from approximately 11 to 21% actual B.

In medium and high density orchards (115 trees/acre or higher), it might be best to apply B on an acre basis. We suggest the following rates per acre of borax (11.1% actual B) or its equivalent: (a) trees 4 to 7 years of age - 12 lbs; (b) trees 8 to 15 years of age - 12 to 24 lbs; and (c) trees 16 to 30 years of age - 24 to 48 lbs.

When the soil application of B is followed by a wet spring, it may be advisable to apply 2 foliar applications of B the following year.

Many growers now rely on annual foliar applications of B. The usual practice is to add Solubor to the first 2 cover sprays. Fertilizer grades of borax may contain grit and should not be used in a sprayer. Mature trees should receive 4 pounds of Solubor per acre each year. Consequently, the goal is to apply about 2 pounds per acre in each of the 2 applications. For young orchards, the addition of 1/2 pound of Solubor per 100 gallons (dilute basis) to the first 2 cover sprays meets the B requirement of these trees. Reports of New York State indicate that sprays can be concentrated up to 8X with satisfactory results.

Leaf samples from orchards treated with Solubor have indicated adequate leaf boron levels but the fruit was deficient in this element. Whether or not B applied as a fertilizer more adequately meets the B requirement of apples than foliar-applied B is not known by us.

Manganese (Mn): Apple leaves from trees showing Mn deficiency in 1978 had 12 to 15 ppm of this element which is much below the desired levels of 30 to 60 ppm. Mn deficiency symptoms are characterized by interveinal fading of chlorophyll with the veins remaining green. For those who are unfamilar with the symptoms of Mn deficiency, we refer you to the photograph that appeared in the May-June 1978 issue of Fruit Notes.

Mn deficiency should be corrected on trees showing considerable foliage damage. Although we have no definite proof, Mn deficiency appeared to be associated with excessive fruit drop on a few trees in one orchard in 1977. Mn deficiency can be corrected by foliar applications of manganese sulfate or of a fungicide containing Mn. Apply manganese sulfate at about first cover at the rate of 3 lbs. per 100 gallons of water. If using a Mn-containing fungicide, 2 or 3 applications are necessary with timings about petal fall, first and second cover.

Zinc (Zn): Based on optimum levels of Zn established by Maine, some of our orchards continue to be low in this element. Dr. Warren Stiles, University of Maine suggests a dilute spray of Zn chelate (EDTA) at the rate of 1 to 2 lbs. per 100 gallons of water at tight cluster or first cover in orchards low in this element. He considers 25 to 50 ppm to be the optimum range for zinc in apple tree foliage.

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POMOLOGICAL PARAGRAPH

Deeper planting may reduce suckering from the rootstock on interstem trees. Dr. James Cummins, New York State Agricultural Experiment Station, Geneva, N.Y. is examining the interaction of interstem length and planting depth. The interstems vary from 10 to 25 cm (1 inch = 2.54 cm) in length and planting depths vary from 1 cm of the interstem being exposed above ground, to the entire interstem being exposed. The most significant results after 3 years are that the numbers of rootstock suckers increased directly with increasing length of interstem exposure, while length of interstem had little effect on numbers of suckers. [Editor's Note - Root suckers are troublesome in some plantings of interstems. Planting the trees with only the top 4 inches of the interstem being above ground may reduce suckering and should be a sufficient height to prevent scion rooting. Even if the tree settles 2 inches, 2 more inches of interstem are still above ground. It is easier to add soil or gravel around the trunk if the interstem is too high than it is to lift the tree if it is too low. Removal of soil from around a tree planted too deep results in "dishing" which allows water to collect near the trunk.]

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APPLE DISEASE INCIDENCE IN MASSACHUSETTS IN 1978

Ted R. Bardinelli,1/ Daniel R. Cooley,1/
and William J. Manning2/

Department of Plant Pathology

The apple plant pathology program in 1978 focused on disease surveys. Orchards in all parts of the state were evaluated periodically for disease incidence. The twenty orchards in the IPM program were the most intensively surveyed, particularly at harvest. Accumulated survey data will allow us to begin to determine the incidence and relative importance of the various apple diseases and will also allow us to examine new problems and re-examine existing ones.

The statewide disease survey showed the current status of diseases to be as follows:

1) Apple Scab:

Apple scab was not a serious problem in most orchards in 1978. Where scab was a problem, it was possible to trace back to reasons such as problems with sprayer calibration, problems with spray distribution, failure to apply fungicides at critical times, and other grower management problems. Some growers expressed concern that fungicide-resistant scab had developed in their orchards. We investigated these situations and found that fungicide-resistant scab was not the problem. To our knowledge, there is no fungicide-resistant scab in Massachusetts.

1/ Extension Technicians, and 2/ Associate Professor, Department Pathology, University of Massachusetts, Amherst, 01003.

2) Quince Rust:

Quince rust was unusually prevalent on Red Delicious fruits. We feel that this is due to late application of the first rust spray. The first application should be made when the pink stage is just beginning. Use of a broad-spectrum fungicide for both scab and rust might be a good idea in problem orchards.

3) Frog Eye Leaf Spot:

Frog eye leaf spot (foliar stage of black rot) was unusually prevalent on early-season leaves, especially on Cortland. Because of extensive early infections, most of these leaves fell off and little fruit or later leaf injury was noted.

4) Black Rot:

Black rot was not severe on fruit. In older, poorly pruned orchards, however, many major tree limbs were heavily cankered or killed back by the black rot fungus. A "Yellow Bark" syndrome was noted on the trunks of some apparently healthy trees in several parts of the state. The black rot fungus was isolated from "Yellow Bark" areas. We are currently investigating the relationship of the black rot fungus to "Yellow Bark" and the significance of "Yellow Bark" to tree health and vigor.

Poor Apple Growth Disease (PAGD):

We investigated six cases of PAGD in 1978. The problem with newly-planted trees either on old or new orchard sites that grow poorly and unevenly and when severely affected they may die. The cause of PAGD is unknown and we are examining possible causes under controlled conditions.

Cedar Apple Rust and Powdery Mildew:

Neither of these diseases was a problem this past season.

Fire Blight:

Scattered pockets of fire blight were noted, principally in Western Massachusetts. Mutsu and the Wayne were particularly susceptible.

Summer Fruit Problems:

Low level incidence of black rot, bitter rot, fly speck, and white rot were noted late in the season and at harvest.

The IPM survey involved 20 orchards in central and western Massachusetts. These were surveyed routinely throughout the season. Results for the full-season survey are given on the next page.

Table 1.Occurrence percent of disease incidence in random samples of apple foliage and fruits as calculated during early, mid and late growing season.

	Early	Mid	Late
Foliage			
Apple scab	1.2	4.5	4.0
Frog eye leaf spot	3.3	1.4	1.3
Cedar apple rust	0.7	<0.1	<0.1
Powdery mildew	<0.1	0.1	<0.1
Alternaria leaf spot	0.2	<0.1	<0.1
Totals	5.4	6.1	5.3
Fruit			
Apple scab	1.0	3.2	2.8
Black rot	0.0	<0.1	0.4
Totals	1.0	3.3	3.2

Apple scab and frog eye leaf spot were the major foliar diseases. Apple scab was the principal fruit disease.

A final fruit survey of 50,000 fruits was also performed just prior to harvest. The results given below show the total disease incidence of the fruits to be 2.8%. Apple scab again proved to be the most important disease affecting 2.3% of the fruits. Other fungal diseases such as black rot, bitter rot, white rot, and fly speck accounted for 0.223%. Calcium deficiencies were responsible for the remaining 0.312%.

Table 2. Average percent of fruits infected by disease at harvest.

Disease	Causal organism	% Incidence
Apple scab	*Venturia inaequalis*	2.3
Black rot	*Physalospora obtusa*	0.2
Bitter rot	*Glomerella cingulata*	0.1
White rot	*Botryosphaeria ribis*	0.1
Fly speck	*Microthyriella rubi*	0.1
Cork spot	Calcium deficiency	0.3
	Total fruit disease incidence	2.8

We will be continuing our surveys in 1979. Fruit growers that have disease problems that they would like to have surveyed or diagnosed, should contact Dr. William J. Manning in the Department of Plant Pathology or their Regional Extension Agent.

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University of Massachusetts
Amherst, Massachusetts
R. S. Whaley
Director
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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 44 (No. 3)
MAY/JUNE 1979

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INFLUENCE OF TRAINING ON GROWTH OF NEWLY-PLANTED APPLE TREES

William J. Lord
Department of Plant and Soil Sciences

Recommendations for training 1-year-old whips the year of planting have always varied. A pruning bulletin published by the University of Massachusetts in the 1950's, when trees on seedling roots were being heavily planted, suggested that trees planted early in the spring on good soil required no heading. Other publications suggested that trees should be shortened to a height of 30 inches at planting to cause branch development down to within 18 inches of the ground. At least one publication stated that heading height at planting was relatively unimportant, the important thing being that trees grow well during the first growing season.

The more current pruning publications, which include suggestions for training trees on the more vigorous of the size-controlling rootstocks, frequently suggest heading heights of 24 to 30 inches and removal of growth closer than within 18 to 20 inches to the ground. It is now common to find growers heading trees at 24 to 30 inches at planting regardless of variety or whether it is a spur or non-spur type tree. Therefore, we became interested in the influence of training on growth of newly-planted apple trees.

Heading Height

Our studies show (Table 1) that shorter trees produce fewer lateral shoots and spurs but shoot length may be longer in some instances.

Table 1. Effects of Heading Height on Growth of Newly-Planted Apple Trees, 1977.

Heading height	Length of leader	No. of laterals: Spurs and shoots	Shoots[z]	Avg. length of shoots	Total Growth
(in.)	(in.)			(in.)	(in.)
		Marshall McIntosh/M7A			
36	13b[y]	10a	5b	7a	51a
30	17a	7b	6a	8a	57a
		Redspur Delicious/M7A			
36	11a	7a	3a	7b	34a
30	13a	4b	3a	9a	39a
		Redspur Delicious/MM111			
39	11b	10a	6a	7b	44a
36	12ab	9a	5a	7b	48a
30	14a	7b	3a	9a	54a

[z] Lateral growth more than 2 inches in length.

[y] Values not followed by a common letter are significantly different at the 5% level.

Heading height did not influence the number of lateral shoots or the total growth (Table 1) or trunk circumference increase (data not shown). The influence of heading height on length of leader was not consistent.

Although the data in Table 1 shows that heading height was not critical in regard to total growth, there are other aspects of tree response to consider. We presently prefer that branches of apple trees be symmetrically arranged around the vertical axis of the central leader tree and be spaced far enough apart to avoid limb crowding when the trees become larger. In contrast, some fruit growing areas prefer having tiers of branches. Regardless, heading a tree low, for example to 24 inches, can limit the number of permanent lateral branches selected the first growing season to 2 or 3 if vertical spacings of 4 to 6 inches are desired. Furthermore, a whorl of closely-spaced shoots may develop on trees headed at 24 inches which compete with the leader unless some are removed and/or spread horizontally with a mechanical device such as wooden, snap clothespins.

We found in 1977 that the lateral shoots on Marshall McIntosh and Redspur Delicious were more widely spaced on trees headed at 36 inches than those cut at 30 inches at planting. The wider vertical spacing could aid in selection of shoots because of our preference of having trees with branches symmetrically arranged around the vertical axis of the central leader, and with vertical spacings of 4 to 6 inches.

Spur-type strains of McIntosh and Delicious tend to produce short lateral growth the year of planting except directly behind the heading cut, particularly Delicious. In some apple growing areas heading heights of 24 inches are considered necessary on spur-type trees that are to be grown free-standing, to insure the development of the first tier of scaffold limbs within the desired location on the tree. Spur-type trees headed at 36 inches, under our conditions, generally produce short lateral shoots the year of planting but this higher heading height presents the opportunity to select more widely-spaced shoots. Furthermore, we have observed that spur-strains headed at this height will produce a good framework of branches during the 2nd and 3rd growing seasons even though the growth was poor the year of planting (Figure 1).

Figure 1. One of the Redspur Delicious/ MM111 trees used in our heading height study. The tree was headed at 36" at planting in 1977. Photograph taken in December, 1978.

However, this may not occur in apple growing regions where spur-type trees are very precocious. Fruiting tends to restrict vegetative growth and will complicate the process of developing framework branches on spur-type strains and/or weaker-growing varieties.

Removal of Low Lateral Shoots

Early vegetative growth of newly-planted trees is made largely from carbohydrate reserves in the woody tissue (the same is true of older trees). Later in the growing season the carbohydrates formed by photosynthetic activity are translocated and stored in the roots and bark for growth next season.

We found in 1977 that growth produced within the vertical distances of 14.5 and 19 inches from ground level on Marshall McIntosh and Macoun trees added considerably to the total shoot growth of the tree, particularly on Marshall McIntosh which produced 2.4 shoots longer than 2 inches within this vertical distance in comparison to only 0.78 shoots on Macoun. Low heading at planting combined with removal of growth within 18 to 20 inches of the ground could produce trees, with little total leaf surface. Leaving low branches until it becomes necessary to remove them could contribute substantially to total growth and carbohydrate reserves for growth the following season. Less distance between the first limb and the ground can be allowed on varieties like Delicious without interferring with mowing and weed control practices because they have an upright growing habit than on varieties like Cortland which have spreading type growth. Limbs on Cortland within 24 inches of the ground begin to give trouble when the trees commence bearing.

Recommendations

Tree growth will vary considerably the year of planting regardless of heading height. Vigorous growth is the first and most important step towards the development of well-shaped trees. Good stock in dormant condition, early planting, and favorable soil conditions are as fundamental as training. Adjust severity of heading at planting time to the conditions of tree, soil, and season under which planting is done. Under average or better conditions heading at 36 inches on 1-year-old whips should produce satisfactory growth on both spur-type and standard strains. If shoots originating lower than 18 inches above ground level do not interfere with cultural practices, leave them. The leaves on these shoots can contribute to tree growth.

Well-branched (feathered) 1-year-old trees are highly desirable. When planting this type of tree, remove only broken branches and remove or restrict shoots with no potential for being a permanent scaffold limb. Head it at approximately 39 inches.

Promalin Studies in 1978 and Comments on Trial Use in 1979

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Promalin* is a plant growth regulator containing gibberellin A_{4-7} and a cytokinin, 6-benzyladenine, in equal amounts. Its primary use at this time is to increase the length ($^L/D$ ratio or typiness)[1] of Delicious apples, thereby making them more attractive to the consumer.

Last year we discussed factors affecting shape of apples and our preliminary studies with Promalin (Fruit Notes 43 (3): 4-7). In this article we report our 1978 findings with Promalin and include comments to consider when using it in 1979.

1978 Studies

Coverage Growth regulators commonly used in fruit production have limited translocation from the site of contact with the plant. The data in Table 1 indicate that the absorption and/or translocation of Promalin also may be limited.

Table 1. The effect of site of Promalin application to 'Richared Delicious' apple flowers on the $^L/D$ ratios of the fruits that developed from these flowers.

Treatment and microliters of solution applied[z]	$^L/D$ Ratio
Check	.93c[y]
Petals, 25[x]	.94c
Petals, 150	.99b
Receptacle surface, 25	1.03a
In calyx end, 25	1.03a

[z] Solution contained 50 ppm Promalin plus 0.05% X-77.

[y] Numbers in a column followed by different letters are significantly different at odds of 19 to 1.

[x] A 25 microliter droplet was large enough to wet the receptacle surface with no runoff.

*Tradename

[1] The higher the $^L/D$ ratio (length/diameter ratio) the longer the apple. A "typey" Delicious will have an $^L/D$ ratio of 1.00 or greater.

When a 25 microliter droplet of Promalin was placed either in the calyx end of the flower or on the receptacle, fruits with large L/D ratios were harvested (Table 1). The same amount of Promalin applied on the petals of a flower produced no response. However, when the amount of Promalin applied to the petals was increased 6-fold, fruit elongation occurred. Nevertheless, 150 microliters of Promalin applied on the petals was not as effective for increasing the L/D ratios of the fruits as 25 microliters of Promalin placed on its receptacle. Therefore, it appears that Promalin must come in contact with the flower parts that are incorporated into the final structure of the apple to be most effective.

Surfactants and Adjusting pH of Spray Solution

In general, we do not recommend the use of surfactants with growth regulators. Many formulated growth regulators (e.g. Alar-85, Fruitone N, etc.) already contain a surfactant. It doubtful that the addition of another surfactant to the spray mixture would be of substantial benefit. In contrast, the Promalin formulation contains no surfactant. Last year we reported that glyodin and Triton B-1956 (both products that increase wetting) enhanced the response of 'Delicious' fruits to Promalin

Table 2. The effects of surfactants and pH modification on the performance of Promalin applied to 'Royal Red Delicious,' Shelburne, MA., 1978.

Treatment[z]	Fruit per cm limb circ.	L/D ratio	Fruit weight (g)
Check	7.1a[y]	.95c	154abc
Promalin	6.0ab	1.00b	142b
Promalin + Sorba (Mg) + Glyodin	4.9bc	1.04a	146bc
Promalin + Sorba (Mg) + Biofilm	4.8bc	1.03a	156ab
Promalin + Buffer-X	4.1c	1.02ab	161a

[z]1 pt of each chemical was used per 100 gal. of water. Treatments applied at a rate of 125 gal/acre at petal fall of the king blossom.

[y]Numbers in a column followed by different letters are significantly different at odds of 19 to 1.

In 1978 trials we made the Promalin solution more acid (to pH 4.0) with Sorba-Mg[2], and added glyodin or Biofilm (a surfactant). These spray mixtures, with the pH adjusted were more effective in increasing the L/D ratio of the fruits than Promalin applied alone (Table 2). The mixture containing Promalin and Buffer-X (contains a surfactant and lowers spray pH) produced fruit elongation comparable to Promalin

[1]A commercial nutrient spray.

alone. Thus we have demonstrated in both 1976 and 1978 that certain surfactants may increase the effectiveness of Promalin and adjustment of the solution pH appeared to be of additional benefit. Since Promalin is a rather expensive product, we feel that the addition of a surfactant to the Promalin spray may allow growers to apply less Promalin per acre or get an enhanced response from that which would normally be applied.

Other Observations Warm weather prevailed during the bloom period in 1978. Fruit elongation with an enlargement of the calyx end was apparent 3-4 days after Promalin application. It is not necessary to wait until harvest to determine if Promalin caused increased fruit length in your orchard. Calyx elongation and enlargement is perhaps most pronounced 1-2 weeks after Promalin application.

The L/D ratio of fruits will vary considerably on a tree. This is due to the location of the fruit on the tree and their origin within the blossom cluster. The L/D ratio distribution of fruits from untreated and Promalin-treated trees is similar (Figure 1).

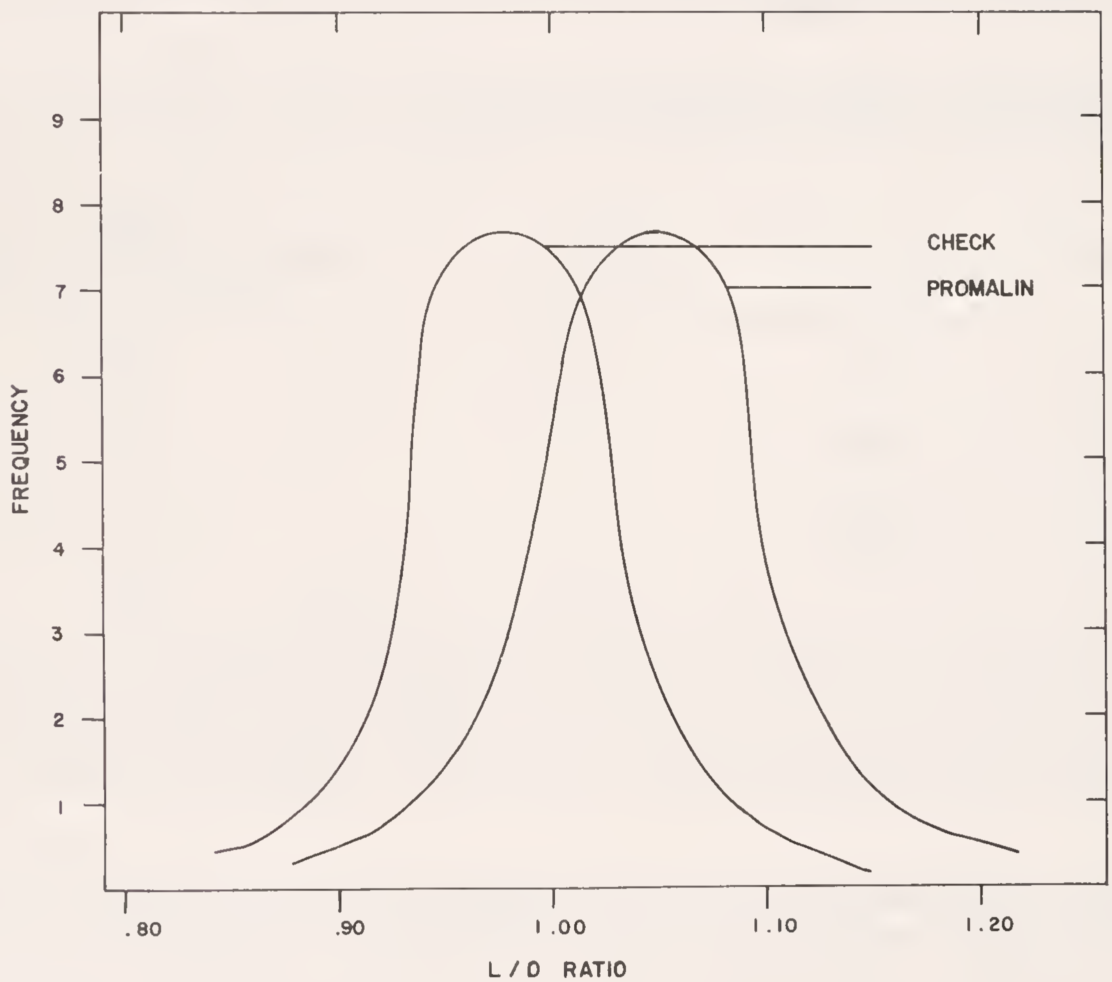

Figure 1. The L/D ratio distribution of fruits from Promalin-treated trees and control trees.

This indicates that a Promalin application increases the L/D ratio of all fruits on the tree equally. Therefore, a grower can expect to find some rather flat-looking Delicious on Promalin-treated trees at harvest time although there should be fewer than on check trees.

Delicious is not the only cultivar that can be elongated with Promalin. If pollenizers are located within the rows of Delicious being sprayed you can expect elongation of these fruit also. Increased length of such cultivars as McIntosh and Cortland in most cases would not be desirable. Therefore, when applying Promalin attempts should be made to avoid spraying pollenizer trees where increased calyx-end length is not wanted.

We observed that the typiness of Delicious was improved remarkably by Promalin throughout Massachusetts in 1978. A response of this magnitude has not occurred every year. It was noted this year that Promalin induced other responses in addition to elongating fruit. Promalin caused thinning on 20-year-old Royal Red Delicious when adjuvenants and a buffering agent were included with the Promalin (Table 2). It is estimated that the crop was reduced slightly below the load considered to be ideal. Promalin does thin young Delicious trees much more severely than mature trees. Seed number and fruit diameter were reduced by Promalin in some experiments but these parameters were unaffected in others. No fruit weight increases have been observed in our tests even though they have been shown to occur in other parts of the country. Increased bitter pit and cork spot were observed this year for the first time when excessive rates of Promalin were used. We do not feel that this is a problem that will be encountered under normal circumstances. However, since Promalin did increase bitter pit and cork spot, in situations where low fruit Ca levels may occur, the use of this plant growth regulator may aggravate the problem.

Comments on Trial Use in 1979

We do not discourage the use of Promalin. However, we do encourage growers to proceed cautiously and apply Promalin to only a portion of their Delicious trees. As a grower gains more experience with Promalin applied at his location, on his trees, and in his sprayer, and is convinced the response is good and the side affects minimal, then, is the time to move ahead and apply it on a larger portion of his Delicious trees.

It is not possible to effectively evaluate the Promalin response (or the response of any other growth regulator) at your orchard without leaving some trees unsprayed. We suggest that 3 or 4 representative trees should be clearly tagged and left unsprayed at 2 or 3 different locations in your orchard. This should provide a valid and unbiased basis for evaluating the effect of Promalin in your orchard.

We offer below some comments for your consideration when applying Promalin in 1979.

1. Use 1 pint of Promalin per 100 gallons of spray solution. Apply 125 to 150 gallons of spray per acre.

2. Apply at king blossom to full bloom. If the temperature is not expected to rise above 50°F and warmer weather is predicted within a day or two, delay the application until the first warm day.

3. If the temperature at the time of application is below 60°F, add 1 pint of Glyodin per 100 gallons of Promalin spray mixture. Other surfactants may be equally effective.

4. Good coverage is important. Calibrate your sprayer and apply Promalin uniformly throughout the tree.

5. We urge caution if planning to chemically thin trees sprayed with Promalin. Promalin can thin. We do not know if excessive thinning can occur should Promalin and chemical thinners be used the same year.

6. Do not apply Promalin on young trees because thinning may occur. Perhaps a good rule-of-thumb is not to apply this chemical on any trees until it is bearing heavily enough to consider chemical thinning.

7. Do not apply Promalin in combination with other pesticides or growth regulators.

HARVESTING EARLY RIPENING APPLE CULTIVARS

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We have observed a tendency of some growers to advance the picking date for many of the early ripening cultivars. In recent years we have seen Julyred, Vista Bella and Quinte picked in mid-July and Paulared in mid-August. Fruit picked too early are often lacking in color, size and in flavor.

Based on observations at the Horticultural Research Station, I would recommend picking Vista Bella during the last week of August and Julyred and Quinte a few days later. Paulared has had better flavor and keeping quality when picked in late August or early September.

CHEMICAL THINNING OF APPLES IN 1979

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When weather conditions during bloom are favorable for bee activity, many apple varieties will overset if they have an abundance of blossoms. In such instances, chemical thinning with naphthaleneacetic acid (NAA), naphthaleneacetamide (NAAm) or carbaryl (Sevin) avoids a tendency toward biennial bearing and also helps increase fruit size and color. It involves some risk since the exact degree of thinning cannot be accurately predicted in advance. Furthermore, it is realized that attempts to determine the time of application of the chemical thinning sprays on the basis of days after petal fall (PF) is not entirely satisfactory. Prevailing temperatures play a primary role in the rate of young foliage and fruit development. If the temperatures are cooler than usual after PF, the time of application should be delayed beyond the suggested treatment period or vice versa if warmer than average temperatures prevail.

Weather conditions before and when applying NAA and NAAm are important. If weather conditions are cool and cloudy or rainy a week or two before spraying, the leaves developing during this time will have a very thin cuticle. Under these conditions, NAA or NAAm would penetrate into the leaf more easily and overthinning may occur. On the other hand, warm, dry, sunny conditions prior to spraying would result in a leaf having a thick cuticle that would impede the movement of NAA or NAAm into the leaf. In this case, the concentration used may have to be increased to obtain adequate thinning. Weather conditions before or after application may not greatly affect the thinning action of carbaryl since the fruit is its primary absorption site rather than the leaves as in the case of NAA or NAAm. Light frost which may not injure flowers or young fruits may injure the foliage and the use of NAA or NAAm at this time may cause overthinning and increased foliage injury. Therefore, delay treatment for several days after such occurrences and reduce the spray concentration and gallonage per tree is thinning still seems necessary.

In 1978, McIntosh blossomed quite heavily in Massachusetts and in many cases were not thinned sufficiently to produce as many fruits of good marketable size as desired. Consequently, it would not be surprising if the bloom on such trees in 1979 was only light to moderate and not require much chemical thinning. A grower should carefully observe the fruit set in his McIntosh blocks 7-14 days after petal-fall (PF) and be reasonably certain that chemical thinning of McIntosh is necessary on the lighter blooming older trees. It should be remembered, however, that trees with a light to moderate bloom may occasionally overset and be more difficult to chemically thin than trees which blossom and set heavily.

The use of Promalin at full bloom (FB) to improve the "typiness" of'Delicious' (increase the length to diameter ratio of the fruit) has been found by Dr. Duane Greene and others to be capable of thinning this variety and its strains. The use of a chemical thinner such as carbaryl (Sevin) following an application of Promalin, might result in overthinning, excessive fruit size and a severe yield reduction. 'Delicious' requires freedom from frost damage and ideal crop pollination conditions for good commercial yields. It is not desirable to apply a chemical thinner (carbaryl) or Promalin (which has the potential to reduce fruit set) on young 'Delicious' which invariably set light crops. In blocks of older 'Delicious' trees having a history of oversetting the use of Promalin at FB may be entirely satisfactory but the use of carbaryl for thinning should be delayed for at least 14 days after PF so that the need for additional chemical thinning can be reasonably well determined. If a Promalin treatment at FB or adverse weather conditions have already limited the initial fruit set there may be no need to reduce the set further with a post petal-fall application of carbaryl. 'Delicious' apples are too valuable for such risks.

NAA or NAAm thinning sprays applied when the temperature is less than 65°F, are usually less effective. Temperatures of 70-75°F are necessary for optimum results. When temperatures rise above 85°F, there is a rather sharp increase in NAA or NAAm penetration. If the high temperatures are accompanied by humid conditions that prevent spray droplets from drying rapidly, overthinning may result. In this case, the concentration of the thinning spray should be reduced. Once the foliage has dried after application of these materials, do not respray if rain occurs shortly thereafter.

NAA or NAAm are best used alone in dilute form. NAA will often cause more foliage injury and thin more than NAAm or carbaryl. Carbaryl is the least injurious to foliage. Mixing a wetting agent with the thinning chemicals may sometimes increase thinning but invariably increases foliage injury so the addition of a wetting agent is not suggested.

Since the best day to apply a treatment cannot be accurately determined in advance, it may be wise to spray a different fraction of the more valuable mid- and late-season varieties at 3 or 4 day intervals during the suggested period. An occasional grower may delay his decision to thin until 3 weeks or more after PF. Applying NAAm or NAA later than 3-4 weeks after PF may result in no thinning and reduced fruit size since these compounds have some temporary fruit size inhibiting action. Carbaryl is usually ineffect- after about 21 days from PF.

Most commercial formulations of NAA contain 1.0 gram of NAA per oz. (a few may have 2 grams per oz.). A material containing 1.0 gram per oz. will yield a 10 ppm concentration when 4 oz. per 100 gallons are used. Four oz. of NAAm per 100 gallons will give a concentration of 25 ppm. It is assumed that the carbaryl (Sevin) used is a 50% wettable solution.

A 0.2% dust of NAA is available for chemical thinning. The dusts should be applied dry on dry foliage under good drying conditions to reduce the possibility of foliage injury and overthinning. When applied under such conditions, NAA dusts are often less injurious to foliage and may reduce fruit set less than comparable NAA sprays.

Young trees generally require less thinning than older trees. If treatment seems necessary, it may be desirable to use the lowest suggested concentration of the chemical thinner, or even reduce this amount by 1/2 to 1/4.

Early fruiting on the leader of young trees can seriously affect the shape of the tree. To reduce fruit load until the tree has reached sufficient size to hold a crop of apples, chemically thin at PF with carbaryl, 1 lb. plus 15 ppm NAA.

<u>Our suggestions for use of chemical thinners on several apple varieties are included in the chart on the following page</u>.

GROWTH REGULATOR SPRAY FOR GROWTH SUPPRESSION ON APPLE TREES

Duane Greene and William J. Lord
Department of Plant and Soil Sciences

Frequently there are blocks of young, non-bearing trees particularly Delicious that are growing too vigorously because of lack of fruitfulness and occasionally bearing trees will lose their crop because of frost at bloom. In these instances, restriction of tree growth would be beneficial. To restrict growth, we suggest the following combination spray of ethephon <u>plus</u> Alar-85*

<u>Young, non-spur trees</u>. Apply 500 ppm ethephon (1-2/3 pints) <u>plus</u> 1500 ppm Alar-85* (1-1/2 lbs.) in 100 gallons of water 10 to 14 days after full bloom or when shoots are 4 to 6 inches long.

<u>Young spur trees or older trees with no crop</u>. These trees are more sensitive to a growth regulator spray than young non-spur trees. Therefore, apply 300 ppm ethephon (1 pint) plus 1500 ppm Alar-85* (1-1/2 lbs.) in 100 gallons of water 10 to 14 days after full bloom or when shoots are 4 to 6 inches long.

In addition to growth restriction, these growth regulators generally increase bloom the year following their use. Increased bloom probably will of of no value on bearing trees that lost their crop due to frost because bloom should be adequate the following year without the use of these growth regulators. However, it may be more difficult to obtain adequate thinning the year following their use because of excessive bloom. Additional bloom because of growth regulators use could be of value on the young, vigorous trees but unfortunately fruit set may not be increased on Delicious.

We suggest that the ethephon plus Alar-85* spray not be applied on young trees until they are large enough to bear a crop.

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*Trade Name

SUGGESTIONS ON USE OF CHEMICAL THINNERS ON SEVERAL APPLE VARIETIES

Variety	Materials & Rate	Timing (days after petal-fall, [PF])	
Duchess Lodi Melba Quinte Yellow Transparent	NAAm, 35-50 ppm	Late bloom to PF	Federal regulations require that NAAm concentration must not exceed 50 ppm or 85 grams per acre as a single spray applied no later than 2.5 weeks after bloom. For greater thinning, use NAAm, 35-50 ppm plus carbaryl, 1 lb. at PF.
Gravenstein Red Astrachan	NAA, 10 ppm or NAAm, 25-50 ppm	Late bloom to PF	Federal regulations require that NAA concentration must not exceed 20 ppm or 35 grams per acre.
Puritan	carbaryl (Sevin*) 1/2-1 lb.	0-10	Remove bees before using carbaryl at PF.
Early McIntosh Wealthy	carbaryl, 1 lb. plus 10-15 ppm NAA or carbaryl, 1 lb. plus 25-50 ppm NAAm.	7-10	Some growers may wish to apply 1 lb. active carbaryl or 50 ppm NAAm at PF, then follow with 20 ppm NAA 10-14 days later.
Milton	NAA, 10-15 ppm or NAAm, 25-50 ppm	7-14	
Cortland Empire Macoun McIntosh Paulared Rome	carbaryl, 1/2-1 lb. or NAA, 5-10 ppm or NAAm, 25-50 ppm	7-14	Carbaryl and NAAm are less likely to overthin than NAA. Carbaryl not very effective on Macoun. Also, Macoun may be thinned more effectively by a PF application.
Delicious & strains Idared	carbaryl, 1/2-1 lb.	7-14	Carbaryl is the best material available for Delicious. NAAm and NAA may result in the persistence of some "pigmy" fruit. Promalin at full bloom may reduce fruit set and make the use of carbaryl for thinning unnecessary.
Baldwin Spartan	NAA, 10-20 ppm or NAAm 50 ppm or carbaryl, 1 lb.	7-14	Carbaryl may not be very effective on these varieties.
Golden Delicious	NAA, 15-20 ppm	7-14	NAAm or carbaryl may not thin this variety adequately.

*50% wettable powder.

ALTERNATE vs. EVERY MIDDLE SPRAYING FOR APPLE PESTS IN 1978

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Departments of Entomology and Plant Pathology

Earlier, we reported our 1977 findings on the comparative effectiveness of alternate middle vs. every middle spray treatments in 3 commercial apple orchards (See Fruit Notes 43 (3): 15-19). Here, we report on our 1978 findings in 4 commercial orchards.

The alternate middle treatment involves spraying alternate halves of each tree on alternate spray dates instead of both halves on all spray dates. For example, in applying the first cover spray, the sprayer would be driven up the middle between tree rows A and B and return down the middle between rows C and D, skipping the middle between rows B and C. For the second cover spray, the sprayer would be driven up the middle between rows B and C, down the middle between rows D and E, and so forth. If this pattern were followed with every spray application, it would save 50% of the spray material costs.

Each of our 4 test blocks was divided into 2 plots of 2-6 acres each. One plot received the alternate middle program on each spray date from pink (or petal fall) through last cover. The other received the every middle program. Each grower used an air blast sprayer at 4X. He followed his normal spray schedule, and used his own selection of pesticides. Except in one block, all trees were full grown - some on M7 rootstock, others on standard. The centers of the trees were fairly well pruned in all blocks.

To determine the extent of insect pest pressure, we hung traps in each plot for monitoring tarnished plant bug, European apple sawfly, apple maggot, codling moth, redbanded leafroller, and oblique banded leafroller adults (see Fruit Notes 44 (2): 1-2 for information on construction of these traps). We caught the following average numbers per trap:

Pest	Every middle plots	Alternate middle plots
Plant Bug	5.8	3.3
Sawfly	1.3	2.5
Apple maggot	2.3	0.8
Codling moth	33.0	39.0
Redbanded	50.8	58.8
Oblique banded	2.3	1.8

These results show that pest pressure from tarnished plant bug, apple maggot, and oblique banded leafroller was greater in the every middle plots, while pressure from sawfly, codling moth, and redbanded leafroller was greater in the alternate middle plots.

To determine the amount of fruit injury caused by these and other insect and disease pests, we examined at harvest 100 fruits per tree from 18 trees in each plot. To determine spider mite and aphid abundance on leaves, we examined 45 leaves per tree on 6 trees in each plot every 3 weeks from April until harvest. The following were the results:

Avg. % leaves infested with:	Every middle plots	Alternate middle plots
Spider mites	6.1	1.5
Aphids	3.8	6.5
Avg. % fruit injured by:		
Plant bug	0.99	0.71
Sawfly	0.31	0.43
Apple maggot	0.02	0.04
Plum curculio	0.03	0.06
Fruitworm	0.08	0.14
Codling moth	0.02	0
Leafrollers	0.05	0
Other insects	0	0
Total insect	1.50	1.38
Apple scab	0.73	1.61
Black rot	0.21	0.19
Other diseases	0.23	0.20
Total disease	1.17	2.00
Grand total	2.67	3.38

The results show that for all blocks combined, an average of 1.50% of harvested fruits in the every middle plots vs. 1.38% in the alternate middle plots was injured by insects. Thus, even with slightly higher pest pressure from sawfly, codling moth, and oblique banded leafroller, the alternate middle plots averaged slightly less total insect injury to fruits.

The results also show that an average of 1.17% of harvested fruits in the every middle plots vs. 2.00% in the alternate middle plots was injured by disease. This difference was due largely to one incidence wherein a grower failed to apply a needed spray for apple scab, and suffered 5.67% fruit scab in the alternate middle plot vs. 2.83% in the every middle plot. This suggests that proper timing of fungicide sprays is very important to the success of an alternate middle program.

The following is the cost-benefit analysis of the every vs. alternate middle treatments:

	Dollar costs/acre		
	Every middle plots	Alternate middle plots	Difference
Insecticide, miticide, and fungicide spray materials	191.56	95.78	-95.78
Labor (3.50/hr.)	12.25	6.13	-6.12
Fuel, etc.	5.50	2.75	-2.75
Value of fruit loss owing to insect and disease injury	67.29	82.39	+15.10
Cost reduction due to alternate middle spraying			-89.55

This analysis shows that the decreased amount of pesticide applied, combined with consequent lower cost of fuel and labor for application of pesticides, even with a slightly greater total percentage of injured fruits at harvest (3.38% in the alternate middle vs. 2.67% in the every middle plots) resulted in an overall net benefit (savings) of $89.55 per acre in the alternate middle compared with every middle plots.

In summary, our findings to date show that the alternate middle spray program can result in greatly reduced pesticide usage, effective pest control, and a greater net profit to the grower. For those growers interested in trying out the program, we would suggest starting with a one or two-acre block to see how the program works with your particular type of sprayer and trees, and under your particular local insect, mite, and disease conditions. We would advise against submitting large acreage to this program until you (and we) learn more about the program's long-term effectiveness and possible shortcomings. Present knowledge suggests that the program works best where the trees are well pruned (open centers) and spaced at recommended intervals (not wider).

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All pesticides listed in this publication are registered and cleared for suggested uses according to Federal registrations and State Laws and regulations in effect on the date of this publication.

When trade names are used for identification, no product endorsement is implied, nor is discrimination intended against similar materials.

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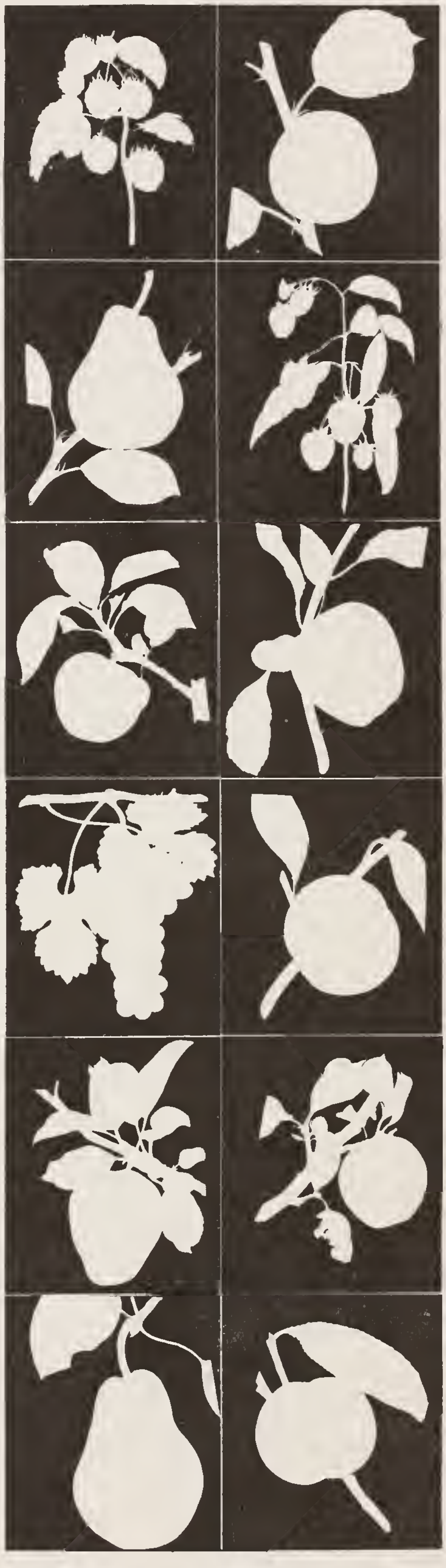

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 44 (No. 4)
JULY / AUGUST 1979

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BROWN-LINE DECLINE OF APPLE

Daniel R. Cooley,[1] Ted R. Bardinelli,[1]
and William J. Manning[2]
Department of Plant Pathology

A new disease of young apple trees has become evident in the Northeast in recent years. The disease is called brown-line or graft union necrosis. Isolated trees in young plantings decline suddenly, may appear to be girdled, and can be snapped off at the point of union between scion and rootstock. A distinct brown-line is evident at the point of graft union.

Researchers in New York State were able to determine that the problem occurs most often when MM106 is used as a rootstock and that it often originates in the nursery. Tomato ringspot virus (TmRSV) was isolated from diseased trees. The dagger nematode, *Xiphenema americanum*, was also associated with the problem. TmRSV and the dagger nematode together appear to cause brown-line decline. TmRSV is found in many plants including raspberry, grape, elderberry, florist's geranium, and many common weeds such as dandelion, chickweed and plantains. The dagger nematode feeds on the roots of infected plants and carries virus particles to clean non-infected roots, where new virus infections are initiated.

Rootstocks and cultivars differ in their sensitivity to TmRSV. Some are tolerant and can carry the virus without showing symptoms or decline. Sensitive plants decline and die over a prolonged period. Hypersensitive plants respond to TmRSV infections by rapid destruction of cells near the point of infection. This prevents the virus from spreading further into the plant.

Dr. James Cummins (Cornell University) believes that union necrosis results when a tolerant rootstock and a hypersensitive scion become infected with TmRSV. MM.106 is highly tolerant to TmRSV and is usually symptomless. A number of apple cultivars, particularly Red Delicious, are hypersensitive to TmRSV. When the virus from the rootstock comes in contact with the hypersensitive scion, the scion reacts by killing its cells at the graft union. The result is a brown line at the graft union which prevents water and nutrient translocation into the scion. The scion dies and is easily broken off at the graft union.

Cummins has rated a number of apple cultivars for brown-line sensitivity and rate of decline when grown on MM.106. Some show

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rapid decline, some slow decline and others no decline at all. His rating is as follows:

Rapid decline	Slow decline	None
Jerseymac	Idared	Cortland
Quinte	McIntosh	Empire
Red Delicious	Spartan	Golden Delicious
Rhode Island Greening	Stayman	Rome Beauty
Tydeman's Red		York Imperial

Those in the slow decline group may show increased susceptibility to other diseases. Stress caused by TmRSV may be a factor in predisposing trees to collar rot, caused by the fungus *Phytophthora cactorum*.

A detection system for TmRSV has been developed, which can be used to detect the virus before brown-line develops. The test takes a day to complete and is useful as an advanced warning of potential problems.

Inarch grafting is one possible way to prolong the life of trees with brown-line decline. Wood from a rootstock other than MM.106 can be used to supply the aerial portions of the tree with nutrients and water.

Nurseries have made considerable efforts to eliminate TmRSV, principally by means of soil fumigation to eliminate the dagger nematode. Proper site preparation by growers is also very helpful. Elimination of weeds and fallowing a year before planting will help to reduce nematodes in new orchard sites.

Note to Massachusetts Fruit Growers:

If you suspect that you have a brown-line decline problem, please contact Dr. William J. Manning, Department of Plant Pathology, University of Massachusetts, Amherst, 01003.

POOR APPLE GROWTH DISEASE IN MASSACHUSETTS

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and Ted R. Bardinelli[2]

Department of Plant Pathology

Poor Apple Growth Disease (PAGD) is a new name for an old problem. It refers to poor growth or even death of newly-planted trees, whether planted in old orchard sites or in new orchard sites (especially those formerly in woodland). Scattered trees, or trees in small areas may make little growth and die during the first season. Adjacent trees may be vigorous and healthy. When new trees do not die, they differ in both size and vigor.

The exact cause of PAGD is unknown. It is probably due to a combination of factors, both biological and physical. It is well-known that poorly-drained locations, and those high in organic matter, especially the remains of old apple root systems, are especially subject to PAGD. Certain rootstocks, notably MM106, are also more susceptible to PAGD. A number of nematodes also contribute to PAGD.

A team of scientists at the East Malling Research Station in England feel that PAGD there is caused by the common soilborne fungus <u>Pythium</u>. <u>Pythium</u> does well in cool moist or wet soils that are high in organic matter. Dr. Geoffrey Sewell, of EMRS, feels that <u>Pythium</u> produces a toxic exudate in soil. This inhibits root hair growth and function and this in turn affects the growth and extension of root tips. Growth of affected trees is considerably reduced.

We investigated PAGD in 6 new orchards in Massachusetts last year. Red Delicious, Jerseymac and McIntosh on M.7A, MM.111, M.26, and MM.106 rootstocks were involved. The trees came from different nurseries in different parts of the country. We brought typical PAGD trees as well as soil from around their roots back to the laboratory and greenhouse. In the laboratory, we isolated the following potential root disease fungi: <u>Cylindrocarpon</u>, <u>Cylindrocladium</u>, <u>Fusarium</u>, <u>Pythium</u>, <u>Rhizoctonia</u>, and <u>Verticillium</u>. These are being used in the greenhouse to determine whether or not they can cause PAGD in apple rootstocks. Apple rootstocks have been planted in these soil samples in the greenhouse to allow us to follow PAGD under controlled conditions.

We do not know what causes PAGD in Massachusetts. We plan to continue our laboratory and greenhouse investigations and to begin field studies in 1979.

<u>Note to Massachusetts Fruit Growers</u>: If you have suspected PAGD problems, please contact Dr. William J. Manning, Department of Plant Pathology, University of Massachusetts, Amherst, 01003.

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COATING THE TRUNKS OF FRUIT TREES TO REDUCE WINTER INJURY

William J. Lord
Department of Plant and Soil Sciences

Growers apply white latex paint to trunks of fruit trees to help prevent winter injury. An application to the south side of trunks and to the base of lower scaffold limbs reduces the amount of heat absorbed by the bark, lessens bark-splitting, and reduces winter injury to crotches of painted branches.

Use only latex water soluble paint. Do not use oil or lead base paints soluble in paint thinner or turpentine. We have found that Glidden 3600 and Kyanize Flat White Latex Paint No.2000, which are available in Massachusetts are safe to use. However, most high quality exterior latex paints are probably suitable. Nevertheless, they should be tested on a few trees before extensive use because some paints can be toxic, particularly to young peach trees, causing discoloration and cracking of bark and later, gummosis.

The latex paint may be used either without dilution or as 50% dilution with water. It may be applied using a car wash mitt with a rubber glove insert, a paint roller, paint brush, or a compressed sprayer (if diluted). When wearing a car washing mitt, dip your hand into the paint and rub the mitt on the bark. When painting the lower scaffold limbs apply the latex in the crotches and out on the limbs for a distance of 6 to 10 inches

Whitewash may also be used to coat tree trunks and branches. It is more economical than latex and can be applied as a spray. However, the durability of whitewash will be less than latex although some formulations of white wash are more durable than others.

Whitewashes that are used in dairy barns and contain no insecticides or fungicides or contain an insecticide for fly control are available from farm supply stores. Application in late fall seems logical because the fruit has been harvested and contamination of leaves is of no concern.

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PHOTOGRAPHS OF NUTRIENT DEFICIENCES

William J. Lord
Department of Plant and Soil Sciences

Nitrogen and calcium are the elements of greatest concern in Massachusetts orchards. Nevertheless, each year the levels of other elements are either excessive or deficient in some orchards. The May/June, 1978 issue of Fruit Notes contained photographs and brief descriptions of bitter pit and cork spot on apples, magnesium (Mg) deficiency symptoms on pear leaves, manganese (Mn) deficiency and toxicity symptoms on apple leaves and wood, and boron (B) toxicity symptoms on apple leaves. For your information we have included below photographs and brief descriptions of Mg and potassium (K) deficiency symptoms on apple leaves and symptoms of B deficiency on the fruit of Bosc pears.

Mg Deficiency of Apple

Pictured on the left is Mg deficiency symptoms on apple leaves. Deficiency symptoms are characterized necrotic (brown) areas between the veins. The older, basal leaves on shoots and spurs are usually affected first, and as the season progresses the injury symptoms appear on the younger leaves. The deficiency symptoms frequently become apparent in late July and early August. By late summer, the shoots on which leaves show Mg deficiency may be defoliated except for a few leaves near their terminals. Mg deficiency increases fruit drop at harvest.

We consider the optimum levels of Mg in leaves to be 0.25 to 0.40%. Symptoms of Mg deficiency are infrequent in comparison with 15 to 20 years ago. Nevertheless, our leaf analysis show that levels are frequently below 0.30%. Thereby, the use of high magnesium lime which has been advocated for years, continues to be needed in our orchards.

K Deficiency of Apple

Figure 2 shows leaf margin burn caused by K deficiency. This symptom can be easily confused with the leaf margin burn from calcium chloride sprays. However, unlike leaf burn from calcium chloride sprays, the scorch of leaf margins due to K deficiency progresses from the older leaves to the younger leaves of current season shoots as the season advances. The scorch may turn gray in color and leaf fall may occur late in the growing season. Nevertheless, in 2 instances leaf analysis was necessary in 1978 to confirm that the problem was K deficiency rather than $CaCl_2$ burn.

B Deficiency of Pear

Occasionally B deficiency is so acute in pear trees that the fruits become malformed and cracked (Figure 3). Soil applications of 13 at the rate suggested for apples is effective for preventing a shortage of this element in pear trees.

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FURTHER OBSERVATIONS OF TREE PERFORMANCE ON M.26

William J. Lord
Department of Plant and Soil Sciences

The 1976 Apple Tree Survey indicated that 8% of the trees in Massachusetts on size-controlling rootstocks are on M.26. Thus, this rootstock is common enough for us to observe its performance under a wide variety of soil and cultural conditions.

Trees on M.26 react more to unfavorable growing conditions than those on more vigorous size-controlling rootstocks. Trees within a block may be extremely variable in vigor, with some of them being weak and/or difficult to train (assuming all the trees are on M.26). Spur-type trees appear weak when planted on light soils (Figure 1), and so do Cortland trees on this rootstock.

The leaders of trees on M.26 often are "droopy" on non-bearing trees, and these trees tend to lean more frequently than trees on other rootstocks (Figure 2). We suggest providing support for the more troublesome trees rather than trying to correct the problem with severe pruning. The objective is to maintain a central leader until the desired tree height is obtained.

Early, heavy bearing is causing weak growth in some instances. Reduction of crop load by hand thinning rather than by chemical thinning appears to be the best solution to this problem because tree vigor varies considerably within a block. At present, we have not seen or heard of any problems with fire blight associated with M.26.

Figure 1 to the left shows a six-year-old Macspur on M.26. The trees in this block are planted 14 feet x 18 feet. It is obvious that on this site the planting distance is too wide and that the trees have low vigor.

In 1976 we planted a block of Rogers McIntosh and Gardner Delicious (a standard-type strain) on MM.106, M.7, and M.26 in heavy soil. The trees on M.26 are very vigorous in comparison to most blocks in Massachusetts on this rootstock. McIntosh but not Delicious were significantly smaller in 1978 on M.26 in comparison to those on M.M.106 and M.7 rootstocks (Table 1). McIntosh produced about 0.1 of a bushel per tree in 1978 regardless of rootstock. The Delicious had a light bloom but produced no fruit.

Growers establishing plantings on M.26 will have to be more selective of soils than in the past. Shallow soils, with hardpans that prevent deep rooting, are producing trees that look like "free-standing M.9's" and the trees are subject to frost heaving. Trees on M.26 require good deep soils to good drainage and waterholding capacity and even on these soils they will appear to require temporary support or permanent support on some sites.

Figure 2 to the left shows trees on M.26 with poor anchorage. Many of these trees in this orchard are now staked for support.

Table 1. Growth and Yield of Rogers McIntosh and Gardner Delicious at the Horticultural Research Center, Belchertown, MA., 1978.

Variety	Rootstock	Bloom/cm trunk circumference	Yield (bushels)	Trunk circumference
McIntosh	M.26	4.64a[z]	0.11a	11.7b
	M.7	6.89a	0.12a	12.7a
	MM.106	6.02a	0.12a	13.2a
Delicious	M.26	0.99b	0.00b	10.5c
	M.7	0.26b	0.00b	11.6b
	MM.106	0.23b	0.00b	10.8bc

[z] Mean in columns not having letters in common are significantly different at the 5% level.

USE OF ETHEPHON TO PROMOTE COLOR AND RIPENING OF APPLES IN MASSACHUSETTS

W. J. Lord and D. W. Greene

The use of ethephon on early maturing varieties and McIntosh to stimulate red color development, increase soluble solids (sugar content), and hasten fruit maturity is now a standard practice in many orchards. However, ethephon must be used with caution. The mis-use of ethephon or an unavoidable delay in the harvest of ethephon-treated fruit could intensify our current problems of supply management and poor fruit condition. The placement in marketing channels of an excessive volume of ethephon-treated 'McIntosh' apples that must be sold quickly because of over-maturity could depress prices.

Successful Use of Ethephon

Ethephon will not completely overcome conditions unfavorable for development of red color. Ethephon, at 1/4 or 1/2 pint may add 10 to 30% red color to 'McIntosh' apples borne on the periphery of the trees within 7 or 8 days after application. Ethephon at 1/4 pint may promote as much fruit color as a 1/2 pint and will cause less fruit softening.

Under conditions that are normally associated with poor fruit color, such as high temperatures, wet and cloudy weather, excessive vigor or dense trees, ethephon-treated fruit may not develop sufficient red color (50% of the surface having red color typical of the variety) within 7 or 8 days after application. Furthermore, on both young and older trees, ethephon may not bring the fruit in the interior of the tree up to a satisfactory level within 7 days after treatment. When the fruit are allowed to remain longer on the tree, however, the color difference becomes greater between the ethephon-sprayed interior fruit and the non-sprayed interior fruit. It is of interest to note that 11 days after an ethephon spray (1/2 pt/100 gals of water) in 1974, 66% of the interior fruit on 10-year-old trees had typical red color and would have graded U.S. Extra Fancy. On the other hand, none of the interior fruit on the check trees would have graded U.S. Extra Fancy due to lack of sufficient red color.

By the time the ethephon fruits in the interior of most trees obtain adequate color, they will probably be suitable only for juice or immediate sale because of excessive loss of firmness. The problem of obtaining adequate color on the interior of large dense trees can be corrected somewhat by pulling the water sprouts during the summer and doing some light summer pruning. These procedures should be followed by spot picking which will lighten the crop load and permit better light penetration into the interior of the tree before the application of an ethephon spray.

Use on early maturing varieties. Ethephon is a very useful tool on early varieties. In general, a single application applied 7-10 days before normal harvest at 1/2 pint per 100 gallons of water will increase red color development within 4-5 days.

Ethephon has been used extensively on Early McIntosh, Puritan and Milton varities by Massachusetts growers with good results. Rate of color development differs from year to year and block to block among orchards. Within a block of trees, the red color generally develops more slowly on the earliest sprayed trees than those sprayed nearer to the normal harvest date.

This shows that color develops more quickly in some instances than others and that there is no substitute for a careful daily check of trees. Early varieties usually ripen unevenly. Therefore, it may be advisable, for some varieties to make one picking to remove the riper fruit and then apply ethephon. This should help minimize the problem of over-ripe fruit at harvest. Some growers may want to apply ethephon, then pick the ripe fruit that day, or 1 or 2 days later. Although the ethephon label does not state a specific interval between application and harvest, the practice of spraying and harvesting within 2 days of application is not recommended. Harvesting all the mature fruit and then applying the ethephon to the remaining fruit on the tree is the preferred practice. Ethephon applied alone accelerates fruit drop. Therefore, naphthalene-acetic acid (NAA) should be used with the ethephon to counteract this abscission effect.

Use on 'McIntosh'. Our suggestions are based on 3 time periods for sale of ethephon-treated 'McIntosh' fruits -- prior to normal harvest time (Labor Day or shortly after), during normal harvest, and after several months of storage (Table 1).

The volume of fruits sprayed with ethephon should be based upon anticipated sales during one or more of these sale periods. The harvest of ethephon-treated fruit must not interfere with the timely harvest of fruit for CA since the placement of ethephon-treated fruit in this type of storage is not recommended. Our data and those from a regional experiment involving New York, Maine and Massachusetts, show that ethephon-treated fruit which still are in good condition will store satisfacotrily in CA, but we are concerned that apples not in good condition will be stored. However, if labor difficulties worsen, it may be necessary to extend the harvest season by advancing it through the judicious use of ethephon on CA 'McIntosh'.

Fruit to be placed in storage at 32^{o}F must be picked at proper maturity. Fruit to be sold through January 1, should receive no more than 1/4 pint of ethephon per 100 gallons of water and be harvested 7-8 days after treatment. Although these fruit should store well until January 1, they may be softer than Alar*-treated fruit.

Alar = Alar-85

Table 1. Suggested use of ethephon for promoting uniform ripening and red color on 'McIntosh' apple trees.

Purpose	Compound, timing and rate
Fruit for sale 1st or 2nd week of September	Alar* - mid-July at 1 lb/100 gals plus ethephon - 8 to 12[z] days prior to anticipated harvest at 2/3 to 1 pt/100 gals plus 2,4,5-TP same timing as ethephon at 20 ppm
Fruit to be picked during normal harvest and held at 32°F in air for 1 month or less	Alar* - mid-July at 1 lb/100 gals plus ethephon - 7 to 8 days prior to anticipated harvest at 1/2 to 2/3 pt/100 gals plus NAA or 2,4,5-TP same timing as ethepon spray at 20 ppm[y]
Fruit to be picked during normal harvest and held at 32°F in air as late as January 1[x]	Alar* - mid-July at 1 lb/100 gals plus ethephon - 7 to 8 days prior to anticipated harvest at 1/4 pt/100 gals plus NAA at 20 ppm or 2,4,5-TP at 10 ppm same timing as ethephon spray

[z] Weather and tree vigor, etc. affect color development. It may be best to allow 12 days, but be prepared to harvest sooner.

[y] 2,4,-5TP is preferred if 2/3 pt of ethephon is used because its preharvest drop control capability is greater than that of NAA.

[x] If fruit are in good condition, they will store satisfactorily in CA.

Alar = Alar-85

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POMOLOGICAL PARAGRAPH

Some apple growers are planning to use foliar sprays of nutraphos* or calcium nitrate in June. We recommend that they switch to calcium chloride in July and August in order to supply adequate calcium to their apples. Please refer to page 11 of the March/April 1979 issue of Fruit Notes for our recommendations on timings and rate of calcium chloride applications on apple trees.

Cooperative Extension Service
University of Massachusetts
Amherst, Massachusetts
R. S. Whaley
Director
Cooperative Agricultural Extension Work
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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 44 (No. 5)
September / October 1979

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A PRELIMINARY EVALUATION OF LABOR PRODUCTIVITY IN GRADING AND PACKING MCINTOSH APPLES GROWN UNDER INTEGRATED PEST MANAGEMENT CONDITIONS

Henry M. Bahn
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In 1978 a pilot program of integrated management for apple pests was initiated in Massachusetts. Developed by the Cooperative Extension Service and Departments of Entomology and Plant Pathology, the program was designed to reduce pesticide usage while maintaining high quality fruit production. Selective pest management may result in lower production costs for pesticides, equipment and labor but may also result in higher grading and packing costs and less marketable fruit due to increased damage levels.

The 1979 summary for the Integrated Pest Management (IPM) program cited net benefits to the participating producers. It is unclear, however, whether changes in insect and disease damage levels as a result of incorporating IPM growing methods will affect grading and packing costs. Studies in Michigan, the Appalachian area, and Washington State have all indicated that quality of fruit is a major influence on grading and sorting costs.

Because the hand packing method is specific to the Northeast, a thorough packing cost analysis should be undertaken. We plan to undertake such a study in Spring, 1980. Meanwhile, preliminary applied study of the relationship between damaged fruit and grading/packing costs was completed in Spring, 1979. By monitoring and comparing the actual packing time requirements for McIntosh apples grown under IPM and conventional practices, some measurement of differences in labor productivity in grading and handling was established.

Yields and size of fruit produced have not been found to be significantly affected by growing under IPM methods. The major difference between IPM and conventional practices is expected to be in the quality of harvested fruit, i.e., levels of insect and disease damage. For the Massachusetts IPM pilot study, comparative data are not available for disease damage levels, but insect damage was reduced from 4.72% in the controls to 2.64% in the IPM samples. This reduction was not expected but it should be noted that this finding is based on only one year's data and a relatively small sample.

Methods and Procedures

To compare IPM versus conventional fruit packing costs and labor productivity, several orchards which participated in the 1978 IPM pilot program were sampled during IPM and conventional packing operations. The quantity of orchard run apples handled, culls removed and quality of daily packout were noted. Total labor requirements for each day's operation for direct labor components were monitored. A simple comparison of labor productivity and labor costs was made for the two types of apples. This analysis did not identify total packing costs for either IPM or conventional fruit, but rather, the relative difference in labor productivity and costs.

Results

The results of the comparative analysis indicate that (1) IPM apples sampled had a higher sortout (cull) rate than the control fruit, i.e., a larger percentage of the control apples was packed as extra fancy or fancy; and (2) IPM fruit required more time per bushel for grading/packing and had correspondingly higher grading and packing costs.

Fruit Injury Levels

Participating IPM and check orchards were monitored throughout the 1978 growing and harvesting season. Numbers of spray applications, dosages, pest populations and injury levels were recorded. A review of the records for the orchards sampled for this study indicates that IPM blocks sustained an average of 4.6% pest-injured fruit, while control blocks sustained 4.0% injury. Thus, the pest injury rate was 16.7% higher for the IPM fruit for the sampled orchards. For a pack of 1,000 bushels, this difference would result in 6.6 extra bushels of damaged fruit for the IPM samples.

Labor Requirements

A typical hand packing line for McIntosh apples would consist of six packer/graders, a worker to supply fruit to the line and to supervise, and a carton handler to fasten and remove filled cartons. Alternatively, all activities other than grading/packing could be undertaken by one individual.

Table 1 depicts the average workday for the packing lines sampled. The workday is typically 7.5 hours with a half hour lunch break and morning and afternoon breaks of 10 to 15 minutes. Although workers are paid for the 7.5 hour workday, the packing line is not operated during lunch and rest breaks. These idle periods were subtracted to determine the actual number of worker hours available per day.

Table 1. Average labor requirements -- McIntosh apple hand grading and packing.

Packing Line Operation	
Workday	7.50 hours
Less lunch break @ .5 hrs.	.50
Less rest breaks 2 @ .234 hrs.	.47
Packing Line Operation	6.53 hours
Personnel Requirements	
IPM	
Grader/Packers 5.8[z] each @ 6.53 hrs.	37.87 hours
Supervisor/Carton Handlers 1.2[z] each @ 6.53 hrs.	7.84
Total Worker Hours Per Day	45.71 hours
Control	
Grader/Packer 5 each @ 6.53 hrs.	32.65 hours
Supervisor/Carton Handlers 1.2[z] each @ 6.53 hrs.	7.84
Total Worker Hours Per Day	40.49 hours

[z] Fractional number of workers is due to averaging data from all sampled packing houses.

According to Table 1, the IPM packing line used a larger number of grader/packers (average of 5.8) than the control (average of 5). Ordinarily, the number of grader/packers would be the same. However, on the same days the samples were taken, several control packing lines were not operating at full grader/packer capacity.

The problem does not affect the comparison of labor productivity for grader/packers, since productivity is based on volumne of apples packed. The supervisor/carton handler's productivity will be lower for the control fruit, however, since all packing lines were operating at normal levels for these personnel.

Labor Costs

The calculations for labor costs presented in Table 2 are straightforward, being merely the average wage rates on a per hour basis for the normal 7.5 hour workday.[1/] In those cases where a premium or piece rate was paid, the wage rates were based on estimated hourly averages for grader/packers for each packing line.

Table 2. Average daily direct labor costs -- McIntosh apple hand grading and packing.

IPM	
Grader/Packers 5.8[z] each @ \$3.42 x 7.5 hrs.	\$148.77
Supervisor/Carton Handlers 1.2[z] each @ \$6.29 x 7.5 hrs.	56.61
Total Direct Labor Costs	\$205.38
Control	
Grader/Packers 5 each @ \$3.42 x 7.5 hrs.	\$128.25
Supervisor/Carton Handlers 1.2 each @ \$6.29 x 7.5 hrs.	56.61
Total Direct Labor Costs	\$184.86

[z]Fractional number of workers is due to averaging data from all sampled packing houses.

Comparative Results

After computing average labor requirements and costs, a comparison was made based on the number of bushels of fruit dumped and packed. In every case, the grader/packer cost for IPM fruit exceeded the cost for control fruit. This caused total direct packing costs to be higher for IPM apples in each case. Supervisor/carton handler costs, on the other hand, were less for IPM apples. This stems from the fact that the control packing lines had less grader/packers working and therefore dumped fewer apples.

[1/]The direct labor costs used here do not include fringe benefits, taxes or insurance payments.

The supervisor/carton handlers for the control packing lines were, in effect, underemployed since those lines were operating at less than normal capacity. Average comparison data are presented in Table 3.

Table 3. Comparison of labor productivity in grading and packing IPM and control McIntosh apples.[z]

Activity	IPM		Control	
Apples Dumped (bu.)	204.0		189.0	
Sortouts (bu.)[y]	29.4		23.0	
Packout (%)	85.58		87.83	
Labor (hrs. per bu. packed)	.262		.244	
Grader/Packers		.217		.197
Supervisor/Carton Handlers		.045		.047
Labor Cost ($ per bu. packed)	1.176		1.113	
Grader/Packers		.852		.773
Supervisor/Carton Handlers		.324		.340

[z] Average data for all packing operations sampled.

[y] Includes utility grade and culls.

The IPM apples exhibited a sortout rate 18.4% higher than the control fruit sampled. This is only slightly higher than the difference between pest injury levels discussed earlier (16.7%). The difference may be due to more critical inspection by the grader/packers, some unidentified deterioration of the IPM fruit during storage, or sampling error since the control fruit packed was not necessarily the control fruit monitored during growing and harvest.

The grading/packing operation took slightly over 10% longer per bushel packed for the IPM apples. The Washington State study mentioned earlier found that grading time increased as cull rates increased. The study results presented in Table 3 are consistent with those findings.

By implication, if grading/packing time per bushel packed increases, grading/packing costs should increase relatively. Such an increase in costs was observed, being just over 10% higher per bushel for the IPM fruit than for the control sample.

Implications and Conclusions

The data analyzed in this study add support to the hypothesis that grading/packing costs increase as insect and disease injury rates increase. Conversely, higher quality fruit is expected to have lower overall grading and packing costs.

The scope of this study is severely limited by the small sample size involved. A very small number of participating growers were sampled and multiple observations were made of some participants. Thus, the data are subject to bias and should be considered as only preliminary results. Because of these limitations, management conclusions should not be based on this report. A more complete sample should be taken on the apples grown in 1979 and a more sophisticated statistical analysis should be undertaken to identify relationships between fruit injury levels and grading/packing costs.

On a general level, however, labor productivity of graders and packers does appear to be lower for IPM grown apples. Higher quality fruit, with the accompanying lower cull rates, can apparently be packed more quickly and at lower per bushel direct costs than fruit with a higher incidence of pest damage. Future research is needed to determine a break-even point between production cost savings of integrated pest management programs and possible increases in packing costs due to increased pest injury.

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TOXICITY OF ORCHARD PESTICIDES TO THE MITE PREDATOR *AMBLYSEIUS FALLACIS*-1979 RESULTS

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Amblyseius fallacis is the most important predator of red and two-spotted mites in commercial apple orchards in Massachusetts. It was found in 23 out of 26 such orchards surveyed by us in 1976.

During the past three years we have been assessing the impact of pesticides on the survival of *A. fallacis* in orchards (*Fruit Notes* 43 (4): 5-8) as well as in the laboratory (*Fruit Notes* 43 (5): 14-18). We discovered that this predator can readily survive some key pesticides such as Guthion (azinphosmethyl) and Imidan (phosmet) at recommended concentrations, but is highly susceptible to certain other pesticides. For example, Zolone (phosalone) at recommended rates virtually decimated field populations of *A. fallacis*, thereby creating large spider mite outbreaks.

Here, we summarize our most recent laboratory results, which deal with pesticides not heretofore tested on a Massachusetts strain of *A. fallacis*. Two of the insecticides tested (the synthetic pyrethroids Pydrin and Pounce) have experimental permits only; we screened them to determine their effects should they become available for possible future use in integrated pest management programs in Massachusetts. Because *A. fallacis* spends considerable time in the orchard understory, especially in spring and early summer, careless use of herbicides can be highly detrimental to predator populations. This is the reason for inclusion of herbicides in our pesticide screening program.

Methods

As in our previous laboratory trials, we employed here the slide dip assay technique in which *A. fallacis* adults (Bishop strain) were dipped into orchard concentrations of pesticide. As before, we determined the percent mortality 48 hours after dipping.

Results

The results are presented in Table 1. Insecticides which proved highly toxic (70-100% mortality) to *A. fallacis* were Lannate (methomyl) 1.8 EC, Cygon (dimethoate) 2.7 EC, Pydrin (fenvalarate) 2.4 EC, and Pounce (permethrin) 3.2 EC. Penncap M (parathion) 2 FM was within our range of low toxicity (0-30% mortality). Although *A. fallacis* has received little exposure to Penncap M in Massachusetts, this low toxicity could very well have been pre-selected by long-term exposure of *A. fallacis* to such chemically closely related materials as Imidan (phosmet) 50 WP and Guthion (azinphosmethyl) 50 WP. The high toxicity of the first four materials does not favor their use in integrated pest management programs.

The fungicide Karathane (dinocap) 25 WP was within the moderately toxic range (30-70% mortality), while Polyram 80 WP, Phygon XL (dichlone) 50 WP and Manzate D 80 WP were of low toxicity. Of these materials, only Karathane would be likely to have a negative impact on orchard populations of *A. fallacis*.

Of the herbicides tested, Ammate X (ammonium sulfamate) was highly toxic to *A. fallacis*, while Dowpon M (dalapon) was of low toxicity. Dowpon M and Princep (simazine) 80 WP (see *Fruit Notes* 43 (5): 14-18) are thus the herbicides recommended for use in integrated pest management programs. When applying herbicides, be carefull to preserve at least 50% ground cover under the trees to provide a habitat suitable for A. fallacis buildup.

With these results, the list of pesticides now known to have highly toxic effects (at recommended orchard rates) on Massachusetts strains of A. fallacis includes Zolone (phosalone) Systox (demeton) 6 EC, Sevin (carbaryl) 50 WP, Diazinon 50 WP, Lannate, Cygon, Pydrin, Pounce, Carzol (formetenate hydrochloride) 92 SP, Paraquat CL (paraquat), Roundup (glyphosate) and Ammate X. (Also, (benomyl) 50 WP has strong anti-reproductive effects on A. fallacis). Those known to have moderately toxic effects include Phosphamidon (dimecron) 8 EC, Kelthane (dicofol) 35 WP, and Karathane. Until we learn more about possible ways in which the detrimental effects of these materials can be reduced, we discourage their use by orchardists aiming at an integrated program of spider mite management except where needed in emergency situations, such as San Jose scale or tentiform leafminer outbreaks.

Table 1. Toxicity of pesticides to *Amblyseius fallacis* (Bishop strain) at recommended orchard rates.

Material	Rate/100 gals.	Mortality,%	Toxicity Rating
INSECTICIDES			
Lannate (methomyl) 1.8 EC	0.5 pt.	100	High
Cygon (dimethoate) 2.7 EC	1.0 pt.	96	High
Pydrin (fenvalarate) 2.4 EC	2.6 oz.	100	High
Pounce (permethrin) 3.2 EC	2.1 oz.	100	High
Penncap M (parathion) 2 FM	2.0 pts.	12	Low
FUNGICIDES			
Karathane (dinocap) 25 WD	0.5 lb.	46	Moderate
Polyram 80 WP	1.5 lbs.	7	Low
Phygon XL (dichlone) 50 WP	0.5 lb.	5	Low
Manzate D 80 WP	1.5 lbs.	8	Low
HERBICIDES			
Ammate X (ammonium sulfamate)	60 lbs.	78	High
Dowpon M (dalapon)	2.5 lbs.	26	Low

PROPAGATING YOUR OWN FRUIT TREES

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Fruit growers in many areas of the country have experienced difficulty in obtaining nursery trees. I know of several Massachusetts growers who have waited 2 or more years to receive tree orders and then have had to accept substitutions as to size and make-up of the tree ordered. Reasons suggested for this scarcity of fruit tree nursery stock are: (1) an increased demand for fruit trees due to both new and replacement plantings; (2) a tendency to use closer planting distances in many of these plantings; (3) loss of both understock and budded trees in the nursery due to adverse weather conditions; (4) shortages of certain understock (1 or 2 favorable and often preliminary reports on a new rootstock will create a demand that may take several years to satisfy); and (5) lack of qualified budders resulting in poorer stands in the nursery row.

Because of this scarcity of nursery stock a number of growers have indicated an interest in propagating their own fruit trees. For those individuals contemplating such an operation I would suggest that they secure and read the following publications: New York Food and Life Sciences Bulletin, No. 19, June 1972; Tree Raising on the Fruit Farm-An Essay on Management. by James C. Cummins, and New York State Agricultural Experiment Station Bulletin 817, May 1967: Propagating Fruit Trees in New York by R.D. Way, F. G. Dennis and R. M. Gilmer. Both are available from the Department of Pomology and Viticulture, New York State Agricultural Experiment Station, Geneva, NY 14456. There is a mailing and handling charge of 20 cents for each publication. Checks should be made out to the New York Agricultural Experiment Station.

It is not unrealistic or impossible for the orchardist to propagate his own trees if he is willing to carry out the necessary nursery operations on a timely basis. Those growers who currently find it difficult to complete their orchard operations on time should not attempt to propagate their own trees.

An open site that has good air drainage and a well drained fertile soil is best suited for the nursery site. It would be desirable for the nursery to be located near the residence or orchard office area to provide for more efficient management and possible protection from deer damage. An isolated planting is more apt to be neglected. The orchardist growing his own nursery trees might use the following tree schedule:

1. Order the desired rootstocks at least 1 year in advance of planting as the demand is often greater than the supply.

2. Prepare the land at least a year in advance of lining-out of the rootstocks, soil fumigation might be a part of this preparation.

3. Line-out the rootstocks in early-Spring, April if possible. The rootstocks are set 8 to 10 inches apart in the row and the rows are 42 to 60 inches apart. The spacing between rows is determined in part by the equipment to be used.

4. Bud the trees, beginning in late July or early August. The bud wood should be collected just prior to budding.

5. During this first year the trees should be sprayed to control insects and diseases and the soil cultivated to suppress weeds.

6. The following spring the top of rootstock is cut-off just above the bud and any suckers arising from the rootstock are removed. This allows the shoot arising from the inserted bud to make maximum growth. Suckers continuing to arise from the rootstock portion of tree should be removed by rubbing them off with the fingers.

7. The trees should be sprayed to control insects and the soil should be cultivated to control weeds during this second season. Herbicides might be used for weed control.

8. The trees may be dug in the late fall (November) where suitable storage conditions are available, or the following spring. DO NOT STORE THEM IN YOUR APPLE STORAGE, since gasses from the fruit may make them break dormancy during storage.

The various steps necessary in the propagation of fruit trees are described in detail in Bulletin 817.

Some Additional Points

1. The propagation of patented varieties is restricted. Growers wishing to propagate such a variety must obtain permission from the holder of the patent rights to it.

2. Cut budwood from trees that are healthy, vigorous, productive and true-to-type. When cutting in an orchard be especially careful, as most rows include pollenizer varieties and some may include partially top-worked trees. Keep your eyes open!

3. All nursery rows should be carefully staked and labelled so as to indicate both rootstock and variety. You should also maintain a nursery register indicating all pertinent information.

4. Budding a few trees is fun; budding for a day is hard work. The novice should start on a small scale.

SOME PROBLEMS THAT CAN REDUCE STORAGEABILITY OF APPLES

William J. Bramlage
Department of Plant and Soil Sciences

At harvest time, a fruit grower not only must gather the crop from the orchard, but he must also make dozens of decisions that will ultimately affect the quality of the product that reaches consumers. To produce a quality product, these decisions must be made with an understanding of the principles of fruit behavior and handling. Last year I reviewed what we think are the most important principles as well as our basic recommendations for apple storage (Fruit Notes 43, September/October issue 1978: pp 1-5). We urge you to take a few minutes and re-read this review of the "basics", because we believe that the growers who stick as close as possible to these "basics" are the ones who year-in and year-out have the fewest storage problems.

Keeping these basics in mind, I will develop here some of the information and ideas about fruit handling that have come to my attention in recent months. These considerations may help you avoid storage problems.

Bruising is an important though often neglected factor in the behavior of fruit after harvest. Beside disfiguring the fruit, bruising also causes it to produce large amounts of ethylene, the hormone gas that causes ripening to begin. Dr. L. M. Massey, Jr., of the New York Agricultural Experiment Station in Geneva, has demonstrated the importance of bruising. If apples are picked before ripening has begun, they are most suitable for long-term storage. But, if these apples have been extensively bruised during picking or handling, their potential can be shortened substantially because ripening will begin almost immediately. Even when apples are picked after ripening has begun, Dr. Massey found that extensive bruising increased their rates of softening and sugar loss during storage. He also found what we too have observed: bruising does not lead directly to breakdown or other apple disorders during storage. Careful harvesting and handling will improve fruit storageability.

Bruising is also a major cause of fruit loss after packing. We reported last year (Fruit Notes 43, September/October issue, 1978: pp 5-7) some results from tests by Dr. George Mattus in Virginia on the amounts of bruising that result from dropping of cartons, and of the influence of different kinds of packaging on this bruising. Dr. Mattus has continued these tests and has generally confirmed last year's findings. Packages differ significantly in the amount of bruising caused by drops, but the basic message is: Don't drop cartons of apples, not even a little bit!

Scald is always a worry during apple storage. We did not have serious scald problems in New England last year, but in many parts of North America scald caused very serious losses. The reason was probably high temperatures during the harvest season--high temperature shortly before harvest increases the susceptibility of apples to scald. When susceptibility is high, conventional scald control measures may not be effective. If high temperatures have prevailed immediately before harvest, and especially if coloring is poor and you know that your nitrogen levels tend to be high, you should take extra precautions to thoroughly apply scald inhibitors at maximum dosage---but not above maximum! You should also be extra careful with storage management to delay ripening as much as possible, since scald development comes with ripening, and make every effort to market the fruit as early as possible. We have also found that a high calcium level in the fruit can reduce scald development.

Your fertilizer program can certainly influence your storage problems with apples. In particular, if nitrogen or potassium are quite high in your trees, or if calcium is low, you may encounter much greater problems during storage. The importance of nutrition is dramatically illustrated by a system now used in England to determine length of storage. In this system, samples of apples are collected from each orchard 2 weeks before harvest and analyzed for 5 mineral elements. Based on the analysis, the grower is informed of the maximum length of time he can store his apples and still market them cooperatively. A simpler system, based solely on fruit calcium analysis, is also being used for export apples in New Zealand.

We plan to test the English system this year, but in the absence of a fruit analysis, observation of your fruit can help avoid problems. If your trees have lush, dark green foliage and the apples are large and poorly colored, nitrogen levels are probably high and the fruit should not be stored late. If you see significant amounts of cork spot or bitter pit on the apples, and especially if the fruit are large, calcium levels are probably low and the fruit should not be stored late. In either case you should consider a post harvest dip treatment in calcium chloride ($CaCl_2$). $CaCl_2$ is compatible with scald inhibitors and fungicides, so the treatment can easily be accomplished if you are dipping the fruit anyway. A high $CaCl_2$ concentration (24 to 32 lbs/100 gal) is essential for success, since most of the calcium is absorbed into the fruit from residues during storage. This high $CaCl_2$ concentration is corrosive and can cause skin injury on the fruit, but injury is much more of a problem in warmer areas, such as Maryland and Virginia, than it has been in New England.

Postharvest $CaCl_2$ dips have repeatedly been shown to reduce softening and storage disorders of apples, and use of these dips is growing in many apple-producing regions. Research is also currently being conducted in several areas on the infiltration, by either pressure or vacuum, of large amounts of $CaCl_2$ into apples, but many questions remain to be answered about this method. We think that there is much potential benefit to be gained from $CaCl_2$ dips.

There is growing evidence that use of growth regulators during the summer can have important influences on the fruit during storage. Ethrel* can of course cause earlier ripening, even when it has been applied long before harvest. Use of Alar* continues to be controversial---its host of effects on apple development makes assessment of its overall effect hard to evaluate. During the past 2 years extensive studies have been carried out in a number of areas, but especially in New York and Maine, and they have failed to show consistent effects of Alar* except for greater firmness at harvest and preharvest drop control. Our own results have also been inconsistent. In the previous 2 years we found greater breakdown in Alar*-treated fruit, but last year there was no more breakdown with Alar* than without it. We believe that Alar* can produce greater breakdown under certain conditions, but that this problem can probably be overcome by harvesting at the proper time. <u>Do not delay harvest of Alar-treated apples</u>; they should be harvested at the same time as if Alar had not been used.

We now see evidence that Promalin* may reduce storageability of apples. Dr. Duane Greene has found in his experiments here with both Delicious and McIntosh that Promalin increased the amount of breakdown after storage, even when applied at low concentrations. However, Dr. Warren Stiles has found no detrimental effects from Promalin* on McIntosh in Maine. Obviously, we have much to learn about the effects of Promalin* but it may be that the cooler temperatures in Maine account for the differences in results. Nevertheless, we believe that growers who have used Promalin* should be extra cautious about long-term storage of these fruit.

The ability to delay ripening of apples for almost a year is a marvelous thing. It is even more marvelous for McIntosh, which is almost a summer variety. Successful long-term storage requires a lot of things being done right, and the capacity of the fruit to withstand this "test of time" can easily be eroded. Most of what has been written above has dealt with efforts to protect against these eroding influences. In conclusion it should be said that from the standpoint of fruit quality nothing is gained by long-term storage. Furthermore, the cost and scarcity of energy are sure to lead to greater efforts to conserve energy during storage operation. An obvious way to conserve energy is to store for shorter lengths of time, and just as obviously, a way to do this is to market more of the crop in the Fall. Ethrel* offers the means for starting harvest sooner, and we think that once Fall marketing has begun it should be utilized much more fully than is presently being done.

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* Trade name

POMOLOGICAL PARAGRAPH

William J. Lord
Department of Plant and Soil Sciences

Benlate* (benomyl)-tolerant storage decays. D.A. Rosenberger, Plant Pathology, Cornell University, NY reported in Cornell Fruit Handling and Storage Newsletter, July 1979 that some blue mold and gray mold rot fungi are tolerant to Benlate. Isolates obtained at several packing house-storages in the Hudson Valley, Champlain Valley, and in the Lake Ontario areas showed that the proportions of Benlate-tolerant to Benlate-susceptible fungi varied greatly among locations.

Tests conducted last fall showed that a combination of 8 oz. Benlate and 1 lb. Captan per 100 gal. provided much better control of blue mold than did Benlate alone where Benlate-tolerant spores were present. Therefore, when using Benlate as a post-harvest dip or drench, we suggest adding Captan at the rate of 1 lb. per 100 gallons.

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COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol 44, No. 6

NOVEMBER / DECEMBER 1979

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CARBON MONOXIDE ACCUMULATION IN CA STORAGES

G. David Blanpied, Pomology Department
Cornell University, Ithaca, New York

Carbon monoxide (CO) is a colorless, odorless gas which causes numerous deaths each year. Almost all of these deaths are caused by CO in the exhaust from internal combustion engines. Human response depends upon the concentration of CO and the length of exposure to it. For example, you wouldn't notice 100 ppm of CO if you were exposed for 3 hours, but after 8 hours you would be nauseous and have a headache. CO at 900 ppm would cause the same symptoms after 1 hour. Exposure to 4000 ppm of CO would be fatal in less than 1 hour.

The possibility of CO in CA storage was brought to my attention this past spring by Warren Stiles. He reported that workers in 2 Maine apple packinghouses had developed headaches and had become nauseous after working in an area adjacent to the door of a newly opened CA room. At both establishments an oxygen burner had been used to reduce the oxygen concentrations in the CA rooms. Analyses of the air in the areas surrounding the newly opened CA rooms revealed the presence of CO at concentrations which could cause CO poisoning symptoms to develop after exposure for several hours.

We analyzed the atmosphere in 10 Hudson Valley CA rooms that had been "burned" with Anderson, Arcat, and SMB burners at harvest and/or after resealing in the spring. The 5 rooms that had been "burned" in the fall had 50-200 ppm of CO. The 5 rooms that had been recently "burned" after resealing had 250-1800 ppm of CO.

Early this summer we sealed an empty CA room at Ithaca. With a new catalyst bed in an Arcat the room was "burned" to 3% oxygen. We learned that most of the CO was produced when the oxygen in the room was between 5 and 3%. Also, the faster the flow of propane to the burner, the higher the amount of CO that accumulated in the room.

The take-home lessons from these observations are clear. If you are lowering the oxygen in a CA room with an open-flame burner, such as an Anderson burner, thoroughly ventilate with fresh air the area adjacent to the discharge from the CA room. When you open a CA room in preparation for removal of apples, ventilate with fresh air the area around the CA door if people will be working nearby.

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EVALUATION OF DELICIOUS STRAINS

William J. Lord, Richard A. Damon, Jr., James F. Anderson
and
Franklin W. Southwick
University of Massachusetts, Amherst

A planting was established in 1964 at the Horticultural Research Center, Belchertown, MA to evaluate the following Delicious strains on M7 rootstock: Richared, Turner Red, Jardine Red, Royal Red, Gardner Red, Red Prince, Rogers Red, Sturdeespur (Miller Strain), and Starkrimson (Bisbee strain), the last two being spurs. The experiment was a randomized block design with 6 single-tree replicates. The trees were planted at 20 feet by 30 feet spacing. Summarized below are our findings to date. The full report is published in the 1979 Proceeding of the Mass. Fruit Growers' Association, Volume 85, pp 76-83.

Color Evaluations

Rogers Red, Royal Red, Starkrimson, and Sturdeespur have rated best in color evaluations. Gardner Red fruits have less intense red pigmentation than these strains and should be suitable for those who like less color intensity. Red color on Turner Red lacks somewhat in uniformity and is less intense than on Starkrimson, Royal Red, Sturdeespur, and Rogers Red. The fruits of Jardine Red are blush with some striping but lack the intensity of red needed to meet present standards for color.

Production

Why Delicious is unproductive in the eastern United States was the subject of a conference hosted by the USDA in 1977. Researchers in attendance stated that strains differ in fruitfulness but there was a lack of supportive data. It was reported that spur-type strains perform somewhat better than standard-type strains and that Red Prince, Richared, and Royal Red in some apple growing areas are less productive than other strains.

We lost 2 of our Red Prince trees in 1972, but by statistical techniques it was possible to obtain an estimate of yields. Thus, the productivity of Red Prince in comparison to other strains in the test is reported.

Early Production: Yield data were first recorded in 1970 when the trees were in their 7th year, and at this time the strains averaged at least a bushel per tree. In 1970 production per tree was similar among strains. Gardner Red produced more fruit per tree than either spur strain in 1971. In 1972, Turner Red was more productive than the spur strains.

Although yield per tree favored the more productive standard-type strains in 1971 and 1972, higher tree numbers per acre are possible with spur trees. Actual spacing trials provide the most reliable estimate of yield per acre. In absence of these, we arrived at theoretical tree spacings for the strains by using tree spread in 1978. Some trees of the standard-type strains have required pruning to keep them in their allotted space; as a result all standard-type strains averaged 19' spread. Tree spread of Sturdeespur and Starkrimson averaged 15' and 14', respectively.

Theoretical yields per acre were determined by multiplying average yield per tree by trees per acre. The theoretical yields showed that Sturdeespur was more productive in 1970 and that there was no difference in productivity between standard-type and spur-type trees in 1971. In 1972, Turner Red was as productive as Sturdeespur and Starkrimson. Thus, in this study yields per acre in the early fruiting years favored neither the standard nor spur-type strains.

Yields from 1970 through 1978: Cumulative yields per tree and per acre the first 9 years showed that Turner Red was more productive than some of the other standard-type strains. However, the productivity of Red Prince, Rogers Red, Richared, Gardner Red, and Royal Red, which are planted in orchards in eastern United States, was comparable.

The trees of the spur-type strains are smaller than those of the standard-type strains, but production per tree of Sturdeespur, Red Prince, Jardine Red, Richared and Rogers Red was similar. Sturdeespur had the highest production efficiency (production per area occupied) of all strains.

The cumulative yields per tree indicated that Starkrimson was the least productive of all strains, but when the theoretical yield per acre was calculated it was not, because the trees of this strain are small. The theoretical cumulative yield per acre generally was similar for the standard-type and spur-type strains.

Water Core

Several indices have been used to estimate maturity of Delicious strains. We chose water core because it is of annual concern and a reliable index of maturity under our conditions. Water core is associated with mature and over-mature Delicious fruits. Fruits with this disorder may fail to meet U.S. Standards for Extra Fancy fruit and severely affected apples often develop internal breakdown during storage.

In this study, Starkrimson fruits have had less water core than other strains. Nevertheless, the percentage of Starkrimson fruits with water core classified as medium and severe was not consistently less than in the other strains. Since water core can develop rapidly, this difference in water core susceptibility may be of little practical significance in some years.

Summary

More spur-type trees than standard-type trees can be planted per acre because they are smaller. Allegedly, yields per acre will be higher on spur-type trees but data to support this claim are limited. In this study, the spur-type and standard-type strains have been equally fruitful.

Among the standard-type strains Turner Red was more productive per tree than Richared and Red Prince. Unfortunately under our conditions, red color on Turner Red fruits lacked somewhat in uniformity.

Fruits of Royal Red, Starkrimson, Sturdeespur and Rogers Red were rated highest for color. Gardner Red appears suitable for growers who like bright red color rather than dark red color. Based on the severity of water core at harvest, the fruits of Starkrimson seemed to mature somewhat later than those of the other strains.

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SPUR-STRAINS OF MCINTOSH

William J. Lord
Department of Plant and Soil Sciences

Spur-strains of McIntosh are now common in Massachusetts. The question was asked about how they differ from their parent - Summerland Red McIntosh - and from each other.

Strains common in Massachusetts are Macspur, Morspur and Starkspur (Gatzke strain), all of which originated in British Columbia. Dr. D. V. Fisher discussed the origin and characteristics of these strains in Fruit Varieties and Horticultural Digest, Vol. 24, in 1970. Strain B (Macspur) was discovered in a small block of McIntosh on seedling roots planted in 1960 or 1961 in the Mervyn Greenslade Orchard in Summerland. Strain C [Starkspur (Gatzke strain)] occurred as a single tree sport on a seedling rootstock planted in about 1960 in Oyama. Six apparently identical whole tree mutants occurred in a large block in the Kelowna district. These were designated as strain D and later named Morspur.

Lapins and Fisher in 1974 (Can. J. Plant Sci 54:359-361) reported that the degree of spuriness was very high in Morspur and Macspur, high in Dewar (Strain E), and moderate in Starkspur. However, in our commercial orchards in New England, we are finding that the degree of spuriness is highly variable in Macspur, with some trees exhibiting branching and spur development characteristic of standard McIntosh.

In 1976, W. Lane and M. Maheriuk reported on a 3-year study (Can. J. Plant Sci. 56:847-851) in which they compared the fruit characteristics of Dewar, Macspur, and Morspur with those of Summerland Red McIntosh. They found no differences in stem-associated defects (short, long, fleshy) except that flat stem cavities occurred more frequently on the fruits of spur strains in 2 of the 3 years. Measurements of fruit length and diameter showed that the fruits of the spur strains were as uniform in shape as those of Summerland Red, but they tended to be longer and larger. Also in some instances, the fruits of the spur strains were softer and had less soluble solids (sugar content), probably because they were larger. In general, the study showed that the fruits of the spur strains differed slightly from those of Summerland Red and that the differences among the 4 strains were less than the variations in strains from year to year.

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VARIABILITY IN MACSPUR STRAIN OF MCINTOSH

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In 1967 Horticulturists became aware of a spur-type sport of McIntosh in the Mervyn Greenslade orchard at Summerland, B.C. That sport, a whole tree, received a great deal of publicity as it appeared to be the first spur-type McIntosh which produced commercially-acceptable fruit and which possessed desirable growth characteristics.

Propagating rights for this sport, named Macspur, were obtained by Hilltop Orchards and Nurseries of Michigan. The British Columbia Fruit Growers Association obtained propagating rights on behalf of the tree-fruit industry and nurseries of British Columbia.

Since the discovery of Macspur numerous other spur-type sports have been found in various B.C. orchards. Propagating rights for those which appeared most promising were picked up by nurseries. Consequently, today there are several spur-type McIntosh strains being propagated in North America.

Macspur is the spur-type strain of McIntosh that has been most extensively planted in B.C. during the 1970's as it is the strain selected by the B.C.F.G.A. and propagated in their budwood orchard for distribution to B.C. orchardists and nursery operators.

In a few of the earlier plantings of Macspur it was noted that the occasional tree would lack spur-type characteristics. For some time it was thought that mixing of spur-type and standard McIntosh trees had occurred. However, during the past 2 years it has been observed that the incidence of standard McIntosh trees in plantings of Macspur has increased significantly; in one extreme case over 25% of the trees in a Macspur planting exhibit the type of growth that is characteristic of standard McIntosh. On the other hand, there are many blocks of Macspur where the trees exhibit a high degree of uniformity.

What is the cause of the problem with lack of uniformity in some plantings of Macspur in British Columbia? Is it due to bud selection? Is it due to a mixing of standard and spur-type trees? Is it due to bud mutation? To date no one has come up with the answer. It may take several years before an answer can be found. However, it can be stated that it is thought that the variability exhibited by Macspur in B.C. is related to bud selection rather than reversion since the problem has been limited to whole trees, not individual limbs.

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1979 DISEASE RESULTS FOR THE MASSACHUSETTS APPLE PEST MANAGEMENT PROGRAM

T. R. Bardinelli, C. W. McCarthy, and W. J. Manning[1]

The 1979 growing season marked the completion of the first full year of operation of the disease component of the Massachusetts Apple Pest Management Program. The objectives of this part of the program include using and developing predictive tools to time fungicide applications to achieve more effective management of apple diseases.

Seven growers participated in the 1979 disease management program. Disease management blocks (10 acres) and control blocks were established in each orchard. This allowed direct comparison of results from control and disease management blocks located in the same orchards.

Apple scab is the major disease to be managed and most attention was focused on it. Several predictive tools are available to manage apple scab. The best known is the Mill's Table (Table 1). Infection periods for primary apple scab can be determined by measuring the length of wetting periods and relating it to average temperatures during the wetting periods. The table can then be used to determine whether or not an infection period has occurred. A recording hygrothermograph was modified to continuously monitor leaf wetness and orchard temperatures. Using this information, a predictive table was devised that was used by participating growers to allow them to decide whether an infection period had occurred and whether to apply an eradicant kickback spray.

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[1] Extension Technician, Scout, and Associate Professor, Department of Plant Pathology, University of Massachusetts at Amherst.

Table 1. Approximate hours of wetting necessary for primary apple scab infection at various temperatures.

Average temperature °F	Number of hours of wetting
78	12
77	11
76	10
60-75	9
57-59	10
54-56	11
51-53	12
48-50	14
47	17
45-46	19
44	22
43	25
42	28
33-41	48

From: Mills, W. D. 1944. Efficient use of sulfur dusts and sprays during rain to control apple scab. Cornell Ext. Bul. No. 630.

Long periods of rain in the early primary scab season made kick-back spraying difficult in most cooperating orchards. In spite of this, good scab and other disease control was achieved. Results for the seven orchards are given in Table 2 below.

Table 2. Comparison of results from disease management and control blocks of seven orchards in the Massachusetts Apple Pest Management Program, 1979.

Criteria	Disease management	Control
Average number fungicide sprays	10.6	13.0
Average dosage equivalent[z]	9.8	11.1
Average % disease on fruit at harvest	0.99	0.93
Average fungicide cost/acre	$108.64	$130.93

[z] Dosage equivalent = $\frac{\text{amount of fungicide used}}{\text{average recommended rate of fungicide}}$

The average number of fungicide sprays in the disease management blocks was reduced by 2.4 or 18%. Average dosage equivalents were reduced by 1.3. Fruit disease incidence at harvest, however, was the same under both conditions. Average fungicide cost/acre was reduced by $22.29/acre or 17%. When individual orchard profiles are examined, several of the participating orchards achieved even greater reductions in fungicide applications and costs.

Four other orchards have been used to evaluate the effects of spraying only every other row on disease incidence. The same fungicide concentrations were used as in an every row program, but applied only to every other row, alternating the rows that were sprayed. Table 3 compares these results to those obtained in blocks where every row was sprayed. By cutting all factors in half, a slight reduction in average fruit disease incidence was also obtained.

Table 3. Comparison of results from four orchards using alternate row and every row spray blocks.

Criteria	Alternate	Every
Average number fungicide sprays	11.8	11.8
Average dosage equivalent[z]	5.8	11.6
Average % disease on fruit at harvest	0.23	0.38
Average fungicide cost/acre	$70.69	$141.38

[z] Dosage equivalent = $\frac{\text{amount of fungicide used}}{\text{average recommended rate of fungicide}}$

The results from our first year's program are encouraging. They are, however, only preliminary results. We need to obtain additional results over several years of varying climatic conditions. We also need to further evaluate and develop additional predictive tools for disease management for apple scab and other apple diseases.

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INTEGRATED MANAGEMENT OF APPLE PESTS IN MASSACHUSETTS COMMERCIAL ORCHARDS--1979 RESULTS: INSECTS AND MITES

W. M. Coli, R. J. Prokopy and R. Hislop[1]
Department of Entomology

The 1979 growing season was the second year of operation of the Massachusetts IPM program[2]. The major objectives of the Massachusetts IPM program are: 1) to produce high yields of top quality apples while decreasing the amount of pesticide usage; and 2) to encourage the use of spray materials which allow for survival of beneficial predators and parasites.

Reduced spray programs on apples have been discussed in previous issues of Fruit Notes [41(1), 41(2), 41(3), 42(3), and 43(3)]. Our 1978 results on insects were summarized in Fruit Notes 44(1).

Information reported here resulted from intensive scouting of 25 blocks in 20 commercial orchards in the 4 major fruit-growing areas of Massachusetts. Scouting in the 16 IPM blocks was on a weekly basis while the 9 check blocks were visited bi-weekly because of gasoline scarcity. In-depth orchard scouting is the keystone of the IPM program and enables us to advise growers as to the need and optimal timing of spray applications.

Materials and Methods

Prior to bud break in the spring, 6 to 12 trapping stations were established in each orchard (4-11 stations per block) taking into account size of block, proximity to likely insect overwintering sites and varietal composition. The majority of trapping sites were near the block periphery inasmuch as most pest pressure originates from outside the orchard. Visual traps were used to monitor tarnished plant bug (TPB), European apple sawfly (EAS) and apple maggot fly (AMF) adults. Pheromone traps were used for monitoring red-banded leafroller (RBLR), oblique-banded leafroller (OBLR), and codling moth (CM) males. Mites and mite predators were monitored from mid-June to harvest using techniques outlined in Fruit Notes 43(4). Tentiform leafminer (TLM), green fruitworm (GFW), green apple aphid (GAA), woolly apple aphid (WAA) and white apple leafhopper (WAL) populations were monitored by examining 10 fruit spurs or 10 terminal shoots in each of 3 tree areas--(top, low inside and low outside) at each trapping station. (A discussion of decision making

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1 Other program field staff for 1979 were: Norman Andersen, scout; Glenn Morin, scout; Annemarie Pennucci, scout; and Mary Tubbs, scout. Mite brushing and counting were by Bonnie Weeks.

2 Funded by a USDA grant from 1978 through 1982. In addition, the Massachusetts Fruit Growers Association contributed $5,600. Additional thanks to Mr. David Chandler, Meadowbrook Orchards, Inc., Sterling Junction for allowing us to base 2 scouts at his picker's housing throughout the summer. As a result it was possible to reduce travel time and gasoline use.

processes based on levels of pest populations as determined by the above techniques will be forthcoming in a future issue of Fruit Notes.)

Fruit injury at harvest was determined in each IPM and check block on the basis of on-tree surveys of 800-2200 fruit per block (100 fruit per tree from each of 2 trees adjacent to trapping stations). In addition, we sampled at harvest fruit injury from another block in each IPM orchard of similar tree size and varietal composition. Injury in these blocks was determined by on-tree surveys of 1000 fruit per block (100 fruit per tree from trees randomly located within the block).

Results

Fruit Injury. Injury at harvest was divided into 2 categories: (a) permanent damage to the skin or flesh of the fruit; and (b) damage to the skin which could be removed by washing (i.e., woolly apple aphids (WAA) in the stem cavity, sooty mold (SM), or white apple leafhopper (WAL) excrement).

Overall, permanent damage was 6% less in IPM blocks than in same orchard non-IPM blocks, and 23% less than in check blocks (Table 1). Removable injury was 95% less in IPM blocks than in same orchard non-IPM and 93% less than in check blocks.

Specifically, as in 1978, TPB was the most damaging fruit pest in Massachusetts commercial apple orchards, with IPM blocks averaging slightly less injury than check or same orchard non-IPM blocks. We believe that this reduction in TPB fruit injury in IPM blocks was due to better timing of spray applications rather than differences in pest pressure, since trap captures of TPB were nearly identical (13.3 per trap in IPM blocks vs. 13.6 per trap in check blocks). We attempted to develop a TPB damage grading index so as to determine how much of this TPB injury would result in down-grading of fruit value. Preliminary indications are that 32% of TPB injury would grade through as U.S. Fancy fruit, 52% would grade U.S. #1 and 16% would be culled. We plan to continue this work in 1980.

Fruit injury as well as trap captures of EAS were down substantially from 1978, with virtually no difference between IPM and check blocks. Plum curculio (PC) injury was about the same as in 1978. Injury from PC was higher in IPM than check blocks due mainly to substantial injury (1.6%) in one orchard. San Jose Scale injury to fruit was considerably less in IPM than check blocks, where, as in 1978, scale was the second most damaging pest. Apple maggot fly (AMF) captures were down substantially from 1978, perhaps due to interference of dry weather with fly emergence from pupae. Trap captures were slightly higher in check blocks, as was injury at harvest from this pest. First captures of AMF in an abandoned orchard in Northboro, MA occurred the week of June 1, while first captures in a commercial orchard occurred July 12. This difference points out the need to monitor AMF directly in commercial orchards rather than relying on abandoned orchard captures (as recommended in Canada) to indicate the need to spray.

Table 1. Average percent of insect injury on fruit at harvest in IPM and check commercial orchards in Massachusetts, 1979

Insect	% injury 16 IPM blocks	 11 Same orchard non IPM blocks	 9 Check blocks
Tarnished plant bug	2.74	3.27	3.10
Plum curculio	0.39	0.16	0.17
San Jose scale	0.33	0.25	1.07
Apple maggot fly	0.12	0.09	0.23
European apple sawfly	0.03	0.03	0.04
Green fruitworm	0.02	0.04	0.07
Leafrollers	0.01	0.01	0.04
Codling moth	0.00	0.02	0.01
Total % of insect injury	3.64	3.88	4.73
Average number insecticide applications[z]	6.0	9.1	11.0
Woolly apple aphids	0.08	0.71	0.08
White apple leafhopper	0.01	0.27	1.18
Sooty mold	0.00	0.67	0.05
Total % of insect injury	0.09	1.56	1.31
Average number aphicide applications	0.36	0.36	0.36
GRAND TOTAL % INSECT INJURY	3.73	5.44	6.04

[z] Does not include materials directed solely at aphids (e.g., endosulfan, phosphamidon).

Codling moth (CM), leafrollers (LR) and green fruitworms (GFW) were relatively unimportant pests in 1979, although injury from these insects was slightly higher in check than IPM blocks. Woolly apple aphid (WAA) injury (i.e., WAA and/or sooty mold growth on the aphid honeydew on fruit) was identical in IPM and check blocks. Speckling of fruit with white apple leafhopper (WAL) excrement was particularly high in 1 check orchard, resulting in high average injury from this insect compared to IPM blocks.

Mite Populations. Overall, IPM blocks had lower European red mite (ERM) peak and average numbers than the check. Two-spotted mites (TSM) did not exceed very low levels in any block, while apple rust mites (ARM) were found in substantial (but well below damaging)numbers in IPM blocks (Table 2). ARM cause no damage to fruit trees unless in excess of 300 per leaf and may serve as an alternate food source for our major mite predator Ambylseius fallacis (AF) when ERM and TSM prey are few in number. Higher ARM populations and avoidance of chemicals toxic to AF probably account for higher average and peak number of AF in IPM than check blocks.

Table 2. Average and peak number of mites per leaf (IPM and check orchards) in relation to acaricide sprays, 1979.

Orchard type	No. Blocks	Avg. no. spray dates	Acaricide dosage equivalents[y] Oil	Other	Number of mites per leaf: European red mites Avg.	Peak	Two-spotted mites Avg.	Peak	Apple rust mites Avg.	Peak	Amblyseius fallacis Avg.	Peak
IPM	15[z]	0.6	1.06	0.4	1.2	4.0	0.3	0.8	34.5	69.3	0.03	0.11
Check	9	1.1	1.04	1.7	2.3	10.0	0.3	0.6	8.3	19.1	trace	0.01

[z] One block not included (grower did not comply with IPM recommendations)

[y] Dosage equivalents = $\frac{\text{actual pesticide rate/100 gal.}}{\text{NY recommended pesticide rate/100 gal.}}$

In keeping with program objectives, IPM growers have generally avoided the use of materials which are known to be harmful to beneficial predators and parasites [Fruit Notes 43(5)]. The recent advent of spotted tentiform leafminer (STLM) as a major pest in Massachusetts and use of the carbamate insecticide, Lannate*, to control STLM posed a serious threat to IPM objectives.

In one Granville area orchard this season, high counts of second generation STLM mines indicated a need to treat for this pest using Lannate*. For the remainder of the season there was a sharp decline in numbers of Amblyseius fallacis (AF). The possibility exists that AF may survive in the ground cover if spray runoff is not excessive, although this remains to be proven.

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* Trade name

Insecticide, aphicide and miticide use. IPM blocks received 46% fewer insecticide sprays (average 6.0, range 4-7) than the checks (average 11.0, range 6-12) (Table 1). Same orchard non-IPM blocks received an average of 9.1 sprays, suggesting that growers applied some information from IPM block scouting to the rest of their orchard. The average numbers of aphicide sprays was identical in IPM, check, and same orchard non-IPM blocks (Table 1). Fewer miticide sprays (e.g., Plictran* and/or Omite*) were applied to IPM blocks (average 0.6) compared to checks (average 1.1) [Table 2] or same orchard non-IPM (average 1.0) [date not shown].

In contrast, use of oil as an ovicide was about equal in IPM and check blocks.

In addition to the substantial reduction in spray application dates, there was also a reduction in dosage equivalents for insecticides (42% reduction), aphicides (60% reduction) and miticides (76% reduction) in IPM compared to check (Table 3).

Cost and benefit comparison. Table 3 summarizes the cost benefit analysis of IPM vs. check blocks. Average costs per acre for insecticide and miticide materials, respectively, were $51.64 and $14.59 lower in IPM blocks, while aphicide costs were nearly identical with the checks. IPM spray material application costs were also lower due to the reduction in number of spray dates. At harvest, IPM blocks had 23% less fruit injury due to insects, resulting in an average of $40.46 less fruit loss per acre than check blocks. As a consequence, compared with check growers, IPM growers realized an average net benefit of $122.83 per acre from the IPM program. This finding, coupled with a $71.00 net benefit from the IPM program in 1978, indicates the potential economic value to Massachusetts fruit growers of implementation of an IPM program on apples.

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* Trade Name

Table 3. Cost benefit analysis of insect and mite results in 16 IPM and 9 check commercial apple blocks in Massachusetts, 1979.

Observation	Orchard: IPM	Orchard: check	Difference IPM vs. check: Difference	(%)
Average number spray dates per acre	6.0	11.0	-5.0	(46)
Average number dosage equivalents for[z]:				
Insecticides	5.8	10.1	-4.3	(42)
Aphicides	0.2	0.6	-0.4	(60)
Miticides	0.4	1.7	-1.3	(76)
Average cost/acre spray materials for:				
Insecticides	$53.99	$105.62	-$51.64	
Aphicides	$ 3.46	$ 3.35	+$ 0.11	
Miticides	$11.25	$ 25.84	-$14.59	
Spray applications[y]	$19.50	$ 35.75	-$16.25	
Average % of insect injury[x]	3.64	4.73	- 1.09	(23)
Average value per acre of fruit loss due to insect injury[w]	$90.01	$130.47	-$40.46	
Average net benefit per acre from IPM	—	—	+$122.83	

[z] Dosage equivalent = $\frac{\text{actual pesticide rate/100 gal.}}{\text{NY recommended pesticide rate/100 gal.}}$

[y] Based on 15 min. time to spray 1 acre, $5.00/hour labor cost and $2.00/acre/application for fuel and oil.

[x] Does not include injury from sooty mold, white apple leafhopper and woolly apple aphids which could be removed by washing fruit.

[w] Based on average values as of Sept. 30: U.S. Fancy fruit @ $10.50/bu., U.S. #1 fruit @ $7.00/bu., Cull fruit @ $2.00/bu. and average yields of 550 bu./acre.

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FRUIT NOTES INDEX FOR 1979

(This index of major articles has been prepared for those who keep a file of Fruit Notes. The number in parenthesis indicates the pages on which the item appears.)

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 45, No. 1
JANUARY/FEBRUARY 1980

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FURTHER TRIALS WITH NAPHTHALENE ACETIC ACID (NAA) FOR TREE TRAINING

William J. Lord and Duane Greene
Department of Plant and Soil Sciences

It was reported in 1977 that 1% NAA in latex paint is an excellent tree training aid when applied as a painted band around the stem of newly-planted apple trees (after heading) to cover the second, third, and fourth buds. The first bud below the heading cut, which was not painted, became a vigorous central leader. This treatment eliminated the cluster of vigorous shoots in the top of the trees which compete with the central leader and increase the number of favorably positioned branches on the newly-planted trees, and improve crotch angles of these branches. If for some reason the bud selected for the central leader died, a strong leader reportedly developed from the NAA-treated area. Basically, the suggested NAA treatment is a replacement for the current training procedures which involve removal by hand, in June, of growth that is in competition with the shoot favored as a central leader.

Directions for use indicated that the 1% NAA in latex paint should be applied after heading the newly-planted tree to the desired height but before growth begins. The treatment is not effective if made after start of growth.

We tried the NAA-tree training technique on Marshall McIntosh, Macoun, and Redspur Delicious in 1977. In the May/June, 1978 issue of Fruit Notes we reported that the treatment was a complete disaster. The first bud below the heading cut, which was supposed to develop into the leader, was with only one exception either severely stunted or killed. When the bud selected for the central leader died, no strong leader developed from the NAA-treated area.

Further tests were conducted in 1978 on 1-year-old Redspur Delicious trees after heading, using concentrations of 0.25%, 0.50%, or 1.0% NAA in latex paint. Applications of 0.50% or 1.0% suppressed leader growth, although the reduction was less than recorded in 1977. Leaders on trees painted with 0.25% NAA in latex were shorter than those on the headed control, deshooted, or disbudded trees when measured on August 8, 1978 but not on September 9, 1978. Thus, it appears that trees may overcome the inhibitory effects of NAA if concentrations applied are not excessive.

Thus, we concluded from our 1977 and 1978 trials that NAA, ethylester at 0.5 to 1.0% in latex may suppress leader growth when applied as a band on newly planted or 1-year-old apple trees after heading.

Furthermore, it has at least 4 obvious drawbacks. Spring is an extremely busy season and chances are good that the NAA will not be applied. Secondly, the treatment must be applied before growth starts. Thirdly, the present procedures of leader selection are less time consuming than the NAA treatment. And lastly, a better choice of a leader often can be made in mid-June and this job can be combined with limb spreading with clothespins. Thus, we will continue to suggest the present procedures of leader selection. This involves selection of the uppermost shoot on the windward side of a newly-planted tree when shoot growth is 6 to 8 inches in length. Shoots competing with the selected leader should be rubbed or pruned off for a distance of approximately 6 inches down the stem.

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WINTER INJURY TO FRUIT TREES IN 1978-79

William J. Lord and Peter Veneman*
Department of Plant and Soil Sciences

Pomologists in the early 1900's considered winter injury to roots of fruit plants to be a major problem of fruit production in northern growing areas. Thus, considerable time was devoted to the study of low temperature effects on tree roots. However, a search of literature shows that root-kill on fruit trees has occurred only once during this century in Massachusetts prior to this past winter.

G.E. Stone, Botanist for the Massachusetts Agricultural Experiment Station, stated that root injury to apple trees occurred during the severe winter of 1903-04. No mention was made of temperatures and snow cover in orchards that sustained injury. Minimum temperatures at Amherst in December, 1903 and January, 1904 were -3.5° F. and -26° F., respectively. The mean temperature for January was only 14.3° F. A total of 36 inches of snow fell at Amherst in December, 1903 and January, 1904.

Whether or not the snow cover was lost in the orchards where winter injury occurred is not known. During the winter of 1898-99 winter injury was widespread in Wisconsin, Iowa, Minnesota, and Canada. It was observed that where there was good snow cover there was no root injury when air temperature went as low as -50° F.

The winter of 1933-34 was also unusually severe but the injury was confined to the above-ground tree portions. February was especially cold with a minimum temperature of -22° F. and a mean temperature of only 11.6° F. for the month at Amherst, MA. The 3 major types

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of winter injury that occurred during the winter of 1933-34 were: killing of the sapwood in the branches and trunks; loosening and splitting of bark on the trunk; and injury to flower buds and spurs.

Winter injury to above-ground portions of fruit trees has also occurred since the writer came to Massachusetts in 1955. In the spring of 1956 we found severe winter injury to the trunks and lower scaffold limbs of bearing trees, mainly McIntosh in several orchards. The bark on the injured tree trunk was split and usually pulled away from the wood. The injury was most predominant on the south side of the tree, but no side was immune. The winter injury appeared to be associated with pruning during late December and early January. During the winter of 1956-57 extensive wood injury and injury to both flower and leaf buds occurred on peach trees and to flower buds on sweet cherries and plums.

Pruning-related injury also occurred during the winter of 1975-76. It was found in more orchards than in 1956 and also occurred in Connecticut and New Hampshire. The trunk injury was associated with pruning done as late as the 3rd week of January in 1976 in some orchards. Cold injury and how it relates to the winter injury in 1975-76 was reviewed by D.A. Kollas in 1978 in Fruit Notes 43(6): 1-5.

This past winter (1978-79) root-kill was the predominant type of injury to apple and peach trees. On peach trees the bark on the trunk at ground level or below ground also was injured.

The main objective of this article is to have a written account of winter injury in 1978-79 for reference if similar damage occurs in the future.

Early Studies on Root Damage

Roots have been found to be the tenderest part of the apple tree although those that have been exposed throughout the previous growing season have cold tolerance equal to the above ground tree parts. D.B. Carrick in New York State (Cornell University Agr. Exp. Sta. Memoir No. 36, 1920) reported that, under laboratory conditions, apple roots frozen in October and November were more tender than those frozen in February or early March. The period of maximum resistance to freeze damage seemed to end before last of March. J.R. Magness in Washington State showed that bark of apple roots was killed at temperatures as high as 23° F. in November. Root samples taken in early December were killed by exposure to 17° F.

G.F. Potter in New Hampshire reported that 16° F. was usually critical for roots of 1-year-old apple trees under laboratory conditions. Very rapid freezing of roots to 18° F (in a half hour or less) caused more injury than when freezing them so that the roots reached the same temperature after 6 or 7 hours. However, rate of thawing did not affect the severity of the low temperature injury.

In studies with peach trees, D.B. Carrick stated that it is not easy to assign an arbitrary limit within which the roots are injured by freezing. "This is because of the great variation in the root tissues. The peach cambium certainly is as hardy as the pear cambium though less so than the apple. Regardless the size of root, most of the peach material tested showed some injury at -10° C. (14° F.), and except in unusual cases, serious injury occurred at -11° C. (12° F.)".

Winter Weather, 1978-79

Temperatures in December, 1978 in Central Massachusetts (where most orchards are located) averaged 0.8° F. higher than normal, and the maximum snow depth varied from 4 to 11 inches depending on location of the weather station. Temperatures in January continued to be somewhat higher than normal and maximum snow cover varied from 3 to 11 inches. At the Horticultural Research Center (HRC) in Belchertown, there were 4 snow storms in January: 2 inches on the 5th and 13th, and 3 inches on the 17th and 20th. However over 8 inches of rain fell after these storms and eliminated the snow cover: 2.3 inches on the 7th and 8th, 1.1 inches on the 13th, 2.5 inches on the 20th and 21st, and 2.5 inches on the 24th and 25th.

Temperatures in Central Massachusetts were 8.6° F. lower than normal in February, snow fall averaged 6 inches, and the maximum depth of snow on the ground varied from 3 to 10 inches, depending on the location of the weather station. There was one snowstorm of 2.5 inches in February at the HRC prior to -10 to -14° F. temperatures from the 9th through the 17th. Although the air temperatures were not extremely low, soil temperatures at 8 and 30 inch depths in one block of trees in sod were 19° F. and 30° F., respectively, on February 16th.

Symptoms of Injury

Apple. The first symptoms of injury to apple trees at the HRC was observed on May 7 at the full pink stage of blossom development. Blossoms on 1 limb, 2 or 3 limbs, or the entire tree were white in color rather than pink and leaf margins were brown. Maximum air temperatures of 84° F., 93° F., and 91° F. were recorded on May 8th, 9th and 10th, respectively. The symptoms worsened considerably during this time, with more trees exhibiting injury, and the blossoms on the affected branches failed to open and eventually wilted and aborted. Examination of the roots revealed that the wood was brown which indicated winter injury had occurred.

Severely affected trees died as the growing season progressed. Other trees began to exhibit light-colored foliage, with interveinal mottling that was orange in color. These trees made little terminal growth and had a light crop. It is possible that many of the severely-weakened trees will have to be replaced in 1980. Injury symptoms did not worsen on trees having only 1 or 2 affected branches. It also was of interest to note that latent buds produced growth on some of these affected branches.

Peach. The injured trees bloomed and then the blossoms wilted. By late-May or early June, thousands of these trees had died or exhibited severe injury. In some orchards entire blocks of trees were removed in June. Weakened trees that were not removed had sparse foliage throughout the summer and few peaches. These trees should be replaced in 1980.

Injury In Other Areas

Winter injury in New Hampshire is discussed in separate article in this issue of Fruit Notes. It also occurred in Washington, New York, Maine and probably in other areas.

According to James Ballard, Yakima County Extension Agent, Central Washington, fruit orchards and vineyards suffered severe damage in January, 1979. Sub-zero weather occurred during the last week of December, 1978, and temperatures remained below freezing for 24 consecutive days. Snow cover did not come until January 11, 1979, and by then the cold had penetrated root zones and soil temperatures had dropped to 14° F. The damage was most severe on trees 5-years-old or younger, planted on rocky, cultivated ground that had little or now snow cover.

Richard Norton, Fruit Specialist in Rochester, NY stated in Spray Letter No. 10, May 13, 1979 that winter injury was the major cause of: "(1) dying cherry trees - most young non-bearing trees; (2) dying lower branches in bearing apple trees, particularly unpruned or poorly pruned trees, (3) spur dieback of young apple trees and outright death of many young apple trees, and (4) death of thousands of peach trees and limb dieback." He attributed the winter injury to combinations of factors such as weather, herbicides, poorly drained soils, heavy crops in 1978, poor management, particularly inadequate pruning, varietal susceptibility and ice.

In July, 1979 Herbert Wave and Warren Stiles reported symptoms of winter injury in Maine. They stated that the injury was varied with malformed and/or russetted fruit, dieback of limbs and/or tops of young trees, or killing of the rootstock. Most root injury occurred on wet soils or where there was little or no snow cover during mid-winter.

Cause and Factors Influencing Injury

We believe the injury to the peach trees in Massachusetts, which are generally planted on well-drained slopes, was due to lack of snow cover which allowed deep penetration of frost and alternate thawing and freezing of the roots. At the HRC, the older bearing peach trees which had large crops in 1978 were injured more severely than younger trees commencing to bear.

Paraquat had been applied annually to control grass and broadleaf weeds under all peach trees at the HRC but they also had received periodic applications of hay mulch, which was last applied in 1977. Thus, mulch did not prevent damage.

Frequently roots of fruit trees appear more susceptible to winter injury in dry than in wet soils. However, at the HRC, the injury to apple trees was worse on heavy, poorly-drained soil. Thus, the combination of poor soil aeration, 8 inches of rain in January and no snow cover intensified the problem of root injury. Nevertheless, trees were injured on well-drained soils both at the HRC and commercial orchards or where ledge prevented deep rooting.

It was not possible to determine whether rootstocks differed in susceptibility. An interplanted block of mature trees on seedling roots and M.7 was equally damaged in a commercial orchard. In other blocks in the same orchard, "filler" trees on MM106 died whereas the injury to those on M.7, MM111, or M.2 rated from none to medium. At the HRC soil rather than rootstocks appeared to be the more important factor contributing to winter injury. No Millerspur or Empire trees with an 8-inch interstem of M.9 on Antonovka, MM111 or Ottawa 11 planted in 1976 on well-drained soil were injured even though soil temperature at 8-inch soil depth went to 19° F. However, McIntosh and Delicious on MM106, M.7 or M.26 planted the same year in the same block, were severely injured where the soil is poorly drained due to a hardpan underneath. In other blocks on MM.106, M.7 or M.26, the injury to roots was clearly associated with areas having poorly drained soil.

Summary

Growers have become concerned because of the winter injury to roots, especially in the absence of sod under their trees because of annual use of a contact herbicide such as paraquat plus a soil sterilant (diuron or simazine). Studies have shown that soil temperatures in winter can be higher under a sod or sod-plus-mulch than under bare sod. However our peach trees at the HRC were severely injured last winter in spite of a heavy residue of mulch. We are more concerned about the occurrence of soil erosion and tree heaving on bare soil, which is much more common, than possible winter injury to roots.

This last summer, we tagged individual limbs and whole trees at the HRC after rating the severity of winter injury. This should enable us to determine the degree of tree recovery in the orchard.

Hopefully, the combination of excessive rainfall in January and bare soil in early February during a period of sub-zero air temperatures, will not reoccur for many years.

WINTER INJURY IN NEW HAMPSHIRE--A GROWER SURVEY

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Winter injury to the roots of apple trees is certainly not a common occurrence in New Hampshire, since an adequate snow cover usually protects tender tree roots from extreme low temperatures. However, throughout much of southern New Hampshire in the winter of 1978-79 snow cover was light and bare wind-blown spots were commonplace. Added to this were low soil moisture levels and long, uninterrupted periods of very cold temperatures--all the ingredients necessary for root injury.

The symptoms of severe injury have been well detailed. At about bloom, leaves and blossoms on the affected trees wilt and die. On less severely affected trees, the leaves wilt but seem to recover and injury to blossoms is less severe. New leaves develop and although the tree sets a very light crop and makes no growth, at least the tree is alive. Damage of these 2 types is easy to assess and tree crop losses can be accurately and easily determined. However, low level injury--injury that shows up as reduced tree growth, poor leaf color, and reduced set and yields--is difficult to assess and, I feel, tremendously underestimated.

This Fall a grower survey was initiated to determine the extent of injury and to correlate the incidence of injury to site, rootstock, variety, etc. The following conclusions can be made based on the survey replies:

1) Rootstock had no effect on the incidence of tree injury. Injury was reported on all the major rootstocks in use in New Hampshire--seedling, M-106, M-7, M-26, and M-9/MM-106 interstems. Where more than one rootstock was present in a particular block showing injury, all rootstocks showed injury.

2) Tree cultivar likewise (and expectedly) had no effect on the incidence of injury.

3) Affected trees ranged in age from 1-year-old semi-dwarfs to 60+year-old standards. Again, no correlation existed between age and injury.

4) Herbicide program effects on tree injury are not so clear-cut. It would appear from the grower responses that the majority of sites reporting injury had no herbicide application in 1978, indicating that perhaps there was a slightly greater incidence of injury in blocks where no herbicides were applied. However, it seems more probable that this simply reflects the smaller number of growers who use herbicides rather than any correlation to injury.

5) There appeared to be a correlation between the occurrence of injury and site. Most injury occurred on wind-blown sites and on sites with a high-water table where the trees had previously shown symptoms of "wet feet".

Estimating crop loss can be difficult; however, I feel we can approximate the actual crop loss using data supplied to us by growers. The grower data indicate the following crop losses.

Trees Dead	Trees Severely Injured	Est. Crop Loss (bu)
3800	10,615	188,965*

* Adjusted to reflect lost crop as replacement trees develop.

As substantial important as these figures seem, most winter injury went unrecorded. The injury that escaped notice was the less severe type--the poor tree vigor and the reduced crop set and yield. This less severe winter injury probably will cost our growers much more in the lost production than the losses recorded above.

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PROGRESS REPORT: HEIGHT CONTAINMENT ON SPARTAN AND IDARED TREES

William J. Lord and Anthony Rossi
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Pyramid-shaped trees on the more dwarfing rootstocks will produce the bulk of their crop within reach from the ground, without a ladder, and should produce well-colored fruits throughout the tree. However, the most heavily planted size-controlling rootstock in Massachusetts is Malling 7 (M7), on which vigorous cultivars will produce trees 16 feet or taller. When asked what they consider to be the ideal height for trees on vigorous size-control rootstocks, the answer given by growers generally varied between 10 to 14 feet.

At present there is no rootstock more suitable than M.7 for our cultivars, with the exception of Delicious. However, it may become necessary to lower or contain the height of trees on M7 in the future because of the shortage of suitable harvest labor. Therefore, questions to be answered are: (1) What is a suitable pruning method for containing tree height? (2) What is the influence of height reduction on yield? To answer these questions we established a demonstration in 1976 on 12-year-old Spartan and Idared trees on M7 planted at the Horticultural Research Center at 20 ft. x 30 ft. spacing. We consider trees of Spartan and Idared to have medium and low vigor, respectively.

Pruning and Training Procedures

The trees were not excessively tall, the Spartan and Idared trees averaging 12 ft. and 11 ft., respectively. However, the leader had lost its dominance on some trees, particularly on Spartan, and no attempt had been made to maintain pyramid-tree shape. Tree height was restricted on even numbered trees in a 25-tree row of Spartan and in a similar row of Idared. This was accomplished by cutting back the leader to an outward growing branch (Figure 1) and maintaining tree height at this level. On odd numbered trees in each row we gradually shortened the central leader so trees of both cultivars are approximately 2.5 ft. shorter than the height-restricted trees. Height of the leader on the height-reduced trees averaged 8.9 ft. and 8.3 ft., respectively, after pruning in February, 1979. Height of the height-restricted Spartan and Idared trees averaged 11.4 and 10.6 ft., respectively.

Figure 1. A Spartan/M7A tree planted in 1964. The central leader was cut to a lower horizontally growing lateral branch. A branch rotation program has been initiated in the top third of the tree.

A comparison of the trees is shown in Figures 2 and 3. (Tree spacing appears much greater in the photographs than in reality. Trees of both cultivars are planted at 20 ft. x 30 ft. spacing. Branch spread of the Spartan trees is 17 ft., therefore, 17 ft. x 25 ft. spacing would be ample. Branch spread of the Idared trees is 14 ft., thus 14 ft. x 22 ft. spacing appears suitable for this cultivar.)

Figure 2. Spartan trees planted in 1964; picture taken March, 1979 after pruning height of the tree on right has been gradually lowered since 1976. The height-reduced trees now average 9 ft. in comparison to 11.4 ft. on the control trees.

On both the control and height-lowered trees some of the stronger branches in the top third of the trees were removed or their length restricted by cutting to a weak lateral branch. A few water sprouts were retained and spread for replacements of pruned vigorous branches. Thus, we have developed a branch rotation program which consists of removing large branches in the top third of the tree and leaving weak branches which in turn will be removed when they become larger (Figure 1).

Figure 3. Idared trees planted in 1964; picture taken March, 1979 after pruning. Height of the tree on the left has been gradually lowered since 1976. The height-reduced trees average 8.3 ft. and the control trees 10.6 ft.

Spreaders with nails, sharpened on an emery wheel, at each end have proven satisfactory for positioning 1-year-old sprouts (Figure 4). The water sprouts positioned in 1976 became sizeable branches within 2 growing seasons (Figure 5). Another method used to develop new lateral branches involved leaving a short stub by making a sloping cut when a favorably positioned lateral branch originating from the central leader was removed.

A shoot that develops from the stub on the central leader is retained and positioned (Figure 6).

Figure 4. Softwood sticks 3/4 x 3/4 inch or 1 x 1 inch and cut to various lengths are frequently used for limb spreaders. Regular box nails (8 or 10 penny) are driven into ends of the sticks and then the nail heads are cut at a sharp angle. Sharpening the nails with an emery wheel will expedite positioning of water sprouts and reduce damage.

Figure 5. A limb on Spartan in November, 1977 that was spread when a water sprout in February, 1976.

Figure 6. Water sprouts that develop from stubs can become valuable replacement limbs if positioned. The arrow points to the wooden spreader on a water sprout on a Spartan tree.

Observations and Results

Limb rotation in the top third of the tree, which involves cutting vigorous branches back to the leader or to a much weaker side branch which in turn will be removed when it becomes large, may be a suitable tree containment technique regardless of planting density.

Retaining and spreading water sprouts to replace pruned branches appears practical and is being done in some commercial orchards. Many trees require no limb spreaders and when used, only 2 or 3 are generally necessary.

A shoot originating from a stub of a branch removed from the central leader can become a valuable replacement limb. Shoots originating from the lower side of the stubs generally have the most desirable crotch angles. Therefore, when removing the branch from the central leader, we suggest a slanting cut be made so that the top of the stub will be flush and the bottom of the stub will project about 1 inch.

The yield reduction on the height-reduced trees was not consistent until 1978 (Table 1). In 1978 and 1979 the shorter trees of both cultivars produced less fruit than the taller trees. The 2.5 foot reduction in tree height reduced yield by 2.5 to 3 bushels in 1979. This is a sizeable reduction in yield and should be considered when reducing tree height in an established planting. New plantings can be designed with higher tree densities to compensate for bearing surface lost by keeping trees shorter.

Table 1. Influence on yield from height reduction of Spartan and Idared trees[z].

Year	Spartan[y] Height reduced	Spartan[y] Control	Idared[x] Height reduced	Idared[x] Control
		Bushels/tree		
1976	6.0[w]	8.0a	6.2a	7.5a
1977	4.0b	5.3a	4.1a	4.8a
1978	10.4b	12.5a	10.2b	12.4a
1979	9.6b	12.9a	8.9a	11.4a

[z] Trees planted in 1964; trial started in Feb., 1976.

[y] Tree height 3/79: Control - 11.4'; height-reduced trees: 8.9'

[x] Tree height 3/79: Control - 10.6'; height-reduced trees: 8.3'

[w] Means in any row for each cultivar followed by different letters are significantly different at odds of 19 to 1.

Summary

We plan to maintain the 2.5 foot height difference between the height-restricted and height-reduced trees in 1980 and 1981 in order to determine the yield differences. It is unfortunate that McIntosh trees are not in this trial because it would be of interest to determine the effect of pruning on fruit color. Nevertheless, this trial and others has supplied valuable information on containment pruning, and should continue to do so. Trees on vigorous-size controlling rootstock are the predominant type tree in Massachusetts. We believe that by maintaining a dominant central leader and doing containment pruning, trees on M7, MM111, and MM106 can be kept to a size suitable for medium density orchards (115-200 trees per acre).

Alternate vs. Every Middle Spraying For Apple Pests in 1979

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Department of Entomology

In previous issues of Fruit Notes, we reported our 1977 and 1978 findings on the comparative effectiveness of alternate-middle vs. every-middle spray treatments for apple pest control. (See Fruit Notes 43(3): 15-19 and 44(3): 13-15.)

The 1979 results of alternate middle spraying for apple diseases have been reported in the November/December, 1979 issue of Fruit Notes. Here, we present (a) our findings on alternate middle vs. every middle spraying for apple insects; (b) further information on diseases, and (c) a cost-benefit comparison with regard to insects, mites and disease control.

Alternate middle spraying involves spraying alternate halves of each tree on alternate spray dates instead of both halves on all spray dates. For example, in applying the first cover spray, the sprayer would be driven up the middle between tree rows A and B and return down the middle between rows C and D, skipping the middle between rows B and C. For the second cover spray, the sprayer would be driven up the middle between rows B and C, down the middle between rows D and E, and so forth. If this pattern is followed on each spray date, it would save 50% of spray material and application costs.

Each of four test blocks in commercial orchards was divided into 2 plots of 2-6 acres each. One plot received the alternate middle program on each spray date throughout the season. The other received the every middle program. Each grower used an air-blast sprayer and a concentration (1X, 4X, etc.) of his own choosing. Growers followed their normal spray schedule and selected their own pesticide materials. Except in one block, all trees were fully grown, some on M7 rootstock, others on seedling. Pruning was generally adequate to allow for good spray penetration into tree centers.

Monitoring of Pest Populations

We utilized commercially available visual traps to monitor populations of tarnished plant bugs, European apple sawflies, and apple maggot flies as well as pheromone traps for

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Other field personnel were Glenn Morin, Senior Scout; Norman Anderson, Clarence Boston, Annemarie Pennucci, and Mary Tubbs, Scouts.

codling moth, redbanded leafroller and oblique-banded leafroller. Visual inspections of fruit and foliage in all portions of the tree canopy were used to monitor populations of plum curculio, spotted tentiform leafminer, green apple aphids, and aphid predators.

Sampling was only tri-weekly, due to gasoline scarcity. An on-tree survey of 1200 fruit per treatment block was performed at harvest to determine injury levels to fruit.

Insect Injury to Fruit At Harvest

Total insect injury at harvest averaged 2.84% in alternate-middle blocks vs. 3.61% in every-middle blocks (Table 1) below.

Table 1. Average percent of insect and disease injury to fruit in 4 alternate-middle vs. every-middle commercial orchard blocks in Massachusetts, 1979.

Insect	Every-middle	Alternate-middle
Tarnished plant bug	3.07	2.48
Plum curculio	0.27	0.12
San Jose scale	0.19	0.04
Apple maggot fly	0.04	0.02
European apple sawfly	0.02	0.02
Green fruitworm	0.02	0.02
Codling moth	0.00	0.00
Other	0.00	0.14
Total	3.61	2.84

Disease	Every-middle	Alternate-middle
Scab	0.24	.06
Rots	0.14	.11
Rusts	0.00	.06
Total	0.38	.23
Total injury from insects and disease	3.99	3.07

In 1979, the most serious pest in both types of blocks was tarnished plant bug, which accounted for 2.48% injury in alternate-middle blocks vs. 3.07% in every-middle blocks.

Injury from the other major insect pests (plum curculio, San Jose scale and apple maggot fly) was consistently greater in every-middle than in alternate-middle blocks. European apple sawfly and green fruitworm injury levels were identical under both treatments, whereas leafroller injury was high (0.58%) in one alternate-middle block.

Disease Injury to Fruit at Harvest

Apple scab was the principal disease problem in all blocks. Various rots were of secondary importance, while rusts were only occasionally present (Table 1).

Overall disease incidence was slightly greater in every-middle (0.38%) vs. alternate-middle (0.23%) blocks. (For more information concerning 1979 disease results in alternate-middle vs. every-middle blocks, see <u>Fruit Notes</u> 44(6): 6-8.)

Cost Benefit Comparison

In 1979, alternate-middle spraying resulted in a savings of $62.61 per acre for insecticide and miticide materials and application costs. Fungicide materials and application costs were $70.69 less in alternate-middle blocks. Fruit loss due to insect and disease injury was $19.03 and $6.70 less, respectively, in alternate-middle blocks (Table 2).

Table 2. Cost benefit analysis of every-middle vs. alternate-middle treatments, 1979.

	Dollar cost/acre		
	Every-middle	Alternate-middle	Differences
Avg. cost of insecticide and miticide materials and application	$125.23	$62.62	-$62.61
Avg. value of fruit loss due to insect injury	$ 78.93	$59.90	-$19.03
Avg. net benefit from alternate-middle spraying for insects and mites			+$81.64
Avg. cost of fungicide materials and application	$141.38	$70.69	-$70.69
Avg. value of fruit loss due to disease injury	$ 17.80	$11.10	-$ 6.70
Avg. net benefit from alternate-middle spraying for diseases			+$77.69
Avg. net benefit from alternate-middle spraying for insects, mites and diseases			+$159.33

Growers utilizing alternate-middle spraying realized a net benefit of $81.64 per acre with regards to insects and mites, and $77.69 for diseases, or a total average net benefit of $159.33 per acre.

We believe that our 1979 results, as well as those from 1978, indicate the potential usefulness of alternate-middle spraying, perhaps most advantageously employed when in combination with intensive IPM weekly scouting and grower advisement. (See Fruit Notes 44(6): 6-8, 9-14.)

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EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 45, No. 2
MARCH/APRIL 1980

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AIRBLAST SPRAYERS FOR ORCHARD SPRAYING[1]

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Airblast orchard sprayers which form, transport, and deposit water droplets onto all above ground parts of trees are essential to the commercial production of deciduous fruit crops in eastern fruit growing areas. One characteristic which these sprayers have in common is a fan that generates the mass of air which carries droplets of pesticide suspensions to the target area. The management and control of all major orchard pests affecting leaves, twigs and fruit (diseases, insects and mites) is dependent upon timely pesticide sprays applied to all areas of the tree. In orchard spraying, the spray target often is not the specific pest being controlled (insect, mite or fungus spore) but rather the leaves or fruit on which it may be present or to which it may visit after the spray has been applied. The target, thus being the tree which is extremely variable in size, shape, density, and row spacing, has created a need for different types of sprayers. Sprayer manufacturers responding to these needs have produced airblast sprayers which are so diverse that a grower in America can buy just about any type he may need for his orchard operation.

Because of the gradual change from standard size trees to semi-dwarf and dwarf types most growers in the mid-Atlantic states have needs for a sprayer that can be used to spray conventional size standard apple trees as well as dwarf apple, peach and cherry. The amount of spray mixture used per acre is another variable that has to be adjusted depending on tree type and size. The amount commonly used varies from 400 gal/A (gpa) in dilute sprays for mature standard apple trees to 10-20 gpa with low volume sprayers. Ultra low volumes of as little as 1.0 to 3.0 gpa have been used with special sprayers but this usage is still very limited. With this magnitude of variation in tree size and spray volume used and the wide range of sprayers available with just about any size tank, it is understandable why growers are often confused when buying a sprayer. To add to the confusion, descriptive phrases such as cfm air volume, air velocity range, dual adjustable blower, axial flow and centrifugal fans, mass median diameter of droplets, shear, disc, mistifier and spinning nozzles, touch command meters, flip over nozzle, and fluid agitation often are used to reveal the wonders of each specific sprayer.

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[1] Appeared in the Maryland Fruit Grower 49(4): 2-6, 1979 and the Pennsylvania Fruit News. April, 1979. Reprinted with permission of the author.

Conventional vs. Low Volume Sprayers

Orchard airblast sprayers available today may for convenience sake be placed in one of three major categories, i.e., conventional, low volume and ultra low volume.

The conventional type airblast sprayer commonly used today and during the past decade was designed to apply both dilute and semi-concentrate rates which ranged from 500 gpa to as little as 50 gpa. These sprayers operate at a pump pressure from 30 to 400 psi that force the spray mixture through a manifold on which several nozzles (6 to 15 per side) are located. Variable nozzle sizes may be selected which regulate the sprayer delivery rate as well as the range of droplet size produced. The droplets are discharged into the airstream which range in velocity from 80 to 120 mph and in volume from 25,000 to 90,000 cubic feet of air per minute (cfm). Air volume specifications for orchard airblast sprayers in the past have been highly controversial and their accuracy questionable to the point where they are not often used today. The droplet size produced by these machines has a wide range from 10 to 600 mu depending on pump pressure and nozzle orifice size. The conventional sprayers are effective in the application of 50 gpa or higher but are limited in the application of smaller amounts.

In recent years sprayers designed to apply 5 to 20 gpa have been introduced and widely used in many apple growing areas of eastern United States. Similar type concentrate or low volume sprayers have been used for the past 20-25 years in Europe, Africa, Australia, Middle-East, Canada, and in several apple growing areas of western United States.

The low volume airblast sprayer differs from the conventional type mainly in pump pressure, air velocity and air volume. Pump pressure ranges from 25 to 100 psi. Nozzles used on these machines vary from 3 to 12 per side and are either a hollow-cone swirl nozzle, a spinning nozzle, or an air jet which does not use swirl plates or discs. The spray droplets are formed when the spray mixture is injected into the airstream which may vary in velocity from 130 to 200 mph and in volume from 15,000 to 25,000 cfm. The high velocity airstream performs two major functions: 1) that of a shearing or impact action in the formation of droplets which range in size from 10 to 110 mu; and 2) as carrier of the droplets to all parts of the target areas at high enough velocity for impingement.

Sprayers which may effectively dispense 1.0 to 3.0 gpa of spray mixture are available and have been proven to be equal to other sprayers in pest control. Uniform droplets are formed by a revolving porous sleeve powered by an electric 12 to 24 v DC motor. Sleeves of porous metal or plastic are available which produce precisely controlled droplets from 5 to 100 microns. The liquid pesticide formulation or suspension in water are forced through the uniform pores by centrifugal force generated by the spinning nozzle. The nozzles are mounted in the airstream which may vary in volume and velocity and the droplets are sheared off and carried to all parts of the tree.

The ultra low volume sprayer is the least tested to date and its use is limited by relatively few pesticide formulations which can be used. This type of sprayer has greater usage potential in the future when pesticides may be delivered directly from their packaged container to the tree without benefit of water as a carrier.

The low volume sprayers in general use in many parts of the world are powered by the "power-take-off" on the tractor used to pull them through the orchard but also may be engine operated. They offer several advantages over the conventional sprayer:

1. Many of these machines cost less to purchase than conventional machines since most have smaller tanks, low pressure pumps and no motor.

2. They often are less costly to operate and maintain since fuel consumption is less with only the tractor motor being used in the spraying operation. Their simple design and low pressure pump which wears at a much slower rate also contributes to their low maintenance.

3. Spraying with these machines requires less total time because more time is spent applying sprays to the trees and less time in filling the spray tank and weighing out chemicals. As much as 50% savings in spray time can be realized with a change from 400 to 20 gallons per acre.

4. Reductions by 80% in the amount of water used has resulted in a significant savings on farms where water is scarce or must be transported for some distance. This reduction in the amount of spray mixture used also eliminates the need for a "nurse tanker" and operator often used in high volume spraying.

5. Low volume spraying generally requires about 20-40% less pesticide per acre than high volume spraying.

Factors Affecting Spray Deposits

Since the mass of air generated by airblast sprayers is the major source of energy dispensed in carrying spray droplets to all parts of the tree, some understanding of its character and factors affecting it should be helpful in deciding the type of sprayer to purchase. The airblast is generated by various types of fans and may vary in volume and velocity depending on the particular design or type. Droplets are either injected into the airstream through nozzles which aid in forming droplets into a range of sizes from 30 to 600 microns (1.0 micron (mu) is equal to 1/25,000 inch or 0.001 mm), or the liquid is released into the airstream under low pressure and is broken or sheared into droplets. This shearing action is typical of the high velocity low volume sprayers commonly referred to as mist-type sprayers.

the rate of evaporation. A droplet moving in an airstream must have a certain minimum momentum in order to penetrate through the layers of air flowing around it. Because of the greater influence of drag force the smaller droplets traveling in relatively slow airstreams tend to follow the random turbulent fluctuation of the airstream more closely and therefore travel a more devious path than the larger droplets.

Considering these facts it is evident that impingement of droplets produced by low volume sprayers would be lower during periods of low R.H. or in slow moving airstreams. Workers in New York have shown that under conditions of high evaporative potential which commonly occur during the growing season, spray droplets may lose more than 40% of their original volume during transport time from sprayer outlet to the foliage. They found that when the R.H. was 95% there was only about 5% water loss at 30 feet from the sprayer outlet, while 20-25% was lost when the R.H. was 42%. Spray deposits in the top of trees was only 37% as much at 35% R.H. as when the R.H. was 95%.

Summary of Conditions Affecting Airblast Sprayer Performance

A number of experiments designed to evaluate the performance of several conventional and low volume sprayers for apple pest control have been conducted in recent years. During the past 2 years Dr. L.A. Hull, Entomologist at the Fruit Research Laboratory, and I have evaluated several sprayers for control of green apple aphid and spray distribution patterns. Control levels of aphids have been correlated with chemical deposits on leaves as measured chemically using dicofol and visually using a fluorescent tracer. A number of conclusions can be drawn from these experiments and a summary of several follows:

1. Sprayer size and design directly affects spray coverage and pesticide deposits and determines the size of tree that can be properly sprayed. Conventional airblast sprayers having an airmass volume of 65,000 cu. ft. per min. or greater with velocities of 120 mph or more and the larger low volume sprayers may be used effectively on standard orchard trees up to 22 feet in height. Low volume sprayers of the small to intermediate size which are power take-off operated perform better in dwarf or semi-dwarf trees with heights of 12-15 feet.

2. The tree size in height and density directly affects the velocity of the airmass by blocking or slowing air movement and subsequently affects the amount of chemical deposit. Sprayers should have sufficient air volume and velocity to blow through the top of the trees to be sprayed.

In a spraying system using air as the carrier of droplets several factors are operative simultaneously which affects the distribution pattern and quantity of chemical deposited. The velocity and volume of the airstream, droplet size, evaporation rate, ground speed and target distance all have individual effects on the results obtained.

Droplet size and air velocity must be critically balanced to obtain effective and efficient spray application. Spray droplets of a predetermined size must travel at specific speeds in order to remain in an airstream. Many tests throughout the years have determined these critical speeds and have shown that as the velocity decreases the larger droplets drop out first followed by proportionally smaller droplets as the velocity continues to decrease. The rate of velocity decrease of different airstreams has been found to be similar regardless of the volume. Thus, two airstreams with similar velocities at the point of outlet but having drastically different volumes will also have similar velocities at 25 feet from the outlet and both may be only 15 to 20 percent of their original speed at this distance.

In view of this rapid velocity decrease with distance from the sprayer outlet, droplet size becomes very important in the impingement of droplets on leaves and fruit which directly affects the level of pest control obtained. The impingement of liquid droplets on a solid surface such as a leaf or fruit depends largely upon two factors; 1) the mass or size of the droplet, and 2) the velocity at which it is traveling. Large droplets will impinge at low velocities but also are the first to fall out of the airstream as the velocity decreases. The smaller the droplets the higher the velocity required for their impingement but these droplets are carried farther in slower airstreams. In slower airstreams droplets are subjected to evaporation for a longer period than in high velocity ones, thus decreasing their size further and diminishing their chances of impingement. With conventional airblast sprayers the air velocity at the outlet may be approximately 120 mph while at 25 feet away it often drops to 15-20 mph. In these airstreams if proper droplet size is not carefully selected and distributed in calibrating the machine the larger droplets fall out on the lower parts of the trees while the smaller ones are carried farther but not deposited in the upper portion of the tree. The end result is often a poor spray distribution with heavy deposits on the lower leaves and fruit which may be phytotoxic and inadequate pest control in the top of trees.

The effect of relative humidity (R.H.) on spray deposition has been recognized and of concern to growers since the introduction of airblast sprayers. The effect of a high evaporation rate due to low R.H. on small droplets produced by low volume sprays is far more significant than on larger droplets because droplet size and momentum greatly affects rate of impingement. It has been shown that the rate of evaporation of the total spray volume will be proportional to the total sum of the diameters of the droplets comprising the spray. Therefore, the smaller the spray droplets the greater

3. The rate of sprayer travel has a direct effect since air velocity loss is proportional to the forward speed. Speeds above 2.5 mph for standard trees and 3.0 mph for dwarf trees are not recommended.

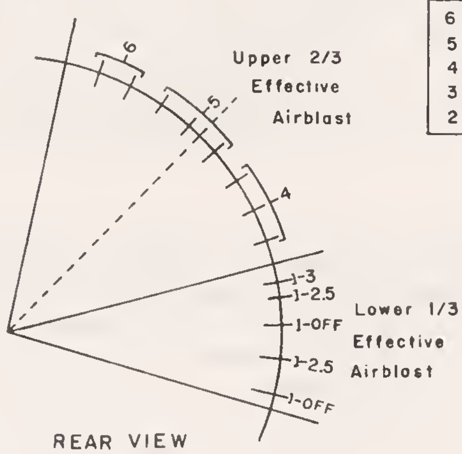
4. Evaporation rate of the droplet and droplet impingement is directly correlated with relative humidity of the ambient air. Spraying during low humidity (35-50% R.H.) periods should be avoided, particularly with rates less than 30 gpa.

5. Spray distribution in the tree as well as undesirable spray drift is greatly influenced by wind conditions at the time of application. No reliable tests under known wind conditions have been conducted to measure effect on pesticide distribution and deposits.

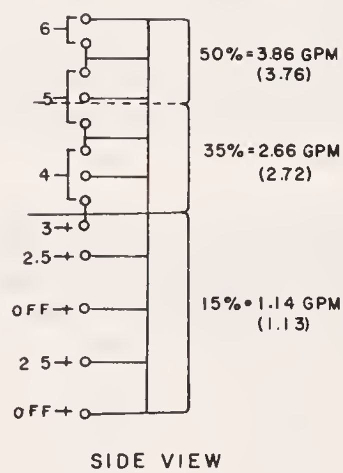
6. The level of pest control obtained is correlated with inoculum or population pressure and the amount of pesticide applied. The lowest deposits and level of pest control are in the top of trees.

7. It is important to keep any sprayer properly adjusted to obtain maximum performance. Frequently checks on pump pressure, nozzle wear, operator speed and air delivery are essential to dependable sprayer performance. It is particularly important that the air velocity of airblast sprayers with shear-type nozzles be checked frequently and maintained at between 165-200 mph.

8. Accurate calibration of airblast sprayers is essential for the uniform application of orchard pesticides. (Details of proper arrangement of nozzles to obtain proper distribution pattern for conventional airblast sprayers are given in Figure 1.)



Noz No.	Discharge GPM
6	1.05
5	0.83
4	0.63
3	0.45
2	0.34



100 GPA - 15.2 GPM (7.6 GPM/side)

Rows 30 ft. Speed 2.5 MPH

2 Hole Whirl Plate - 200 PSI

SPOTTED TENTIFORM LEAFMINERS: BIOLOGY, MONITORING, AND CONTROL

Ronald J. Prokopy, Robert G. Hislop, and William M. Coli
Department of Entomology

INTRODUCTION

From the early 1950's until 1978, spotted tentiform leafminers (STLM) could occasionally be found in low numbers in unsprayed apple trees in Massachusetts, but were rare in commercial Massachusetts apple orchards. Since then, STLM have appeared in comparatively large and damaging numbers in some commercial orchards, especially west of the Quabbin reservoir. Thus, in 1979 STLM mines were found at levels of 0.1 or more per leaf in 12 of 13 orchards sampled west of the Quabbin, but at this level in only 3 of 13 orchards sampled east of the Quabbin.

There are 2 species of STLM in Massachusetts: *Phyllonorycter crataegella* and *Phyllonorycter blancardella*. More than 90% of the STLM sampled by us in Massachusetts in 1979 were *P. crataegella*.

Recent studies by Dr. Richard Weires of the Hudson Valley Fruit Laboratory in Highland, New York and by Drs. John Leeper and Harvey Reissig of the Geneva, New York Experiment Station have clearly shown that in New York, both these STLM have developed strong resistance or tolerance to azinphosmethyl (Guthion), phosmet (Imidan), phosalene (Zolone), carbaryl (Sevin) and several other broad-spectrum insecticides commonly used in orchards over the past decade or two. On the other hand, the principal parasites of STLM continue to remain highly susceptible to these insecticides. The result is yet another instance of pesticide-induced population explosion, comparable to the situation we have experienced with spider mites over the past 3 decades. The pest, no longer influenced by the effects of pesticide and freed from the presence of natural enemies, is able to multiply very rapidly.

Resistant populations of STLM were apparently first detected in Columbia County, New York in 1974. Since then, such populations have spread throughout most of the Hudson Valley and much of Connecticut, and are now being carried into Massachusetts through natural dispersal (often aided by warm southwest winds) and importation of infested leaves in bins of apples from infested orchards.

Even in cases when the original introduction of STLM into an orchard may have consisted of only a few resistant individuals, population buildup may be very rapid. Each female lays an average of 25 eggs, and there are 3 generations per year. Hence, if there were no egg, larval, or pupal mortality, a single 1st generation mated female in May could give rise to more than 15,000 STLM larvae by September. Fortunately, there is considerable natural mortality, even in the absence of pesticide-resistant parasites or predators, so that the full biotic potential of this pest is rarely if ever realized.

In this article, we will outline the biology and monitoring methods of STLM, and suggest various possible approaches to control. Drs. Weires, Leeper and Reissig have been studying these aspects in New York since 1976. Much of what we will describe here is drawn from their excellent work, some of which is published in the 1977 Proceedings of the New York State Horticultural Society, the August 1977 issue of the Journal of Economic Entomology, the March, 1978 issue of the American Fruit Grower, and New York Food and Life Sciences Bulletin 85 (1980).

BIOLOGY

Description of Stages and Life History. STLM overwinter as pupae in apple leaves on the orchard floor. First generation adults begin to emerge when McIntosh trees are in the green tip stage of development. The adults are small (about 1/8 inch long) light brown moths with white wing spots that appear as transverse bands when the wings are folded. Though frequently found resting in ground cover vegetation during the day, they are particularly active from late afternoon through dusk, and may be found then on the undersides of leaves, the tree trunk, or interior scaffold limbs. The tiny white eggs (1/75 inch diameter) are laid singly on the undersurface of the leaves, and require about 6-10 days to hatch. First generation eggs are laid predominantly on fruit-cluster leaves in the lower half of the interior of the tree. Second and third generation eggs may be laid on any leaves anywhere in the tree. In addition to apple leaves, leaves of other trees such as crabapple, hawthorne, quince, plum, and wild cherry may also serve as STLM hosts.

The larva develops in the same leaf on which the egg was laid. Larvae develop first through 3 sap-feeding stages and then 2 tissue-feeding stages. The total period of larval development is about 3-4 weeks. Sap-feeding larvae feed just inside the lower leaf surface, and they are first evident by the presence of a thin brown u-shaped trail between leaf veins. In time, the trail will take the form of an irregular oval, circumscribing the area within which the larva will eventually develop to maturity. By the 3rd larval stage, the lower leaf surface tissue circumscribed by the trail will have a light green or whitish appearance and can be readily removed, revealing the feeding larva. Tissue feeding larvae feed just below the upper surface, producing tent-like mines with whitish spots visible when the green tissue has been eaten. The last-stage larva transforms into a pupa in the leaf tissue, with the pupal stage lasting about 10 days. The entire life cycle requires about 35-55 days, depending on weather conditions.

Mines of 1st generation larvae can be first detected in late pink or bloom, those of 2nd generation larvae in late June or early July, and those of 3rd generation larvae in mid or late August. Generations may overlap owing to the extended period of egg-laying.

Injury. STLM do not directly injure apple fruits. Rather the damage results from injury to the leaves caused by larval feeding. There is some suggestion, not yet confirmed that STLM larval feeding interferes with the ability of leaves to produce or transfer to fruit a hormone which inhibits ethylene production by the fruit. STLM injury may result in greater than normal concentration of ethylene within the atmosphere of the tree canopy.

Principal effects of extensive STLM larval feeding on McIntosh and other earlier-season cultivars such as Milton, Early McIntosh, Wealthy, and Puritan may be early ripening of fruit, premature fruit drop, reduction in fruit size and color, reduction in fruit firmness and storagability, and/or reduction in fruit set the following year.

Additional effects of STLM feeding may be: (a) greater susceptibility of larval-infested leaves to phytotoxic effects of insecticides, fungicides, or calcium chloride nutrient sprays; (b) reduced capability of larval-infested leaves to absorb growth-regulator sprays applied to prevent early fruit drop or promote ripening, or (c) compounding of detrimental effects of large spider mite populations, low plant nitrogen, or poor pruning.

In New York, there have been little or no detrimental effects of large STLM populations on Red Delicious.

Natural Enemies. Several species of tiny wasps have been found parasitizing STLM larvae in New York and Southern New England. The parasite larvae hatch out from eggs deposited in STLM mines and suck out the body fluids of STLM larvae. In Massachusetts, we have found at least 5 such parasite species, the most abundant of which is *Apanteles ornigis*. Among 9 Massachusetts commercial apple orchards sampled in September and October, 1979, we found the average percent parasitism of 3rd generation larvae to be 10.1% (range = 1.1 - 45.3%). This corresponds closely to Weires finding of 9% parasitism of 3rd generation STLM larvae in commercial Hudson Valley orchards in 1976.

We speculate that there might be a more or less continual immigration of parasite adults from unsprayed trees into commercial orchards during the growing season. However, regular application of insecticide from petal fall through early August undoubtedly kills most adults immigrating at this time. This is borne out by the fact that both Weires and we find very little parasitism of 1st and 2nd generation STLM larvae. Adoption of integrated pest management techniques and corresponding reduction of unneeded insecticide applications, especially in July, could open the way to increased levels of parasitism of 2nd generation larvae. Termination of insecticide applications by early August may allow comparatively high survival of parasites attacking 3rd generation larvae. Such parasitism of these larvae, together with natural enemies feeding upon overwintering STLM pupae, could result in substantial mortality to overwintering numbers of STLM.

MONITORING

Adults. STLM Adult seasonal activity may be monitored by employing sticky traps baited with synthetic female sex pheromone caps (obtainable from Conrel Corporation, 110 A Street, Needham Heights, MA).

Adults can also be captured on white sticky-coated visual traps used for monitoring tarnished plant bug and European apple sawfly adults (obtainable from New England Insect Traps, Box 938, Amherst, MA). In 1980, we plan to assess which color of visual trap is most attractive to STLM adults. At present, there is no reliable means of relating numbers of adults captured in pheromone or visual traps to potential injury levels. Future research is aimed in this direction.

Larvae. In most orchard situations, the most useful monitoring method to date has proven to be examination of the leaves for STLM larval mines. For 1st generation larvae, leaf monitoring should begin at late pink and continue at 4-7 day intervals until 1 week after petal fall. For 2nd generation larvae, monitoring should begin in late June and continue at 4-7 day intervals through late July. Monitoring of 3rd generation larvae is unnecessary, as the New York researchers have found that while these larvae cause characteristic mines, this injury occurs too late in the season to threaten the crop or warrant additional insecticide applications.

For monitoring, it is best to examine at least 10 leaves per tree on at least 1 tree per acre. For 1st generation larvae, choose fruit cluster leaves at head height in the lower half of the tree interior. For 2nd generation larvae, choose leaves on new woody tissue (but not water sprouts) from anywhere in the tree.

It is extremely important to look carefully for evidence of earliest sap-feeding mines on the lower leaf surface. This is best done by holding the leaf toward the sky, and locating the thin winding brown trail and/or the light green or whitish appearing mine.

CONTROL

One or a combination of the following 3 pesticide-treatment programs may be used for STLM control. Research conducted in New York and Canada shows that high levels of adult immigration and/or high overwintering mortality of STLM pupae render the previous year's level of STLM abundance in a given block of little value in predicting this year's STLM abundance. Thus, each grower should keep a careful eye on each block during the current growing season.

A. Endosulfan (Thiodan) Program. This program is aimed at controlling STLM adults and consists of 1 application of endosulfan (half strength) at half inch green and a 2nd application (full strength) at pink against 1st generation adults, and/or an application of endosulfan (full strength) in late June or early July timed to coincide with emergence of 2nd generation adults.

Pre-bloom application of endosulfan will also give good control of plant bugs. In some years, such as 1979, emergence of over-wintering adults may be strung out, and a pink application of endosulfan may not have sufficient residual activity to carry over and kill adults emerging after petalfall. Best results will be obtained if application is made in the evening, when adults are most active, and if trees are well pruned to facilitate pesticide coverage.

One of the major advantages of this program is that endosulfan has very little adverse effect on the principal predators of spider mites and aphids in Massachusetts, and is therefore fully compatible with an integrated pest management program.

B. Methomyl (Lannate) Program. This program is aimed at control of STLM larvae in mines and consists of 1 petalfall application of methomyl (full strength) directed at 1st generation sap-feeding larvae and/or 1 application of methomyl (full strength) in July against 2nd generation sap-feeding larvae. Application should be made only if STLM populations reach or exceed an average of 1 mine per leaf at petalfall or 2 mines per leaf in July. Petalfall application of methomyl will control green fruitworm and leafrollers but will not control plum curculio.

The need for precise timing and proper concentration of methomyl application can not be over-stressed. Application at less than full strength may give poor control. Delay of application until many larvae have reached the tissue-feeding stage may not only result in poor control, but more importantly, may seriously exacerbate phytotoxic effects of a variety of insecticides and fungicides, as well as calcium chloride sprays.

To illustrate, we are familiar with a situation in 1979 when a grower applied methomyl against 2nd generation larvae after a substantial number of the larvae had already entered the tissue feeding stage. Control was fair, but the resulting large amount of phytotoxicity from subsequent fungicide and insecticide treatments greatly exacerbated the adverse STLM effects on premature fruit ripening and fruit drop.

Methomyl may cause severe injury to the foliage of many early season apple cultivars and thus should not be applied to such cultivars. Also, methomyl is a highly dangerous compound, requiring careful use of a good respirator and gloves.

A major disadvantage of this program is the strong toxicity of methomyl to mite and aphid predators which may result in large spider mite and woolly apple aphid population buildup in mid- and late summer.

C. Oxamyl (Vydate) Program. This program is aimed at control of STLM adults and larvae and consists of 1 application of oxamyl (half strength) at pink directed against 1st generation adults and larvae and/or 1 application (full or half strength) in July against 2nd generation larvae. The latter application should be made only where sap-feeding mines reach or exceed an average of 2 per leaf. Massachusetts has received a special 24 (c) registration for use of oxamyl on bearing apple trees in 1980.

Inasmuch as oxamyl will not control plant bugs, an additional pesticide should be included in pre-bloom treatments for this purpose. Oxamyl has thinning effects, and should not be applied at petalfall or for 30 days thereafter. Because oxamyl is systemic and has better residual activity than methomyl, timing of application may be somewhat less critical than with methomyl. Also oxamyl may be used with much less risk of phytoxicity than methomyl on early ripening apple cultivars.

There are 2 major disadvantages of this program. First, oxamyl is an extremely dangerous compound, having caused considerable sickness among a number of Hudson Valley growers in 1979. Its inhalation toxicity is many times greater than that of methomyl. Use of a good respirator and gloves is an absolute must. Second, oxamyl, like methomyl, is highly detrimental to mite and aphid predators, although it may provide some degree of spider mite control during the first years of use before resistance develops. Be prepared for eventual outbreaks of spider mites and aphids if you use oxamyl.

CONCLUSIONS

The information gained by New York researchers during 5 years of recent experience with STLM is of immense value to our ability to cope with the new insecticide-resistant strains of STLM entering Massachusetts orchards. Several of the possible measures aimed at controlling this pest pose a serious threat to the survival and build-up of spider mite and aphid predators in integrated pest management orchards. However, if growers use discretion in application of measures for STLM control, and employ control measures only when truly necessary and at optimal times, then the chances for successful integrated pest management in the future are greater. In this regard, treatments against 1st generation STLM larvae will have much less adverse effect on beneficial predators than treatment against 2nd generation larvae. We must be very careful not to apply excessive numbers or rates of those few materials currently effective against STLM, lest we induce rapid development of STLM resistance to these materials. Further research by colleagues in New York and other surrounding states, coupled with our own studies here in Massachusetts, will hopefully lead to less hazardous and less disruptive means of controlling STLM in the future.

MORE ABOUT NEMATODES AND FRUIT TREES

R.A. Rohde
Department of Plant Pathology

A university student majoring in pomology probably wonders sometimes how, with all of the potential problems, a new orchard is ever established. Problems with soil structure and fertility, drainage, toxic decomposition products from fruit tree roots, soil fungi, bacteria, viruses and nematodes can all injure young trees. Sometimes the injury has a name such as crown gall, collar rot or SARD (specific apple replant disease) but more often the result is slow or uneven growth that is difficult to diagnose, or even measure. Sometimes trees die from winter injury but were weakened by poor growth the previous summer.

Nematodes are one of the many factors contributing to the replant problem. Nematodes are microscopic worms which live in the soil along with bacteria and fungi and feed on root tips. The feeding process injures or kills root tips and leads to problems of water and nutrient absorption. The resulting wounds usually become infected by root rotting fungi. In addition, some nematodes can transmit virus diseases.

A vigorously growing, mature tree can support a large number of nematodes without showing any symptoms. However, trees coming from the nursery, especially those in poor condition or being planted under adverse conditions, cannot tolerate this damage. Experiments at Cornell University and elsewhere have shown that the head start given to small trees by soil treatment is never lost even when high nematode populations return after a year or two.

Soil samples from Massachusetts orchards always contain plant-parasitic nematodes, usually of several different species. The three most common, and most injurious, are the lesion, dagger and ring nematodes.

Lesion nematodes, *Pratylenchus* spp., migrate through the inner root tissues breaking them down as they feed. Injury on peach trees is much more severe than on apple because peach roots contain the cyanide-producing compound amygdalin (also known as laetrile). The cyanide produced in injured tissue increases the amount of damage. Tissues killed by lesion nematodes are quickly invaded by root-rotting fungi and bacteria.

Dagger nematodes, *Xiphinema americanum*, have spears which penetrate into the root tip and cause it to swell and stop growing. Dagger nematodes can transmit the virus that causes peach stem pitting or apple brown line and theoretically only one infective nematode is necessary. The virus is not common in Massachusetts, but it is present.

Ring nematodes, Criconemoides and Macroposthonia, are root surface feeders. Injury is not severe, but helps to slow down the growth of young trees. Other species of ring nematodes are part of the "Slow Decline of Peach" complex in South Carolina.

Soil sampling. Because nematodes are distributed in clusters throughout the field, it is important to collect soil from several areas. For each 5000 sq. ft. area, 10 or more subsamples taken to a depth of 8-10" from the strip where trees are to be planted should be collected with a trowel or spade. Mix the soil in a bucket and then put one quart of mixed soil in a plastic container. If a sampling tube is used, about one quart of soil should be collected.

Soil samples may be taken at any time during the year although winter and spring populations will be low and less representative of the potential of the population to build up. Samples should be sent to one of the Regional Fruit Specialists or directly to the Department of Plant Pathology, University of Massachusetts, Amherst, 01003. Remember, dried out soil is useless.

Sampling soil and extracting, identifying and counting nematodes is time-consuming and requires a fair amount of experience and training. But the most difficult step comes next, when a prediction should be made about how much injury might be expected and what control methods, if any, should be used. The experience of the grower is invaluable at this point because he will often know if problems have occurred in this area in the past and the overall potential of the area to produce fruit trees.

Soil fumigation. Treatment before planting to reduce all disease organisms is probably still the best procedure and has been discussed at length before (Fruit Notes 41 (6): 3-5, 1976). Fumigation is expensive, requires extensive preparation and specialized equipment, and does not always fit in well with the planting schedule.

Planting hole treatment. Several insecticide-nematicide chemicals have been used as root dips or mixed with soil around the tree as it is planted. All of these materials, oxamyl (Vydate(R)), phenamiphos (Nemacur(R)), aldicarb (Temik(R)), carbofuran (Furadan(R)), are highly toxic to humans and are at least partially systemic. At present time, only oxamyl is registered for use in Massachusetts, and only on non-bearing fruit trees.

The "state of the art" at present calls for caution. There is enough preliminary evidence to suggest that replant problems exist and treatments will pay off. Because so many factors are involved and because each orchard, indeed each block, is a different ecosystem, small scale field trials are necessary in order to establish the value of any one particular treatment.

Cooperative Extension Service
University of Massachusetts
Amherst, Massachusetts
R. S. Whaley
Director
Cooperative Agricultural Extension Work
Acts of May 8 and June 30, 1914

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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Vol. 45 No. 3
MAY/JUNE 1980

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THE WAY YOU FERTILIZE YOUR FRUIT TREES CAN AFFECT THE QUALITY OF THE FRUIT YOU HARVEST

William J. Bramlage, Mack Drake, and William J. Lord
Department of Plant and Soil Sciences

In the first half of this century, studies of the fertilizer needs of fruit trees focussed on what was needed to maximize tree growth and fruit yield. In the last couple of decades, however, attention has turned toward the effects of nutrition on the quality of harvested fruit. While the effects of calcium (Ca) deficiency have been the driving force behind the reconsideration of mineral needs, effects of nitrogen (N), potassium (K), magnesium (Mg), boron (B) and phosphorus (P) levels in fruit on their postharvest quality have been noted.

It is clear that the mineral composition of fruit at harvest is an extremely important factor in determining how well fruit will keep after harvest. Most of the research on this problem has been on apples and to a lesser extent, pears, but presumably the same relationships also have some relevance to postharvest problems with other kinds of fruit. It seems appropriate to review these relationships between fruit nutrition and fruit quality as we enter into a new growing season.

Calcium: In 1936 bitter pit was found to be related to low Ca levels in apples. Thirty years later it could still be stated that "Inspite of the very low Ca status of many orchard soils...there have been few reports of direct responses by bearing apple trees to Ca..." (Temperate to Tropical Fruit Nutrition, Norman F. Childers, Editor.) Today, however, there is strong concern about Ca levels in apples and pears just about anywhere in the world that they are grown.

At first, this concern was directed at bitter pit and cork spot but today we know that many physiological disorders may be at least partly related to low Ca levels in the fruit. In warmer fruit growing areas, cork spot and bitter pit remain the most serious effects of low Ca, but in cooler areas various forms of internal breakdown are the most serious Ca-deficiency problem. In British Columbia, Canada, the 'Spartan' apple industry was almost destroyed by breakdown problems before methods of raising fruit Ca levels were successfully developed.

Many approaches have been taken to try to raise fruit Ca levels. Since Ca is less available in acid soils, regular liming programs are essential in areas of low soil pH. Calcitic lime is more soluble and is preferable to dolomitic lime unless Mg deficiency exists, since dolomitic lime supplies little available Ca to the soil. Use of calcium nitrate ($Ca(NO_3)_2$) as a source of fertilizer N is often recommended, and we have found that it can provide a small increase in fruit Ca levels. In areas where soil is droughty, irrigation is often recommended to maintain Ca uptake by the tree roots.

Foliar sprays with Ca salts are the most direct way of insuring adequate fruit Ca levels during growth. There is little movement of Ca into fruits by the tree as long as vegetative growth is abundant, so the value of sprays is that it places Ca directly on the surface of the fruit, where it can be taken in by the fruit if conditions are appropriate. At first, $Ca(NO_3)_2$ sprays were recommended, but tests with many other Ca compounds have shown that calcium chloride ($CaCl_2$) is generally the most effective material. Leaf injury from $CaCl_2$ can prevent its use in many growing areas, but in Northern North America it can be used if proper precautions are taken. Frequent applications throughout the growing season are usually the most effective way of applying $CaCl_2$. A single massive application shortly before harvest substantially raises fruit Ca and improves keeping quality of apples. This idea originated in British Columbia and we have tested it extensively, but we believe that the severe foliar damage, the potential for fruit injury or preharvest drop, and the residue that may be objectionable in hand-packing operations make it an unlikely commercial practice.

Post-harvest dips in $CaCl_2$-containing solutions reduce softening and breakdown during storage. The use of a thickening agent greatly increases the effectiveness of a dip, but thickeners leave an objectionable residue that can be very difficult to remove. High concentrations of $CaCl_2$ must be used, and these can cause corrosion of metal and injury to fruit, and may also leave a noticeable residue. However, in the appropriate circumstances much benefit can be obtained from a dip. In New England, fruit growers have preferred foliar sprays, but postharvest dips are an alternative.

Nitrogen. To stimulate growth of young trees, N is usually applied at high rates. Fertilizer rates should be reduced when cropping begins, but they are sometimes continued because yields can be increased. Even when N application is reduced when cropping begins, the trees may continue to be supplied with excessive amounts of N from the large reserves that have accumulated in the soil, sod and tree. We have found that high N levels in trees fall very slowly even when no additional N fertilizer is supplied.

Excessive amounts of N in the tree and fruit can severely reduce fruit quality. The vigorous growth that it encourages reduces the Ca level of the fruit. Moreover, the high N fruit tend to be larger, greener, softer, more subject to preharvest drop, and to have more cork spot and bitter pit. These fruit also tend to develop greater amounts of scald, bitter pit, internal browning, and internal breakdown during and after storage.

Over-fertilization with N is probably very common. In the Pacific Northwest it has been estimated that 50 to 75% of apple orchards, and a smaller percentage of pear orchards, are excessively high in N. The effects of high N on apples are perhaps being masked at harvest by use of growth regulators, especially Alar, but growth regulators cannot mask their consequences after storage.

Until recently the cheapest form of N was usually the one chosen for fertilizing orchards. It is now recognized that the form of N as well as the total amount of N that is used can influence fruit quality. USDA researchers first found that ammonium (NH_4) forms of N can intensify Ca deficiency in apples by interfering with absorption of Ca by roots. It has been recommended that NH_4-containing fertilizers not be applied to apple orchards before or soon after bloom if growers are concerned about fruit Ca levels.

Use of $Ca(NO_3)_2$ as an N-source both supplies available Ca to the roots and avoids NH_4 interference with Ca absorption. Our experiments with use of $Ca(NO_3)_2$ rather than NH_4NO_3 show that $Ca(NO_3)_2$ may produce a small increase in fruit Ca levels, but that this is not enough to correct Ca deficiency if it already exists. Whether the additional cost is justified by the benefit is a question for growers to decide.

Our experience leads us to conclude that the total amount of N being applied to fruit trees is a more important concern to fruit quality than is the form of N that is being used.

Potassium: K deficiency reduces growth and yield of trees and severe K deficiency in apple and pear trees causes "leaf scorch", a browning of the leaves. K deficiency has only a mild effect on fruit quality, reducing acidity of the fruit and reducing red coloration. Excessive amounts of K in fruit are a greater danger to fruit quality, since they lead to increased scald, bitter pit, and internal breakdown after storage.

Fruit accumulate large amounts of K, and large yields can remove a large amount of K from an orchard. Therefore, fertilizing with K is most likely to be needed after a large crop. Nevertheless, fruit quality will suffer far more from excess K than from deficient K. Most of the effects of high K are the result of its interference with Ca in the fruit, and too much K will generally have the same effects as too little Ca.

Magnesium: Mg deficiency can produce weak and unproductive trees, and cause increased preharvest fruit drop, and its distinctive color patterns on leaves have often been observed. It may be corrected by application of dolomitic limestone or by foliar sprays with materials such as Epsom salts. There is little evidence that either too little or too much Mg directly affects fruit quality. However, excess Mg interferes with Ca just as does excess K, so excessive amounts of Mg will produce Ca deficiency effects in fruit.

Phosphorus: P deficiency can reduce tree growth and yield, and in several parts of the world it has also been shown to cause increased amounts of breakdown of apples during storage. However, in North America there has been very little evidence for P deficiency in fruit. However, we have recently found that high levels of P in apples, especially in combination with low levels of Ca, greatly increased breakdown of apples during storage.

Boron: B deficiency has occurred over much of North America, causing both internal and external cork development in fruit. Excessive levels of B in fruit can cause earlier maturation and increased amounts of watercore at harvest, and increased amounts of breakdown after storage. Thus, a moderate level of B is important for good fruit quality.

B also influences Ca movement in the tree. If it is deficient, less Ca is moved to the fruit and Ca deficiency can result. It is therefore important to maintain adequate B levels as a part of a program to avoid Ca deficiency.

Periodic application of borax to the soil is a standard commercial practice in many parts of North America. A widely used alternative is 1 or 2 foliar applications of a soluble form of B in sprays shortly after blossoming, although it is not clear how much of this B moves from leaves into the fruit.

It is clear that deciding on a fertilizer program for an orchard is no simple matter. The awareness that Ca deficiency is common and that it greatly increases losses of stored fruit has caused a thorough re-evaluation of fertilizer practices. We conclude that from the standpoint of fruit quality, Ca and B are probably the only fertilizer elements that are beneficial. Fertilization with N, K and Mg should be limited to situations where they are needed to maintain necessary growth, and applications should be at moderate rates. We know of no evidence that P should be applied in apple orchards in New England, after initial starter fertilizer applied at tree planting.

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SUGGESTIONS FOR USE OF CALCIUM SPRAYS IN 1980

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Calcium chloride ($CaCl_2$) foliar sprays are recommended for all growers, to increase the flesh Ca content of Massachusetts apples. Higher flesh Ca can markedly reduce pit, cork and storage breakdown.

Apply foliar sprays of $CaCl_2$, starting about 3 weeks after petalfall and repeat at 2 week intervals totalling 6 or 8 applications. Apply 6 pounds $CaCl_2$ per acre per spray until mid-July. After mid-July apply 8 to 10 pounds/acre spray. Use a technical grade $CaCl_2$ such as Allied Chemical Flakes, 77-80% $CaCl_2$. Other brands may be equally suitable.

Experience in Massachusetts has shown that $CaCl_2$ can be combined with pesticide sprays. However there is limited evidence that the combination of Captan or Guthion (azinphos methyl) 50 WP and $CaCl_2$ may increase foliar burn. DO NOT MIX $CaCl_2$ AND SOLUBOR SPRAYS! Always dissolve the $CaCl_2$ in a pail of water and add this last and when the spray tank is nearly full.

Foliar $CaCl_2$ sprays may be applied dilute (300/acre) or up to 10X concentration (30 gallons/acre). In our research, flesh calcium was increased more by concentrated than by dilute sprays. In 1977, foliar $CaCl_2$ sprays at 6X and 10X concentration were equally effective for increasing McIntosh flesh calcium.

$CaCl_2$ sprays can cause burn of leaf margins. Foliar injury is more serious on McIntosh than Delicious. Apple leaves are less susceptible to $CaCl_2$ burn after mid-July. McIntosh growing on M7 may be more susceptible to foliar burn than ones on standard rootstock. Weak or injured trees may be more susceptible than healthy trees. Do not repeat a foliar calcium chloride spray unless at least 1 inch of rain has fallen since the last application.

Foliar $CaCl_2$ sprays should be continued until the apples are harvested. Growers using alternate row pest control, should apply $CaCl_2$-water sprays in those rows that were missed.

$CaCl_2$ is not a substitute for a sound soil-liming program. Lime orchards to pH 6.5 with a Ca-Mg/limestone containing 5-7% MgO.

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SUPPRESSING WEED GROWTH UNDER FRUIT TREES

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Growers have become concerned, particularly due to the root-injury on apple and peach trees last winter, about the absence of sod under their trees because of annual use of a contact herbicide such as Paraquat CL* (paraquat) plus a soil sterilant (terbacil, diuron, or simazine). Of more concern is the occurrence of soil erosion and in some instances tree heaving. Therefore, growers have expressed interest in re-establishing sod and then suppressing grass and weed growth rather than eliminating this growth.

Dacamine*, Dacamine 4D*, paraquat or Dowpon*M (dalapon) appear to be the logical herbicides to use for re-establishment and maintenance of sod under apple trees. Where heaving of trees has occurred applications of mulch and re-establishment of the sod may help prevent it. In peach orchards, many of which are relatively small, it might be feasible to substitute mulch for herbicides or use paraquat or dalapon alone.

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* Trade name

The first year after herbicide applications are discontinued broadleaf weeds like cinquefoil, dandelions, lambsquarters, ragweed, and plantian will probably be the predominant types of vegetation. If these weeds become troublesome by late-July or in August, Dacamine or Dacamine 4D can be applied under apple trees for their control without injuring grasses. Continue to use Dacamine or Dacamine 4D in subsequent years as needed under apple trees until grasses are re-established, then switch to dalapon or paraquat. Under peach trees it will be necessary to use paraquat because Dacamine or Dacamine 4D are not labelled for this crop.

Dalapon is labelled for grass control at 5 to 10 lbs. per acre under apple trees (use the low rate for trees less than 4 years old) and at 2 to 3-1/2 lbs. per acre under peach trees. Nevertheless, 5 lbs. per acre may be sufficient for apple trees of all ages. Trials in the past showed that this rate in some instances merely suppressed grass growth and in other instances, it eliminated 40-90% of the grasses. Therefore, the degree of grass control with 5 lbs. per acre is not predictable. However, users of dalapon may find that lower rates are necessary under older trees where grass growth is less luxuriant than under young trees.

The re-established sod probably will be a mixture of grasses and broadleaf weeds; therefore, it may be necessary to control troublesome weeds with paraquat, Dacamine or Dacamine 4D since dalapon controls only grasses.

A paraquat program alone also should be suitable for re-establishment and maintenance of sod. Apply in spring under apple and peach trees when grass is 10-12 inches high. A repeat application may be necessary in mid-July.

Studies by Hislop and Prokopy (Fruit Notes 44(5): 6-8) showed that dalapon had low toxicity to *Amblyseius fallacis*, the most important predator of red and two-spotted mites in commercial orchards in Massachusetts. In contrast, in earlier studies Hislop *et al*. (Fruit Notes 43(4): 5-8) found paraquat highly toxic to *A. fallacis*. Therefore, Hislop and Prokopy (Fruit Notes 44(5): 6-8) suggested the use of dalapon as the herbicide in integrated pest management programs. These workers have not determined Dacamine or Dacamine 4D toxicity to *A. fallacis*.

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POMOLOGICAL PARAGRAPH

Pruning well-feathered trees at planting. If you receive well-feathered trees from the nurseryman, it is important to leave as many favorably positioned branches on the trees as possible because when all but 2 or 3 branches are removed, these tend to grow very vigorously and develop narrow crotch angles when growing conditions are favorable. Head the trees at 39", or 10 or 12" above the highest useful branch, if the tree is well feathered. Don't head the branches, or remove any more low branches than necessary. Heading adds to the problem of excessive vigor on vigorous cultivars and delays production. Low branches contribute to the total leaf surface of the tree. Low branches and extra scaffold limbs can be removed in subsequent years.

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INFLUENCE OF PRUNING PEACH TREES LATE IN THE SPRING

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Growers generally prune peach trees late in the spring so that a fungicide can be applied immediately after pruning to help prevent valsa canker. However some peach blocks are being pruned as late as shuck split, which raises the question of the effects of late pruning on tree growth, yield, and fruit maturity.

This question was tested by the late Dr. Leon Havis, of the U.S. Department of Agriculture. In 1951, he determined the influence in pruning time on yield, size and maturity of fruit, shoot length, and flower-bud development of Elberta peaches (Proc. Amer. Soc. Hort. Sci. 58: 14-18). The trees were pruned during the dormant season, at full bloom, at shuck fall, 3 weeks after shuck fall, or not at all. The study showed that among the pruned trees, those pruned during the dormant season produced the largest crops. When pruning was delayed until shuck fall or 3 weeks after shuck fall, yields were less than on trees pruned at bloom.

Timing of pruning also affected fruit maturity. Fruit from trees pruned at full bloom matured earlier than those from trees during the dormant season or 3 weeks after shuck fall. Fruit from trees pruned at shuck fall or from unpruned trees matured earlier than those from trees pruned during the dormant season or 3 weeks after shuck fall.

Shoot growth was longer on the dormant-pruned trees but there were not differences in growth among the trees pruned at full bloom, at shuck fall or 3 weeks after shuck fall. The unpruned trees produced the shortest growth.

The largest number of flower buds per foot of shoot growth occurred on the dormant-pruned trees. Trees pruned at full bloom produced more flower buds per foot of shoot growth than those pruned at shuck fall, 3-weeks after shuck fall, or those that were not pruned.

Based on this study, it appears that in orchards where valsa canker is not troublesome, dormant pruning may be advantageous from the standpoint of more shoot growth and flower buds and higher yields. Where valsa canker is troublesome, it appears advisable not to delay pruning later than full bloom.

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THE USE OF PROMALIN TO ELONGATE DELICIOUS APPLES: RESEARCH OBSERVATIONS AND SUGGESTIONS FOR USE IN 1980

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Promalin* has been used in orchards in Massachusetts for several years to increase the length of Delicious apples. Increased use has given us experience so that we may better and more safely use this growth regulator. It is the purpose of this article to review our research findings and update our recommendations for the use of Promalin in 1980.

Coverage. Last year (Fruit Notes 44(3): 4-8) we showed that the absorption and/or translocation of Promalin was quite limited. This is supported by our 1979 data showing that when a 25 microliter droplet of Promalin was placed on the flower petals there was no increase in the L/D ratio** of fruit at harvest (Table 1 below).

Table 1. Effect of the site of Promalin application on the L/D ratio of 'Richared Delicious' apples.

Treatment[z] (microliters)	L/D ratio 1978	L/D ratio 1979
1. Check	.93c[x]	.91c
2. Petals, 25[y]	.94c	.91c
3. Petals, 150	.99b	———
4. Receptacle surface, 25	1.03a	1.03a
5. In calyx end, 25	1.03a	1.04a
6. Pedicel, 25	———	.97b
7. Spur leaves, 250	———	.90c

[z] 50 ppm solution containing 0.05% X-77 applied at full bloom. All blossom clusters reduced to one flower and then hand pollinated with 'Early McIntosh' pollen.

[y] A 25 microliter droplet was large enough to wet the receptacle and pedicel surface with no runoff.

[x] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

*Trade Name

**Larger the L/D ratio, longer the fruit. A "typey" Delicious will have an L/D ratio of 1:00 or more.

A comparable amount placed in the calyx end of the receptable surface resulted in "typey" fruit at harvest whereas treatments applied to the pedicel (flower stem)were intermediate. A 10-fold increase in volume of Promalin applied to the spur leaves caused no fruit elongation. Thus, 2 years of research indicates that it is essential for the Promalin droplet to come in direct contact with the flower part that eventually will become the fruit. Application to any other part of the flower or spur has either no effect or a reduced effect. Thorough uniform spray coverage is absolutely essential for a consistent Promalin response.

Field Observations Following Promalin Application

Within 2-3 days following a Promalin application calyx swelling and closing is apparent, first on the king blossom and then on lateral blossoms. Promalin merely accelerates that which normally occurs on pollinated flowers. Ten to 12 days after application, Promalin appears to increase fruit set. About 15 days after bloom, yellowing of the pedicels occurs on many of the developing fruit in the cluster. By 3 weeks after bloom most of the less vigorous fruit have dropped and within 4 weeks fruit set has been determined and subsequent drop is minimal.

Thinning Due to Promalin Application

It has been our impression, as a result of observations made the past 2 years, that thinning due to Promalin may be more apparent than real. We believe that Promalin causes earlier removal of many fruit that would normally drop later. It would certainly appear that Promalin was increasing thinning if you assessed fruit set 2-3 weeks after bloom. However in most situations it appears that Promalin has advanced the 'June-drop' by about 2-3 weeks, thus giving only the impression of thinning. While Promalin can indeed cause thinning, caution should be exercised in concluding that this has happened on your trees.

Chemical Thinning Following Promalin Application

Since Promalin applied by itself is capable of thinning, it is important to know if excessive thinning is likely to occur if Promalin treatment is followed by an application of Sevin* (Sevin is the only chemical thinner recommended for use on Delicious in Massachusetts). This is particularly important to know since it is well established that the thinning responses may be increased when 2 different thinning agents are applied. We attempted to answer this question in 1979.

In 1 experiment, Promalin at 25 ppm-plus-Glyodin was applied as a dilute spray at full bloom (Table 2). (This is about a 3-fold over-application since the label recommendation is for 125-150 gal/acre). Half the trees sprayed with Promalin-plus-Glyodin also received Sevin about 20 days after bloom. Other trees received Sevin alone. The Promalin-plus-Glyodin spray increased the L/D ratios of the fruit but also caused thinning (Table 2).

*Trade Name

Table 2. Effects of Promalin and Sevin on thinning, fruit size, L/D ratio, and seed number of 'Richared Delicious' apples.

Treatment[z] (ppm)	Blossom clusters per cm limb circ.	Fruit per cm limb circ.	Fruit per 100 blossom clusters	Fruit Wt. (g)	L/D ratio	Seeds/ fruit
1. Check	12.6a[y]	8.1a	70a	170ab	.93b	5.0a
2. Promalin 25 + Glyodin	12.0a	3.7b	31b	185a	1.03a	4.8a
3. Promalin 25 + Glyodin + Sevin	12.4a	3.6b	31b	146c	1.03a	2.5b
4. Sevin	12.8a	6.6a	52a	156bc	.94b	2.7b

[z] F.B. May 10, 1979. Promalin 25 ppm + 1 pt/100 gal.of Glyodin applied as a dilute spray on May 10, 1979. Sevin 1/2 lb/100 gal. applied as a dilute spray June 1, 1979.

[y] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

However, the degree of thinning was not increased by the application of Sevin about 20 days after bloom. Sevin alone did not cause thinning. It is apparent that Sevin was taken into the trees because it reduced seed number of the fruit, even though it caused no thinning. The Promalin-Sevin combination appears to have reduced fruit size below that of Promalin alone (Table 2), perhaps due to the reduction of seed number.

In another experiment, Promalin concentrations of 25 to 100 ppm were applied at full bloom as dilute sprays to another group of Delicious apple trees. Sevin was applied as a dilute spray 20 days after full bloom on half the trees in each treatment. Promalin alone at 25 ppm caused no thinning (Table 3). Promalin at this concentration-plus-Glyodin tended to increase the thinning response but the difference was not significant. Promalin alone at both 50 and 100 ppm caused excessive thinning. The application of Sevin on half of the Promalin-treated trees caused no additional thinning. Thus, it appears that the thinning response to Sevin in 1979 was not greater on trees that previously received an application of Promalin. <u>However</u>, June drop was light and Sevin did reduce seed number. Therefore, under different conditions thinning might have occurred.

Table 3. Effects of Promalin at different concentrations on fruit thinning of 'Red Prince Delicious' apples. 1979.

Treatment[z]	Sevin[y]	Fruit/ cm limb circ.	Fruit/ 100 blossom clusters
1. Check	-	5.2a[x]	60a
	+	3.3abc	43abc
2. Promalin 25	-	4.8ab	45ab
	+	3.5ab	36bc
3. Promalin 25 + Glyodin 1 pt/ 100 gal.	-	3.2bc	41abc
	+	2.9bc	31bc
4. Promalin 50	-	2.3cd	25bcd
	+	1.7cd	23bcd
5. Promalin 100	-	0.7d	9d
	+	0.6d	7d

[z] Treatments applied May 10, 1979 at full bloom.

[y] Sevin 1/2 lb/100 gal was applied to 1 limb per tree on June 1, 1979.

[x] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

Variable Promalin Responses

Another concern of Promalin users in Massachusetts is the lack of a consistent and predictable response. Sometimes fruit from Promalin-treated trees are similar to those from untreated trees; in other years Promalin causes significant fruit elongation. It is our feeling that Promalin always elongates fruit, provided that it was applied near full bloom. Why then is there a variable response? Promalin promotes at least 2 independent processes: fruit elongation and fruit thinning. We believe that Promalin thins off elongated fruit early in the season in the years when it appears not to be effective. However, further observation will be necessary to confirm this.

Suggestions for Promalin use in 1980

1. Calibrate your sprayer. Thinning due to Promalin has often been traced to overapplication because of improper sprayer calibration and nozzle adjustment. The margin of error with Promalin is not great. The label suggests that Promalin should be applied in 100-200 gal/acre. Therefore, an error in application of only 50 gal/acre can result in a 50% increase in the amount of Promalin applied.

2. Do not apply more than 1-1/2 pts/acre of Promalin.

3. Do not apply Promalin when the temperature exceeds 85°F. Excessively warm temperatures may increase the thinning response without a corresponding increase in the shape response.

4. Do not apply Promalin on young trees. A good rule-of-thumb is not to apply this growth regulator on any tree until it is bearing heavily enough to consider chemical thinning.

5. Apply Promalin as soon as weather permits after opening of the king blossom. This is earlier than we have suggested in the past. It is our feeling that the reduced leaf surface at this earlier timing may reduce the possibility of thinning.

6. The addition of surfactants or spreader stickers increases both the fruit shape and thinning response to Promalin.

7. Our thinning trial in which an application of Sevin followed Promalin usage was not conclusive. It is possible that no thinner is needed on Promalin-treated trees. Therefore, we urge you to carefully assess the need of Sevin prior to its use.

8. Leave a few untreated and representative trees in the Promalin-treated block. Initial fruit, subsequent drop and fruit shape are never constant from year to year. Therefore, the only way to accurately assess the performance of Promalin in your orchard is to leave a few untreated trees in the same block to indicate what would have happened in the absence of the Promalin spray.

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SOIL MANAGEMENT OF PEACH TREES

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Peach trees withstand grass and weed competition during summers of inadeuqate rainfall less successfully than do apple trees. We found in a study of 6-year duration that even though we mowed the grass and broadleaf weeds under Jerseyland peach trees 5 or 6 times annually they were generally lower in nitrogen, made less growth, and produced less fruit than those receiving annually 40 lbs. of hay, 2 applications of paraquat, 1 application of paraquat-plus-simazine mixture, or cultivation.

Peach trees produce well under the sod-plus-mulch system of soil management in Massachusetts. An annual application of a 40-lb. bale of hay under peach trees can produce growth and yields comparable to those produced by cultivation. However, mulch generally increases leaf potassium in comparison to cultivation, which may then depress leaf magnesium and calcium.

Where mulch is not readily available, trashy cultivation or sod with herbicide-treated areas under the trees are the suggested systems of soil management. Trashy cultivation which involves only partial incorporation of the cover crop and shallow disking 1 or 2 times to give adequate control of weeds and grass is preferred over clear cultivation because it is less costly and less apt to permit soil erosion. Nevertheless, trashy cultivation alone may fail to give adequate control of grass and broadleaf weeds under the trees. It frequently should be supplemented with herbicides to eliminate the competition for nutrients and moisture and to make it easier to obtain adequate spray coverage for peach tree borer control. Chemical weed control does not disturb the soil and the tree roots as does cultivation and is relatively inexpensive and easy to apply. Paraquat, simazine, dichlobenil and terbacil are currently labelled for peaches. Suggestions for their use can be found in the New England Weed Control Chart for tree fruits which is available from your County Extension Service. However, weeds such as brambles which are resistant to these herbicides sometimes invade the grass and broadleaf weed-free areas.

Trashy Cultivation-plus-Herbicides

Trashy cultivation should commence early enough in the spring to partially incorporate into the soil the cover crop or the volunteer cover of grass and weeds. The herbicide spray in the tree row or under the trees should be applied, in case of paraquat or a paraquat-plus-simazine mixture, when the grass is 8 to 10 inches high (about mid-May). Spray the area under the trees that is not easily reached when cultivating. Paraquat can be used the year of planting if care is taken to avoid getting spray on the trunk of the trees. A second application will be needed by early-July, and possibly a third application for quick kill of the grass and weeds under bearing trees may be needed if a moisture deficit occurs within 3 to 4 weeks of harvest. Paraquat-plus-simazine can be used as a single application under trees established a year or more. However, we found that annual grasses and broadleaf weeds were not as readily controlled by the residual simazine in the soil from the annual applications of a paraquat-plus-simazine in early-May, as by 2 applications of paraquat annually in early-May and mid-July.

Cultivation should cease by the middle of July in young orchards where trees are vigorous, to help prevent excessive or late growth which could make the trees more susceptible to cold injury. Bearing trees should be cultivated late enough to prevent grass and broad-leaf weed growth from affecting fruit size. (The critical period is that of rapid swell.......30 to 35 days preceding harvest.)

At completion of cultivation some growers sow a cover crop to help supply organic matter and prevent erosion. Most commonly used is "cover rye" sown in September at the rate of 1-1/2 to 2 bushels per acre. Rye will develop a good stand, live over winter, and be easily killed by disking in the spring. The principle objection to its use is that it may be difficult to "disk it under" when wet weather prevents early cultivation in the spring. Growers who prefer a cover crop that winter-kills can use buckwheat (50 to 75 lbs./A), Japanese millet (5 to 20 lbs./A), or oats (2 to 3 bu./A). These are sown in early to late-August. Oats probably will provide the best ground cover.

Sod-plus-Herbicides

The sod-plus-herbicide system of culture, besides being economical and reducing soil erosion, has another advantage over the trashy cultivation-plus-herbicide system of soil management; it enables the grower to smooth the land and establish a sod in the alley between the trees, which should help reduce bruising when transporting fruit. The herbicides to use in conjunction with the sod-plus-herbicide system of culture are discussed in the previous section of this article.

Concern has been expressed about complete elimination of grass and broadleaf weed cover under peach trees with herbicides. With no snow cover, a soil free of vegetation might expose the trees to a deep freeze and root injury as occurred in 1979. In all of our herbicide studies with apple and peach trees, annual grassy and broadleaf leaves invaded the treated areas by late summer. Furthermore, mature peach trees at the Horticultural Research Center that had been heavily mulched at periodic intervals since planted suffered winter injury to roots in 1979. Nevertheless, it is well substantiated that a sod or a mulch will help protect plant roots from winter injury. Thus, growers have expressed interest in re-establishing sod under fruit trees and then suppressing grass and weed growth rather than eliminating this growth. Suppressing weed growth under fruit trees is discussed in another article in this issue of Fruit Notes.

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SAMPLING METHODS AND PROVISIONAL ECONOMIC THRESHOLD LEVELS FOR MAJOR APPLE INSECT AND MITE PESTS IN MASSACHUSETTS

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Department of Entomology

In our article on integrated management of apple insects and mites in the November/December 1979 issue of Fruit Notes, we stated that in a forthcoming issue, we would indicate how we make decisions on need and timing of pesticide applications based on levels of pest and natural enemy abundance in samples taken in IPM orchards. This article presents such information.

To briefly review our sampling procedures, we designate 1 tree per every 1-2 acres in IPM blocks as a sampling station for pests and beneficial species. The majority of sampling stations are near the block periphery, inasmuch as most adults of major pests attacking the fruit immigrate from outside the orchard. Sampling at each station by a team of 2-3 scouts occurs once or twice per week from green tip until one week before harvest. At each sampling station, fruit, foliage or pruning cuts are sampled according to a modified random scheme, with samples divided equally among the lower outside, lower inside, and upper inside parts of the tree. Except whem sampling for plant-feeding mites and mite predators, no part of the tree is removed during the sampling process. Each fruit or leaf examined serves as a sampling unit for a number of different species. Each week the numbers of pest insect adults captured on visual or pheromone traps are counted and removed.

A key element in our decision making process is what is termed the "economic threshold level" (ETL). We consider the ETL to be the pest population density at which pesticide application is recommended to prevent the population from reaching a level capable of causing economic injury (= the amount of injury we estimate would justify the cost of a pesticide application). We recognize that an

ETL is not a static level, but may fluctuate considerably from one locale to another and from one year to another, depending on a variety of environmental, biological, and economic factors. The ETL's which we use in our IPM program are still highly provisional, and will most certainly need to undergo substantial refinement in future years, pending further research and fuller consideration of the variables influencing ETL's. This is at least a beginning.

We employ the following sampling methods and ETL's for principal pests and beneficial predators.

Tarnished plant bug. One sticky-coated 15 x 20 cm white rectangle (New England Insect Traps, Box 938, Amherst, MA.) is hung in each sample tree at about 0.7 meters above ground and about 0.5 meters from the outermost foliage to monitor adult plant bug populations. Traps are emplaced at the silver tip stage of apple bud development and removed one week after petal fall. Based on our previous research, the ETL for plant bug consists of an average cumulative capture of 5 adults/trap for the initial pesticide treatment, and 3 adult/trap (disregarding captures from 0-7 days after the initial treatment) for a 2nd treatment.

European apple sawfly. One sticky-coated 15 x 20 cm white rectangle (New England Insect Traps) is hung in each sample tree at about 2 meters above ground and about 0.5 - 1 meter from the outermost foliage (on the south side of the tree) to monitor the abundance of sawfly adults. Traps are emplaced at the early pink stage of bud development and removed one week after petal fall. Based on our previous research, we use an ETL of average cumulative capture of 4 adults/trap for the initial pesticide treatment, and 2 adults/trap (disregarding captures from 0-7 days after the initial treatment) for a 2nd treatment.

Green fruitworms. From pink through mid-June, 30 developing fruit/sample tree /sample date are examined for presence of green fruitworm larvae, and evidence of fresh feeding injury. Using the work of Chapman and Lienk in New York as a guide, we provisionally set the ETL at an average of 1 larva or fresh feeding scar/tree.

Leafrollers. One Pherocon 1 CP^R trap (Zoecon Corp., Palo Alto, Calif.) baited with a synthetic redbanded leafroller sex pheromone cap is placed in the center of each block for monitoring male leafroller abundance (the cap attracts both obliquebanded and redbanded males). The traps are in position from green tip until harvest, with pheromone caps renewed every 6 weeks. In addition, from bloom until harvest, we examine 30 developing fruit/sample tree/sample date for presence of leafroller larvae and evidence of fresh feeding injury. Using the research of Reissig in New York as a guide, we provisionally set the ETL at an average of 1 larva or fresh feeding scar/tree.

Plum curculio. We examine 60 developing fruit/sample tree/sample date (1 or 2 sample dates/week) from petal fall through mid-June for evidence of fresh curculio egglaying scars. The ETL is provisionally set at 1 fresh egglaying scar among the 300 or 600 fruit sampled/block.

<u>Codling moth</u>. One Pherocon 1 CP^{R} trap (Zoecon Crop.) baited with a synthetic codling moth sex pheromone cap is placed in the center of each block for monitoring abundance of codling moth males. The traps are in position from bloom through August, with pheromone caps renewed every 6 weeks. For initial pesticide treatment, the ETL, based upon the recommendations of Embree and Whitman for Nova Scotia growers, is set at cumulative capture of the following numbers of first-generation males: 60-100, 100-200, or 200 or more males/trap = pesticide application at 1/4, 1/2 or full strength, respectively. A capture of 10 males/trap after the first pesticide treatment against codling moth suggests that a second treatment may be needed.

<u>Apple maggot</u>. One unbaited, sticky-coated, 8.5 cm dark red wooden sphere (New England Insect Traps) is hung in each sample tree at about 1.5 meters above ground and about 0.5 - 1 meter from the outermost foliage to monitor apple maggot fly abundance. Traps are in position from late June until harvest. Once, in August, other insects are removed and the sticky-coating replenished if needed. The ETL can be briefly described as capture of 1 fly/block 7 or more days after the last insecticide treatment.

<u>San Jose scale</u>. We do not monitor San Jose scale abundance on the twigs, but instead use the simplified method of Madsen and colleagues in British Columbia: examination of fruit at harvest for evidence of scale injury. Our ETL is provisionally set at 0.1% of fruit infested with scale. Where this level is reached or exceeded, we recommend for the following season 1 or 2 pre-bloom oil treatments and/or a mid-June and early July application of diazinon or Penncap (timed to coincide with crawler emergence).

<u>Mites and mite predators</u>. For sampling mites and mite predators, we pick 15 leaves/sample tree/sample date from mid-June through August, immediately place the samples in a portable cooler, and at the laboratory in Amherst brush and process the leaves. The principal mite pests of apple in Massachusetts are: European red mite (ERM), two spotted spider mite (TSM), and apple rust mite (ARM). The principal mite predator in Massachusetts commercial apple orchards is <u>Amblyseius fallacis</u>. We use the following ETL's: combined total of 8 ERM and TSM active stages/leaf if no <u>A. fallacis</u> are present; 300 ARM/leaf. If any <u>A. fallacis</u> are present, we base our ETL for ERM and TSM on an index of the ratio of <u>A. fallacis</u>/prey mites developed by Croft in Michigan. Each year, we recommend a pre-bloom oil application against ERM eggs in each IPM block.

<u>Green apple aphid and aphid predators</u>. From petal fall through August, we examine 30 foliage terminals (the 10 most distal leaves on 1st year woody growth, but not water sprouts)/sample tree/sample date for apple aphids, and eggs and larvae of the principal predators of apple aphids in Massachusetts commercial apple orchards: the cecidomyiid <u>Aphidoletes aphidimyza</u>, and the syrphid <u>Syrphus ribesii</u>. We also examine 30 developing apples/sample tree/sampling date for presence of aphid honeydew droplets on the fruit surface. If there are

no predator eggs or larvae present, we provisionally set the ETL at either 50% of the terminals infested with apple aphids (based on work of Madsen and colleagues in British Columbia) or 10% of the fruit with honeydew. If there are predator eggs or larvae present, we base our ETL on an index of the ratio of predators/aphids.

Woolly apple aphid. From early June through August, we sample 15 recent pruning cuts/sample tree/sample date for presence of woolly apple aphids. The ETL is provisionally set at 50% of the cuts infested with woolly aphids.

White apple leafhopper. From petalfall through August, we examine 30 leaves/sample tree/sampling date for leafhopper nymphs and adults. The ETL, based on work of Madsen and colleagues in British Columbia, is provisionally set at 0.25 active stages/leaf.

Spotted tentiform leafminer. From bloom through July, we examine 30 fruitcluster leaves/sample tree/sample date for leaf-miner mines. The ETL, based on work by Weires and Forshey in the Hudson Valley of New York is set at 1.0 sap-feeding mines/leaf on McIntosh and Cortland and 3.0 sap-feeding mines/leaf on Red Delicous for 1st generation larvae, and at 2.0 sap-feeding mines/leaf on McIntosh and Cortland and 6.0 sap-feeding mines/leaf on Red Delicious for 2nd generation larvae.

CONCLUSIONS

As suggested in the introduction, many of the above sampling procedures and ETL's which we currently employ in our apple IPM program will require considerable refinement and fuller consideration of the variables influencing them before they will be of long-term value to IPM scouts, growers, and farm advisors in Massachusetts and other regions. Ultimately, the amount of time and money required to employ all of the sampling procedures at the level of intensity indicated here (1 sampling station per every 1-2 acres) may turn out to be so great that usefulness on a broad scale would be economically unfeasible. We recognize that less intensive or more simplified sampling procedures might ultimately prove to be more optimal from a cost-benefit point of view. One of our major research goals for the 1980's is aimed at developing more refined and yet still simple and workable sampling procedures and ETL's for major apple insect and mite pests.

MANAGING MUMMY-BERRY DISEASE OF BLUEBERRIES IN MASSACHUSETTS

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Mummy-berry disease is caused by the fungus Monolinia vaccinii-corymbosi. It is probably the most serious blueberry disease in Massachusetts, though no accurate loss estimate is available.

In order to manage the disease, the disease cycle as shown on the following page must be understood. The fungus is an Ascomycete and produces two types of spores: ascospores and conidia. These spores disseminate the fungus.

The disease gets its name from the so-called mummy berry which allows the fungus to overwinter. This mummy is actually a fungal mass which winters on the ground, and in the spring produces apothecia, which look like small mushrooms. In the apothecia, ascospores are formed. These ascospores are discharged in moist weather during early spring, and land on leaves and twigs, where infections start. This is called the leaf and twig blight stage, or bud and twig blight stage, of mummy berry. As symptoms develop, conidia form in diseased tissues. These secondary spores are disseminated by rain, wind and bees to blossoms and other new tissues. The fungus grows into the blossoms and tissue, invading the developing fruit. This is the blossom blight stage of the disease. The fruit turns salmon-colored or grey by mid-summer, and drops to the ground. There it becomes a mummy of mycelia. The fungus overwinters in the mummified fruit.

Researchers (Ramsdell et al., 1974, 1975) have found that ascospore release is not closely correlated with the stage of the blueberry plant's growth. Ascospores are generally present when the first green tissue appears in the spring, and continue to be present through bloom. Conidial release overlaps the end of ascospore release and continues until after bloom. Ascospore release is inversely correlated with relative humidity; conidia release is inversely correlated with leaf wetness. A combination of drying and wetting stimulates release; maximum release periods come during dry periods following free moisture, usually rain, on the leaves. After release, spores can travel at least 1000 ft.

It has been concluded that inoculum is generally present in such large amounts that protective chemical controls applied throughout both primary and secondary infection periods are necessary to effectively manage the disease (Ramsdell et al., 1976). Since this strategy is protective, it is based almost entirely on plant growth stages. Cover spra s begin just before bud break, and continue until just after petal fall. Early infections are effectively inhibited by triforine (Funginex), applied at or just prior to bud break, and continuing

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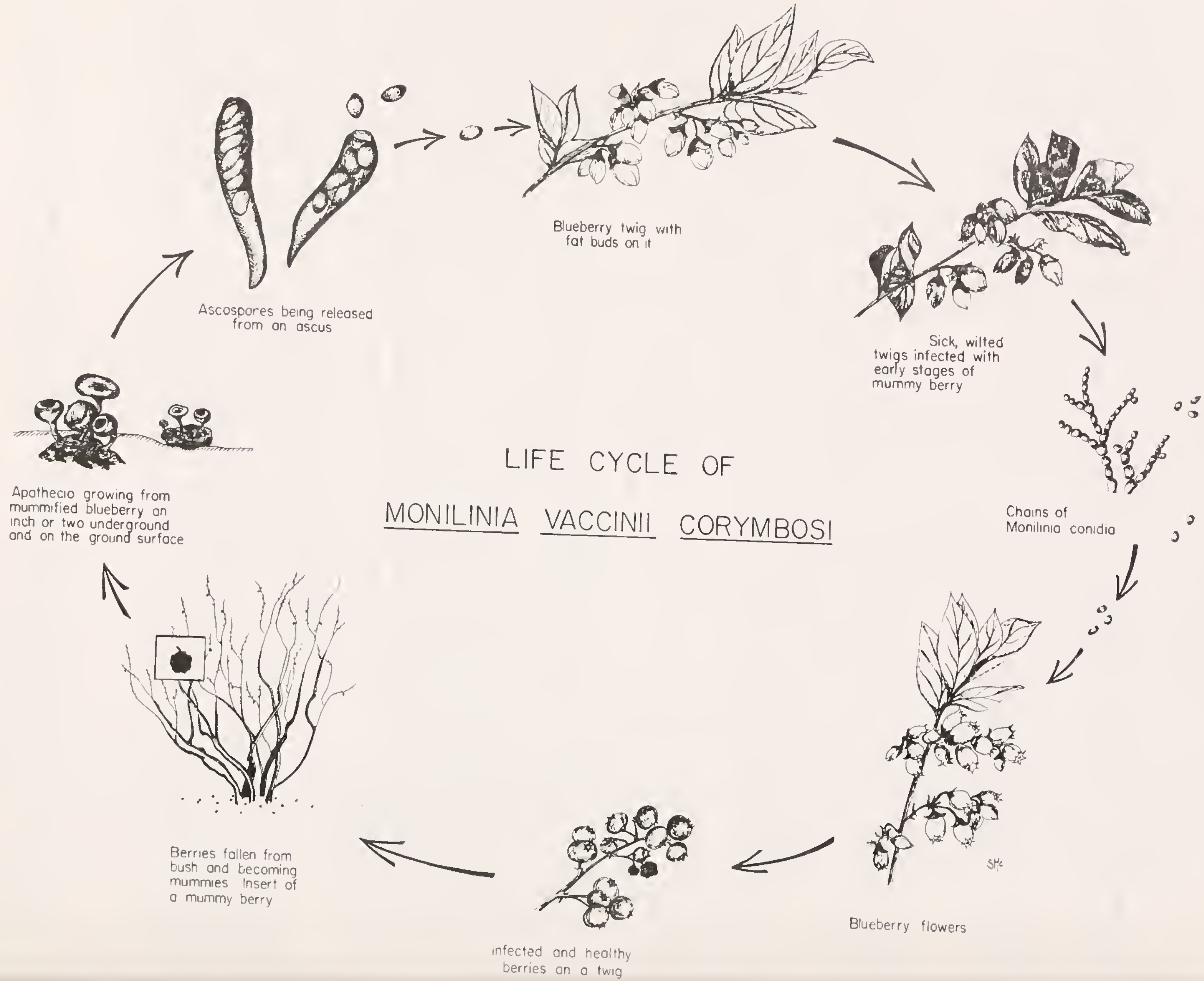
LIFE CYCLE OF
MONILINIA VACCINII CORYMBOSI
Blueberry twig with fat buds on it
Sick, wilted twigs infected with early stages of mummy berry
Chains of Monilinia conidia
Blueberry flowers
SMc
infected and healthy berries on a twig
Berries fallen from bush and becoming mummies Insert of a mummy berry
Apathecia growing from mummified blueberry an inch or two underground and on the ground surface
Ascospores being released from an ascus

for two covers at 7 to 10 day intervals (the residual life of triforine). Thereafter, cover sprays are made with benomyl (Benlate) at 7 to 10day intervals, depending on rain. Benomyl is not very effective against the bud and twig blight stage, but it is effective during the blossom blight stage. Cultural controls can play an important part in managing the disease (Ramsdell et al., 1976). Primary infection can be greatly reduced by cultivating between plants, and raking under apothecia. Combining this practice with an application of 50% urea prills is especially effective (Stretch, personal communication). This is done when the apothecia start to emerge in the spring. Other chemicals have been used against apothecia, but are not currently registered.

Resistant varieties are almost non-existent. Only one numbered selection was reported resistant to both primary and secondary infections (Nelson & Bittenbender, 1971). Of named varieties, Bluetta, Collins and Darrow were somewhat resistant to primary infections. Jersey, Rubel, Burlington, Pemberton and Dixi are the least susceptible in New Jersey (Varney & Stretch, 1966), while Earliblue, Blueray, June, Atlantic and Ivanhoe are most susceptible.

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COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 45, No. 4

JULY / AUGUST 1980

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PROGRESS REPORT: SCION/ROOTSTOCK AND INTERSTEM EFFECTS ON APPLE TREE GROWTH AND FRUITING

William J. Lord
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In 1976, in cooperation with 9 other states, we established a planting of Empire and Millerspur Delicious trees containing an 8-inch interstem of M.9 on either MM.111, Antonovka, or Ottawa 11 rootstocks. The trees were small and weak at planting and we have experienced significant tree losses.

The interstem portion of the trees is above ground and we have encountered considerable suckering from this portion of the tree and the rootstock (Fig. 1). Maintenance of a strong central leader has been difficult on these trees. Therefore, temporary support was provided in July, 1978 to aid leader development.

Fig. 1. An interstem tree with a 8-inch M9 stempiece grafted between MM.111 rootstock and Empire, the scion cultivar. (The lower white line is painted on the stempiece, and the upper white line is painted on the scion portion of the tree.) The union between the M9 stempiece and MM111 is 2-inches above ground. Interstem trees planted at this depth produce more root suckers (shown in picture) than if most of the stempiece is below ground. Note that the diameter of the stempiece is larger than that of the rootstock or scion.

Stephen Long-Photo Center

The significant losses of trees in this planting make most data meaningless except for overall observations. Some of the trees cropped in 1978, particularly the Empire trees. However, both in 1978 and 1979 yields were much less than in an adjacent block of McIntosh of the same age on MM106, M.7 or M.26.

Measurements of the scion and interstem circumferences, tree height, and tree spread in 1979 indicate that the Empire trees are larger than those of Millerspur Delicious. The interstem portion of the trunk is misshapen on some trees (Fig. 2)perhaps due to the presence of burr knots (adventitious roots which disrupt the continuity of the bark). The numbers of burr knots on the interstem portion vary considerably among trees.

Fig. 2. The presence of burr knots on the M9 stempiece (with the lower white line in its center) of interstem trees disrupts the continuity of the bark and as shown in the picture can cause distortion of the stempiece.

Stephen Long - Photo Center

The data from the 10 states is being summarized and will appear in a future issue of Compact Fruit Tree.

SOIL, TREE, AND FRUIT RESPONSE TO LIME AND TYPE OF NITROGENOUS FERTILIZER APPLIED AT TWO TIMINGS UNDER STURDEESPUR DELICIOUS TREES

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A number of fertilizers are used in orchards to supply nitrogen (N). They may contain only an N carrier, or the N carrier may be mixed with carriers of other elements. N carriers contain nitrate N, ammonia N, a combination of both, or urea.

Apple trees usually absorb N in the nitrate form because ammonium N after fixation in the surface soil is rapdily converted to nitrate N under most soil conditions. However, under some conditions ammonia N may persist for considerable time. Urea is rapidly hydrolyzed to ammonia N and then behaves like ammonia. Nevertheless, apple trees can absorb urea and ammonia N if they are in solution.

N sources have been compared frequently in apple orchards in the past. Differential responses have been obtained on acid soils from N carriers supplying either ammonium or nitrate N because of slower availability of ammonium N following spring application. Fixation of ammonia can influence timing of fertilization in irrigation water during the growing season, and sodium nitrate could be harmful on soils with high sodium content. However, these are unusual situations and it is generally suggested that price per unit of actual N should determine choice of nitrogenous fertilizer for orchards.

These studies preceded the concern with low calcium (Ca) levels in apple fruits and their association with cork spot, bitter pit, and breakdown of apples. Dr. Shear in 1971 reported that apple fruits had more severe Ca deficiency symptoms when nutrient-culture-grown trees received low Ca and 3/4 of their N as NH_4^+, than when they received all NO_3^--N. He concluded that the effect of N -source on the differential movement of Ca into fruit and leaves could be an important consideration when determining the type of nitrogenous fertilizer for apple orchards and timing of application. Shear and Faust suggested that apple growers concerned with low flesh Ca in apples should not use ammonium N before or soon after bloom because the absorption of this element may be reduced if ammonium N is present.

Calcium nitrate [$Ca(NO_3)_2$] was suggested as a replacement for ammonium nitrate by Eggert _et al_. in New Hampshire because it does not affect soil pH and it supplies a highly water soluble source of Ca which moves readily into the soil.

To investigate the soil, tree and fruit response to lime, type of nitrogenous fertilizer, and/or time of application we initiated an experiment in 1972 with Sturdeespur Delicious trees at the Horticultural Research Center, Belchertown. The trees were planted in a soil having a pH of 6.0 to 6.5 to a 2-foot depth. Two and one-half lbs. of high Ca lime (40% CaO; 7% MgO) were mixed with the soil in the planting holes for half the trees. Ammonium nitrate (NH_4NO_3), $Ca(NO_3)_2$ or potassium nitrate (KNO_3) was applied annually from 1972 through 1979 either approximately 1 month before bloom or at bloom. The trees fertilized with NH_4NO_3 and $Ca(NO_3)_2$ also received muriate of potash so all trees received equivalent amounts of potassium (K). Herbicides were applied annually except in 1979 in a 3-foot band on each side of the tree trunk to suppress grass and broadleaf weeds. Paraquat was applied twice a growing season from 1972 through 1975. Paraquat-plus-simazine was used in mid-May of 1976, 1977, and 1978. Soil samples to determine pH were obtained within the herbicide-treated strip in 1975, 1977, 1978 and 1979. Below are our results to date.

Influence of Lime

Incorporating high calcium lime with the soil in the planting hole significantly increased Ca content of the foliage in 1972 and 1973 but the differences were small (Table 1). Although the pH of this soil was high and/or lime was incorporated into the soil, leaf Ca was still relatively low, further emphasizing the difficulty of increasing the level of this element in apple trees.

Table 1. The effect of incorporating lime with soil in the planting hole on leaf calcium (Ca) of Sturdeespur Delicious trees.

	Leaf Ca (%):					
Treatment	1972	1973	1974	1975	1976	1977
Lime[z]	1.08a[y]	0.79a	0.91a	1.30a	1.07a	0.76a
No lime	0.96b	0.74b	0.90a	1.28a	1.05a	0.74a

[z] High Ca lime 2-1/2 lbs. per tree at planting.

[y] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

Influence of N Source of Soil pH

NH_4NO_3, as expected, increased soil acidity while soil pH under the trees that received KNO_3 or $Ca(NO_3)_2$ remained fairly constant (Table 2).

Table 2. The influence on soil pH of three sources of nitrogen applied annually under Sturdeespur Delicious trees since 1972.

Year soil sampled	Soil pH under trees receiving: $Ca(NO_3)_2$ 0-6" depth	$Ca(NO_3)_2$ 6-12" depth	NH_4NO_3 0-6" depth	NH_4NO_3 6-12" depth	KNO_3 0-6" depth	KNO_3 6-12" depth
1975	6.16a[z]	6.09a	5.90b	5.90b	6.18a	6.15a
1977	6.05a	6.03a	5.51b	5.65b	6.20a	6.09a
1978	5.93a	5.85a	5.21b	5.20b	5.99a	5.71a
1979	6.00a	5.92a	5.20b	5.22b	6.14a	6.14a

[z] Numbers in a row followed by a different letter are significantly different at odds of 19 to 1.

In 1979 we also sampled the 20 to 24-inch soil depth and found the acidifying influence of NH_4NO_3 at these depths but the pH was higher than at the 12-inch and 6-inch depths (Table 3).

Table 3. Influence of ammonium nitrate and calcium nitrate on soil pH at different depths, 1979[z].

Soil depth	Soil pH under tree receiving: NH_4NO_3	$Ca(NO_3)_2$	KNO_3
0-6	5.20b[y]	6.00a	6.14a
6-12	5.22b	5.92a	6.14a
20-24	5.57a	6.07a	6.14a

[z] Applied annually since 1972

[y] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

Influence of N Source on Elements in Leaves

Leaf analyses showed that N and Mg were not influenced by N source. In 1976 KNO_3 increased K and suppressed Ca probably due to the interaction between these 2 elements. In 1974, 1976 and 1977 the KNO_3 trees were lower in foliar Ca than those fertilized with $Ca(NO_3)_2$. This is probably an influence of K in KNO_3 rather than an enhancement of Ca by $Ca(NO_3)_2$ since Ca was not influenced by NH_4NO_3.

Fruit Ca levels were analyzed in 1978 and 1979. Fruit Ca was higher on trees fertilized with $Ca(NO_3)_2$ on April 12, 1978 (93 ppm), than those from trees that received NH_4NO_3 on May 22, 1978 (84 ppm), otherwise N source and time of application has not influenced fruit Ca levels.

Influence of Time of N Application on Elements in Leaves

We suggest that nitrogenous fertilizers be applied as early as possible in the spring. Among the several things early application accomplishes is early absorption of N rather than late absorption which could cause higher levels of this element at harvest, reduced red color of fruit, and delayed maturation. However, our data showed that with the exception of leaf N in 1974, the level of this element and Ca, K and Mg were similar in mid-July for the 2 timings of fertilization. The fertilizer application on April 12, 1974 was followed by 0.7 inches of rain on April 14, thus it probably was more rapidly dissolved and carried to feeder root depth than the May 15 application which was followed by 0.3 inches and 1.1 inches of rain on May 24 and June 1, respectively.

Influence of N Source on the Incidence of Bitter Pit

The trees commenced bearing in 1974, but it was 1976 before cropping was considered sufficiently uniform among trees to examine the fruits for bitter pit. A frost eliminated the crop in 1977. However, in 1976, 1978 and 1979 N source did not influence the amount of bitter pit (Table 4), which gives further evidence of the lack of differential Ca response to N source.

Table 4. The influence of N source on the incidence of bitter pit

Nitrogen source	Bitter pit (%): At harvest 1976	At harvest 1978	At harvest 1979	After storage 1978	After storage 1979
KNO_3	11a[z]	17a	9a	22a	13a
NH_4NO_3	8a	14a	6a	18a	9a
$Ca(NO_3)_2$	7a	16a	6a	21a	11a

[z] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

Summary

Mixing lime with the soil used in planting hole for apple trees enhanced Ca levels for only the first 2 years. $Ca(NO_3)_2$ and KNO_3 are neutral in reaction and have not affected soil pH, whereas NO_4NO_3 increased soil acidity. N source or time of application had little influence on N, K, Mg, and Ca content of leaves, no effect on the incidence of bitter pit, and no appreciable influence on fruit Ca. Thus, it would appear, under the conditions of this experiment, that no change is needed in the "old idea" that price per unit of actual N should determine choice of nitrogen fertilizers for orchards.

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HOW ETHEPHON IS BEING USED TO ADVANCE THE MATURITY OF APPLES IN MASSACHUSETTS

W. J. Lord[1], J. Williams[2] and K. Hauschild[2]

Ethephon has been used commercially for several years on early-maturing cultivars and on McIntosh to stimulate red color development, hasten fruit maturity, and advance the harvest season. We published a circular with suggestions on the use of ethephon in 1976. The information was up-dated last year and the suggestions appeared in the July/August, 1979 issue of FRUIT NOTES.

Climatic conditions vary in the state and affect the rate of ethephon needed to obtain the desired response. Furthermore, ethephon's use is influenced by the marketing needs of the grower. Thus, the purpose of this article is to describe how ethephon is being used commercially by some growers in Massachusetts.

Horticultural Research Center. Tony Rossi, farm foreman, needs McIntosh apples the first week of September for sale to the University of Massachusetts dining halls. He applies ethephon at 1 pint, plus 20 ppm 2,4,5-TP, per 100 gallons of water with an air blast sprayer at 1X. Tony uses 2,4,5-TP rather than NAA because it provides better pre-harvest drop control and contributes more than NAA for advancing fruit maturity. The data in Table 1 show the 1974 to 1979 dates of ethephon application and harvest. Tony selects vigorous young trees because the fruit are larger and the ethephon effect is greater because of less shading. Direct sunlight enhances the fruit color response to ethephon.

It can be noted in Table 1 that the fruit have been harvested 7 to 10 days after the ethephon application. Except in 1979, the fruit have been harvested in one picking.

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Table 1. Ethephon usage at the Horticultural Research Center: Date of application and harvest date.

Application date[z]	Harvest date	Days from application to harvest
August 20, 1974	August 29	9
August 27, 1975	September 2	6
August 16, 1976[y]	August 25	9
August 23, 1977	September 2	10
August 30, 1978[x]	September 7	8
August 20, 1979	August 29 and September 3	9 14

[z] 1 pint of ethephon + 20 ppm 2,4,5-TP

[y] Applied earlier than usual because fruit were needed in late August.

[x] Application date was delayed because of rain.

Edward Roberts and Sons, Hillside Orchard, Granville. The Roberts' harvest 10,000 to 12,000 bushels of ethephon-treated McIntosh apples each fall for immediate sales. Beginning the last week of August or the first week of September, they apply ethephon to a different set of trees every 2 or 3 days, depending upon the weather.

In 1979, the first 2 sprays of ethephon were applied at 1/2 pint per 100 gallons of water at 1X (Table 2). (However some years only 1/3 pint of ethephon per 100 gallons of water was used on the earliest spray dates. The higher rate was used in 1979 in order to enhance a quicker response.) The next 5 ethephon sprays in 1979 were applied at 1/3 pint. Sprays applied September 4 or later were applied at 1/4 pint.

NAA at 10 ppm is used with the ethephon sprays for pre-harvest drop control. They prefer NAA because it hastens ripening less than 2,4,5-TP.

The ethephon-sprayed fruit are examined twice daily, starting 5 days after spraying, to determine color development. The fruits are harvested when they obtain 50 to 60% red color, which is generally 6 to 7 days after the ethephon application (Table 2). (They believe that by waiting for more color, condition on the retail counter is sacrificed.)

Table 2. 1979 dates of ethephon application and harvest on McIntosh at Hillside Orchards.

Application date	Harvest date	Days from application to harvest
August 22[z]	August 28	6
August 24[z]	August 29-30	6 - 7
August 26[y]	September 1	6
August 28[y]	September 2	5
August 30[y]	September 5	6
August 31[y]	September 6	6
September 3[y]	September 9	6
September 4[y]	September 10	6
September 7[y]	September 13	6
September 9[x]	September 16	7
September 11[x]	September 18	7

[z] 1/2 pint ethephon plus 10 ppm NAA

[y] 1/3 pint ethephon plus 10 ppm NAA

[x] 1/4 pint ethephon plus 10 ppm NAA

Apples picked September 5 or later are refrigerated, packed within 2 days and shipped within 4 days of harvest.

They have a market for Cortland apples in September. Therefore, 1/3 pint of ethephon plus 10 ppm NAA in 100 gallons of water at 1X is applied on trees of this cultivar the first week of September. Excellent results have been obtained on young Cortland trees that produce large fruit.

<u>Atkins Farms, Inc., Amherst</u>. Howard Atkins considers ethephon a good tool for assisting harvest and permitting sales during harvest. Ethephon is used on Wealthy, Milton, Mollie's Delicious and other early maturing cultivars as well as on McIntosh. When used on early maturing cultivars, farm manager Stanley Kielbasa has found that the number of pickings has been reduced from 4 or 5 to 2. On early cultivars ethephon may be applied before first harvest or it may be applied after the fruit is first "spot-picked", so that the trees can be "stripped" at the second picking. These early maturing cultivars are sold at the roadside stand.

Table 3. 1979 dates of ethephon application and harvest dates at Atkins Farm.

Cultivar	Ethephon application dates	Harvest dates	Days from application to harvest
Wealthy	August 11[z]	August 25	14
Milton	August 18[z]	September 2	15
Mollie's Delicious	August 20[z]	August 27	7
Mollie's Delicious	August 28[z]	September 5,6	9,10
McIntosh	August 23[z]	September 7	15
McIntosh	September 5[y]	September 19	14

[z] 2/3 pint ethephon plus 20 ppm 2,4,5-TP

[y] 3/4 pint ethephon plus 20 ppm 2,4,5-TP

Ethephon is applied on McIntosh blocks scheduled for pick-your-own or for early sales at both the roadside stand and wholesale. Dates of ethephon applications and concentrations on McIntosh and harvest dates are shown in Table 3.

Marshall Farms, Fitchburg. Marshall Farms need about 2,000 bushels of well-colored McIntosh apples 1 week prior to the normal harvest period of the Rogers and Hermann strains of this cultivar. Fruit from trees of their own strain, the Marshall McIntosh, should fulfill this need in the future, but at present it is necessary to apply ethephon on some Rogers and Hermann McIntosh trees.

In 1979, the Marshall Farms delayed their ethephon application until September 4 when cool weather replaced the high temperatures of late-August and the first 3 days of September. They applied 1/2 pint of ethephon plus 15 ppm 2,4,5-TP per 100 gallons of water with a Hardy air blast sprayer at 1X. The McIntosh trees sprayed were 14-years-old on M9, 12-years-old on M7, and seedling trees over 50 years of age. Alfred Marshall noted that the coloring response to ethephon was best on the young trees, probably because of better light penetration. Harvest of the ethephon treated trees commenced 5 days after application.

Marshall Farms in 1979 successfully stored some ethephon treated McIntosh in regular storage for 3 to 4 weeks. As a trial they placed

6 bins of ethephon-treated McIntosh in CA storage. These fruit were harvested September 7, 1979 (5 days after ethephon was applied) and dipped in 25 pounds $CaCl_2$/100 gallons of water and placed in CA storage. The storage was opened in early April and on May 18, 2-1/2 inch apples were pressure tested and had pressure of approximately 14 pounds. Three inch apples were pressure tested on May 19 and had pressure of approximately 12.5 pounds. Marshall McIntosh harvested on September 6 were placed in the same CA storage (untreated) on the same date. They were pressure tested on May 19, 1979 and 2-1/2 to 2-3/4 inch fruit had pressure of approximately 12.5 pounds.

Marshall Farms produce about 2,000 bushels of Early McIntosh for immediate sale from trees ranging in age and size from 14-years-old on M7 to 20, 25 or 35-year-old trees on seedling roots. Trees of this cultivar are sprayed annually about 5 to 7 days prior to normal harvest with 1/4 pint of ethephon plus 10 ppm 2,4,5-TP per 100 gallons of water at 1X. This treatment improves red color and generally reduces the number of times necessary to "spot pick" trees from 4 to 2.

Bolton Orchards, Bolton. Steve Ware, orchard manager, generally uses ethephon on Early McIntosh and Puritan trees to improve red color and reduce the number of times required for "spot picking". Ethephon is applied at 1/2 pint plus 20 ppm NAA (for drop control) per 100 gallons of water with a Hardy air blast sprayer at 1X. The first group of trees was sprayed on August 1, 1979. Ethephon was applied at 3 to 4 day intervals to different trees. Enough trees were sprayed each time to permit harvest of approximately 150 bushels. Beginning on the 4th day after treatment, Steve observes daily the color development. The fruit are generally harvested 5 to 7 days after the ethephon application and are sold at retail to satisfy early consumer demand.

Wholesale buyers expressed some resistance to purchase of McIntosh apples treated with ethephon in 1978 because of a "dull" red color that Steve Ware described as "not a natural red".

Carlson Orchards, Harvard. In 1979 Carlson Orchards applied 3/4 pint of ethephon plus 10 ppm NAA per 100 gallons of water with an air blast sprayer at 1X on 20-year-old Early McIntosh trees. This spray was applied at 3-day intervals on a few row of trees. The apples were harvested 5 to 7 days after the spray application. The trees were "strip-picked" because the fruits with insufficient color to meet marketing requirements were used for cider. The remainder of the Early McIntosh apples were sold at retail and wholesale.

Authors comments. The Hillside Orchard in Granville is favorably located for obtaining well-colored McIntosh. This may partly explain why they obtain good color enhancement with late-August applications of 1/2 pint or less ethephon. In our early trials with ethephon at the Horticultural Research Center, it was applied the 1st or 2nd week of September at 1/4 or 1/2 pint per 100 gallons, with either NAA or 2,4,5-TP for drop control. Even though the applications were nearer to normal harvest than those applied at the Hillside Orchard, color did not develop as rapidly. Eight days after application, only an additional 10 to 20% of the fruit surface had red coloration.

The growers used either NAA or 2,4,5-TP for drop control on McIntosh. Our trials showed that NAA when combined with ethephon gives effective drop control for 7-10 days. On the other hand, 2,4,5-TP may cause more fruit ripening than NAA, but it does eliminate, in case of a delay in harvest, the chance of excessive fruit losses due to preharvest drop or the need of a second NAA application.

One grower interviewed expressed concern about possible tree injury to McIntosh when using 2,4,5-TP with ethephon. (Injury from 2,4,5-TP is noticeable the year following application. The tips of terminal shoots in the tops of affected trees appear "naked" because of injury to lateral buds.) We have not observed tree injury on McIntosh at the Horticultural Research Center from 20 ppm 2,4,5-TP. However, the same rate injured Early McIntosh and Puritan trees when it was used with 1/2 pint ethephon to enhance ripening of fruits of these cultivars. McIntosh and Delicious trees can be injured by 2,4,5-TP under certain conditions, one of which is over application.

We believe that NAA will generally provide adequate drop control on early maturing cultivars because the fruits are generally harvested before drop becomes troublesome. However, if you do use 2,4,5-TP, 10 ppm of this material should be sufficient.

<u>When using 2,4,5-TP for drop control be sure to read the label.</u> It is available at both 1X and 2X concentration and growers have cans of both concentrations on their shelves.

EXCESSIVE APPLE BUD ABSCISSION IN 1980: WAS IT CAUSED BY TARNISHED PLANT BUG FEEDING OR COLD TEMPERATURES?

Ronald J. Prokopy[1], Geoffrey L. Hubbell[2]
William M. Coli[3], and William J. Lord[4]

At the Horticultural Research Center in Belchertown, as well as in a number of commercial orchards, we observed an unusual amount of apple bud abscission this year. The majority of abscissed buds which we observed never exceeded 1/4 inch in length and turned dark brown shortly after tight cluster. Some reached 1/2 - 3/4 inch long before abscission occurred, with the calyx cup then turning yellow. In some cases, all 5-7 buds in a cluster abscissed. Usually, however, there were at least one or two healthy buds per cluster.

Our examination of approximately 300 flower bud clusters in each of 8 commercial orchards revealed an average of 1.6 and 9.2% abscissed buds in 1978 and 1979, respectively. This year, an average of 18.1% of the buds in these same 8 orhcards was abscissed, with one orchard reaching 36.7% abscission. Our sample consisted almost exclusively of 'McIntosh' and 'Red Delicious' trees, with the level of abscission about the same on each. Abscission levels appeared to be greater on 'Cortlands', although we sampled few trees of this cultivar. This observation is in agreement with bloom data obtained from other experiments involving these cultivars.

In an earlier study (FRUIT NOTES 42(2): 10-14, 1977), we showed that feeding by tarnished plant bug (TPB) adults on apple flower buds from the silver tip up to the tight cluster stage could result in substantial bud abscission. The large number of TPB adults captured on our white monitoring traps from silver tip to tight cluster in commercial orchards this year suggested to us that TPB adults may have been principally responsible for the high level of bud abscission.

At our research block at the Horticultural Research Center, we had placed cages over several hundred dormant buds in early April to prevent entry of TPB and other insects. Abscission of uncaged buds on these trees was high (68%), but it was nearly as great (54%) for the caged buds. The large number of TPB adults (7.2/trap by tight cluster) in this block may have accounted for most or all of the 14% difference here, but these adults obviously were not the principal cause of bud abscission.

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We therefore believe that the majority of bud abscission in commercial orchards this year was caused by low temperatures. It is possible that the rather high temperatures from April 11-15 (59^{o}-68^{o} F) followed by the low temperatures on April 16 (24^{o} F), may have been the responsible factor. It is too soon to tell if the size of the 1980 fruit crop will be affected by this abnormally high level of bud abscission.

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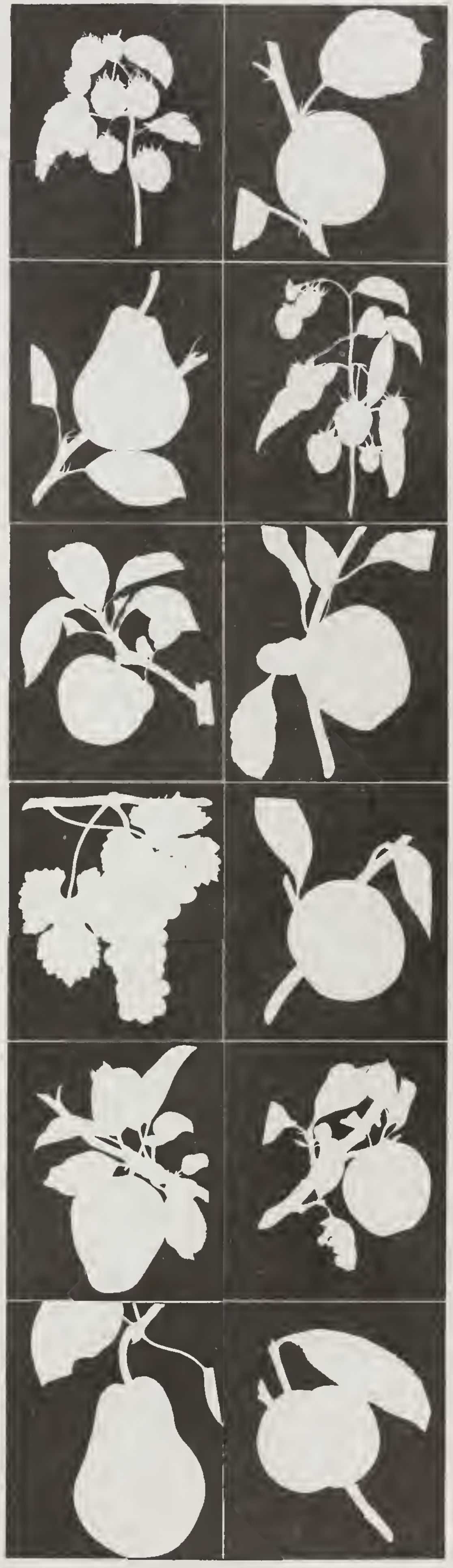

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 45 No.5
SEPTEMBER/OCTOBER 1980

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PROGRESS REPORT: PRUNING EFFECTS ON TREE GROWTH AND FRUITING OF SPARTAN APPLE

William J. Lord and Joseph Sincuk
Department of Plant and Soil Sciences

Small trees on size-controlling rootstocks can be more economically pruned, sprayed, and harvested than large trees on seedling rootstocks. Nevertheless, training and pruning of trees becomes increasingly important as planting density increases. In the past, we had low density orchards with standard-type trees on seedling rootstocks which performed well on a wide range of soil types and there was little concern about tree height and spread. We now have low, medium and high density orchards in Massachusetts and each type requires somewhat different training and pruning procedures. The trees are spur-type, standard-type or interstems, and tree vigor varies considerably especially on weaker growing rootstocks because of soil types. In spite of the trend to smaller trees, some growers report that pruning hours per acre have increased rather than decreased. Therefore, in 1976 we initiated several long-term trials to compare pruning systems with those used in the past. Below is a summary to date of a study of pruning effects on tree growth and fruiting of Spartan apple trees.

The Spartan apple trees on M.7 rootstock were planted at the Horticultural Research Center, Belchertown, MA in 1975. In February, 1976, we established the following pruning programs: (A) a program suggested by Dr. D.R. Heinicke in USDA Agriculture Handbook No. 458 (Figures 1B, 2), hereafter referred to as the USDA system; (B) limbs in tiers and central leader headed annually, hereafter referred to as the tier system (Figure 3); (C) minimum of pruning and 'zig-zagging' the central leader (Figure 4), hereafter referred to as the slender spindle system; and (D) pruning as done in the past (Figure 1A), hereafter referred to as regular pruning. Twelve trees have been pruned by each method.

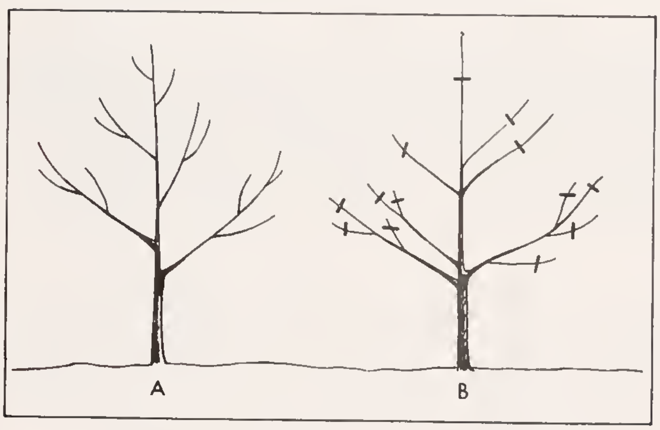

Fig. 1A. Two year old tree being pruned by standard pruning procedures. The lowest limb should be 18 to 20 inches from the ground, all others spaced 4 to 8 inches apart vertically on the trunk and each one about 90° around the trunk from the one below it.

Fig. 1B. Two year old tree being pruned as suggested by the USDA. It has 2 layers of limbs. The leader will be headed annually [heavy marks (—) indicate heading cuts]. The one year old wood on the branches is headed annually until branches on which this wood is borne start to fruit.

Pruning and Training Methods

USDA System. The system involved heading cuts and developing limbs in tiers (Figure 2).

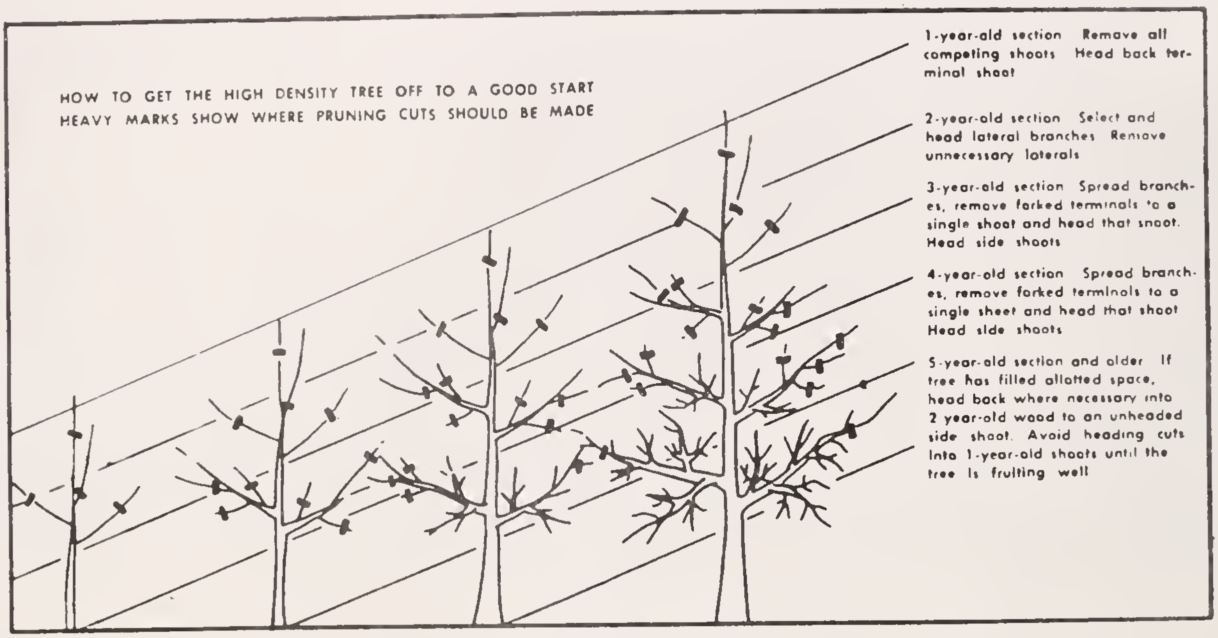

Fig. 2. A diagram of the "constructive training" program suggested by Dr. D.R. Heinicke in USDA *Agriculture Handboo[k] No. 458* entitled "High Density Apple Orchards—Planning, Training and Pruning." (Reproduced with permission [of] the author.)

The central leader and each 1-year-old shoot on scaffold limbs were headed during dormant pruning by removing 1/4 to 1/2 of the past season's growth. The central leader was headed to induce branching so that a tier of scaffold limbs could be developed 24 inches above a lower tier of limbs. The heading cuts on shoots originating from scaffold limbs were made to encourage development of lateral shoots to increase fruiting potential.

In May of each year, 2 or 3 vigorous shoots developed from the buds directly behind the heading cut on the central leader and lateral shoots. When shoot growth was 4 to 6 inches long, one shoot on each central leader and each headed lateral shoot was selected as the permanent extension shoot and competitors were removed. Limb spreaders were used when needed.

Tier System. Pruning and training procedures were similar to those for the USDA system except that none of the 1-year-old shoots on scaffold limbs were headed.

Slender-spindle System. All the scaffold branches 18 inches above ground level were kept except for those with narrow crotch angles.

Frequently, 2 or more branches of approximately the same size originated adjacent to each other. These whorls of branches were not eliminated until their presence appeared to be suppressing the dominance of the leader. At this time, one branch in the whorl was retained and the others were removed at their point of origin on the central leader.

Figure 3. A 4-year-old Spartan/7A being trained with limbs in tiers. The paint, except on the trunk, marks where heading cuts were made on the leader. Photographed March, 1979.

Figure 4. A 4-year-old Spartan/7A being trained as slender spindle. Tree has received a minimum of pruning. The leader has been pruned to an upward growing lateral branch in attempt to zig-zag the leader. Photographed March, 1979.

The procedure of removing the strong vertical leader during dormant pruning and using a weak competitor as the new leader was was not successful because it became apparent that the dominance of the leader was difficult to maintain. Thus, it became necessary in most instances to establish a dominant leader and delay, until dormant pruning in 1979, the procedure of using a weak competitor as the new leader (Figure 4). Limb spreaders were used when needed.

Regular type Pruning. This system involved selection of branches symmetrically arranged around the vertical axis of the tree and spaced far enough apart to avoid limb crowding when the trees became larger. Less temporary branches were left to provide additional leaf surface than on the slender spindle trees. Whorls of branches were eliminated in order to allow only one branch to develop at a given level. The dominance of the central leader was maintained by suppressing or removing competing leaders.

Results and Discussion

USDA System. We found the USDA system to be time consuming due to having to make heading cuts and remove competitor shoots during the summer. In March, 1979, pruning time per tree was: (a) USDA trees - 2.25 minutes; (b) Regular-type trees - 1.66 minutes; (c) Tier trees - 0.91 minutes; and (d) slender spindle trees - 0.66 minutes. The time required to summer prune the USDA and tier trees was not recorded. Most time consuming during dormant pruning were heading cuts on the USDA trees and pruning decisions on those pruned by the regular system. Few cuts were made on the slender-spindle trees but most time consuming was pruning decisions.

The heading cuts during dormant pruning followed by removal of competitor shoots in late May failed to encourage growth behind the area of removal in 1976 and 1977. However, in 1978 and 1979 lateral shoots behind the heading cuts were longer on the headed than on the non-headed 1-year-old shoots on scaffold branches (Table 1), but the response was much less than that shown in photographs in USDA Agriculture Handbook No. 458. This can be noted when comparing branching on the tree shown in Figure 5 with that shown in Figure 6.

Table 1. Current season lateral shoot growth on headed and non-headed 1-year-old shoots of Spartan apple trees[z].

Type of pruning on 1-year-old shoots on scaffold limbs	Mean length of current season lateral shoots on 1-year-old wood (cm)		Current season lateral shoots longer than 4 cm on 1-year-old wood (%)	
	1978	1979	1978	1979
Heading cuts				
USDA system	5.4a[y]	5.3a	32a	26a
No heading cuts				
Slender-spindle trees	3.3b	2.3b	11b	10b
Regular-pruned trees	3.7b	2.0b	16b	6b
Trees with limbs in tiers	3.3b	1.8b	14b	5b

[z] Trees planted in 1975.

[y] Means in columns not having letters in common are significantly at odds of 19 to 1.

Therefore, heading cuts do not appear worthwhile on these vigorous Spartan trees which produce adequate lateral branching because of their standard-type growth habit.

At the end of the 5th growing season in 1979 the USDA-system trees had 3 tiers of branches spaced about 2 feet apart with 4 or 5 branches per tier (Figure 5).

Figure 5. A Spartan tree on which 1-year-old shoots on scaffold limbs were headed during the dormant seasons of 1976 through 1979. This tree in comparison to the tree shown in Figure 6 has more lateral branches. The paint, except on the trunk, marks where heading cuts were made on the leader and 1-year-old shoots. Photographed May, 1980.

Figure 5.

When the tiers were formed, 6 or 7 limbs were retained because the extra limbs provided leaf surface and permitted a choice when selecting permanent limbs. When the extra limbs were removed, limb selection was made to maximize the vertical spacing of the permanent limbs. The extension growth from the headed leaders was longer than that on the non-headed leaders in 1976 and 1978 but not in 1977 (Table 2.) The extension growth of the central leaders was not measured in 1979.

Figure 6. A tree on which no heading cuts were made on 1-year-old shoots. Photographed May, 1980.

The USDA system trees, in comparison to the slender spindle trees, made less trunk circumference increase in 1976 and 1977 (Table 2). In 1978 trunk circumference increase was similar for the 4 pruning treatments probably because cropping restricted vegetative growth on the slender spindle and regularly pruned trees (Table 2). The influence of cropping on trunk circumference increase also was evident in 1979.

Table 2. The response of Spartan trees to pruning systems initiated in 1976 at the Horticultural Research Center, Belchertown, MA[z].

Year response measured	Pruning system			
	USDA	Slender spindle	Regular	Tiers
	Length of extension growth of central leader (cm)			
1976	103a[y]	–	76b	99a
1977	98a	–	90a	97a
1978	67a	–	51b	63a
	Trunk circumference increase (cm)			
1976	4.3b	5.6a	4.8b	4.3b
1977	4.3bc	5.0a	4.6ab	4.2c
1978	5.0a	5.1a	5.0a	5.0a
1979	4.6a	3.9b	4.3ab	3.8b
	Yield (bushels)			
1978	0.00b	0.12a	0.09a	0.02b
1979	0.32b	1.32a	1.02a	1.38a

[z] Trees planted in 1975.

[y] Means in rows not having letters in common are significantly different at odds of 19 to 1.

Yields were higher in 1978 on the less-severely pruned slender spindle trees and regular pruned trees than on the USDA and tier trees. In 1979, yields were higher on the slender spindle, regular and tier trees than on the USDA trees.

The heading cuts on 1-year-old shoots of the USDA trees removed growth on which fruit spurs would have developed. Furthermore, measurements in 1979 indicated that the average distance of the first blossom cluster from the tip of shoots produced in 1977 was 10 cm on headed-wood in comparison to 2 cm on non-headed wood. This indicates that the buds directly behind the heading cuts, made in February, 1978 remained vegetative during the growing season of 1978 instead of producing flower buds. This appears to explain why the USDA trees were less productive than the tier trees in 1979.

Trees with limbs in tiers. Trees pruned by this system responded similarly to the USDA trees in regard to growth in 1976, 1977 and 1978 and to yield in 1978 (Table 2). However, these trees were more productive than the USDA trees in 1979 and trunk circumference increase was less. Pruning time has been less because no heading cuts were made on 1-year-old branches on scaffold limbs.

Slender spindle trees. Pruning of the slender spindle trees has been the least time consuming of the 4 systems. The trees, based on trunk circumference increase, produced more growth than the heavily pruned USDA and tier trees in 1976 and 1977 and more fruit in 1978 (Table 2). In 1979 yield on the slender spindle trees was higher than on the USDA tree.

It is well known that non-pruned trees are larger and more productive than pruned trees. The slender spindle trees are a compromise. The trees have been lightly pruned leaving as many branches as possible without stunting the growth of the central leader.

Regular-type pruning. The pruning system has been somewhat more time consuming than on the slender spindle trees but less than that for the USDA trees. Yields of the slender spindle and regular-pruned trees were comparable in 1978 and 1979 (Table 2).

Summary

The USDA pruning system has been more time consuming than the tier system, slender spindle system, or regular pruning and reduced yields in 1978 and 1979. Heading cuts caused some lateral shoot development on 1-year-old wood but much less than shown in USDA Agriculture Handbook No. 458 following similar pruning.

At present we prefer the slender spindle system which involves leaving as many branches as possible without stunting the growth of the central leader.

Recommendations

At present we will continue to suggest the following for non-bearing trees of standard-type strains: (a) prune as little as possible without dwarfing the central leader; (b) make heading cuts only when necessary to stiffen the central leader or scaffold branches, or to stimulate growth; and (c) spread branches when necessary.

DO CALCIUM CHLORIDE SPRAYS AFFECT APPLE MAGGOT FLY EGGLAYING?

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Department of Entomology

In an earlier issue of FRUIT NOTES (Vol. 42, No. 1), we described how, after laying an egg, an apple maggot female drags its ovipositor on the fruit surface. In so doing, the female releases a substance (called a pheromone) which deters other females from attempting to lay an egg in that fruit.

For the past three years, in cooperation with chemists from the USDA Lab in Gainesville, Florida and neurophysiologists from the Department of Zoology at the University of Massachusetts, we have been working on the chemical identity of this pheromone and on various physiological, behavioral, and ecological aspects of the pheromone deterrent system in the flies. Our eventual aim is to apply synthetic pheromone in sprays to prevent maggot fly egglaying.

In the course of recent laboratory studies, we found that apple maggot fly egglaying is deterred not only by the pheromone but also by sodium chloride (table salt). As shown in Table 1, sodium chloride at concentrations of 2 and 9 pounds per 100 gallons gave about the same moderately-strong levels of egglaying deterrence as 2 and 3 ovipositor dragging equivalents (ODE) of pheromone laid down by the flies (1 ODE = amount of pheromone deposited after laying 1 egg). Apparently the flies do not like to lay eggs in fruit treated with table salt any more than they like to lay eggs in fruit treated with pheromone.

Table 1. Percent arriving females attempting egglaying into hawthorn fruits treated with different concentrations of pheromone, sodium chloride, and calcium chloride (ODE = ovipositor dragging equivalent).

Pheromone	Attempting egglaying (%)	Sodium chloride	Attempting egglaying (%)	Calcium chloride	Attempting egglaying (%)
Clean check	77	Clean check	79	Clean check	86
2 ODE	50*	2 lbs/100 gal	49*	3 lbs/100 gal	68
3 ODE	28*	9 lbs/100 gal	35*	7 lbs/100 gal	83

* Significantly less than egglaying in clean check fruit.

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[2] Extension Technicians

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These results suggested that calcium chloride sprays applied to apple trees in July and August (maggot fly season) to increase calcium in the fruit might possibly act like sodium chloride salt sprays, and deter egglaying of apple maggot flies. However, the data in Table 1 shows that at the recommended rates of 3 pounds per 100 gallons, and even at double that rate (7 pounds per 100 gallons), calcium chloride sprays have no discernible deterrent effect on maggot fly egglaying. Apparently the flies' contact chemical receptors (located on the bottom of their feet) respond differently to calcium compared with sodium salts.

Thus, to their advantage, the flies are not put off by the type of salt we offer them in our orchards.

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CAUSES OF DEFECTS ON MCINTOSH APPLES AT PACKING SHEDS AND THEIR EFFECTS ON RETURNS

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and
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Department of Entomology

Last year we summarized in FRUIT NOTES (Volume 44, No. 5) our evaluation of labor productivity in grading and packing McIntosh apples grown under integrated pest management conditions in 1978. It was suggested that during the 1979-1980 storage season we inspect McIntosh apples at packing sheds in Massachusetts to determine why they failed to meet grade requirements for US Fancy fruit and analyze the effect of defects on returns. The results of this study are presented below.

Experimental Procedures

Culled McIntosh apples at 10 packing sheds were examined during the period from November, 1979 through January, 1980 to determine the reasons for rejection. At least one-half day was spent at each packing shed which, with one exception, were all manual sorting, sizing, and packing operations. A total of 1431 bushels were packed and 315 bushels were culled.

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The culls were inspected to determine the reason for rejection. Only the first or most obvious defect observed was listed as the reason for culling. Thus, fruit with multiple defects were not double counted and the additional defects were not recorded. This procedure was used to duplicate as closely as possible the normal grading method. The packer/grader is interested primarily in removing defective fruit from the line rather than determining the specific type of defect. The first or most obvious defect is, therefore, the critical one. All culled apples were inspected by the same individual.

During inspection of the culls, defects were noted and later categorized by type. Each category was expressed as a percentage of total culls and as a percentage of total apples graded.

Results

Defects on stored apples. The fruit sampled had a cull rate averaging 22.2 percent (Table 1). Cullage ranged from 3.3 percent to 53.4 percent. This large variation may be partly explained by the fact that the samples included first, second and strip pickings.

Table 1. Reasons why McIntosh apples were below grade at grower packing sheds, 1979

Grade defects	Bushels of culls	Percentage of culls showing this defect	Percentage of total apples culled because of this defect
Misshapen	3.0	1.0	0.2
Insect damage	5.7	1.8	0.4
Disease damage	7.0	2.2	0.5
Russeting	18.5	5.7	1.3
Bruise	25.5	8.1	1.8
Mechanical[z]	25.5	8.1	1.8
Stem puncture	31.2	9.9	2.2
Color (< US No.1)	53.0	16.9	3.7
Size (< 2-1/4")	145.0	46.0	10.3
Other	0.6	0.3	—
Totals	315.0	100.0	22.2

[z]Includes limb rub, cuts, and cracks.

Size and color defects account for 46 and 16.9 percent, respectively, of all culls (10.3 and 3.7 percent of total fruit graded). Reducing size and color defects is no easy task. Following proper cultural practices is imperative, with particular emphasis on pruning, thinning and proper fertilization. Beyond cultural practices, however, both of these categories are highly dependent on local growing and climatic conditions. They are, therefore, to some degree beyond the grower's control. Less than ideal growing periods during some portion of the 1979 growing season may have made the number of size and color defects disproportionately large in this study. An additional study should be undertaken to determine the "normal" distribution of defects.

Physical damage (bruise, mechanical and stem puncture) represent over 26 percent of the culled fruit and 5.8 percent of the total graded. Being a soft fleshed fruit, McIntosh apples are more susceptible to damage during harvest, handling and packing than most other varieties. For example, a McIntosh apple dropped three inches onto a flat board surface will develop a bruise of about 7/8" diameter. This defect will downgrade apples to as low as U.S. Utility.

Physical damage is an area in which cull rates could be reduced and is thus worthy of the grower's attention. Using extra care when removing fruit from the tree, dumping picking buckets, during handling from the tree to the storage, and packing could reduce these injuries. It could be worthwhile to monitor closely the handling of fruit to determine when and how the damage occurs. One study showed that 17 percent of the apples harvested were severely bruised (bruises larger than 3/4" in diameter) by an experienced picker. Whereas only 4 to 6 percent of the fruits were severely bruised by other experienced pickers in the same harvest crew. Such a level of damage should be unacceptable to the grower.

Pest and disease are two areas in which fruit growers use a variety of control measures. Defects in these categories account for only 4 percent of the culled fruit and less than 1 percent of all apples handled. These low damage levels are indicative of the importance growers place on controlling insects and disease in the orchard. The low levels are also a measure of the effectiveness of the research and development of preventive technology.

Economic implications of defects. All damaged or defective fruit represents a loss of revenue to the grower. This loss can be expressed as the difference between the value of the fruit if undamaged (Fancy or Extra Fancy) and the cull (cider) value. The information, presented in Table 2, was developed using an estimated yield of 600 bushels per acre, an average value of $10.50 per bushel for undamaged fruit and a value of $2.50 per bushel for culls.

The loss in revenue can be thought of as the "cost" of the defect. By being aware of this cost, the grower is in a position to assess the net value of taking some additional preventive action. Suppose, for example, most physical damage is found to occur when fruit is dumped from picking buckets into bulk bins. An estimate of the lost revenue due to the rough handling can be made. The grower can then determine if the cost of a little more time and effort to reduce handling damage is exceeded by the increase in returns.

Table 2 gives an indication of those areas which cost the grower the most in terms of lost revenue. Size and color deficiencies together account for a loss in revenue of $672 per acre ($494 for size and $177.60 for color). Fruit culled because of physical damage represents a loss of $287.40 per acre ($86.40 each for bruise and mechanical damage and $105.60 for stem puncture).

Table 2. Revenue loss on cull McIntosh apples at grower packing sheds, 1979.

Grade defect	Percent of total apples culled because of this defect	Culls per acre with this defect[z]	Value of culls if not damaged[y]	Cull value[x]	Loss of revenue due to this defect
		bushels	$	$	$
Misshapen	0.2	1.2	12.60	3.00	9.60
Insect damage	0.4	2.4	25.20	6.00	19.20
Disease damage	0.5	3.0	31.50	7.50	24.00
Russeting	1.3	7.8	81.90	19.50	62.40
Bruise	1.8	10.8	113.40	27.00	86.40
Mechanical	1.8	10.8	113.40	27.00	86.40
Skin puncture	2.2	13.2	138.60	33.00	105.60
Color (< US No.1)	3.7	22.2	233.10	55.50	177.60
Size (<2-1/4")	10.3	61.8	648.90	154.50	494.40
Totals	22.2	133.2	1398.60	333.00	1065.60

[z] Yield, 600 bushels per acre.

[y] At $10.50 per bushel.

[x] At $2.50 per bushel.

[w] Column 4 minus column 5.

For insect and disease damage, the revenue loss per acre is a relatively low $43.20. This includes $19.20 for insect damage and $24 for disease. The cost of reducing these injury levels any further may be nearly as great as the value of the fruit saved. This again is an indication of the grower's success in dealing with pests and disease.

Note that a 10 percent reduction in physical damage would mean additional revenue of $27.84 per acre. This would more than offset the loss due to either insect or disease damage. Such a reduction may be nearly cost free if it could be accomplished by handling the apples just a bit more carefully.

Summary and Conclusions

The packing operations sampled had a combined cull rate of 22.2 percent. Assuming a 600 bushel per acre yield, the culls mean a reduction in revenue of $1065.60 per acre. Note that at higher yields, the loss of revenue would be even larger.

The challenge to the grower is clear: by reducing cull rates, revenue per acre can be increased. Given the high cost of equipment, materials and labor, however, the cost of reducing some types of damage such as insect and disease may nearly equal the revenue gained.

Bruise, mechanical and puncture defects might be reduced without increasing costs too much if the grower is careful to determine where and when the damage occurs. Although speed is important when picking, grading and packing, the labor force should be reminded that they are dealing with a very fragile apple and that some extra care is necessary. Likewise forklift, tractor and truck drivers should be cautious when handling the apples. A 6 inch drop can cause considerable bruise and puncture damage to the contents of a box or bin.

Good cultural and pest control practices have reduced insect and disease damage to acceptable levels. Similar attention to detail in labor management and handling may go a long way toward reducing physical damage.

The large revenue losses due to size and color defects and physical damage have some research and Extension implications as well. More attention should be given to practices that can reduce fruit size and color deficiencies. Harvesting and handling procedures and both hand and mechanical grading and packing methods should be scrutinized to determine which result in the lowest damage levels.

CONTROLLING ORCHARD MICE

Edward R. Ladd, Wildlife Biologist
U.S. Fish and Wildlife Service

Unless preventive measures are taken, orchardists can expect mouse damage to fruit trees during the winter months. Most fruit growers know from past experience which areas or blocks of trees are likely to be damaged. Still, it is a good idea to check the orchard in the fall to determine the status of old problems, and if any new trouble areas have developed. Areas having clean mouse trails, chewed apples, or the characteristic fan-shaped mounds of soil, pushed up by pine mice, are indicative of potential mouse damage problems. The amount of these indicators found will determine if greater than normal mouse control is necessary.

Meadow Mice

These are the surface-living mice most common to orchards in the Northeast. They injure fruit trees by chewing bark from the root collar upward. Since these mice, like all animals, require food and shelter for survival, some protection can be gained by close mowing of the vegetation in the orchard. Control of grass and weeds in the orchard should be done periodically throughout the year, but especially in the fall. Close mowing removes cover and makes the area less acceptable to mice. Any reduction in cover should help prevent damage prior to snowfall.

Control of vegetation should not be used as the primary meadow mouse control method in the fall, but merely as a supplement to the use of toxic baits. Remember that during the winter deep snow will provide the needed cover for mice and they will be able to reach the trees without exposing themselves.

The best method for controlling orchard mice is still the proper application of mouse control baits. All sections of the orchard having meadow mice should be treated in the fall following apple harvest. Those areas having an overabundance of mice will need an extra treatment, if for some reason the initial one does not give adequate control. If mouse concentration sites with wood, roofing squares or other materials are used, they make excellent areas to check on mouse activity in addition to their bait exposure use.

In addition to regular mouse control within the orchard, the mowing and baiting of buffer areas is still recommended. This is particularly true if fall orchard checks show high mouse activity. These treated buffer strips should help reduce mouse migration into the orchard during the winter months.

Periodic checks during the winter months, particularly after a thaw, may reveal spots still having meadow mouse infestations. A few tablespoonfuls of mouse bait, poured into the holes, may give added protection for the remaining winter months.

Pine Mice

Pine mice are an underground species found in many orchards in the Northeast. Their location in the orchard may be restricted to a portion of a tree block or to a single tree. These mice damage apple trees by girdling the root system. This form of injury may not be readily apparent until the tree loses its vigor, the leaves take on a yellow cast, or sprouts appear from the damaged roots.

Control of pine mice is more difficult and seldom as effective as for meadow mice. The broadcast method of distributing poisoned baits recommended for meadow mice may be only partially successful in controlling this species. It should be noted that control of vegetation may not have any effect on pine mice because of their subterranean living habits.

To obtain good control, orchard mouse baits should be placed in underground trails where the animals spend most of their time. If the infested area is small, hand baiting of the pine mouse natural runways is effective.

For larger areas, the use of the Trial Builder Machine is an advantage if soil and sod conditions permit. Be sure the machine is aligned properly and is making a good tunnel through the sod. Artificial trails on at least 2 sides of each tree are required for adequate coverage.

Whether an orchardist hand baits for pine mice or uses a machine, there is one absolute necessity: the artificial trail and the natural runs must be kept as clean as possible. Pine mice maintain clean, well-packed trails. They remove all foreign matter and debris, especially soil, from the tunnel. In the process, mice quite often will cover or carry out the treated bait with other materials.

NOTE: As in previous years, a permit for bait application must be obtained from the Massachusetts Division of Fisheries and Wildlife, 100 Cambridge Street, Boston, Massachusetts 02202, before any orchard mouse control can be done using toxic baits.

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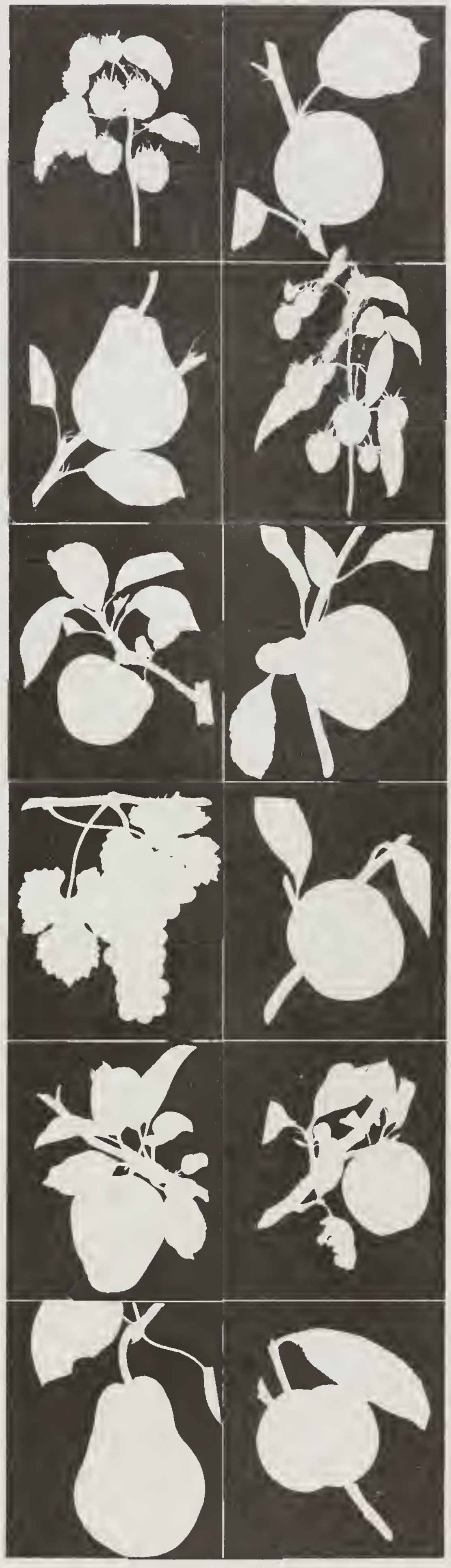

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 45 No. 6
NOVEMBER / DECEMBER 1980

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EVALUATION OF SEVERAL PEAR PSYLLA CONTROL PROGRAMS IN CONNECTICUT

Roger G. Adams and David A. Kollas
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The adult pear psylla is dark reddish-brown, about 1/10 inch long, and looks like a miniature cicada. They overwinter under the bark of pear trees and in other sheltered areas. Yellow, rice-grain shaped eggs are first deposited on fruit spurs, but as the buds open eggs are laid on exposed leaf tissue. There are five instars or nymphal stages. The first four instars feed on plant sap and excrete a drop of clear colored, sticky honeydew liquid around their bodies. The fifth instar is not surrounded with honeydew and is called the "hardshell" stage. It is dark brown with prominent wing pads. The earlier instars range in color from yellow to greenish-brown. About one month is required to complete the life cycle. There are several generations each year.

The pear psylla was first reported in the United States from Connecticut in 1832. Since that time it has become the most important insect pest of pears in North America.

The pear psylla has become resistant to many formerly effective insecticides, thus making control increasingly difficult.

Five treatment programs and a check were evaluated in 1979 for the control of the pear psylla on 18-year-old Bartlett pears at the University of Connecticut Spring Hill Orchard in Storrs. The treatment programs, dosage rates, and dates of application are presented in Table 1 on the following page. All insecticide treatments were applied as dilute sprays by handgun. Five, single-tree replicates were used per treatment.

To sample for eggs and nymphs, 4 spurs per tree (one from each quadrant) were collected and brought back to the lab where pear psyllas were counted with the aid of a microscope. Adults were sampled by tapping limbs with a rubber covered piece of wood and recording the number of adults falling onto an 18 by 18 inch cloth-covered frame. One tap per limb was used from four locations per tree. On July 27, 1979 tree limbs and leaves were visually examined and rated for the presence of honeydew and sooty mold. The following damage index scale was used: 0 = clean; 1 to 2 = light; 3 to 4 = moderate; 5 to 6 = heavy. Percent clean fruit was determined by examining 20 fruits per tree.

Table 1. Schedule of insecticide treatments for the control of pear psylla on pears. Spring Hill Orchard, CT. 1979.

Treatment programs[ab]	Dosage/100 gals.	Dates applied
A. Superior oil	3 gals.	4/12, 4/23,5/18, 6/15, 6/29
B. Superior oil pre-bloom; fenvalerate 2.4EC (Pydrin) starting at white bud stage	3 gals. 10.7 fl. oz.	 4/12, 4/23, 5/3, 5/18
C. Superior oil pre-bloom; phosalone 3EC (Zolone) starting at white bud stage	3 gals. 1.7 pts.	4/12, 4/23,5/3, 5/18, 6/4, 6/15, 6/29
D. Fenvalerate 2.4EC (Pydrin)	10.7 fl. ozs.	5/3, 5/18
E. Superior oil pre-bloom; fenvalerate 2.4EC (Pydrin) starting at petal fall	3 gals. 10.7 fl. ozs.	4/12, 4/23, 5/18
F. Check (untreated)	——	——

[a] All treatments, with the exception of the check (F) received one application of azinphosmethyl (Guthion) on 5/18 at the rate of 10 ozs./100 gals., and one application of amitraz (BAAM) on 7/31 at the rate of 2 pts./100 gals.

[b] All insecticides applied dilute to runoff by handgun.

Damage ratings are presented in Table 2. Percent clean fruit was highest (94, 94 and 92%) in treatment programs using fenvalerate (Pydrin) either alone (Treatment Program D) or in conjunction with pre-bloom oil treatments (B and E). Oil used alone (A) or in conjunction with phosalone (Zolone) (C) resulted in 75 and 88% clean fruit, respectively. Few (6%) clean fruits were found on check trees (F). Limb and leaf contamination ratings corresponded well with the percent clean fruit findings.

Table 2. Effect of various pear psylla control programs on honeydew and sooty mold on pears. Spring Hill Orchard, Storrs, CT. 1979.

	Honeydew and sooty mold ratings	
Treatment programs	Limb and leaf[a]	Clean fruit[b] (%)
A. Superior oil	3.0	75
B. Superior oil pre-bloom; fenvalerate 2.4EC (Pydrin) starting at white bud stage	1.0	94
C. Superior oil pre-bloom; phosalone 3EC (Zolone) starting at white bud stage	2.4	88
D. Fenvalerate 2.4EC (Pydrin)	1.0	94
E. Superior oil pre-bloom; fenvalerate 2.4EC (Pydrin) starting at petal fall	1.8	92
F. Check (untreated)	5.6	6

[a] The following damage index was used: 0 = clean; 1 to 2 = light; 3 to 4 = moderate; 5 to 6 = heavy.

[b] Based on 100 fruits per treatment.

Figure 1 on the following page shows the seasonal history of pear psylla populations for insecticide treatment programs A-E and the check (F).

Programs utilizing 1-2 sprays of fenvalerate (Pydrin) (B, D, and E) were the most effective in managing pear psylla and minimizing damage. In these treatments, nymph and adult numbers averaged about one or less per spur or limb tap from early May through late June. In all other treatments, at least one of the developmental stages of psylla exceeded this level. Phosalone (Zolone) (C) was moderately effective but required 5 sprays and resulted in somewhat greater damage than the fenvalerate (Pydrin) treatments. Oil used alone (A) did not give acceptable control.

Nymph populations in treatments A and F declined more slowly and resurged sooner than in other treatments. Egg numbers also resurged more rapidly on trees in treatments A, C and F. These differences in population decline and resurgence rates may also have contributed to differences in damage ratings among the treatments.

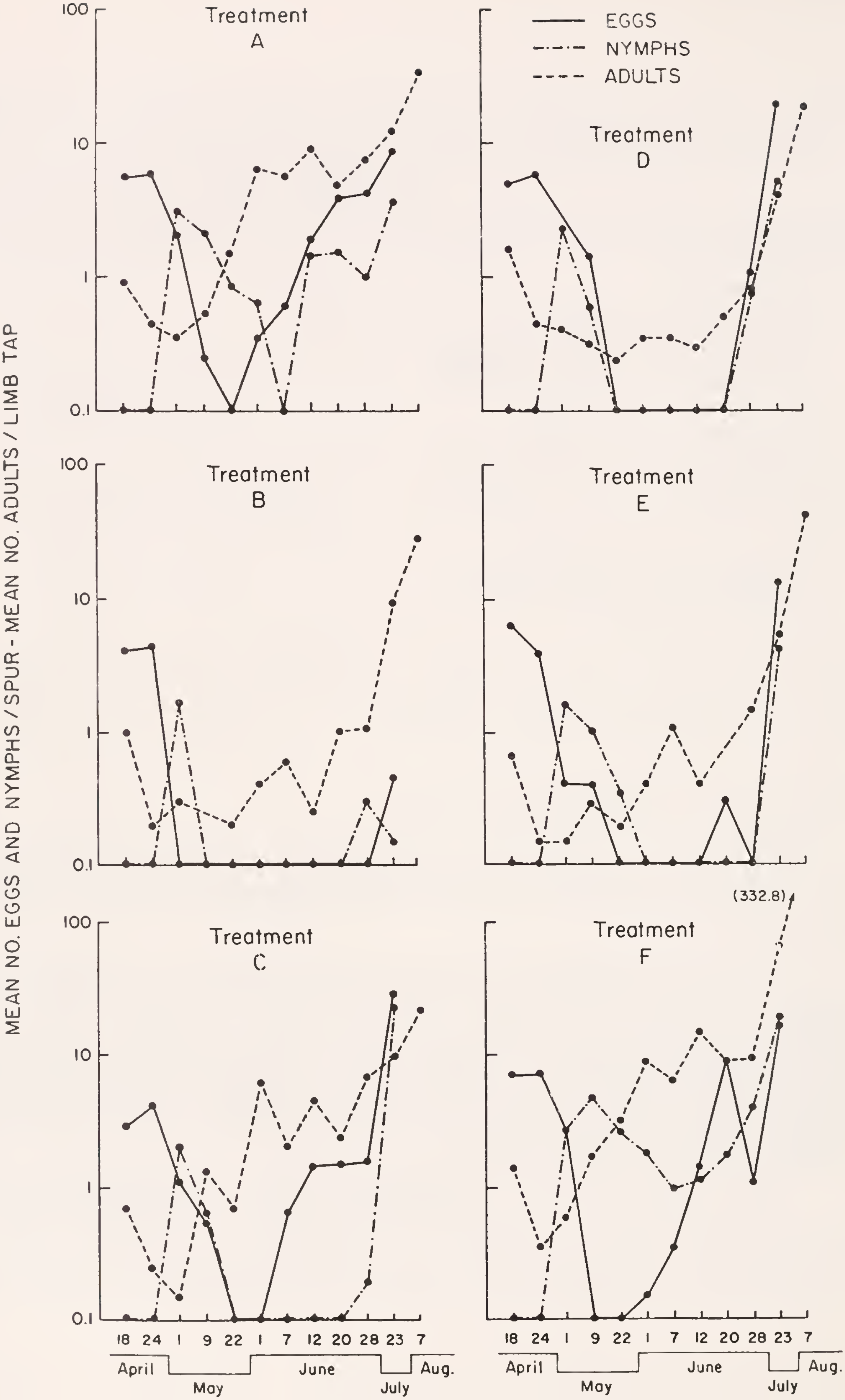

Fig. 1 Seasonal history of the pear psylla under 5 different insecticide treatment programs and a check. Spring Hill Orchard, Storrs, CT. 1979.

Adult populations in early spring were lowest on treatments which received oil (A, B, C and E). Zwick and Westigard (1978) in Oregon reported a delay and a reduction in egg laying by overwintering pear psylla adults attributable to the use of petroleum oils. We observed a similar delay in egg laying on oiled pear trees at Storrs in 1978. We did not note a delay or reduction in egg laying in 1979 but we suspect that our oil treatments were applied too late to have gained that benefit.

Hoyt, Westigard, and Burts (1978) have reported fenvalerate (Pydrin) to be highly toxic to predators of spider mites in pear orchards in the Pacific Northwest. In view of the current lack of effective insecticides for pear psylla control, fenvalerate (Pydrin) appears to be of considerable value, especially when used as prebloom treatments. Early season treatments might allow predators to recover in time to help manage summer spider mite populations.

Connecticut is now in the process of applying for a special state registration to allow the use of fenvalerate (Pydrin) in 1981 for the control of pear psylla on pears.

A summer treatment of amitraz (BAAM) applied to all plots was not highly effective in controlling pear psylla in our tests, and was associated with considerable leaf scorch. It could not be determined whether BAAM was directly responsible for this injury. A period of several days of high temperatures and humidity following the treatment may have contributed to the appearance of damage. Further tests are needed to evaluate more fully the role of BAAM for pear psylla control on pears in Connecticut.

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ORCHARD PRACTICES NECESSARY FOR GOOD PEACH PRODUCTION

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Rutgers University, New Jersey[1]

The peach industry is now and has been a stable segment of the agriculture in New Jersey. The industry dates back to the early 1600's. Extensive orchards were planted by 1650 and the industry grew until 1890 when there were over 4 million trees in the state. Production per tree was low since there were only 775,000 bushels produced in 1890. Production improved as pest control became a more standard practice and in 1920 from about 2 million trees the production was 2.1 million bushels.

The 1977 tree survey shows a total of all trees to be slightly over 1 million with about 200,000 in the 1-3 year age. Today the tree numbers are probably a bit above the 1977 survey figures based on observations of tree planting in 1979 and 1980.

Production for the state in 1980 is estimated at about 2-1/2 million bushels. Production usually varies from 2 to 2-1/2 million bushels annually. The most recent above-average crop was in 1971 when it exceeded 3 million bushels on the trees, and the poorest crop in more than 40 years was in 1972 when only 500,000 bushels were recorded.

Geographical location of New Jersey is especially suited to peach growing as evidenced by the fact that the most recent freeze-out of the entire crop and severe tree killing occurred in the 1934-35 winter. Few if any other peach producing areas in the country have been as fortunate.

Serious Problems and Solutions

There are serious growing and production problems and there is constant change in growing, harvesting, handling and packing.

The short life of peach trees is being discussed in grower meetings and this is a problem in New Jersey as well as Georgia, South Carolina, Michigan and several other areas of peach growing. We have recommended and growers are following procedures for increasing the vigor, health and life of the tree.

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1 Talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association, Inc., July 10, 1980.

Much research has been conducted in an effort to increase the life of a peach tree and Dr. E.F. Savage of Georgia devoted many years to this problem. As a result of his work and that of others, including those in New Jersey, our cultural recommendations have been updated and are as follows:

1. Soil fumigation is being practiced; both pre-plant and post-plant treatments are made to reduce nematode populations. This is an established practice in all peach growing areas since soil fumigation has improved tree vigor and extended tree life. Trees are less subject to cold damage and the virus disease "Stem Pitting" is reduced through fumigation. Fumigant type nematicides recommended for pre-plant treatment include DD*, Telone II*, EDB W-85*, Vorlex* and Telone 17*. Post-plant soil fumigants recommended are Nemagon 12.1* and Fumazone 12.1*. Non-fumigant nematicides include Furidan 10G* and 4F*, Nemacur 15G* and 3SC*, and Vydate L* as a foliage spray.

2. Calcium nutrition is important. Keep the soil pH between 6 and 6.5 using calcium lime. Apply 1/2 to 1 pound calcitic limestone mixed with the soil around the roots at planting. The late Professor M.A. Blake stressed the need for N-P-K fertilizer and liming to maintain a soil pH of 5.5 - 6.5 in the 1920's.

3. Paint tree trunks with interior white latex (water base) paint in the fall to reduce cold damage. This is most essential on trees from 2 through 5 years of age. This reflects the sun's rays and the temperature of the trunk of the tree is more nearly the air temperature rather than 80 to 85°F as it can be on the south side of the tree in January and February. Research in this field was done in 1943-1944 by Dr. R. Eggert in New Hampshire.

4. Prune peach trees in late winter, after the coldest weather is past. March is a good time to start pruning if possible. If pruning must begin before March, prune the oldest trees first and the young last. It is better to prune young trees in bloom than to prune in January or February.

5. Cytospora (Valsa) canker can be a tree killer if ignored. On 1- and 2-year-old trees, prune off infected portions if possible. Cankers on the trunk that cannot be pruned out should be cut out, removing all diseased tissue until healthy, green bark shows. Paint the area with tree paint containing 2 tablespoons of Benlate per pound of tree wound paint or white latex paint or spray the trees with 1/2 pound Benlate 50WP* in 100 gallons within a day or two after pruning and cutting out cankers.

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* Trade name

6. Stem Pitting virus is less a problem today than it was 10 or 15 years ago but it is present in some orchards every year. It was a very serious problem in the late 1950's and was identified as a virus in the early 1960's through the efforts of Drs. J.G. Barrat, W. Virginia; S.M. Miretich and H.W. Fogel of the USDA and Drs. F.H. Lewis, R.F. Stouffer and F.N. Hewetson in PA. Nursery trees purchased today are far superior to those of 15 years ago from the standpoint of being free of the Stem Pitting virus. Nematodes transmit the disease and this is a major reason for fumigating the soil. Bud wood selection by the nursery is equally or more important.

Other Practices

Variety Selection. In New Jersey the two major requirements in the selection of peach varieties for planting are cold hardiness of buds and bacterial spot disease resistance. Observations during the last 10 years make it possible to recommend a series of varieties that are superior in these two characteristics. Other desirable qualities include fruit firmness, color, flavor, and size, and tree vigor and growth characteristics. It isn't possible to find all of the best in any one variety, perhaps, but a few varieties have the 2 major requirements plus several other desirable qualities. A few of the best that we recommend in order of ripening include: Candor, Garnet Beauty, Harbelle, Redhaven, Harken, Harbrite, Summerglo (NJ233), Norman, Biscoe, Cresthaven, Jerseyglo (NJ244) and Emery. A few nectarines that show promise include: Harko and Sunglo (Redhaven season), RedGold (Cresthaven season) and LateGold (Rio). Loring, Blake, Jerseyqueen and Rio-Oso-Gem are major varieties in New Jersey and yet Loring, Jerseyqueen and Blake are not bud hardy; Blake, Jerseyqueen and Rio-Oso-Gem frequently have serious infections of bacterial spot and Rio is a poor tree. Blake is probably phasing out and Jerseyqueen also, but wholesale market demand is a factor in variety selection. Retail or pick-your-own selling can include some varieties not the best for shipping.

Bulk Hauling. Bulk handling from the orchard to the packing house, into the storage and on to trucks is common practice in practically all orchards. Bulk hydrocooling has replaced packed box hydrocooling in many operations for more rapid cooling and efficiency, especially during heavy harvest.

Fruit Thinning. Growers have tried and used all chemical thinners available as they appeared, and watched them disappear sometimes with regret. Dinitro first appeared in the 1940's, and then through the years NPA and CPA appeared, stayed for a while and then were removed. There is no chemical for use on peaches today but Ethephon will thin. Considerable research has been done regarding Ethephon as a peach thinner beginning in 1968. One of the problems has been leaf damage and heavy leaf drop but Dr. L. Edgerton in New York has included ProGibb* in the spray with ethephon and eliminated most of this damage.

In the absence of a chemical thinner, some limb shakers, a few full tree shakers, clubs and whiffle bats are used to thin the fruit, plus much hand removal. Thinning is a most important cultural practice. Size is so very important in the wholesale market and frequently, 1/8" increase in peach size will return an additional $1.00 per 38 lb. box. Twice as many 2" peaches are required to equal weight of 2-1/2" peaches. Peaches gain 4% a day in volume as they approach harvest.

Pruning for Low Profile Trees. Most trees in New Jersey orchards are being pruned to maintain a height of 7 to 8 feet. This makes possible the pruning, thinning and harvesting without ladders. Machine topping is extensive mainly with sickle bar mowers. Mowing is done in the dormant season on most acreage but more and more summer mowing is being done in orchards where tree and row spacing permits. Summer mowing is usually done between July 15 and August 1. There are several good reasons for summer mowing in addition to accomplishing some pruning: more sunlight enters the tree, fruit ripens more evenly and with less pickings, fruit color is improved and better fruiting wood develops in the center of the tree.

Hand pruning is essential to complete any machine pruning to maintain good tree vigor and the best fruiting shoots throughout. Pneumatic pruners are used to some extent and custom pruning is done on a sizeable acreage. There is room for improvement in the pruning of much of the acreage but it's a time consuming, costly job and too few people are willing or able to do the job properly, so less than satisfactory pruning must be accepted.

Irrigation. Most peach orchards are equipped with some kind of irrigation and during some time each year in late spring and summer the irrigation is usually needed.

Tricke irrigation is established on perhaps 10 farms with capacities ranging from 50 to 100 acres per farm. There is no strong movement into trickle because of other equipment still in use and the cost of establishing trickle. Irrigation is a very necessary cultural requirement in peach growing.

Chemical Weed Control. Some orchards are grown in an established sod, usually fescue, with chemical weed control in the tree row. More of the orchards, especially in southern New Jersey, are cultivated with chemical weed control in the tree rows. Herbicides used for annual weeds include simazine, terbacil, diuron and a combination of diuron + terbacil. For established weeds, paraquat and dichlobenil are recommended.

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* Trade name

In one and 2-year-old orchards some growers combine 1-1/2 gal. per acre of Furidan 4F* with the herbicide for nematode control plus weed control.

Recent Innovations. Machine planting of peach trees is being done on substantial acreage in the southern area of the state and probably will increase. There are only a few planters as of this date but they are shared since a grower needs the machine for only a a day or 2 to plant considerable acreage. The tree planter can not be used in all soils but in New Jersey it can be used in the areas where 90% of the peach trees are grown. Observations to date indicate no serious problems. Some orchards have completed 4 years and trees are growing well. Usually the trees are lined up in one direction only so cross cultivation or spraying is not easily done. Trees could be set on the square but this requires more time and effort and many growers feel this is not necessary. Subsoiling before planting is recommended where old trees have been removed and limestone placement in the subsoil is also recommended.

Hedgerow planting is being tried in one orchard rather extensively and a few other plantings have been made on a limited acreage. Trees are planted 10 feet in the row and the rows are 15 feet apart. Trees are summer mowed vertically and across the top at about 10 feet. The width of the trees is held about 3-4 feet. Some hand pruning is done in the dormant season to remove diseased and broken limbs and any strong growth growing into the row middle. As with trellised trees, there should be an open space for cross traffic at about 50 foot intervals.

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NEW ENGLAND FRUIT MEETINGS AND TRADE SHOW

The New England Fruit Meetings and Trade Show will be held at the New Hampshire Highway Hotel, Concord, New Hampshire. The meetings are scheduled for January 7 and 8, 1981.

The hotel is accessible from all major highways. Routes 3 and 93, which lead to Concord, are accessible from anywhere in Massachusetts. Persons coming from Western Massachusetts and Southern Vermont may find the most convenient route to be Routes 9 or 10 to Keene, New Hampshire, and then Routes 9 and US 202, 89 and 93 to the Highway Hotel.

* Trade name

INTEGRATED MANAGEMENT OF APPLE PESTS IN MASSACHUSETTS 1980 RESULTS: INSECTS[1]

W.M. Coli[2], G.E. Morin[3], N.D. Goodhue[3], M. Kuzontkoski[4], T. Green[4], M.R. Paul[4], S. Marafino[5], and R.J. Prokopy[6]

Summary of Results.

Intensive weekly scouting and grower advisement in 18 good-cooperator IPM blocks, resulted in a savings in insecticide, aphicide, and miticide spray use (dosage equivalents) of 40%, 97% and 56% respectively. Permanent type fruit injury was 8% lower in IPM than Check blocks. Cost benefit analysis indicated an average net savings from IPM of $93.37 per acre.

Compared with previous years, 1980, the third year of operation for the Massachusetts apple IPM program, was characterized by significant changes in number of orchards scouted, grower financial support, grower participation in orchard scouting and sampling methodology [7].

Program objectives continue to be: 1) to aid in the production of high yields of high quality fruit while reducing the amount of pesticide usage; and 2) to encourage the use of spray materials which allow for survival of beneficial predators and parasites.

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1 Special thanks to Mr. David Chandler, Meadowbrook Orchards, Inc., Sterling Jct. for allowing us to room 2 scouts at his housing for harvest labor throughout the summer which allowed significant savings in travel time and gasoline.

2 Pest Management Specialist

3 Senior Field Scouts

4 Field Scouts

5 Lab Technician, Entomology Department

6 Extension Entomologist

7 Reduced spray programs on apples have been discussed in previous issues of Fruit Notes [41(1), 41(2), 41(3) and 43(3)1], and our 1978 and 1979 results were summarized in Fruit Notes 44(1) and 44(6).]

Number of orchard blocks scouted

Each week, field staff visited 23 IPM blocks in 16 commercial orchards throughout the major fruit growing regions in Massachusetts. IPM growers received a weekly written scouting report and were contacted either in person or via telephone by the IPM Specialist and advised as to the need for spraying, materials to use, and timing.

In addition, we monitored Check blocks in 6 commerical orchards on a weekly basis when possible. Insect monitoring was identical to that in IPM blocks, although growers followed their own pesticide application program with no advice from us.

Also, 4 orchards were Alternate Middle vs. Every Middle spray blocks. We will discuss the results of this aspect of the program in the next issue of Fruit Notes.

Grower financial support

The majority of funding for the IPM program continues to be the original 5 year USDA Grant which began in 1978. However, inasmuch as USDA funds for scouts are scheduled to decrease each year and grower support for scouts is meant to increase, participating IPM orchards were charged $300 for combined insect and disease scouting and advice or $200 for insect scouting and advice alone. Growers paid a total of $4,500 into a special Extension Activity Fund, which was used exclusively for paying scout salaries. No fee was assessed Check or Alternate-Every Middle orchards.

Grower participation in orchard scouting

In response to substantial grower interest we offered a series of training sessions to acquaint growers or designated orchard personnel with insect identification and life histories, IPM monitoring techniques, and recommended control measures. These "grower scouts" were encouraged to participate in weekly scouting and data collection in their IPM blocks, and to scout additional blocks of their orchard on their own. Of the 16 IPM orchards, 11 utilized "grower scouts" on a weekly basis, 4 used them sporadically, and 1 not at all. Interest in the "grower scout" concept appears to be high, and may offer a means for growers to continue to implement IPM programs after September, 1982 when Federal funding is scheduled to end.

Sampling methods

Weekly, intensive orchard monitoring continues to provide the soundest basis for accurate pest management decision making and grower advisement. However, if IPM techniques are to be applied to large orchard acreages, more rapid methods of accurately estimating insect densities are desirable. For this reason in 1980 we utilized fewer trapping stations per block (1 per 2-3 acres) than in 1978 or 1979 (1 per 1-2 acres), although time spent at each station was similar to previous years.

Sampling stations were usually near the block periphery, 2 or 3 rows in from the border while one station for pheromone (sex odor) traps was positioned in the block center. Visual traps were used to monitor tarnished plant bug (TPB), European apple sawfly (EAS), and apple maggot fly (AMF) adults. Pheromone traps were used to monitor Codling moth (CM), Oblique banded leafroller (OBLR), redbanded leafroller (RBLR), San Jose' scale (SJS), tufted apple budmoth (TABM), and spotted tentiform leafminer (STLM) males. Mites and mite predators were monitored using leaf brushing techniques (Fruit Notes 43(4)) from mid June to harvest. Plum curculio (PC), green fruitworm (GFW), green apple aphids (GAA), and their predators, woolly apple aphids (WAA) and STLM were monitored by examining 10 fruiting spurs or foliar terminals in each of 3 tree areas (top, low inside and low outside) at each trapping station.

Immediately prior to appropriate harvest dates for early, mid, and late season apple cultivars, insect injury levels were determined in each IPM and Check block using on-tree surveys of 400-1600 fruit per block (100 fruit per tree from each of 2 trees adjacent to trapping stations). In addition, we sampled at harvest fruit injury from another block in each IPM orchard of similar tree size and varietal composition. Injury in these blocks was determined by on-tree surveys of 1000 fruit per block (100 fruit per tree from trees randomly located within the block).

Results

Fruit injury

At harvest, fruit injury was divided into categories: 1) injury to the skin or flesh (= permanent injury); and 2) injury confined to the skin surface (= temporary injury usually removable by washing, i.e., WAA in the stem cavity, sooty mold (SM) on aphid honeydew, or white apple leafroller (WAL) excrement).

Drawing on the experience of IPM researchers in other states, we analyzed harvest injury levels (Table 1) and spray application totals (Table 2) taking into account the degree of adoption of IPM recommendations by participating growers. Specifically those growers who followed more than 60% of spray recommendations were considered "good" cooperators, while those following less than 60% of these recommendations were considered "partial" cooperators.

Overall, permanent fruit injury was only 25% as great in good cooperator IPM blocks as in partial cooperator blocks, 50% as great as in same orchard non IPM blocks and 92% as great as Check blocks. These data indicate that partial cooperation with IPM recommendations can result in poorer quality fruit than if growers follow their own spray approach without IPM advisement.

Table 1. Average percent insect injury on fruit at harvest in good or partial cooperator IPM and in Check commercial orchards in Massachusetts, 1980.

Insects	1980 injury (%)[z] Good cooperators (18 blocks)	Partial[y] cooperators (5 blocks)	Same orchard[x] non IPM (13 blocks)	Check (9 blocks)
	Permanent injury			
SJS	0.72	11.8	4.26	1.43
TPB	1.44	2.0	2.09	1.44
PC	1.19	1.28	1.00	0.87
EAS	0.24	0.46	0.22	0.11
AMF	0.10	0.04	0.09	0.14
CM	0.04	0.0	0.0	0.0
LR	0.02	0.04	0.05	0.03
GFW	0.01	0.02	0.0	0.07
Total permanent injury (%)	3.76	15.64	7.71	4.09
	Temporary injury			
WAA	0.05	0.0	0.15	0.0
WAL	0.64	0.0	1.49	0.11
SM	0.03	0.0	0.33	0.08
Total temporary injury (%)	0.72	0.0	1.97	0.19
Total Percent insect injury (permanent and temporary)	4.48	15.64	9.68	4.28

[z] Based on on-tree survey of 600-1600 fruit per block at harvest (100 fruit per tree from each of 2 trees adjacent to trapping stations).

[y] Partial cooperators were those who followed less than 60% of advised spray recommendations.

[x] Does not include "partial cooperator" blocks.

Removable fruit injury was only 37% as great in IPM as in same orchard non-IPM blocks, but 74% more than in Check blocks, while no superficial type injury was found in partial cooperator blocks.

Specifically, TPB remained a highly damaging fruit pest in Massachusetts commercial orchards (Table 1), as was the case in 1978 and 1979. Tarnished plant bug injury in IPM and Check blocks was identical inspite of higher pest pressure in IPM blocks (7.4 TPB adults per trap in IPM vs. 6.0 adults per trap in Checks). Continuing our attempts to develop a TPB grading index, we found that 61% of TPB injured fruit would grade through as US Fancy, while 33% would grade US No. 1 and 6% would be culled. This high percentage of very minor TPB injury may relate to the rapid, early buildup in TPB populations before pink, when feeding results primarily in bud abscission rather than serious scars resulting in downgrading of fruit value.

San José scale continues to be a serious pest of apples in Massachusetts, although injury in IPM blocks was only 50% as great as in the Checks. The high average injury due to scale in partial cooperator blocks resulted from one grower's failure to treat for scale with prebloom oil, despite advice to do so. The result was scaleinjury on 55% of fruit sampled.

Plum curculio injury was substantially higher in all blocks in 1980 than in 1979 even though some growers applied as many as 4 insecticide sprays to control this pest. Injury in IPM blocks was 27% greater than in Checks, due primarily to 9.4% PC injury in one block (the grower was unable to apply a recommended spray over the May 24-26 weekend, when PC activity was high, because beehives were still in the orchard).

Trap captures of AMF adults were higher than in 1979, as was the injury from this pest in both IPM and Check blocks. In one IPM block, no AMF adults were captured until August 15, and CM captures were also low. As a result no insecticide sprays were applied between June 9 and August 15, and no AMF sprays were needed thereafter. Our harvest injury survey found no injury from either of these pests in this block, pointing out the potential savings to growers that may result from use of sticky sphere and pheromone traps for AMF and CM, respectively.

No spray applications were required in any IPM blocks for CM, LR, or GFW, and combined injury from these pests was slightly lower in IPM than Check blocks. Injury from WAA, WAL and SM was substantially higher in IPM than Check blocks, due principally to high (6.9%) WAL injury in one IPM block. Inasmuch as speckling from WAL excrement is superficial and would probably be removed by normal post harvest handling, it is doubtful that this "injury" is of economic importance.

Mite populations

Populations of harmful plant feeding mites were virtually identical in IPM and Check blocks in 1980. European red mite and two spotted mite numbers generally peaked in late July and early August, in response to hot dry weather, and may have caused some fruit drop at populations lower than would normally be expected to cause drop. Perhaps mite feeding combined with the stress of below average rainfall contributed to this phenomenon. Apple rust mites, which cause little damage except at very high population (about 300/leaf) but may serve as an alternate food source for *Amblyseius fallacis*, were found in substantially higher numbers in IPM than Check blocks.

Table 2. Mean abundance at peak sampled population of pest and predaceous spider mites in relation to acaricide sprays, 1980.

Orchard type	Acaracide dosage equivalents[z] Oil	Other	Number of mites per leaf: European red mite	Two-spotted mite	Apple rust mite	*Amblyseius fallacis*
IPM	1.0	0.8	8.1	2.0	66.5	0.07
IPM partial cooperators	0.7	1.4	6.2	3.2	50.4	0.02
Check	1.1	1.8	8.4	1.9	22.4	0.03

[z] Dosage equivalent = Actual pesticide rate/100 gal / Amt. recommended in Southern New England Apple Pest Control Guide

Predator mite numbers were insufficient to achieve biological mite control because they never exceeded 0.5 per leaf in any block. We believe that the lack of snow cover during the 1979-80 winter may have resulted in substantial overwintering mortality to *A. fallacis*, as was the case in Michigan after a recent winter with similar conditions.

Insecticide, aphicide and miticide use.

IPM blocks received 26% fewer insecticide sprays (average 6.5, range 5-9) than the Checks (average 8.8, range 5-12) or same orchard non-IPM (average 8.8, range 5-10)[8]. These results appear to indicate that growers (same-orchard non-IPM and Check) are implementing some aspects of IPM on their own. Partially cooperating IPM growers applied 11% fewer sprays than good cooperators. However, any savings in spray material and application costs were negated by substantially higher fruit injury levels in these blocks.

IPM growers applied 26% and 53% fewer miticide sprays compared to Check and partially cooperating IPM growers, respectively (Table 3). Use of oil as an ovicide was nearly identical in IPM and Check blocks, but 36% lower in partial cooperator blocks.

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[8] Data incomplete

Table 3. Number of pesticide treatments and dosage equivalents[z] of pesticide applied for insect and mite pest control in IPM and Check blocks, 1980.

Number of treatments	IPM	IPM partial cooperators	Check	IPM as % of Check
Oil	1.1	0.7	1.0	110
Insecticide	6.5	5.8	8.8	74
Miticide	1.4	3.0	2.0	70
Aphicide	0.1	0.3	0.5	20
Number of dosage equivalents				
Oil	1.0	0.7	1.1	90
Insecticide	4.8	5.5	8.0	60
Miticide	0.8	1.8	1.8	44
Aphicide	0.01	0.3	0.4	3

[z] Dosage equivalent = $\frac{\text{Actual rate/100 gal water}}{\text{Recommended rate in Southern New England Apple Pest Control Guide}}$

While there was a substantial reduction in spray application trips, there was an even greater reduction in number of dosage equivalents of insecticides, aphicides and miticides in IPM compared with Check blocks (60, 3 and 44% as much used, respectively). (Table 3.).

Pesticide use 1977-80

Figure 1 shows trends of pesticide use in IPM and Check blocks in recent years. It is interesting to note in (Figure 1a and Figure 1c) that a general reduction in pesticide dosage equivalents has occurred. Although IPM orchards use substantially less pesticides, Check orchards also appear to be utilizing some IPM information as well. In addition, the rapidly rising costs of pesticides (petrochemical derivatives) probably accounts for some portion of this overall downward trend in spray material usage. As more sprays are

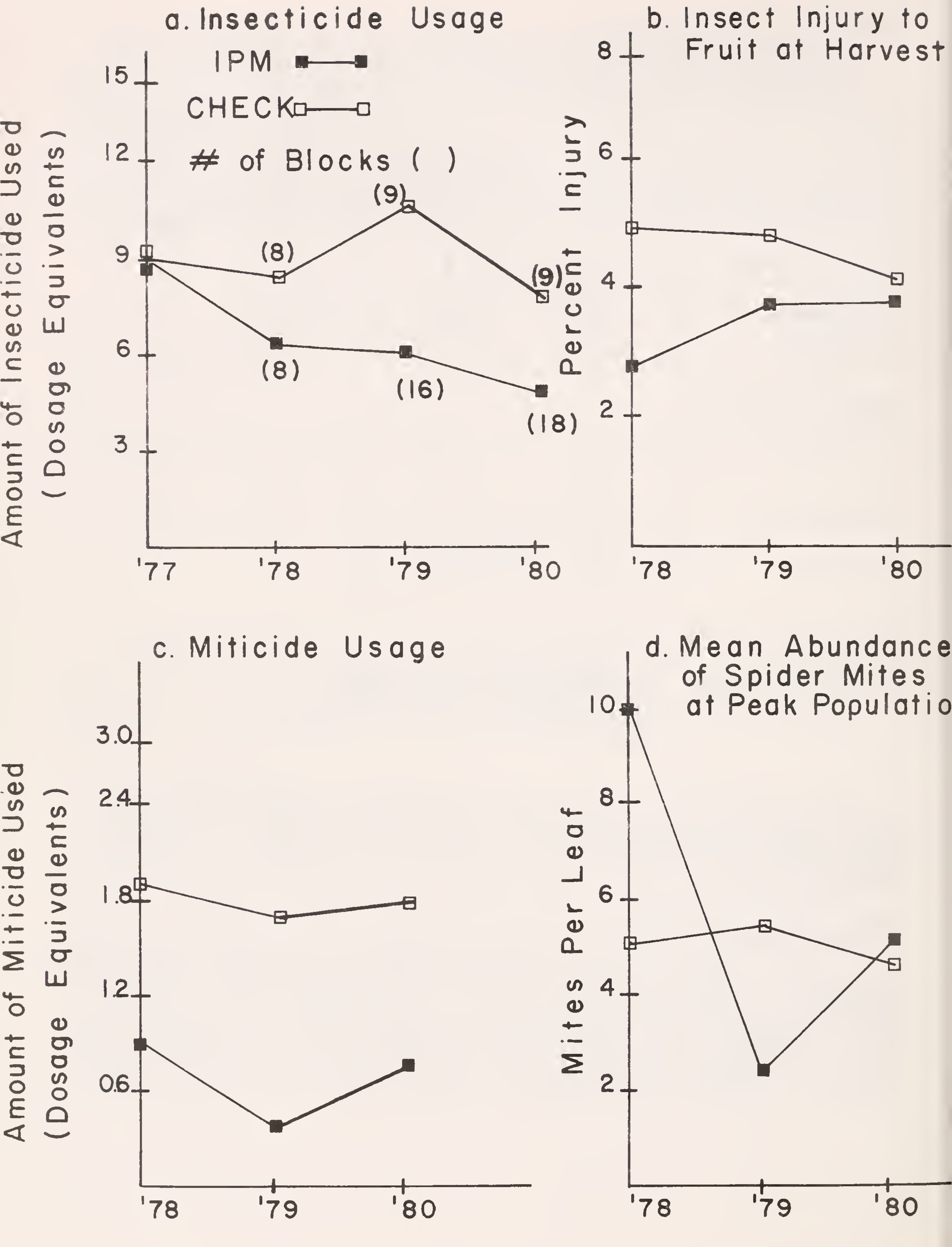

Fig. 1. Trends in pesticide use, injury to fruit, and spider mite populations. 1977-1979.

required for STLM and SJS control, however, it is possible that this trend may be reserved in the future years.

Cost and benefit comparisons

Table 4 summarizes our cost benefit analysis of IPM vs. Check blocks. IPM orchards realized substantial savings in spray materials and application costs per acre compared to Checks. (Table 4). (All calculations were done using suggested retail prices, with no attempt made to account for grower bulk rate discounts, which vary considerably).

Table 4. Cost benefit analysis of insect and mite results in 18 IPM and 9 Check commercial apple blocks in Massachusetts, 1980.

Parameter	Orchard		Difference IPM vs. Check	
	IPM	Check	(Numerical)	(%)
(Avg. no. sprays/A)				
Oil	1.1	1.0	+0.1	+10
Insecticides	6.5	8.8	-2.3	-27
Aphicides	0.1	0.5	-0.4	-80
Miticides	1.4	2.0	-0.6	-30
(Avg. no. of dosage equivalents for)[z]				
Oil	1.0	1.1	-0.1	-10
Insecticides	4.8	8.0	-3.2	-40
Aphicides	0.01	0.36	-0.35	-97
Miticides	0.8	1.8	-1.0	-56
(Avg. insect injury (%))[y]	3.77	4.09	-0.32	8
(Avg. application cost/A)[x]	$26.45	$34.27	$ -7.82	
(Avg. cost/A spray materials)				
Oil	$18.53	$21.37	$ -2.84	
Insecticides	55.54	98.04	-42.50	
Aphicides	1.50	5.89	-4.30	
Miticides	20.30	39.79	-19.49	
(Avg. value/A of fruit loss due to insect injury)[w]	$200.96	$217.38	$-16.42	
(Avg. net benefit/A from IPM			$+93.37	

[z] Dosage equivalent = $\dfrac{\text{Actual pesticide rate/100 gal}}{\text{Recommended rate in Southern New England Apple Spray Guide}}$

[y] Does not include injury from sooty mold, white apple leafhopper and woolly apple aphids which could be removed by washing fruit.

[x] Based on 15 min. time to spray 1 acre, $5.50/hr. labor cost and $2.20/acre/application for fuel and oil.

[w] Based on average values as of October 10: US Fancy Fruit $11.33/bu. US #1 fruit $7.00/bu., cull fruit $1.60/bu. and average yields of 550 bu./acre.

Average value of fruit loss per acre was $16.42 lower in IPM blocks as well, resulting in an average net benefit per acre of $93.37 from IPM scouting and grower advisement.

It should be noted that savings in spray materials and application costs seen in 1978, 1979 and 1980, are only the most immediate benefits of IPM. IPM has essential long-term benefits as well in reducing selection pressure for pesticide resistance and thus greatly delaying development of resistance, and prolonging the period of usefullness of currently available spray materials.

FRUIT NOTES INDEX FOR 1980

(This index of major articles has been prepared for those who keep a file of Fruit Notes. The number in parenthesis indicates the pages on which the item appears.)

FRUIT NOTES INDEX (continued)

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COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 46 No. 1
JANUARY/FEBRUARY 1981

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NOTICE

The Massachusetts Cooperative Extension Service is faced with a crisis situation relative to funds. Therefore, in 1981 there will be only 4 issues of FRUIT NOTES a winter, spring, summer and fall issue.

CALYX-END ROT OF APPLES IN MASSACHUSETTS

T.R. Bardinelli[1], C.W. McCarthy[2], and W.J. Manning[3]
Department of Plant Pathology

During the 1980 apple growing season, calyx-end rot disease caused greater than usual losses. Calyx-end rot is caused by the fungus *Sclerotinia sclerotiorum*. This organism has a wide host range, including many vegetable and ornamental plants.

The first symptoms were observed as a dry tan-colored rot on the calyx end of young fruits during mid-July. Often the surrounding tissue ripened prematurely causing the epidermis in this area to turn red. The red areas make the diseased fruits highly visible. Severely affected fruits may drop prematurely. Other fungi can quickly invade the weakened fruit and further decay results if adequate moisture is available.

The life cycle of *S. sclerotiorum* on apples in Massachusetts is not well understood. Infections probably begin during bloom and may extend into June from windblown ascospores. Wetting periods are probably necessary for infection. After the infected fruits drop and decompose, small hard black structures (1/4 - 1/2" diameter) called sclerotia are produced. This is the resting or overwintering stage. On other crops, sclerotia can remain dormant for up to 3 years. Sclerotia give rise to small brown apothecia during late spring or early summer if proper environmental conditions occur. Ascospores from these structures are produced and windblown to the host where infections again occur.

The average incidence of calyx-end rot in Massachusetts during 1980 was 2%. Severely affected orchards had losses of 4-8% in Red Delicious and McIntosh blocks. The most susceptible varieties appeared to be Milton, Macoun, and McIntosh. Red Delicious and Cortland fruit were also susceptible to calyx-end rot but to a lesser extent and Golden Delicious appeared to be the least susceptible.

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[1] Extension Technician

[2] Extension Aide

[3] Associate Professor

Two severely affected orchards were routinely surveyed for this disease in 1980 and the data in Table 1 show the percent of infected fruits for the period between mid-July and mid-September.

Table 1. Percent calyx-end rot fruit infection in two severely affected orchards in Massachusetts, 1980.

Orchard	July			August		September
	10	16	30	13	27	17
1	4.0	6.0	1.6	1.2	1.6	1.2
2	3.9	8.9	4.9	5.2	4.7	2.6
Average	3.95	7.45	3.25	3.20	3.15	1.90

The highest incidence of calyx-end rot was observed on July 16 with an average of 7.45%. Many of the diseased fruit dropped prematurely and only 1.9% of the fruits on the trees September 17 were infected. Visual examinations of infected fruits on the trees at harvest showed a successful walling-off and healing of the previously rotted calyx-end.

Calyx-end rot and other blossom end rots of apple fruits can easily be confused. The only reliable way to determine the cause of calyx-end rots is to culture tissues on media in the laboratory and identify the fungi that grow out. Many different fungi have been associated with calyx-end rots of apple, including *Botrytis cinerea*, *Alternaria spp*., *Physalospora obtusa*, and *Sclerotinia sclerotiorum*.

Isolations were made in mid-July from 200 fruit with early symptom expression and in early August from the same number of fruit with late symptom expression (Table 2).

Table 2. Occurrence of various fungi from calyx-end rot isolations.

	Early symptom isolations		Late symptom isolations	
	% Incidence	% Pure culture	% Incidence	% Pure culture
Sclerotinia sclerotiorum	98	60	36	18
Alternaria spp.	34	0	57	21
Botrytis cinerea	14	0	20	1
Other	0	0	13	6

Ninety-eight percent of the isolations from apples with early symptoms yielded S. sclerotiorum and 60% were pure culture. This, plus pathogenicity test results, indicated that S. sclerotiorum was the probable cause of calyx-end rot. Isolations from fruit with advanced symptoms showed a marked decrease in S. sclerotiorum and an increase in the isolation of other saprophytic and weakly pathogenic fungi. This illustrates the importance of early diagnosis in determining the cause of a calyx-end rot disease of apple.

Our observations indicate that an adequate apple scab spray program may not prevent an outbreak of calyx-end rot, as both of the affected orchards surveyed had excellent management of all other apple diseases.

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DISEASE RESULTS FOR THE 1980 INTEGRATED PEST MANAGEMENT PROGRAM FOR APPLES IN MASSACHUSETTS

T.R. Bardinelli[1], C.W. McCarthy[2], and W.J. Manning[3]
Department of Plant Pathology

During the 1980 growing season, 11 commercial apple orchards cooperated in the disease management aspect of the Integrated Pest Management (IPM) Program. IPM and Check blocks were located in the same orchards.

The disease management strategy for the IPM program was based on biological and environmental monitoring, such as apple scab ascospore release data, tree growth stage, length of leaf wetting periods, and average temperature during these wetting periods. These factors were most important during the primary apple scab season, as determined by the period of ascospore release. Spray decisions were based on the Mill's Table which gives the approximate number of hours of leaf wetting required at various temperatures for the occurrence of a light apple scab infection.

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1 Extension Technician

2 Extension Aide

3 Associate Professor

Consideration was given to other diseases in addition to apple scab when choosing fungicides. Most sprays were applied after an apple scab infection had been determined. Intervals between sprays were at least 7 days and fungicides were incorporated with insecticides whenever possible. Occasionally preventative sprays were applied on a management decision basis, rather than a calendar basis. Only fungicides with an adequate kickback action were recommended.

The end of the primary apple scab season was determined by the end of apple scab ascospore release. Fungicide applications recommended after this time was based on each orchards's specific disease problems. In certain orchards, only 1 or 2 fungicide applications, at approximately 1/4 to 1/2 dosage rate, were applied after the primary scab season. Fungicides were no longer applied after infection but rather incorporated with an insecticide or other type sprays.

Results and Discussion

The results of 1979 and 1980 IPM programs are compared in Table 1 to demonstrate trends associated with the program.

Table 1. Cost benefit analysis for fungicide usage and fruit quality on IPM programs in 1979 and 1980.

	1979		1980	
	IPM	Check	IPM	Check
Number of fungicide sprays	10.64	13.00	9.45	10.36
Dosage equivalents	9.77	11.11	8.11	8.80
Fungicide cost per acre ($)	74.06	88.68	85.26	94.58
Percent diseased fruits at harvest	0.99	0.93	0.88	0.90
Loss to disease per acre ($)	46.28	43.48	50.31	56.30
IPM net benefit per acre ($)	11.82		15.31	

The reduction in the number of fungicide sprays in the IPM blocks in comparison to Check blocks was 18% and 9% in 1979 and 1980, respectively. The amount of fungicide used in the IPM blocks also was reduced by 12% in 1979 and by 8% in 1980. Since the incidences of diseased fruit in the IPM and Check blocks were very similar both years, the savings of $11.82 and $15.31 per acre in 1979 and 1980, respectively were mainly the result of reduced fungicide usage. Savings were greater in 1980 because of inflation even though the reduction in fungicide usage was less than in 1979.

We have noticed that growers tend to apply some information from IPM blocks in the remainder of their orchards. A more dramatic difference in fungicide usage can be noted in Table 2 where we also included non-IPM commercial orchards in our comparisons.

Table 2. 1980 spray record comparisons in Massachusetts.

	Types of orchards		
	IPM	Check	Commercial
Number of fungicide sprays	9.45	10.36	12.00
Dosage equivalents	8.11	8.80	10.55
Cost of fungicide per acre ($)	85.26	94.58	120.56

IPM orchards had 21% fewer fungicide spray applications and used 23% less material than other commercial non-IPM orchards. This amounts to a $35.30 per acre savings.

The results clearly show monetary savings for Integrated Pest Management and the use of environmental and biological monitoring for more efficient use of fungicides. It is realized, however, that it is difficult to spray large acreages on an after-infection or kickback program. New pesticides with extended kickback action (up to 92 hours) are presently being used on an experimental basis and might solve this problem in the future. We are also working on a spray prediction program based on fungicide residue sampling on apple foliage. This program may aid in the timing of fungicide applications and help reduce fungicide applications.

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RESEARCH IN PROGRESS

In January, 1981 the personnel who conduct pomological research at the University of Massachusetts reviewed their projects with members of the Massachusetts Fruit Growers' Association-University of Massachusetts Fruit Advisory Committee. Perhaps our readers also would like to know how the University of Massachusetts is attempting to serve the fruit industry in Massachusetts through research. Therefore, during the next several issues of FRUIT NOTES, we plan to have the leader of each project write a brief report that will state why the project was initiated and the major findings to date. The reports will appear under the heading of RESEARCH IN PROGRESS.

I. Scion/rootstock and interstem effects on growth and fruiting of apple trees. William J. Lord

New rootstocks and also virus-free clones of both rootstocks and varieties became available during the 1970's. A surge of interest also developed in interstem trees due to the high cost of providing support for trees on M9, and an interest in high density plantings. Thus, our basic objective in this project is to evaluate tree size, yield, production efficiency and fruit quality of several varieties on various rootstocks and interstem/rootstock combinations.

Unfortunately, our oldest rootstock and interstem trials are only 5 years old, which is short when one considers the long life-span of apple trees. Nevertheless, our data and observations to date show that interstem trees, particularly with Empire as the variety, are more time consuming to train than are trees on more vigorous rootstocks such as M7. It has been necessary to stake many interstem trees to support the leaders and to eliminate tree leaning.

Suckering is profuse on interstem trees planted with the stem-piece/rootstock union 2 inches above ground level, whereas it can be minimized by deeper planting.

The presence of burrknots on the M9 stempiece is readily apparent when the stempiece rootstock union of interstem trees is above ground. On many trees the burrknots are large and numerous and their presence has caused the stempiece to become twisted and distorted.

In plantings established at the Horticultural Research Center in 1976, Empire trees on M9/MM111, M9/Ottawa 11, and M9/Antonovka are larger and have been more productive than Sturdeespur Delicious on similar interstem/rootstock combinations. Trees on M26, which in general are doing poorly in many commercial orchards, have performed well to date. Rogers McIntosh has had higher production efficiency on M26 than on M7 or MM106. Rogers McIntosh on M26, M7 or MM106 began fruiting in 1978 (in the 3rd leaf) whereas the first crop of Gardner Delicious on the same rootstocks was harvested in 1980.

A planting of Empire on M26, M27, M9, M9/MM106, M27/MM106, M9/MM111 or M27/MM111 was established at the Atkins Orchards, Belchertown, MA in 1976. After 5 growing seasons differences in tree spread are still small, although the spread of trees on M9 and M27 is less than that of trees on M9/MM106, M27/MM106 and M26.

M27 is producing the smallest tree but has the highest produciton efficiency of the various rootstock and interstem combinations.

A planting of Starkspur Supreme Delicious (Pagnelli strain) on M9, EMLA[1]9, EMLA27, EMLA7, EMLA26, MAC[2]9, MAC24, OAR[3]I, and Ottawa 3 was established in 1980 at the Horticultural Research Station. In 1981, a planting of Starkrimson Delicious (Bisbee) strain) on M27, C6/Antonovka, P2 Antonovka, and P22/Antonovka will be established.

The effects of the rootstocks and interstem/rootstock combinations on fruit maturation and quality in our plantings will be evaluated in the future.

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II. Effect of rootstocks and stempiece/rootstock combinations on the tree performance and fruit quality of McIntosh and Delicious strains. F.W. Southwick

In Spring, 1979, a randomized replicated McIntosh rootstock trial was planted at the Horticultural Research Center. Both Rogers and Macspur strains are being tested on four rootstocks planted in rows 20 feet apart: M7A, M26, M9, and M9/MM111. On M7A, Rogers and Macspur are planted 16 and 14 feet apart, respectively, in the row. On M26 and M9/MM111 they are planted 14 and 12 feet apart, respectively and on M9 they are planted 10 and 8 feet apart, respectively. All combinations are being trained as staked free-standing trees to a slender spindle system. In addition, both Rogers and Macspur on M9 are also being trained as staked trees on a 4-wire trellis. Bisbee and Vance Delicious and Cortland serve as pollenizers.

All blossoms were removed in 1979 and 1980. Training began in 1980, and cross-sectional areas of all trees were taken. In 1981 training and measurements will continue and fruiting may be allowed to begin.

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1 EMLA(East-Malling and Long Ashton): virus-free

2 Introduced by Michigan State University

3 Selected by Oregon Agricultural Experiment Station

In Spring, 1981, a similar randomized replicated Delicious rootstock trial will be planted. Both Gardner and Bisbee strains will be planted on M7A, M26, MM111, M9/MM111, and M9/MM106 rootstocks. Gardner and Bisbee on M7A and MM111 will be planted 16 and 14 feet apart in the row, and they will be planted 14 and 12 feet apart, respectively, on M26, M9/MM111, and M9/MM106. All trees will be trained as staked free-standing trees to a slender spindle system. Rogers McIntosh and Cortland will be the pollenizers. Training and cross-sectional measurements will begin in 1981.

As these plantings develop, it is intended that numerous evaluations will be made, including the following:

a. annual yields per tree
b. each tree's production efficiency
c. tree survival
d. prevalence of rootstock suckering
e. nutritional status of each tree, and fruit susceptibility to bitter pit
f. fruit maturation (firmness, red color development, watercore, etc.)
g. postharvest storage life and susceptibility to physiological disorders following Ca and regular cold storage.

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III. Fruit variety evaluation at the Horticultural Research Center. James F. Anderson

We are beginning a new phase in tree fruit evaluation at the Horticultural Research Center. This has been made possible by the removal of several of the original plantings made in 1964. Because of space limitations very few new varieties or selections were planted between 1965 and 1978.

Most of the varieties and selections under test in these original plantings have been reported on at past meetings and in earlier reports. Two varieties that have not been reported earlier are Akana (TOHOKU #3) and Magnolia Gold. Akana looks promising for early September apple market and Magnolia Gold is an attractive, good quality Golden Delicious type apple, that has been completely russet free in our trials.

Plantings of apple varieties in the past 2 years include a number of strains of Red Delicious, McIntosh and Cortland. Additional apple varieties will be set next spring.

The peach orchard set in 1980 has 15 peach and 6 nectarine varieties under evaluation. Five pear varieties have been added for evaluation in the past 2 years. Additional pear varieties will be set next spring.

Small fruit varieties and selections are also evaluated at the Research Center. The emphasis has been on strawberry variety evaluation in recent years. This past summer, 9 numbered selections and about 10 varieties were evaluated. Scott a newly released variety from the U.S.D.A. was evaluated for 4 seasons and will be recommended for trial planting in Massachusetts. Several grape varieties that show promise are Alden, Lakemont and Steuben.

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IV. Adaptability of apple tree rootstocks to representative orchard soils in Massachusetts. Peter L. Veneman

Several new rootstocks have been introduced during the last few decades and claims pertaining to their adaptability to various environmental conditions sometimes have been contradicting and confusing. These claims as well as statements regarding the "old" rootstocks (M9, M7, M26, MM106 and MM111) often are not based on reliable field trials. Observations by pomologists and commercial fruit growers indicate that local differences in soil type probably are largely responsible for variations in growth of apple trees on particular kinds of rootstocks. An evaluation of the effects of different environments on apple tree growth seemed justified and several studies were initiated to research this interaction. Following is a brief description of the various soil-rootstock research projects and a synopsis of this year's progress.

Size-control rootstocks are, in general, more demanding than seedling rootstocks in respect to drainage, depth of soils and water holding capacity. When choosing which rootstock to use it is important to have a proper understanding of the particular rootstock-soil type interaction. The right match between rootstock and soil may be the difference between commercial success or failure of the planting. A wide variety of different soil types is used in Massachusetts for growing apple trees. It is impossible to do an experimental planting on each different soil type but the most commonly used soils are closely related, which allows extrapolation of the results of a limited number of research sites to most Massachusetts and New England conditions. This project consists of two stages, one of which is concerned with the carefully monitored growth of selected rootstocks on 9 representative orchard soils. The second stage involves the evaluation of the growth of the different size controlled rootstocks as related to type of soil in a large number of orchards throughout Massachusetts.

Ten research sites have been selected, each site being representative for a certain type of soil. The following soil series were chosen on the basis of importance for the New England fruit industry: Charlton, Colrain (2 sites), Paxton, Shelburne, Wethersfield, Woodbridge, Ridgebury, and Cabot. The first two soil series do not have a hardpan and are well drained. The other soils have a hardpan within 3 ft. depth and are increasingly wetter; Paxton, Shelburne, and Wethersfield being well drained and Ridgebury and Cabot representing the poorly drained soils.

The tree planting at each experimental site will consist of standard type 'McIntosh' on either M7A, M26, M9/MM106, and M9/MM111 rootstock. Spur 'Delicious' on M7A rootstock will be used as a pollinator. Each row will contain the four different rootstocks at random with the 'Delicious' in the middle. Spacing between trees in a row will be 14 ft. There will be 8 rows spaced 20 ft. apart. The planting will be established in the spring of 1982. Most soils at the experimental sites have already been described, classified and sampled for physical and chemical laboratory analyses.

During the second phase of this project a large number of orchards are visited. Production of selected rootstocks is evaluated, especially in relation to soil type. Rootstocks, in general, seem to grow and produce reasonably well on soils with a hardpan at depths greater than 20". This was substantiated by observations made in the fall of 1979 at the Horticultural Research Center in Belchertown. Trees planted in loamy soils with a hardpan within 20" did, in general, poorly or perished; while rootstocks in deeper, better drained soils did much better. During the dry 1980 season, M7 rootstocks were observed to suffer on shallow soils with a restrictive layer within 24" of the soil surface. Tree growth and especially anchorage was poor and several trees tipped over. Growth of MM106 on well drained Paxton soils (hardpan within 36") was judged excellent to good even during the dry 1980 summer.

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V. <u>Effect of soil water and depth to hardpan on rootstocks.</u>

Peter L.M. Veneman

More than 50% of the Massachusetts orchards are located on relatively shallow soils over bedrock or are at some depth underlain by a hardpan. Both types of phenomena limit root penetration and ultimately restrict tree development. High seasonal or permanent water tables may have the same detrimental effects on rootstock performance. This project is an attempt to accelerate the evaluation of the effects of soil moisture regime and depth of growth restricting layers on the performance of apple trees on clonal rootstocks. This is accomplished by a newly developed testing procedure under controlled conditions in a greenhouse.

The effect of a hardpan will be simulated by using growth containers with different heights. The bottoms of the containers will limit expansion of the root system and thus are limiting growth in the same fashion as actual hardpans. Massachusetts orchard soils often have growth restricting layers at 2-3 ft. and the growth containers in this trial are, therefore, either 2 or 3 ft. deep. The containers are equipped with a specially designed bottom which permits control of the soil moisture regime. Three moisture conditions are possible: dry, moist, or wet. Growth performance of each rootstock will be evaluated over a period of time until differences become evident.

A greenhouse was erected in the fall of 1980 at the Horticultural Research Center in Belchertown. The necessary experimental equipment was assembled over the 1980 summer and the current set-up allows for the simultaneous evaluation of 8 different rootstocks. However, the greenhouse roof has yet to be installed because of adverse weather conditions, but it is hoped that an evaluation cycle can be started in January. That testing cycle will compare the growth of 'McIntosh' apple trees on M7, M9, M26, MM106, MM111 and standard rootstocks.

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AN UPDATE ON FRUIT TREES INJURED IN 1978-1979.

William J. Lord
Department of Plant and Soil Sciences

Winter injury to fruit trees in 1978-1979 was predominantly damage to roots. The cause and factors influencing the injury, and symptoms of the injury were discussed in the JANUARY/FEBRUARY 1980 issue of FRUIT NOTES. The majority of the weakened peach trees were removed during the summer of 1979, but not the apple trees. In late-summer we tagged individual limbs and whole apple trees at the Horticultural Research Center in Belchertown after rating the severity of winter injury. This was done to enable us to determine the degree of tree recovery in 1980.

Lack of snow cover and relatively mild temperatures characterized the winter of 1979-1980. No injured limbs or trees died during the winter. Bloom was heavy on many of the injured trees but fruit set was very light. Nevertheless, the fruits were removed chemically and by follow-up hand thinning.

Trees severely affected in 1979 showed no signs of recovery in 1980 and some died. Injury symptoms did not worsen on trees having only 1 or 2 affected limbs. However, the affected limbs produced little terminal growth in 1980.

Our experiences with the winter injury of 1979-1980 lead us to conclude that damage to apple trees was most severe on poorly drained soils and that recovery from injury of severely injured trees may be slow. It appears that the best solution to the problem is tree removal.

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ALTERNATE vs. EVERY MIDDLE SPRAYING FOR APPLE PESTS: 1980 RESULTS FOR ARTHROPOD PESTS AND 5-YEAR TRENDS

W,M, Coli[1], G. Morin[2], N.D. Goodhue[2], M. Kuzontkoski[3], T.A. Green[3], M.R. Paul[3], S. Marafino[4], and R.J. Prokopy[5]
Department of Entomology

In previous issues of FRUIT NOTES, we have reported our findings on the relative effectiveness of alternate-middle vs. every middle spray programs for apple pests in 1976-1979 growing seasons. (See FRUIT NOTES 42(3), 43(3), 44(3), and 45(1).

Here we present (a) our 1980 findings on alternate middle vs. every middle spraying for insects and mites, (b) a cost-benefit analysis with regard to insect and mite control in 1980 and (c) a summary of pest injuries and cost-benefit analysis for a multiple year period.

Four test blocks in commercial orchards located in the major fruit-growing regions in Massachusetts were each divided into 2 plots of 2-6 acres. One plot received the alternate-middle program on each spray date throughout the season. The other received the every middle program. Each grower followed his normal spray schedule, using an air-blast sprayer and spray materials and concentrations (1x, 4x, etc.) of his own choosing. Except in one block, all trees were fully grown; some on M7 rootstock, others on seedling. Pruning was generally adequate to allow for good spray penetration into tree centers.

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[1] Pest Management Specialist

[2] Senior Field Scouts

[3] Field Scouts

[4] Lab Technician, Entomology Department

[5] Extension Entomologist

Monitoring of Pest Populations

We monitored adult populations of tarnished plant bugs (TPB), European apple sawflies (EAS) and apple maggot flies (AMF) using commercially available visual traps. In addition, pheromone (sex odor) traps were used to monitor redbanded leafroller (RBLR), oblique-banded leafroller (OBLR), codling moth (CM), San Jose scale (SJS), tufted apple budmoth (TABM) and spotted tentiform leafminer (STLM). Visual inspections of fruit and foliage in all portions of the tree canopy were used to monitor populations of plum curculio (PC), green apple aphids (GAA). woolly apple aphids (WAA) and aphid predators and spotted tentiform leafminer (STLM). Mites were monitored using leaf brushing techniques described previously.

Sampling was weekly through petal fall and tri-weekly thereafter. At harvest, an on-tree survey of 1200 fruit per treatment block was performed to determine injury levels to fruit.

Insect Injury to Fruit at Harvest

In 1980, total insect injury at harvest averaged 0.96% in alternate-middle blocks vs. 1.17% in every middle blocks. (Table 1).

Table 1. Average percent of insect injury to fruit in 4 alternate-middle vs. every middle commercial orchard blocks in Massachusetts, 1980.

Insect	Every middle	Alternate middle
Tarnished plant bug	0.78	0.38
Plum curculio	0.25	0.15
San Jose Scale	0.00	0.20
Apple maggot fly	0.03	0.00
European apple sawfly	0.03	0.00
Green fruitworm	0.03	0.00
Codling moth	0.00	0.00
Leafrollers	0.05	0.08
Sooty mold	0.00	0.15
Other	0.00	0.00
Total % insect injury	1.17	0.96
% leaf terminals infested with apple aphids	10.2	5.5
Avg. number of mites/lf	2.0	0.7

In 1980, TPB was the most serious insect pest in both types of treatment blocks, although injury in each was substantially lower than the statewide average percent TPB injury in IPM or Check blocks (1.44%). This variation in TPB injury probably relates simply to differences in pest pressure rather than any direct treatment effect.

Injury to fruit from several of the major insect pests (PC, EAS, AMF, LR and GFW) was at acceptable levels, with no outstanding differences between treatment blocks (Table 1). However, SJS injury was higher in the alternate middle blocks in 1980, indicating the need to thoroughly apply dilute rates of oil in an every middle treatment regime in 1981 to prevent further buildup of this pest.

It is interesting to note that both the percent of leaves infested with aphids and the average number of plant-feeding mites per leaf were lower in alternate vs. every-middle blocks in spite of reductions in pesticide use in these blocks.

Cost-Benefit Analysis

In 1980, alternate-middle spraying resulted in a savings of \$53.22 per acre for insecticide and miticide materials and \$12.41 for application costs. In addition, fruit loss due to insect injury was \$10.72 less per acre in alternate vs. every middle blocks (Table 2).

Table 2. Cost-benefit analysis of every middle vs. alternate middle treatments, 1980[z].

	Dollor cost/acre		
	Every middle	Alternate middle	Differences
Avg. cost of insecticide and miticide materials	\$156.72	\$103.50	-\$53.22
Avg. application costs	32.22	19.82	- 12.41
Avg. value of fruit loss due to insect injury	61.36	50.64	- 10.72
Avg. net benefit from alternate-middle spraying for insects and mites			+\$76.35

[z] Based on suggested retail pesticide costs published by J. Williams, Regional Fruit Specialist: labor costs of \$5.50 per hour, fuel costs of \$2.20 per acre and average yields of 550 bu/acre.

It is interesting to note that in 1980, alternate middle program costs were not exactly one half of those of every middle program costs. This is due to the fact that two growers applied oil and miticide sprays on an every middle basis, which resulted in somewhat higher than expected material and application costs.

Nevertheless growers utilizing alternate middle spraying realized an average net benefit of $76.35 per acre in 1980.

Summary of 5-year trends in alternate vs. every middle blocks.

Overall, during the period 1976-1980, average percent injury at harvest from insects was virtually identical in alternate vs. every middle treatment blocks (Table 3).

Table 3. Average percent of insect injury to fruit at harvest and percent infestation with aphids and mites in four alternate middle vs. every middle commercial orchard blocks, 1976-1980.

Insect	Every middle	Alternate middle
Tarnished plant bug	1.6	1.4
Plum curculio	0.2	0.1
San Jose scale	0.1	0.1
Apple maggot fly	0.1	0.1
European apple sawfly	0.2	0.2
Green fruitworm	0.1	0.1
Codling moth	0.1	0.0
Other	0.0	0.1
Total percent insect injury	2.4	2.1
% leaves with aphids	7.8	8.6
% leaves with mites	8.8 (2.0)[z]	11.2 (0.7)[z]

[z] 1980 data in ( ) = no. mites per leaf.

Specifically, while it is evident that tarnished plant bug is the single most damaging pest in alternate and every middle blocks, all the major fruit damaging insect pests appear to be equally amenable to control using either alternate middle or every middle spray techniques.

Table 3 also shows the average percent of leaves infested with aphids and mites in alternate vs. every middle blocks for the period 1976-1980. During this period aphid populations were slightly higher in the alternate middle blocks. However, there was no significant fruit injury from aphid honeydew or sooty mold growth in either block, indicating that aphid infestations were below economic injury levels and would not justify the cost of additional spray applications (data not shown).

Mite populations followed similar trends, with the exception that, in 1980, mite numbers (given in mites/leaf) were 65% lower in the alternate vs. every middle treatment blocks.

Three year cost-benefit analysis

While we are not able to perform cost benefit analyses on the 1976 and 1977 data owing to differences in sampling techniques and data collection methods, we believe that the composite of the 1978, 1979, and 1980 data indicates the potential benefits of alternate middle spraying over time.

Table 4 indicates that for the latter 3 years, growers realized a net benefit from alternate middle spraying of $41.40 to $85.38 per acre. Although it is difficult to make comparisons between years owing to variability in costs from year to year, alternate-middle spraying would appear to result in an average net benefit of about $67.00 per acre.

Table 4. Cost benefit comparison of alternate vs. every middle spray treatments, 1978-1980[z].

	Cost reduction/acre due to alternate-middle spraying		
	1978	1979	1980
Insecticide & Miticide spray materials	-$29.61	-$48.05	-$53.22
Spray application costs	- 8.87	- 14.22	- 12.41
Value of fruit loss due to insect injury	- 2.92	- 23.11	- 10.72
Net benefit from alt. middle spraying	+$41.40	+$85.38	+76.35

z
Labor costs: 1978 - $3.50/hr; 1979 - $5.00/hr.; 1980 - $5.50/hr.
Fuel costs: 1978 - $1.50/A; 1979 - $2.00/A; 1980 - $2.20/A
Fruit value: Variable in each year based on current market quotations at harvest.
Pesticide costs: Based on Coop. Extension Service suggested retail prices.

The value of $67.00 average net benefit per acre compares to an average net benefit over the same period of about $105.00 per acre (exclusive of scouting costs) from the IPM scouting and grower advisement program. Even allowing for scouting costs of $25.00 per acre (NY presently charges $17.00/acre), the IPM scouting and advisement program appears to yield a greater net benefit per acre than the alternate middle program. Perhaps the greatest potential rests in combining the IPM scouting and grower advisement program with the alternate middle program. We introduced this approach to orchard spraying on a limited basis in some of our IPM blocks in 1979 and 1980, with apparent success. We hope to continue on in this direction in 1981.

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Amherst, MA 01003

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE,
UNIVERSITY OF MASSACHUSETTS, UNITED
STATES DEPARTMENT OF AGRICULTURE AND
COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
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Vol. 46 No. 2
SPRING ISSUE 1981

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NECTARINE VARIETIES

James F. Anderson
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There is an increasing interest in the production of nectarines by Massachusetts growers who market their fruit through farm stores and pick-your-own operations. In the past the production of nectarines in this region was not very profitable. This was due in part, to the susceptibility of the fruit to brown rot and lack of fruit size. Breeding programs at Experiment Stations in Canada, New Hampshire, New Jersey, New York and Virginia and by the U.S.D.A. and several individuals have resulted in the introduction of many new varieties with improved size, flavor and hardiness. The development of improved pesticides and application equipment has allowed for better control of brown rot and the insects that contribute to its spread.

We have had a very limited recent experience with nectarine varieties in our College orchards. We fruited Lexington, Cavalier, Nectaheart and Nectarose for 10 or more years at the Belchertown facility, all performed satisfactorily but none of these are currently offered by major nurseries.

Nectarine varieties planted in our new orchard include Cherokee, Harko, Stark Early Bird, Stark Crimson Gold, Stark Sweet Melody and 2 numbered selections, hopefully other varieties will be added this spring.

As we have had no experience with the varieties currently offered, the comments that follow have been abstracted from several publications and nursery catalogs. This material is offered for informational purposes only and does not indicate a recommendation. The varieties are listed in order of ripening.

Nectared 1: An introduction from the New Jersey Station. Introduced in 1962. Fruit is of medium size, oval in shape and is nearly completely covered with a dark red blush. The flesh is yellow, juicy, slightly coarse and moderately soft. The flavor is sweet and good. It is a clingstone. The flower buds are moderately hardy and it is productive. The New York Station considers this to be the best very early, yellow fleshed nectarine that they have tested. Ripens 12 to 14 days before Redhaven.

Morton: Introduced by the New York Agricultural Experiment Station, Geneva in 1965. Fruit is attractive dark red but somewhat small in size. The fruit is white fleshed, juicy, slightly coarse and medium firm. The flavor of this semi-clingstone variety is very good. The tree is hardy and vigorous. Ripens about 5 days before Redhaven.

Harko: Originated at Harrow, Canada. Introduced in 1974. Fruit is medium in size, roundish, with a solid red skin and a freestone. The flesh is yellow, medium in firmness with good texture and flavor. The trees are medium in size, spreading and productive. The trees are tolerant to bacterial spot and brown rot. Ripens 1 or 2 days after Redhaven.

Independence: Originated in Fresno, California by the U.S.D.A. Introduced in 1965. Fruit is large, dark red over a yellow undercolor and slightly oval in shape. The flesh is yellow, firm, slightly coarse in texture and the flavor is good. The stone is free. Tree is vigorous, productive and about equal to Redhaven in bud hardiness. Ripens about 2 days after Redhaven.

Hardired: Another 1974 introduction from Harrow. Fruit is of medium size with a brilliant almost solid red color. The flesh is yellow, medium-firm with good texture and flavor. The trees are vigorous, very hardy and very productive, requiring heavy thinning to maintain its medium fruit size. The trees are tolerant to bacterial spot and brown rot. Ripens 5 days after Redhaven.

Flavortop: Originated in Fresno, California by the U.S.D.A. Introduced in 1969. Fruit is large, ovate mostly red and a freestone. The flesh is yellow, firm and smooth, the flavor is excellent. The tree is said to be vigorous and productive but tender to cold and susceptible to bacterial spot. Ripens about a week after Redhaven.

Mericrest: An introduction from the New Hampshire Experiment Station. Fruit is medium in size, round with a pronounced suture. The flesh is yellow, juicy and has excellent flavor. The trees are vigorous, highly productive and tolerant of bacterial spot and brown rot. Ripens 7 to 10 days after Redhaven.

Nectared 4: Fruit is medium in size, attractive with a dark red blush over a yellow undercolor. Flesh is yellow, medium firm and slightly fibrous in texture. The flavor is sweet and rich. A semi-freestone. The tree is moderately hardy and is productive, heavy thinning is required. Ripens 7 to 10 days after Redhaven.

ROOT SYSTEM DISTRIBUTION OF HIGHBUSH BLUEBERRY UNDER A SAWDUST MULCH

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Even though vegetative and reproductive growth of plants is very dependent on a functioning root system, relatively little attention has been given to root system development in fruit crops. This is certainly true of the highbush blueberry. Several studies show that the root system of mature plants is shallow and fibrous, but no one has studied its distribution in the soil. Therefore, in 1979, at the University of Rhode Island we undertook a study to determine the root distribution and general shape of the root system of young and mature bushes of cultivated highbush blueberries.

Six 13-year-old Coville and five 7-year-old Lateblue bushes were growing on a Bridgehampton fine sandy loam soil at a pH of 4.8. Bushes were spaced 6 feet x 10 feet and the entire area within and between rows was maintained under at least 6 inches of sawdust mulch for the entire life of the bushes. The sawdust was a mixture of hardwood and softwood and was approximately 1-year-old prior to annual application. The water table was at least 5 feet below the soil surface. Bushes generally were not irrigated. Each bush received an annual application of 2 pounds of 5-10-10 fertilizer.

Core samples containing roots were taken at different locations around each bush and a trench was excavated completely beneath the center and half way around 1 bush to determine the extent of vertical root penetration and the regularity and the relative density with which roots radiated from the crown.

The dripline of all bushes was located approximately 2 feet from the crown. In all cases, the bush crown, considered to be that area from which new canes arose, was about 16 inches in diameter.

Findings

The root systems were primarly composed of fine, fibrous roots less than 0.1 inch in diameter. They were shallow and formed an inverted cone of from 11 to 33.5 cubic feet in volume. Roots tended to be primarily oriented parallel to the soil surface with very few noticeable vertical roots. In no case were roots found in the undecomposed layer of mulch. Fine, fibrous roots, intermingled with larger roots, first appeared in the upper layers of partially decomposed mulch.

Stark SunGlo: Originated in LeGrand, California by F.W. Anderson. Introduced in 1962. Fruit is large, symmetrical, globose with a yellow skin partly overspread with red. Flesh is yellow with some red around the pit, firm and the flavor is good. This freestone variety ripens evenly and has good keeping and shipping quality. The tree is large to medium, moderately vigorous and productive. Ripens 10 to 14 days after Redhaven.

Fantasia: Originated in Fresno, California by the U.S.D.A. Introduced in 1969. Fruit is large, ovate, bright red with a yellow undercolor and a freestone. The flesh is yellow, firm, smooth and has good flavor. The trees are productive but susceptible to bacterial spot. Ripens about 2 weeks after Redhaven.

Nectared 6: Fruit is of medium size, 75% to full red over yellow. Flesh is yellow, slightly soft, juicy sweet and good in flavor. This freestone variety is vigorous, hardy and productive. Ripens 16 to 19 days after Redhaven.

Nectacrest: Originated at the New Jersey Agricultural Experiment Station, New Brunswick. Introduced in 1947. Fruit is large, white fleshed and freestone. The flesh is fairly firm and has a fine nectarine flavor. The tree is vigorous and hardy. Ripens about 20 days after Redhaven.

Stark Red Gold: Originated in LeGrand, California by F.W. Anderson. Introduced in 1962. Fruit is medium to large in size, skin is yellow overlaid with red. Flesh is yellow with red around the pit, firm and the flavor is very good. The tree is fair in hardiness, productive and is susceptible to bacterial spot and mildew. Ripens 4 weeks after Redhaven.

There are other varieties that may be equal to or better than the above.

ERRATUM IN JANUARY/FEBRUARY, 1981 ISSUE

An error should be corrected on page 8 of the January/February 1981 issue of FRUIT NOTES. In the article entitled "FRUIT VARIETY EVALUATION AT THE HORTICULTURAL RESEARCH CENTER, James Anderson mentioned the apple variety Akana. The correct spelling of this variety is Akane.

The root system of 13-year-old 'Coville' plants extended in measurable amounts up to 4 feet from the perimeter of the crown, and a few roots were noted regularly at distances of up to 6 feet. Roots were recorded at depths of 32 inches on most bushes.

Overall, approximately 50% of the root system was located within 1 foot of the crown, while 84% of the root system occurred within 2 feet of the crown, which was approximately the dripline of the bushes.

The root system of a typical 7-year-old 'Lateblue' plant is usually located within less than 2 feet from the crown perimeter. In only 1 instance were roots detected at a 2 foot distance and these were within 11 inches of the soil surface and comprised only 0.31% of the total root dry weight for that bush. Roots were occasionally found at depths of 32 inches within the first 1 foot from the crown perimeter. However, most or all of the root system (88-100%) of individual plants was located in the upper 14 inches of soil. Virtually 100% of the root system of these plants was located within the dripline.

Discussion

The shallow root system may be in part responsible for the blueberry's ability to survive in swampy locations. However, the general depth of the mature system coincides with those reported for other crops such as apple, peach, cherry, grape and olive. Depths can be expected to vary, however, depending upon soil type and aeration. For example, apple roots have been reported to penetrate to depths in excess of 32 feet in a well-aerated Nebraska soil, while the roots of similar trees growing in deep loam soils in California were found to penetrate to only half that depth. Presumably, the root system of the blueberry can also vary greatly as soil conditions are changed.

Use of mulches certainly modified blueberry root distribution. Our finding of an absence of blueberry roots in the upper layers of mulch is similar to a report on apple root distribution. In a study of the effects of various mulches and fertilizers on yield and survival of blueberry plants, Kramer et. al, in Maryland found remarkable differences in root distribution under peat mulch as compared to no mulch. They reported that the roots of 2-year-old 'Pioneer' and 'Concord' plants spread approximately 35 inches from the main stem but were limited totally to the upper 3 inches of mulch, while those of the control plant spread only 12 inches but penetrated to a depth of 9 inches. They reported similar but less dramatic results with other mulches, including pine needles, oak leaves, and straw.

This experiment indicates that the cultivated highbush blueberry plant posseses a shallow, fibrous root system that is primarily distributed within the area between the crown and the dripline of the bush. Fertilizer should therefore be placed beneath the dripline of the bush and cultivation, if practiced at all, must be very shallow in this area.

POMOLOGICAL PARAGRAPH

Insect larvae entering burrknots. Low light intensity at tree trunk level, caused by shading from the ground cover, low limbs and/or plastic mouse guards, favors the enlargement of the root initials on the M9 stempiece of interstem trees or on M26 rootstock. The clusters of root initials, called burrknots, are serving as entrance sites for insect larvae especially apple bark beetle larvae (apple bark beetles are close relatives of the peach tree borer). Damage from these tree borers is occurring in Massachusetts and other fruit growing areas in Eastern United States. The use of mouse guards made from hardware cloth and deeper planting of interstem trees (setting the variety/M9 stempiece union 3 inches above ground at planting) should reduce burrknot formation and permit better spray coverage.

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CONSIDERATIONS IN ESTABLISHING GROWER-OWNED IPM ORGANIZATIONS IN MASSACHUSETTS

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In November, 1980, Dr. David Ferro, Extension Vegetable Entomologist and I participated in the third annual National Extension Workshop on organizing grower-owned IPM organizations held at Kansas City, Missouri. Our purpose in attending this meeting was to familiarize ourselves with current model IPM organizations in other states. This would enable us to present Massachusetts growers with the numerous alternatives to implement IPM programs in the absence of federal government funding.

At this writing, apple growers are the sole commodity group in Massachusetts participating in an IPM program. This program, sponsored by the Cooperative Extension Service, and funded by a 5 year USDA grant has resulted in increased interest in IPM. Growers have asked for aid in deciding how to continue to implement IPM when Federal funding ends in September, 1982. Thus the intent of this article is to present a discussion of a broad range of potential considerations and options available so that Massachusetts growers may decide which means of implementing IPM are best for their unique conditions.

Why IPM? Integrated Pest Management pilot programs are presently operating in nearly every state in the union in crops as diverse as fruit, cotton, soybeans, and alfalfa. Workshop participants agreed that there are important short and long-term benefits from IPM and that likely candidates for IPM are progressive farmers, farmers using a multi-spray, calendar-based spray schedule, and crops which have high pest control costs.

Who Should Perform IPM Scouting? If growers are to have peace of mind regarding pest pressures on their orchards, and if pesticide costs (especially for insecticides and miticides) are to be reduced, some form of field scouting is needed. This scouting may be performed by the grower, by a staff person, or by someone other than the grower or staff member.

It was the general opinion of workshop speakers that scouting is probably best not left with growers since they are frequently busy with other management decisions. Some capable staff person would be acceptable provided they are free to scout when necessary rather than as other orchard jobs permit.

Massachusetts IPM, with the institution of our "grower scout" training appears to be unique in this regard, as the majority of our "grower scouts" made observations with our field teams on a weekly (sometimes more often) basis. Several "grower scouts" scouted additional acreage in their orchards as well as indicated their interest in continuing the scouting procedures after IPM pilot program funds ended in September, 1982. However, most speakers at Kansas City agreed that some outside person, whose only responsibilities were scouting, is more likely to have the time and interest for training in pest identification, control measures (including alternatives) and economic threshold levels.

What is Cooperative Extension's Role in IPM? Conference participants generally stressed that Cooperative Extension's role in IPM is threefold. One important area is the implementation of research programs related to IPM, including an in depth look at pest biologies and life histories, development of effective monitoring techniques and the establishment of appropriate economic threshold levels (ETL).

A second role consists of creation and operation of effective commodity-based pilot programs to develop necessary base-line data and demonstrate, if possible, the potential environmental and economic benefits that accrue to participating growers.

Lastly, there was unanimous agreement that Extension should continue after pilot program funding ends to play a role with regard to education of growers, updating monitoring methods and ETL's, as well as training and supervision of field scouts.

It would appear that the Extension Service is best equipped to utilize high technology (computers, weather forecasting networks, etc.) for information gathering and dispersal, to carry out needed research, and to coordinate an interdisciplinary approach to pest management once pilot programs have run their course.

Several states offer scout training courses (up to 80 hrs. in some cases) through their Extension Service. Many have an exam (open book in some cases) leading to state certification of field scouts, since some form of quality control is deemed desirable to prevent farmers from hiring minimally qualified scouts.

Possible Alternative Forms of IPM Organizations After Pilot Program Funding Ends.

1. IPM ceases to be implemented on any significant scale. Workshop participants uniformly believed that this is not likely to happen so long as growers realize potential advantages of IPM and so long as viable alternatives exist.

2. Some private commercial entity takes over. Such entities can be in the form of independent scouts making no recommendations, or private consultants who make recommendations (and perhaps serve as a supervisor of scouts hired by a group of growers for a large number of growers). If not enough qualified consultants or scouts are available to accomodate interested growers, problems will ultimately result and IPM might fail.

3. Creation of a grower-owned entity (Cooperative). Where a cooperative is already in existence and providing services, there is the option to add IPM services. It is important to keep sales of pesticides separate from IPM services in order to maintain credibility with growers and reduce potential for conflict-of-interest.

   Growers may choose to form a cooperative (one member-one vote, limited return to capital, and division of earnings in proportion to usage) independent of already existing supply or marketing cooperative in order to provide IPM services, completely removed from pesticide sales. Such a cooperative could provide only IPM scouting, scouting plus purchasing supplies and/or services, or full agronomic services. A cooperative providing only IPM services, however, will have problems due to the seasonal nature of the work, so the best option here is perhaps to offer other services (leaf & soil analysis for example).

4. Creation of a non-profit grower-owned association (incorporated or unincorporated). Such an entity attempts to make no income over expenses. This type of organization typically supplies scouting services only, with no pesticide sales or application services and can serve as a data collecting agency for the Extension Service, receiving technical, educational and quality-control service in return. Once growers have the scouting information, they can either make their own decision, ask the advice of a private consultant or ask the Extension Service. Alternatively, a non-profit grower-owned organization can hire a scout supervisor who maintains extension liason, and makes recommendations to participating growers.

Alternatives in program scope and organization. Three principal topics were discussed.

1. Alternative geographic scopes: That is, should IPM programs be organized (a) on an individual grower basis with each contracting for IPM services independently, (b) on a county (or multi-county) basis, or (c) under a state wide umbrella.

2. Alternative program scopes: A first consideration is to decide whether to organize so as to cover single or multiple crops (e.g. vegetables, apples, or both, etc.)

3. Alternative services: Once program scope has been decided upon, it next remains to be decided whether to offer (a) scouting services only (this has minimal risks and minimal supervisory costs but requires a close alliance with the Extension Service for training and interpretation of scouting reports, (b) scouting plus other IPM services (spray material purchase, contracts with aerial applicators, predator releases, etc.) or (c) IPM services plus non-IPM services (soil testing, leaf analysis, etc.).

    These latter two options typically require a full-time manager, substantial capitalization and some form of democratic organizational structure.

Liability considerations. Conference participants agreed that this area was potentially one of the largest stumbling blocks to providing IPM services after Extension-run pilot programs ended. Several aspects of this problem must be considered.

1. Protecting individual growers from liability (as in the case of an independent scout injured during orchard scouting).

2. Protecting scouts or private consultants from suits resulting from improper scouting or incorrect recommendations.

3. In the case of grower owned organizations (cooperative or non profit entity), protecting this entity from suits brought by individual participating growers.

There are numerous options in this area such as whether to limit liability by incorporation, best decided with advice of legal counsel when setting up IPM organizations. Scouts (or private consultants) can for example, be hired utilizing a service contract which specifies the job requirements. This contract would also specify that growers will not sue under any circumstances, whether by negligence or improper recommendations. Individual growers (or grower organizations) can then carry scouts or consultants under farm liability and workmen's compensation insurance.

Alternatively, individual scouts or consultants could purchase Errors and Omission insurance through private vendors. The difficulty here is that costs are so high, independents would probably find it impossible to carry adequate insurance and still make any money.

It is apparent that there are numerous legal considerations and optional organizational forms for growers interested in implementing IPM practices on their farms. National Workshop participants continually stressed the need for careful planning of IPM organizations utilizing skilled legal counsel, well in advance of anticipated need.

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POMOLOGICAL PARAGRAPH

The Spread of San Jose Scale Revived Interest in Dwarf Apple Trees in the Late 1800's. The influx of San Jose scale in Massachusetts this past season brought to mind the fact that the rapid spread of this insect in New York State during the late 1800's was responsible for one of the periodic revivals of interest in dwarf apple trees. At that time it was expected that San Jose scale would eventually spread throughout the fruit growing areas of the state and that the spread probably could be controlled only by fumigating trees under tents. Since it was thought that fumigation of dwarf trees might be feasible, fruit growers asked the New York State Agricultural Experiment Station to determine if dwarf apple trees could be grown profitably in commercial orchards. U.P. Hedrick of the New York Agricultural Experiment Station said in 1915, "Had it not been for this apprehension of grievous disaster from San Jose scale it is doubtful if the fruit growers would have called for the investigation, or the Station have voluntarily undertaken it". Fortunately for commercial apple production but unfortunately for continued interest in dwarf trees, lime-sulfur and oil, which were introduced between 1907 and 1910, proved effective for the control of San Jose scale. Development of dwarf trees therefore had to wait until another crises threatened the industry many years later.

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A CHEMICAL BIRD REPELLENT FOR HIGHBUSH BLUEBERRIES

F. W. Southwick
Department of Plant and Soil Sciences

It is virtually impossible to produce a crop of highbush blueberries in the Northeast without providing protection from birds. Consequently, successful producers of this crop have been forced to completely enclose plantings with netting to insure the harvest of a major portion of the crop. Trapping, scare devices, noisemakers, distress calls of birds, electronic sounds, etc. are usually ineffective or so objectionable that their use is impractical or prohibited. The use of netting is very satisfactory but its cost is excessive.

The carbamate material methiocarb (Mesurol) originated as an insecticide by Farbenfabricken Bayer A.G. of Leverkusen, Germany. Since the early 1970's investigators associated with the U.S. Fish and Wildlife Service, have studied the bird repellent potential of this chemical sprayed on sprouting seeds, grain, cherries, grapes and blueberries, and in some cases these tests have been successful. At the present time methiocarb has been approved for use as a bird repellent on cherries, and in some states it has a "special needs" registration for use on blueberries.

Since we were aware of the potential value of this bird repellent for highbush blueberries but lacked data comparing its effectiveness with protective netting, an experiment was conducted in 1980 at the Horticultural Research Center, Belchertown, MA., within a 100' x 150' area that contained about 40 varieties or numbered selections. Each variety or selection was in a plot consisting of 4 or 5 plants. Prior to treatment in early July, 16 plots were selected for uniformity of growth and yield potential, and then 4 plots were randomly selected for each treatment.

Each plot represents a different variety or selection and, therefore, time of fruiting ripening and harvesting was variable. Nevertheless, the results show that methiocarb is an excellent bird repellent (Table 1).

Table 1. The influence of bird repellents on highbush blueberry yields, 1980[z].

Treatments	Dates applied	Average plant yields (lbs.) for each replication[y] I	II	III	IV	All replications
Check (uncovered)		11.94	0.42[x]	8.99	10.15	7.88
Methiocarb 1#/100 gals H_2O	7/11,7/31,7/27	13.16	7.00	12.02	23.63	13.95
Methiocarb 2#/100 gals H_2O	7/11,7/31,8/27	16.13	18.14	8.73	12.80	13.95
Net covered	7/3	18.56	10.64	11.35	16.22	14.19

[z]The harvesting period was from 7/22 to 9/8.

[y]Each randomized replication was a plot of 4 or 5 plants. Each plot contained a different variety.

[x]Check plot in replicate II ripened 7 to 10 days earlier than all the other plots and the crop was largely consumed by birds prior to the initial methiocarb applications.

The yield data show that 2 lbs. of 50% WP per 100 gallons of H_2O applied 3 times at about 3 week intervals was as effective as the 4 lb. rate and as suitable as netting from July 3 to September 8. It also appears that yield of some of the check plots (replicate I, II and IV) which were adjacent to one or more sprayed plots was not greatly reduced by birds. This suggests that the presence of some treated plots in a field may tend to repel birds from unsrayed plants in the area. The poor yield (0.42 lbs. per plant) of the Replicate II check plot was related to its extreme earliness in ripening. This selection was fully ripe 7 to 10 days before the other plots and prior to the first methiocarb application on July 11. Consequently, birds had an opportunity to devour the crop from this selection before coming in contact with methiocarb on any of the chemically treated plots. This chance situation provides additional evidence of the effectiveness of methiocarb as a bird-repellent for highbush blueberries.

Present recommendations of 2 to 3 lbs. of actual methiocarb per acre are suggested per application where clearance for use of this material has been obtained. A tolerance of 25 ppm on harvested fruit is allowable and a preharvest interval of 7 days will insure no harmful residues. No more than 3 applications per season are allowed.

The effect of methiocarb on birds is reported to be temporary. Ingestion of small quantities of fruit treated with methiocarb is claimed to cause birds to become excited, slightly disoriented and unable to continue feeding. Affected birds give off distress calls and/or react in an agitated manner which conveys a warning signal to other birds. In a 1973 Fish and Wildlife Service study, blueberries treated with 1 lb. actual methiocarb per 100 gallons of water were fed to robin, starling and grackle nestlings of different ages. Nestlings fed from 3 to 10 treated berries at one feeding survived without any incidence of ill effects. The data from this study indicate that feeding nestlings fruit treated with methiocarb at recommended bird repellent levels should not influence their long-term survival.

RESEARCH IN PROGRESS

Fruit Research in Plant Pathology

William J. Manning
University of Massachusetts, Amherst

1. Etiology of the Apple Replant Problem

Apple replant is a problem of unknown origin that can affect the growth and development of new apple trees in old orchards and sometimes on newly-cleared sites. Some trees decline and die in the first season. Others survive, with varying degrees of stunting and uneven growth.

We have investigated a number of instances of the apple replant problem in Massachusetts. At the present time we are determining which potential pathogens are involved and planning greenhouse work with rootstocks and seedlings to determine pathogenicity. Future work will involve screening major rootstocks and rootstock/scion combinations for reaction to the agent(s) of the replant problem.

2. Biomonitoring of Fungicide Residues on Apple Leaves

As part of the Integrated Pest Management Program, we have been developing in the laboratory a method for determining biologically-active fungicide residues on apple leaves. This is done by plating leaf discs on agar plates seeded with spores of *Gloeosporium* or *Saccharomyces*. Zones of spore germination inhibition indicate the relative concentrations of biologically-active fungicide residues on the leaves. This information can be used to predict fungicide spray timing. Limited field results were obtained last year and more extensive data will be obtained from field tests this year.

3. Disease Resistant Fruit Trees

Apple cultivars that are immune to scab, and varying in their resistance to powdery mildew, rust and fireblight, have been planted at the Horticultural Research Center in Belchertown. These include 4 trees each of: NY613452, Liberty, Priscilla, Sir Prize, Mac Free, Nova Easygro and Prima.

Imperial McIntosh trees are used as disease-susceptible comparison trees.

Pear Cultivars that are resistant or tolerant to fireblight have also been planted. Four trees each of HW602, HW603, and Highland have been planted. Bartlett trees are used for comparison.

We plan to evaluate these trees under our conditions and to begin looking at possible differences in leaf surface microflora between resistant and susceptible trees, as a prelude to biological management of apple scab and other diseases.

4. New Disease Investigations Block

A new block has been established to do research on integrated chemical and biological management of apple diseases: 15 trees each of Cortland, Empire, Roger's McIntosh, Double Red Delicious, and Yellow Delicious were planted in 1978 for a total of 75 trees. Trees are in randomized units of three, with 5 replications.

CONTROL OF WATER SPROUTS AND SUCKERS WITH TREE-HOLD*

William J. Lord and Joseph Sincuk
Department of Plant and Soil Sciences

Water sprouts, which generally are removed to maintain tree form and prevent shading, are particularly troublesome on standard-type Delicious and following heavy pruning. Unfortunately, their removal becomes more time consuming in succeeding seasons because of the proliferation from the stubs created by pruning. Sucker growth from the trunks and roots of mature seedling trees and in plantings of M.7, M.7A and interstem trees is a serious problem in Massachusetts. Suckers are costly to remove, increase in number annually, provide mouse cover, and are a haven for insects and diseases.

Recently, Union Carbide Agricultural Products Company received a Federal conditional registration for TRE-HOLD Sprout Inhibitor A112 for control of sprout growth on bearing apples, pears and olives and on ornamental olives, pears and crabapples.

TRE-HOLD Sprout Inhibitor A112 contains 13.2% 1-Naphthaleneacetic acid equivalent, as the ethylester. This formulation <u>must be diluted</u> before use, with either water or white interior latex paint.

Tree-Hold diluted in a combination of water and water-base, interior-grade, white latex paint has given good control of water sprouts at our Horticultural Research Station in Belchertown and in grower orchards. <u>However</u>, the results with our trials using Tree-Hold to control suckers under mature Cortland and Early McIntosh trees on M7 rootstocks have been disappointing. Tree-Hold was applied under the trees on June 19, 1978, June 8, 1979 and June 4, 1980. Sucker counts have not been made this spring but counts made in the spring of 1980 indicated that the spray applied in 1978 and again in 1979 failed to reduce the number of suckers. The failure of Tree-Hold to effectively control the suckers is indeed a disappointment and we believe further trials are needed. Perhaps the Tree-Hold should have been applied earlier when the suckers were smaller. Or perhaps Tree-Hold is more effective for sucker control under younger trees than with which we have been working. We certainly hope that growers will conduct some trials with Tree-Hold for sucker control because grower experiences will add to the information currently being obtained.

<u>Mixing for Water Sprout and Sucker Control</u> For the control of water sprouts use 10 fluid ounces (2/3 pt) of Tree-Hold and make up to a volume of 1 gallon with a combination of water and interior-grade latex paint. The latex paint "marks" the treated areas and makes the mixture more viscous, thus restricting the NAA to the treated area. It has been our experience that at least 4 pints of latex paint should be used in each gallon of treating solution. Be sure to use an interior-grade latex paint and one that does not contain a mildewcide.

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* Trade Name

For spraying suckers on a trial basis, mix 10 fluid ounces of Tree-Hold with sufficient water to make 1 gallon of spray mixture. Eight gallons of Tree-Hold are required for 100 gallons of spray.

Control of Water Sprouts Prune water sprouts and then apply Tree-Hold mixture thoroughly over the cut surfaces. It can be applied with a paint brush or a small compressed air sprayer. We found that a 1-1/2 gallon compressed air sprayer with a 12-foot hose worked well, and that attaching a sponge to the nozzle was useful for swabbing the mixture on pruning cuts. The treatment can be applied anytime weather permits before growth starts in the spring. Areas where pruning cuts have been made should be covered thoroughly but drip on to other parts of the tree should be avoided. The Tree-Hold mixture can kill buds. Be sure to follow the label.

Control of Suckers Prune the suckers during the dormant season. The Tree-Hold mixture can be sprayed on the stubs during the dormant season or when the new shoots from the suckers are 6 to12 inches in height. However, the most effective timing is when the suckers are actively growing. Since the Tree-Hold mixture contains 10,000 NAA, the label restricts its use from bud swell through 4 weeks after petal fall to eliminate the possibility of fruit thinning and leaf damage. Therefore, the Tree-Hold mixture should be sprayed the 3rd or 4th week in June when the suckers are 6 to 12 inches in height. Coverage should be thorough.

The Tree-Hold mixture is too expensive to apply as a band application under the trees. Since the population of suckers is generally more dense near the trunk and very troublesome inside wire mouse guards, the spray may be limited to these areas using a compressed air sprayer, a weed sprayer with an air gun, or a weed sprayer and boom with a trunk-directed nozzle.

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 46 No. 3
SUMMER ISSUE 1981

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U.S. APPLE EXPORTS MARK 'COMING OF AGE' AS VOLUME REGISTERS 41-YEAR HIGH[1]

Gilbert E. Sindelar
Director of Horticultural and Tropical Products Division, FAS.

It was the year of the American apple in Taiwan as sales there led a world-wide surge in U.S. exports, with the 1979/80 volume hitting the highest level in 41 years. Taiwan became the leading foreign market for U.S. apples, taking the top spot long held by Canada. Outlook for the 1980/81 season points to another banner year.

The 1979/80 season was the third straight strong showing for U.S. exports and marks a "coming of age" for U.S. apples in foreign markets.

Today, apple exports are beginning to be a factor in the marketing equation, with one out of 10 cartons for the fresh market moving into export. Thirty years ago, when controlled atmosphere storage was in its infancy, apple export markets were virtually nonexistant-except for Canada.

The importance of export markets for U.S. apple producers has been aptly demonstrated the past three seasons. Both 1977 and 1978 were excellent export years, with 7.9 million cartons (42 lbs. each) moving abroad in 1977 and 7.5 million in 1978. But the 1979 season-that ended on June 30, 1980-was even better as the equivalent of 12.4 million cartons of U.S. apples moved into export, with impressive gains in all major markets being topped off by the tremendous success in Taiwan. The 1979/80 volume to all destinations was the largest since the 1938 season when 13.8 million cartons were exported.

The final tally of the 1979/80 season revealed a gain of almost 5 million cartons-or 65 percent-over the very good showing of the preceding season. Exports earnings totaled $125 million versus $67 million in 1978/79 as the derived unit value of export sales averaged $10.06 per equivalent carton, compared with $8.87 the season earlier.

As the 1980/81 export season begins to shift into high gear, it is still difficult to project export totals, especially for the two leading markets of Canada and Taiwan, because of the volatility of the marketplace. Although early estimates indicate a dropoff in these two markets, gains elsewhere are expected to nearly offset these losses. As a result, U.S. apple exports in the 1980/81 marketing year are forecast at 12.3 million cartons, just under last year's

[1] Reprinted from February, 1981 issue of *Foreign Agriculture*

level. However, because of the higher-than-expected U.S. crop this season, particularly in the Pacific Northwest, exports could exceed this projection.

Recently, USDA estimated total U.S. sales of fresh apples-domestic and export-at 102.4 million units (42 lb) in 1979/80. Exports alone represented 12.1 percent of these-a sharp contrast to the early 1970's when exports amounted to less than 3 percent of the total U.S. marketings of fresh apples.

Export gains this past season were widespread, with advances of 19 percent in Western Europe, 48 percent in Central America, 35 percent in both South America and the Caribbean, and 12 percent in the Middle East.

In the Far East, U.S.apple exports to Hong Kong, a key market of long standing, rose 7 percent while those to Singapore, another market of growing importance, expanded 61 percent.

Further brightening the picture as the all-time high of 3.2 million cartons to Canada-an increase of 600,000 from the year earlier.

While these gains were remarkable, they were overshadowed by the sensational performance in Taiwan. On August 1, 1979 Taiwan liberalized its import policy for apples. U.S. exporters, mostly in the Pacific Northwest, responded quickly, moving 3.4 million cartons to Taiwan. Value of these sales totaled $41.6 million or $12.26 per equivalent 42-pound carton. In the preceding five seasons, U.S. apple exports to this market averaged a mere 134,000 cartons.

A sizable increase was expected following Taiwan's decision to liberalize its import policy, but the final U.S. export volume exceeded expectations. Prior to liberalization, Taiwan's limited import volume drew fantastically high retail prices-sometimes as much as U.S. $1.75 or U.S. $2 per apple.

With liberalization, many importers sensed an opportunity for large profits. As a result, many newcomers entered the importing business.

In addition, some established importers of hard goods with no experience in handling perishables got into the market. The result: skyrocketing imports.

Can the U.S. export performance in Taiwan be repeated in the 1980/81 season? This is perhaps the major factor in projecting the quantity of U.S. apple exports for 1980/81. A region-by-region survey follows.

<u>Far East</u> The big export question is this area centers on Taiwan. Because of the market turbulence last season, those traders

who experienced unprofitable ventures are likely to drop by the wayside this season. As a result, a degree of stability should return to the market, and shipments of U.S. apples should take a more orderly flow.

While the 1980/81 projection remains conditional at this point, U.S. apple exports to Taiwan should be down from 3.4 million cartons in 1979/80. Other markets in the Far East and the Pacific should show a slight gain from the 1.6 million cartons in 1979/80.

Canada The large increase in the export volume to Canada last season still defies pinpoint measurement. Costs may have had a bearing on the record flow of U.S. apples to our northern neighbor, but the most plausible reason probably rests on the fact that Canada's per capita consumption of fresh produce is rising rapidly. The so-called "fresh approach" seems to be catching fire there as in many other countries around the world.

But the export projection for U.S. apples to Canada this season is guided only by the distribution of the Canadian crop. In view of the anticipated crop increases in Ontario and to a lesser extent in Quebec, movement of U.S. apples will probably be somewhat less than last season's.

Western Europe The apple crop in this area is down very slightly to 13.4 million metric tons in 1980/81, with most of the drop occuring in the southern European countries, especially Spain and Greece.

The combined crops in the three key exporting countries-France, Italy, and the Netherlands-are almost on par with last year's production of 4.3 million tons.

Turning to the key market countries, apple production in the United Kingdom is expected to be about 358,000 tons, about 1 percent below the 1979/80 outturn.

Market prices in the United Kingdom were exceptionally low this past season. As a result, the National Farmers' Union has been waging a vigorous campaign, claiming that the very survival of the English apple is at stake. Charges of unfair competition against French goldens have been denied in France.

In 1980/81, U.K. growers hope the low prices of last season will not be repeated because of an agreement with French exporters to limit shipments of French goldens to only the higher grades, with bulk shipments excluded.

In 1979/80, French apples represented a staggering 87 percent of the total U.K. imports during the winter months.

In Norway, the apple crop this season is expected to top last season's total, so the opening of the import market was delayed. However, importers remain confident that the import level will remain high-possibly around 200,000 cartons. A small plus for

U.S. apples lies in Sweden where the commercial crop is estimated at 33 percent below last season's output.

In total, U.S. shipments of apples to Western Europe are expected to be the same as the 1.1 million cartons moved in 1979/80, with the major markets being Sweden, Norway, Finland, and the United Kingdom.

Mexico and Central America Mexico's crop loss from a severe frost last spring has been estimated at 20-25 percent by Conafrut, a national fruit organization. Although increased imports may result from this shortfall, Government efforts to provide relief to growers through higher prices could mean a lower-than-expected import level. How much goes across the border is the most important factor in projecting U.S. apple exports to this region.

Though still small, markets of the Central American bloc have shown a modest growth over the past few years in purchasing apples from the United States.

The 1980/81 outlook calls for U.S. apple exports to exceed last season's level of 744,000 cartons.

Caribbean Collectively, the islands in the Caribbean have been showing rather steady growth since 1973 in their takings of U.S. apples. The generally increasing tempo of tourist traffic in this area is largely responsible for this increase, especially in the Netherlands Antilles and Trinidad. The trend should continue in 1980/81 with U.S. apple exports topping the season-earlier shipments of 343,000 cartons.

South America Colombia has been the shining import star in this area. Since its import liberalization of 1976, there has been a buildup every year in U.S. apples to this market, reaching a high of 289,000 cartons last season.

Elsewhere in South America, the outlook is not as bright. Brazil remains-and is expected to stay-a small market for U.S. apple exporter while Venezuela continues as an erratic market.

U.S. apple exports to South America are almost certain to rise substantially above the previous season's figure of 676,000 cartons.

Middle East For three straight seasons, moderate gains in U.S. exports to Middle Eastern markets have been posted, and the overall volume is fairly high. Last season, 1.3 million cartons of U.S. apples were shipped to the region, with Saudi Arabia taking about 1 million and the United Arab Emirates most of the balance. The recent trend should continue in 1980/81.

Africa This region represents only a small slice of total U.S. apple exports. U.S. exports to this area should approximate last season's performance of about 64,000 cartons.

LABORATORY REPELLENCY OF ORCHARD PESTICIDES TO THE MITE PREDATOR AMBLYSEIUS FALLACIS

Robert Hislop[1], Peter Auditore[2], Bonnie Weeks[2]
and Ronald Prokopy[3]

For the past four years, we have been evaluating the impact of orchard pesticides on the survival of *Amblyseius fallacis*, the most important spider mite predator in Massachusetts apple orchards (FRUIT NOTES 43(4): 5-8; 43(5): 14-18; 44(5): 6-8). In our laboratory and field trials, we found that *A. fallacis* could readily survive exposure to field rates of several key orchard pesticides, including phosmet, azinphosmethyl, endosulfan, and captan. However, in certain commercial orchards sprayed with these materials, we observed occasional buildup of red or two-spotted spider mites. We theorized that application of such pesticides at a time when spider mites were building could actually enhance buildup by repelling *A. fallacis* from treated areas. Recently, we explored this possibility of pesticide repellency to *A. fallacis* in laboratory tests, and we present here our findings.

Our tests were conducted in the following manner. First, we sprayed one half of a 2-inch-diameter bean leaf disc with pesticide and allowed the residue to dry. Next we placed 15 two-spotted mite eggs (previously sprayed with the same pesticide) on the sprayed half of the disc, and placed 15 unsprayed eggs on the unsprayed half. After two hours, we placed one adult female *A. fallacis* on each disc, incubating all discs for 14 days. Each day during the incubation period, we recorded three types of information: (a) the number of two-spotted mite eggs consumed by *A. fallacis* (consumed eggs were replaced daily); (b) the location of each *A. fallacis* female every two hours from 8:00 AM to 6:00 PM; and (c) the number and location of all eggs laid by *A. fallacis*. We replicated each test 14 times.

Our results are presented in Table 1. Compared with the unsprayed halves of bean leaf discs, the presence of residues of phosmet, azinphosmethyl, captan, or Dikar on the sprayed halves resulted in substantially lower consumption of spider mite eggs by *A. fallacis* females. Residues of endosulfan, dodine, inert carrier powder, or distilled water had little or no such effect. In addition, residues of phosmet, azinphosmethyl, captan, and Dikar resulted in substantially less oviposition and substantially reduced presence of *A. fallacis* on treated sites. To a lesser extent, this was true of endosulfan and inert carrier powder residues as well.

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Together, these results show that residues of commercially-formulated wettable powder applications at orchard rates of phosmet, azinphosmethyl, captan, and Dikar have substantial repellent effects on _A. fallacis_ females. This could have negative implications for integrated pest management programs involving biological control of spider mites by _A. fallacis_. For example, summer application of any of these four materials at a time after _A. fallacis_ has entered the trees could affect the food supply available to _A. fallacis_ by rendering spider mite eggs less palatable, thus reducing the rate of increase in the _A. fallacis_ population. In addition, pesticide repellency could force _A. fallacis_ into less well sprayed parts of the tree or out of the tree altogether, thereby allowing more rapid buildup of pesticide resistant spider mites in the well sprayed parts. Further research under field conditions is needed to determine the true impact of pesticide repellency on _A. fallacis_.

Table 1. Influence of pesticide residues on prey egg consumption, oviposition, and location of _Amblyseius fallacis_ on bean leaf discs.

Pesticide	Disc half	% prey eggs consumed	% _A. fallacis_ eggs laid	% _A. fallacis_ observed locations
Phosmet 50 WP	Sprayed	38.3	24.5	31.4
	Unsprayed	61.7	75.5	68.6
Azinphosmethyl 50 WP	Sprayed	31.2	25.7	29.6
	Unsprayed	68.8	74.3	70.4
Endosulfan 50 WP	Sprayed	47.1	38.0	34.3
	Unsprayed	52.9	62.0	65.7
Captan 50 WP	Sprayed	37.3	12.4	22.4
	Unsprayed	62.7	87.6	77.6
Dodine 65 WP	Sprayed	51.1	55.3	55.4
	Unsprayed	48.9	44.7	44.6
Dikar 80 WP	Sprayed	31.3	4.7	22.3
	Unsprayed	68.7	95.3	77.7
Inert carrier powder	Sprayed	47.7	33.8	41.7
	Unsprayed	52.3	66.2	58.3
Distilled water	Sprayed	50.1	44.7	46.4
	Unsprayed	49.9	55.3	53.6

SUMMARY OF APPLE GROWING QUESTIONNAIRE

William J. Lord
Department of Plant and Soil Sciences

We frequently are asked questions by pomologists and fruit growers from other areas about apple growing practices in Massachusetts. In most instances we think we know what growers are doing but, this may not be true. Thus, we asked growers this past January to complete a short questionnaire. We were pleased that 55% of the apple grower members of the Massachusetts Fruit Growers' Association answered the questionnaire and wish to share the results with our readers. We have listed the questions below and under each have summarized the response to the question and added some comments of our own.

1. What do you consider the ideal height of apple trees on M7a or MM106?

   The tree height considered "ideal" by growers averaged 12.4 feet with 68% of the answers falling between 10 to 14.8 feet.

   At our Horticultural Research Center in Belchertown, average height of mature Delicious trees on M7 is 11.5 feet in one block and 13 feet in another, although we believe that spur-type trees of the same cultivar on this rootstock could be easily maintained at 9 feet (height of central leaders). In contrast, tree height of 9 feet is too low for the natural vigor of non-spur Delicious on MM106 at our Research Center and watersprouts have been troublesome. However, we are maintaining Idared and Spartan trees on M.7 at 8.2 feet and 9 feet, respectively, without difficulty.

2. Do you use chemical thinners (yes or no)? If the answer is yes, which chemical thinner do you use on McIntosh ________________; on Delicious ________________?

   Ninety-six percent of the growers stated that they use a chemical thinner on McIntosh. Of those using a chemical thinner: 54% used carbaryl (Sevin); 15% used naphthaleneacetamide (NAAm); 13% used naphthaleneacetic acid (NAA); and 18% used carbaryl and/or NAAm, carbaryl and/or NAA, or NAAm or NAA.

   It is obvious that the growers prefer carbaryl for thinning McIntosh trees, possibly because of convenience (Delicious and McIntosh are usually in the same block of trees and carbaryl is the only thinner suggested for Delicious) or because of less risk of overthinning than when using an application of NAAm or NAA. Nevertheless, NAAm and NAA do have some direct flower-promoting capabilities, an attribute not shared by carbaryl, and will thin later in the season than carbaryl.

A surprising 90% of the growers used a chemical thinner on Delicious. This certainly would indicate that at least in some years, lack of fruitfulness is not a problem as frequently mentioned with Delicious in many fruit growing areas of the United States.

Of the growers using chemical thinners on Delicious: 85% used carbaryl, 9% used NAA, and 6% used carbaryl or NAA, or carbaryl or NAAm. We do not recommend the use of NAA or NAAm on Delicious because following their use many small seedless fruits may persist on the tree.

3. Do you apply a growth regulator to prevent pre-harvest drop (yes or no?) If the answer is yes, what material do you use on McIntosh, on Delicious?

As expected most growers (98%) used a growth regulator to prevent pre-harvest drop of McIntosh. Of them, 93% used Alar-85* and 7% used NAA. Only 51% of the growers used a growth regulator to prevent pre-harvest drop of Delicious, and of these, 93% used Alar-85*, 3% used 2,4,5-trichlorophenoxypropionic acid (2,4,5-TP), and 3% used either Alar-85* or 2,4,5-TP.

We caution growers to avoid rates in excess of 1.5 lbs. of Alar-85* per acre (assuming 300 gallons/A of dilute spray) on Delicious because of possible fruit size suppression and fruit flattening. On trees where fruit size may be small, 2,4,5-TP is suggested rather than Alar-85*. At 20 ppm, 2,4,5-TP will reduce rate of drop for about 4 weeks. This growth regulator is generally applied in early October before frost injures the leaves.

4. Have you used Promalin* within the last 2 years to elongate Delicious (yes or no)? Do you plan to use Promalin* next spring (yes or no)?

Forty percent of the growers indicated that they had used Promalin* on Delicious. Of the growers that have used Promalin*, 64% stated that they plan to use this growth regulator again. Nine percent of the growers who have not used Promalin* plan to use it, weather permitting.

The author considers the results of Promalin* to be very unpredictable under Massachusetts conditions. It can increase the typiness of Delicious but frequently the fruit response is slight and this growth regulator has fruit thinning capabilities if misused.

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* Trade Name

5. What kind of fertilizer do you use in bearing apple orchards (a complete fertilizer, ammonium nitrate or what)?

Fifty-six percent of the growers applied a complete fertilizer and 30% of the growers used calcium nitrate ($Ca(NO_3)_2$.

Perhaps some growers like the convenience of obtaining and applying a complete fertilizer rather than purchasing a "bulk" mix containing nitrogen, potassium and minor elements such as boron. However, cost could be reduced by using fertilizer containing no phosphorous (P) since there is no evidence that our apple trees need this element beyond what is present in the soil.

P deficiency can reduce tree growth and yield and in several parts of the world it has been shown to be associated with fruit breakdown in storage. Nevertheless, there has been very little evidence of P deficiency in fruit. In fact, Drake and Bramlage of our Department of Plant and Soil Sciences recently found that high levels of P in apples, especially in combination with low levels of calcium, greatly increased breakdown of apples during storage.

Soil applications of $Ca(NO_3)_2$ are being used to enhance the Ca levels in fruit. Nevertheless, we have no evidence that $Ca(NO_3)_2$ in comparison with ammonium nitrate (NH_4NO_3) or potassium nitrate will increase fruit Ca levels. $Ca(NO_3)_2$ unlike NH_4NO_3 will not acidify the soil but NH_4NO_3 is a more economical source of nitrogen (N). We believe that the cost and the amount of N applied to apple trees is more important than the source except under unusual situations.

6. Do you apply calcium chloride sprays to improve the calcium level in your trees and fruit (yes or no)?

Changes in cultural practices frequently are slow, thus it was a pleasant surprise to note that 71% of the growers are using calcium chloride sprays.

7. Do you have early maturing apples (yes or no)? If the answer is yes, have you applied ethephon (Ethrel*) within the last 2 years to advance the maturity of your early maturing apples (yes or no)?

Of the growers having early maturing varieties, 47% used ethephon to advance their maturity.

8. Have you used within the last 2 years ethephon (Ethrel*) to advance the maturity of McIntosh apples (yes or no)? What % of your McIntosh crop was treated?

The author was surprised to find that more growers (64%) were applying ethephon to McIntosh than to early maturing varieties.

The response also indicated a rapid acceptance of this relatively new growth regulator as a marketing tool for McIntosh.An average of 8% of the McIntosh crop is being sprayed with ethephon by the growers.

9. Have you planted McIntosh (non-spur) apple trees on M7 or M7a within the last 10 years (yes or no)? What tree spacing or spacings did you use? If you were planting the same trees would you used wider or closer spacings?

   The tree spacing used by growers averaged 18 feet apart in the row with 68% of the answers by the growers falling between 14.4 feet and 21.6 feet. Between row spacing averaged 25.1 feet with 68% of the answers falling between 20.4 feet and 29.8 feet. The percentage of growers stating that they now would plant the trees closer was about comparable to the percentage favoring wider spacings, and 41% were satisfied with present planting distances. Thus, it is obvious that there is no trend for close spacing of trees on M.7 rootstock.

   We have a heavy soil at our Horticultural Research Center and tree spread of our mature non-spur trees averages from 16 to 19 feet depending upon the variety and block.

10. Do you have trees on M26 rootstock (yes or no)? What varieties? Are you sufficiently satisfied with the trees and plan to plant more?

   Forty percent of the growers had trees on M26 rootstock and of those that had trees on this rootstock only 39% were sufficiently satisfied with the trees and plan to plant more.

   There are probably several reasons why so many growers are not satisfied with tree growth and fruitfulness on M26. This rootstock reacts more to unfavorable growing conditions than those on more vigorous clonal rootstocks. Trees within a block may be extremely variable in vigor, with some of them weak and difficult to train. Spur-type trees appear weak when planted on light soils, as do Cortland and Empire on this rootstock. Trees on M26 require good deep soils with good drainage and waterholding capacity and even on these soils they may require temporary support or permanent support on some sites.

A Comparison Among States

The questionnaire also was sent to Maine and Connecticut growers by the Extension Fruit Specialists in these states. The comparisons among Massachusetts, Maine and Connecticut growers regarding the answers on the questionnaire are of interest, and the differences regarding the practices are probably due to climatic conditions and

and emphasis given by Extension and Research personnel in these states.

The growers from the 3 states virtually agreed on the answer to the question concerning the "ideal" height of apple trees on M7a or MM106. The tree height considered ideal by Connecticut, Maine and Massachusetts growers averaged 12.6, 12.1 and 12.4 respectively.

Sevin was more frequently used in Maine than in Massachusetts for chemical thinning of McIntosh, but the reverse was true regarding the use of NAAm. A higher percentage of Massachusetts and Maine growers thinned Delicious than did growers in Connecticut.

The pre-harvest drop control practices were similar among the growers in the 3 states except that none of the Maine growers used 2,4,5-TP for drop control on Delicious.

Only 16% of the Maine growers had used Promalin* within the last 2 years to elongate Delicious in comparison to approximately 40% of the Massachusetts and Connecticut growers.

The fertilizer formulations used varied strikingly among the 3 states. An orchard mix (6-0-16 formulation) was used by 84% of the Maine growers and none mentioned the use of calcium nitrate $(CaNO_3)_2$. Fifty-six percent of the Massachusetts growers applied a complete fertilizer and 30% of the growers mentioned using $CaNO_3$. Eighty-four percent of the Connecticut growers used a complete fertilizer but only 5% mentioned the use of $CaNO_3$.

Calcium chloride sprays to improve the calcium level in apple fruits were used by only 11% of the Maine growers and 28% of the Connecticut growers in comparison to 71% of the Massachusetts growers.

A higher percentage of Maine growers (75%) used ethephon to advance the maturity of early maturing varieties than did growers of Massachusetts (47%). Only 26% of the Connecticut growers used ethephon to advance fruit maturity on early maturing varieties. About 64% of the Maine and Massachusetts growers and 42% of the Connecticut growers used ethephon to advance the maturity of McIntosh.

The tree spacing for non-spur McIntosh apple trees on M7 or M7a used by Connecticut, Maine and Massachusetts growers averaged 16.2 feet x 23 feet, 15.7 feet x 20.4 feet, and 18 feet x 25.1 feet, respectively. Some of the Maine growers indicated that they had planted McIntosh on M7 too closely with spacings of 9 feet x 14 feet, 10 feet x 16 feet, 12 feet x 18 feet, 10 feet x 18 feet, and so forth. Therefore, the average planting distance used in Maine for McIntosh on M7 was considerably lower than that used in Massachusetts.

Slightly more growers in Maine (52%) and Connecticut (53%) had trees on M26 rootstock than did Massachusetts growers (40%). The percentage of growers stating that they were sufficiently satisfied with their trees on M26 and plan more was relatively small (averaging 30 to 39% among the states) because of dissatisfaction with tree performance, or because the plantings are too young to be adequately evaluated.

GRADE DEFECTS ON MCINTOSH APPLES: STRIP VERSUS SELECTIVE PICKINGS

Henry M. Bahn[1], Janice O'Kelley[2] and Glenn Morin[3]

In a previous study of causes of defects on McIntosh apples (FRUIT NOTES, Volume 45, No. 5) we noted a large variation in packout rates ranging from 96.7 percent to 46.6 percent. We felt this variation was due at least in part to the fact that the 1979-1980 samples included both strip picked and selectively picked (picked for color) fruit. In repeating the study this past year we separated the fruit into 2 categories: strip picked and selectively picked apples.

Sampling Procedure

We used the same general sampling format as was employed in the previous study. A total of 16 packing sheds were visited between January and March 1981 and the amount of fruit packed, cullage and the reason for culling were noted. A total of 3,930 bushels were packed and 885 bushels were culled for an overall packout rate of 77.5 percent. The culls were inspected in the same manner as in 1979-80 although the volume of culls in 1981 did not allow the inspector to check each apple. Depending on the volume of culls and the length of the sampling period, the inspector checked from 15 to 100% of the culls to determine the reason for rejection. An average of 69% of the culls were physically inspected. The same individual inspected the culls in 1980 and 1981.

Results

Composition of defects. The cull rate and reasons for culling were similar for 1979-80 and 1981 (Table 1). The largest differences between the years were in color and size, russeting and "other". The large difference in the "other" category can be traced to hail damage and to soot due to malfunctioning refrigeration equipment at one packing shed in 1981.

Insect and disease damage totaled 0.9% of total fruit packed in 1979-80 and 1.0% in 1981. This indicates the importance growers place on controlling pests and disease and of the effectiveness of preventative measures.

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Table 1. Composition of defects on McIntosh apples at grower packing sheds in 1979-80 and 1981.

Defect	Culls showing this defect 1979-80 (%)	Culls showing this defect 1981 (%)	Total fruit culled because of this defect 1979-80 (%)	Total fruit culled because of this defect 1981 (%)
Insect damage	1.8	2.9	0.4	0.6
Disease damage	2.2	1.5	0.5	0.4
Color(US No.1)	16.9	22.5	3.7	5.3
Size (2-1/4")	46.0	34.5	10.3	7.5
Bruise	8.1	9.9	1.8	2.6
Stem puncture	9.9	5.5	2.2	1.2
Mechanical[z]	8.1	8.3	1.8	1.7
Russeting	5.7	1.9	1.3	0.5
Other[y]	1.3	13.0	.2	2.5
Totals	100.0	100.0	22.2	22.3

[z] Includes limb rub, cuts and cracks.

[y] Includes misshapen, bitter pit, sun scald, hail damage, rodent damage, storage freeze and soot.

Physical damage (bruise, mechanical and stem puncture) accounted for 23.7% of culled fruit (5.5% of total fruit packed) in 1981. This is just slightly better than in the 1979-80 study. We feel this is an area where damage could be reduced by closer monitoring of picking, handling and grading practices.

<u>Strip picked vs. selectively picked--some economic comparisons.</u> Separating the samples into strip picked and selectively picked (picked for color) categories did not, as we had hoped, account for the variation in packout rates. Although selectively picked apples did have a higher packout rate than the strip picked (82.8% vs. 72.6%) the variance for selectively picked fruit was greater. Packout rates for selectively picked fruit ranged from 96.6% to 42.2% while the range for strip picked was 88.9% to 54.4%. The large variation on the packout of selectively picked fruit was due to one sample with considerable handling damage and another with hail damage far in excess of what might be considered normal.

An examination of Tables 2 and 3 reveals a substantial difference in lost revenue due to the cullage of apples. Selectively picking fruit (Table 2) resulted in an additional $451.20 per acre from undamaged fruit. As might be expected, selectively picked apples had a lower incidence of culling for color, 15.1% of the culled fruit compared with 29.3% for strip picked fruit. Note that this does not necessarily mean that selectively picked orchards had less color-rejected fruit; the pickers simply left it on the trees while strip picked rejects were picked, stored, graded and culled. In order to assess the economics of strip versus selective picking, growers must consider several points including the skill and wage rates of pickers, storage capacity and costs, and skill and wage rates of grader/packers. The grower must consider the cost of picking, storing and grading the additional substandard fruit against the costs of selectively picking.

By comparing Tables 2 and 3 the reader can note a similarity in cullage rates for most defects other than color and size. (Presumably selective pickers leaves more undersized apples on the trees than do strip pickers.) In nearly every category the selectively picked fruit has slightly fewer culls and correspondingly less lost revenue due to defects.

In the area of physical damage (bruise, stem puncture and mechanical) strip picked fruit had 24% more of total fruit culled than the selectively picked and the additional revenue lost was $57.60 per acre. Strip pickers may hurry a bit more than selective pickers and may thus do more physical damage. Although most growers feel they can effectively control their pickers, they may need to monitor them closer to reduce damage.

The similarities between strip and selectively picked fruit damage for other categories including insect and disease damage, russeting and "other" (misshapen, bitter pit, sun scald, hail, rodent and refrigeration damage) are as expected since these defects are not affected by picking and handling procedures.

Conclusion

We feel that growers have the potential to increase packout rates, and thus net revenue, by carefully evaluating causes of defects, determining which defects may be reduced and taking the necessary action at the proper time to insure that less defective fruit is picked, stored, and graded. After color and size, both of which are difficult for the grower to control, physical damage is the most often occurring and most expensive defect. Close scrutiny of picking, handling and grading operations and an understanding of the additional costs of handling and storing defective fruit may enable growers to increase returns by raising their packout rates.

Table 2. Revenue loss on cull McIntosh apples -- Selectively picked, 11 orchards, 1981

Defect	Culls showing this defect (%)	Total fruit culled due to defect (%)	Culls per acre[z] (bu)	Value if undamaged[y] ($)	Cull value[x] ($)	Lost revenue/acre due to defect[w] ($)
Insect damage	2.9	0.5	3.0	28.50	4.50	24.00
Disease damage	1.7	0.4	2.4	22.80	3.60	19.20
Color	15.7	3.2	19.2	182.40	28.80	153.60
Size	37.0	6.0	36.0	342.00	54.00	288.00
Bruise	10.8	2.6	15.6	148.20	23.40	124.80
Stem puncture	6.5	1.0	6.0	57.00	9.00	48.00
Mechanical	8.4	1.3	7.8	74.10	11.70	62.40
Russeting	2.3	0.5	3.0	28.50	4.50	24.00
Other	14.7	2.5	15.0	142.50	22.50	120.00
Total	100.0	18.0	108.0	1,026.00	162.00	864.00

[z] Assumes 600 bu/acre yield.

[y] @ $9.50/bu.

[x] @ $1.50/bu.

[w] Column 4 minus column 5.

Table 3. Revenue loss on cull McIntosh apples -- strip picked, 6 orchards, 1981

Defect	Culls showing this defect (%)	Total fruit culled due to defect (%)	Culls per acre[z] (bu)	Value if undamaged[y] ($)	Cull value[x] ($)	Lost revenue/acre due to defect[w] ($)
Insect damage	2.9	0.7	4.2	39.90	6.30	33.60
Disease damage	1.2	0.3	1.8	17.10	2.70	14.40
Color	29.3	8.2	49.2	467.40	73.80	393.60
Size	32.0	9.0	54.0	513.00	81.00	432.00
Bruise	9.0	2.6	15.6	148.20	23.40	124.80
Stem puncture	4.5	1.3	7.8	74.10	11.70	62.40
Mechanical	8.1	2.2	13.2	125.40	19.80	105.60
Russeting	1.5	0.4	2.4	22.80	3.60	19.20
Other	11.5	2.7	16.2	153.90	24.30	129.60
Total	100.0	27.4	164.4	1,561.80	246.60	1,315.20

[z] Assumes 600 bu/acre yield.

[y] @ $9.50/bu.

[x] @ $1.50/bu.

[w] Column 4 minus column 5.

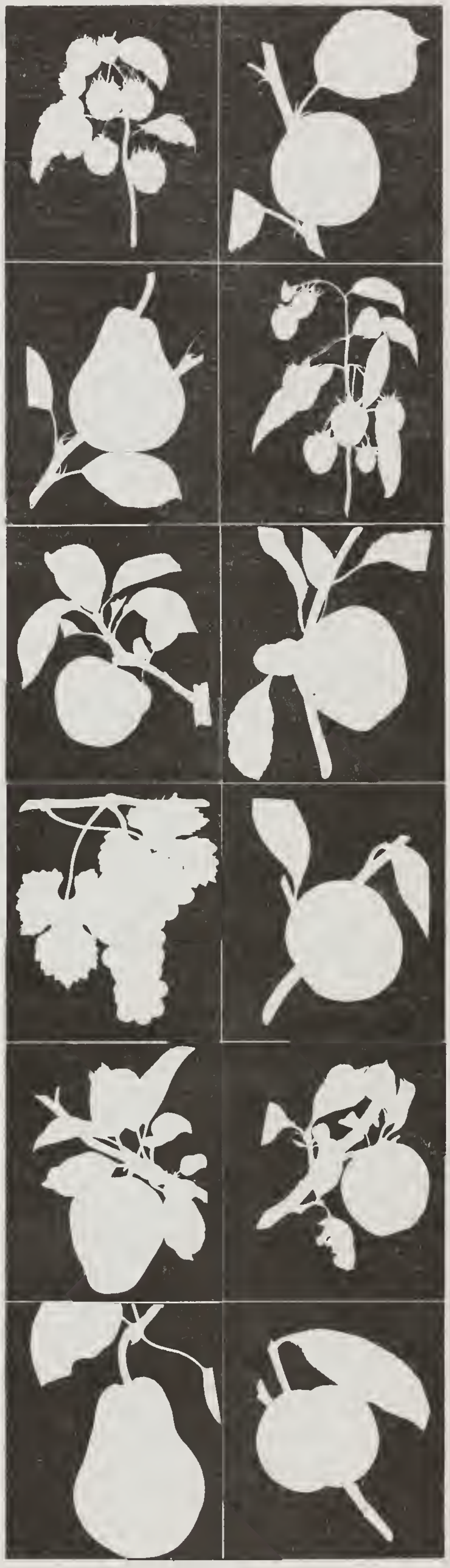
Cooperative Extension Service
U. S. Department of Agriculture
University of Massachusetts
Amherst, MA 01003

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE



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Publications available

Proceedings of the New England Small Fruit Meetings which was held at Concord, New Hampshire in January, 1981 may be obtained by making a check payable to the University of New Hampshire and send it to Prof. W. G. Lord, Department of Plant Sciences, University of New Hampshire, Durham, NH 03824.

The Strawberry: Cultivars to Marketing. Edited by Norman F. Childers. This publication resulted from the 1980 National Strawberry Conference held in St. Louis, Missouri. The book includes over 40 papers presented by outstanding breeders, researchers and growers. This book is an invaluable reference and should be included in the library of anyone interested in the strawberry. It is obtainable from Horticultural Publications, 3906 N.W. 31st Place, Gainesville, FL 32601. The cost of $21.90 includes postage and handling.

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ORIGIN OF SOME OLD AND NEW APPLE VARIETIES

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There is a continuing request for information as to the origin of both old and new apple varieties. Most of these requests come from operators of farm markets who are frequently asked such questions by their customers.

Most of the apple varieties planted in this country originated here, but the history of many is obscure and except for varieties more recently introduced, few came into existence as as the product of the plant breeder. Most of the varieties originated as chance seedlings and were discovered and introduced into cultivation by some observer or admirer of the fruit. McIntosh, Delicious, Wealthy, Northern Spy and Baldwin are examples of commercial varieties that originated as such chance seedlings.

The following is a list of some of the apple varieties being sold in Massachusetts and their origin. Where varieties have resulted from a controlled cross between two other varieties, the origin of such varieties is expressed by placing the letter "X" between the parent varieties. For example, the Milton variety is a cross between Yellow Transparent and McIntosh.

Akane	Jonathan X Worcester Pearmain. Introduced by the Fruit Tree Research Station, Aomovi, Japan in 1970. Also listed as TohoKu #3, Primerouge and Prince Red.
Baldwin	A chance seedling discovered about 1740 on a farm in Wilmington, Massachusetts. It was widely planted in Eastern Massachusetts as early as 1784.
Cortland	Ben Davis X McIntosh. This cross was made in 1898, selected in 1911 and introduced (named) in 1915 by the New York State Agricultural Experiment Station, (N.Y.S.A.E.S.), Geneva
Delicious	A chance seedling discovered in 1881 in Peru, Iowa. It was named and introduced by the Stark Brothers Nurseries in 1895.
Early McIntosh	Yellow Transparent X McIntosh. The cross was made in 1909, selected in 1921 and introduced in 1923 by the N.Y.S.A.E.S., Geneva.
Empire	McIntosh X Delicious. An open-pollinated cross made in 1945. It was selected for trial in 1954 and introduced in 1966 by the N.Y.S.A.E.S., Geneva.
Golden Delicious	Originated as a chance seedling in Clay County, West Virginia about 1895. It was named and introduced by the Stark Brothers Nurseries in 1916.
Idared	Jonathan X Wagener. Was selected in 1935 and introduced in 1942 by the Idaho Agricultural Experiment Station, Moscow.
Jerseymac	New Jersey 24 X Julyred. The cross was made in 1956 and introduced in 1971 by the New Jersey Agricultural Experiment Station, (N.J.A.E.S.), New Brunswick
Jonagold	Golden Delicious X Jonathan. The cross was made in 1943, selected in 1953 and named in 1968 by the N.Y. S.A.E.S., Geneva.
Lodi	Montgomery X Yellow Transparent. The cross was made in 1911, selected in 1922 and named in 1924 by the N.Y.S.A.E.S., Geneva.
Julyred	N.J.8 X [Melba X (Williams X Starr)]. Selected in 1955 and introduced in 1962 by the N.J.A.E.S., New Brunswick.
Macoun	McIntosh X Jersey Black. The cross was made in 1909, selected in 1922 and introduced in 1923 by the N.Y. S.A.E.S., Geneva.

<u>Melba</u>	An open pollinated seedling of McIntosh selected in 1909 and introduced in 1924 by the Canada Dept. Agricultural Experiment Station, Ottawa.
<u>McIntosh</u>	Originated as a chance seedling in Dundas County, Ontario, Canada. Propagation of this variety began in about 1870.
<u>Milton</u>	Yellow Transparent X McIntosh. The cross was made in 1909, selected in 1920 and introduced in 1923 by the N.Y.S.A.E.S., Geneva.
<u>Mollie's Delicious</u>	(Golden Delicious X Edgewood) X (Red Gravenstein X Close). The cross was made in 1948, selected in 1956 and introduced in 1966 by the N.J.A.E.S., New Brunswick.
<u>Mutsu</u>	Golden Delicious X Indo. The cross was made in 1930 and the cultivar was introduced by the Fruit Experiment Station, Aomori, Japan in 1948. It was introduced into the United States in 1948. Called Crispin in England.
<u>Northern Spy</u>	Originated as a chance seedling in East Bloomfield, Ontario County, New York about 1800.
<u>Paulared</u>	Originated as a chance seedling. Discovered in an orchard in Sparta, Michigan in 1960 and introduced in 1967.
<u>Puritan</u>	McIntosh X Red Astrachan. The cross was made in 1929 and the cultivar was introduced in 1953.
<u>Quinte</u>	Crimson Beauty X Red Melba. A selection of the Canada Department of Agriculture Research Station, Ottawa. Introduced in 1964.
<u>Red Astrachan</u>	This is a Russian variety imported by the Massachusetts Horticultural Society in 1935.
<u>Rhode Island Greening</u>	Originated as a chance seedling probably in the vicinity of Newport, Rhode Island in about 1750.
<u>Rome Beauty</u>	Originated as a chance seedling in Lawrence County, Ohio before 1848.
<u>Spartan</u>	McIntosh X Yellow Newtown. The cross was made in 1926 and introduced in 1936 by the Canada Dept. Agr. Res. Sta., Summerland, British Columbia.
<u>Spencer</u>	McIntosh X Golden Delicious. The cross was made in 1926, selected in 1938 and introduced in 1959 by the C.D.A. R.S., Summerland, British Columbia.

<u>Vista Bella</u> N.J. 77349 X Julyred. The cross was made in 1956, selected in 1962 and introduced in 1974 by the N.J.A.E.S., New Brunswick.

<u>Wealthy</u> Originated in Excelsior, Minnesota from a seed of the Cherry Crab planted about 1860.

<u>Winter Banana</u> Originated as a chance seedling on a farm in Cass County, Indiana about 1876. It was introduced in 1890.

<u>Wisconsin Viking</u> N.J. 148842 X PRI 187-4. The cross was made in 1956, selected in 1963 and introduced in 1969 by the Wisconsin Agr. Exp. Sta., Sturgeon Bay.

<u>Yellow Transparent</u> This variety was imported from Russia by the United States Department of Agriculture in 1890.

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ORCHARD MOUSE BAIT AND THE WEATHER

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One of the more common rodenticides used today for the control of orchard mice is zinc phosphide (Zn_3P_2). It is a dull gray crystaline material insoluble in water and alcohol, slightly soluble in alkalis and oil and readily degraded under various acid conditions. Because zinc phosphide is more stable under certain conditions than others, the question arose concerning how long it remains effective under various field conditions.

There are several research findings on zinc phosphide which tends to clarify the question on field stability.

1. Zinc phosphide kept in a sealed, dry condition should remain stable for 3 or more years. Grain treated baits stored under the same dry conditions should have a similar shelf life.

2. Grain baits placed out-of-doors under protected conditions can remain toxic for several months.

3. The use of oils or waxing materials in bait preparations or as an overcoating will extend the field life span of baits.

4. The major cause of loss in effectiveness of field applied baits is the physical removal of zinc phosphide by rainfall. One inch of rain can remove up to 60% of the toxicant.

5. Zinc phosphide eroded from the bait material decomposes quite rapidly in soils. Wetter the soil the faster the breakdown.

6. Under moist, humid conditions carrier grains and other materials used to present zinc phosphide tend to mold and disintegrate becoming unacceptable to mice.

With all of these conditions in mind plus the knowledge that microtus are most active on warm, sunny days the following recommendations are given:

1. Pick a series of warm, sunny days to apply orchard mouse control materials. This is particularly true if material is applied by a broadcast method.

2. Consider placing at least part of the baits under some type of protective cover....i.e., a square of roofing, a board, or 1/2 a tire to protect bait.

3. Keep a small amount of your orchard mouse bait in a dry container. If a rain of any consequence does fall, run a visual check on bait from several locations in the orchard. Compare the two; if the field applied material shows a loss of 15-20% of its zinc phosphide coating consider re-application where necessary.

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THE MEDITERRANEAN FRUIT FLY IN MASSACHUSETTS: CAN IT HAPPEN?

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Whither the Mediterranean fruit fly? This insect, picturesque to behold and so enticing to an entomologist studying its behavior and ecology, has for decades proven to be a devastating pest of fruit wherever it has become established. Will it eventually reach Massachusetts, and if so, might it establish itself here as a pest of our own locally grown fruits? Drawing upon the extensive literature published on this insect (in particular the fine article by Hagen, Allen, and Tassan in the March-April 1981 issue of California Agriculture), and upon my own research experience with the behavior of Medflies in apricot groves in Greece and coffee plantations in Hawaii and Guatemala, I will attempt here to briefly describe the biology of the Medfly and to predict its future in Massachusetts.

The Medfly is a close relative of the apple maggot fly. Both are members of the same subfamily, and both have similar behavior. The main differences are twofold: (1) the Medfly attacks 253 different species of fruits, nuts, and vegetables, while the apple maggot fly attacks only six, and (2) the Medfly cannot readily survive cold conditions while the apple maggot fly can easily overwinter in very cold regions or as pupae in the soil.

What are the principal fruits grown in Massachusetts which are potential favorable hosts for the Medfly? The most favored one would probably be peaches, followed (but not necessarily in order) by nectarines, apricots, plums, cherries, apples, and pears. Occasional host fruits include grapes, peppers, and tomatoes.

Where did the Medfly come from? It originated in tropical West Africa, spread to north and south Africa, and then in the 1800's moved into Spain, France, Italy, Greece, and the Middle East. It arrived in South America in 1901, Hawaii in 1907, Costa Rica in 1955, and northern Guatemala in 1977. It has remained firmly established in all of these countries ever since.

The first record of Medfly infestation in the USA occurred in 1929 in Florida. Since then, it has re-entered Florida thrice more (1956, 1962, and 1963), Texas in 1966, the Los Angeles area in 1975 and again in 1980, and finally, in June of 1980, the Santa Clara County area of Central California. Biochemical genetic analysis studies suggest that the flies which entered Santa Clara County probably came from Central or South America.

Except for this last infestation, the Medfly in the USA has in each case been successfully eradicated through ground or aerial application of insecticide bait sprays, aided by fruit stripping. In the present central California outbreak, an attempt was made to achieve eradication through a combination of sterile male releases to render female eggs infertile (more than 100 million sterile flies per week were released for several months), stripping of susceptible fruits from plants, and ground applications of malathion bait sprays. Because these combined techniques did not prove successful, state and federal agencies have been recently obliged to resort to the only proven method of eradicating Medflies from substantial pockets of infestation in the USA: aerial application of malathion bait sprays.

This article is not aimed at debating the merits of aerial application of pesticide for Medfly eradication vs. the possible injury that may result to those few individuals which may be highly susceptible to deleterious effects of malathion (as with bee stings, we can expect purely on the basis of probability that a small percentage of people in every population are inordinately susceptible to the effects of potentially harmful materials entering their system). Suffice it to say that if the Medfly cannot be contained within its present bounds, the amount of pesticide application then necessary to prevent fruit injury in California and possibly other states and the amount necessary to fumigate fruit picked from infested areas would vastly exceed the amount presently contemplated for use in aerial bait sprays.

Why has the infestation spread so rapidly since last June to now cover more than 1000 square miles in 3 California counties? There may be 2 principal reasons. First, the Medfly in California has probably undergone 4-5 generations of reproduction and multiplication since last June. Under ideal conditions, each female can lay as many as 1000 eggs, but under normal field conditions, each probably lays only 400 eggs or so. Thus, even though half of the eggs were to yield males, a single fertile female by the fifth generation could conceivably give rise to more than 300 billion other females. Of course, given natural mortality, only a small percentage of this possible number is actually realized. Still, it has been enough to result in a major outbreak. A second factor contributing to the rapid spread is the dispersal characteristics of the Medfly. Several research studies have shown that Medflies infrequently fly more than 1 mile or so. However, many years of observing fruit fly behavior in nature in several countries have emphatically illustrated to me that under certain weather conditions, the distance of dispersal can be great, exceeding several miles. These conditions are hot, dry days with strong winds. On such days, I have observed large numbers of fruit flies leaving favorable host trees and dispersing with the wind. If some of the dispersers were to be carried into upper air currents, they could go for a very long distance. It turns out that such weather conditions have been frequent in the infested California areas this spring and summer. Thus, there is real danger of flies being carried over the mountains which presently form a barrier between the great agricultural Central Valley of California and the present areas of Medfly infestation.

Will the Medfly eventually reach Massachusetts? If the current infestation in California cannot be eradicated, the chances are good that at some time in the future, a shipment of California produce, or more likely an individual travelling from California to Massachusetts carrying a sack of infested fruit from a backyard tree, will result in introduction of the fly to our state. Although since 1955 the fly has spread by natural dispersal from Costa Rica to northern Guatemala, the chances of its spreading by natural dispersal from California or other states into Massachusetts is extremely remote.

Can the Medfly survive in Massachusetts? To answer this question, we must examine the temperature range tolerance of the Medfly. At a constant 30°F, the adults die within 100 hours, and few survive more than 12 days at 45°F. The eggs cannot develop unless the temperature is above 52°F. The larvae are incapable of growing at temperatures below 50°F. The pupa is the most cold resistant stage. But if Medfly pupae are subjected to 32°F for 4 consecutive days, or to 42°F for 10 consecutive days, few, if any, can survive. Thus, under normal winter conditions in Massachusetts, no Medflies can be expected to survive, just as they cannot normally survive in central Europe. However, should a very mild winter occur, a few individuals might possibly survive in the most temperature parts of the state, that is, areas near the ocean. Even if this were to happen, however, chances are the infestation would be wiped out by colder temperature the next winter.

To conclude, it is conceivable that should Medfly larvae in infested fruit accidentally be introduced into Massachusetts in May or June, then the adults which they produce could lay eggs in locally-grown fruits, especially stone fruits, and establish a population for one or two generations before winter sets in. This population would probably be restricted to a small area around the site of introduction. Unless there were to be a dramatic shift in climate toward very warm winters, however, it is extremely unlikely that the Medfly could become firmly established in any part of our state.

Postscript: Would it be a fair exchange if California were to send us the Medfly in return for our sending them the apple maggot fly? In fact, the apple maggot fly, for the first time ever west of the Rockies, was discovered in Oregon in 1979 and now sits just a few miles north of the California border. It could become a real threat to California apples, and numerous red sphere traps and baited yellow rectangle traps are currently in use in apple growing regions of northern California to detect any possible apple maggot flies. If there had to be an exchange between these two pests, I think we would get the better of the deal, given our cold winters.

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WHAT'S HAPPENING IN CA STORAGE RESEARCH?

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To answer this question, the Third National Controlled Atmosphere Research Conference was held July 22-24, 1981 at Oregon State University, Corvallis, Oregon. Approximately 100 people participated in this Conference, including numerous researchers from the U.S. and Canada, researchers from a number of other countries, and representatives of business with interests in CA storage. Here is a summary of the information from this Conference that I think would be of interest to Northeastern fruit growers.

A major development of CA storage of apples is the demonstration that apples can be successfully stored at about 1% O_2, with considerably better retention of quality than at the normally recommended O_2 concentrations. Research in a number of places, most notably England, Nova Scotia, and Michigan, has produced very successful results, especially on soft varieties like McIntosh. However, as Dr. E.C. Lougheed of the University of Guelph, Ontario put it: "Low oxygen storage is not for everyone. The user must be prepared to take risks." And he might have added, the user must be prepared to take a number of extra precautions and to be extra careful in storage management.

The primary risk is that storing near 1% O_2 offers extremely little margin for error. We have long known that 3% O_2 is a conservative recommendation, but it allows for some error. With low-O_2 storage, precision is essential. For example, a tiny leak in the CA sample line could cause loss of an entire room of fruit due to fermentation. Either a new sampling system must be employed or else very careful and frequent cross-checking of atmospheric composition must be made. In England, Cox's Orange Pippin rooms need to be read every hour, so they have developed automatic control systems for low-O_2 storages. However, in North America once-a-day readings appear to be satisfactory if done with sufficient precision.

Different speakers emphasized different limitations of low-O_2 storage of apples. Dr. Perry Lidster, in Nova Scotia, emphasized that only less mature apples (judged by a starch test) could be stored in low O_2; more mature ones developed a form of internal browning. He also found temperature to be critical for McIntosh, and recommends 35-36°F. Several speakers emphasized that CO_2 had to be very close to 0% with low-O_2 to avoid low-O_2 injury.

The benefit from low-O_2 storage is a much slower ripening of the fruit in CA. Dr. Lidster estimates that McIntosh can be kept 18 months in low-O_2 CA, and ones kept 6-10 months are much firmer and less ripe than ones in normal CA for the same length of time. Certainly, low-O_2 storage is something that will receive much attention in the next few years. We have no experience with it in Massachusetts, <u>but are very wary of its use in most of our storages</u>. It is clear that it can work, but it is also clear that substantial new risks are involved and only a storage operator who has an excellent storage system and who is willing to invest great care and significant risk should consider employing it at this time.

A closely related subject is that of ethylene scrubbing in CA storages. Ethylene gas is the hormone that causes apples to begin ripening and it has long been debated whether or not ethylene levels in CA storages were important. The debate exists largely because there has been no way of preventing ethylene build-up, or of scrubbing it down to a very low concentration that is not biologically active. Recently, Dr. Frank Liu and Dr. David Blanpied at Cornell University have had impressive results in maintaining McIntosh firmness during storage when they have succeeded in preventing ethylene buildup, although they have not always been successful in preventing buildup. They presently think that a commercial ethylene adsorbant plus special harvest and storage management may be commercially successful, but the cost of the adsorbant is high. They continue to test this approach. Meanwhile, at Michigan State University Dr. David Dilley is using catalytic burners to remove ethylene from storage atmospheres. His equipment is still in the experimental stage, but his results are encouraging. Perhaps "ethylene scrubbing" is approaching reality, and if so a new dimension may be added to CA storage.

In the early 1970's, a high CO_2 treatment was developed for Golden Delicious apples in Washington State. The apples are treated with a high CO_2 environment for a few weeks at the beginning of CA and they remain firmer much longer during CA. In neighboring British Columbia, Golden Delicious were severely injured by the treatment. Later tests in a number of areas showed that McIntosh were also too susceptible to injury from the treatment. Dr. George Mattus has now found that Virginia Golden Delicious can be successfully treated with high CO_2, so the treatment is now being used for the first time outside of Washington State.

In British Columbia, Dr. O.L. Lau has found that "rapid CA" is as effective as high-CO_2 treatment in retaining firmness during storage. "Rapid CA" simply means reaching CA conditions within a day or 2 after loading the room, and doing so produced fruit that were 2 lbs. firmer at removal from storage than ones that had slow pull-down. However, we believe that it is essential to thoroughly cool the fruit before sealing a room and pulling it down. "Rapid CA" would require very high cooling capacity or else a system for pre-cooling. Rapid pull-down makes good sense---but not at the expense of thorough cooling.

It should also be noted that in conventional CA, the CO_2 level is important to retention of firmness. Dr. D.H. Dewey at Michigan State showed that putting dry lime into the CA room produces softer apples by keeping CO_2 too low in the room.

Humidity in the storage is something that has been given little attention, although it has long been recognized that too high a humidity causes excess rotting and increases breakdown, while too low humidity causes excess weight loss and can cause shrivelling.

Dr. Blanpied surveyed humidity in 40 sealed Northeastern CA rooms this past year. He found that in rooms with wet coils the relative humidity averaged 89%, and in rooms with dry coils it averaged 93%. This is a substantial difference and indicates that excess weight loss is occurring in the wet coil rooms. He also found that fruit lose less water when the refrigeration coil is operated at a higher temperature, even though the system is operating over longer periods of time. Fan speeds did not affect the humidity level in storages. Humidities were about the same in 36-38^{o} rooms as in 32^{o} rooms, but it should be pointed out that more water will be lost from fruit at 36-38^{o} than at 32^{o}, even though the relative humidity is the same. Mr. D.L. Hunter of Food Plant Engineering Co., Yakima, Washington, pointed out that use of ammonia rather than Freon as the refrigerant allows operation of the coil at a higher temperature, and therefore reduces moisture loss from the fruit.

CA continues to be a storage method used almost exclusively for apples and pears. Much research continues to be done to try to find ways of using it on other commodities, but benefits are limited. Some sweet cherries are CA stored, but only for short times. A small amount of avocados are also CA stored, and studies suggest that CA storage of kiwi fruit may be successful. Peaches and nectarines can be stored successfully in CA, but it requires intermittent warming of the fruit and has not been adopted commercially.

With vegetables, cabbage is successfully stored in CA. Many other vegetables are shipped in modified atmospheric conditions although their long-term storage is not attempted. Some vegetables such as tomatoes can be CA stored for moderate lengths of time but their quality, while better than for air-stored vegetables, is not as good as that of freshly harvested produce. Research with flowers is continuing, but benefits are quite limited in most cases.

This Conference provided an excellent opportunity to re-examine the best uses of CA storage. We in the Northeast have a rather stable CA situation, but changes are always being considered and it is essential to keep abreast of current developments so that we neither get left behind nor mistakenly apply new techniques without understanding them.

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TREE FRUIT PHYSIOLOGY TRIALS UNDERWAY AT THE C.D.A. FARM OF FRELIGHSBURG, QUEBEC[1]

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Response of apple trees to mycorrhizal fungus: *In vitro* propagated apple trees of the clones Malling Merton 111 (MM111) and Malling 7 (M7) were planted in pots containing sterile chips of baked Montmorillonite clay and placed in a greenhouse. At planting time they were inoculated with vesicular-arbuscular (VA) mycorrhizal fungus (*Glomus epigaeus*), fed weekly for 15 weeks with a Long Ashton solution and watered with distilled water as needed. Tree height was measured once a week. At the end of the experiment both the total leaf area and the volume of the root system of every tree were also measured. Root samples of every tree were then stained with red Fuschin for microscopic examination.

The weekly measurements showed the heights of the M7 mycorrhizae-treated trees to be 1.7 times greater than those of the control group (Table 1).

Table 1. Mean effect of *Glomus epigaeus* on the growth of two apple rootstocks (St-Jean, Quebec, 1981).

Rootstock	Root volume (cm^3)	Leaf area (cm^2)	Plant height (cm)
M7			
treated	16.06a[z]	479.56a	38.67a
untreated	11.89a	257.05b	24.28b
M111			
treated	12.72a	392.29a	37.17a
untreated	15.83a	363.58b	36.56a

[z] Numbers in a column followed by a different letter are significantly different at odds of 19 to 1.

Similarly, after 15 weeks the total leaf area and the root volume of the former were 1.9 and 1.4 times greater than the latter, growth differences having appeared three weeks after inoculation. At the end of the experiment microscopic examination revealed that the roots of both clones of inoculated M7 trees were colonized by the fungus (Table 2). However, no growth differences were observed on the trees of the MM111 clone (Table 1).

[1] Talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association, Inc., July 15, 1981

Table 2. Mean percentage of root penetration by <u>Glomus epigaeus</u> in two clonal apple rootstocks (St-Jean, Quebec, 1981)[z].

Tree No.	MM111 rootstock	M7 rootstock
1	22[y]	70
2	23	32
3	31	47
4	30	67
5	48	23
6	61	31
7	16	93
8	62	39
9	0.7	47
$\bar{X}$	33	50

[z] No mycorrhizal colonization was observed on the control trees.
[y] Each mean represents 90 systematic microscope scannings.

These findings indicate that apple clones do not respond uniformly to a given species of mycorrhizae. This phenomenon may reflect the different phosphorus requirements of each clone since mycorrhizae increase availability of P to roots. <u>In vitro</u> propagation apple trees might benefit greatly from mycorrhizal treatments provided their genetic make-up allows for the mycorrhizal symbiosis along with the appropriate mineral nutrition regime.

<u>Training and density studies on compact apple trees</u>: The Spartan and McIntosh cultivars, grafted on M9, M7, Ott. 3 and M26, were planted at 296, 592, and 984 trees/acre and trained as slender bell, oblique palmette, Van Roechoudt palmette and free standing trees. 1980 was the fourth cropping year for the trees of this trial.

The highest yields came from the Spartan/Ott.3 trees planted at a density of 984/acre and trained as slender bell. With a net profit of $1379/acre this combination almost reached the break-even point in 1980 and yielded 20,455 lbs/acre. The second most profitable combination was that of Spartan/M9 planted at 484 trees/acre and trained in the slender bell system. It yielded 18,567 lbs/acre. The McIntosh/M9 trained in the Van Roechoudt palmette system was the poorest combination, producing only 506 lbs/acre. The free standing trees of Spartan gave an overall mean of 12, 273 lbs/acre.

Nutrition trial in a close planting of compact apple trees: Upon reaching their fourth leaf stage 'slender bell' shaped apple trees, planted at 500 trees/acre had their third cropping year in 1980. Twelve fertilizer treatments were applied at zero, low and high levels of N, P, K, Ca, Mg to the cultivar Morspur McIntosh grafted on M9, M7, Ott. 3 and M26.

The best yields of 25 lbs. per tree were obtained from the trees submitted to low N and high amounts of the other elements. The analyses revealed that the amount of elements kept increasing in the soil, as did the pH in the Ca treated plots. Mg deficiency was the prime cause of low yields and poor tree vigor. Trees on Ottawa 3 were particularly sensitive to this deficiency while those on M26 proved to be affected mostly by lack of P. A low Ca regime aggravated preharvest fruit drop. Data on fruit and leaf mineral content are not yet available.

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NOTES CONCERNING THE HARSH WINTER OF 1980-81[1]

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The winter of 1980-81 was the second most severe of this century in the province of Quebec. It was preceded by drought in June and July, 1980 and then the fruit trees received an abundance of rain in early and late fall. Thus, the trees lacked maturity at the first cold period on September 28, 1980. Unharvested fruits were frozen on the trees.

On Christmas Eve thermographs recorded -33° C for 2 hours at the C.D.A. farm at Frelighsburg. This was followed by some bark splitting. From February 16 to the 24th in 1981 we had unusually warm weather. At this time some of our apple trees grafted on M. robusta 5 started to break their dormancy with bud swelling. In March we had some sun scald injury. April was more or less normal but in May a freeze was experienced at bloom and growers used burners and irrigation systems to protect their apple crop. Regardless of the fact that there were long periods without snow cover the frost penetration in the ground was not abnormal and no particular injury to the root system of fruit was noticed.

[1] Talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association, Inc., July 15, 1981.

It was the scion cultivars which were hit by cold and not the rootstocks. However, many apple trees on M. robusta 5 rootstock died this year with those 10 to 15 years of age particularly affected. Trees over 20 years of age on M. robusta 5 were not damaged. It looks as if the young M. robusta trees which started to come into bearing were more susceptible to low temperatures in late winter or early spring.

The most affected areas in the province were those located along the U.S. Border and the Two Mountains region. The Rouville region proved to be somewhat less vulnerable to winter injury. The Lower St-Lawrence region (below Quebec City) suffered the least from the 1980-81 winter. The presence of a large body of water, the more abundant snow precipitation and the late blooming season of that location are certainly the prevailing factors which may explain the better performance of the fruit trees (apple, plum, pear, cherry) in this area.

The cultivar Lobo sustained the least winter injury in all regions of the province. Along with Lobo some other cultivars such as Melba, Jersey Mac, Wealthy, Jonamac, Melred, Yellow Transparent, Vista Bella and Paulared proved to be cold resistant. However, cultivars such as Mutsu, Red Delicious, Golden Delicious, Northern Spy, Rhode Island Greening and Golden Russet were classed as those most sensitive to winter injury. Cultivars such as McIntosh, Cortland, Idared, Empire, Spencer, Spartan and Red Haralson fell into the medium class of resistance to cold injury.

Needless to mention, having experienced such a severe winter this year's apple crop is greatly reduced. Our average production for the past 5 years has been 5.3 million bushels. This year's crop will most likely fall between 2 or 3.5 million bushels. Because of the late spring frosts there also will be a larger percentage of culls (misshapen fruit) this year. Since the trees are weaker than normal there also is a fairly large quantity of apples that were attacked by diseases and insects.

Special attention had to be given to the cold injured trees during the summer of 1981. Dead limbs were removed to prevent the development of cankers. Painting large pruning wounds or tree crevasses with Bordeau paint appears to have proven very effective. This paint consists of a mixture of 2 pounds of monohydrated copper sulfate or fixed copper (c.o.c.s., etc.), 4 pounds of hydrated lime and two parts of boiled linseed oil. It is important to mix the two powders first and then add the oil. Otherwise the mixture will not be uniform. Moreover the Bordeau paint dries very rapidly. It will harden within 6 hours if exposed to air. Since it is a paste-like mixture it could be easily applied with a brush. Other coatings such as interior white latex paint plus mercuric bichloride or plus a fungicide such as sulphur or Thiram have been used and seem to have served the purpose. In several cases a special tree nutrition program was followed to help the tree to recover. A few growers who used soil injections with root feeding solutions claimed that it did help a great deal. In many cases irrigation has also helped tremendously.

The winter of 1980-81 did more harm to pear, plum and cherry trees than it did to apple trees. The pear cultivars or selections which suffered most from cold injury were Bartlett, Beurre Bosc, Highland, O-361, H-68-31-1-12, HW-603, Baierschmidth, Larwick, Sierra, HW-601 and Magness. On the other hand the cultivars Flemish Beauty, Clapp's Favorite, Guyot, Enie, Gaspar #5, Krol Sobiensky, Pioneer, Phileson, Soothworth and Luscious were quite resistant to cold injury. Najou, Aurora, Kieffer and Patten were of medium cold hardiness. Of 30 cultivars of plums evaluated only a few seem to be cold resistant. These are Mont Royal, Stanley, Grenville, Kahinta, Damas and Reine Claude. Among the sour cherry cultivars Meteor, Suda Hardy and English Morello seem to be more cold hardy than North Star and Montmorency.

In general the trees which bore a bumper crop of fruits in 1980 proved to be quite tender to cold injury during the winter of 1980-81. The trees which were weak and the ones located in frost pockets or the ones growing in poorly drained areas behaved the same way. Many McIntosh trees that were girdled (scored) 10 days after full bloom in 1980 died during the winter of 1980-81. Almost all the trees which had been pruned in November, December and January died. Severe summer pruning during June and July of 1980 created a weak resistance to cold stress. Deer damaged trees in many instances appeared as severely injured by the winter injury as those that were summer pruned. In many cases excessive herbicide applications caused the death of fruit trees. Thus factors that interfered with tree maturity during the summer and fall of 1980 had an important bearing on cold tolerance during this last test winter.

White plastic mouse guards protected the bottom of many trees as well as did a heavy coat of snow. The trees pruned with the new TTS (Tip top shape) pruning method were less injured by cold than others.

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FRUIT NOTES INDEX FOR 1981

(This index of major articles has been prepared for those who keep a file of FRUIT NOTES. The number in parenthesis indicates the pages on which the item appears.)

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01003

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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Vol. 47 No. 1
WINTER ISSUE, 1982

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A COMPARISON OF TREE SIZE, PRODUCTIVITY AND FRUIT QUALITY OF DELICIOUS STRAINS

W.J. Lord, F.W. Southwick, R.A. Damon, Jr., and J.F. Anderson

The performance of Delicious strains at the Horticultural Research Center was discussed in a previous issue of FRUIT NOTES (Vol. 44, No. 6). Information reported here includes 1979 findings and data previously not presented.

Experimental Design

A planting was established in 1964 at the Horticultural Research Center, Belchertown, MA to evaluate the following Delicious strains on M7 rootstock: Richared, Turner Red, Jardine Red, Royal Red, Gardiner Red, Red Prince, Rogers Red, Sturdeespur (Miller Strain), and Starkrimson (Bisbee Strain), the last two being spurs. The experiment was a randomized block design with 6 single-tree replicates. The trees were planted at 20 feet by 30 feet spacing. Summarized below are our findings to date.

Tree Size

The trunk cross-sectional areas of the trees with the standard-type growth habit were similar and about twice as large as those of the spur strains (Table 1).

Table 1. Mean size of the 7 standard and 2 spur strains of Delicious, 1979.

Growth habit	Trunk cross-sectional area (cm^2)	Tree height (ft)	Tree spread (ft)
Standard	342	13	19
Spur	173	12	14

The difference in tree height was not large because commencing in 1977 we restricted height on the standard strains. Of particular interest to note is that we could have allowed 5 feet less spacing in-the-row and between-the-row for the spur trees than the standard trees without encountering tree crowding.

No limb spreaders were used when the trees were young. This practice, which has recently been adapted almost universally, may have altered tree spread and productivity. Branches of spur strains are more upright growing than those on standard strains, but our differences are much less striking than what have been illustrated in some publications and what we have observed in some other orchards.

Nevertheless, limb spreading probably would have altered tree structure and spread more on the spur than on the standard strains. Other researchers have reported that the need of spreading is greater on spur than on non-spur Delicious trees and that the practice will increase fruitfulness. In an earlier study at the Horticultural Research Center we increased bloom but not fruit set on young Delicious trees by limb spreading.

Nutrition

Leaf analysis in 1972, 1973, 1977, 1978 and 1979 showed that within a year nitrogen, potassium, calcium, and magnesium levels varied among the 8 strains. In 1973 and 1979 the spur strains were higher in calcium than the standard strains. Nevertheless, no strain was consistently different from another in regards to nitrogen, potassium, calcium or magnesium levels in the leaves. Differences in leaf N and Ca among Delicious strains have been reported but it has not been shown that these differences persist among the same trees in successive years.

It is of particular interest to note that the elements did not vary consistently between the standard and spur strains even though equivalent amounts of fertilizer were applied annually to both types of trees and the spur trees were smaller (Table 1). Our data suggest that it may not be necessary to fertilize spur and standard 'Delicious' strains differently.

Production

Why Delicious is unproductive in the eastern United States was the subject of a conference hosted by the USDA in 1977. Researchers in attendance stated that strains differ in fruitfulness but there was a lack of supportive data. It was reported that spur-type strains perform somewhat better than standard-type strains and that Red Prince Richared, and Royal Red in some apple growing areas are less productiv than other strains.

We lost 2 of our Red Prince trees in 1972, but by statistical techniques it was possible to obtain an estimate of yields. Thus, the productivity of Red Prince in comparison to other strains in the test is reported.

Early production: Yield data was first recorded in 1970 when the trees were in their 7th year, and at this time the strains average at least a bushel per tree. In 1970 production per tree was similar among strains. Gardiner Red Produced more fruit per tree than either spur strain in 1971. In 1972, Turner Red was more productive than the spur strains.

Although yield per tree favored the more productive standard-type strains in 1971 and 1972, higher tree numbers per acre are possible with spur trees. Actual spacing trials provide the most reliable estimate of yield per acre. In absence of these, we arrived at theoretical tree spacings for the strains by using tree spread in 1979.

Theoretical yields per acre were determined by multiplying average yield per tree by trees per acre. The theoretical yields showed that Sturdeespur was more productive in 1970 and that there was no difference in productivity between standard-type and spur-type trees in 1971. In 1972, Turner Red was as productive as Sturdeespur and Starkrimson. Thus, in this study yields per acre in the early fruiting years favored neither the standard nor spur-type strains.

Yields from 1970 through 1979. The mean cumulative yield per tree, except for Red Prince, was higher on the standard trees than on the spur trees. Theoretical cumulative yields per acre of Sturdeespur and Turner Red were similar but Sturdeespur was more productive than the 7 other strains. Sturdeespur had the highest production efficiency (production per area occupied) of all strains. The theoretical cumulative yields of Starkrimson, Red Prince, Rogers Red, Richared, Royal Red, GardinerRed and Jardine Red were similar. Thus, the results of our strain comparisons differ from those reported from other areas which indicate that Red Prince, Royal Red, and Richared are less fruitful strains of Delicious.

The mean yield of the 36 McIntosh pollinator trees in comparison to that of the Delicious strains are of interest because the trees were interplanted in the same block. This frequently is not true when yields of Delicious have been compared to other cultivars. The McIntosh pollinators averaged 11.2 bushels per tree in comparison to a mean of 1.1 bushels for all Delicious strains in the frost year of 1977 (Table 2). However, except for 1977, the standard strains of Delicious and McIntosh were equally productive. Our study shows that consistent high yields of Delicious can be obtained if the trees are planted on a relatively frost-free site and provision is made for adequate cross-pollination.

Table 2. Comparative yields of McIntosh and Delicious strains with standard growth habit.

Cultivar	Yield (bushels per tree) in:									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
McIntosh	2.0	3.7	2.4	8.3	5.6	14.2	9.5	11.2	15.1	14.1
Delicious	1.3	3.6	2.8	9.6	4.1	9.2	11.0	1.1	13.2	15.1

Fruit color: With the exception of Rogers Red, which is a tree sport found in Massachusetts, the color characteristics of the strains have been described by others since our study was initiated. Most fruits of Red Prince were striped whereas descriptions from other areas vary from prominently striped, to slightly red striped during early period of coloration, to solid red.

Rogers Red has blush-type fruits with color intensity similar to Royal Red in most years. Red color on Turner Red lacks somewhat in uniformity and is less intense than on Starkrimson, Royal Red, Sturdeespur, and Rogers Red. J.E. Swales, Summerland, B.C. stated (personal communication) that Turner Red has proven very stable in Okanagan Valley of British Columbia and no lack of uniformity of color has been observed where the fruit is well exposed to sunlight. Like ourselves, Dr. Marshall Ritter in Pennsylvania reported that color of Turner Red was quite variable.

The fruits of Jardine Red are blush with some striping but lack intensity of red to meet present standards for color. Sturdeespur, Starkrimson, Royal Red, and Rogers Red have consistently been rated high for color by our orchard personnel and pomology students because of their intense red color. In good coloring years, however, some individuals considered these strains too dark and preferred the bright red blushed fruit of Gardiner Red and Richared.

Fruit Weight and Shape

We measured fruit weight and fruit shape in 1978, 1979 and 1980 because some early evaluators of Delicious sports reported some mutants produced longer fruits. Starkrimson fruits were smaller than Royal Red, Richared and Rogers Red in 1978 but there were no differences among strains in 1979 and 1980. The fruits of Starkrimson (spur strain) and Gardiner Red (standard strain) were longer than those of Jardine Red in each of the 3 years, otherwise there was no consistent difference among strains in fruit length. Thus, our data on fruit length appear to differ somewhat from those of researchers in Washington and British Columbia. Ketchie and Olsen in Washington found no specific trend in fruit circumference, weight or shape. These workers concluded that there may be more variability in fruit size and shape among years and locations than differences among strains themselves. Meheriuk et al. in British Columbia showed that the fruits of spur strains were longer than those from standard strains but in our study Sturdeespur was not longer than the standard strains.

Watercore

Fewer Starkrimson fruits had watercore in 3 of the 4 data years but many fruits were as severely affected with the disorder as some other strains. The severity of watercore at harvest is of more concern than the presence of the disorder. Watercore will disappear from a high percentage of fruits during storage but internal breakdown may develop in severely affected fruits.

In contrast, an earlier 3-year study by the senior author showed that watercore was more severe in Richared than Starking Delicious. Overmaturity is a common problem with Delicious in new England because the fruits are not harvested until McIntosh and other earlier-maturing cultivars have been picked. Watercore is of annual concern and a reliable index of overmaturity under our conditions. Based on watercore development, it appears that strains of Delicious mature at different times but the present study and those of others indicate that maturity differences may be small; however, these differences might be accentuated by local conditions.

Spur Flowering and Fruiting of Three Strains

During the 1979-80 and 1980-81 periods the amount of flowering and fruiting on previously fruiting or non-fruiting spurs was determined for Red Prince, Richared and Starkrimson (spur-type) strains of Delicious. The relationship of seed number to subsequent flowering of previously fruiting spurs was studied as well.

Table 3. Flowering and fruiting of three Delicious strains, 1979-80

Strains	% Spurs flowering in 1980		Avg seed number, 1979 fruiting spurs	
	Fruiting in 1979	Non-fruiting in 1979	Flowering in 1980	Non-flowering in 1980
Red Prince	13	64	4.7	6.5
Richared	57	89	4.4	5.9
Starkrimson	2	60	3.0	6.3

Table 4. Flowering and fruiting of three Delicious strains, 1980-81

	% Spurs flowering in 1981		% 1980 fruiting spurs fruiting in 1981	% 1980 non-fruiting spurs fruiting in 1981
	Fruiting in 1980	Non-fruiting in 1980		
Red Prince	11	93	4	38
Richared	12	76	7	29
Starkrimson	2	78	2	36

It is apparent (Table 3) that spurs which failed to bear fruit in the previous year are much more apt to flower the following year than those which fruited the year before. The Richared strain was more likely to produce spurs which bear fruit one year and flower the next year than the other two strains. However, the spur-type Starkrimson strain is clearly inferior in this regard to either Red Prince or Richared.

The data also show that spurs bearing fruit with low seed numbers were more likely to produce a "repeat" bloom.

The data obtained in 1980-81 (Table 4) show that the 1980 fruiting spurs which flowered in 1981 set very few fruits in 1981 in comparison to the spurs that did not fruit in 1980. This was most noticeable for the Starkrimson strain where only 2% of the 1981 "repeat" bloom set fruit whereas 36% of the 1980 non-fruiting spurs possessed apples in 1981. These data indicate that a sizeable proportion of non-fruiting spurs are essential on bearing trees if substantial annual production is to be maintained.

Summary

A planting was established in 1964 and 1965 to evaluate the following Delicious strains: Red Prince, Jardine Red, Royal Red, Turner Red, Richared, Rogers Red, Gardiner Red, Sturdeespur, and Starkrimson the last 2 being spur types. The strains have been evaluated through 1980. Leaf N, K, Ca and Mg levels varied among the strains but none was consistently different from another. The cumulative yield per tree from 1970 to 1979 was higher for all standard strains except Red Prince than for the spur strains. Theoretical cumulative yield per acre was highest for Sturdeespur and significantly higher than all other cultivars with the exception of Turner Red. Sturdeespur had the highest production efficiency. Watercore severity at harvest was inconsistent among the strains, but in 3 of 4 years fewer Starkrimson fruits were affected. A sizeable number of non-fruiting spurs are essential each year on bearing trees if substantial annual production is to be maintained.

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POMOLOGICAL PARAGRAPH

Publication available. A book entitled "Tree Fruit Growth Regulators" edited by Ronald B. Tukey, Washington State University and Max W. Williams, USDA-SEA-AR, is available for $12 from Growth Regulators, Conference Office, Room 323, AG. Sciences II, Washington State University, Pullman, WA 99164. Checks should be made out to Washington State University. This book is a compilation of papers presented at a shortcourse held in February, 1981 on the subject of growth regulators and chemical thinning of deciduous fruit trees. Among the topics discussed are: growth and development of fruit trees, pollination and fruit set, growth regulator and cultural techniques to promote early fruiting of apples, physiological aspects of pruning and training, chemical thinning of apples, and growth regulator uses of tree fruits. This book should be valuable to growers desiring to increase their understanding of fruit trees and of the use and action of plant growth regulators.

A VISIT TO YAKIMA AND WENATCHEE CA STORAGES

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A group of 6 eastern CA storage specialists spent July 27 in Yakima with D. Loyd Hunter (Food Plant Engineering, Inc., Yakima) and July 28 in Wenatchee with Dick Bartram (Coop. Extension Agent, Chelan County). In this report I will share with you some observations from these visits.

CA construction in Washington is booming. Approximately 4 million boxes of new CA capacity will be added in 1981 to their present total of about 26 million. Their construction techniques are very different from ours. Perimeter walls are almost exclusively tilt-up concrete panels, which are poured at the construction site. Polystyrene insulation (less expensive than urethane) is frequently set into the wet concrete before erection. The gas seal for the inside of the perimeter walls, a thin layer of sprayed urethane, is applied to the polystyrene after the panels are erected. Urethane in storage rooms is covered with a fire barrier (Zonolite-3300). Partition walls and ceilings are 3/8 to 1/2 inch plywood (waterproof glue) nailed to 2 inch x 6 inch wall studs or to ceiling joists, leaving 1/16 inch spaces on all sides. Seams between the plywood sheets are then filled and taped. Wall-wall, wall-ceiling, and wall-floor joists are flashed. The partition walls and ceiling are then spray coated twice with an acrylic rubber coating. Ceilings and warm interior walls are insulated with fiberglass; walls common to 2 storage rooms are not insulated. The plywood-acrylic rubber gas seal is used for the partition walls and ceilings to cut costs. Under Eastern U.S. conditions of outside high relative humidity, the plywood-acrylic rubber gas seal should be considered only for ceilings, and then only when attic spaces are well ventilated to keep the insulation dry.

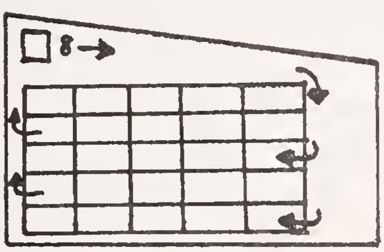
Built-up roofs are installed and built with a slight pitch above aluminum, laminated-wood trusses, which are not available in the east. Although roofing felt between 2 concrete slabs is sometimes used to seal floors, a single concrete slab treated with a floor sealer and hardner is frequently used. A metal-clad, sliding door is usually sealed with rubber gaskets between the door and the jam or with duct tapes applied inside the room after the room has been filled.

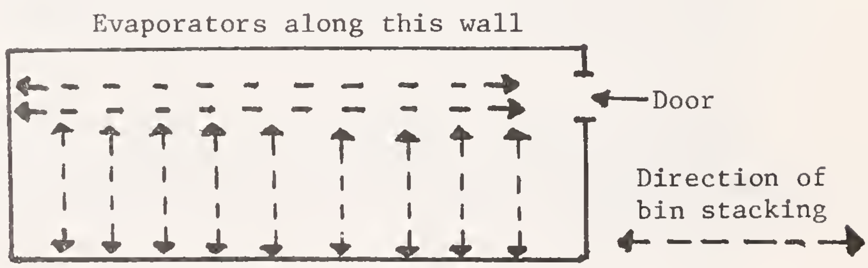
What's the turn-key cost, including electricity and refrigeration? About $3 per box for a one million box plant, and $3.75 if only 100,000 box capacity is built. In the east we pay in excess of $5 per box. Are they tight? Most storage operators require a pressure drop of 1 inch to no less than 0.75 inches water gauge in 1 hour. They get it. Many of our CA rooms could meet that requirement, but many are not that tight.

CA equipment in most establishments is similar to ours. I believe all rooms are equipped with a Tectrol-Samifi or a COB oxygen burner. After the rapid O_2 pulldown, CO_2 scrubbing is usually done with lime and/or a molecular sieve scrubber. The latter draws many kilowatts, which cost only 1.1¢ along the dammed Columbia River. Most operations still use an Orsat gas analyzer, but a few are trying Teledyne or Beckman O_2 analyzers. Most operators still rely on alcohol thermometers (Taylor 1106 or the more easily read Taylor 5499), which are normally placed at the CA door and at least 1 additional thermometer is placed adjacent to the windows located behind the evaporators. These windows also permit visual inspection of defrost. Many rooms are equipped with breather bags to equalize pressure in the rooms. All rooms have pressure relief valves to release excessive pressure or vacuum in the rooms. Ammonia is the most common refrigerant, all evaporators are dry coil, and most are defrosted with water. Modulating back-pressure valves on the evaporators, which automatically control the evaporator coil temperature according to the heat removal requirement in the room,are common when ammonia is the refrigerant. My recent survey study of eastern CA rooms indicated higher relative humidity when these back-pressure control valves are used.

CA strategies are more diverse than ours. Four CA regimes appeared to be in general use. (1) Normal CA. Rooms are filled in 7 to 10 days, oxygen is lowered to 2% (if possible) in 3 to 7 days with O_2 burner. The room is maintained at 1.5 to 2.0% O_2 and below 1% CO_2. If the O_2 cannot be held below 2%, the CO_2 is raised to 2%. This regime is similar to ours except that we do not recommend O_2 concentrations below 2.0% (2) Rapid CA. The room is filled and sealed in 3 days. Field heat removal requires 7 to 14 days. The O_2 is quickly burned to below 2% and held at about 1% (if possible) for 1 week. For the remainder of the season the O_2 is held at 1.5 to 2.0% and the CO_2 below 1%. The short delay between harvest and the time when O_2 is below 2% results in a substantial increase in firmness. We would consider this to be a dangerous practice because our test results with McIntosh indicated rapid cooling is more important than rapid O_2 pulldown. We also would consider the 1% O_2 for 1 week to be very risky. This strategy is worthy of trial if apples are rapidly precooled in adjacent rooms and assembled in 1 room for CA. Also, the O_2 should be kept at 2.0 to 2.5%. (3) Low O_2 CA. The room is filled as quickly as possible, but not so quickly that field heat removal takes more than 7 days. Immediately after filling, the room is sealed and O_2 is reduced to below 2% with an O_2 burner. The O_2 is then held at 1.0 to 1.5% and the CO_2 below 1% for the entire season. Benefits from low O_2 CA seem to be similar to benefits from rapid CA. We recommend keeping the O_2 above 2%. Too many cases of low O_2 injury have occurred in the northeast when lower O_2 concentrations were used experimentally and/or commercially (by accident). We also saw and tasted some low O_2 injury on Delicious in Wenatchee. (4) High CO_2 pretreatment (about 14% for 10 days) is rapidly being replaced by rapid CA and low O_2 CA because the latter 2 strategies yield the same flesh firmness advantage and will not cause CO_2 injury to the apples. With the exception of Washington and Virginia grown Golden Delicious, high CO_2 pretreatments have not looked promising because injury has occurred when CO_2 was sufficiently high to increase flesh firmness.

Bin spacing and stacking patterns are given top priority. Every storage we saw had yellow painted on the floor to assure at least 12 inches clearance from all walls and 4-1/2 to 6 inches between rows of bins. To assure the fastest possible cooling and the most uniform temperatures throughout the storage season, evaporators are located to move the air quickly on a short route through the bins and back to the evaporators, i.e., the evaporators are located over the center aisle in large rooms and on the long wall in smaller rooms. In the large rooms the doors are located in the center of the short wall, but in small rooms (see drawing below) the doors are located at the edge of the short wall so bins can be stacked across the room, channeling the air quickly back to the evaporators.





We returned to the east coast impressed with the size and the rate of growth in the Washington CA apple industry and with the many CA innovations, some of which can be adapted to our conditions. The following should be considered for immediate adaption. (1) Plywood-acrylic rubber gas seals for ceilings to cut costs. (2) Minimization of the time between harvest and rapid O_2 pulldown. The time interval between harvest and 2 to 3% O_2 should be 7 days if possible, but not at the expense of rapid field heat removal. (3) Bin stacking and spacing to channel the air quickly back to the evaporator(s) to facilitate rapid field heat removal and uniformly low temperatures throughout the storage season.

OBSERVATIONS OF THE NEW YORK FRUIT INDUSTRY

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My association with the New York fruit industry began on July 1, 1980. Prior to that time, I had not seen the Lake Ontario region and had only limited knowledge of the Hudson and Champlain Valley areas During the last year considerable time was spent in learning the make-up of the industry, observing current practices and conditions, and analyzing strengths, problems, and needs for future development.

The diversity of this industry in terms of crops, production areas, and marketing systems must be recognized. Nationally the state ranks second in the production of apples, grapes and tart cherries; fourth in pears; and sixth in sweet cherries. In addition to these crops, peaches, strawberries and raspberries and produced in commercially important quantities along with smaller quantities of several other fruits. A thorough examination of all aspects of these different crops and their specific problems is beyond the scope of this discussion. Therefore, we will concentrate on examining some aspects of the apple industry.

In perspective, the major apple producing regions are the Lake Ontario region, Hudson Valley, and the Champlain Valley, with additional output from the Finger Lakes, Central New York and Long Island.

Climatically, the Lake Ontario region is generally least subject to temperature extremes. Soils in this region vary from deep well-drained sands to somewhat poorly drained finer textured soils requiring extensive drainage. This region has long been strongly oriented toward production for processing. This will continue because of the location of major processing facilities. However, there is increasing interest in expanding the production of fresh market apples. Planting of fresh market varieties is gaining momentum under both high-density trellis systems and medium density free-standing systems. As older orchards of varieties suited solely for processing are replaced, consideration is being given to varieties such as McIntosh, Delicious, Empire, Idared, Golden Delicious and Rome Beauty.

Rootstocks in new plantings include M.9 for trellises, M.9/111 or M.9/106 interstems, as well as 106, 111 and M.7. Many of the slowly drained soils would be better matched to the use of M.13 if such trees were available.

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1 Talk presented at the Annual Summer Meeting of the Massachusetts Fruit Growers' Association, Inc., July 15, 1981.

As this region moves further into fresh fruit production several changes must be accomplished. Greater investment in fruit handling equipment, expansion of storage and grading facilities, and the development of a strong marketing system must be considered. These changes must be accompanied by greater attention to all aspects of fresh fruit production and handling related to development and maintenance of high quality.

The Hudson and Champlain Valley situations are considerably different from that in the Lake Ontario region, and even different from each other. For the most part, soils in the eastern regions are the glacial tills. Many of these are coarse-textured and must be irrigated in order to be adequately productive. After the drought experienced in 1980 there is increasing grower interest in trickle irrigation, particularly in the Hudson Valley. At the same time, soil drainage problems exist in the fragipan and finer textured soils.

In both the Hudson Valley and the Champlain Valley too many orchards are planted on sites that are subject to frost. This was strongly illustrated this spring. We must consider that costs of establishing new orchards do not allow much room to gamble on losing a crop to frost. On the matter of frost, several methods were used this year, none being totally effective under the conditions encountered. Overhead irrigation and spraying trees increased the degree of damage in several instances. Heating and wind machines were limited in effectiveness because of slight wind and high inversion layers. Helicopters working air downward from the inversion layer were more effective than those operating at tree top level, but were limited in the area they could cover.

High temperature during the harvest season and the color development and fruit ripening problems associated with it are more a problem in the Hudson Valley while early freezes must be considered in the Champlain Valley.

Variety choices are therefore changing somewhat in an attempt to more closely match variety to weather conditions. In the Hudson Valley, many of the newer plantings include fewer McIntosh with greater emphasis on Empire, Delicious, Idared and Rome. Other varieties that are performing favorably include Jerseymac, Tydeman, Paulared and Spartan.

By contrast McIntosh, particularly spur-types, continues to be the leading variety in the Champlain Valley. Empire, Cortland and Spartan also appear to be increasing in that area.

Rootstock choice for the eastern areas have included M.7 and MM.106 but is tending toward MM.111 or M.9/111 interstem trees. The greater tolerance of the MM.111 root to prevailing soil conditions and lower susceptibility to collar rot are major reasons for this shift. M.26 has been tried but is too soil-specific for general use.

Tree planting across the state is largely done by machine. This presents something of a paradox in that trees can be planted rapidly and they usually start better than auger-planted trees. In a sense it is almost too easy to plant trees with a planter. Many trees can be planted so quickly that they do not receive the detailed attention that is required. Particularly when interstem trees are used, care must be taken to adjust planting depth so that the scion bud union is at the same relative level in relation to the soil surface. With M.9/106 trees, care should be taken to be sure that the 106 is buried so that the M.9 section, which is less susceptible to collar rot, extends 3 to 4 inches below the surface. With M.9/111 trees the M.9 section should be set at a given height <u>above</u> ground. Also care must be taken to straighten the trees.

The importance of tree quality and early tree training is magnified by precocious strains and varieties, particularly when these are used on interstems. These trees tend to 'mature' before adequate fruiting surface has been developed. In order to develop strong trees of this type, greater attention must be given to central leader training from the time of planting until they have reached the desired height. Smaller, less-vigorous nursery trees are especially troublesome in this respect. Annual heading-back <u>plus</u> defruiting of the leader are critical factors with such trees. Failure to do this usually results in top-heavy trees that bend over with the wind, or that have no leader on which to build a fruiting system.

Weed control practices are receiving attention throughout the state. Variations in soil types require more attention, particularly in young plantings, in selecting proper herbicide programs. We are evaluating a wide range of combinations of herbicides in an attempt to develop programs that will be effective and safe for use on some of the coarse-textured soils. Special emphasis is also being placed on more effective methods for controlling poison ivy, brambles, wild grape and other persistent perennials.

Lack of weed control under the trees and infrequent mowing of sod middles contributes to mouse control problems. Greater attention to ground cover management should help to minimize such problems.

Problems of orchard nutrition are complicated by the wide range of soil conditions. Many of these problems are common to those found throughout New England. Those encountered most frequently involve low soil pH, shortages of potassium, magnesium, boron and zinc. Under high pH conditions manganese and copper also appear to be involved. Standard values for leaf analysis interpretation are being adjusted to allow more precise diagnosis of nutrient status. Much work is needed in evaluating the potential of various types of materials for foliar application, their safety and effectiveness when applied as concentrate sprays, and their compatability with newer pesticides.

Pruning practices vary considerably. Mechanical hedging of trees is more common in the Lake Ontario region. Alar sprays offer some help in controlling shoot growth of hedged trees, but further study is needed to establish the best rates and timings according to vigor of the variety and orchard involved. Combining hedging with follow-up manual pruning and growth regulators may offer a means of reducing pruning labor in the future. Summer pruning is also gaining in use as a means of controlling tree vigor. This practice is particularly effective with high-density plantings where close control of tree vigor is essential.

Spraying methods must also be mentioned. The machinery available covers the range found throughout the industry. Many orchardists have been spraying dilute, others at concentrations of 3X, 15X, 20X and higher. Variations in tree size and configuration have created confusion as to correct dosages of materials required under various conditions. In an attempt to overcome some of these problems, our recommendations were revised to include guidelines for tree-row volume spraying. Essentially, this amounts to calculating tree-row volume (tree height x tree width x length of row per acre) and applying approximately 0.7 gallon of dilute spray equivalent per 1,000 cubic feet. On this basis, dilute spray equivalents used per acre may vary from approximately 100 gallons on some trellis plantings to 450 gallons or more on large standard trees. We feel that this type of adjustment is necessary in order to avoid the use of excessive amounts of materials in higher density plantings and to ensure that adequate amounts are used to obtain satisfactory pest control with large trees.

These comments illustrate some aspects of the New York fruit industry as it exists today, some of the changes taking place, and some areas in which further attention will be directed. The industry is large, diverse and dynamic and will continue to adapt to meet challenges as they arise.

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DEFOLIATION BY GYPSY MOTHS PREDISPOSES YOUNG APPLE TREES TO CANKER AND DIEBACK

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Department of Plant Pathology

Canker and dieback diseases were unusually prevalent on apple trees of all ages in Massachusetts in 1981. The fungi that causes these diseases are weak pathogens that usually infect and cause disease only on trees weakened by various stress factors, such as drought, winter injury, etc.

Cold temperature injury from the previous winter seemed to have weakened a number of young trees. Sunken cankers were noted at the origin of young branches on trunks (see Figure 1). The young branches were often girdled and dieback resulted by late June or early July. In other cases, dark sunken lesions developed near branch tips, resulting in dieback of new shoots. The canker-causing fungus *Nectria* was usually associated with these dieback problems.

An interesting case of canker incidence occurred in our own new block at the Horticltural Research Center in Belchertown. Gypsy moths completely defoliated some young Red Delicious, Mutsu and Rome trees. As a result of the defoliation, these trees developed cankers and branch dieback. The canker shown in Figure 1 is an example. While these may have been some cold temperature stress on these trees, it appears that stress from gypsy moth defoliation resulted in canker and dieback that was, in this case, caused by the fungus *Cytospora*.

Fig. 1. *Cytospora* canker on 3-year-old Red Delicious following severe defoliation by gypsy moth caterpillars.

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[1] Apple Pest Management Technician

[2] Professor of Plant Pathology

Defoliation by gypsy moths alone will not kill a young apple tree. This defoliation, alone or combined with other stress factors, may result in predisposition to cankers and extensive branch die-back of young apple trees.

****

INTEGRATED MANAGEMENT OF APPLE PESTS IN MASSACHUSETTS 1981 RESULTS: INSECTS[1]

W.M. Coli[2], G.E. Morin[3], L.J. Mancino[3], D. Gordon[4], T. Green[4], C. Sienkiewicz[4], R. Spitko[4], and R.J. Prokopy[5].

Summary of Results[6] - Intensive weekly scouting and grower advisement in 19 orchard blocks that had been on an IPM program for one or more years resulted in a savings in insecticide and miticide use (dosage equivalents) of 27% and 60% respectively compared to the checks. Fruit injury in such IPM blocks averaged 2.5% versus 2.0% in the checks. In spite of this slightly higher injury level, IPM blocks experienced a benefit of $40.18/A from IPM (exclusive of scouting costs).

Number of Orchard Blocks Scouted - In 1981, each week (April 1 through October 1) field staff visited 41 IPM blocks (about 450 acres) in 22 commercial orchards throughout the major fruit-growing regions in the state. Growers received a written scouting report and were contacted either in person or via telephone by the IPM Specialist and advised as to the need for spraying, materials to use, and timing.

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1 Special thanks to Mr. David Chandler, Meadowbrook Orchard, Inc., Sterling Junction, for allowing us to room 3 scouts at his housing for harvest labor, throughout the summer.

2 Pest Management Specialist

3 Senior field scouts

4 Field scouts

5 Extension Entomologist

6 Reduced spray programs on apples have been discussed in previous issues of Fruit Notes: 41(1), 41(2), 41(3) and 43(3), and our 1978, 1979 and 1980 results were summarized in Fruit Notes 44(1), 44(6) and 45(6).

In addition, 7 commercial check orchards were monitored for presence of aphids and mites and their predators 2-3 times during the season. An on-tree survey of insect and disease injury was performed in these check orchards as well as an analysis of spray usage.

Grower Financial Support and Cooperation with IPM Specialist Advisement - Participating IPM growers paid $16-20/A (depending on total acreage scouted) for insect scouting and advisement in 1981. The charge for disease scouting and advisement was $100 per orchard. Total grower contribution to the IPM program was $8,500 (up from $4,500 in1980). This was used to pay scout salaries.

The degree of grower cooperation with IPM specialist recommendations was quite high in 1981, averaging 89% cooperation (range 65% - 100%) compared to 78% cooperation in 1980. This indicates increasing willingness of IPM growers to (a) rely on predators when possible, (b) to better synchronize sprays with vulnerable stages in pest cycles, (c) to use reduced rates of pesticides, and (d) to withhold sprays entirely should pest numbers be below economic threshold levels.

Sampling Methods - We have discussed our monitoring techniques in previous issues of Fruit Notes: 44(1), 44(6) and 45(6). With few changes, we employed these same methods in 1981 with the principal changes being: more extensive use of San Jose Scale (SJS) pheromone traps than in 1980, field testing of a visual trap for monitoring Spotted Tentiform Leafminer (STLM), and mite brushing of leaf samples taken proximal to "hot spots" rather than at random locations in blocks.

Results

New or Unusual Outbreaks - The Gypsy Moth (GM) was a problem at numerous sites in 1981. Early instar larvae "ballooning in" were controlled well by pink sprays of endosulfan (Thiodan) or azinphos-methyl (Guthion). In cases where insecticides were not applied at pink, petal fall sprays provided excellent control, but in some cases not before foliage and fruit were fed on extensively. Later instars were also troublesome, as the large larvae migrated from defoliated hardwood stands into adjacent orchards in search of food. In some cases, repeated border sprays were required to prevent extensive damage from these GM larvae.

Pesticide resistant Spotted Tentiform Leafminer (STLM) advanced into central and eastern parts of the state. First generation STLM counts averaging only 0.1 mine per leaf (10 mines per 100 observed leaves) resulted in second generation counts averaging 0.8 mines per leaf, and third generation counts averaging 2.8 per leaf.

No IPM blocks experienced pre-harvest drop that could be characterized as severe and clearly related to STLM injury. In most cases, drop severity appeared more related to factors such as calcium chloride application, stop-drop use, tree vigor, or crop size. 1981 data collected with the cooperation of IPM grower Elmer Fitzgerald, Jr. of Ashby, MA., indicated that while STLM injury undoubtedly predisposed apple trees to a certain amount of pre-harvest drop, moderate to severe phytotoxicity from calcium chloride sprays in one block where third generation STLM was controlled (only 0.8 mines per leaf), resulted in substantial drop (19%) compared to an adjacent block (11% drop) where second generation and third generation mines reached 1.5 and 4.5 mines per leaf, respectively.

Fruit Injury - As mentioned above, degree of grower cooperation with IPM specialist advice was generally excellent. Consequently, comparison of good cooperator blocks (18) with the few partial cooperator blocks (5) as in 1980 was not feasible. For the following reasons, we chose for purposes of analysis to group IPM blocks as either First Year IPM or previous year IPM (those blocks which have been on the IPM program for one or more years previous to 1981): (a) First Year IPM blocks typically present numerous residual pest problems (1st year growers frequently assign field staff to monitor "problem" blocks), (b) there may be less likelihood of bio-control agents being present in First Year blocks in substantial numbers due to previous spray practices, (c) program field staff are hampered by a lack of knowledge as to which pests can be expected to exert the most serious pressure on First Year blocks.

Overall, fruit injury in Previous Year IPM, First Year IPM, and check blocks was 2.5, 3.7 and 2.0% respectively (Table 1). All these were within acceptable injury limits for Massachusetts commercial orchards.

As in previous years, injury from Tarnished Plant Bug (TPB), represented the largest single source of fruit injury from insects in Massachusett's commercial orchards. It is questionable whether or not this injury is economically important, however, since a relatively small proportion (4%) of such injury results in downgrading of fruit quality during packout. White rectangular TPB traps indicated that several IPM blocks could safely eliminate pre-bloom insecticide sprays directed at TPB. Due to substantial pressure from Gypsy Moth and Spotted Tentiform Leafminer, however, only three such blocks were actually able to do without pre-bloom insecticide sprays in 1981.

San Jose Scale (SJS) injury ranks third in importance in Previous Year IPM (0.27%) or check blocks (0.23%) but second in importance in First Year IPM blocks (0.94%). The relatively high average injury from SJS in First Year blocks resulted primarily from assessment by 2 growers that SJS was not a serious enough problem to require the recommended spray treatments. We feel that a year of experience in IPM blocks allows us to develop a management program for SJS that leads to effective control. For example, a partial cooperator IPM block that in 1980 had 55% injury to fruit from SJS sustained only

1.8% injury from SJS in 1981 after a concerted effort by field staff and the growers to accurately time sprays with regard to observed stages of SJS development.

Plum curculio injury was substantially lower than in 1980, amounting to 0.61, 0.74 and 0.47% injury in Previous Year IPM, First Year IPM and check blocks respectively. PC injury in most cases was confined to the block periphery, indicating that accurate spray timing in response to a surge of PC emergence shortly after bloom, prevented more widespread PC activity, and injury to fruit. In some blocks, further PC sprays confined to block borders were adequate to prevent PC immigration and resulting higher injury.

Injury from European Apple Sawfly (EAS), Apple Maggot Fly (AMF), Codling Moth (CM), White Apple Leafhopper (WAL), Green Fruitworm (GFW) and Leafrollers (LR) was relatively low in all blocks. Total injury from these pests averaged 0.28, 0.35, and 0.75% in Previous Year IPM, First Year IPM and check blocks respectively.

One block of 5 year old "spur-type" Cortlands on M7 experienced substantial injury from first generation European Corn Borer (ECB). This was observed during the course of grower hand-thinning of fruit, although no injury from ECB was found at harvest. This is perhaps because hand thinning removed the protected feeding sites within fruit clusters on spurs, and aided in spray penetration and control. It is also possible that sprays against apple maggot killed second generation ECB adults or that mowing of tall grasses and weeds near the trees deprived ECB adults of egglaying sites.

Mite Populations - 1981 marked a partial resurgence of populations of *Amblyseius fallacis*, our major predatory mite. It was found in relatively high numbers ($>$ 0.4/leaf) in 8 IPM blocks in 1981, while no *A. fallacis* were found in check blocks (Table 2). This compares to 1980, when predator numbers were extremely low throughout the state, perhaps due to high overwintering mortality resulting from lack of snow cover.

With a few exceptions, spider mites were more easily controlled in 1981 than in other years, although some blocks, especially those with normally troublesome cultivars such as 'Puritan' and 'Delicious' required repeated treatments. Other blocks, several of which had required miticides in the past, needed little if any miticide. Heavy oil use directed at San Jose Scale may have contributed to this latter phenomenon. In addition, heavy rain showers in May, June and July may have contributed to the fewer than usual mite problems in 1981.

Insecticide, Aphicide and Miticide Use.

Previous Year IPM blocks (averaging 7.95 sprays, range 3 to 11) and First Year IPM blocks (averaging 7.57 sprays, range 5 to 10) received 23% and 26% fewer insecticide applications, respectively, than check blocks (average 10.28 sprays, range 8-13) (Table 3).

Uneven performance of repeated, early season endosulfan sprays for STLM adult control, as well as an earlier than normal third generation of STLM in some blocks, required unanticipated added use of methomyl or oxamyl in IPM blocks. Insecticide use in IPM blocks would likely have been lower had growers been advised to rely more heavily on early season use of the latter two materials.

Residual San Jose Scale problems in several blocks necessitated frequent sprays aimed at this pest. Fortunately use of Penncap M against scale also provided excellent apple maggot control.

Previous Year IPM growers applied 34% fewer miticide sprays compared to the check, while First Year IPM growers applied 10% more such sprays. Difficulties with First Year grower sprayer calibration, poor penetration of concentrate sprays into overly thick tree canopies, and the reluctance of some of these growers to utilize spot treatments for mites, probably account for this difference.

No aphicides were used in check or IPM orchards in 1981, and syrphid fly and cecidomyiid midge predators of aphids were abundant in most blocks (Table 2). Predator numbers, combined with numerous hard rainshowers in June and July, helped to keep fruit from accumulating aphid honeydew. Endosulfan used for STLM control may have resulted in a highly favorable prey/predator ratio, with an enhanced likelihood of biological control.

Dosage equivalents (DE) of insecticide and miticide use reflecting pesticide application rates, showed patterns similar to those for number of spray application trips. DE of insecticide used in Previous Year and First Year IPM blocks were 27% and 26% less than the check. DE of miticide used were 60% lower in Previous Year IPM blocks compared to the checks, while First Year IPM blocks used 10% fewer miticide dosage equivalents than the checks.

Cost and Benefit Comparison - Table 4 summarizes our cost benefit analysis of IPM vs. check blocks in 1981. Both Previous Year and First Year IPM blocks realized substantial savings in insecticide and miticide materials costs, as well as spray application costs, compared to the checks. Due to somewhat higher fruit injury levels, however, value of fruit loss due to insect injury was $25.26 and $87.54/A higher than the checks in Previous Year and First Year IPM blocks respectively. As a result, while Previous Year IPM blocks experienced a net benefit from IPM of $40.18/A, First Year IPM blocks experienced a net loss of $29.84/A.

It should be emphasized that this analysis is intended to show relative not absolute numerical or percentage differences, and that the values therein are average ones. As such, they do not reflect grower wholesale prices for spray materials, per acre yields higher (or lower) than 550 bu/A., nor fruit prices that may differ substantially from those used in this analysis.

This latter analytical component likely introduces substantial error in 1981, a crop year when growers throughout the state are reporting better than normal packout percentages (i.e., relatively few fruit being culled for insect or disease injury, poor color or poor size). Recent work of Bahn, et al. (Fruit Notes 46:3) shows that only about a third of insect injured fruit observed in on-tree harvest surveys actually ends up in the cull bin. As a consequence, we believe that the "avg. value/A of fruit loss due to insect injury" parameter should not be weighed as heavily as it is here, and that the cost benefit analysis should principally reflect differences in spray application and pesticide material costs.

Pesticide Use and Insect Injury, 1977-1981.

Figure 1a details trends in Insecticide use in IPM and check blocks since the onset of the Massachusetts' Apple IPM program. These data indicate that while check insecticide use has remained relatively constant at or near 1977 levels, IPM growers (all 1980 IPM data from 18 good cooperator blocks) have substantially reduced the number of dosage equivalents of insecticide used in their orchards, averaging about 30% fewer such sprays during the four year period noted.

A similar pattern is evident in Figure 1b, with IPM orchards registering about 60% fewer dosage equivalents of miticide used in comparison to the checks. Check blocks nonetheless showed a slight downward trend in miticide usage over this period as well.

Such savings were not made at the expense of fruit quality, however. Figure 1c indicates about 20% less permanent type fruit injury in IPM blocks vs. the check overall, with IPM blocks sustaining less average injury than the check in 3 out of the 4 years.

Fruit injury resulting from aphids has been relatively unimportant during the period cited (Figure 1d) with a steady downward trend evident in IPM and check blocks alike.

Table 1. Average percent insect injury on fruit at harvest in Previous Year IPM, First Year IPM, and check commercial orchards in Massachusetts, 1981.

	1981 Injury (%)[z]		
Insects	Previous Year[y] IPM (20 blocks)	First Year IPM (21 blocks)	Check (7 blocks)
TPB	1.25	1.57	1.20
PC	0.61	0.74	0.47
SJS	0.27	0.94	0.23
EAS	0.16	0.11	0.02
GM	0.11	0.14	0.04
AMF	0.05	0.12	0.01
LR	0.05	0.03	0.01
WAL	0.02	0.07	0
GFW	0	0.01	0.03
CM	0	0.01	0
Total Insect Injury	2.52	3.73	2.01

[z]Based on on-tree survey of 600-2400 fruit per block at harvest (100 fruit per tree from each of 2 trees adjacent to each trapping station).

[y]Orchards which have been on an IPM program one or more years.

Table 2. Mean abundance at peak sampled population of aphids and their predators and of pest and predaceous spider mites, 1981.

	Number of mites per leaf			% terminals		
Orchard type	European red mite	Two spotted mite	*Amblyseius fallacis*	With Aphids	With Syrphids	With Cecidomyiids
Previous Year IPM	8.8	0.7	0.14	26	6	6
First Year IPM	9.4	0.9	0.16	27	8	3
Check	1.4	0.5	0	6	1	1

Table 3. Number of pesticide treatments and dosage equivalents[y] of pesticide applied for insect and mite pest control in IPM and Check blocks, 1981.

Treatment	Previous Year[z] IPM blocks	First Year IPM blocks	Check blocks
Oil	1.1	0.9	1.0
Insecticide	8.0	7.6	10.3
Miticide	0.9	1.4	1.3
Aphicide	0	0	0
Dosage equivalents			
Oil	1.0	0.8	1.1
Insecticide	6.2	6.3	8.5
Miticide	0.4	0.9	1.0
Aphicide	0	0	0

[z]Blocks which have been on an IPM program for one or more years

[y]Dosage equivalent = $\frac{\text{Actual pesticide rate/100 gal}}{\text{Amount recommended in Southern New England Apple Pest Control Guide}}$

Table 4. Cost benefit comparison of insect and mite results in 20 Previous Year IPM, 21 First Year IPM and 7 Check commercial apple blocks in Massachusetts, 1981.

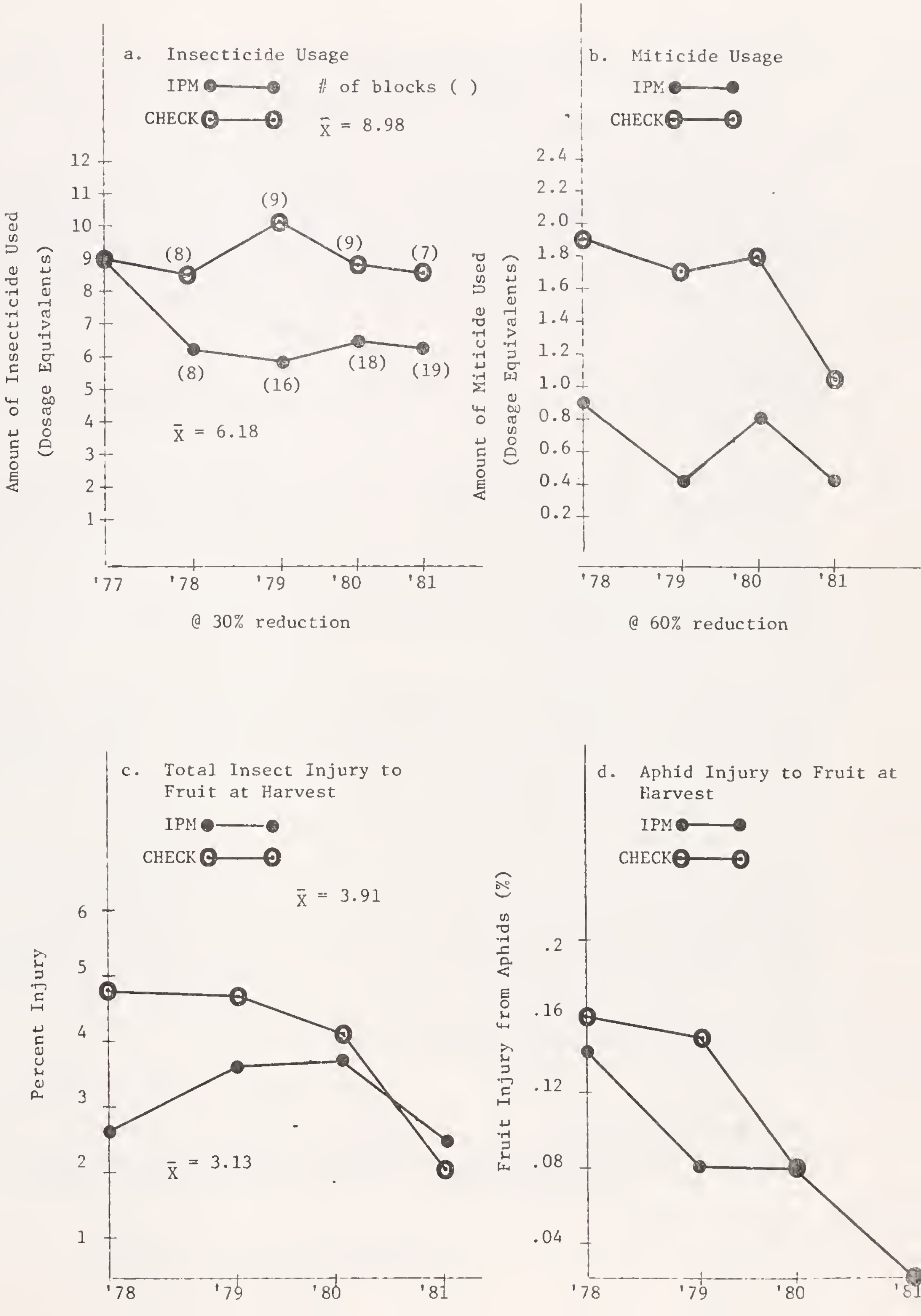
Parameter	Orchard: Previous Year IPM	Orchard: First Year IPM	Orchard: Check	Difference (%) vs. check: Previous Year IPM	Difference (%) vs. check: First Year IPM
(Avg. no. sprays/A)					
Oil	1.1	0.9	1.0	+5	-9
Insecticide	8.0	7.6	10.3	-23	-26
Aphicide	0	0	0	0	0
Miticide	0.9	1.4	1.3	-34	+10
(Avg. no. of dosage equivalents/A)					
Oil	1.0	0.8	1.1	-10	-28
Insecticide	6.2	6.3	8.5	-27	-26
Aphicide	0	0	0	0	0
Miticide	0.4	0.9	1.0	-60	-10
(Avg. cost/A spray materials)					
Oil	$26.16	$20.93	$28.78	-$2.62	-$7.85
Insecticide	$87.86	$95.53	$124.87	-$37.01	-$29.34
Aphicide	0	0	0	0	0
Miticide	$11.74	$19.11	$28.59	-$16.85	-$9.48
(Avg. application cost/A)[y]	$35.37	$33.30	$44.33	-$8.96	-$11.03
(Avg. % insect injury)	2.5	3.7	2.0	+25	+85
(Avg. value/A of fruit loss due to insect injury)[x]	$126.46	$188.74	$101.20	+$25.26	+$87.54
(Avg. net benefit or loss from IPM)[w]				+$40.18	-$29.84

[y]Based on 15 mins time to spray one acre, $6.05/hr labor cost and $2.42/acre per spray date for fuel and oil.

[x]Based on average values as of Nov. 15: U.S. Fancy Fruit @ $12.50/bu, U.S. #1 fruit @ $8.50/bu, cull fruit @ $3.30/bu and average yields of 550 bu/A.

[w]Does not include cost of scouting, traps, travel or administration in IPM blocks (estimated at $45.00 per acre per year).

Figure 1. Trends in Pesticide Usage and Insect Injury to Fruit, 1977-1981.



FROST HEAVING: CAUSES AND EFFECTS

Peter L.M. Veneman
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Soil structure is generally improved by the annual cycle of freezing and thawing. These processes result in better aeration, increased water holding capacities, smaller clods, and smoother seedbeds. Considering these beneficial effects most agronomists and soil scientists will recommend fall plowing to farmers especially in areas where fine textured soils are predominant and if soil erosion during the following winter and spring is not of great concern. While freezing and thawing cycles may be advantageous for the production of annual crops, their detrimental effects on perennials such as alfalfa have been demonstrated in those parts of the country where the soils are periodically frozen.

Like alfalfa, the fruit tree has its feeder roots in the upper 18 inches of the soil profile, which is also the part mostly affected by annual frost action. In the spring and early summer of 1979 we observed that many trees throughout Massachusetts experienced root injury the preceding winter especially on sites with soil drainage problems. Injury initially was limited to the tree roots but later in the year it resulted in the loss of some branches and in the most severe cases the trees died. Some of the partially damaged trees are still weak and need to be replaced.

Most of the winter injury problems are related to the formation of ice lenses in the soil profile as a result of excess soil water. Since the cold season is with us once again, it seems appropriate to discuss this matter in greater detail in this winter issue of Fruit Notes and to indicate possible ways to prevent such damage to fruit trees in the future.

Frost heaving occurs mostly on moist to wet soils, although it sometimes can be found in well drained, fine textured soils with shallow water tables. Researchers (2) studying the susceptibility of alfalfa to frost heaving in southern Illinois found that poorly drained soils with high ground water tables exhibited the most heave and greatest winter-kill of alfalfa seedlings. Well drained soils had some heave but this did not result in significant injury to the plants. These experiments showed that the greatest amount of heave occurred when the night temperatures were a few degrees below freezing and the day temperatures were above 32°F.

Water in freezing soils is transformed into ice crystals. This ice functions as a center for further crystallization of moisture when additional water is allowed to flow towards the frozen part of the soil, which can happen when the initial soil was wet or has a water table close to the soil surface. As long as water can move through the soil, the ice will continue to grow, until most pores are filled with ice and the formation of ice lenses begins. The overlying soil is pushed up while the ice lens is expanding. Most injury to the plants occurs at this time. The roots are locked in the frozen soil clods and when an ice lens is forming between the clods, it pushes the aggregates apart with a force much greater than the strength of the roots, resulting in breakage of especially the smaller roots. The tree loses part of its anchorage and is pushed up with the overlying soil by the growing ice lens, or more likely, a combination of several such lenses. When the weather warms the following spring, some of the surrounding soil may fill the cavity left by the ice lens while the tree remains uplifted, thereby exposing the roots. This may result in drying-out of the roots or injury by subsequent cold temperatures.

The immediate cause of frost heaving is excess moisture, but a soil does not always have to be excessively wet to be prone to heaving. Dirksen and Miller (1) in a series of laboratory experiments found that water lost from the unfrozen soil enters the frozen soil and causes its ice content to increase. This transport of water occurs even when the soil is frozen, through thin liquid water films associated with the ice surfaces. These researchers (1) concluded that when ever the soil was about 90% saturated, ice wedge formation and thus heaving could be expected.

The practical implication for the fruit grower is to provide adequate soil drainage. When the soil is kept sufficiently dry the movement of water in the soil is reduced and ice lens formation and subsequent frost heaving can be prevented. Sometimes, such as during the 1978-79 winter, the weather conditions may be so adverse (e.g., rainstorms during short, warmer periods in the winter) that significant wetting of the profile occurs and frost heaving results. If the grower suspects that such root injury occurred, measures such as extra pruning should be taken to balance the above-ground vegetative parts with the reduced root system. This will be especially important when the growing season following the winter injury has lower than average rainfall and thus puts an extra demand on the already strained root system.

The extent of the root injury also depends on the soil texture. Sandy soils drain quickly, have a lesser capability to utilize water and are therefore less susceptible to winter injury. The finer textured soils are generally more prone to frost heave damage.

Fortunately, the winters in Massachusetts are rather cold without too many warming cycles in January and February and significant root injury due to frost heaving most likely will remain the exception rather than the rule.

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COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 47 No. 2
SPRING ISSUE, 1982

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Issued by the Cooperative Extension Service, Daniel I. Padberg, Director, in furtherance of the Acts of May 8 and June 30, 1914; United States Department of Agriculture and County Extension Services cooperating. The Cooperative Extension Service offers equal opportunity in programs and employment.

CHEMICAL CONTROL OF WATER SPROUTS AND ROOT SUCKERS OF APPLES[1]

William J. Lord, Joseph Sincuk and
Maureen Tumenas

Department of Plant and Soil Sciences

Water sprouts are particularly troublesome on standard-type Delicious and following heavy pruning. Generally they are removed to maintain tree form and prevent shading. Unfortunately, their removal becomes more time consuming in succeeding seasons because of the proliferation from the stubs created by pruning. Sucker growth from roots of mature seedling trees and in plantings of M.7, M.7A and interstem trees is a serious problem and difficult to control in Massachusetts. Suckers are costly to remove, increase in number annually, provide mouse cover, and are a haven for insects and diseases.

Water sprouts and suckers can be controlled with a special formulation of naphthalene acetic acid (NAA). This formulation is available as Tre-Hold Sprout Inhibitor A112* and is registered for use on bearing apple trees.

Mixing Directions

For the control of water sprouts use 10 fluid ounces (2/3 pint) of Tre-Hold and make up to a volume of 1 gallon with a combination of water and interior-grade latex paint. The latex paint "marks" the treated areas and makes the mixture more viscous, thus restricting the NAA to the treated area. It has been our experience that at least 4 pints of latex paint should be used in each gallon of treating solution. Be sure to use an interior-grade latex paint and one that does not contain a mildewcide. <u>Do not use</u> oil base or exterior grade latex paint, since they can cause injury.

<u>For spraying suckers</u>, mix 10 fluid ounces of Tre-Hold with sufficient water to make 1 gallon of spray mixture. Eight gallons of Tre-Hold are required for 100 gallons of spray. The addition of a surfactant or spreader-sticker to the Tre-Hold mixture may increase its effectiveness.

Application for Control of Water Sprouts

Prune water sprouts and then apply the Tre-Hold mixture thoroughly over the cut surfaces. It can be applied with a paint brush or a small compressed air sprayer. We found that a 1-1/2 gallon compressed air sprayer with a 12-foot hose worked well, and that attaching a sponge to the nozzle was useful for swabbing the mixture on pruning cuts. The treatment can be applied anytime weather permits but before growth starts in the spring. Areas where pruning cuts have been made should be covered thoroughly but dripping onto other parts of the tree should be avoided. <u>The Tre-Hold mixture can kill buds. Be sure to follow the label</u>.

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[1] Water sprouts are vigorous shoots arising from any part of the tree above the ground. Suckers are shoots which arise from the roots.

*Trade name

Application for Control of Root Suckers

Root suckers are more difficult to control than water sprouts because they originate from roots below the soil surface and their source is not treated directly. Sucker control is achieved by killing the suckers sprayed and by the translocation of the NAA in the Tre-Hold downward through the suckers.

Clumps of suckers, with their height varying within the clump, proliferate from stubs created by pruning. Therefore, good coverage of Tre-Hold on all suckers within each clump appears necessary for their control. Spray coverage also is facilitated by the control of weeds with herbicides. We found that spraying the grass, weeds and suckers with paraquat 2 weeks prior to the application of Tre-Hold effective for increasing sucker control. This treatment killed the grass and weeds and "injured" the leaves on suckers. The injury of the leaves made good spray penetration into clumps of suckers easier and yet allowed enough leaf surface to remain for effective absorption.

Adequate spray coverage of dense sucker populations is likely to be difficult when using a tractor-mounted weed sprayer and boom since the sprayer should be used at low pressure (10-20 psi) to avoid fruit thinning or ripening from spray drift. Better spray coverage can be obtained with hand-carried or back-pack sprayers because the nozzle of the sprayer can be thrusted into clumps of suckers. Merely directing the spray at the suckers fails to provide adequate coverage and sucker control. Even following the procedure for increasing spray penetration within clumps of suckers may not eliminate the need of repeat annual applications of the Tre-Hold to achieve complete sucker control.

Avoid spraying Tre-Hold on windy days to reduce drift of fine spray particles. Do not apply Tre-Hold when the temperature exceeds 85^{o}F. because volatilization of the NAA can cause leaf damage or fruit ripening on early maturing varieties.

The Tre-Hold mixture is very expensive and to reduce the expense of application apply on suckers beyond the reach of the mower. The sucker population is generally most dense near the tree trunks and most troublesome inside the wire mouse guards. Therefore, in general, the spray should be limited to these areas.

The most effective timing of the Tre-Hold application is when the suckers are actively growing. The suckers should have been pruned during the dormant season prior to treatment to shorten their height and to force succulent growth. Since the Tre-Hold mixture contains 10,000 ppm NAA the application should be delayed until about 4 weeks after petal fall to eliminate the possibility of fruit thinning and leaf injury.

VARIETIES OF PLUMS FOR MASSACHUSETTS

James F. Anderson
Department of Plant and Soil Sciences

Variety	Recommended for	Harvesting season
Formosa (J)	C & H	Early August
Shiro (J)	C & H	Early to mid-August
Santa Rosa (J)	C & H	Mid-August
Ozark Premier (J)	T	Late August
Redheart (J)	C & H	Late August
Bradshaw (E)	H	Late August
Mohawk (E)	T	Early September
Seneca (E)	T	Early September
Iroquois (E)	T	Early to mid-September
Elephant Heart (J)	C & H	Early to mid-September
Imperial Epineuse (E)	H	Early to mid-September
Stanley (E)	C & H	Mid-September
Bavay (E)	H	Late September
Oneida (E)	T	Late September

(J) Japanese Species
(E) European Species
T Trial
H Home
C Commercial

Varieties so marked are not equally adapted to all sections of the state.

Note: To insure successful pollination and fruit set, it is advisable to interplant two or more varieties of each species. <u>Suggested pollenizers for the Japanese varieties are listed following each variety description</u>.

Variety Notes

Formosa - The tree is large, vigorous and moderately productive. The fruit is large, attractive, and the yellow color tends to become completely overlaid with red as the fruit ripens. The flavor is very good and the fruit holds well in storage. (Elephant Heart, Redheart)

Shiro - The tree is medium in size and vigor. Shiro tends to overset and thinning may be necessary to maintain good fruit size and annual production. The fruit has a very attractive, bright yellow color, is of medium-small size and good flavor. (Ozark Premier, Redheart) .

Santa Rosa - A large reddish purple Japanese plum of good quality. The tree is large and vigorous. Santa Rosa ripens about a week later than Formosa. The fruit keeps and ships well. Though usually a productive variety, Santa Rosa has been a poor producer in our University orchards. (Elephant Heart, Redheart)

Redheart - A very good producer of medium-sized, heart-shaped, red-fleshed plums. The fruit has not developed satisfactory flavor in our orchards. Redheart ripens in the third week of August. This variety is said to be a very good pollenizer for other Japanese plums and may prove valuable for that purpose alone.(Elephant Heart)

Bradshaw - The tree is medium to large in size and productive. The fruit is above medium size, blue and of good quality. Bradshaw is recommended for those who desire a succession of varieties in the home garden.

Seneca - A large reddish-blue plum of very high quality. The fruit ripens in early September. The tree was a good producer in our Amherst orchards.

Mohawk - Mohawk is an attractive blue prune, ripening in late August. The size is medium to large, and the quality is very good. Production has been moderate. Mohawk is said to be self-unfruitful.

Iroquois - An attractive blue prune that ripens in early September about a week before Stanley. The fruit is of medium size, longer than Stanley and of good quality. The tree is productive. There was some splitting of the fruit when the trees first came into bearing. Iroquois is said to be self-fruitful.

Elephant Heart - The tree is large and vigorous. The fruit is very large, dark red and heart-shaped. The flesh is blood-red in color and good in quality. Elephant Heart is a desirable variety where high yields can be maintained. (Redheart)

Imperial Epineuse - The tree is large, upright-spreading and productive. The fruits are reddish-purple in color, medium to large in size and of excellent flavor. This rather unattractive prune is recommended for the home orchard where high quality is desired. This variety is highly susceptible to brown rot.

Stanley - The tree is medium in size, vigorous and productive. This attractive blue prune is medium to large in size and very good in quality. Stanley is a desirable variety for canning.

Bavay - The tree is large, upright, vigorous and moderately productive. This green gage type plum is of medium to small size, unattractive, but of high quality. Bavay is recommended for the home garden.

Oneida - The tree is medium in size, vigorous and productive. The fruit is large, reddish-black, prune-shaped and very good. Oneida keeps well in storage and appears to be worthy of trial where a late ripening plum is desired.

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BORON FOR PEACH TREES

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Analyses of peach leaves from commercial orchards in 1981 showed that in some instances boron (B) was less than 30 ppm. Since 30-50 ppm is considered optimum for peaches, the question of whether or not to apply this element arose.

Peach trees are more sensitive to excessive applications of B than apple trees, thus this element should be applied only in small amounts if needed. Peach tree symptoms of excessive B are characterized by withering and dying-back of terminal shoots during the growing season, the development of cankers and gumming along the shoots, rough bark, prominent lenticels, and excessive development of lateral shoots. To avoid B toxicity, Ernest G. Christ, Extension Specialist of Pomology at Rutgers University in New Jersey is very cautious about recommending the use of this element when fertilizing peach trees. He states that..."fertilizer with 5 pounds of borax per ton is usually OK for peaches. No additional B is ever needed or added. Also, keep pH of soil 6-6.5".

We suggest that peach growers in Massachusetts follow the recommendations of Ernest Christ concerning use of B.

EVALUATION OF DILUTE vs. CONCENTRATE SPRAYER PERFORMANCE

Frank Drummond[1], James T. Williams[2], and Ronald J. Prokopy[3]

There has been debate during the past decade as to the efficacy of low-volume spraying in comparison to dilute spraying in orchard crop protection practices. The advocates of low-volume spraying in orchards cite several advantages for this practice, the most important of these being water conservation and greater spray droplet deposition on the foliage (Brann 1964, Lewis et al. 1969, and Hall et al. 1981). Steiner (1976) reported that approximately 70% of pesticide-active ingredients are deposited upon target surfaces with low-volume spraying whereas only 55% is deposited with dilute spraying. However, growers as well as researchers (Hall et al., 1975) have found that low-volume sprays are not always deposited efficiently in all parts of the apple tree canopy. Our objective in this study was to evaluate the deposition of dye applied by 2 types of orchard sprayers on Cortland and Delicious trees 17 feet and 8 feet in height, respectively.

The experimental design incorporated an early season trial on May 4 (trees were in the pink stage of bud development) and a mid-season trial on July 28. On May 4th the sky was overcast and the temperature was in the mid 60's. The wind velocity averaged 15 mph from the northeast, with gusts up to 25 mph. On July 28, the sky was clear, the temperature was approximately 74^{o}F and the wind velocity ranged 0-5 mph from the east.

Both spray trials were conducted at Marshall Farms in Fitchburg, Massachusetts. The treatments were applied with a Hardie sprayer at 4X and 125 psi gauge pressure, and a Kinkelder sprayer at 25X and 25 psi gauge pressure. The Kinkelder was used both with and without the operation of an electrostatic charger. Each experimental block consisted of a row of trees running north to south from which subsamples of leaves were collected. The sprayers were driven on each side of the treatment row. There were 2 buffer rows between each treatment row to minimize the effects of drift.

Spray deposition was measured by a method similar to that used by Jubb (1980). A fluorescent dye, Dayglo* fire orange (AX-14-N) was applied at the rate of 1 lb./acre. Surfactants were used to aid in incorporating the dye into water (1/2 pt./100 gal. Ajax* liquid soap for the first trial and 1 pt./100 gal. Triton-B* spreader sticker for the second trial). The distribution and

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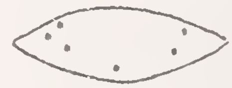
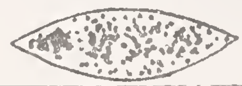
* Trade name

amount of dye per leaf was estimated by a single index rating made visually under a 15 watt ultra-violet lamp (Table 1).

Table 1. Rating system for evaluating deposition of fluorescent dye on apple leaves.

Amount of dye	Value assigned	Typical appearance
None	0	
Trace	1	
Light	2	
Medium	3	
Heavy	4	
Very heavy	5	

Leaves from 6 positions in the tree canopy (top center, bottom center, north, south, east, and west peripheries) were rated separately for initial analysis of droplet distribution and were later pooled into four positions (top center, bottom center, alley periphery, and within row periphery) for subsequent analysis.

Results

The dye deposition on May 4 in the small Delicious trees by the sprayers was similar except in the top center of the trees where the low-volume sprayer without the electrostatic charger did not provide as heavy a coverage as the dilute sprayer (Table 2). However, differences in dye distribution were more discernible in the tall Cortland trees. Leaves from top center and bottom center of these trees after being sprayed with the Kinkelder had heavier dye deposits when the electrostatic charger unit was in operation than when not used (Table 2). The dilute sprayer appeared to apply a more evenly distributed coverage throughout the tall trees than either of the low-volume methods.

The results of the July 28th trial indicate no discernible differences in dye deposition on small trees due to sprayer type. Such was not the case, however, in the Cortland trees. Here, the dilute sprayer proved far superior to the low-volume sprayer in delivering impinging droplets to the top center of the trees. Analysis of droplet deposition in the bottom center of the trees suggests that the electrostatic charger played a positive role in dye deposition at this site.

Table 2. Due deposition on leaves sampled from different sections of the tree.

	Low-volume spray electrostatic with	Low-volume spray electrostatic without	Dilute spray
May 4	Dye deposit rating (0 = no coverage; 5 = heavy coverage		
Delicious, height 8 ft.			
Top center	3.0ab[z]	2.3a	3.3b
Bottom center	3.1a	2.8a	2.4a
Within row	2.9a	3.2a	3.0a
Alley	2.9a	2.7a	2.9a
Cortland, height 17 ft.			
Top center	3.2b	1.4a	2.8b
Bottom center	3.1b	1.5a	3.3b
Within row	2.2a	3.1ab	3.4b
Alley	2.8a	2.2a	3.1a
July 28			
Delicious, height 8 ft.			
Top center	3.0a	2.8a	3.0a
Bottom center	2.8a	2.4a	3.1a
Within row	3.9a	2.9a	3.8a
Alley	4.1a	3.6a	4.2a
Cortland, height 17 ft.			
Top center	2.5a	2.6a	4.4b
Bottom center	3.0b	1.8a	3.2b
Within row	2.8a	2.9a	3.3a
Alley	3.9a	3.6a	3.9a

[z] Within a row (⟶) ratings followed by a different letter are significantly different at odds of 10 to 1 (Lehman-Hodges test).

Discussion

One should be careful in formulating general conclusions from a study such as this. One problem is that an interaction between sprayer performance, tree phenology, and weather conditions exists. As a result, it is difficult to evaluate the impact of these factors when formulating general guidelines for selection of appropriate sprayer type.

Nevertheless, it has been shown by this study that under windy conditions in the spring, and calm conditions during mid-season the low-volume Kinkelder sprayer with or without electrostatic charger in operation performed with nearly equal efficiency as the dilute sprayer when used to spray small trees. The positive influence of the electrostatic charger was more easily discernible when used in spraying tall trees (17 feet in height) in the spring. Here the Kinkelder (25X) with electrostatic charger in operation performed about as efficiently as did the Hardi dilute (4X) sprayer, both being superior to the Kinkelder without the use of the electrostatic charger. The dilute sprayer appeared to apply more evenly distributed dye coverage throughout the tall trees both on May 4 and July 28 than either of the low-volume methods.

It may not be possible to translate our findings on spray coverage to actual pesticide efficacy. One might assume that the best coverage will yield the best pesticide effectiveness. However, this relationship may not always hold true. In a recently published work, Dr. Franklin Hall of the Ohio Agricultural Research Center (1981) found that no direct correlation could be made between spray deposition (amount and droplet size) of Permethrin and mortality of two spotted spider mites (*Tetranychus urticae* Koch). Until more research is conducted, comparison of sprayer efficiency will have to be based on a relative method such as the one utilized in this study.

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VARIETIES OF APPLES FOR MASSACHUSETTS

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Variety	Recommended for	Harvesting season
Vista Bella	C*	Late July to early August
Jerseymac	T	Mid to late August
Tydeman's Early	C	Late August to early Sept.
Paulared	C	Late August to early Sept.
Akane	T	Early September
McIntosh	C	Mid September
Macoun	C & H	Late September
Spartan	C & H	Late September
Empire	C & H	Late September
Cortland	C & H	Early October
Delicious	C & H	Early to mid October
Golden Delicious	C & H	Mid October
Idared	C & H	Mid October
Spencer	C & H	Mid October
Mutsu	C	Mid October

* T = Trial; H = Home garden; C = Commercial - Varieties so marked are not necessarily equally adapted to all parts of the state.

Variety Notes

Vista Bella: The fruits are of medium size, firm, and have a bright smooth finish and medium red color. The fruits are very good quality for an apple of this season. The tree is large, vigorous, and productive.

Jerseymac: An attractive McIntosh type. Fruit color is attractive (80% red), size is above medium, texture is medium-firm, but fruits show bruises easily. Eating quality is good. The trees are annual and productive.

Tydeman's Early: Often labeled Tydeman's Red. A McIntosh type, ripening in late August. Fruit has green undercolor overlaid with a medium-red blush. May average larger than McIntosh in size. Similar to Rome in habit of growth.

Paulared: Ripens with or slightly later than Tydeman's Early. The fruits are medium to large in size, roundish-oblate in shape and have excellent color and finish. The fruits color very early. The fruit has tended to cluster on our young tree. Production appears to be good.

Akane: The fruits are of medium size, attractive with a bright red color but show some russet. The flavor and keeping qualities are very good. The trees in our plantings have been less than medium in production.

McIntosh: Fruit is attractive and has excellent quality but bruises easily. Tree is vigorous, hardy, annual and productive. A good red strain such as Rogers, Summerland, Imperial or Marshall is preferred. Spur types are available.

Macoun: Fruit of excellent quality, attractive dark red color. Tree has poor structure, is biennial and requires thinning to maintain good fruit size.

Spartan: Fruit has good color and quality but has a tendency to small size. Tree is vigorous and of good structure, annual, will pollinate McIntosh.

Empire: A very attractive apple with full red color, medium size, and very good dessert quality. Empire is annual, and productive and a good keeper.

Cortland: Fruit is attractive, good quality, excellent for salads as flesh does not discolor, very susceptible to storage scald. Tree is hardy, productive, and annual. An excellent pollenizer for McIntosh.

Delicious: Fruit of excellent quality but susceptible to watercore and internal breakdown. Tree is of medium vigor, often biennial and may require thinning. A good pollenizer. Among the non-spur red strains Royal Red, Rogers Red and Gardiner Red have looked good in our plantings. Starkrimson (Bisbee) and (Miller) Sturdeespur are recommended where spur types are desired.

Golden Delicious: Fruit of excellent quality and attractive where well-grown. Fruit is subject to russeting. Tree is of medium vigor, biennial and requires thinning to obtain satisfactory size, color and quality. Russet-free and spur type strains are now available.

Idared: Attractive, bright red, winter apple of good quality and size. Suitable for both dessert and cooking. Tree is productive and annual.

Spencer: Fruit is attractive, bright red and has very good quality. Suitable for dessert and pie. Tree is hardy, productive and annual.

Mutsu: A Golden Delicious type that is less susceptible to fruit russeting and storage shrivel. Tree is vigorous and productive. Mutsu pollen is triploid and not viable. Fruit size may be too large and a susceptibility to blister spot has been noted.

APPLE DISEASE MANAGEMENT IN MASSACHUSETTS: 1981 RESULTS AND A FOUR YEAR SUMMARY

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The Massachusetts Apple Integrated Pest Management (IPM) program has been in operation for 4 years. As the IPM program enters its final year, we present the disease management results for 1981 and a 4-year summary of the disease management program.

1981 Season

During the 1981 season, 17 commercial apple orchards were involved in the disease management part of the IPM program. Eleven of the orchards were scouted and visited on a regular basis and participated in apple disease management. Modified hygrothermographs were placed in each orchard so that fungicide sprays for apple scab could be applied on an after-infection or "kickback" basis. The other six orchards were not in the IPM program and served as controls.

The 1981 growing season was most unusual. Usually the apple tree buds and the spores of the apple scab fungus (Venturia inaequalis) develop at about the same rate and growers begin spraying when green tissue shows. However, in 1981, green tissue developed prior to the discharge of scab spores, but it was difficult to convince growers not to spray and some growers applied 1-2 unnecessary sprays. Also, many wetting periods were encountered and it was difficult in the early growing season to reduce fungicide sprays and manage apple scab.

The wetting periods for primary scab development at the Horticultural Research Center in Belchertown, Massachusetts are shown in Table 1. The ascospores did not begin to mature until near the end of April, whereas green tissue was present on April 14.

The first 2 significant apple scab infection periods at the Horticultural Research Center (Table 1) occurred when 8% mature scab spores were released during two severe infection periods at tight cluster and pink. Despite the low percentage of spores, the relatively long wetting periods (50 and 27 hours) were most important in designating them as significant and severe infection

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1 IPM technician
2 IPM scout
3 Professor of Plant Pathology

periods. Another severe infection period was recorded at petal fall, when 38% of all potential scab spores were discharged during a 34 hour wetting period. A moderate infection period on June 20 and 21 ended the primary scab season.

Table 1. Apple scab season at the Horticultural Research Center, Belchertown, Massachusetts, 1981.

Apple growth stage	Date	Wetting period (hrs)	Mean temp °F	Rainfall (mm)	Cumulative scab spores discharged [1]	% potential scab infection severity[2]
Green tip	4/14	11	45	Trace	0	No infection
1/2" green	4/17	12	56	0.3	0	Light
Tight cluster	4/23-25	50	50	0.6	2	Severe
Pink	4/29-30	27	59	1.0	8	Severe
Bloom	5/11-12	16	62	0.5	20	Moderate
	5/12-13	8	55	0.4	22	No infection
Petal fall	5/15-16	34	61	36.8	60	Severe
1/2" fruit	5/29	9	70	29.5	68	Light
	6/6	7	66	8.9	72	No infection
1" fruit	6/9	11	69	20.3	86	Light
	6/10-11	12	57	Trace	90	Light
	6/12-13	12	59	Trace	94	Light
	6/20-21	13	67	12	99	Moderate
	END OF PRIMARY SEASON ------------------					

[1] Collected weekly.

[2] Infection severity was determined by the Mill's Table for primary scab infection.

Fungicide usage and the incidence of fruit diseases at harvest in the IPM orchards are summarized in Table 2, and similar information for control orchards is found in Table 3. The IPM orchards averaged 2 less fungicide sprays than the non-IPM orchards, and received about 3 less dosage equivalents. In contrast, a slightly higher percentage of diseased fruits were harvested from the IPM orchards (Table 2) than from the control orchards (Table 3). Neverthless, $7.79 per acre was saved in the IPM orchards, because the savings from reduced fungicide usage more than offset the higher loss due to downgrading of fruit because of diseases (Table 4).

Table 2. Cost benefit analysis of fungicide usage and fruit quality for IPM orchards in 1981.

Orchard	Number of fungicide sprays	Dosage Equiv.[z]	IPM orchards % diseased fruits at harvest	Fungicide cost per acre	$ loss to disease per acre
1	14	8.83	0.1-Scab 0.3-Other	100.14	18.26
2	11	10.43	0.5-Scab 0.2-Other	125.57	31.95
3	11	11.68	0.1-End rot	93.61	4.65
4	8	8.27	0.2-Scab 0.5-Other	132.05	31.95
5	11	9.36	0.5-Scab 1.1-Other	97.17	73.04
6	11	7.95	0.5-End rot & Black rot & Bitter rot	92.37	22.82
7	13	10.53	0.1-Scab 1.0-Other	93.73	50.21
8	9	7.96	0.2-Scab	123.88	9.13
9	11	10.62	0.1-Scab 0.6-Other	101.31	31.95
10	12	9.88	0.1-Scab 1.1-Other	96.10	54.78
11	10	10.48	0.1-Scab 1.2-Other	117.96	59.34
Averages	11	9.63	0.17-Scab 0.60-Other 0.77-Total	106.72	35.28

[z] Dosage equivalent = $\frac{\text{amount of fungicide applied}}{\text{average recommended rate for that fungicide}}$

Number of fungicide sprays varied from 8 to 14 among the IPM orchards, with dosage equivalents ranging from 7.95 to 11.68 (Table 2). The lower number of fungicide sprays and dosage equivalents were due to efficient timing of fungicide applications aimed especially at apple scab. (Fungicides were

Table 3. Cost benefit analysis of fungicide usage and fruit quality for control orchards in the IPM program in 1981.

Orchard	Number of fungicide-sprays	Dosage Equiv.	Control orchards: % diseased fruits at harvest	Fungicide cost per acre	$ loss to disease per acre
1	13	10.20	0.1-Scab 0.1-Other	113.48	9.30
2	13	9.77	0.2-Scab 0.8-Other	130.36	46.50
3	14	13.54	0	147.45	0
4	13	14.01	0	157.95	0
5	14	14.33	0	140.17	0
6	11	10.43	0	135.57	0
Averages	13	12.04	0.2	140.00	9.79

applied as protective sprays just prior to predicted long wetting periods while sprays were withheld prior to predicted shorter wetting periods, applying kickback sprays only when wetting periods and temperature suggested infection periods--as measured by hygrothermographs.) Increased number of fungicide applications, without

Table 4. Cost benefit analysis of fungicide usage and fruit quality for IPM programs 1978 through 1981.

	1978		1979		1980		1981	
	IPM	Control	IPM	Control	IPM	Control	IPM	Control
No./fungicide sprays	11.80	12.5	10.64	13.00	9.45	10.36	11.00	13.00
Dosage equiv.	12.04	12.18	9.77	11.11	8.11	8.80	9.63	12.04
Fungicide cost/ acre ($)	-[z]	-	74.06	88.68	85.26	94.58	106.72	140.00
% diseased fruits at harvest	3.45	1.32	0.99	0.93	0.85	0.40	0.77	0.20
Loss to disease/ acre ($)	-	-	46.28	43.48	50.31	56.30	35.28	9.79
IPM benefits per acre ($)			11.82		15.31		7.79	

[z] Data not taken.

increased dosage equivalents, in several of the IPM orchards were attributed to the growers' addition of low rates of fungicides when applying insecticides or growth regulators. Increased dosage equivalents were mostly due to applications of a high rate of fungicide (esp. Cyprex*) aimed at "burning out" established scab lesions.

4-year Summary

The average number of fungicide sprays has traditionally been correlated with weather patterns, especially rain. Increased numbers of spring and summer rains usually has necessitated increased fungicide applications and dosage equivalents. Long periods of rain in 1978 and 1979 and weekly wetting periods early in 1981 made kickback spraying difficult in IPM orchards. Therefore, protective sprays were necessary prior to predicted long rainfalls, with at least one extra fungicide application to "burn out" established scab infections and inhibit secondary infections. 1980 was a much drier growing season; therefore, fewer numbers of fungicide applications were required (Figure 1), with fewer dosage equivalents (Figure 2). Fungicide applications were greatest in control blocks in 1979, but there were fewer dosage equivalents than the other wet years of 1978 and 1981. This is explained by growers adding low rates of fungicides with insecticides in spring. Regardless of weather, IPM disease management has consistently reduced number of fungicide applications and dosage equivalents in IPM vs. control blocks.

While the first year of the IPM disease management program reduced fungicide applications only by 5.6% and dosage equivalents by 1.2% (Table 5), during the wet years of 1979 and 1981, IPM blocks experienced 18.2 and 15.4% reductions in fungicide sprays and a 12.1 and 20.1% reduction in dosage equivalents. The drier year, 1979, had an 8.8% reduction in fungicide sprays, with 7.9% fewer dosage equivalents. Percent fruit disease at harvest (Figure 3) has consistently showed IPM blocks to have disease percentages lower or comparable to control blocks. In Table 4, dollar amounts are given for fungicide applications and losses due to fruit diseases. IPM benefits per acre for 1979, 1980, and 1981 were $11.82, $15.31, and $7.79.

Table 5. Fungicide usage in IPM orchards in comparison to control orchards; 1978 through 1981.

Year	No. fungicide sprays		% diff.	# dosage equivalents		% diff.
	IPM orchards	control orchards	fungicide usage IPM vs. control	IPM orchards	control orchards	fungicide usage IPM vs. control
1978	11.80	12.50	5.6	12.04	11.18	1.2
1979	10.64	13.00	18.2	9.77	11.11	12.1
1980	9.45	10.36	8.8	8.11	8.80	7.9
1981	11.00	13.00	15.4	9.63	12.04	20.1

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* Trade name

In connection with the IPM Apple Program, several workshops on disease and insect control are conducted. In addition, non-IPM growers used information gathered by IPM scouts. Thus, it is possible that fungicide usage also has been reduced in many non-IPM blocks, as a result of this information.

The IPM Program has another season to go before being terminated. Nevertheless, it is evident that disease management practices can reduce fungicide usage without lowering pack-out and saves money for the grower.

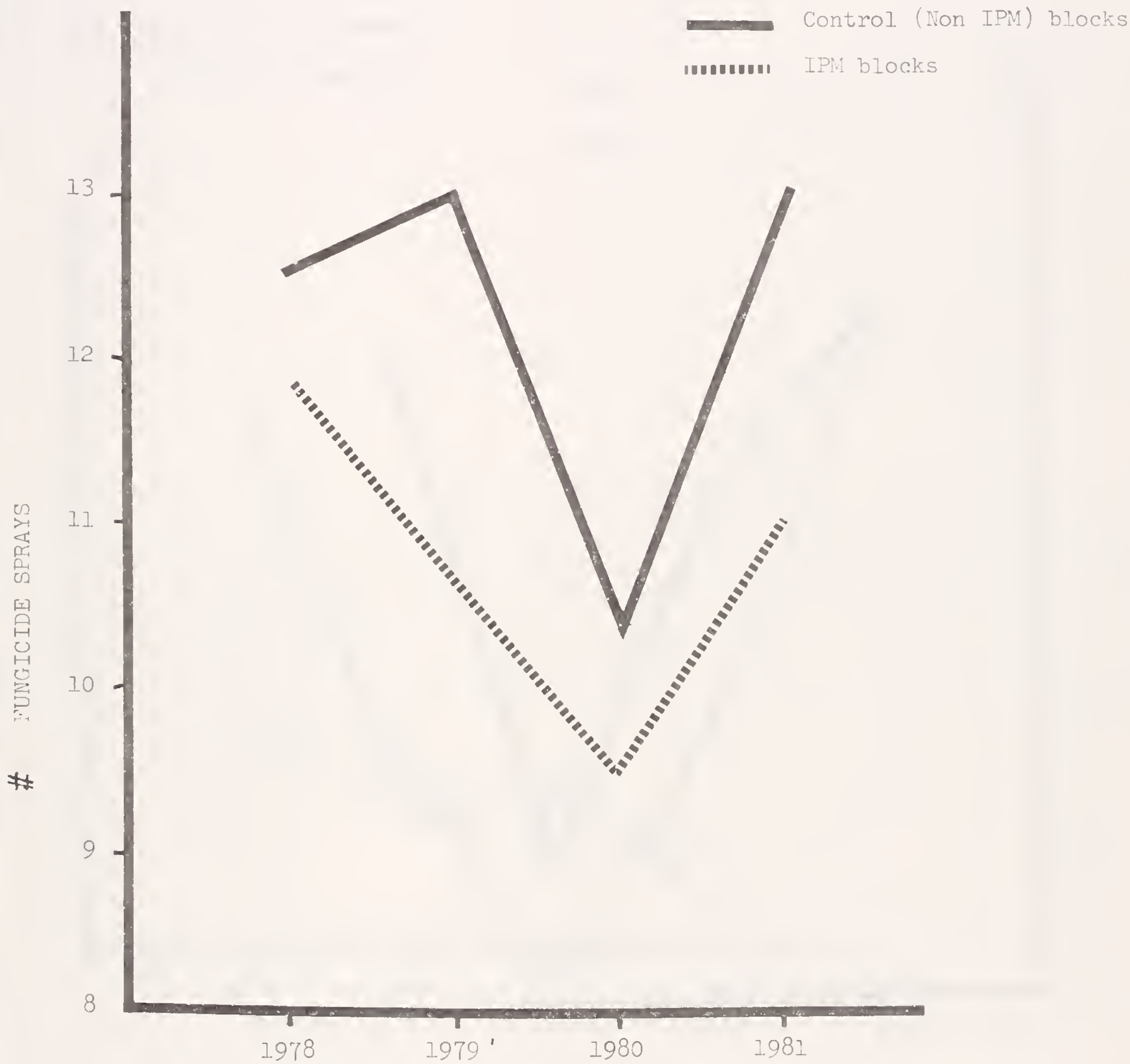

Figure 1. Trends in the average number of fungicide sprays applied to IPM and non-IPM blocks: 1978-1981.

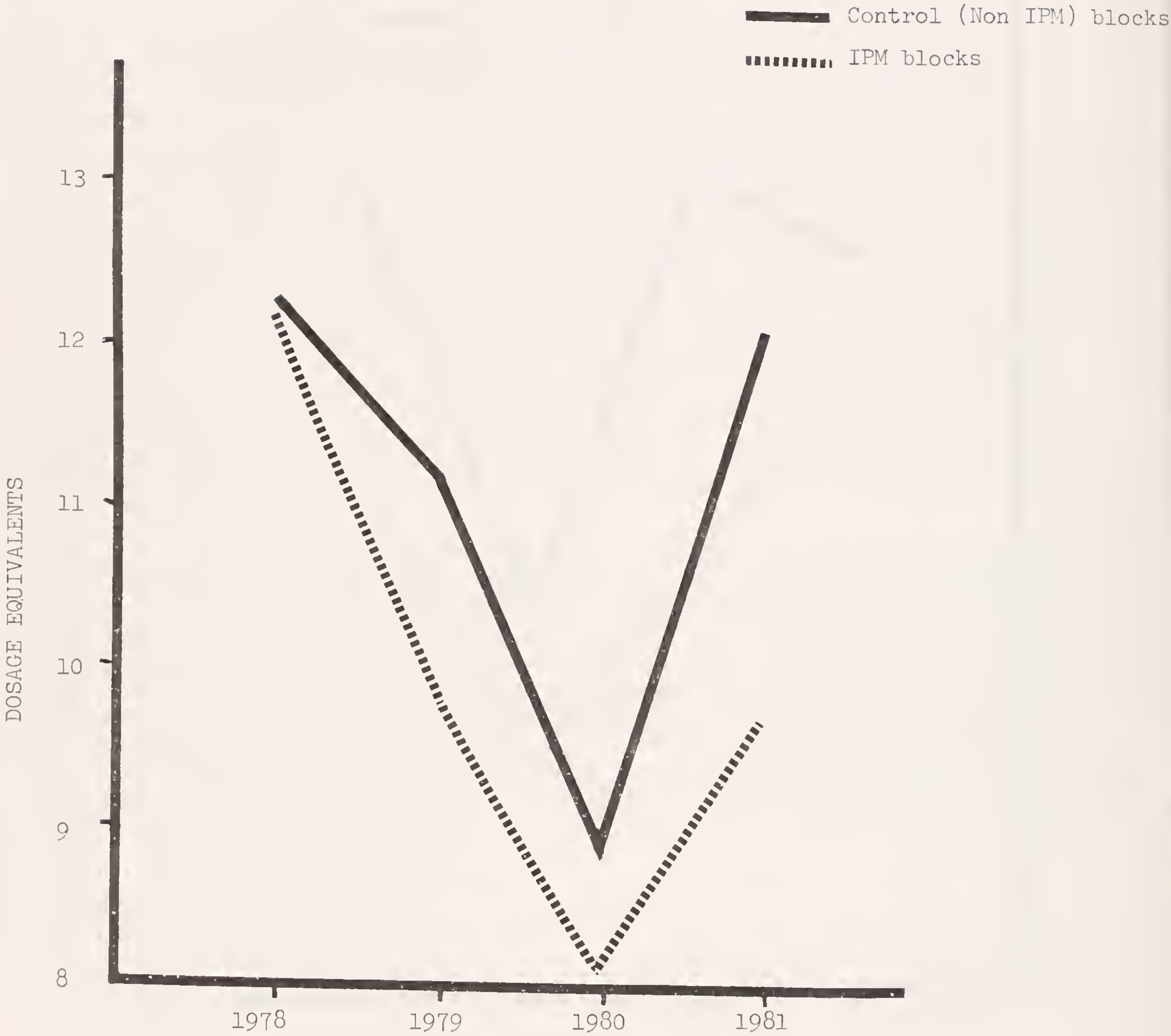

Figure 2. Trends in the average number of dosage equivalents used in IPM and non-IPM blocks: 1978-1981.

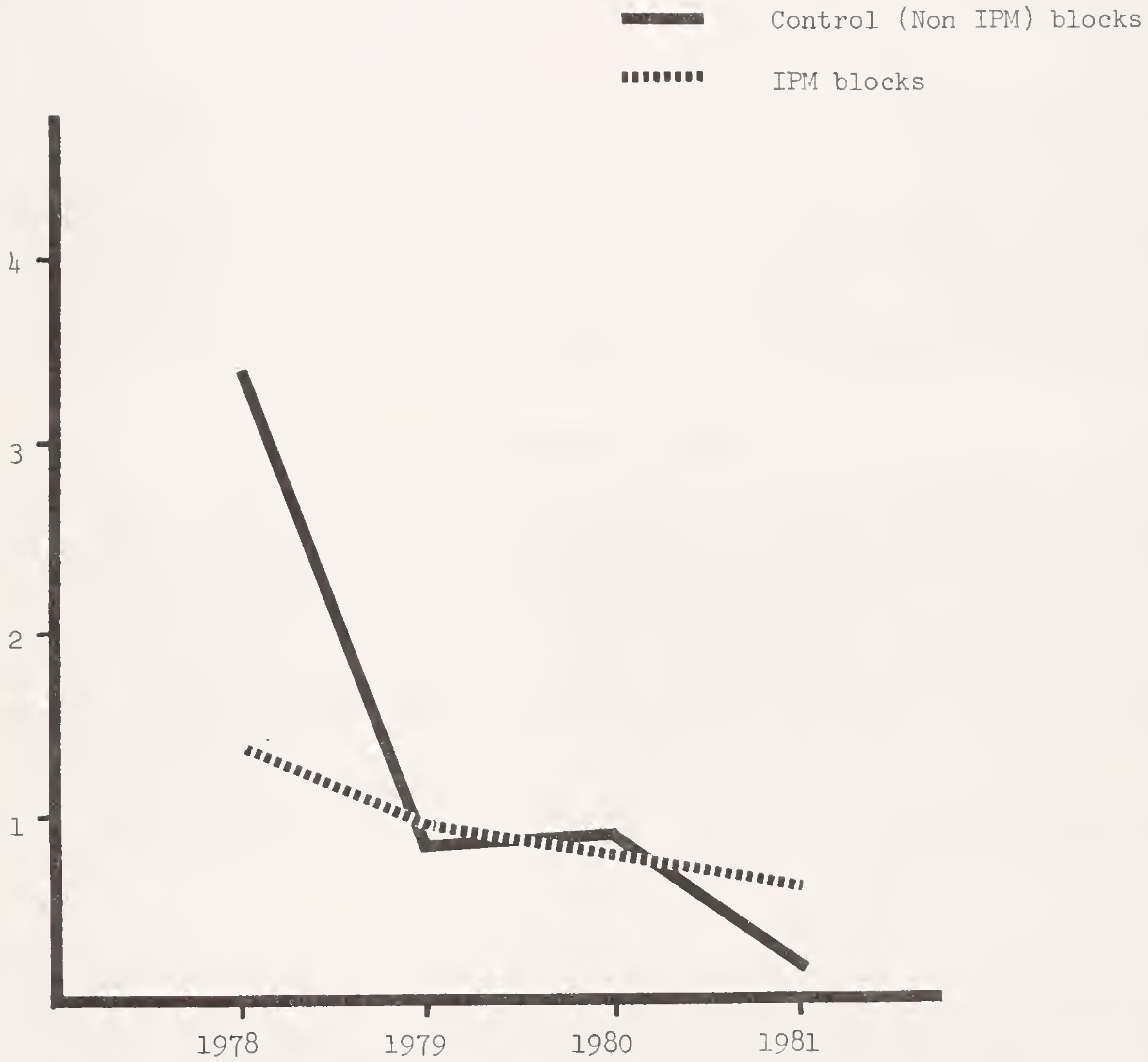

Figure 3. Average per cent fruit disease at harvest in IPM and non-IPM blocks: 1978-1981.

ORCHARD NUTRITION

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Orchard nutrition is often a major factor influencing orchard productivity and fruit quality. More intensive planting systems, higher yields, and changes in production management systems require re-evaluation of orchard nutrition needs.

Orchard nutrition management starts with an evaluation of conditions that exist in the soil and in the trees. Limited soil depth and imperfect internal drainage limit root development and the volume of soil from which the tree can obtain nutrients and water. Likewise, coarse-textured soils may have limited exchange capacity as well as limited water holding capacity. Any factor that limits root development or water supply will influence tree nutrition. Soil pH, cation exchange capacity, inherent nutrient supplying power as determined by parent materials and organic matter content must also be considered in developing fertilizer programs.

Soil Testing

Soil testing is one means of measuring chemical soil factors. Soil testing to determine pH, lime requirement, calcium (Ca), potassium (K), magnesium (Mg) and phosphorus (P) levels gives some information on nutrient status and possible causes of problems. Samples of both topsoil (o to 8") and subsoil (12 to 24") should be examined. When preparing a new site or in renovating an old orchard site, soil tests are the only feasible means of determining the amounts of lime, type of lime, and amounts of other nutrients that must be added before the trees are planted. After trees have been established, soil testing is useful in monitoring soil pH and may help to explain abnormalities detected in leaf sample analyses.

Soil pH and Lime Requirements

Adjustment of soil pH and incorporation of lime is easier and more effective during site preparation than after trees have been planted, particularly if large corrections are required. The amount of lime required to raise the plow depth to a pH of 6.2 to 6.5 varies with soil texture and initial pH approximately as follows:

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1 Associate Professor of Pomology

Table 1. Soil pH and lime requirements (approximate values)

Initial soil pH	Soil texture			
	Sands	Sandy loams	Loams & silty loams	Silty clay loam
			Tons per acre	
4.5-4.7	3.0	5.5	9.0	12.0
4.8-5.1	2.5	5.0	7.0	10.0
5.2-5.5	1.5	3.0	4.0	5.0
5.6-5.9	0.5	1.0	1.5	2.5
6.0-6.3	0.25	0.5	0.75	1.0

Actual quantity of lime needed varies with the equivalent neutralizing value of the limestone used. High-magnesium (Mg) limestones usually have greater neutralizing value than low-Mg limestones. Applications of over 2 to 3 tons per acre should be made as split applications to established orchards. During preplant soil preparation, part of the lime can be applied and worked in before plowing the soil and applying and working in the remainder.

Soil test results for potassium (K), calcium (Ca), and magnesium (Mg) are helpful in identifying potential problems especially during site preparation. The amounts of these elements that should be applied varies with soil texture, exchange capacity and initial quantities present. In general, these should be built up to high or very-high levels before the orchard is planted. In most Eastern New York orchard soils this means <u>200 lbs. or more of K</u> (over 150 lbs. in some of the heavier clayey soils); and 200 lbs. or more of Mg per acre. Ca levels should approximate 2500 lbs. per acre. Since not all soils have the exchange capacity to hold these quantities it is best to start with a soil test.

P is often overapplied in apple orchards. An initial application of 100 to 120 lbs. of P_2O_5 per acre during soil preparation, combined with correction of soil pH, should be sufficient to provide adequate amounts of P for a number of years. P requirements of apple trees are relatively low (approximately 8 to 10 pounds removed per year in the fruit). No clear-cut beneficial effect of increased P levels has been shown on tree growth, flesh quality or keeping quality of the fruit as long as leaf samples contain at least 0.08 to 0.16% P. On the other hand, excessive rates of P application may precipitate zinc (Zn) or copper (Cu) as insoluble phosphates and produce deficiencies. It is suggested that the initial broadcast application of P in preplant soil preparation may be supplemented with a high P starter solution applied to the newly set tree to possibly help tree root development and that further application of phosphates be eliminated unless leaf samples of P fall below 0.08%.

This is not likely to occur if soil pH is properly maintained.

Leaf Analysis

Leaf analysis, with all of its faults, still represents the best tool available for monitoring the nutritional status of established trees. Some basic considerations must be kept in mind:

1. Method and time of sample collection should be uniform if samples are to be compared. Specifying the sampling time, i.e., 60 to 70 days after bloom, and location of leaves to be sampled is helpful in comparing results to standards.

2. The leaf sample analysis indicates the amounts of various elements in the sample as submitted. Leaf analysis does not distinguish the amount of an element that is physiologically active from the amount that may be present as contamination from various sources such as spray materials.

3. Varieties, rootstocks, growth status and cropping levels, as well as soil variability and weather conditions during the growing season, influence leaf contents of elements in various ways and must be considered in interpreting leaf analysis results. When growth is severely limited by deficiency of some elements, the concentrations of all elements including the deficient one(s) may appear to be normal. In such cases diagnosis of the actual cause of the problem may require much additional information, or even field trials of suspected elements. Some of these types of relationships will be illustrated as individual elements are considered.

4. Leaf analysis can be used for various purposes such as diagnosing possible causes of a problem, or, preferably, to monitor nutrient status so that corrections can be made before a problem becomes serious. In practice, both approaches are usually involved.

Leaf Analysis Standards for Apples

1. N. Optimum N varies with variety and purpose for which it is grown. Usually the optimum values fall within an overall range from 1.8 to 2.4%. Values below 1.8% N are usually associated with reduced growth, smaller fruit size, and greater tendency toward biennial bearing. Annual removal of N by fruit is in the range of 30 to 40 lbs. per acre. An additional 30 to 60 pounds may be required for tree growth, to build reserves, and to support grass growth

under the trees. Eliminating grass competition by herbicides reduces the rate of N applications required by approximately 30 to 40 pounds per acre per year. Excessive tree vigor resulting from excessive N applications can be partially compensated for by late summer pruning. This has two main effects: it improves fruit color by improving light distribution, and tends to limit root growth. Fruit size may also be reduced by summer pruning.

2. P. Leaf concentrations of P may range from 0.08 to over 0.30%. McIntosh tends to accumulate less P than Delicious. High levels of P in leaf samples indicate the possibility that tree growth has been stunted by lack of N, drought, competition from grass, root and/or trunk injuries, or because of other nutrient deficiencies.

3. K. Optimum K levels usually fall between 1.2 and 1.8%. Varieties such as Delicious appear to be more efficient in taking up K than others such as McIntosh. K levels should be considered in relation to N levels, with N/K ratios of 1.25 to 1.50 indicating reasonable balance. Levels below 1.2% indicate possible need for additional application of K; those below 0.8% indicate deficiency. The form of K applied should be related to Mg levels. If both K and Mg are needed, sulpomag should be applied, while if Mg is adequate the use of muriate of potash or other forms may be appropriate.

4. Ca. Ca levels below approximately 1.24% should be considered as low, those below 1.00% as deficient. Low levels of Ca may indicate insufficient soil levels of Ca (particularly as indicated by the subsoil), and/or low pH, but may be the result of shortages of other elements such as N or boron (B) or of other factors that limit the ability of the tree to absorb and translocate Ca. Leaf Ca levels normally show a direct positive relationship with leaf N concentrations. Liming and correcting soil pH should be the first step in dealing with low Ca levels. If additional corrective treatments are required these might include soil applications of calcium sulfate (gypsum) if pH is too high, and/or foliar applications of calcium chloride. Fruit content of Ca has been related to keeping quality. Large fruit usually contains lower concentrations of calcium. Foliar sprays and/or post-harvest application of $CaCl_2$ may be needed on such fruit.

5. Mg. Optimum levels of Mg fall in the range of 0.30 to 0.45%. Rapidly growing young trees and trees bearing heavy crops of fruit are most susceptible to Mg deficiency. Low Mg supply in the soil is the major limiting factor. High-Mg dolomitic lime and applications of Mg salts such as kieserite or langbeinite (sulpomag) are usually required to overcome

this problem. Raising soil pH with calcitic lime may give a partial and temporary improvement in Mg availability but does not correct the basic Mg shortage. Response to soil applications of Mg salts may be slow. Inclusion of Epsom salts in the petal fall, first and second cover spray is usually necessary until soil Mg levels are corrected. Epsom salts should be applied at a rate of 45 lbs. per acre in each of these 3 sprays if Mg levels in leaf samples are less than 0.3%.

6. B. Optimum leaf concentrations of B are in the range of 35 to 50 ppm. B sprays are effective in meeting fruit requirements and avoiding cork formations and early drop associated with B deficiency. However, B is also necessary for root development. Annual applications of B in the fertilizer or applied separately plus foliar sprays may be required to meet the needs of high-producing orchards on size-controlling rootstocks. Using annual soil applications of 1-1/4 to 2 lbs. actual B per acre (equivalent to 6-1/4 to 10 lbs. of a 20% fertilizer grade borate) approximate annual needs but may require 1 or 2 foliar sprays of Solubor (total of 2 to 6 lbs. depending on tree size and planting density) to fully meet the boron requirements.

7. Zn. Optimum Zn leaf levels are similar to those of B, i.e., 35 to 50 ppm. Leaf concentrations below 15 ppm should be considered deficient. Varieties that accumulate higher levels of P appear to have higher Zn requirements than those that accumulate less P. Annual requirements for Zn are approximately 2 lbs. per acre if applied as inorganic salts in dormant sprays or approximately 0.2 to 0.3 lbs. of actual Zn applied as foliar sprays of EDTA chelates (3 to 5 lbs./acre). Amounts of Zn required to correct severe deficiencies may be 4 to 5 times these amounts. Zn-containing fungicides provide some benefit but are not adequate to supply the total need. Leaf samples from trees sprayed with Zn-containing fungicides may contain 150 ppm to 500 ppm Zn but most of this is not active. In such cases, P contents of the samples and tree growth and fruiting are usually more indicative of the Zn status.

8. Mn. The optimum levels of Mn range from 35 to 50 ppm. Mn deficiency may be associated with high pH conditions, K deficiency, or in some cases may be associated with long-term effects of certain herbicide programs. It is easily supplied by using Mn-containing fungicides in the petal fall, first and second cover sprays, or by applying Manganese sulfate (2 to 4 lbs. per 100 gallons dilute rate equivalent) at first cover. Leaf samples from trees

sprayed with these materials may contain high levels of Mn, but much of this represents inactive contamination.

9. Cu. Optimum levels of Cu are in the range of 7.5 to 12 ppm. Leaf concentrations below approximately 3.5 ppm are deficient. High soil pH and/or high P levels may aggravate Cu deficiency. Cu can be added to the fertilizer but this is usually less effective and more expensive than a spray of a fixed-copper fungicide applied between green-tip and 1/4-inch green. Delaying this spray to 1/2-inch green may result in fruit russeting.

10. Iron (Fe). Fe is not usually a problem and leaf concentrations vary considerably depending on several factors. Levels of 50 ppm appear to be adequate under most circumstances. High levels of Fe in relation to Mn may be used as an indicator of Mn deficiency, i.e. if Fe/Mn ratios approach or exceed 2.0.

11. Sulfur is not included in most leaf analyses but requirements are believed to fall in a range between those for P and those for Mg, i.e. approximately 0.2% + leaf content. Responses obtained from soil applications of gypsum, or sulfate of potash magnesia, or foliar sprays of Epsom salts suggest that at least a part of the response to such treatments may be related to sulfur. Until more definite information, pro or con, about sulfur requirements is developed. it would appear appropriate to rely on sulfate forms of other nutrients to supply this element.

Combinations of Deficiencies

It is common to find two or more elements involved in a particular orchard nutrition problem. These combination problems may involve low K plus low Mg, low B plus low Zn; low Mg plus low Zn; high P plus low Zn or low Cu among others. In a few such cases, the cause of the problem may be a matter of imbalance, but in most instances the amounts of each of the elements available to the trees can be considered independently.

For example, if both K and Mg are in short supply, application of both will be required. The apparent aggravation of a Mg shortage by increased application of K indicates a need for increasing the supply of Mg rather than limiting the supply of K.

Another common problem involves B and/or Zn shortages. Young trees that are flowering heavily for the first time or that bore their frst heavy crop during the previous season may show varying degrees of shoot dieback resembling winter injury. Examination of these trees usually shows that the cambium has not been damaged by cold.

Prompt application of B and Zn sprays usually enables such trees to recover before dieback occurs. Left untreated, however, the same trees may lose a high percentage of terminal shoots and leaders, with the damage extending considerable distances back into older wood. As is the case with deficiencies of most micro-nutrients, this type of injury may be evident only on some branches and not as a general condition throughout the tree.

Summary

The nutritional status of an orchard should be evaluated by thoroughly analyzing soil test results, leaf sample analysis and observations of tree performance on a block to block basis. Varietal, cultural, soil and weather factors must be considered. After this has been done, a preventive fertilizer program can be developed and applied. This approach should minimize the adverse effects of nutrient shortages and optimize the production of high-quality fruit.

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FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

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Vol. 47 (3)
SUMMER ISSUE, 1982

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EFFECTS OF SUMMER PRUNING ON GROWTH AND YIELD OF APPLE TREES AND ON FRUIT QUALITY

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Recent results from England, South Africa, Europe, and the United States indicated that late summer pruning can restrict growth, increase red color on fruit, increase leaf Ca, reduce the incidence of bitter pit, increase fruit flesh Ca, and reduce internal breakdown in storage. In England Preston pruned by the established spur method. This involved the removal of strong laterals not needed for new branches and shortening of weak ones to 3 inches to induce spur formation. Laterals of medium vigor, mainly on the tree periphery, were not pruned. Subsequently, these were shortened to a spur, or removed when crowding occurred or they became too large. Laterals from spur systems or induced spurs were shortened to 1 inch. In the United States, the trees were summer pruned by removing all current season's shoots. Terblanche et al. in South Africa removed all current season's growth of the bearing units as well as excessive shoot growth. Only sufficient shoots were left to serve as future bearing units. Utermark in West Germany drastically reduced leaf area by removing growth beyond the outermost fruiting spur on each branch.

The summer pruning techniques that enhanced fruit quality seem severe and time consuming, and contradictory findings have been reported. Thus, this experiment was designed to compare effects of summer pruning with winter pruning and to evaluate methods that fruit growers might adapt.

Studies With Red Prince Delicious

These trees planted at 14 foot x 21 foot spacing, were badly crowded by the end of their 8th growing season in 1977. Stubbing cuts (cuts made in 2 or 3 year-old-wood to reduce the length of limb) were necessary for passage of equipment prior to harvest in 1977. Pruning treatments were initiated in 1978 and consisted of 1) light dormant pruning (to simulate current pruning practices of growers), 2) corrective dormant pruning, and 3) corrective dormant pruning-plus-summer pruning in early-August.

Corrective dormant pruning was initiated in March, 1978 and consisted of removal of 1-2 large limbs per tree that caused crowding and/or competed with the leader. Removal of very few large limbs was necessary during the 1978-79 dormant pruning season and none were removed in 1979-80 season. Tree height was lowered by about 2 feet and a limb renewal program was initiated in the top third of the tree. The limb renewal program consisted of removing some of the stronger branches or their length was shortened by cutting to a weak lateral branch. All water sprouts were removed except those that were in a favorable location for limb replacement. These were retained and spread. Thus, we developed a branch rotation program which consisted of removing large branches in the top third of the tree and leaving weak branches which in turn are removed when they became large. These pruning procedures have helped to contain tree height and to maintain a conical tree shape (Christmas tree shape).

Equally important procedures of corrective dormant pruning were stubbing into older wood to stiffen branches that drooped because of fruiting and shortening branches causing in-row and between-row crowding.

Summer pruning procedures followed were: (1) removal of limbs or portions of limbs of 1 inch diameter or less if too vigorous or causing shading, (2) removal of water sprouts and vigorous upright growth, and (3) branches stubbed to weak lateral when additional stiffening was required.

Table 1. Effect of summer pruning on growth, fruiting and quality of Red Prince Delicious apples.

Parameter	Responses		
	1978	1979	1980
Growth			
Trunk circ. incr.	No effect	Decrease	No effect
Terminal growth	-	No effect	No effect
Fruiting			
Flower bud formation	-	No effect	No effect
Fruit set	-	No effect	No effect
Yield	No effect	-	No effect
Fruit quality at harvest			
Fruit size	No effect	No effect	Increase
Flesh firmness	No effect	No effect	No effect
Soluble solids	No effect	No effect	No effect
Bitter pit	No effect	No effect	No effect
Flesh calcium	No effect	No effect	No effect
Fruit quality after storage			
Flesh firmness	No effect	No effect	No effect
Breakdown	Increase	No effect	No effect
Bitter pit & cork spot	No effect	No effect	Increased

The pruning treatments have had virtually no effect on growth, fruiting, fruit quality, and storage (Table 1). Nevertheless, the corrective pruning procedures have enabled the grower to keep the Red Prince Delicious trees within their allotted space.

Studies with Cortland

This study was initiated on 6-year-old on Malling 7 rootstock planted at 14 foot x 21 foot spacing. These vigorously growing trees were not crowding when the treatments were started, but if some growth restriction was not used a crowding situation would have soon developed. The summer pruning treatments in this experiment were as follows: 1) control (dormant pruning), 2) dormant pruning-plus-summer pruning in early July, and 3) dormant pruning-plus-summer pruning in early-August.

The summer pruning procedures consisted of cutting shoots back to the first fruit (the terminal apple on 1-year-old-wood) and/or a lateral branch originating from 1- or 2-year-old wood. Some upright growing shoots also were removed.

Dormant pruning-plus-summer pruning in early August in comparison to dormant pruning restricted trunk circumference increase consistently and terminal growth the year after pruning was greater (Table 2). Otherwise, there were either no effects of summer pruning, the responses were not consistent from year to year, or they were undesirable. Examples of undesirable responses are smaller fruit, lower soluble solids (sugar content), more scald, bitter pit and cork spot (Table 2).

Table 2. Effects of summer pruning on growth, fruiting and quality of Cortland apples.

Parameter	Responses 1978	Responses 1979	Responses 1980
Growth			
Trunk circ. incr.	Decrease (J&A)[z]	Decrease (A)	Decrease (J&A)
Terminal growth	--	Increase (A)	Increase (J&A)
Fruiting			
Flower bud formation	-	No effect	No effect
Fruit set	--	No effect	No effect
Fruit quality at harvest*			
Fruit size	Decrease (J&A)	No effect	No effect
Flesh firmness	No effect	No effect	No effect
Soluble solids	Decrease (J&A)	Decrease (J&A)	Decrease (J&A)
Red color	Increase (A)	No effect	No effect
Bitter pit	No effect	No effect	No effect
Flesh calcium	No effect	No effect	No effect
Fruit quality after storage			
Flesh firmness	Decrease (J&A)	No effect	No effect
Breakdown	No effect (J&A)	No effect	No effect
Scald	No effect	Increase (J&A)	No effect
Bitter pit & cork spot	No effect	Increase (J&A)	No effect

[z] July and August pruning treatments.

*To determine the effects of summer pruning on fruit quality, the fruits were sampled near the pruning cuts.

Studies with McIntosh

This study was initiated on 8-year-old McIntosh trees on seedling roots planted at the Horticultural Research Center in Belchertown. The pruning treatments were: 1) check (no pruning), 2) dormant type pruning in early August, 3) mechanical hedging (simulated) in early August, 4) cutting terminal branches back to the first fruit in early August, 5) removing in early August water sprouts and removing or stubbing limbs in the upper third of the tree that shaded the lower two-thirds of the tree, 6) cutting all current season's shoots to 4-6 buds in early July and 7) cutting all current season's shoots to 4-6 buds in early August.

All pruning treatments consistently increased red color with the exception of treatments 6 and 7, otherwise there has been little response to summer pruning (Table 3).

Table 3. Effects of summer pruning on growth, and quality of McIntosh apples.

Parameter	Responses		
	1978	1979	1980
Growth			
Trunk circ. incr.	No effect	Decreased	No effect
Fruit quality at harvest*			
Fruit size	No effect	No effect	No effect
Flesh firmness	No effect	No effect	No effect
Soluble solids	No effect	No effect	No effect
Red color	Increase	Increase	Increase
Flesh calcium	No effect	No effect	No effect
Fruit quality after storage			
Flesh firmness	No effect	No effect	No effect
Breakdown	No effect	No effect	No effect
Brown core	No effect	No effect	No effect
Internal browning	No effect	No effect	No effect

Summary and Discussion

The corrective winter pruning or corrective winter pruning-plus-summer pruning procedures reduced the problem of tree crowding in the block of Red Prince Delicious trees. However, corrective winter pruning-plus-summer pruning in comparison to corrective winter pruning had little or no effect on growth or fruit quality (Table 1).

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* To determine the effects of summer pruning on fruit quality, the fruits were sampled near the pruning cuts.

Summer pruning has been suggested as a technique for devitalizing trees in crowded plantings. The overall growth of the Cortland trees, as indicated by trunk circumference increase, was reduced by summer pruning (Table 2). Nevertheless, terminal growth the year following summer pruning was greater than on the dormant-pruned trees (Table 2). The Red Prince Delicious trees also were not devitalized by summer pruning (Table 1). The only consistent beneficial effect of summer pruning was improved red color of McIntosh apples from trees receiving the dormant-type, mechanical hedging, or the cutting to the first fruiting spur summer pruning treatments (Table 3).

When large branches were thinned or stubbed in the top of the McIntosh trees in early August (Treatments 2 and 5) they caused bruising and drop of some fruit on lower branches as they fell. This could have been avoided by stubbing or thinning large branches during dormant pruning. Otherwise, the dormant-type pruning treatment on McIntosh, the treatment of restricting growth in the upper third of McIntosh and the summer pruning procedures on Red Prince Delicious were not particularly troublesome or time consuming. These procedures could provide work for employees experienced in pruning during the slow season, in some orchards, prior to harvest. Cutting all current season's shoots on McIntosh and the summer pruning methods on the Cortland trees were most time-consuming of the summer pruning practices. However, these procedures could be performed by labor inexperienced in pruning. Hedging performed by a mechanical device would be the least time consuming of the summer procedures followed. Emerson and Hayden in Indiana reported that in comparison to normal winter pruning, summer hedging every year plus dormant pruning every third or fourth year, reduced pruning costs, increased fruit color, and maintained good yields.

Other researchers besides the authors have reported that summer pruning failed to suppress terminal growth. Nevertheless, it is difficult to explain why cutting to the first fruit on the McIntosh and Cortland trees failed to increase fruit calcium (Ca). In an earlier study at the Horticultural Research Center in Belchertown, MA, Drake and Bramlage reported that the removal of all current-year shoots improved fruit Ca levels and fruit quality. However, it does seem reasonable to assume that the magnitude of responses to summer pruning depends on tree vigor and the amount of leaf surface removed. The responses may develop more quickly with precocious varieties on the more dwarfing rootstocks. It is possible that Drake and Bramlage and others who have reported an improvement in fruit quality following summer pruning removed a much higher proportion of the total leaf surface than in present study. Also the effects may be cumulative, thus the responses to summer pruning of trees on seedling roots or vigorous size-controlling rootstocks may be slow to develop except in situations where a larger percentage of the leaf area is removed.

Conclusions

Majority of trees in Massachusetts are on vigorous-size controlling rootstocks and the responses to summer pruning, with the exception of improved red color, may be slow to develop. Summer pruning can reduce the amount of pruning necessary during the winter months and possibly improve work efficiency during the summer. However, it is doubtful that summer pruning will become a common practice except in a few situations of severe tree crowding. Summer pruning will be mainly practiced for tree training in non-bearing blocks and has the potential for improving fruit color in crowded bearing trees.

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NUTRIENT SPRAYS FOR TREE FRUITS

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Foliar application of nutrients can supply essential elements directly to foliage and fruit at times when rapid responses may be desired. This method of application, with few exceptions, should be considered as a temporary measure that supplements soil applications. Conditions such as cold weather during the period of bloom, or cold soils in the spring may require the foliar application of certain elements to avoid short stress periods. At other times, such as the grand period of growth, particularly in young trees, rapid expansion of foliage may demand more of certain elements than can be supplied by normal root absorption and transport processes.

Nutrient sprays, then, can be looked at as a fine-tuning technique. In addition, such sprays can be used to confirm a deficiency diagnosis and provide guidance in adjusting fertilizer programs for future seasons.

Foliar nutrient sprays have been tested more on apples than on the other tree fruits. Therefore, the majority of this discussion will concentrate on apples, with suggestions for trial treatments with other crops where feasible.

Nitrogen (N). Foliar sprays of urea have been used on apples for over 20 years. Formulations of urea that are low in biuret content are suggested for this purpose. Reasons for using urea sprays include temporary adjustment of nitrogen level to favor

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fertilization of ovules to increase fruit set, and to supplement, or replace a part of soil applications of nitrogen. Low N status of the flower buds and/or low temperatures during the pollination and fertilization period lead to more rapid degeneration of the ovules. Conversely, high temperatures and/or high N status can delay this degeneration and allow a longer period of time for fertilization to be completed.

To acheive this situation, urea sprays can be applied at the rate of 3 lbs/100 gallons dilute rate in the pink spray and/or 5 lbs/100 gallons dilute rate in the petal fall spray. This approach should be considered whenever the preceding season's leaf samples indicate a leaf N content of less than 2.2 percent. Used in this manner, the amount of actual N applied per acre will range from approximately 3 lbs on close trellis plantings to 16 lbs on large standard trees.

The foliar sprays of urea are not suggested for use on pear, peach, or cherry trees because they do not absorb and utilize urea as efficiently as apple trees.

Magnesium (Mg). Foliar sprays of Mg sulfate (Epsom salts, technical grade) have been used to overcome temporary deficiency of Mg in a number of fruits. These sprays are most effective if applied soon after bloom while foliage is capable of absorbing the material. With apples, the usual suggestion is to apply 15 lbs. of Epsom salts per 100 gallons (dilute rate) in the petal fall, first and second cover sprays. Epsom salts is compatible with most pesticides up to 15X concentrate (225 lbs. per 100 gallons of tank mix). Young rapidly growing trees may require additional applications to provide adequate amounts of Mg.

Mg chelates (EDTA) are available in liquid or powdered formulations. Because of greater efficiency in correcting deficiencies, the chelates are used at lower rates (i.e. 1 lb. or 1 qt. per 100 gallons) and may be more amenable to use in concentrate applications.

Corrective treatments for Mg deficiency must be considered in terms of both soil and foliar applications. In a preventive program, suggested combinations might include the following:

Leaf Mg (% dry wt.)	Magnesium treatment
0.30 to 0.45 (Satisfactory)	Continue present program.
0.20 to 0.30 (Low)	Apply dolomitic lime if pH is below 6.5, plus 600 lbs. of Sulpomag per acre if K level is not excessive, plus three sprays of Epsom salts or equivalent Mg treatment.
below 0.20 (Deficient)	

For fruits other than apples there is less information available on foliar applications of Mg. Epsom salts (10 to 15 lbs. per 100 gallons dilute rate) have been suggested for use on pears and peaches, and, at lower rates (2 lbs. per 100 gallons plus a casein spreader) on plums, prunes and apricots. Manufacturer's suggested rates should be followed in trials with magnesium chelates.

Boron (B) sprays are commonly used on apple orchards. Rates suggested are usually in the range of one-half pound to one pound of Solubor or Polybor per 100 gallons of dilute spray equivalent in one or two post-bloom sprays. Spray timings most often suggested are first and second cover sprays. Applications at the one-half pound rate at tight-cluster or pink have been found to increase pollen germination in some tests and might be suggested where leaf samples collected the previous year indicate boron to be low. B sprays may be used in conjunction with soil applications as follows:

Leaf B (ppm dry wt.)	Boron treatment
35 to 50 (Satisfactory)	Continue present program.
25 to 35	Ground application of 20% fertilizer grade borate (approximately 10 to 15 lbs/acre) or apply 1 or 2 sprays of Solubor or Polybor (2 to 3 lbs per spray) during the period from petal fall through second cover.
below 25	Ground application of 20% fertilizer grade borate (10 to 15 lbs per acre) plus Solubor or Polybor at tight cluster or pink (one-half pound per 100 gallons) plus Solubor or Polybor at first to second cover (one lb/100 gallons dilute rate).

With pears, a post-harvest application of Solubor or Polybor (one to two lbs. per 100 gallons dilute rate) has been reported to be more effective than early spring applications in avoiding a temporary boron deficiency during bloom. Additional trials are needed to determine the value of this treatment under our conditions. Foliar sprays of B are not recommended for peaches because of their sensitivity to this element.

Zinc (Zn) is best supplied to tree fruits in dormant or foliar sprays. Dormant sprays of Zn sulfate (36% zinc sulfate monohydrate) at rates of 10 to 20 lbs per 100 gallons as a dilute spray (do not concentrate above 2X) have been generally recommended for all deciduous tree fruits. Dormant sprays (before green tissue appears) have resulted in injury to buds and spurs of apple trees if frost occurs within 24 to 48 hours of the application or if oil sprays are used.

Zn-containing fungicides contribute a certain amount of zinc to the tree, but are not adequate to correct deficiencies. Zn chelates (EDTA) offer the most satisfactory control. These are compatible with many of the commonly used pesticides. Rates as suggested by the manufacturer would be adequate under most circumstances. In relation to leaf analysis results, the following may be suggested:

Leaf Zn (ppm dry wt.)	Zinc treatment
35 to 50	Continue present program. If zinc fungicides were used add 1 spray of ZnEDTA (1 lb. per 100 gallons dilute rate) at first cover.
20 to 35	One spray of ZnEDTA (1 lb. per 100 gallons dilute rate) at first cover.
below 20	Two sprays of ZnEDTA (1 lb. per 100 gallons dilute rate) at tight cluster <u>plus</u> first cover.

Correction of Zn deficiency is often difficult. Contributing factors include cold soil temperatures during the spring, high soil organic matter content, and high levels of P in the soil. The ratio of P/Zn sometimes indicates the Zn status more accurately than Zn alone. Ratios over 150:1 generally are associated with Zn deficiency, while ratios below 100:1 indicate adequate Zn availability. Varieties such as Delicious and Golden Delicious usually accumulate higher levels of P and are more sensitive to Zn deficiency than varieties like McIntosh. Severe pruning results in temporary relief from Zn deficiency. One difficulty in diagnosing Zn deficiency from leaf analysis results from the lack of normal dilution because growth is limited.

Similar treatments are suggested for other tree fruit crops.

<u>Manganese (Mn)</u> shortages are most likely to occur under high pH conditions (generally above 6.3). Coarse soils, especially those of glacial-till origin, may be inherently low in manganese. Trees on these soils may show Mn deficiency at lower pH levels.

Mn-containing fungicides applied in 2 or 3 cover sprays, or a single spray of Mn sulfate (2 to 4 lbs. per 100 gallons dilute rate) applied 1 to 2 weeks after bloom are usually adequate to overcome Mn deficiencies in tree fruits. In a preventive program, these applications might be suggested where leaf samples are found to contain less than 35 ppm Mn, or where symptoms are evident.

Mn deficiency may be associated with low or deficient levels of K under orchard conditions. In addition, the use of herbicides has been shown to reduce manganese levels, possibly because of increased soil temperatures.

Copper (Cu) deficiency in the East is usually associated with high soil pH (6.3+) and/or soils that are inherently low in Cu, i.e. coarse glacial tills and sands or gravels. Fixed Cu fungicides such as Tribasic Copper Sulfate or C.O.C.S. applied at green-tip to 1/4-inch green at rates of 2 to 4 lbs. per 100 gallons dilute rate are effective in supplying Cu to apple trees. These sprays are suggested for trial on apples and pears when leaf samples contain less than 5 ppm of Cu. The higher rate is usually required to overcome Cu deficiency (leaf samples containing 3.5 ppm or less copper). DO NOT apply Cu sprays after flower buds are exposed.

The foliage of peaches is highly sensitive to copper sprays. Low rates of Cu sulfate (1/2 lb. per 100 gallons dilute rate) have been reported to be effective in supplying Cu to prunes and plums and to be somewhat effective in reducing cracking in sweet cherries when applied as foliar sprays. Further work is needed to determine safe corrective treatments for use on stone fruits.

Summary

Nutrient sprays represent a means for immediate applications of an element to the foliage and fruiting surfaces of fruit trees. In most cases, these sprays should be considered as supplemental treatments for adjusting nutrient status rather than as the sole means of supplying the element in question. Zn sprays, however, represent the most efficient and effective means of supplying this element because of numerous problems involved in obtaining adequate response to soil applications of Zn.

Frequently, multi-element imbalances are encountered that present difficulties in correctly identifying the critical problem. In cases involving reduced growth, lack of normal dilution may interfere with identification of nutrient deficiencies. Visual evaluations of factors such as vigor of shoot growth, leaf size, crop level, and fruit development should be used to supplement leaf analysis in diagnosing the need for additional amounts of a particular element or elements.

GROWER RESPONSES TO THE APPLE IPM PROGRAM*

William M. Coli and Ronald J. Prokopy
Department of Entomology

In December, 1981, the IPM sub-Project Steering Committee discussed the future prospects of the IPM Program for apples in Massachusetts. Many at the meeting agreed that an integrated approach to pest management was desirable for growers. However, no agreement was reached on whether or not growers were prepared to continue some form of IPM once USDA pilot program funds end in September, 1982.

It was suggested that a questionnaire be mailed to fruit growers to gauge the interest in IPM, indicate the feasibility of private scout/consultants providing IPM services in Massachusetts, and determine the need to continue staffing of an Extension Pest Management Specialist.

This article summarizes the responses to the questionnaire and adds comments where pertinent.

In all, 87 questionnaires were returned out of 850 that were sent. Thirty five were from individuals with less than 20 acres of bearing trees, 43 respondents had more than 20 acres, and 9 did not indicate their acreage. The total acreage listed by the respondents was 3,605, or just about half of the total apple orchard acreage in the state.

The questions and responses are as follows:

1. Do you feel that you have received any direct or indirect benefit from the Apple IPM program during its pilot program phase (1978-present)?

   81 Yes 6 No

2. If *yes*, please indicate all of the ways listed below in which the program has been a benefit.

   64 Educational/training sessions
   49 Has enabled me to reduce pesticide usage and costs.
   60 Improved pest messages received through Regional Agent newsletters and "code-a-phones".
   18 Direct participation in pilot program.
   62 FRUIT NOTES articles summarizing program results and related research.
   27 IPM information passed on from other growers.
   10 Other

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*We would like to express our sincere thanks to those individuals who took the time to answer and return the questionnaire on which this review is based.

A substantial percentage (56%) indicated savings in pesticide costs and application costs, suggesting that growers other than those directly participating in the pilot program have been able to contain costs because of the IPM Program. Undoubtedly, the improved pest messages may have been a factor here, together with the fact that 31% of respondents reported receiving IPM information from other growers.

3. If it were possible to expand the pilot program into your area, would you wish to receive IPM scouting and grower advisement for a fee of $20-25/acre?

   45 Yes 36 No

Personnel and logistical considerations have limited the number of pilot program participants. However, such a positive response to this question may indicate a strong potential for private scout/consultants to offer IPM services in the future.

Sixty percent of those with less than 20 acres responded with a "yes" answer to Question #3. In spite of this interest, it may be difficult for private scout/consultants to accommodate these smaller growers unless a substantial number of orchards located reasonably close to one another can be contracted.

4. Do you feel that grower education, training, and informational needs would be adequately met once IPM pilot program funding ends, utilizing levels of Plant Pathology, Entomology, and County Extension staff input as before the initiation of the apple IPM program?

   16 Yes 61 No

Seventy percent of respondents acknowledged the difficulty of adequately meeting grower needs in a fast-changing agricultural environment with staff input levels that existed before the apple IPM pilot program. As noted in the cover letter that accompanied the questionnaire, federal funds which have for the period 1978-1982 been earmarked for apple IPM, will in 1983 be mandated for implementing IPM in other commodities. It is possible, therefore, that many of the benefits noted by growers (Question #2) resulting from the IPM pilot program will be difficult to maintain.

Prokopy and Groden* indicated plans to continue with an ongoing format of IPM information transfer via monthly IPM training sessions in grower orchards in spring and summer after 1982. Inasmuch as Prokopy and Manning have substantial research and teaching responsibilities, they may not be able to adequately respond to the high volume of day-to-day questions from growers regarding pest management decisions presently being handled by IPM program specialists Coli (insects and mites) and Becker (diseases). Also, building a

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*The Annual March Entomology Message to Massachusetts Fruit Growers, 1982.

framework within which growers or private scouts can do their scouting with regular advice from extension pest managers, as well as providing for a rapid, computerized system of delivering accurate timely pest messages, may be difficult.

5. If not, should an IPM specialist continue to be located at the University to serve as a resource person for growers interested in practicing IPM and/or to assist with private sector implementation of IPM?

   66 Yes 6 No

This question was similar in intent to Question #4 and while 17% of those returning questionnaires chose not to answer this, 76% felt that an IPM specialist position should continue to be located at the University.

6. If an IPM specialist continued to be located at the University, should this person have responsibility for:

   (3) 111 Only insect and mite IPM.
   (4) 55 Only disease IPM
   (2) 220 Both diseases and insect/mite IPM
   (5) 44 Weed IPM
   (6) 40 Vertebrate IPM (rodents, deer, etc.)
   (1) 226 All the above

Options ranked by growers with a (1) were given 4 points; those ranked (2) were given 2 points; and those with a (3) were given 1 point. Options marked (4), (5) and (6) received no points. The numbers appearing in this summary next to the option are the total number of points awarded that option, and the number in parentheses indicates its rank with respect to the other options. This ranking was also used for Questions #7, #8, and #9.

It is not surprising that the first choice of respondents to Question #6 was "all of the above", since IPM is a blend of many disciplines. While it is unlikely that any one person has substantial expertise in all of these areas, this response indicates areas where growers feel further effort is required. The close second choice also points out the need for a specialist with multi-disciplinary skills and responsibilities.

7. Due to cutbacks at both State and Federal levels, it is not certain whether funds for an IPM specialist position would be available from these sources. Were such a specialist to be retained at the University, should:

   (2) 157 Individual growers contribute to the partial financial support of such a position (remaining support to come from available state and/or federal funds).

(3) 142 The Massachusetts Fruit Growers Association, Inc. be asked to contribute to the partial financial support of such a position (remaining funding to come from available State and/or Federal sources).

(1) 205 The Massachusetts Cooperative Extension Service and/or the Federal government be asked to fully fund such a position.

In designing this questionnaire, we felt it important to present growers with several options regardless of their feasibility. The only realistic option here is for individual growers to contribute to the partial funding of an IPM Specialist, with remaining funds to come from Federal/State sources. It should be apparent by now that one of the tenets of President Reagan's "New Federalism" is more self reliance on the part of the states as well as commodity groups and less reliance on steadily declining Federal support. As noted in the Annual March Entomology Message To Massachusetts Fruit Growers, 1982 by Prokopy and Groden, an Apple IPM Specialist position can only be continued if fruit growers are willing to match a certain level of Federal/State support with yearly support of their own. While most growers with more than 20 acres indicated an interest in full funding from Federal/State sources, most growers with less than 20 acres preferred that individual growers partially fund such a position.

8. When pilot funding ends in September, 1982, I would like to see:

(6) 28 IPM cease to exist, and growers return to a standard preventative spray schedule.

(5) 32 Private IPM scouts offer services presently offered by the pilot program, with no University contact.

(3) 138 Private IPM scouts offer services presently offered by the pilot program, with scout training and periodic orchard visits provided by a University IPM Extension Specialist.

(4) 36 The grower or some member of orchard staff perform IPM scouting with no University contact.

(1) 217 The grower or some member of orchard staff perform IPM scouting, with training and periodic orchard visits provided by a University Specialist.

(2) 204 IPM related training and information provided by the Regional Fruit Agents.

It seems clear that respondents prefer to continue grower or private scout contact with University IPM specialists after the pilot program ends. In many other states, extension personnel continue in a resource capacity to make available updated IPM techniques and assist with training and occasional supervision of growers and private scouts. Cooperative Extension administration as well as USDA IPM program leaders have expressed support of this relationship, believing that it makes little sense to spend 5 years developing a system of pest management and information transfer, and then fail to provide growers and scouts with continued extension staff support.

Questionnaire respondents' second choice here was to have IPM related training and information provided by the Regional Fruit Agents. Thus, it would seem desirable to intensify efforts to better utilize Regional Agent skills, grower contacts, and field observations as part of the overall statewide IPM effort. However, the uncertainties associated with county funding for Extension may limit the extent to which this can be accomplished.

9. Should private IPM scouts be available for a reasonable cost, say $20-25/acre, I would:

(5) 57 Not choose to hire one for scouting my orchard.
(4) 80 Hire one to scout my acreage only.
(2) 179 Hire one in cooperation with some other grower(s).
(3) 93 Rely on chemical company fieldmen for assistance in daily or weekly spray decision making.
(1) 191 Rely on County Extension staff for assistance in daily or weekly spray decision making.

Due to budget uncertainties mentioned above, it is questionable whether the respondents' first choice is realistic. Of course, it would be the least costly to the grower. A substantial number of growers appear willing to hire private IPM scouts either alone or in cooperation with other growers. Numerous growers, however, would continue to rely on the traditional sources of advice concerning spray decisions, such as fieldmen from chemical companies.

Summary

It appears that substantial numbers of growers believe they have benefited from the apple IPM program. A majority of respondents also felt that the level of extension input prior to the IPM Apple Program may not be adequate for present needs and that an IPM specialist with multi-disciplinary responsibilities should be continued at the University. This person would supplement the activities of present extension faculty and serve as a resource and liason person between practicing IPM growers, private scouts, and University extension personnel.

Finally, while respondents would prefer funding for such a position to come from Federal sources, a substantial number feel costs for a specialist position and for private scouting should be borne partially by the growers.

BROWN ROT OF PEACHES: AN UPDATE ON MANAGING THE DISEASE

Daniel R. Cooley[1], Christopher M. Becker[1]
William J. Manning[2]
Department of Plant Pathology

Where peaches, plums and cherries are still grown in Massachusetts, brown rot remains the most serious disease problem on these fruits. It attacks blossoms, spurs, twigs, stems and fruit. Throughout the season, and after harvest, brown rot is a problem.

The Life Cycle of The Fungus

Brown rot is caused by a fungus, *Monilinia fructicola*. This fungus survives the winter in cankers, on twigs and branches, or in mummified fruit. In spring, when the first green tissue appears on fruit trees, the fungus also starts to grow. It produces a grayish fuzzy mold, which contains a huge number of spores called conidia. These conidia will produce new infections when they are carried to new, growing tree tissue.

Conidia are not the only type of spore produced by the fungus. Ascospores are also released in the spring. Tiny cup-like "mushrooms" grow from mummified fruit on the ground, and ascospores are released as visible clouds from these structures when conditions are right.

Air currents carry ascospores and conidia to new tissue. Flowers are particularly susceptible. It takes only a few hours for these spores to germinate and cause infection. If unchecked, the fungus grows in two ways. It quickly produces new tufts of conidia on blossoms which are then released. It also grows down the blossom petiole to the fruit spur and twig. In the twig, a reddish-brown, sunken canker develops. The twig is often girdled by the fungus and soon dies. The surface of lesions soon grows greyish tufts of conidia. These conidia will infect fruit later in the season.

Brown rot does not infect leaves and/or bark directly, but grows in from blossom and fruit infections. Ascospores and conidia do not live long. The apothecia which produce ascospores also disintegrate in late spring. Therefore, when fruit ripens, the ascospores have disappeared. When ripening fruit become infected, the infection is caused by conidia from twig cankers. As fruit matures, it

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becomes more susceptible to infection. Wounds made by insects, wind or hail increase infections, but even without wounds the fungus often invades the ripe fruit. As the fungus grows in the fruit, it produces more conidia, which can spread the rot to more fruit. Infected fruit can also dry on the tree to form a shriveled mummy, which, after falling, can last in the ground for two or more years. These mummies will produce apothecia and ascospores in the spring. The life cycle of the brown rot fungus is outlined in Figure 1.

Management

To satisfactorily manage brown rot, it is important to pay attention to the life cycle of the pathogen. In particular, the following facts should be kept in mind.

1. Spores which cause primary infections come from twig cankers, stem cankers, and mummified fruit. Getting rid of cankers and rotten or mummified fruit prior to growth in the spring will reduce the number of spores in an orchard, and thus reduce the chance of early infections.

2. Reducing early infections reduces the number of later infections. Fewer spores are available to cause infection throughout the rest of the season.

3. When spores are available, they cause infection during wet weather. At 45°F the infection is established in 6 to 7 hours; at 70°F infection occur in 3 hours. To get protection fungicides must be applied before a rain or before the time for establishing an infection has gone by.

4. There are two times when brown rot control is particularly important; (a) during blossoming to protect from blossom blight, spur blight and later twig blight; (b) during ripening and harvest to protect against fruit rot.

   (a) Brown rot blossom blight: As mentioned, preventing infection at this time greatly aids in preventing fruit rots later in the season. The number of fungicide applications needed depends on rain and the fungicide used. All fungicides should be applied around pink blossom, providing the rain necessary for infection is occurring or expected. Thereafter, applications may be necessary at as little as 3 day intervals if rain is heavy and tree growth is rapid. These intervals may be extended as the rain allows. One exception is the fungicide triforine 18.2% EC (Funginex). Start at pink, make a second application after 50% bloom and a final after petal fall. In dilute sprays, use 12 to 16 fluid ounces per 100 gallons of water. For low volume use 36 to 48 fluid ounces in 50 to 200 gallons of water per acre. No more than 3 applications of Funginex should be made. Often, this is enough to cover bloom even during warm, wet weather. Other fungicides may be used as needed. These include dichlone 50 WP 1/2 lbs. (1-1/2 lbs/acre low vol.); dichlone 50 F 6.4 oz. (19.2 oz/acre low vol.); captan 50 WP 2 lbs (6 lbs/acre low vol.); thiram 65 WP 2 lbs (6 lbs/acre low vol.); benomyl 50 WP plus captan 50 WP, 4 ounces plus 2 lbs, (12 ounces plus 6 lbs/acre low vol.); thiophanate-methyl (Topsin) 70 WP 8 ounces (24 ounces/acre low vol.); DCNA(Botran) 75 WP 1-1/3 lbs (4 lbs/acre low vol.). Captan may cause leaf injury such as "shot-holing" on some varieties. Thiram is a good alternative if such injury occurs. Dichlone should not be used after petal fall. Dichlone is effective up to 12 hours after rain starts; benomyl applied dilute is effective up to 15 hours after rain starts. Always check label recommendations and precautions.

(b) Fruit rot: Immature fruit will not generally rot unless there is a great deal of wet weather. Fruit becomes increasingly susceptible as it starts to ripen. There can be considerable fruit rot in trees if weather is rainy unless the fruit is well-protected with fungicide. Rot will continue through harvest and marketing.

Fungicides should be applied starting about 3 weeks before harvest and be repeated as needed until fruit is harvested. Repeat sprays may be made at 7 days (possibly longer) if there is little or no rain.

Captan or benomyl plus captan used at the above rates may be used up to harvest; Botran and Topsin may be used up to 1 day before harvest; thiram may be used up to 7 days before harvest.

Postharvest brown rot. Brown rot and another disease, Rhizopus rot, may be reduced on harvested fruit by postharvest dips or sprays. Captan 50 WP (2 lbs) plus Botran 75 WP (1 lb) in 100 gallons of water is recommended.

In addition, rotting fruit should be culled rapidly. Hands which touch a fruit with brown rot transfer spores to healthy fruit causing new infections. Likewise, containers which are used repeatedly carry infections to healthy fruit, so use new or disinfected containers.

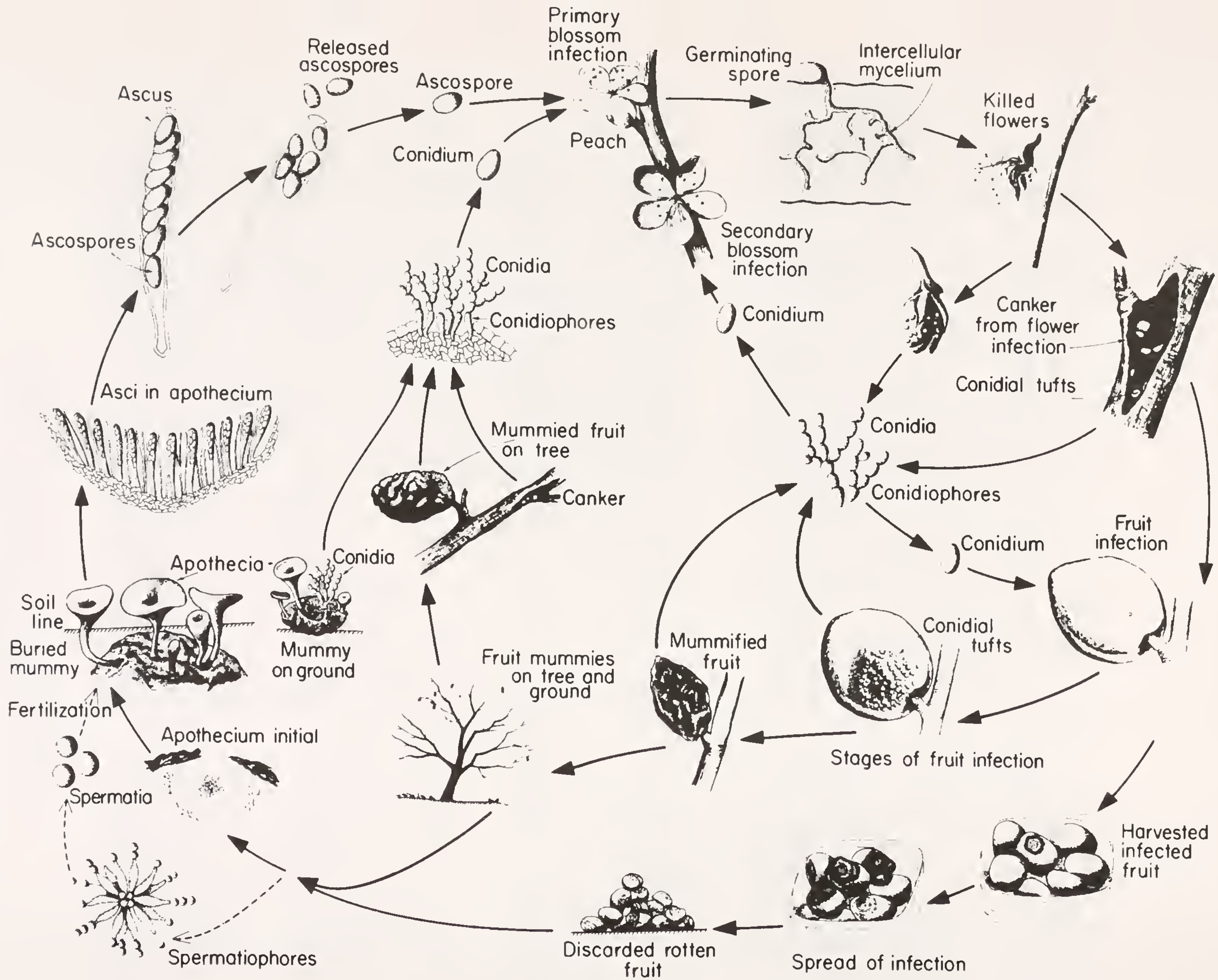

FIGURE 1
Disease cycle of brown rot of stone fruits caused by *Monilinia fructicola*.
Photo courtesy Plant Pathology, G.N. Agrios; Academic Press, New York, NY

DISEASE DIAGNOSIS: INFORMATION FOR GROWERS

Daniel R. Cooley[1], Christopher M. Becker[1]
William J. Manning[2]

Department of Plant Pathology

The Plant Pathology Department has a number of facilities in the state devoted to plant disease diagnosis. The department at Fernald Hall, the Shade Tree Laboratories, the Field Stations at Waltham and Wareham, and specialists in different regions of the state all offer assistance in identifying plant disease problems. In addition, private consultants, usually working for agrichemical companies, offer assistance.

This system allows basically three options to fruit growers. First, most problems are identified by growers themselves. When a problem is outside the realm of a grower's experience, a regional specialist or chemical company representative can be consulted. If the problem is not resolved at that level, a fruit grower or the regional specialist will then go to the University. Hence, generally it is the most difficult diagnosis problems which find their way to the University.

Sometimes these problems can be resolved in a matter of hours, by examining the sample microscopically and consulting reference books or other specialists. However, disease problems often take longer to identify. Samples must be submitted for culturing and then the organisms in these cultures have to be identified. This may take weeks. Virus diseases are particularly difficult to identify, and may require months or even years to diagnose, as artificial growth media which speed identification of other pathogens do not work for viruses.

The policy at the University is to give growers an informed opinion as soon as possible. If culturing tests or other information contradicts the initial diagnosis, then the revised diagnosis is relayed to the grower. The amount of effort involved in a diagnosis will also reflect the options available in managing a problem. For example, if the same fungicide plus pruning program are recommended for managing several different canker diseases, it is not vital that the specific canker problem be identified, as long as it is one which can be managed by the program. To most growers, economical disease control is the goal of diagnosis. The goal of the Plant Pathology Department is to fit diagnosis to the growers needs.

We encourage growers to consult with us on any problem. We would appreciate suggestions as to how we might improve our diagnostic services.

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SUGGESTIONS FOR USE OF CALCIUM SPRAYS IN 1982

Mack Drake and William J. Bramlage
Department of Plant and Soil Sciences

Calcium chloride ($CaCl_2$) foliar sprays are recommended in Massachusetts for all apple growers to increase the flesh calcium (Ca) content. Higher flesh Ca can markedly reduce bitter pit, cork spot and fruit breakdown during storage.

Apply foliar sprays of $CaCl_2$, beginning 3 weeks after petal fall and repeat at 2 week intervals totaling 6 to 8 applications. Apply 6 pounds $CaCl_2$ per acre per spray until mid-July. After mid-July apply 8-10 pounds per acre per spray. Continue foliar $CaCl_2$ until fruit are ready for harvest. Use a technical grade of $CaCl_2$ such as Allied Chemical Dow Flake, 77-80% $CaCl_2$. Other brands may be equally suitable.

Experience in Massachusetts has shown that $CaCl_2$ can be combined with pesticide sprays. However, some growers have observed that the combination of Captan or Guthion (azinphos methyl) 50 WP and $CaCl_2$ may increase foliar burn. DO NOT MIX $CaCl_2$ AND SOLUBOR SPRAYS! ALWAYS DISSOLVE $CaCl_2$ IN A PAIL OF WATER and add this last, when the spray tank is nearly full, to insure that the $CaCl_2$ is completely dissolved before spraying begins.

Foliar $CaCl_2$ sprays may be applied dilute (300 gallons/acre) or up to 10X concentration (30 gallons/acre). In our research, apple flesh Ca was increased more by concentrated than by dilute sprays. In 1977, 6X and 10X foliar $CaCl_2$ sprays were equally effective in increasing McIntosh flesh Ca.

$CaCl_2$ sprays can cause burn of leaf margins. Foliar injury has been more serious on McIntosh than on Delicious or Cortland. Apple leaves are less susceptible to $CaCl_2$ burn after mid-July. McIntosh growing on M7 may be more susceptible to foliar burn than those on standard rootstock. Weak or injured trees may be more susceptible to $CaCl_2$ burn than heathy trees. To reduce the chance of leaf burn, DO NOT REPEAT A FOLIAR $CaCl_2$ SPRAY UNLESS 1 INCH OF RAIN HAS FALLEN SINCE THE LAST APPLICATION.

In 1981, 3 different materials were used to supply foliar Ca at the University of Massachusetts Horticultural Research Center. Rate of application was that recommended by the manufacturer. Control, $CaCl_2$, Carrier 1, and Carrier 2 supplied a total of 0, 86, 64 and 16 grams Ca per tree in 8 applications.

Fruit Ca was 109, 155, 142 and 118 parts per million in dry flesh, respectively. Breakdown was 33, 4, 10 and 17%, respectively, for fruit air stored at 32°F for 5 months and then at 72°F for 7 days. These results agree with those of previous years and show the positive effect of increased fruit Ca to reduce storage breakdown of Massachusetts-grown McIntosh apples. We do not recommend long-term storing of McIntosh apples with less than 150 ppm flesh Ca.

Questions have been asked about possible accumulations of chloride (Cl) in the soil. Chloride salts are highly soluble. Research in the Netherlands showed that there was no annual buildup or accumulation of chloride where annual rainfall exceeded 30 inches per year. Rainfall in all areas of Massachusetts exceeds 30 inches per year.

Annual rates of application of potassium chloride fertilizer for corn silage, vegetable crops and alfalfa in Massachusetts usually exceed 200 pounds per acre, supplying about 100 pounds of chloride per acre. Our recommendation of foliar $CaCl_2$ amounts to 75 pounds $CaCl_2$ annually. This contains about 35 pounds of chloride per acre. Also it is important to note that this 35 pounds of chloride is applied in 6 to 8 increments of 4 to 6 pounds per acre per foliar application as compared to the 100 pounds of chloride in one application for corn, vegetables and alfalfa.

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RECOMMENDATIONS FOR USE OF GROWTH REGULATORS

Readers of FRUIT NOTES from outside New England have in the past requested our recommendations for use of growth regulators. Our recommendations for growth regulator use on apple trees, starting this year, now are included in the New England Apple Pest Control Guide which is revised annually.

IS IT WORTHWHILE TO REFRIGERATE BLUEBERRIES?

William J. Bramlage
Department of Plant and Soil Sciences

Blueberries are not stored for prolonged periods of time because their relatively short postharvest life, even at low temperatures, does not make this practical. In fact, many are not stored at all, being sold directly to the consumer at harvest. Yet, some do pass through marketing channels and their short postharvest life can lead to substantial losses, usually due to berry rotting.

As with all plant materials, blueberry postharvest life can be extended considerably by refrigeration. Most plant materials change as much in 1 day at 85°F as they do in about 2 weeks at 32°F. Still, many blueberries are sent to the market without refrigeration, and it is reasonable to ask whether or not it would be worthwhile to refrigerate them first.

Two recent reports from New Jersey are enlightening. One by Cappellini, Ceponis, and Koslow (HortScience 17: in press) of Rutgers University assessed the extent of defects in blueberries on the counter in New York City supermarkets. They found that an average of 15% of the berries were defective, with rots accounting for two-thirds of these defects. Shriveling, mechanical damage, and overripeness accounted for the other one-third of the defects. As would be expected, the percent of fruit that were defective was higher for late harvests than for early harvests (about 20% vs. 10%). These results show clearly that thereis a problem with quality of blueberries in the supermarkets.

The second report, by Hudson and Tietjen (HortScience 16: 656-7) of the USDA Lab in New Brunswick, NJ, shows the impact that refrigeration can have on blueberry losses. They obtained commercial Bluetta and Bluecrop berries, which at the packinghouse had temperatures ranging from 72° to 85°F.

In 1 test, some of these berries were cooled to 35°F in 2 hours while others were cooled to only 50°F over the course of 24 hours. Both batches of berries were then put in a 50°F room for 3 days, after which they were put at 70°F for 1 or 2 days. This test examined the value of rapid cooling to a low temperature before marketing with limited refrigeration.

After the 3 days at 50°F, all of the samples had 2-3% rotted berries. However, after an additional day without refrigeration (as is often the case in the market) the berries that were rapidly cooled to 35°F still had about 3% rot while those not cooled to 35°F had 7 to 9% rot. After a second day without refrigeration the rapidly cooled berries now had about 15% rot and those not cooled to 35°F before marketing had 30% rot.

In a second test some of these berries were cooled to 35°F in 2 hours, and others were cooled to 35°F over the course of either 24 or 48 hours. They were all kept at 35°F for 10 days and then placed at 70°F for 1 or 2 more days. This test therefore examined the importance of the speed of cooling.

Right out of storage, the berries cooled over the course of 1 or 2 days had about 4% rot while those cooled quickly had about 2% rot. After 1 day without refrigeration the amount of rot had doubled, and after an additional day without refrigeration the amount of decay tripled again, so that 2 days after removal from storage over 20% of the slowly cooled berries were rotting while about 10% of the quickly cooled berries were rotting.

These tests showed that rapid and continual refrigeration can control rotting of blueberries during the normal transit and marketing periods. The best temperature for blueberries is about 32°F.

One cause for concern about refrigerating berries is the moisture that condenses on their surface when they are removed from the cold. Condensation might cause loss of bloom, and many shippers and receivers believe that condensed moisture will increase the amount of rotting. While it is true that moisture on berries can help mold spores germinate and grow, there is no clear evidence that it actually increases rot because the cooled berries are in better condition and can resist infection better than berries of the same age that were not properly cooled.

Hudson and Tietjen concluded that by rapidly cooling blueberries to near 32°F and keeping them at this temperature, they should be suitable for shipment by boat to Europe. If they can withstand this kind of transport, it should certainly be worthwhile to refrigerate blueberries thoroughly before they enter the normal marketing channels.

Cooperative Extension Service
U.S. Department of Agriculture
University of Massachusetts
Amherst, Massachusetts 01003

FRUIT NOTES

PREPARED BY
DEPARTMENT OF PLANT AND SOIL SCIENCES

COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MASSACHUSETTS, UNITED STATES DEPARTMENT OF AGRICULTURE AND COUNTY EXTENSION SERVICES COOPERATING.

EDITORS
W. J. LORD AND W. J. BRAMLAGE

Vol. 47 No. 4
FALL ISSUE, 1982

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A GLIMPSE AT THE TREE FRUIT INDUSTRY IN THE PACIFIC NORTHWEST[1,2]

William J. Lord
Department of Plant and Soil Sciences

In late October and early November, 1981 the author visited orchards in Oregon, Washington and for the longest period of time in British Columbia (BC). It would take months to adequately assess the fruit industry in the Pacific Northwest. Nevertheless for the benefit of the reader who have never had the opportunity to visit this area I have included below some general and specific comments on fruit growing, mainly apple, in Oregon, Washington and BC.

General Comments

In contrast to those in Massachusetts, apple trees in the Pacific Northwest are irrigated, closely spaced, heavily spurred, more uniform in size within a block, and more vigorous growing. High light intensity in the Pacific Northwest and long days during the growing season make high tree density possible and enhances spur development and other growth. I suspect that soil variability in orchards is less than in Massachusetts. This fact and the ability to supply water by irrigation when it is needed are responsible, in part, for fruit tree size uniformity in the Pacific Northwest.

M26 is gaining popularity and seems to be performing more satisfactorily than in Massachusetts, although leader support is being provided in some instances. This rootstock is being used because it induces early bearing and produces smaller less vigorous trees than more vigorous size-controlling rootstocks. It appears promising as a rootstock for the extremely vigorous Granny Smith.

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[1] The writer is indebted to Dr. Robert Stebbins, Extension Horticulture Specialist, Oregon State University; Dave Burkhart, Extension Agent, Hood River, OR; Tom Darnell, Extension Agent, Milton-Freewater, OR; Dr. Tom Toyama, Research and Extension Center, Prosser, WA; James Ballard, Horticulturist for Carlton Nursery, Selah, WA; Dr. Max William, Horticulturist, USDA-SEA-AR, Wenatchee, WA; J.E. Swales, Horticulturist, Okanagan Similkameen Cooperative Growers' Assoc., Oliver, British Columbia, and numerous fruit growers for showing him the fruit industry in the Pacific Northwest.

[2] A more detailed account of the author's comments on the fruit industry in the Pacific Northwest can be found in the Proceedings of the Massachusetts Fruit Growers' Association, Volume 88, 1982.

Disease problems in the Pacific Northwest are less than in Massachusetts, because of the arid climate. Nevertheless, apple powdery mildew is much more troublesome than in Massachusetts. On Golden Delicious this disease causes fruit russeting. Powdery mildew damages leaves and russets fruit on Newtown and Rome Beauty trees and the Granny Smith trees are highly susceptible to leaf damage.

Mites, San Jose scale, and codling moth are perennial pests of apples. The apple maggot now poses a threat to the fruit industry in the Pacific Northwest and Spotted Tentiform Leafminer can be found in isolated areas with the potential to spread.

Bulk bins are constructed from plywood with no air spaces in the sides of the bins. I question whether similarly constructed bins would permit adequate cooling in many of our older storages which frequently have less refrigeration and insulation than newer storages.

High light intensity and long days during the growing season enable growers with well-managed orchards and with newer varieties and strains to obtain higher yields of Extra Fancy apples than in Massachusetts. It was suggested that New England growers can survive on lower fruit quality because of their nearness to market and more profitable market outlets for lower quality fruit. This may be partly true but no apple grower can do well financially without a high pack-out of Extra Fancy apples.

Pruning was a popular topic of discussion among the growers, fruit specialists and the author. The central leader tree has been the basic tree form in Massachusetts for many years and is now common in the Pacific Northwest. There were few points of disagreement among us concerning the training of central leader trees, however, heading cuts on 1-year-old wood to contain growth and induce lateral branching were common. Under Massachusetts conditions, I believe that the main value of heading cuts is for stiffening the scaffold limbs or the central leader. Heading cuts under our conditions are relatively ineffective for inducing lateral branching and delay production on young trees.

We certainly are indebted on Don Heinicke, now a grower in Orondo, WA, for making growers conscious of the benefits of limb spreading. It was interesting to note that "tie downs" are gaining favor among growers in the Pacific Northwest for limb spreading (polypropyene twine attached to the limb and a "w" clip (hop clip)) pressed into the soil. Also, some growers delay spreading limbs on spur Delicious until the trees are 3 or 4 years old. Early spreading reduces growth which frequently is undesirable and regardless, longer wooden spreaders are required when the trees becomes older. One grower advocated using no spreaders shorter than 12 inches in length. This length of spreader is unsuitable for 1-to 3-year-old trees.

Summer pruning is gaining favor as a method of controlling excessive vigor and "compacting" young trees and for controlling size and vigor of bearing trees. An application of Alar-85* and Ethrel* is also being used to control growth on young trees large enough to bear. Alar-85 alone is used on bearing trees to restrict growth and increase fruitfulness.

Specific Comments on Oregon

Of most interest in Willamette Valley were 2 trellised hedgerow plantings on M9 or M26 with tree height comparable to the 12 feet or 15 feet alley width. In Massachusetts trellised trees on M9 rootstock are short and can be harvested by a picker standing on the ground. Thus, the tall hedgerows in the Willamette Valley should produce higher per acre yields than the trellised trees in Massachusetts and also allows the removal of low limbs that have to be harvested by bending or kneeling less costly from the standpoint of reduced yields.

The trees in the trellised hedgerow planting of Dr. Eugene Petroff in Salem are on M9 and M26 rootstocks. The trees are attached to a 4-wire trellis by staples. However, when the leaders are too small for stapling, they are tied to the wires. The trees are trained like free-standing trees with pyramid (Christmas tree) shape; the only function of the wire is to provide leader support. Gravensteins on M9 planted in 1975 are spaced 8 feet by 15 feet with 1 tree in 9 being a Jerseymac pollenizer. The Gravenstein trees produced 12.7 tons per acre in 1980. The planting also contains Delicious and Golden Delicious on M26 rootstock planted in 1975 and spaced 6 feet by 15 feet and 6 feet by 14 feet, respectively. The Delicious and Golden Delicious produced 6 tons and 32 tons, respectively, in 1980 but the Goldens had a light crop in 1981.

An adaption of Tatura Trellis, developed in Australia for mechanization of peach harvest, was being tried in the Petroff orchard. Each peach tree will have 2 limbs attached to wire so each can be trained at an angle of 60-70^{o} from the horizontal towards limbs in the next row. The final canopy of the trees will be "v" shape. The goal is to maximize yield rather than attempt mechanization of harvest.

It is the author's opinion that the high cost of wire and posts for any trellis preclude their use except in a few instances such as high land values, for maximizing yields on small holdings, or when the goal is early, heavy yields. The multitude of training systems being experimented with throughout the tree fruit

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*Trade name

growing world shows that the fruit trees are remarkably tolerant to the manipulation of their natural configuration by man.

In the Milton-Freewater area I first learned that Promalin* was being used to increase the typiness of Delicious in the Pacific Northwest and that drip irrigation appeared to be improving crotch angles on spur Delicious.

The Red King Oregon Spur strain of Delicious was found in the orchard of Wayne Trumball in Milton-Freewater. This strain is popular in the Pacific Northwest because it produced better crotch angles than Starkrimson and the tree is more vigorous. Nevertheless, some limb and tree reversion has been encountered on older trees. These reversions produce fruit similar to the Standard Delicious. The Red King Oregon Spur now is being planted in Massachusetts.

Specific Comments on Washington

Acreage and Production

The apple industry continues to expand rapidly in Washington with thousands of acres being planted annually. Nevertheless, the average orchard size is only about 50 acres with few plantings in excess of 1000 acres. In one of the large holdings being developed it was impressive to see 1-year-old trees in orchard rows approximately 6600 feet long.

In 1980 Washington produced about 72 million bushels of apples. One reliable source predicted that unless something unforeseen happens, future crops could exceed 100,000,000 bushels annually. Thus, over-production of apples in the United States seems possible because modest production increases also are predicted in other areas. Unfortunately, some orchardists will fail financially if the predicted production increases become a reality. But I was reminded that orchards with a sizeable percentage of the total acreage planted to well-managed young trees of newer varieties and strains should continue to be profitable.

Rootstocks

Most apple orchards are now planted with 200 to 300 trees per acre. Seedling trees are the most common rootstock but many successful orchards are on M7a, MM106 and MM111.

Granny Smith

This variety continues to create much excitement in the apple industry. It produces long willowy growth, particularly on vigorous rootstocks, and some fruit is borne terminally. Thus, there is much interest in vigor control with M26 rootstock, summer pruning, limb spreading and growth regulators. At least one grower

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* Trade name

summer prunes twice annually and supports the leaders of trees on M26 with a wire to which the leader is attached by string to prevent tree swaying. This same grower has double rows with densities of 950 to 1900 trees per acre. The trees have responded well to his system of heavy fertilization, pruning and training. Whether these double rows of Granny Smiths can be maintained at such high density remains to be seen. Currently, they are producing exceptionally heavy yields, which was the goal of the grower when the planting was established. If tree removal becomes necessary, I expect that the extra trees will have made money for the grower because of the high prices for Granny Smith apples.

It is commonly stated that Granny Smith requires 180 days to mature but soil, slope and climate are factors that influence this requirement. In one orchard, a grower stated that his Granny Smiths would mature in 165 days.

Immature Granny Smiths are highly susceptible to scald but on the other hand, the market wants dark green skin color. Unfortunately, a red blush may develop on mature fruit or those exposed to bright sunlight. Perhaps a cheek with a tinge of red could be the trademark for Granny Smiths from some orchards.

Granny Smith fruit are highly susceptible to bitter pit, and calcium sprays may be required in some instances to reduce the severity of this disorder. Also, it was of interest to note that fruiting spurs develop no abscission layer, thus the harvested fruit has a sheared stem or it is stemless.

The Granny Smith apple is partially self sterile, thus cross pollination is necessary. Pollenizers being used for Granny Smith are Delicious, Rome Beauty, Golden Delicious and Winter Banana.

There is interest in spur type trees of Granny Smith, namely Greenspur and Granspur, but questions remain concerning productivity, in comparison to trees with standard growth habit, and fruit quality. Mutations in fruit color also have been found.

The production potential of Granny Smith based on present acreage, is a guess however, one guess is 10,000,000 bushels. It also is believed that the full market potential for Granny Smith has not been reached and that demand can be increased by advertising.

Specific Comments on British Columbia

The Industry

Orchards in this beautiful province of Canada were visited with J.E. (Ted) Swales, Horticulturist for the Okanagan Similkameen Cooperative. The cooperative has 600 grower members who on 5,000 acres produce apples, pears, cherries, peaches, apricots and prunes.

It is obvious that many members have small acreages since the orchard holding per member averages about 8 acres. (The British Columbia Fruit Growers' Association classifies growers with more than 1 acre as being commercial. The opinion was expressed that 25-30 acres were necessary to support a family.)

According to Swales, 95% of the 30,000 acres in tree fruit are planted in the Okanagan and Similkameen Valleys with approximately 70% of this acreage in apples. Apple growers produced 10.6 million bushels in 1980 and the 1981 crop also will exceed 10 million bushels. The leading apple varieties are Delicious (50%), McIntosh (25%) and Spartan (10%).

Approximately 2000 acreage of peaches are grown in Okanagan and Similkameen Valleys. Varieties grown include Redhaven, Triogem, T.H. Hale, Valient, Fortuna A., Veteran and Vedette.

Apple Orchards

MM106 and MM111 rootstocks are not recommended in BC because of collar rot. Whereas, M4, which is more vigorous than M7a, M2 and M26 are currently the most popular size-controlling rootstocks. Trees are being planted at 250 trees or more per acre even when on vigorous-size controlling rootstocks.

Many of the spur-type strains of McIntosh originated in BC. A discussion by Ted Swales of these strains can be found in the Proceedings of the Massachusetts Fruit Growers' Association, Volume 87, pages 90-98, 1981.

As in Massachusetts, BC growers have encountered trees with standard-type growth habit in plantings of Macspur and the variability is between trees rather than within a tree. The problem also occurs in plantings of Morspur McIntosh and whether it will occur in the recently introduced Starkspur Ultra Mac (Dewar strain), remains to be determined. The Dewar strain, a whole tree mutation of Summerland Red, was discovered in the Dewar orchard in Oyama, BC and the propagating rights were purchased by Stark Brothers Nurseries in 1977.

Trees on Antonvoka rootstock were seen in one orchard. (There is considerable nursery interest in this rootstock because of its winter hardiness.) The Antonvoka rootstock in this planting and at our Horticultural Research Center in Belchertown is producing numerous root suckers. At the Horticultural Research Center, Antonvoka is being used as the understock on interstem trees.

Peach Orchards

Most striking in orchards visited were high tree vigor and the absence of Fusicoccum and/or Valsa Canker. Perhaps the absence of the devitalizing effects of these cankers helps explain the good tree vigor and why even older blocks had no missing trees.

During the 2-day tour of peach growers, I observed a variety of tree spacings and training systems. Tree spacings varied from double rows with trees 8 feet x 8 feet and a 12 foot alley, 7 feet x 14 feet, (432 trees/acre), 10 feet x 18 feet, 12 feet x 16 feet, 10 feet x 20 feet, 16 feet x 18 feet to 20 feet x 20 feet. The trees were being trained on wire using the 2-arm oblique cordon system, by the open-center method, by the modified central leader system, or as central leader trees. Yields as high as 30,000 lbs. per acre were reported.

The major problem being encountered in older plantings of closely-spaced trees was that of containing tree height. In these plantings the majority of the current season's growth (3-5 ft. in length) was beyond the reach of a person standing on the ground. It also was interesting to note that summer pruning was being practiced to restrict tree size in some plantings.

Orchard Value

The most frequent question asked of the writer was about the value of orchards in Massachusetts. With orchards in the Okanagan Valley valued from $15,000 to $25,000 per acre, the BC growers were amazed at the comparatively modest value of our orchards. Certainly high land values and concern about fruit tree loss from periodic winter freezes helped explain the high trees densities in BC in relation to tree densities in Massachusetts. Tree fruit growers in BC could make more money by selling their land than by selling apples because the scarcity of suitable land and the need for water limits acreage available for tree fruit production, residences and businesses. Unfortunately the freeze on sub-division of agricultural land has not deterred buying sizeable acreages for real estate. It is, however, a deterrant for most people wanting to become fruit growers or for growers wanting to expand their acreages.

Labor Force

It was estimated that 60 to 70% of the orchard labor were transients from Quebec who receive "starting" salaries of approximately six dollars per hour. Harvest help is paid on a piece work basis, nevertheless, attempts are being made by the Canadian Farmworkers Union to organize the transient labor force.

Summary

In retrospect the most striking difference between orchards of the Pacific Northwest and Massachusetts is tree density. Densities of 250 to 300 trees per acre even with seedling rootstock are common whereas in Massachusetts growers are planting trees on M7a or MM106 rootstocks at 72 to 140 trees per acre. The question is, why the difference? We are not blessed with the long hours of high light density as in the Pacific Northwest. Our land values are less. There is no strain of McIntosh that will produce 100% red color like many Delicious strains. To obtain a high packout of Extra Fancy McIntosh fruit we need well pruned, well managed, and non-crowded trees and long-term storage potential of fruit. Many Massachusetts growers store, grade, and sell themselves at least part of their crop which means less time is available for the orchard. This generally is not true in the Pacific Northwest. Lastly and perhaps the most important reason for our lower tree densities is Yankee conservatism.

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CONTROLLED ATMOSPHERE GENERATORS - THEIR FUNCTION AND MALFUNCTION

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The process of controlled atmosphere (CA) storage consists of storing fruit in a virtually air tight and well insulated refrigerated room at high humidity in 2 to 3% oxygen plus 1 to 5% carbon dioxide with the balance of the atmosphere being mostly nitrogen. Room size varies from 10,000 to 100,000 cubic feet. Various means are employed to adjust the gas atmosphere initially and to subsequently control it for storage duration of up to 10 months.

The disastrous explosion of a controlled atmosphere storage room and resulting personal tragedy at Peabody Orchards, Inc. near Fenton, Michigan in November (See GLFGN Nov. 1981) caused great concern among storage operators and suppliers. This accident occurred as an Arcat CA generator was being employed to lower the oxygen level for the CA storage of apples. Propane gas used in the CA generator was theorized to have accumulated to an explosive concentration in the sealed room. Several kinds of CA generators are used in Michigan and elsewhere that are fueled by natural gas or propane. The purpose of this article is to describe CA generators and to answer many questions that have risen since the storage disaster. Hopefully, this will direct the attention and action of owners, operators and suppliers of this equipment to ensure that all possible precautions are taken to prevent such accidents in the future. More knowledge about CA generators may also be important to arrest unwarranted fear in the use of this important equipment and technology for fruit storage.

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An explosion hazard results when propane or natural gas passes through the generator uncombusted due to a malfunction and accumulates to an explosive ratio with oxygen in the storage room. What are the facts about explosive levels of propane and natural gas? For propane the lower explosive limit (LEL) is 2.2% in air and the upper explosive limit (UEL) is 9.5%. This means that at any concentration between 2.2 and 9.5% propane in air an explosion can occur if touched off by a spark or flame. At less than 2.2% there is insufficient propane to cause an explosion and at more than 9.5% propane there is insufficient oxygen in the air to cause an explosion. Air contains 21% oxygen. A minimum of 11% oxygen is required to cause an explosion with propane. In the case of Peabody CA storage explosion this means that at least 2.2% propane was present while the oxygen was greater than 11%. For methane, the primary component of natural gas, the LEL and UEL are 5.3% and 14.0%, respectively, and a minimum of 12.1% oxygen is required for an explosion. Incomplete combustion of propane also produces carbon monoxide and ethylene which are also combustible. Moreover, carbon monoxide may accumulate in work areas and this poses a health hazard as a poison. There will be more about this later but let's return to some beginning questions about CA generators. What are they? Why are they used and how do they work?

The term CA generator means a mechanical device that lowers the oxygen concentration of the atmosphere by causing a net increase in the percentage of nitrogen in a storage room. CA generators were introduced in the early 1960's and currently most of the controlled atmosphere facilities in North America are equipped with some type of generator. They are used to rapidly establish the desired low oxygen level of 2 to 3% within 2 to 5 days after hermetically sealing the refrigerated storage room of fruit. Without using such a device it generally takes several weeks to lower the oxygen content of the storage room to the same level as the fruit consume oxygen in the process of respiration. There are numerous reasons and beneficial effects of rapidly establishing the CA condition that need not be elaborated here.

Some CA generators adjust the level of both carbon dioxide and oxygen while others adjust only oxygen and a separate device is used for scrubbing carbon dioxide. Since carbon dioxide is produced by the fruit by respiration some means is necessary to limit carbon dioxide accumulation in both conventional or generated CA storages. The CA generator provides a means to adjust the oxygen level in the room independently of the fruit.

There are several types of CA generators used commercially and differ widely in basic principles. They include: nitrogen purge systems using liquid or gaseous nitrogen; inert gas generating systems which produce the low oxygen atmosphere external to the storage and recirculatory systems which utilize the storage atmosphere as part of the system. The basis for the nitrogen purge and inert gas generating systems is to dilute the initial storage oxygen by displacing it with the nitrogen-rich atmosphere. The recirculatory system removes oxygen directly by converting it to carbon dioxide. Each system will be described.

Nitrogen Purge System

Liquid or gaseous nitrogen is bled into the storage room where it displaces an equal volume of storage atmosphere. It is basically inefficient because at the start each cubic foot of pure nitrogen introduced pushes out 1 cubic foot of air which contains 79% nitrogen and 21% oxygen. As the oxygen level is reduced the inefficiency becomes more pronounced. Some improvement can be made by connecting several rooms in series. No one in Michigan employs this system.

Inert Gas Generators

There are three basic types. Tectrol System: This was introduced in the early 1960's which combusts propane or natural gas with fresh air in a flame and uses a catalytic burner to ensure clean combustion. The storage room is purged with this low oxygen atmosphere (about 2% oxygen) at a flow rate of 700 to 1200 cubic feet per hour until the storage room has been lowered to the desired low level, e.g., 2 to 3% oxygen. A minimum of 11% oxygen is required to support a flame with propane so this type of generator can not be used in a recirculatory system. The carbon dioxide produced is removed with an activated carbon adsorber. This is now known as the Gen-o-Fresh system of the Samifi Transfresh Corporation. When operating properly with propane with an effective catalyst the atmosphere introduced into the storage room contains about 2% oxygen and 97% nitrogen with less than 1 ppm of carbon monoxide, ethylene and other hydrocarbons. If the catalyst is functioning poorly the effluent from the burner can contain several hundred ppm of carbon monoxide and ethylene and if the air fuel mixture is not adjusted properly, several thousand ppm of carbon monoxide and ethylene along with other hydrocarbons. One thousand ppm equals 0.1%. It is important to supply fresh make-up air to this type of generator. If the make-up air becomes contaminated with the refrigerant freon, the catalyst can become poisoned by hydrofluoric and hydrochloric acids formed as freon is decomposed on the hot catalyst. This is the reason that these units should not be located near the refrigeration compressors. The catalyst can also be damaged by over heating which causes it to agglomerate and fuse which reduces the effective calalytic surface area. This is one reason the catalyst on these units has a cooling jacket.

Open Flame Burner

This is known variously as the Eaves, Australian, Anderson and Wilde system. Propane or natural gas in combusted with fresh air in a flame. And, as with Tectrol, a minimum of 11% oxygen is required to support a flame so a recirculatory system can not be used safely. No catalyst is employed to ensure removal of incompletely combusted fuel so proper adjustment of the air/fuel mixture is essential. The storage room is purged with the low oxygen effluent from the burner and the carbon dioxide produced is generally removed by dry lime in the storage room or by adsorbers or absorbers. It is not uncommon for these systems to introduce atmospheres into the storage room containing several thousand ppm of carbon monoxide and ethylene! And, carbon monoxide can permeate the storage room walls and enter work areas where it is a hazard to workers.

Ammonia Cracking

This system is known as the Smit Oxydrain process and converts ammonia to nitrogen and water vapor at high temperature and the room is purged as with the other inert generators. We have no experience with this system in Michigan. It is being used to a limited extent in the U.S. but more widely in Europe where it was developed. Since no hydrocarbon fuel is used only the carbon dioxide produced by the fruit needs to be scrubbed from the room. There seems to be no danger of ammonia leaking into the CA room and damaging the fruit.

Recirculatory Systems

These include the Arcat and COB units already widely in use and the Acotec unit under development by Atmosphere Control Technology, Inc. of Grand Rapids. Unlike the inert gas generators such as Tectrol, Gen-o-Fresh or Wilde which rely on flame combustion to convert oxygen to carbon dioxide, the recirculatory system oxidizes the fuel on a catalyst surface without a flame. Catalytic oxidation of the fuel will occur, without flame down to as low as 0.5% oxygen. It is necessary to maintain the proper balance of fuel and oxygen to ensure there is sufficient oxygen to combine with all the fuel introduced. As the oxygen supply becomes limiting with propane as fuel, the propane is 'cracked' to carbon monoxide and ethylene.

The recirculatory systems consist of an air blower, pre-heater, catalyst and cooler. Air from the storage room is heated to a temperature of about 450° to 600°F to initiate the catalytic oxidation of fuel. Propane is then introduced and as it undergoes catalytic oxidation the heat of combustion increases the operating temperature of the catalyst to 1000 to 1200°F. This high temperature will be maintained as long as the fuel and air flow remain at the proper setting and the catalyst remains functional. The catalyst allows the fuel to be completely oxidized to carbon dioxide and water at temperature as low as 900°F which is about half the temperature of a flame.

The oxidation of propane becomes progressively poorer as the catalyst temperature decreases below 900°F. If a minimum operating temperature of 900° can not be achieved at the recommended fuel and air flow rate the catalyst many need renewal. Over-heating and freon from a leak in the refrigeration system in the storage room can damage the catalyst as mentioned earlier.

With each pass of the storage room atmosphere through the catalyst of the recirculatory system, a reduction of 3 to 4% oxygen is obtained. When the oxygen level of the CA storage room reaches 5%, the fuel flow must be reduced to about one-half the initial rate as recommended by the manufacturer. With insufficient oxygen, propane is 'cracked' to carbon monoxide and ethylene. Moreover, as oxygen becomes limiting this reduces the amount of propane oxidized so the temperature of the catalyst will decrease. When the catalyst temperature decreases to the low temperature thermostat setting this turns the fuel supply and the equipment off.

If there is any question of propane or other combustible gases in the storage room when using a recirculatory system, simply turn off the fuel supply but continue to recirculate the CA room atmosphere through the generator. This will remove the combustible gases from the storage room and the catalyst will remain hot until the gases have been reduced to safe levels. Several users of Arcat and COB units routinely do this to scrub out the combustible gases after an oxygen pull-down.

A survey of CA storage room atmospheres was conducted in Michigan after the Peabody storage explosion. It revealed that the amount of combustible gases such as carbon monoxide, ethylene, and propane in storage rooms varied widely even between rooms at a single storage location depending on the type of CA generator used and how it operated. Since the explosion, no instances have been found where propane or other combustible gases approached explosive levels. Propane levels of 0.1 to 0.5% are commonly found where Arcat units have been employed. In one storage 1.7% propane was found and this was lowered by recirculating the atmosphere through the CA generator. Similar experiences of significant levels of combustible gases in CA storage rooms have been observed in New York and Washington with Arcat, COB, Wilde and Tectrol units. These experiences point out the need to more carefully monitor the operation of CA generators to see that they are operating properly to ensure complete oxidation of the fuel being used. Safety devices such as thermostats for high and low temperature cut-off should be tested. Air pressure switches, fuel regulators and solenoid valves should be checked.

An additional safety device such as a combustible gas sensor could be installed in the exhaust of the CA generator to shut-off the equipment and fuel supply to prevent a significant amount of fuel or products of incomplete combustion from entering the storage room. The Acotec oxygen/ethylene scrubber now under test at Chase Fruit Storage in Sparta, Michigan has a combustible gas sensor as a component of the safety controls. The Acotec unit is designed to initially reduce the oxygen level in a CA storage by catalytic oxidation similar to an Arcat or COB unit and subsequently scrub ethylene from the storage atmosphere for the first several months of the storage season.

Portable gas analyzers are available from numerous manufacturers to determine combustion efficiency of CA generators, to adjust fuel/air ratios, and determine the effectiveness of catalysts in oxidizing the fuels.

In summary, CA generators of various types can all serve a very useful purpose in the storage and marketing of apples and pears in all major fruit areas. Operating a CA generator that utilizes a combustible or toxic fuel can pose a risk but safety precautions can and are being employed that minimize these risks. To ensure proper maintenance and operation of a CA generator it is essential that operators understand the theory of operation and be thoroughly familiar with the functioning of the equipment. Much has been learned since CA generators were first introduced and since the Michigan storage disaster and instrumentation is now available to ensure the safe operation of CA generators at all times. Understanding how generators function and what might make them malfunction should help arrest unwarranted fear in the minds of those who use and depend on this equipment.

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APPLE MAGGOT TRAP EFFICACY AND OPTIMAL POSITIONING

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Presently, several different traps for monitoring apple maggot flies (AMF) are used in commercial apple orchards in the USA and Canada. These traps are essentially variations of 2 basic types. One type, a sticky-coated red sphere, mimics the fruit, and constitutes an oviposition-type stimulus (see FRUIT NOTES, Vol. 41 (6), 1976). The other, a baited sticky-coated yellow rectangle, mimics honeydew-coated foliage and constitutes a feeding-type stimulus (see FRUIT NOTES, Vol. 41(5), 1976). Researchers in different apple growing regions have arrived at disparate conclusions regarding the comparative efficiency of these 2 basic trap types. All AMF traps have one attribute in common, a visual component acting as a stimulant to the flies. On this account, one may expect a trap's position within a tree to have a strong effect on trap visibility and hence effectiveness.

In 1981, we investigated (1) the comparative efficacy of different AMF traps and (2) the effect of within-tree trap positioning (relative to surrounding fruit and foliage) on AMF captures on red sphere traps. The study was conducted in 4 commercial apple orchards located in Middlesex, Worcester, and Hampden Counties in Massachusetts.

Efficacy of Different Traps

We compared 5 different AMF traps: (1) unbaited wooden spheres, 8.5 centimeters (cm) in diameter, painted red (Tartar Red Dark enamel-Sherwin Williams Corp., Cleveland, Ohio); (2 & 3) baited and unbaited Pherocon ICYTM yellow rectangular traps (Zoecon Corp., Palo Alto, Calif.); (4 & 5) baited and unbaited Pherocon ICYTM yellow rectangular traps with a red disc, 8.5 cm in diameter, painted at the center of each side of the trap. All traps received an initial coating of Tangle Trap[R] (The Tanglefoot Co., Grand Rapids, MI). A 0.5 gram mixture of equal parts of ammonium acetate and enzymatic yeast hydrolysate was added to the Tangle trap for each side of the baited traps tested. All traps were hung 25-50 cm from the nearest foliage or fruit. They were emplaced during the first week of July (when the earliest flies were found entering commercial orchards) and remained there for 8 weeks.

TABLE 1

Type of trap	Mean number captured AMF per trap[z]	
	First sample date (July 21)	Combined sample dates
Red sphere	1.2	14.8
Baited yellow rectangle (with red disc)	0.3	1.8
Unbaited yellow rectangle (with red disc)	0.5	1.2
Baited yellow rectangle (plain)	0.2	1.4
Unbaited yellow rectangle (plain)	0.0	1.4

[z] 15 replicates per treatment.

Table 1 shows that early in the season as well as throughout, red sphere traps were far more effective in capturing AMF than any of the yellow rectangle traps. In fact, by the first sample date, 81% of the sphere traps had captured at least one AMF, compared with values of 0-31% for the rectangle traps. Previous studies in commercial apple orchards have shown the red sphere trap to range from being equally effective (compared with baited yellow rectangle traps) at detecting early season AMF to being consistently more effective in capturing the first AMF. This result pattern is contrary to that obtained in unsprayed, abandoned orchards where first captures usually occur on baited yellow rectangles. The difference may be due to the fact that first-captured AMF in unsprayed orchards are likely to be newly emerged and probably more apt to respond to feeding stimuli. Hence, they are attracted to yellow rectangles mimicking the reflectance of leaves (the feeding site). First-captured AMF in commercial orchards are usually sexually mature (immigrating to commercial orchards from abandoned trees or orchards). They respond somewhat to feeding stimuli, but even more so to egg laying stimuli, thus being attracted to fruit-mimicking red spheres.

Trap Positioning

We conducted 2 experiments aimed at defining an effective, within-tree position for the red sphere trap. In the first, we evaluated the influence of spatial distribution of fruit within a 1 meter radius around a sphere. The 3 treatments were: fruits solely above a sphere; fruits solely below a sphere; and fruits both above and below a sphere. In the second experiment, we evaluated the influence of distance of sphere from nearest surrounding fruit alone and from nearest surrounding fruit and foliage combined. The treatments were: spheres cleared of all foliage to a standard distance of 25 cm, with surrounding fruit cleared to a distance of 0 cm, 25 cm, 50 cm, or 100 cm (1 meter); and spheres cleared of surrounding fruit as well as foliage to these same distances. For all treatments, spheres were hung about 2 meters above ground, toward the outside of the tree canopy.

TABLE 2.

Within-tree position of red sphere trap	Mean number captured AMF per sphere[z]
Location of fruit relative to sphere	
Above	11.4
Below	16.0
Above and below	14.6
Distance of sphere from nearest surrounding fruit	
0 cm	6.9
25 cm	16.1
50 cm	17.1
100 cm	8.5
Distance of sphere from nearest fruit and foliage	
0 cm	2.7
25 cm	14.2
50 cm	19.5
100 cm	1.3

[z] 15 replicates per treatment

Data in Table 2 suggests that the effectiveness of spheres in capturing AMF is greatest when there is substantial fruit below the sphere, and when the sphere is 25-50 cm from the nearest surrounding fruit and foliage, but no further away than this. Our behavioral observations indicate that more AMF flights to fruit originate from below fruit than from above, affirming the value of placing a sphere in a position with substantial fruit below. While our results suggest that clearing foliage and fruit increases sphere visibility to AMF, too great a distance between a sphere and surrounding fruit or foliage may exceed the average distance of within-tree movements or visual capabilities of AMF, making it difficult for an AMF to detect a sphere.

Conclusions

Research conducted by Dr. W.H. Reissig of Geneva, NY on AMF trap height and direction within a tree, combined with that presented here, suggest that the most effective currently-available trap for monitoring AMF in commercial apple orchards is a red sphere positioned about 2 meters above ground toward the outside of the tree canopy, with 25-50 cm of distance maintained between the trap and the nearest foliage and fruit, but not further than 50 cm from abundant (though not excessive) foliage and fruit.

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ORCHARD MOUSE BAITING AND VEGETATION

Edward R. Ladd
U.S.D.I. Fish and Wildlife Service

To be effective orchard mouse control materials have to be placed so that mice can find them. With hand or machine bait placements this is no problem. When baits are broadcast however, the condition of grasses and other vegetation in the orchard can be very important.

The question when to mow the orchard now has to be considered. The best answer is to bait first and mow later. Mowed vegetation particularly if it is tall and thick will fall in a mat and prevent the broadcast bait from getting down to soil level where they are most effective.

This same matting effect under trees will be present shortly after picking. In this case it will be caused by harvesting crews working around and under the trees. For the broadcast baits to reach the soil level a week or two should be allowed after harvest for the vegetation to recover and for the mice to re-establish their travel systems.

After the bait is applied mowing can then work to the growers advantage by providing protective cover for the bait and giving the mice the secluded feeding cover they require.

Reminder: A permit is required from Massachusetts Division of Fisheries and Wildlife to applying orchard mouse bait. Apply early and beat the last minute rush.

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PREVENTING EXPLOSIONS IN CA STORAGES WHEN ATMOSPHERE GENERATORS ARE EMPLOYED

F. W. Southwick
Department of Plant and Soil Sciences

Many Controlled Atmosphere (CA) storage operators have atmosphere generators available to hasten the rate of oxygen (O_2) decline to around 3%. These generators often use propane as the fuel source but some may use natural gas. Incomplete combustion or leakage past the generator burner may result in the accumulation of propane (where propane is the fuel source) or methane (where natural gas is the fuel source) above their lower explosive limit (L.E.L.) in the CA room. Propane and methane detectors are available to warn CA operators before these gases reach explosive levels so that the generator can be shut down before any hazard exists. The safety of personnel and property is so important that we believe all CA operators utilizing atmosphere generators should have a suitable gas detector available whenever a generator is being used.

In addition, CA operators can greatly reduce the explosive hazard associated with the use of an atmosphere generator by not using a generator until the O_2 level in CA rooms is below 10%. Theoretically, neither propane nor methane is explosive at O_2 levels below 10%. Also, annual tightening of CA rooms against atmosphere leaks can greatly reduce or completely eliminate the need for an atmosphere generator. Apples in CA rooms which are very gas tight are capable of reducing the O_2 level to the desired point (by their normal respiration) within the time span allowed by our CA laws without any assistance from an atmosphere generator.

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