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Fruit Notes

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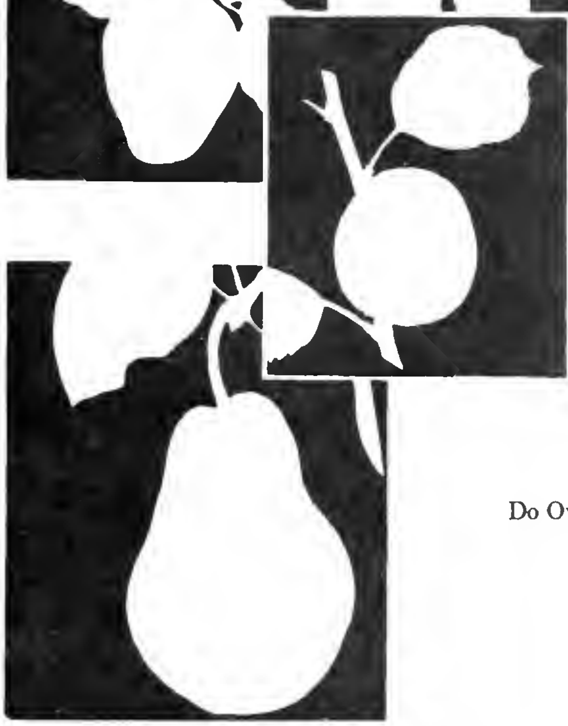

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Fruit Notes

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COOPERATIVE EXTENSION SYSTEM POLICY:

Peach Pests III: Diseases of Fruit and Foliage

Karen I. Hauschild
University of Massachusetts Cooperative Extension System

In "Peach Pests I" and "II," I discussed insect and mite pests of peach fruit, foliage, and wood. In this article I will focus on the diseases of peach fruit and foliage.

There are several frequently observed disease problems of peach fruit in Massachusetts. The most common of these is brown rot; however, peach scab and bacterial spot also can be troublesome. X-disease and peach leaf curl are the most frequently encountered foliar disease problems.

Below is a brief description of each of these problems and basic information on non-chemical control measures.

Brown Rot

Brown rot of peaches is caused primarily by *Monilia fructicola* (Wint.) [There is another species of *Monilia*, *M. laxa* (Aderh. & Rhul.) which normally is associated with almond, apricot, or tart cherry.] *M. fructicola* is a fungus that overwinters in mummified fruit, or in infected flowers or twigs. As fruit buds open in the spring, small apothecia (cup-shaped mushroom-like fruiting bodies) develop from mummied fruit. Development is favored by adequate moisture and temperatures between 63 and 68°F. Within each apothecium, asci bearing 8 ascospores each are produced. When moisture hits these asci, the ascospores are ejected and carried by wind to peach blossoms where they cause infections. The most susceptible flower part is the pistil.

Brown rot infections also can occur when conidia arise either from cankers on the tree or from the surface of fruit mummies. Spores from these conidia are carried by wind or rain to susceptible peach flowers. (For conidia to form, relative humidity must be 85% or higher.) Infected blossoms brown and wither but remain attached to twigs.

During summer months, brown rot activity decreases, but increases again as fruit begins to mature. Conidia produced on infected blossoms or on green fruit usually are the source of infection for fruit at harvest. Fruit infection can occur directly through the fruit cuticle, through natural openings on the fruit, or, most readily, through wounds. Warm, wet weather favors brown rot infections. Under optimum conditions for the fungus, mature fruit can decay in a matter of hours. Initial infections on fruit appear as brown, dry blotches that spread rapidly over the fruit. Spores are produced from these blotches, resulting in grey fuzz. Handling infected fruit also can spread the disease to uninfected fruits.

Removing infected and mummified fruits can reduce disease inoculum levels. Mowing in late fall also helps reduce inoculum. Removal of twigs infected with blossom blight helps control future brown rot infections. Fungicides applied at bloom and **before** moisture forms on the surface of maturing fruits help prevent brown rot infections.

Peach Scab

Peach scab is an occasional problem locally, but is more prevalent in warmer peach growing areas than here. Peach scab is caused by a fungus, *Cladosporium carpophilum*, that overwinters on twig lesions. Conidia are produced from these lesions in the spring and they infect peach fruit a few weeks after petal fall. Forty to 70 days after an infection has occurred small, greenish circular spots appear on fruit surfaces, especially near the stem end. As lesions age, they become velvety (like apple scab) and black. If infections are severe, the lesions coalesce, resulting in abnormal fruit growth and fruit cracking.

Pruning to facilitate good air circulation within trees helps to control peach scab. Fungicides applied to control brown rot usually also are effective against peach scab. Peach scab generally is more prevalent when warm, wet weather occurs just after shuck split.

Bacterial Spot

Bacterial spot, caused by the bacterium *Xanthomonas pruni*, can infect leaves, shoots, and fruit of peaches, apricots, and nectarines. In the spring, bacteria oozing out of overwintering cankers are carried by water droplets to young fruit leaves or shoots. Moisture in fog or dew is sufficient to spread the bacteria. Heavy rain spreads the disease even further. Frequent rains accompanied by moderate temperatures and high winds also encourage infections, especially during the months of June and July.

Leaf lesions are small and angular, appearing first as water-soaked spots and then turning brown to black. Centers of these spots often fall out, leaving reddish colored margins. Lesions generally are more severe at the tips of leaves. Leaves that are severely infected turn yellow and drop. Early season infections on fruit develop into cracks. Lesions are not confined to the fruit surface, but rather go deep into the fruit flesh.

Non-chemical controls for bacterial spot include the use of resistant cultivars such as Redhaven, Loring, Sunhaven, Jefferson, and Madison. Excessive use of nitrogen may aggravate bacterial spot problems.

Peach Leaf Curl

Peach leaf curl is caused by the fungus *Taphrina deformans*. Spores of the leaf curl fungus are very resistant to adverse weather and can remain dormant on twig surfaces for two years or longer. Overwintering spores are washed to the surfaces of leaf buds by spring rains. These spores then multiply during wet weather until leaf bud scales open. Once bud scales become loose, spores are carried by water to leaf tissue and infection then can occur. Leaf curl is most severe during cool, wet weather, particularly at temperatures between 50 and 70°F. Peach trees are susceptible only during the short period of bud swell to bud opening. Symptoms appear about two weeks after leaf emergence. Small, reddish areas develop on small leaves. As the disease infection progresses, the leaf wrinkles and puckers in small areas or along the entire leaf. The majority of infected leaves drop. The fungus produces ascospores which spend the summer on the peach tree, but then produce overwintering bud conidia.

Where leaf curl is severe, maintain tree vigor by: 1) thinning fruit, 2) irrigating during periods of drought, and 3) fertilizing by mid-June. A dormant spray of a copper-containing fungicide after leaf drop or before bud swell usually will control leaf curl.

A recent study conducted by L. Burkham ("Alternatives for Controlling Peach Leaf Curl" appearing in *Common Sense Pest Control Quarterly*) found that organic growers in California were able to control peach leaf curl by spraying a seaweed fertilizer once a month. Speculation is that susceptibility to leaf curl may be related to magnesium deficiency. Seaweed contains a high level of this element.

Also, numerous nectarine and peach cultivars have been evaluated for susceptibility to leaf curl. (Scorza, R. 1992. Evaluation of foreign peach and nectarine introductions. *Fruit Varieties Journal* 46:141-144). All of the North American cultivars mentioned in this study (Harbelle, Elberta, Redhaven, Reliance, Loring, and Sunlight) showed varying degrees of susceptibility.

X-disease

X-disease is caused by a virus-like organism known as a mycoplasma. Leafhoppers carry the disease from infected chokecherries or peaches to other peach, nectarine, or cherry trees. Once in the trees, mycoplasmas live in phloem cells, a type of vascular conducting cell.

Symptoms of x-disease are leaf yellowing or reddening with shot-holing appearing during July and August. Affected leaves drop, leaving "tufts" of green leaves at ends of twigs. As the disease progresses through the tree, limbs die back and each year more of the tree becomes infected. Fruit on infected trees at first appear normal, but they most often drop prematurely.

Young trees infected with x-disease should be removed and destroyed. In older trees, removing infected limbs may slow the spread of the mycoplasmas; but once x-disease has started, it is difficult to control. Antibiotic therapy may help also.

Removing chokecherries near peach orchards is essential.

For additional information on any of these pests, please refer to:

Jones, A.L. 1976. *Diseases of Tree Fruits*. Cooperative Extension Services of the Northeast States. NE 96.

LaRue, J.H. and R.S. Johnson (eds.). 1989. *Peaches, Plums, and Nectarines: Growing and Handling for Fresh Market*. Cooperative Extension, University of California. No. 331.

Prokopy, R.J., P.J. Powers, D.R. Cooley, and J.W. Gamble. 1991. *Peaches, Pears, Plums - Pest Control Guide for Commercial Growers in Southern New England*. University of Massachusetts Cooperative Extension System Circular C-159 R 1991-2.

Peach Pests IV: Diseases of Peach Wood

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This is the last in a series of four articles describing major insect and disease pests of peaches in Massachusetts. In this article I will describe diseases that attack peach wood, primarily canker diseases.

In general canker diseases occur where peach trees are stressed due to drought, poor growing conditions, cold temperature, or poor pruning. Healthy, vigorous trees are less susceptible to attack by canker diseases. Several disease organisms cause canker formation on peaches. Following are brief descriptions of the major causal agents of perennial cankers found on peaches and nectarines in Massachusetts orchards.

Cytospora (Valsa) Canker

Two species of *Cytospora* are associated with peach canker -- *C. leucostomia* Saac. and *C. cincta* Saac. *Cytospora* overwinter in cankers or on dead peach wood. Bumps containing pycnidia with small conidia are produced under bark. These pycnidia grow through the bark and expose spores to rain. Splashing rain or rain driven by heavy winds spread conidia to other infection sites on damaged or injured bark. Canker growth is related to temperature and growth habit of the peach tree itself. *C. cincta* is most active during spring and fall at temperatures between 60 and 75°F. *C. leucostomia* is more active at temperatures between 86 and 91°F, that is, during the summer months. Canker development can occur in one of three ways. First, cankers may extend down limbs toward tree trunks, with limb death occurring at the rate of one or two limbs per year over a period of several years until the entire tree eventually is killed. This pattern is the classic "perennial canker syndrome." Second, cankers may develop in twigs, small branches, or around pruning cuts but remain localized. This type of canker generally results in only minor damage to the tree. Third, trees may leaf out normally, followed by sudden wilting and total tree death. In cases like this the tree usually is severely damaged by cold temperatures and the trunk and lower scaffold limbs quickly are colonized by *Cytospora*. Again, tree health and environmental factors play a major role in the severity of *Cytospora*.

Since both species of *Cytospora* require a wound or natural opening to infect peach trees, proper pruning and pest management practices help prevent serious infections. Pruning in fall or early winter can contribute to *Cytospora* infections because pruning cuts made at these times do not heal as quickly as those made in the spring.

For injured or weak trees, there are no chemical control measures for *Cytospora* that have proven completely successful, partly because spores can be released throughout the year. If only a few cankers are present, removing and destroying infected branches below any sign of disease can be helpful. Do not plant new peach orchards on poor sites. Do not prune in the fall or early winter. Additional measures that will help prevent Cytospora canker infections include the following:

1. fertilize trees early in the spring to avoid late growth spurts;
2. avoid mechanical injury to trees;
3. apply a fungicide spray after pruning, but **before** a rain;
4. avoid weak crotch angles; and
5. whitewash southwest sides of trees and lower limbs (this practice can help prevent injury due to cold temperatures).

Brown Rot

As mentioned in "Peach Pest III," brown rot, *Monilia fructicola*, can infect twigs. When the fungus moves into woody tissues it causes the development of small cankers. Cankers, as they grow, can girdle twigs eventually, resulting in withering and death of terminal growth. Gummosis often accompanies spur blight and canker formation.

Cankers caused by brown rot may develop as a result of blossom blight or may move down from the fruit pedicel into a twig or larger branch. On twigs or small branches, brown rot cankers normally are elliptical, well-defined, and brown. During wet weather, gummosis appears, followed or accompanied by tufts of grey spores. Cankers on larger branches caused by rotted fruit appear (similar to those described above, but likely to be much more severe and eventually kill the infected branch). In the year following severe canker development, leaves above the girdling cankers first appear normal then later turn yellow, wilt, and eventually die.

Phytophthora Root and Crown Rot

Crown rot does not appear to be a serious problem in Massachusetts peach orchards, but a brief description is given below.

Waterlogged soil, air temperature, plant nutrient status, species of *Phytophthora* involved, and susceptibility of host tissue all play roles in the occurrence and severity of *Phytophthora* infections. Most infections occur during the spring, summer and fall months and are spread by infected plants, soil, or water. Infections that occur in crowns or larger roots (especially of young trees) spread rapidly, often killing trees in one or two seasons. Infected trees may appear healthy in the fall, leaf out normally in the spring, but then collapse when warmer temperatures occur. Symptoms of infection vary from withered, bright rust-colored leaves on severely infected trees to decreased overall growth and smaller, yellow leaves on trees that show slower decline. Infected roots or crowns show reddish-brown necrosis of bark and outer wood with a distinct, layered margin; however, after some time roots decay and turn grey-black.

Avoiding waterlogged soils, proper scheduling of irrigation, and proper planting practices help prevent *Phytophthora* infections from occurring and becoming severe.

Bacterial Canker

Bacterial canker, caused by either *Pseudo-*

monas syrincae or *P. morsprunorium*, is thought to be an increasing problem in Massachusetts peach orchards. Damage by *Pseudomonas* varies among types of host fruit. On peaches, leaf and flower buds fail to open in the spring and are thought to have been infected during winter months. Or, in other instances, infected spurs show normal growth in the spring but collapse during summer months, turning into wilted leaves and dried-up fruit. If infection occurs annually, trees lose bearing surface.

Bacteria overwinter in infected buds or cankers. Spring rains wash bacteria to unfolding plant tissue. Frost-injured leaves and blossoms are thought to be more susceptible to *Pseudomonas* infection. Periods of cool, rainy weather foster early-season infections and disease spread. Disease spread also occurs under similar weather conditions in the fall.

Canker removal is the only known cultural control practice

For additional information on any of these diseases, please refer to references listed in "Peach Pests III."

* * * * *

Apple Maggot Fly Behavior: Probability of Fly Capture on Red Sticky Spheres in Relation to Fly Age and Fruit Maturity

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To augment our current program of second-level apple IPM involving the use of baited sticky red spheres to intercept and capture apple maggot flies (AMF), we have been tracking foraging behavior patterns of female AMF. We want to know if the probability of a fly being captured on a sphere or of laying eggs in apples changes as flies age or apples mature.

Methods Used

In 1991, two potted apple trees were placed in screen cages on the campus of the University of Massachusetts. Each tree had approximately the same canopy size as a normal four-year-old dwarf (M.9) fruit-bearing tree. We placed either 50 green or 50 red evenly-spaced Gravenstein apples on a tree. The leaf-to-fruit ratio was about 20:1. The green fruit were picked on June 19 and had a diameter of about 3 cm. The red fruit were picked on August 1 and had a diameter of about 4.5 cm. In all, 36 AMF of each of five ages were tested in the presence of only green fruit, and 30 of each of five ages in the presence of only red fruit. The flies were collected from naturally infested fruit and were 3, 7, 11, 15, or 19 days old when tested. Flies seven days old or younger usually are not capable of laying eggs in fruit.

A single fly was released onto a leaf at the lower center of the tree. A sticky red sphere, baited with one vial of the synthetic apple odor

Table 1. Behavior of apple maggot females of different ages when released individually on a caged apple tree containing a sticky red sphere baited with butyl hexanoate and 50 green or 50 red Gravenstein apples.*

Fly age (days)	Flies captured (%)**		Number of fruit visited per fly***		Flies that laid one or more eggs (%)***		Fruit that received an egg (%)	
	Green	Red	Green	Red	Green	Red	Green	Red
3	25 b	27 b	1.9 a	2.8 b	0 b	0 b	0 b	0 b
7	68 a	47 a	2.7 a	3.9 a	6 b	0 b	2 b	1 b
11	61 a	57 a	1.8 a	3.8 a	22 a	10 a	12 a	6 b
15	71 a	57 a	1.7 a	4.3 a	26 a	13 a	10 a	5 b
19	64 a	57 a	1.6 a	2.7 b	19 a	30 a	8 a	19 a

* Values in each column not followed by the same letter are significantly different at an odds ratio of 19:1.

** Represents flies captured on a sphere before leaving tree or before one hour had elapsed.

*** Visits and egg laying before being captured on a sphere, before leaving the tree, or before one hour had elapsed.

butyl hexanoate, was placed in the upper part of the tree canopy. After the fly was released, its movement was tracked during one hour of foraging within the tree. Tracking involved recording all leaves and fruit visited, all oviposition attempts and ovipositions, and whether or not the fly was captured on the sticky sphere. Any fruit in which the fly made an oviposition, or an attempt at it, was removed from the tree and dissected to see if eggs had been laid.

Results

Fly captures when either green or red fruit were on the tree increased significantly when the flies were more than three days old (Table 1). For flies seven or more days old, consistently more were captured when fruit were green than when they were red. Sixty-six percent of flies seven or more days old were captured when fruit were green; whereas, 55 percent were captured when fruit were red.

Regardless of fly age, red fruit received more visits than green fruit (Table 1). Flies 11 or more days old were more likely to oviposit in a fruit than were younger ones. Interestingly, except for the oldest flies tested, a greater percentage of green fruit than red fruit received eggs.

Conclusions

Our results demonstrate that the age or maturity of a female AMF can strongly affect its fruit foraging and egg laying behavior and the probability of capture on a baited sticky red sphere. Once a female reached seven days of age, the chance that it would be captured on a sticky red sphere baited with butyl hexanoate hung in our test trees was 50% or better. As fly age increased above seven days, the probability of capture on a sphere did not increase, but the probability that it would lay eggs before being captured on a sphere did increase. This result indicates that for greatest effectiveness in controlling AMF, baited sticky red spheres should be hung very early in the fly season, before immigrating AMF have reached maturity. In addition, our findings suggest that while green apples may receive fewer visits by AMF than red apples, green apples may be more susceptible to oviposition by arriving AMF. This result again affirms the need to hang baited sticky red spheres early in the fly season for greatest effectiveness in avoiding fruit injury by immigrating AMF.

Acknowledgements

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* * * * *

Evaluation of Four Rootstocks and Two McIntosh Strains

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Through the 1960's and 1970's, the trend in the New England apple industry was from seedling-rooted trees to trees on M.7 or similar sized rootstocks. In the latter part of the 1980's, the trend shifted toward smaller trees. In the 1990's, growers are planting significant numbers of dwarf trees, mostly on M.9 and Mark rootstocks. In 1979, a planting was established at the University of Massachusetts Horticultural Research Center to assess rootstocks in the size range from M.7 to M.9.

The planting included Rogers Red McIntosh and Macspur McIntosh on M.7A, M.26, M.9 (trained either to a post or on a 4-wire vertical trellis, seven-feet tall), and M.9/MM.111. Seven replications were planted, and each replication had four trees of each cultivar/rootstock combination. Two trees of each group were used for data collection, and any Macspur that reverted to a nonspur habit was eliminated from the experiment. Normal fertilization and pest management practices were used. All trees were maintained as central leaders. With the exception of tying branches to the wires in the trellis treatment, very little limb positioning was performed in the planting.

After 10 growing seasons, trees on M.7A were the tallest, regardless of McIntosh strain (Table 1). Trees on M.26 and M.9/MM.111 were similar in size and intermediate. Trees on M.9 were the shortest. Rogers trees were significantly taller than Macspur trees. Tree spread followed a similar trend (Table 1); however, trees on M.9 trained to a trellis had a greater tree spread after 10 seasons than those trained to a post. Clearly, this difference related to the support provided to lateral branches by the trellis wires.

Tree spread was used to calculate potential tree density (Table 1). It was assumed that trees could be planted 10 percent closer than the spread measured after 10 seasons. Seven feet

Table 1. Tree size after 10 growing seasons and projected tree densities of Rogers Red McIntosh and Macspur McIntosh on different rootstocks.

	Tree height (ft)			Tree spread (ft)			Tree density (trees/acre)*		
Treatment	Rogers		Macspur	Rogers		Macspur	Rogers		Macspur
M.7A	14.8	a**	14.9	15.8	a	14.5	145	c	172
M.26	12.0	b	9.9	13.2	bc	11.5	202	b	254
M.9 (post)	8.8	c	8.4	10.2	d	9.3	297	a	363
M.9 (trellis)	9.3	c	9.0	12.9	c	10.6	295	a	363
M.9/MM.111	11.5	b	10.0	14.3	b	12.0	172	b	239
Average	11.3	***	10.4	13.3	***	11.5	222	***	278

* Distance between trees within rows was projected to be 10% less than the natural tree spread, allowing for overlap of trees. The distance between rows was the distance between trees plus seven feet, with the exception of the trellis, which was assumed to be spaced 13 feet between rows.

** For the three characteristics in this table, the relative differences between rootstock treatments were statistically similar for each strain. The letter presented between the Rogers and Macspur columns represents the differences among rootstock treatments only. For a particular characteristic, if not represented by the same letter, rootstock treatments are significantly different at odds of 19:1.

*** Rogers and Macspur averages are different at odds of 999:1.

were added to the distance between trees in a row to determine between-row spacing, with the exception of the trellis. Because of the shape of the trellis, it was assumed that all trellis combinations could be maintained at 13 feet. (This assumption is conservative, and it depends on the final width of the trellis rows.) Potential tree density ranged from over 360 trees per acre of Macspur/M.9 to 145 trees per acre for Rogers/M.7A. Because of the difference in spread, Macspur could be planted at approximately a 20 percent higher density than Rogers, assuming no reversion.

Figures 1 and 2 show the cumulative yield per tree for the rootstock treatments and the McIntosh strains, respectively. Generally, larger trees yielded more per tree than smaller trees, that is, trees on M.7A yielded more than those on M.26, which yielded more than those on M.9. The exception is M.9/MM.111. Trees on M.9/MM.111 yielded significantly less than the trees on M.26, which were of similar size. Trees on M.9 trained to a trellis yielded more than those trained to a post. This result may have occurred because the trellis maintains wood at a more desirable angle for continued fruiting and allows for upper branches to fill a larger portion of the canopy than when no additional support is provided. Additionally, the larger Rogers trees yielded more than the Macspur

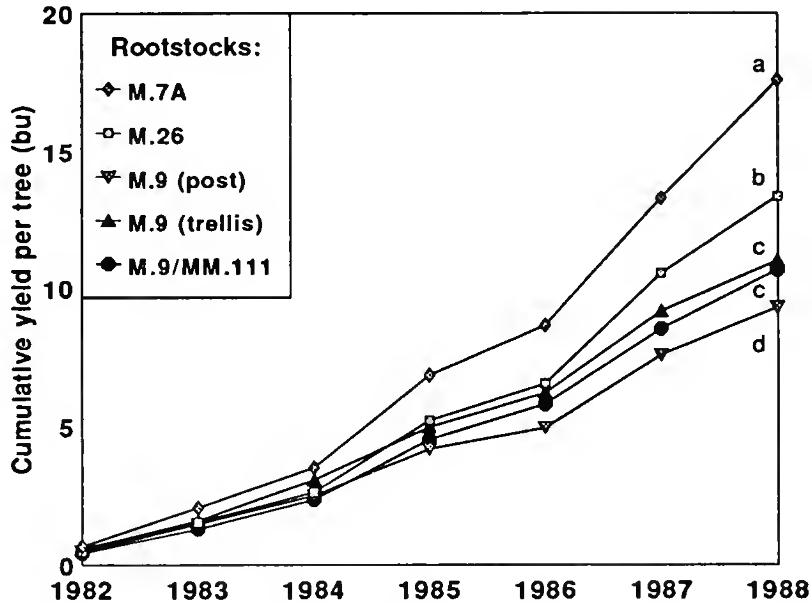

Figure 1. Cumulative yield per tree through the tenth growing season for each rootstock treatment (average of the two McIntosh strains).

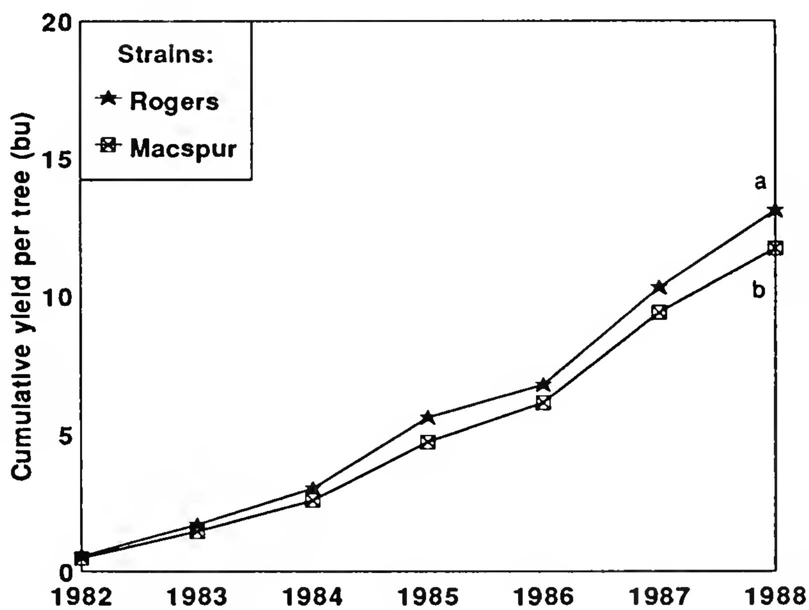

Figure 2. Cumulative yield per tree through the tenth growing season for each McIntosh strain (average of the five rootstock treatments).

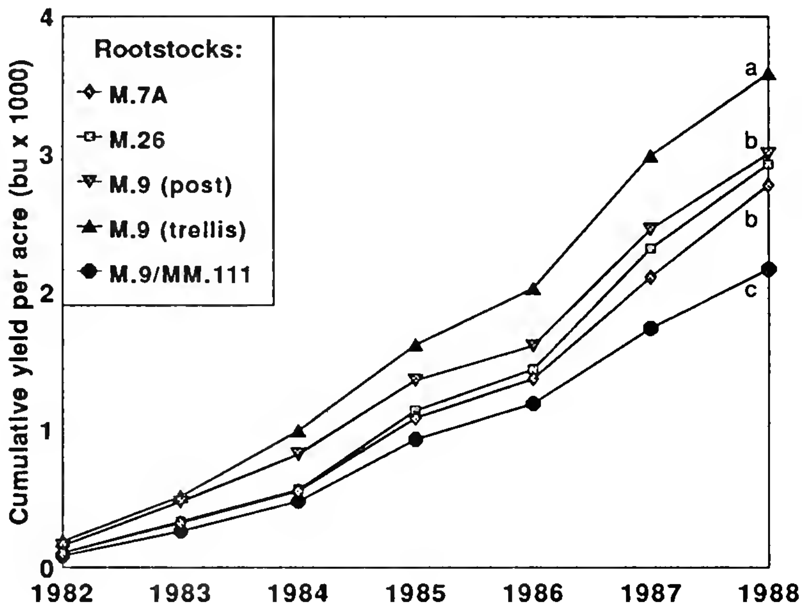

Figure 3. Cumulative yield per acre through the tenth growing season for each rootstock treatment (average of the two McIntosh strains).

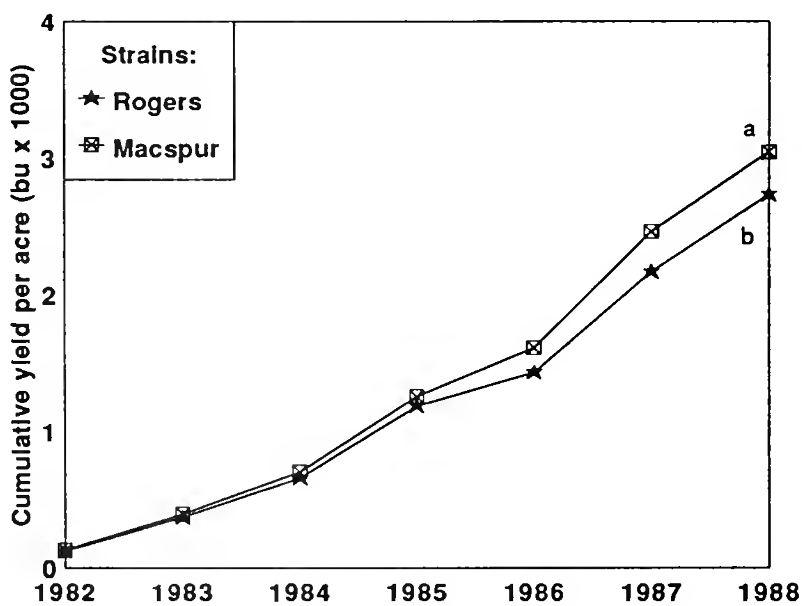

Figure 4. Cumulative yield per acre through the tenth growing season for each McIntosh strain (average of the five rootstock treatments).

Table 2. Economic comparison of the five rootstock treatments (average of both strains of McIntosh). Establishment costs were modified from those presented in *Fruit Notes* 55(4):1-5. Growing and harvesting costs were modified from those presented in *Fruit Notes* 53(1):4-7.

Item	M.7A	M.26	M.9 (post)	M.9 (trellis)	M.9/ MM.111
Costs:					
Establishment	$920	$2,030	$2,980	$3,900	$1,730
Growing	$6,660	$6,540	$7,010	$7,190	$6,540
Harvesting	$4,780	$5,040	$5,170	$6,170	$3,730
Total yield (bu)*	2780 b	2930 b	3010 b	3590 a	2170 c
U.S. Extra Fancy, 1987 + 1988 (%)*	37 d	62 bc	64 b	51 c	80 a
Fruit count per 42 lbs, 1988*	140 a	125 b	120 c	119 c	144 a
Estimated crop value	$25,890	$36,210	$39,310	$42,650	$25,370
Net returns	$13,530	$22,610	$24,150	$25,390	$13,370

* Within a row, means not followed by the same letter are significantly different at odds of 19:1.

trees.

Obviously, the amount of fruit obtained from individual trees is of little importance when the trees are at different densities. Figures 3 and 4 show the cumulative yield per acre for the rootstock treatments and the McIntosh strains, respectively. M.9 trained to a trellis resulted in the highest yields per acre. M.9 trained to a post, M.26, and M.7 were statistically similar in cumulative yield, and M.9/MM.111 resulted in the poorest yield per acre, yielding only 60 percent of trees on M.9 trained to a trellis. Macspur trees outyielded Rogers trees on a per-acre basis.

Factors other than yield must be considered before selecting the most desirable rootstock or training system. Establishment, growing, and harvesting costs vary from treatment to treatment. Estimates of these differences are presented in Table 2. Also, packout is an important consideration. Table 2 presents the percent of a whole-canopy random sample which made the U.S. Extra Fancy grade in 1987 and 1988. Trees on M.9/MM.111 produced the most high grade fruit; whereas, trees on M.7A produced the least. Of the M.9-rooted trees, those on posts produced more U.S. Extra Fancy fruit than those on trellises. These numbers were used to approximate the grade distribution of fruit. It was assumed that one half of the fruit not making U.S. Extra Fancy were Number 1 and the other half were used for cider. These esti-

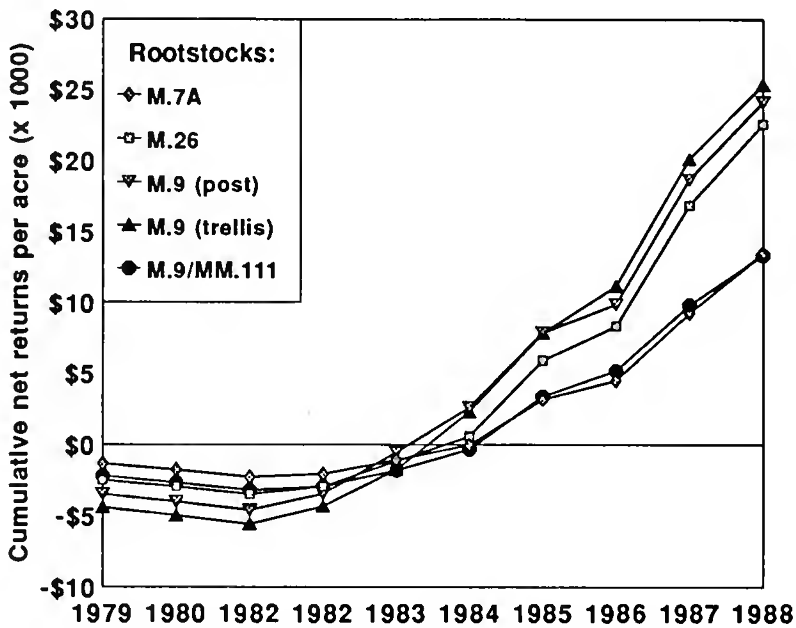

Figure 5. Cumulative net returns per acre for the ten years 1979 through 1988.

mates are conservative, since the sample for grading was random. Multiple pickings would have resulted in greater percents in the highest grade. Additionally, no summer pruning was performed in our trellis treatment, and fruit quality clearly would have benefitted greatly from summer pruning.

Fruit size also varied significantly among the treatments (Table 2). The average fruit from trees on M.7 or M.9/MM.111 were 140-count or smaller. Fruit from trees on M.9 averaged nearly 120-count in size, and those from trees on M.26 were somewhat smaller than 120-count.

When size and grade are considered, along with yield, crop value can be estimated (Table 2). Accounting for crop value and costs, Table 2 presents the net returns possible from these treatments. The two M.9 and the M.26 treatments produced similar returns, with the M.9 trellis treatment giving approximately five percent more, and the M.26 treatment giving approximately six percent less than the M.9 post. The M.7A treatment netted only 53 percent of what the M.9 trellis netted. M.9/MM.111 was slightly less profitable than M.7A.

When evaluating different rootstocks and training systems, it is necessary to assess many different characteristics. Costs of establishment, training characteristics, yield potential, fruit grade, fruit size, and costs of management must all be considered before selecting an appropriate combination. The best system is the one that can be managed within the constraints of a particular grower and that provides the best net returns to the orchard. In this study, trees on M.9 and on M.26 were the most profitable over the first ten years, and clearly would be better choices than trees on either M.7A or M.9/MM.111.

Do Overwintering Red Mite Eggs Portend Summer Mite Troubles?

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Among foliar pests, European red mites (ERM) remain a major problem for apple trees. They can be particularly difficult in second-level IPM blocks, where growers are dependent on predator mites to control summer ERM populations. In these blocks, current non-biological control measures consist of one or two dormant oil sprays in the spring prior to egg hatch. To maintain control of ERM, predators build up to levels capable of controlling the mites that hatch. Unfortunately, it is difficult to balance spring oil control of ERM and encouragement of a healthy population of predator mites. This leads to the question: Can prebloom oil alone effectively control summer ERM populations?

During January of 1992, we collected 200 buds per orchard from 11 orchards that participate in the second-level IPM project. Six of these were full second-level IPM blocks, and five were transitional second-level blocks. The percentage of buds with ERM eggs present was recorded for each block, and orchards were placed into three categories: low (0-33%), medium (34-66%), and high (67-100% of buds with mite eggs).

During late spring and summer months, mite populations in each block were recorded as part of normal IPM scouting procedures. ERM presence or absence was counted on 200 fruit cluster leaves beginning in May and continuing through September. Examination of peak ERM populations in the second-level IPM blocks in May showed little or no apparent relationship between winter ERM egg percentages and spring mite numbers. Peak ERM populations in June, however, were related to winter egg percentages (Table 1). The low and medium ERM egg groups both had very low June ERM populations, but all orchards in the high ERM egg group had substantial numbers of June mites. In first-level blocks there appeared to be no consistent relationship between overwintering egg numbers and June mites, which were low in all of these orchard blocks (Table 1).

Of the second-level blocks, all received at least one dormant oil spray prior to egg hatch in the spring (Table 1). In the high group, two blocks had received two sprays. In the low and medium orchards, it appears that dormant oil sprays were sufficient to control mite populations through June. In the orchards in the high group, however, even those receiving two applications had thriving ERM populations by the end of June.

Further work needs to be done on the relationship between dormant oil sprays, overwintering ERM eggs and resulting early summer ERM populations before any firm conclusions can be drawn. If these results are established as fact, then oil spray recommendations may need to be revised for blocks where high numbers of overwintering ERM eggs are found in winter counts. Without a strong predator population, these orchards may be subjected to large summer ERM populations if they depend on normal amounts of prebloom oil to be effective. Higher rates of oil (e.g., three gallons of oil per 100 gallons of water) at green tip or half-inch green may be necessary, with a second oil treatment at a lower rate at tight cluster. It is possible, however, that the higher mite numbers in the high blocks may be "attractive" to predator populations, and that these orchards may eventually become areas of good biological control.

Table 1. Overwintering egg and peak mite levels in eleven second-level and eleven first-level IPM blocks.

Orchard	Number of prebloom oil sprays	Number of dosage equivalents of oil	Twigs with overwintering eggs (%)	Leaves with ERM in June (peak %)
Second-level IPM blocks				
A	3	1.8	4.5	2.5
B	2	0.9	8.5	0.0
C	1	1.0	16.0	0.5
D	2	1.5	35.0	0.0
E	2		44.5	0.0
F	2	1.3	56.0	0.5
G	2	1.5	58.0	1.5
H	1	0.8	81.0	13.0
I	1	0.3	90.0	19.5
J	2	1.0	90.0	13.0
K	2	1.5	92.0	19.5
First-level IPM blocks				
A	3	1.8	4.5	2.5
B	2	1.3	31.0	1.5
E	2		37.5	2.0
F	2	1.3	40.0	2.5
G	2	1.5	44.0	0.5
C	1	1.0	63.0	0.5
J	2	0.8	75.5	6.5
I	2	0.8	78.5	0.0
D	2	1.5	81.0	0.0
K	2	1.5	81.5	0.0
H	1	1.0	87.0	4.0

Acknowledgements

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Evaluation of Red Coloring Strains of Gala Apple

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Gala is an apple that has experienced a recent and rapid rise in popularity throughout the world. It is being planted heavily in Europe, South America, New Zealand, and the United States. Gala represented 25% of all apple trees sold by Washington State nurseries in 1990.

Gala has many desirable characteristics, including very high flesh quality, attractive appearance, precocity, and high productivity. The original strain of Gala is not a red apple, but rather, a cream-yellow one with an orange-red cheek. Mutations in fruit skin coloring occur readily. There is a general preference among nurserymen and growers for red coloring strains of a cultivar because there is the perception that these strains are preferred by the consumer. It is commonly accepted that the red coloring strains of Delicious that are being sold today, although very attractive, have decidedly inferior quality compared with the original Delicious strain. Further, production from some strains of Delicious may be only one third of more productive strains.

There has been no comprehensive evaluation of the commonly-available strains of Gala. A Gala strain trial containing Kidd's D-8 (standard), Royal, Regal (Fulford), Imperial, and Scarlet Gala was planted at the University of Massachusetts Horticultural Research Center in Belchertown in 1988. This report summarizes growth, flowering, fruit characteristics, and fruit quality of these five strains of Gala.

Trees

Kidd's D-8 and Royal Gala were obtained from Stark Bros. Nursery, Louisiana, Missouri, and Imperial and Regal Gala were obtained from Newark Nursery, Hartford, Michigan. All trees were on M.26 rootstock and were similar in caliper at planting. Propagating wood of Scarlet Gala was obtained from Turkey Hollow Nursery (Cumberland, Kentucky) in the spring of 1987, bench grafted on M.26 rootstock and then lined out in the nursery. In the spring of 1988, trees were planted in a randomized complete block design with eight replications. Each tree was supported by a one-inch x 10-foot metal conduit post set three feet in the ground. The first data on these trees were collected in 1990.

Table 1. Growth in 1990 of five strains of Gala planted in 1988.*

Strain	Tree height (ft)	Tree spread (ft)	Trunk cross-sectional area increase in 1990 (in^2)	Final trunk cross-sectional area (in^2)
Kidd's	9.6 a	7.9 a	1.4 a	5.3 a
Royal	9.9 a	7.6 a	1.5 a	5.6 a
Scarlet	8.9 a	5.0 b	1.4 a	4.0 b
Imperial	10.2 a	7.6 a	1.7 a	5.2 a
Regal	9.2 a	6.9 a	1.6 a	4.9 a

* Means within columns not followed by the same letter are significantly different at odds of 19:1.

Growth

Prior to bud break in 1990, a line was painted 20 inches above the soil surface and the trunk circumference was measured. After leaf fall, height, spread, and trunk circumference were measured.

At the end of the third leaf, Gala strains differed little in vegetative growth. The height of all Gala strains was comparable, while the spread of Scarlet was smaller than that of the others (Table 1). The trunk circumference increase of all Gala strains in 1990 was similar, but the total cross-sectional area of Scarlet was less. Scarlet Gala trees were smaller at planting because they were bench grafted and grown for only one year; the other strains were budded on roots that were in the ground for one growing season and grew an additional year after budding. Therefore, the small spread and trunk cross-sectional area of Scarlet Gala trees is probably a reflection of the tree size at planting rather than inherent vigor of the strain.

Bloom and Fruit Set

Two limbs per tree were selected at the pink stage of flower development and the circumferences were measured. The numbers of blossom clusters on one-year-old and two-year-old wood were counted. In 1991, fruit set also was assessed on these two limbs in July by determining separately the fruit persisting on one-year-old and on older wood.

Spur bloom density was lowest on Scarlet Gala and highest on Royal Gala in 1990, but there were no differences in 1991 (Table 2). Fruit set on all strains of Gala was comparable

Table 2. Flower bud formation and fruit set of five strains of Gala.*

	Bloom density (blossom clusters/in^2 limb cross-sectional area)			Fruit set (fruit/in^2 limb cross-sectional area)		
Strain	Spur	One-yr-old	Total	Spur	One-yr-old	Total
			1990			
Kidd's	52 ab	124 a	176 ab	--	--	--
Royal	63 a	123 a	186 a	--	--	--
Scarlet	16 c	128 a	144 bc	--	--	--
Imperial	34 bc	103 a	137 c	--	--	--
Regal	46 ab	102 a	148 bc	--	--	--
			1991			
Kidd's	67 a	147 a	214 a	35 a	85 a	121 a
Royal	66 a	127 a	193 ab	44 a	77 a	121 a
Scarlet	61 a	132 a	192 ab	30 a	77 a	108 a
Imperial	48 a	117 a	164 b	25 a	67 a	92 a
Regal	52 a	134 a	185 ab	23 a	68 a	92 a

* Means within columns and years not followed by the same letter are significantly different at odds of 19:1.

and very heavy. In general, the bloom density of Imperial Gala was lower than that of the other strains. Bloom on all trees was considered 'snowball' and excessive when compared to most other cultivars. Although the lower bloom density of Imperial may have been real, it is of little practical significance because of the excessive bloom that occurred on all strains in this trial.

All strains of Gala bloomed extensively and comparably on one-year-old wood, accounting for over two-thirds of the bloom. Following June-drop, over two-thirds of the fruit that persisted originated from one-year-old wood. Fruit produced from bloom on one-year-old wood generally was small and the quality was inferior. Since fruit size of Gala is normally small, and lateral fruit are even smaller, it is important to develop a thinning strategy for all strains of Gala to remove fruit developing from lateral bloom selectively.

Fruit Characteristics and Quality

At normal harvest, 15 fruit per tree were sampled. Fruit were weighed, flesh firmness and soluble solids measured, ground color and starch pattern were rated, and percent red color on each fruit was estimated to the nearest 10%. In 1991, fruit were harvested September 3, 12, and 19. Additionally, stem-end cracking was evaluated and the length-to-diameter ratio was determined.

Table 3. Fruit characteristics of five strains of Gala at harvest.*

Strain	Fruit size (count/ 42-lb box)	Flesh firmness (lbs)	Soluble solids (%)	Red color (%)	Ground color index**	Starch index***	L/D ratio	Pedicel-end cracking (%)****
				1990				
Kidd's	111 a	19.2 ab	14.2 b	74 b	7.1 b	5.6 a	--	--
Royal	114 a	19.9 a	14.6 b	88 a	7.1 b	5.0 a	--	--
Scarlet	119 a	19.7 a	15.0 ab	80 ab	7.2 b	5.4 a	--	--
Imperial	110 a	20.0 a	14.5 b	86 a	7.2 b	4.7 a	--	--
Regal	107 a	18.3 b	15.7 a	84 ab	8.1 a	6.8 a	--	--
				1991				
Kidd's	135 b	18.3 b	13.0 c	70 c	6.7 b	5.4 a	0.86 a	2.2 b
Royal	131 b	18.0 ab	13.2 b	77 b	6.8 b	5.2 a	0.87 a	1.1 b
Scarlet	126 b	19.6 a	14.2 a	78 b	6.9 b	5.1 a	0.86 a	4.6 b
Imperial	126 b	18.6 b	13.3 b	87 a	6.9 b	5.3 a	0.87 a	6.7 b
Regal	112 a	18.7 ab	14.4 a	89 a	7.5 a	5.9 a	0.86 a	21.1 a

* Means within columns and years not followed by the same letter are significantly different at odds of 19:1.

** Adapted from a New Zealand Gala ground color chart provided by Dr. Ian Warrington, 1 = green; 10 = orange.

*** Starch chart developed by W. R. Autio, 1 = immature; 9 = overmature.

**** Cracking on the third harvest, September 19, 1991.

There were no differences in fruit weight among strains in 1990, but in 1991, Regal Gala stood alone as the strain with the largest fruit (Table 3). Strains differed in flesh firmness and soluble solids but the differences were not consistent in the two years evaluated. All strains of Gala colored well, although red coloring selections generally had more red color. Quantitative differences in red color among red coloring sports were not consistent. Regal had the highest ground color rating, indicating a greater loss of chlorophyll. Strains did not differ in either starch index or length-to-diameter ratio. Significant stem-end cracking did not occur until the last harvest in 1991 and then it occurred only on Regal Gala.

There were clear indications that Regal Gala was an early maturing strain. As Gala ripen, ground color index, starch index, red color, soluble solids and fruit cracking increase. Regal Gala differed consistently from the other strains in each of these characteristics in a way that indicated advanced ripening.

Cracking at harvest has been cited as a problem with Gala in some areas, and that problem may be associated with uneven ripening. If trees are thinned properly and pruned to allow good light penetration, we have observed that Gala can be picked in just two harvests. No significant cracking occurred until the last harvest, and even then, it was restricted to Regal Gala. All strains could have been harvested before September 19, 1991, and Regal Gala a week earlier, when cracking was minimal. Therefore, we feel that cracking is not a problem with Gala if fruit are harvested at the proper time. When cracking does become a problem, fruit maturity has advanced to a point where fruit feel 'greasy', and the postharvest life has been diminished significantly.

Sensory and Visual Evaluation

In 1991, sensory and visual evaluation of strains (Table 4) was done by 17 judges including pomology faculty, pomology graduate students, technical assistants, and students in an orchard management class. Each panelist evaluated three replications. A replication included one fruit of each of the five strains and one

Table 4. Visual and sensory evaluation of five strains of Gala at harvest.*

Strain	Aroma	Skin toughness	Flesh crispness	Juiciness	Sweetness	Acidity	Starchiness	Flavor
Kidd's	-0.1 a	0.2 a	0.1 b	0.2 a	0.2 a	-0.3 c	0.0 a	0.1 c
Royal	-0.3 a	0.5 a	0.8 a	0.4 a	0.5 a	0.6 ab	-0.2 a	0.9 a
Scarlet	0.0 a	0.5 a	0.8 a	0.3 a	0.4 a	0.8 a	-0.1 a	0.7 ab
Imperial	-0.6 a	0.5 a	0.2 b	0.3 a	0.1 a	0.3 b	-0.2 a	0.4 bc
Regal	-0.1 a	0.6 a	0.4 b	0.4 a	0.7 a	0.5 ab	0.0 a	1.1 a

Strain	Color brightness	Color uniformity	Attractiveness	Overall desirability
Kidd's	0.1 c	-0.1 c	0.1 b	0.2 b
Royal	0.8 b	0.9 b	0.7 b	0.8 a
Scarlet	0.7 b	0.6 bc	0.5 b	0.7 a
Imperial	0.7 b	0.8 b	0.8 b	0.5 ab
Regal	1.7 a	1.7 a	1.6 a	1.0 a

*Means within columns not followed by the same letter are significantly different at odds of 19:1.

reference fruit to which all of the strains were compared. The reference fruit was Kidd's D-8, and this fact was not divulged to the panelists. Judges scored each fruit on a horizontal scale with opposite descriptive terms at each end of the line and the center represented by the reference fruit. The intensity of the deviation of each fruit from the reference fruit was recorded by a pencil mark either to the right or left of the reference fruit.

Taste panelists were able to distinguish differences in quality and appearance among the Gala strains. Royal, Scarlet, and Regal Gala all were judged to have better flavor than Kidd's D-8. Royal and Scarlet had the crispiest flesh. The flesh of all red-coloring strains was more acid than Kidd's D-8. There were no differences among strains in aroma, skin toughness, juiciness, sweetness, or starchiness. Regal Gala was judged to be the most attractive Gala strain. It also had the brightest red color and the most uniform color.

There are legitimate concerns that the Gala strains selected solely on the basis of red skin color may not have the same high quality characteristics of the original Kidd's D-8 strain. Not only were all strains judged to be equal to Kidd's D-8, but when panelists considered all factors and rated overall desirability, Royal, Scarlet, and Regal Gala were selected as being better than Kidd's D-8.

Conclusions

Growth and bloom characteristics of Gala strains appeared to be similar; however, all strains bloomed heavily on one-year-old wood. Because of the lower value of fruit borne on this wood, thinning strategies should target these fruit.

Regal is an early maturing strain of Gala, and was selected by panelists as the most attractive strain. Royal, Scarlet, and Regal were judged to have better flavor and to be, overall, more desirable than Kidd's D-8 Gala.

Spiders in Second-level and First-level Apple IPM Blocks

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One of the principal practices of full second-level IPM is to control key summer fruit pests by a combination of behavioral and ecological techniques, thus allowing beneficial predators and parasitoids to increase enough to control summer foliar pests. Spiders may be an important group of such predators. Insecticides can reduce numbers and diversity of spiders in apple orchards. Therefore, full second-level IPM, which eliminates insecticide use after early June, may allow spiders to proliferate in apple orchards.

In 1992, we assessed spider populations in blocks of apple trees under full second-level IPM compared with first-level IPM practices. Additionally, we conducted a laboratory test of the effects of Guthion™, Thiodan™, and Omite™ on the most common spider species found in second-level IPM blocks.

Besides these evaluations, we also were interested in the effects of herbicides on spider populations in these orchards. Frequently, vegetation growing under apple trees is controlled in commercial orchards with herbicides applied early in the growing season, while vegetation between the tree rows is mowed throughout the season. These practices reduce competition for nutrients, lower humidity (which may contribute to higher disease pressure), and eliminate alternative sources of food and shelter for many orchard pests. Herbicides can decrease spider numbers in vegetable production systems (Riechert and Bishop, 1990), but their effects have not been examined in an orchard system. Hence, in 1992, we examined the effects of herbicide treatments on the number of spiders on apple trees in second-level IPM blocks.

Spider Numbers in Full Second-level and First-level IPM Blocks

Spiders were sampled in six apple orchards. Each orchard contained a six- to nine-acre block under full second-level IPM and a nearby six- to nine-acre block under grower-supervised first-level IPM. Guthion and Thiodan were used in both types of blocks through early or mid-June to control early-season insect pests. After mid-June, second-level blocks received no insecticides while first-level blocks received an average of 2 sprays of Guthion or Imidan (once in July and once in August). All blocks were sprayed with carbaryl in early June to thin fruit.

Beginning in early July, spiders were sampled on twenty randomly chosen trees every two to three weeks in both types of blocks in each orchard by tapping tree branches with a rubber mallet over a two-by-two-foot tray. Spiders were preserved in 70% alcohol and returned to the laboratory for identification, a process not yet complete.

Figure 1 summarizes the results obtained over the entire season. The mean number of spiders collected per tree at the beginning of the sampling period (July 2) was very low and was the same in both second-level and first-level IPM blocks. As the season progressed, however, these numbers increased to 1.5 spiders per tree by late September in the second-level blocks compared with 1.0 spiders per tree in the first-level blocks. Data trends were similar for each orchard considered, except for one orchard where there seemed to be no difference between the two types of blocks.

The low numbers of spiders per tree in early July in all blocks may have been due to spraying for plum curculio, which extended through early to mid-June in all blocks. Beyond mid-June, growers continued to use insecticides in the first-level blocks but not in the second-level blocks. This difference probably accounted for the greater abundance of spiders in the second-level

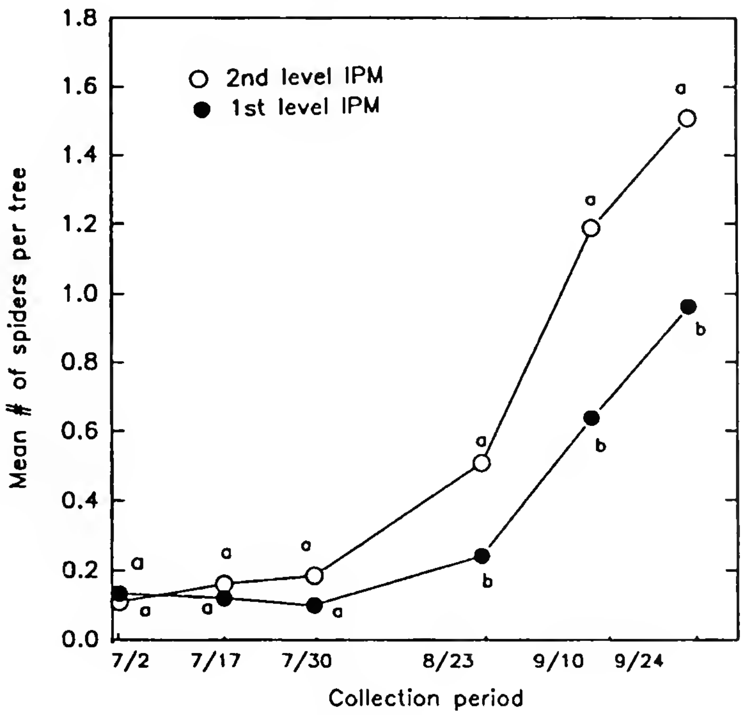

Figure 1. Numbers of spiders collected per tree in full second-level and first-level IPM blocks during 1992. Means within each date accompanied by a different letter are significantly different at odds of 19:1.

blocks during August and September, a conclusion reinforced by laboratory findings (next section).

Insecticide and Miticide Effects on Spiders

To test the effects of insecticides and miticides on spiders directly, a laboratory test was conducted on the most common spider species found in all six orchards: *Araniella displicatta* (Araneidae). All individuals tested were immature, averaging 2 mm in size (the size found in early September in the field). All were collected at the same time in the same orchard. Spiders were placed individually in glass jars coated with the substance to be tested. Ten jars were coated with Guthion, 10 with Thiodan, and 10 with Omite (each at standard field rate of application). Ten additional jars were coated with water as controls.

After 9 hours all 10 spiders in the Thiodan jars were dead, as were 9 of the 10 in Guthion jars. None died in the Omite or control jars, although one spider died in the Omite jar after 45 hours.

These results indicate that these insecticides were highly toxic to spiders, or at least to this particular found species. Omite, on the other hand, was not very toxic to this species of spider. It would be inappropriate, however, to apply these findings to all orchard pesticide-use situations, in that pesticide effects may not be confined to pure contact toxicity. Also, many different spider species exist and some may differ from *A. displicatta* in susceptibility to pesticides.

Effects of Herbicides on Spiders on Apple Trees

To determine if herbicide treatment of ground cover affects the number of spiders on trees, some trees in five second-level IPM blocks were not treated with herbicide while a herbicide treatment was applied in May beneath other trees. Two additional blocks (likewise under full second-level IPM) at the University of Massachusetts Horticultural Research Center (HRC) in Belchertown also were employed in this experiment. Herbicides used included paraquat and simizine in the HRC blocks, and these herbicides as well as Post™, amate, and Fusilade™ in the five second-level IPM blocks. The two HRC blocks consisted of dwarf trees

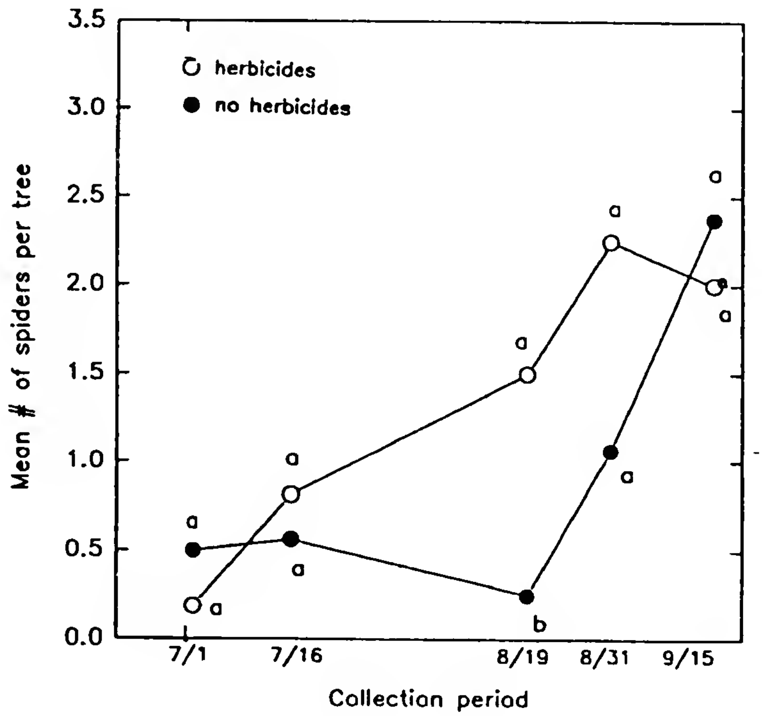

Figure 2. Effects of herbicide treatment of ground cover on the mean number of spiders per tree at different times of the season. This portion of the study was conducted in two blocks at the University of Massachusetts Horticultural Research Center which were under second-level IPM. Means within each date accompanied by a different letter are significantly different at odds of 19:1.

(seven feet tall). On each sampling occasion (five in all, starting July 1), spiders were collected from 40 trees of each treatment. The five second-level IPM blocks contained larger trees (10 to 13 feet tall). Forty to 65 of these in each treatment were sampled on four different occasions from each orchard. Sampling was carried out by tapping the branches as described above.

In the five full second-level IPM blocks, herbicide treatments did not have any effect on the number of spiders on trees. Mean numbers of spiders per tree show the same seasonal trend for herbicide as well as non-herbicide treatments. In the two HRC blocks (Figure 2), herbicide-treated trees contained significantly more spiders in August than non-herbicide-treated trees. There were no significant differences earlier and later in the season.

Lack of any difference between herbicide- and non-herbicide-treated trees in the five second-level IPM blocks might have been due to the fact that trees in these blocks were mature. Their canopies reached well into the vegetative region between rows, diminishing the contrast between herbicide and non-herbicide treatments.

In general, it can be concluded that no negative effect of herbicide treatment on numbers of spiders per tree has been demonstrated by these data. Among smaller trees there may be a slight positive effect. Perhaps when an understory cover exists directly beneath the trees, spiders may forage there for prey and be diverted away from the trees. They may move back into the tree canopies when there are more insect prey to be found there than in the ground cover.

Conclusions

Spiders were found to be significantly more abundant in second-level than in first-level IPM blocks. This result suggests that elimination of insecticide use after early or mid-June allows an increase in population of at least one group of natural enemies. High toxicity of broad-spectrum insecticides to spiders, as revealed in our laboratory tests, supports this suggestion, as do findings of Mansour et al. (1980), Madsen and

Madsen (1982), and Bostonian et al. (1984) and other authors.

The decreased number of spiders in first-level IPM blocks may have been due not only to direct contact toxicity of insecticide but also to insecticide acting as a repellant to spiders, toxicity to spiders of prey feeding on insecticide-treated plant material, lack of prey insects (as a result of prey being killed or driven away by pesticide), destruction of webs by turbulence created by spraying, or a combination of these and other factors.

Several questions still remain to be answered. One of them is whether or not the increased number of spiders in second-level IPM blocks is great enough to contribute significantly to the control of foliar pests. Can spiders prey effectively on leafminers, leafhoppers, and mites? Will they eat enough of such pests to make a difference? We plan to address these questions in the near future.

Acknowledgements

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Apple Integrated Pest Management in 1992: Insects and Mites in Second-level Orchard Blocks

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Last spring, in *Fruit Notes* [57(2):5-13], we reported results of our first year of second-level IPM trials in Massachusetts apple orchards. Under second-level IPM, orchard management is integrated across all classes of pests: insects, mites, diseases, weeds, and vertebrates, rather than focusing on a single type of pest. Here, we report results of the second year of second-level IPM trials on insects and mites in commercial Massachusetts orchards.

Insect and mite management under second-level IPM practices requires application of three to four selective insecticide sprays from April to early June to manage tarnished plant bug (TPB), European apple sawfly (EAS), plum curculio (PC), green fruitworm (GFW), the first generations of codling moth (CM), lesser appleworm (LAW), leafminer (LM), and leafhopper (LH). Insecticide application to the interior of the block ceases after the final plum curculio spray in early June, allowing natural populations of predatory insects and parasitoids to increase to levels we hope will be sufficient to provide control of summer populations of foliar pests. In full second-level IPM blocks, apple maggot flies (AMF) are controlled by perimeter interception traps. In transitional second-level blocks, use of AMF interception traps is replaced by perimeter row spraying with Guthion™ or Imidan™ every three weeks beginning in early

Table 1. Average percent injury by early-season insect pests in second-level and first-level IPM blocks in 1992.*

Type of block	TPB	PC	EAS	GFW	Total
Full second-level	1.5 a	0.1 a	0.1 a	0.0 a	1.7 a
First-level	2.3 a	0.1 a	0.1 a	<0.1 a	2.5 a
Transitional second-level	1.1 a	0.5 a	0.1 a	0.2 a	1.9 a
First-level	0.7 a	0.1 a	0.1 a	0.1 a	1.0 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each of three cultivars (McIntosh, Cortland, and Delicious) were sampled at harvest. TPB = tarnished plant bug; PC = plum curculio; EAS = European apple sawfly; GFW = green fruitworm.

July. In both types of blocks, removal of unmanaged apple and pear trees within 100 yards of each block reduces immigration of CM and LAW. Removal of drops after harvest discourages buildup of within-orchard populations of AMF, CM, and LAW.

In early April of 1991, we selected six full and six transitional second-level IPM test blocks of six to nine acres each. In 1992, we replaced one of the transitional blocks (which had been sold and was no longer available to us) with a new block on another farm. Each second-level block was matched with a nearby control block which was managed by the grower, using first-level IPM methods.

Early-season Fruit-injuring Pests

For control of arthropod pests active up to early June, second-level IPM relies on early-season pesticide treatment based on monitoring. We monitored each orchard weekly beginning in mid-April, then biweekly from mid-June through September. Five each of four types of sticky traps were hung in each block to monitor for TPB, LM, and EAS. We examined 100 or 200 leaves or terminals per block for LM, LH, aphids, mites, and mite predators. Fruit were examined both by IPM scouts and growers for fresh PC injury. Based on this monitoring, recommendations were made to the grower for treatment of the experimental block.

In second-level IPM blocks (both full and transitional) in 1992, combined injuries from early-season fruit pests were similar to those in nearby first-level IPM (grower control) blocks. In both first- and second-level IPM blocks, TPB caused the greatest amount of injury, followed by PC, EAS, and GFW (Table 1). Early season insecticide use was similar in both types of blocks, probably because both types were managed through identical first-level IPM techniques (Table 2). Injury by these early-season pests was lower in 1992 than in 1991.

Table 2. Dosage equivalents (spray events in parentheses) of insecticides and acaricides used in second-level and first-level IPM blocks in 1992.*

	Fruit pests		Mites				
Type of block	Before mid-June	After mid-June	Oil	Other miticides	LH	ABLM	Total
Full							
second-level	2.4	0.0	0.9	0.0	0.2	1.1	4.6
	(4.0)	(0.0)	(1.8)	(0.0)	(0.2)	(1.0)	(7.0)
First-level	2.8	2.0	1.1	0.1	0.0	0.4	6.4
	(3.8)	(2.2)	(1.8)	(0.2)	(0.0)	(0.5)	(8.5)
Transitional							
second-level	2.7	0.7	1.2	0.3	0.0	1.0	5.9
	(3.4)	(2.6)	(2.0)	(0.2)	(0.0)	(1.0)	(9.2)
First-level	3.3	3.1	1.3	1.1	0.0	0.5	9.3
	(3.6)	(3.2)	(2.0)	(1.0)	(0.0)	(0.6)	(10.4)

* LH = leafhopper; ABLM = apple blotch leafminer.

Table 3. Season-long apple maggot fly (AMF) injury and trap captures in second-level IPM blocks and first-level IPM blocks in 1992.*

Type of block	% AMF injury to fruit at harvest	Interior monitoring trap captures per trap	Perimeter monitoring trap captures per trap	Interception trap captures per block
Full second-level	0.4 a	9.0 a	16.2 a	2430
First-level	0.1 a	6.9 a	14.4 a	--
Transitional second-level	0.2 a	3.5 a	5.9 a	--
First-level	0.1 a	3.7 a	5.6 a	--

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each of three cultivars (McIntosh, Cortland, and Delicious) and two hundred border row fruit of mixed cultivars were sampled at harvest.

Table 4. Fruit injury by codling moth (CM), leafrollers (LR), lesser appleworms (LAW), and San Jose scale (SJS) in second-level and first-level IPM blocks in 1992.*

Type of block	CM	LR	LAW	SJS
Full second-level	<0.1 a	0.2 a	0.0 a	0.0 a
First-level	<0.1 a	0.1 a	0.0 a	0.0 a
Transitional second-level	0.0 a	0.2 a	0.0 a	0.0 a
First-level	0.0 a	<0.1 a	0.0 a	0.0 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each of three cultivars (McIntosh, Cortland, and Delicious) were sampled at harvest, and for CM and LR and additional two hundred border-row fruit of mixed cultivars were sampled at harvest.

Summer Fruit-injuring Pests: Full Second-level IPM

Odor-baited sticky red spheres were hung every five yards on perimeter apple trees of each full second-level experimental block to intercept immigrating AMF. These were baited with both butyl hexanoate, a synthetic fruit odor deployed in polyethylene vials, and ammonium acetate, a synthetic food odor released through a Consep™ membrane.

Interception trap captures averaged 2430 in the six full second-level blocks, indicating that AMF pressure was moderate in 1992. In 1991, trap captures averaged 3562 in three blocks in which traps were baited with both food and fruit odor. Captures of AMF on four interior unbaited monitoring traps (indicative of AMF penetration into the block interior) were statistically similar in second-level blocks and in nearby first-level blocks. AMF injury to fruit at harvest in second-level blocks was similar to that in nearby first-level blocks (Table 3). One second-level block, however, had 8% injury to Cortlands in mid-September. The nearby first-level block had no Cortlands, and all the McIntosh had been picked, so no comparison was available.

The second year of use of both butyl hexanoate and ammonium acetate (or carbonate) to bait the AMF interception traps indicates that this double-odor strategy may be very effective in large blocks. We eliminated the problem of quick loss of ammonia by replacing polyethylene vials with slow release membranes. Tests performed in our laboratory showed that flies continue to be attracted to these membranes even after they have been in the field for several months. Tests also indicated, however, that fewer flies approached the trap if the membrane flapped loosely in the wind. In addition, traps may require more frequent cleaning than we had previously thought, especially if the double-odor trapping procedure results in the capture of additional non-target insects. In 1992, we cleaned our traps once a month, but in one orchard, trap captures during a one-month period were 271% higher on traps which were cleaned of all insects than on those which were not cleaned thoroughly, indicating that as insects build up on the traps, trap captures decrease. In high-pressure situations, more frequent trap cleaning may be necessary if AMF are to be captured effectively.

Fruit injury by CM averaged less than 0.1% in both block types for the second year. Leafroller (LR) injury averaged 0.2% in full second-level blocks for the second year, and was 0.1% in nearby first-level blocks (Table 4). We will continue to monitor carefully for leafrollers because of concern that leafroller populations may grow in blocks in which the interior is not sprayed after early or mid-June. No LAW or San Jose scale (SJS) injury was found (Table 4).

No insecticides were applied in second-level blocks after mid-June. In the companion first-level blocks, growers applied an average of 2.0 dosage equivalents of pesticide after mid-June, and sprayed the block an average of 2.2 times (Table 2).

Summer Fruit-injuring Pests: Transitional Second-level IPM

Every three weeks after early June, perimeter row apple trees in transitional second-level blocks were treated with insecticide to control AMF. The block interior remained free of insecticide after early June. AMF injury averaged 0.2% in transitional second-level blocks and 0.1% in the nearby first-level blocks, slightly lower in both cases than in 1991. On average, 3.5 AMF were captured on unbaited interior monitoring traps in transitional second-level blocks and 3.7 in first-level blocks, indicating that in most cases relatively few AMF penetrated into the orchard interior (Table 3). Insecticide use after mid-June was reduced significantly in transitional second-level blocks compared to first-level blocks because applications were made only to the block perimeter. Total dosage equivalents of insecticide applied against fruit pests after mid-June averaged 0.7 in transitional second-level blocks and 3.1 in first-level blocks. Growers also sprayed transitional second-level blocks slightly less frequently (Table 2).

Unmanaged apple and pear trees were removed from within 100 yards of the six transi-

Table 5. Peak levels of mites and mite predators in second-level and first-level IPM blocks in 1992.*

Type of block	Mite presence (% of leaves) ERM+TSM	Af	YM	Ratio of ERM+TSM to Af
Full second-level	43.2 a	1.5 a	3.7 a	29:1
First-level	42.5 a	2.7 a	0.9 a	16:1
Transitional second-level	25.7 a	0.5 a	0.4 a	51:1
First-level	20.3 a	1.0 a	0.7 a	20:1

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. ERM = European red mite; TSM = two-spotted mite; Af = *Amblysieus fallacis*; YM = yellow mite.

Table 6. Foliar insect pest peak population and injury levels in second-level and first-level blocks in 1992.*

Type of block	PLH	PLH injury	WALH	WALH injury	ABLM	GAA	GAAP	WAA
Full second-level	11.2 a	15.0 a	13.8 a	0.3 a	10.8 a	68.7 a	54.5 a	6.2 a
First-level	2.3 b	6.3 a	10.6 a	3.4 a	13.6 a	69.5 a	44.3 a	3.3 a
Transitional second-level	7.2 a	4.5 a	6.1 a	9.3 a	10.8 a	77.3 a	55.3 a	8.2 a
First-level	0.5 b	0.5 a	1.1 a	0.4 a	11.8 a	65.3 a	57.0 a	11.0 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. PLH = potato leafhopper, WALH = white apple leafhopper; ABLM = apple blotch leafminer; WAA = wooly apple aphid; GAA = green apple aphid; GAAP = green apple aphid predators: cecidomyiids and syrphids. Data for PLH, PLH injury, and WALH is in terms of percent of terminals examined. Data for WALH is in terms of percent of fruit examined at harvest. Data for ABLM is in terms of the average number of mines per 100 leaves. Data for GAA, GAAP, and WAA is in terms of the percent of watersprouts examined.

tional second-level blocks. No CM injury was seen in the transitional second-level blocks or their companion first-level blocks. LR injury was slightly, but not significantly higher in the transitional second-level blocks than in the first-level blocks. LR injury in transitional second-level blocks was no higher in 1992 than in 1991. No sampled fruit in either block were damaged by SJS or LAW (Table 4).

Foliar Pests and Predators: Full Second-level IPM

In 1991, we reported season-long average population levels of foliar pests; this year we noted their peak populations in an effort to reflect damage more accurately. Cool and wet summer weather helped to maintain low populations of foliar pests in most cases.

Mite populations remained low in most cases, as were populations of *Amblysieus fallacis* predators, which were not seen in full second-level blocks until late August, and were never present in numbers thought to be sufficient to achieve biocontrol. Yellow mite predator populations were slightly higher in second-level than in first-level blocks throughout the summer, but their ability to control any but the lowest mite populations is questionable (Table 5).

Another predator, *Typhlodemus pyri*, which is present in orchards in Western New York, was released in two second-level IPM blocks. Sampling one month after release revealed high numbers of these mite predators on release trees. We will not know until 1993 whether or not they survived the winter and spring and successfully colonized the blocks.

Both full second-level and nearby first-level blocks were treated with about one dosage equivalent of oil (Table 2). No other miticide was used in full second-level blocks, and only one grower applied miticide to a first-level block.

Potato leafhopper peak population levels on terminals were higher in full second-level than in first-level blocks. Potato leafhoppers infested 11% of sampled terminals in full second-level blocks and 2% in nearby first-level blocks. Peak potato leafhopper injury to terminals was 15% in second-level and 6% in first-level blocks. White apple leafhoppers infested 14% of sampled terminals in second-level blocks and 11% in first-level blocks; however, injury to fruit averaged only 0.3% in second-level blocks, versus 3.4% in first-level blocks (Table 6). Injury in first-level blocks, however, was confined primarily to one orchard. In August, we identified rose leafhoppers in all types of orchard blocks, but further study is needed to determine their importance in Massachusetts orchards. Pesticide was applied against leafhoppers in early June in only one second-level block, which had a significant late-season infestation in 1991 (Table 2).

Average peak leafminer population levels were similar in the second-level blocks and first-level blocks (Table 6). All of the six full second-level blocks were treated with Dimilin™ against leafminers (Table 2). Leafminer population levels throughout the summer confirmed our previous conclusion that application of Dimilin against the overwintering generation of leafminer adults, when indicated by trap captures, is the most effective and least invasive technique for their control. Treatment with Dimilin is preferable to use of other materials which are harsher on beneficial insects and mites. Dimilin was not available for use in first-level blocks, and few growers chose to treat leafminers in those blocks. If registered, Dimilin will be a good option for control of leafminers without serious disruption of beneficials. We chose to apply it before bloom so that it did not affect leafroller and codling moth populations, which we are trying to study in the absence of insecticide use after mid-June. If registered, Dimilin could be used later in the season after first-generation mines have appeared, allowing growers to avoid its use in years in which it may not be needed.

In other articles, we provide data indicating that predacious spiders are significantly more abundant late in the growing season in second-level blocks than in first-level IPM blocks, and that some of these spiders feed on leafminer larvae inside mines as well as on leafhopper nymphs.

Green apple aphid (GAA) populations were almost the same in the two types of blocks. At their peak, aphids infested 69% of sampled terminals in full second-level blocks and 70% in nearby first-level blocks. Two aphid predators, syrphid and cecidomyiid flies, were slightly more prevalent in second-level blocks than in first-level blocks. These high levels indicate that predators achieved control of GAA in both second-level and first-level IPM blocks. Infestation of terminals by wooly apple aphid (WAA) was similar in second-level and first-level blocks, but in both types of blocks WAA populations were lower in 1992 than in 1991 (Table 6).

Foliar Pests and Predators: Transitional Second-level IPM

Very few *Amblysieus fallacis* predatory mites were seen in transitional second-level or nearby first-level blocks until September (Table 5). Mite levels in most cases remained low, although one grower had European red mite populations in his transitional second-level block sufficient to warrant treatment with a miticide in mid-summer (Table 2). Mid-season miticides were applied in four of the six first-level blocks, with an average of 1.1 dosage equivalents of miticide per block (Table 2).

Potato leafhopper infestation levels on terminals averaged higher in transitional second-level blocks than in nearby first-level blocks. In transitional second-level blocks, white apple leafhoppers infested 6% and potato leafhoppers 7% of terminals at their peak, while in nearby first-level blocks, both white apple leafhopper and potato leafhopper populations peaked at about 1% of terminals infested. White apple leafhopper injury to fruit at harvest was statistically similar in transitional second-level and first-level blocks, and potato leafhopper injury also was statistically similar in transitional second-level and first-level blocks (Table 6). In no case did these insects cause serious problems for growers.

All six transitional second-level blocks were treated with Dimilin against first generation leafminers. Only two growers treated their first-level blocks for leafminers (Table 2). Peak numbers of mines on 100 leaves averaged 10.8 in transitional second-level blocks and 11.8 in first-level blocks, considerably lower in both blocks than in 1991 (Table 6).

GAA populations were higher in 1992 than in 1991. At their peak, they infested an average of 77% of terminals in transitional second-level blocks and 65% of terminals in nearby first-level blocks. Predator populations were higher this year as well; their populations peaked at an average of 55% of terminals infested in transitional second-level blocks and 57% of terminals in first-level blocks. In both cases predators were adequate to provide control of aphid pests. Similar numbers of terminals in the transitional second-level blocks and in first-level blocks were infested with wooly apple aphids (Table 6).

Conclusions

We continue to be pleased with the success of implementation of second-level IPM for apple insects and mites in six- to nine-acre blocks in commercial orchards. In 1992, full second-level IPM blocks received 28% less total dosage equivalents of insecticide and miticide and 18% fewer total spray events for insects and mites than first-level IPM blocks. Excluding prebloom sprays of oil (non-toxic in the environment), dosage equivalents were reduced 30% and spray events were reduced 22%. Despite this difference, total fruit injury by insects was similar in full second-level and first-level IPM blocks, and peak populations of foliar pests were not different, except for leafhoppers.

Early season fruit injury from PC, TPB, EAS, and GFW was low in all cases, as was fruit injury by CM, LR, LAW, and SJS. GAA were controlled by predators in both second-level and first-level blocks. We continue to work toward gaining registration of Dimilin, which provides good control of leafminers without disrupting beneficial parasites and predators.

Transitional second-level IPM appears to be an effective reduced-spray management program for insect and mite pests in commercial orchards. In 1992, transitional second-level IPM blocks received 37% less total dosage equivalents of insecticide and miticide and 12% fewer total spray events for insects and mites than first-level IPM blocks. Total fruit injury by insects did, however, average slightly but not significantly higher in transitional second-level blocks than in first-level blocks. Peak populations of foliar pests were little different, except for leafhoppers, which were somewhat more abundant in the transitional second-level blocks.

For 1991 and 1992, combined, transitional second-level IPM blocks received about 17% more insecticide and miticide and 23% more spray events than full second-level IPM blocks. Insect-caused fruit injury averaged over both years was virtually identical in full and transitional second-level blocks.

Our main concern with the benefits of transitional second-level IPM over the long-term lies with the potential buildup of AMF from infested fallen drops not removed at harvest. The odor baits employed with the interception traps under full second-level IPM can attract these AMF. A second concern with the long-term benefits of transitional second-level IPM lies with potential negative effects of perimeter-row sprays on immigration of beneficial predators and parasites. Two more years of planned comparison of full second-level IPM vs. transitional second-level IPM vs. first-level IPM orchard practices should provide more insight into the benefits and costs of each practice.

A second year of trials has not answered all of our questions about two foliar pests, mites and leafhoppers. Although mites were rarely a problem in this wet, cool summer, predator populations were low even where pest mites existed in numbers sufficient to support them. We need to learn more about overwintering locations of mite predators and about the exact identity of predators in Massachusetts orchards. Further monitoring of the newly-released predator, *Typhlodemus pyri*, will help us to determine if release of this pesticide-resistant predator could help to control pest mites in Massachusetts orchards. We will continue to study the role of spiders in preying on leafminers in mines and on leafhopper nymphs.

In our judgement, the key to grower adoption of second-level IPM practices for insects and mites lies in availability of a low-cost approach to interception trapping of AMF. At present, costs of labor and materials to employ odor-baited sticky red spheres exceeds by nearly twofold the cost of applying insecticide sprays against AMF and other summer fruit-injuring insects. The frequent cleaning of sticky traps necessary to provide an effective capturing surface is a major component of the cost of this system. We believe that development of pesticide-treated spheres (now in progress) as a substitute for sticky spheres will provide a cost-effective approach to using interception traps for this insect.

Even if we assume that a pesticide-treated sphere interception trap system for AMF will be no more costly than applying insecticide after mid-June, why should a grower want to switch from an insecticide-based first-level IPM approach? We believe there are at least four reasons for doing so: (1) saving money on sprays against foliar pests by allowing beneficial natural enemies to build up and provide control in the absence of pesticide use; (2) reducing the likelihood that foliar pests will develop resistance to pesticides, thereby preserving the long-term effectiveness of these pesticides; (3) reducing pesticide intrusions on neighbors or the environment adjacent to orchards; and (4) greatly reducing or eliminating pesticide residues on fruit at harvest. For some growers, these potential advantages could be large.

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Fruit Notes

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COOPERATIVE EXTENSION SYSTEM POLICY:

Spiders That Feed on Leafhoppers and Leafminer Larvae

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Recently in *Fruit Notes* [58(1): 20-23], we showed that spiders were significantly more abundant in second-level than in first-level IPM blocks. We concluded by asking whether or not increased numbers of spiders in second-level blocks were great enough to contribute to the control of foliar pests. Here, we describe 1992 laboratory studies in which some of the most abundant types of spiders collected in second-level blocks were offered white apple leafhopper nymphs and adults and apple blotch leafminer larvae as potential prey.

Each spider was placed in a waxed paper cup (four inches tall by three inches in diameter) with a plastic lid. Into each cup we introduced an apple leaf kept turgid by placing its stem in water. The leaf harbored one tissue-feeding (late instar) leafminer larva and two leafhopper nymphs (or one nymph and one adult). The test lasted for 24 hours. Results are given in Table 1.

Table 1. Laboratory tests of orchard-collected spiders feeding on potential prey.

Family of spiders	Number tested	Spiders that fed on leafhoppers (%)	Spiders that fed on leafminer larvae (%)
Philodromidae	27	4	0
Araneidae	22	28	0
Salticidae	11	36	0
Anyphaenidae	10	100	90
Thomisidae	7	0	0

Of the five families of spiders examined, members of three families fed on leafhoppers: Anyphaenidae (hunting spiders), Salticidae (jumping spiders), and Araneidae (orb web spiders). The Anaphyenid spiders were the most voracious, as 100% of the tested individuals fed on leafhopper nymphs and adults (their behavior will be described later in conjunction with predation on leafminers).

Of the Salticid spiders, 36% fed on leafhoppers. These visually oriented spiders are often observed running around on leaves and branches moving their heads from side to side as they search for prey. Once they locate a prey insect, they stalk it much as a cat stalks a mouse before the final pounce. They may even capture it in mid air and then climb back to the leaf from which they have jumped using a piece of silk previously attached to that leaf. Salticid spiders are successful nine times out of ten. They are active only during the day.

Of the Araneid spiders, 28% fed on leafhoppers. Most of these spiders were small immature individuals of *Araniella displicatta*, which are found commonly on terminals of apple tree branches. They build tiny orb webs stretching across dorsal surfaces of leaves. Their webs are found at night and during the day. These spiders prayed mostly on the adult leafhoppers which got caught in their webs.

Only members of the Anyphaenid family fed on leafminers. Predation on leafminer larvae took place by 90% of the Anyphaenid spiders tested. In all cases the mines were opened from the underside of the leaf and the larvae were missing. It was not possible to identify the specific species, because they all were immature. But our best guess is that 9 of the 10 individuals tested were *Aysha gracillis*. These hunting spiders are common on foliage. They forage for prey mostly by sensing vibrations on leaves and (possibly) branches. They were often found foraging at night but they may also be active during the day.

The type of leafminer predation observed in this experiment is characterized by a very specific mark left on the leaves. For this reason it may be possible to quantify predation by Anyphaenid spiders in the field by counting the leaves which have the signs of predation and those which do not, provided that observations are made soon after predation. We conducted a preliminary study to quantify predation in this way.

In one of the three orchards where spiders were collected for use in the feeding test (University of Massachusetts Horticultural Research Center, Belchertown), we inspected 600 randomly selected leaves from 60 different apple trees on October 7. Of these leaves, 228 had leafminer mines, 20% of which appeared damaged due to spider predation. In other words, 20% of the leafminer larvae in the orchard in late September may have been prayed upon by Anyphaenid spiders. To compare this finding with what may be taking place in an orchard that has more spiders, on November 5, we inspected 169 randomly selected leaves containing leafminer larvae on four apple trees in an abandoned apple orchard (Orchard Hill area at the University of Massachusetts at Amherst). Of these mines, 37% appeared damaged due to predation of Anyphaenid spiders.

Even though these findings are very preliminary, they suggest that spiders of at least three families exhibiting different foraging strategies may be able to prey upon some of the most troublesome foliar pests of apple orchards. *Aysha* species of the family Anyphaenidae, in particular, may play a beneficial role in leafhopper and leafminer control.

In 1993, we plan to conduct feeding tests on more spider species commonly found in second-level orchard blocks and more individuals of each species. We also plan to conduct these tests under more natural conditions than the highly confining conditions of the laboratory used in 1992. We also hope to investigate the relationship between spiders feeding on leafminers and beneficial parasitoids feeding on leafminers. For example, it would be important to know if (and how much) spiders are likely to prey upon parasitized leafminers. Are spiders beneficial if they selectively extract parasitized leafminer larvae but leave unparasitized larvae alone? Hopefully our planned 1993 research will provide greater insight into the value of spiders as biological control agents of foliar apple pests.

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Apple Growing in China

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In June of 1992, we had the wonderful opportunity of visiting several apple orchards in various parts of east-central China in combination with a trip to the International Congress of Entomology in Bejing. We thought it might be interesting to convey some of the things that impressed us.

First of all, a bit of history. According to our Chinese colleagues, apples have been grown in China for at least 2000 years. Apples are planted on nearly four million acres in China, equal to about one-third of all acreage devoted to horticultural crops. China is roughly the size and shape of the continental United State. This means that a greater percent of the land area of China is devoted to apples than in the United States (which has about 500,000 acres in apples). Although production per acre is not nearly as great in China as in the United States, total production is about the same: 230 million bushels a year. Many Chinese orchards are newly planted, thus partly accounting for low average yield. In the United States, we produce about one bushel for every person. In China, production is about one bushel for every five people. Because living standards are improving very rapidly in China, there is a potential market for fruit appearing from either a major increase in Chinese apple production or major importation of apples from abroad. The most popular cultivars in China are Delicious and Golden Delicious and more recently Fuji and "Red Snake."

Presently, most orchards are owned by communes. Each family in the commune is entitled to lease about three acres of land from the commune and farm it in any way the family sees fit. The family can keep whatever it earns. All the trees that we saw were dwarf or semi-dwarf. One of the fascinating things to us was that every 20 rows or so were managed by a different family and often in a different way. So your immediate neighbor's horticultural practices could have a very strong influence on your crop, for better or for worse.

Another fascinating thing was the absence of any vegetation whatsoever beneath the trees but the lush vegetation of other crops grown in the alleyways between rows. These crops included peanuts, cotton, strawberries, melons, corn, and several others. All vegetation beneath trees was removed by stout Chinese hoes in order to reduce the drain of vegetation on water and nutrients. We wondered how it was possible to run tractors and sprayers down the alleyways without crushing the other crops. The answer was: tractors and motorized sprayers are few and far between. Nearly all the spraying is done by attaching a hose 30 yards or so in length to an outlet from an underground pipe that supplies the spray mixture from a central mixing point. The farmer simply sprays all trees within reach of the hose before picking up and moving on to the next attachment site. Some spraying is also done with backpack sprayers and "bucket-pumps." In this way there is no harm to crops in the alleyways (other than pesticide drift). Most applicators did not seem concerned about potential dangers from pesticide. They wore no gloves, masks or other protection, much the way it was in the United States in the 1940's!

Nearly all of the 20 or so orchards that we saw were maintained in excellent condition. Tree structure was particularly good, generally better than the average Massachusetts block of dwarf trees. It was mainly based on a three-tiered, central-leader tree pruning and limb training system. Advice on tree planting, tree training, fertilization, and pest control is given to all apple-growing members of a commune at least four times a year through visits by extension pomologists from the Division of Fruit and Forestry. We were told that the average family sprays about eight times a year, mainly against mites, aphids, moth larvae, powdery mildew, scab, and canker. From our perspective, tree foliar growth was very lush (probably too lush). So it was not surprising that mites and aphids took a strong liking to it. Maybe the lack of competition for nutrients in the absence of understory plants was too much of a good thing. The high upright growth of many trees was at least partly due to the common practice of tying branches down to horizontal or below horizontal positions, which then results in unnecessary uprights. There was a great deal of interest in biological control of mites and aphids but less progress on this area than we expected.

We wondered how apples were stored and sold after harvest. It turns out that cold storage does not exist to any appreciable extent. The fruit are trucked by the buyer to the local markets for immediate consumption. The storages that do exist are mostly in underground cellars or in above-ground clay structures that are periodically hosed with water for cooling.

Of all the many surprising things we encountered, perhaps the most surprising of all was the intent interest by the governor of a county of about two million people in the possibility of making apple juice or cider. She questioned us at length about how cider was made in the United States. It seems that apples have never been used in this way in China. She said that her people would love to have apple cider if they knew a good way to make it. What an opportunity for marketing low cost hand-operated cider presses.

We were treated royally with unexcelled hospitality (including 35-course lunches) wherever we went. It was indeed an eye-opening, unforgettable experience.

Evaluation of New Apple Cultivars

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In recent years, apple cultivars originating primarily from New Zealand, Australia, or Japan have gained considerable consumer acceptance in the market place. Prices received for these new cultivars have exceeded those for the traditionally-grown apples. This differential has led to a new awareness and a heightened interest in planting new apple cultivars. Many new apples are under test but there is a dilemma about which of these to plant. The decisions are made somewhat easier now since there are a number of good and legitimate choices available to growers.

About five years ago we started planting some of the most promising new cultivars and numbered selections. Scion wood was obtained for propagating trees from several countries and from various breeding programs. During the 1992 season many of these cultivars fruited. This report presents evaluations of some of these new cultivars.

Fruit evaluation started the first week in August and continued weekly through the third week in October. Where sufficient fruit were available, multiple harvests were made. Fruit on each harvest date were evaluated in two ways. First, fruit were weighed, counted, the diameter measured, and then red color was estimated to the nearest 10% on red coloring cultivars or on those yellow cultivars that had a prominent red cheek. Flesh firmness and soluble solids were measured. Fruit then were evaluated visually and sensory characteristics were judged on a specially prepared evaluation sheet (Figure 1). Lines approximately 10 cm in length were anchored at either end with descriptive terms. In each category a line was drawn through the line at a point that was judged to be appropriate for the apple. For example, if the color was judged to be neither dull nor bright a pencil mark was drawn half way between the terms. The length of this was measured from the zero point on the left and then recorded in the blank. The numerical value given in this instance would be 5.0. All other parameters were evaluated similarly and measured. A value of 6.5 is considered to be very good and a score of 7.5 or greater is excellent. A summary of the taste, visual, and laboratory evaluations of selected parameters are presented in Tables 1 and 2. Cultivars are listed in order of the harvest date at which they were considered best.

A log was kept and notes were taken for each cultivar at each harvest date. Below, listed by alphabetical order, are summaries of observation made on many of the cultivars evaluated. The star rating system recommended by the Pacific Northwest Fruit Tester's Association was used.

****	A cultivar tested in many areas and found worthy as a good risk for commercial recommendation.
***	A very promising cultivar but with some possible limiting factors.
**	A cultivar, new or old, worthy of testing for today's changing apple world.
*	A cultivar or strain that has been through enough testing and/or commercial trials to be classified as not worthy of commercial recommendation.
↑	An upward-pointing arrow with a star indicates increasing interest.
↓	A downward-pointing arrow with a star indicates decreasing or waning interest.

Akane (***) continues to be one of the apple cultivars that we favor. It is a very attractive apple and few apples in its season have the flavor that Akane does. It must be allowed to stay on the tree long enough to mellow. It is the most aromatic apple we evaluated. A major fault is that it is a shy bearer.

Alkemene (**) is a yellow apple with a deep orange cheek. It is somewhat russeted which detracts from its overall attractiveness. It has a spicy, sprightly, flowery taste. Flavor was rated quite high. A problem is that it is competing with Gala, Elstar, and Arlet. It may not be different enough or better enough to compete successfully with these cultivars. It is a disease-resistant cultivar, however, and this characteristic may increase its appeal.

Ambitious (*) has fruited for three years. It is a very late apple with too much competition from other cultivars to succeed. It ripened properly in only one of the three years. Fruit size is small. It is one of the ugliest apples in our plot with only fair flavor. Fruit are susceptible to Pseudomonas.

Cultivar ______________________________ Date ______________

Visual and sensory evaluation:

Color	dull	________________________	bright	________
Attractiveness	dislike	________________________	like	________
Aroma	none	________________________	intense	________
Skin	tough	________________________	tender	________
Crispness	low	________________________	high	________
Juiciness	low	________________________	high	________
Sweetness	low	________________________	high	________
Acidity	bland	________________________	tart	________
Starchiness	low	________________________	high	________
Astringency	low	________________________	high	________
Flavor	dislike	________________________	like	________
Desirable	dislike	________________________	like	________

Weight ______________

Color ______________

Flesh firmness ______________

Soluble solids ______________

Figure 1. Cultivar evaluation form.

Arkcharm™ AA-18 (**) is a very attractive light cherry red apple with semiprominent lenticels. It has a spicy taste, not sweet, flesh not too crisp, with acidity quite high. Fruit were harvested over a two-week period. Even when watercored, they still are very acid. Arkcharm warrants further evaluation.

AA-44 (**†) is a large blotchy cherry red apple. Flavor is good but not strong. It is equal to Paulared in flavor and ripens slightly before Paulared. It shows some tendency to drop. This cultivar warrants further evaluation.

AA-62 (*) looks somewhat like a Golden Delicious and ripens at about the same time. The finish is good, with no russeting; however, fruit show severe bitter pit and Pseudomonas. Fruit have a good but not an outstanding taste with an anise flavor. It is more acid than Golden Delicious. If it is not better than Golden Delicious it may not have a future.

AA-63 (**) was a very pleasant early surprise. It has speckled red skin, perhaps like an Early McIntosh. It also tastes like a very good early McIntosh, without the sharp astringent taste. It is small with a very short shelf life. We rated it very high for color, flavor, and overall. It is better than Sumac which ripens at a similar time.

Arlet (**†) remains high on the new cultivar list despite its three major faults: preharvest drop, russet, and poor color. It received one of the highest flavor rating. It has a good sugar-to-acid ratio that tends to favor acid. It stores quite well and keeps it taste for a long time. The greasiness that develops on Arlet is quite different from that developing on other apples, since it can be washed off. Even though it feels greasy, internal condition can still be very good.

There is a very good relationship between development of red color and drop. The quality of this apple is too good to discard right now, even with its faults.

BC 9-17 (*) is a medium sized dull cherry red apple with semiprominent lenticels. The flavor is not strong, and when ripe it has a hint of perfume and pineapple. It is a fairly good apple, but certainly not outstanding.

BC 78-9-28 (*) is a medium sized, attractive red apple. The skin is smooth and lightly striped. The flesh is slightly chalky and the flavor is like licorice. The very different taste makes it difficult to decide whether or not we like it.

BC 8C-27-96 Sunrise (**↓) is a very attractive apple but when it develops outstanding red color, it is too ripe. The flesh characteristics are outstanding. It is crisp, juicy, and just feels wonderful. A major weakness of this apple is that it has a very weak apple flavor and the flavor that it does have is acceptable but not outstanding. We do not rate Sunrise very high.

BC 15-30 (*) is a large, light cherry red apple with prominent brown lenticels. Even when ripe (September 1) acidity is high. It has a pronounced pineapple flavor that is not totally related to watercore. This apple was rated average for red color, fairly high on attractiveness, and average for taste and flavor. This fruit is neither outstanding nor poor.

BC 9P-14-32 (**↑) was one of the pleasant surprises this year. It is not very attractive because the cherry red is not intense and there is considerable net-like russeting. Fruit size is medium, flesh is yellowish-white, flesh texture is good, and the sugar-to-acid ratio is good. The taste and appearance is reminiscent of Arlet. This apple was rated among the highest for flavor and overall desirable. It is a very good apple.

BC 2-8 (*) is a very attractive red apple that resembles Delicious; however, the beauty is only skin deep. Even when very ripe fruit were tasted, the acid level was almost off the scale. It is an attractive apple with only fair to good quality. Fruit were dropping on September 21.

BC 8M-15-10 (**↑) was the second British Columbia selection that we thought was truly outstanding. This apple has blotchy pink-red color. Overall it is not an attractive apple. The flesh is yellow with a mild banana flavor. It is extremely crisp and juicy. Unlike published reports, it does not remind us of Fuji, but is more reminiscent of Braeburn. As far as taste, crispness, and juiciness are concerned, you could not ask for a better apple. It is outstanding.

BC 8B-14-56 (**) is a fairly attractive and fairly good tasting apple. It looks like a Delicious and has cream yellow flesh. Fruit are deep cherry red at the optimal harvest date. The longer fruit stayed on the tree the better it got, although flesh firmness and texture were poor. The flavor of this apple is very complex: fruity and tropical. Since the taste is different and it improves with age, this cultivar may benefit from a period of cold storage.

DIR 98T-486 (**) is a very attractive deep red apple on a cream yellow ground color. The irregular surface detracts somewhat from the appearance, but still it was one of the most attractive to be evaluated this year. Flavor improve with time on the tree. Fruit harvested on October 5 were quite good but the ground color indicated that the shelf life then would be rather short. The fruit is very juicy, yellow-white fleshed, and slightly tough skinned. It is so attractive, that based solely on appearance, it should be looked at further.

BC 17-30 (**↑) is a very attractive, dark-burgundy-red apple of the McIntosh type. The flavor is reminiscent of McIntosh with Spartan overtones. Perhaps it tastes most like Acey Mac. The flavor may be a little bland but it is still a very good apple. Flesh is white with a greenish tinge. The pedicle is long and lenticels are semiprominent. This apple warrants further evaluation.

BC 8K-21-39 (**) is a fairly good apple with better than average appearance. It is round to conic, has yellowish-white flesh that is somewhat dry. Fruit shows some russeting. Where the surface is red it is attractive. The red looks muddy on the green-red interface. The longer the fruit remained on the tree the better it tastes.

BC 8C-6-62 (*) is a dark cherry-red apple with a bumpy surface caused by raised lenticel. The flesh is yellowish white. The flesh was so acid that it was not possible to evaluate flavor effectively. This fruit was about the most highly acid apple that we evaluated this year. We were not impressed.

Bonza (*). This is the second year that we have evaluated Bonza. It is somewhat attractive and red color is good. The surface of the apple is not smooth, the flesh is rather dry, and the flavor is acceptable but not outstanding. We are not encouraged to

Table 1. Taste evaluation of apple cultivars grown at the University of Massachusetts Horticultural Research Center. 1992.

Cultivar	Date	Attractiveness	Red color	Sweetness	Acidity	Flavor	Overall desirable
AA 63	Aug. 6	5.1	6.8	5.3	6.1	7.4	6.7
Sumac	Aug. 6	2.3	3.0	5.1	6.4	7.1	5.3
NY 66305-139	Aug. 6	3.6	2.2	1.8	9.0	3.3	2.4
BC 9-17	Aug. 11	4.5	4.5	4.0	8.8	6.5	5.0
Arkcharm (AA 18)	Aug. 17	7.9	6.5	2.7	8.0	5.3	5.1
Jerseymac	Aug. 17	5.5	6.7	5.6	4.8	6.2	5.9
BC 78-9-28	Aug. 17	6.9	6.5	6.5	5.3	5.0	4.8
BC 15-30	Aug. 17	4.8	5.0	2.4	7.9	4.4	4.0
Williams Pride	Aug. 20	5.6	6.4	4.5	4.8	6.1	6.2
Redfree	Aug. 20	8.4	8.8	5.2	5.5	7.6	7.4
OSU 31-19	Aug. 20	3.0	3.6	5.2	6.1	7.0	6.8
AA 44	Aug. 24	5.5	5.9	5.1	7.8	5.7	5.8
Paulared	Aug. 24	6.3	6.4	2.3	6.9	5.0	5.3
BC 8C-27-96	Sept. 1	6.3	5.0	5.2	5.5	5.1	5.3
Sansa	Sept. 1	6.4	6.3	7.4	5.5	7.4	7.4
Nebuta	Sept. 1	6.5	7.0	5.5	6.7	5.1	5.3
BC 15-30	Sept. 1	5.7	5.2	5.2	8.8	5.1	4.0
Himekami	Sept. 8	7.0	7.0	3.3	8.5	4.1	3.9
Akane	Sept. 8	8.5	8.4	5.5	6.9	6.8	6.8
BC 9P-14-32	Sept. 8	4.1	4.4	6.2	7.0	7.9	7.4
Dayton	Sept. 8	5.6	6.3	5.7	6.4	5.8	5.1
Ginger Gold	Sept. 14	8.0	---	6.5	6.2	5.8	7.4
Fiesta	Sept. 14	4.2	3.5	4.8	5.0	5.7	5.2
Tsugaru Homei	Sept. 14	5.2	5.0	8.1	4.8	6.3	6.3
Arlet	Sept. 14	4.7	4.7	5.6	7.0	7.5	6.5
Elstar	Sept. 14	4.5	4.4	3.2	8.1	4.7	4.6
NY 66305-289	Sept. 14	6.8	6.8	3.4	7.1	5.3	5.9
NY 74828-12	Sept. 21	6.7	6.8	3.4	7.3	5.5	5.8
Alkemene	Sept. 21	5.3	5.6	6.3	6.8	5.9	5.6
Honeycrisp	Sept. 21	2.9	3.5	6.8	5.2	6.3	5.2
BC 2-8	Sept. 21	7.1	6.9	4.2	8.2	4.8	5.3
Shamrock	Sept. 28	4.8	---	5.7	5.3	7.0	6.5
NY 75414-1	Sept. 28	7.8	7.8	6.2	7.0	7.3	7.4
Natco 81	Sept. 28	6.7	6.7	5.3	4.6	6.3	6.3
BC 8M 15-10	Sept. 28	3.6	4.2	7.0	5.2	7.3	7.0
NY 75413-30	Sept. 28	6.8	6.8	4.7	8.1	3.6	3.6
Bonza	Sept. 28	6.4	6.9	3.3	4.8	5.5	5.0
BC 8B-20-13	Sept. 28	7.5	---	4.1	7.6	5.7	5.8
BC 8B-14-56	Sept. 28	5.0	5.0	5.6	5.0	6.2	5.8
Yataka	Sept. 28	5.1	5.1	7.1	4.2	6.9	6.9
Dulcet	Sept. 28	5.4	5.3	5.5	5.0	5.5	5.5

continue evaluating this cultivar. Bonza tasted in Australia seemed to be quite different and far superior to that grown in our trials.

Braeburn (*) was one of the poorest performing cultivars that we had in our plots. Fruit were harvested on October 19, and they appeared not to be ripe. Fruit were unattractive, high in acid, and not sweet. They just did not taste mature. We have trees fruiting that came from two sources. The fruit from both sources are equally poor. This is the second year that fruit quality was very poor. We may not

Table 1 continued.

Cultivar	Date	Attractiveness	Red color	Sweetness	Acidity	Flavor	Overall desirable
DIR 98-T-486	Oct. 5	7.8	8.4	5.2	5.0	5.9	6.3
Yoko	Oct. 5	5.1	5.0	6.3	6.5	6.3	5.9
NY 65707-19	Oct. 5	6.3	6.8	5.1	4.1	6.3	6.4
Rubinette	Oct. 8	2.6	2.6	3.9	7.1	5.8	5.1
Freyburg	Oct. 8	5.3	---	7.0	5.5	6.8	6.8
NY 75441-67	Oct. 13	5.7	6.3	3.0	7.5	5.3	4.8
BC 17-30	Oct. 13	8.2	8.4	7.1	5.3	6.9	7.1
Jonagold	Oct. 13	5.7	5.1	6.9	5.3	7.5	6.9
Senshu	Oct. 13	5.1	4.8	6.5	5.5	6.9	6.4
NY 429	Oct. 13	7.8	7.5	3.9	5.9	6.1	6.3
Hawaii	Oct. 13	5.0	---	6.1	3.5	6.5	5.9
Shizuka	Oct. 13	5.9	---	5.2	5.8	7.4	7.3
Hokuto	Oct. 13	4.8	4.6	5.5	4.4	5.7	5.6
NY 617	Oct. 13	6.2	6.1	2.7	8.4	5.3	5.5
Splendour	Oct. 13	7.0	6.2	6.0	3.8	5.8	6.8
Brock	Oct. 13	4.4	2.9	5.5	5.3	6.1	5.1
NY 73334-35	Oct. 13	5.5	5.5	4.2	7.6	4.5	5.0
NY 75413-30	Oct. 13	6.9	7.0	5.5	5.5	4.8	5.9
Fantazja	Oct. 13	7.0	7.0	5.2	6.8	6.7	6.7
NY 752	Oct. 13	3.6	3.5	5.5	5.6	5.5	5.1
AA 62	Oct. 13	4.8	---	5.3	4.8	5.9	5.6
BC 8C-5-62	Oct. 13	5.5	5.5	1.1	9.6	2.3	2.4
BC 8K-21-39	Oct. 19	5.9	5.9	5.8	5.9	6.8	6.9
Natco 24	Oct. 19	6.3	5.9	3.6	7.0	5.6	5.8
Coop 29	Oct. 19	4.2	---	3.6	6.3	5.9	5.7
Newtown Seedling	Oct. 19	5.6	5.1	4.8	6.8	5.0	4.8
Criterion	Oct. 19	6.1	---	4.6	3.6	5.5	5.5
Nittany	Oct. 19	5.8	5.3	5.2	6.2	6.2	6.2
Reinette Simirenko	Oct. 19	5.3	---	4.6	6.3	5.7	5.5
Florina	Oct. 19	6.3	6.2	7.1	3.8	7.1	7.1
Braeburn	Oct. 19	4.1	3.9	3.5	8.2	3.9	4.0
Ambitious	Oct. 19	2.9	2.3	6.5	5.9	4.1	3.6
Orin	Oct. 19	5.5	---	8.2	4.1	7.1	6.5
Kinsei	Oct. 19	4.4	---	7.9	4.6	7.4	6.8
NJ 100	Oct. 19	7.0	---	5.0	4.6	5.5	5.9
Natco 58	Oct. 19	5.7	5.3	3.2	8.1	3.5	4.4
Natco 3	Oct. 19	6.5	4.1	7.1	36	5.2	5.8
Suncrisp (NJ 55)	Nov. 4	5.2	---	4.8	6.5	7.0	6.7

All fruit characteristics were rated on a scale ranging from 0 to 10.
Color: dull = 0, bright = 10.
Attractiveness, Flavor, and Overall desirable: dislike = 0, like = 10.
Sweetness: low = 0, high = 10.
Acidity: bland = 0, tart = 10.

have environmental conditions that favor production of this cultivar. An added observation that may contribute to the poor taste is that mites show a distinct preference for Braeburn. Only Braeburn trees were heavily damaged by mites. Since trees were located in two different locations, it appears that this is a characteristic of Braeburn. We cannot recommend Braeburn for New England, based upon our observations this year.

Brock (**↓) was a good but not outstanding apple this year. Red color is not attractive with a burned or grayish cast. Flavor is better than appearance. We rate flavor as good but not outstanding. It tastes very much like a Spencer. Fruit was dropping on October 13. We have better apples than Brock.

COOP 29 (**) is a green-yellow apple with a brown pink cheek. These characteristics, coupled with some russeting, make this apple not very attractive. Flesh was firm, tart, astringent, and crisp with a very distinct and strong strawberry taste. In fact, this is the only apple that we have ever tasted that even remotely reminds us of strawberries. Although it is unattractive and flavor only good, it is disease resistant and it may be different enough to make it.

Criterion (*). We have not been able to mature Criterion properly for two out of three years. Fruit were mostly green on October 19, even when flesh firmness was only 13.5 pounds. Skin was tough, flesh whitish-green, and the flavor acceptable. Criterion is not going to replace Golden Delicious.

Dayton (**). We evaluated Dayton for the first time this year. We were hoping for more than we got. It is a large, not-too-attractive, red apple with a bumpy irregular surface. It has a pleasant, perfumy, spicy flavor but other cultivars ripening in early to the mid-September are better. It may have a future as a disease-resistant apple, but on its own it will not beat better apples in the same season.

Dulcet (**) is a deep burgundy red apple with prominent lenticels. It is too dull a red to be a truly attractive apple. Although reminiscent of Delicious, it appears to have a fairly low L/D ratio. The flavor is sweet, buttery, but not overwhelming. The juice seemed quite thick and the whitish green flesh does not appear to brown when exposed to the air. Dulcet was a good but not an outstanding apple.

Elstar (*) continues to leave us unimpressed after three years of evaluation. The color is not outstanding and the acid level is too high even when the ground color is yellow. Last year the trees overcropped. Even with a very light crop this year due to biennial bearing, fruit size was still unacceptably small. This is the same pattern that we observe here with Empire. Elstar is just not good enough to compete with other apples in its season (Gala and Arlet). If one places Elstar in storage to mellow, it still must then compete with other later cultivars that are vastly superior. We can not recommend Elstar.

Fantazja (**↑) was an unexpected surprise. It is a Polish apple that came from Dick Van Well of Van Well Nursery. We planted and cropped the same trees in 1992, so the October 13 harvest date may not be the correct harvest date, since trees were fruiting in their first leaf. It is a very attractive red apple that resembles McIntosh. It has white flesh and tastes similar to McIntosh but it is crisper and has courser flesh and better flavor. We were quite impressed with our first look at this apple.

Fiesta (**↓). This is our second year looking at Fiesta. In both years, it showed severe preharvest drop. It is dull in color and quite unattractive. Although it is fairly large and we rated flavor quite high, we do not think it has what it takes to make it here. It is an OK apple, but certainly not very exciting.

Florina (**) is a late-maturing, disease-resistant apple that is both attractive and has good taste. The flavor is very mild. The flesh is whitish-yellow and very crisp. It tastes sweet with a low acid level. This apple certainly deserves further evaluation.

Freyburg (**) is an elongated yellow apple that resembles Delicious in shape. The flesh is white and it seems dry. It is very sweet with a strong fruity flavor. The strong flavor may turn some people off.

Gingergold (***) is one of the most attractive apples that we grow, regardless of the season. When ripe it is a beautiful yellow green that completely lacks russet or surface blemishes. It is the best early Golden Delicious type that we know of. It is firm crisp, but the apple flavor is not strong. September 1 was too early to harvest this apple, and fruit harvested on September 8 were yellow but still starchy. Fruit harvested on September 14 were still very crisp and the seeds were still white. The proper time of harvest of this may be later than the suggested time. Regardless of time of harvest, this is an excellent apple that has a future.

Hawaii (**). This is the first year we fruited Hawaii. It is a somewhat attractive yellow apple that resembles a Golden Delicious without the russet. It has a red cheek like Goldens get in the Northeast. It is fairly sweet, has low acidity and good flavor, with a strong banana taste. It bruises easily. It probably will no replace Golden Delicious.

Himekami (*) is a very attractive apple that looks like a cherry-red Delicious ripening during the first week in September. We rated flavor and overall desirability quite low. The appearance of this apple is much better than its taste. We are not enthusiastic about Himekami.

Hokuto (Northern Star) (**). The brownish red, muddy red color on the surface of this apple makes it somewhat unattractive. Even when the ground color is intensely green, it appears to be acceptable to eat. The flesh is somewhat sweet and sprightly, and this perception may be accentuated because acidity appears to be very low. We do not consider this to be an outstanding apple. There are better apples available that ripen at the same time.

Honeycrisp (**↑) distinguished itself as one of the best apples that we evaluated. It was the most productive apple in our plot, producing over 1.5 bushels of 3-inch apples per tree on M.26 in their third leaf. It was one of the least attractive apple that was evaluated. It was also one of the crispest and juiciest apples tasted. The flavor was good but not strong. It has outstanding storage potential. It maintains crispness, juiciness, and flavor after at least 20 weeks of regular air storage. This apple requires further evaluation but the more we taste Honeycrisp, especially out of storage, the better it looks.

Kinsei (**↑). This is the first year that we evaluated Kinsei. It is quite an unattractive apple but it is also one of the best tasting apples in our plot at harvest time. Following 15 weeks of regular air storage, it had lost much fruit condition and flavor that was present at harvest. The appearance and taste of this apple are not dissimilar to NJ 55.

Jonagold (****) was evaluated more as a marker than a new cultivar. It clearly is an outstanding apple that should be planted. It has good size and outstanding flavor; however, it lacks long storage life.

New Jersey 100 (**) is a large, very attractive yellow apple with a waxy smooth surface. It has a spicy licorice taste that was very strong. It is not very sweet and is low in acid. It may just be another apple that gets lost in the crowd.

Natco 3 (**) is a fairly attractive yellow apple with a prominent reddish pink cheek. It appears to have a very large L/D ratio, perhaps 1.05 or greater. It tastes sweet and it has a distinctive, strong spicy flavor that lingers after your have eaten the apple. It is an extremely interesting and complex apple. Some fruit had watercore when they were harvested on October 19.

Natco 24 (**) is a fairly attractive, large, dark cherry red apple with striped red over yellow-green ground color. Flavor is good but astringency is quite high. It probably can benefit from a period of storage. Flesh is somewhat dry and it did not appear to be ready to eat at harvest; however, it is attractive enough and the taste is good enough to warrant further evaluation.

Natco 58 (*) was harvested on October 19, yet the acid was so high that it was difficult to identify or characterize the taste. Color and appearance are not exceptional. This cultivar does not appear to be a good prospect for the Northeast.

Natco 81 (**↑) is a very attractive apple that rated rather high in red color, appearance, flavor, and overall. It is Spartan-like in appearance and bears a striking resemblance to Acey Mac in flavor, appearance, and time of ripening. Although they were not compared directly, they appear to be identical twins.

Nebuta (**↓) is a somewhat attractive apple that resembles Delicious in many respects. It ripens at the end of August. It is somewhat irregular in shape, shows signs of uneven ripening, and is distinctly acid even when watercored. Flesh texture is somewhat undesirable. Overall, this apple has not distinguished itself enough to be recommended.

New York 429 (**) is a very attractive, large, smooth, red apple. It is somewhat irregular in shape. Flesh is purfumy, white with a green cast, and when ripe the flesh seems somewhat on the soft side. We believe that it is a good apple. Our major question is whether or not it is good enough to stand out among all of the other good apples.

New York 617 (**) was an extremely large, somewhat irregularly shaped red apple. Even though the ground color is yellow, fruit are still high in acid at the optimal harvest date. It is not a good fresh market fruit; however, it appears to have the flesh characteristics required for an outstanding processing apple.

New York 752 (**) is a large, somewhat blotchy burned-red apple with yellow flesh. It has a spicy licorice-almond flavor that may be too distinctive to be acceptable.

New York 66305-139 (**) is the earliest of the disease-resistant selections from New York. The major strength of this apple is that it is one of the first disease-resistant apples to ripen. Within a very short time, apples go from green and very tart to red, soft, and still tart. This apple is good enough to compete with Early McIntosh or Puritan, but that is really not saying much. AA 63 or Sumac are better and they all ripen at about the same time.

New York 66305-289 (**) is a very attractive dis-

Table 2. Laboratory analysis of apple cultivars evaluated in 1992 at the University of Massachusetts Horticultural Research Center.

Cultivar	Best date	Also evaluated	Weight (g)	Diameter (in.)	Firmness (lbs.)	Soluble solids (%)	Red color (%)
AA 63	Aug. 6		99	2.54	9.8	11.3	74
Sumac	Aug. 6		91	2.48	10.2	12.5	85
NY 66305-139	Aug. 6	8/11	115	2.65	15.4	11.8	50
BC 9-17	Aug. 11 & 17		151	2.84	16.4	13.9	66
Arkcharm (AA 18)	Aug. 17	8/24, 9/1	196	3.10	13.8	12.4	73
Jerseymac	Aug. 17		166	3.03	13.2	10.8	75
BC-78-9-28	Aug. 17		135	2.84	13.8	14.4	90
Williams Pride	Aug. 20	8/11, 8/17, 8/24	202	3.20	15.6	11.6	80
Redfree	Aug. 20		148	---	17.0	11.8	73
OSU 31-19	Aug. 20	9/1	---	---	---	---	---
AA 44	Aug. 24	8/17, 9/1	264	3.48	16.7	12.6	68
Paulared	Aug. 24		145	2.94	15.3	10.4	78
BC 8C-27-96	Sept. 1	8/24, 9/8	225	3.21	13.3	12.9	77
Sansa	Sept. 1		183	2.96	15.9	15.4	86
Nebuta	Sept. 1	8/24	155	2.84	16.2	13.9	73
BC 15-30	Sept. 1		300	3.67	18.6	13.6	70
Himekami	Sept. 8	8/24	154	2.85	16.0	13.1	79
Akane	Sept. 8		194	---	15.7	12.9	93
BC 9P-14-32	Sept. 8		200	3.08	17.0	15.5	80
Dayton	Sept. 8	9/14	290	3.52	16.9	12.9	75
Ginger Gold	Sept. 14	9/8	259	3.30	20.0	13.9	---
Fiesta	Sept. 14	9/21	199	3.19	17.6	13.4	76
Tsugaru Homei	Sept. 14	9/28	216	3.12	15.6	13.4	72
Arlet	Sept. 14	9/21	195	2.99	17.8	12.8	67
Elstar	Sept. 14		137	2.76	16.7	13.5	62
NY 66305-289	Sept. 14	9/21	183	3.07	15.7	12.7	85
NY 74828-12	Sept. 21		149	3.04	17.3	12.0	86
Alkemene	Sept. 21		156	---	16.5	15.5	---
NY 75414-1	Sept. 21	9/8, 9/14, 9/28	167	3.07	14.8	12.1	91
Honeycrisp	Sept. 21	9/14, 9/28	256	3.34	15.2	12.0	69
BC 2-8	Sept. 21		252	3.42	14.7	12.1	86
Shamrock	Sept. 28	9/14, 9/21, 10/5	178	3.04	17.8	13.7	---
Natco 81	Sept. 28	9/21	231	3.40	15.8	11.9	91
BC 8M 15-10	Sept. 28		235	3.07	16.8	14.7	50
NY 75413-30	Sept. 28		425	4.01	15.8	12.9	80
Bonza	Sept. 28	10/5	210	3.30	17.3	11.9	90
BC 8B-20-13	Sept. 28	Pick Earlier	337	3.70	11.6	16.3	---
BC 8B-14-56	Sept. 28	10/5, 10/19	228	3.28	14.6	14.5	90
Yataka	Sept. 28	10/5, 10/19	183	2.99	15.6	14.6	65

ease-resistant apple that resembles a McIntosh except that it has dark cherry red color and a long thin pedicel. It has yellowish flesh, quite tart, and different flesh texture than McIntosh. It ripens between September 15 and 20 but ripen unevenly. This is a nice apple that should be evaluated further.

New York 74828-12 (**) is a disease-resistant apple that looks and tastes like Jonamac. When the ground color changes to green-yellow the acidity is still very high. There is a tendency for this cultivar to ripen unevenly and show some preharvest drop. This apple was for the most part an average apple.

New York 75414-1 (***). There was more excitement generated about this apple than any other disease-resistant apple. It is an extremely attractive medium-sized apple, that develops a deep burgundy

Table 2 continued.

Cultivar	Best date	Also evaluated	Weight (g)	Diameter (in.)	Firmness (lbs.)	Soluble solids (%)	Red color (%)
Dulcet	Sept. 28	10/8	185	3.03	16.1	13.2	90
BC 98T 486	Oct. 5	9/21, 9/28	204	3.08	14.5	11.0	83
Hudson	Oct. 5		210	3.06	20.4	12.6	---
Yoko	Oct. 5	10/13	225	3.20	19.6	15.4	65
NY 65707-19	Oct. 5	10/13	208	3.18	16.5	11.2	80
Senshu	Oct. 5	10/13	205	3.10	14.3	13.8	80
Jonagold	Oct. 8		278	3.43	15.8	13.3	68
Rubinette	Oct. 8	10/13	155	2.88	15.1	16.4	50
Freyburg	Oct. 8	10/19	193	2.97	19.6	16.5	---
Shizuka	Oct. 8	10/8, 10/19	395	3.83	16.3	14.3	---
NY 429	Oct. 13	10/5	244	3.37	14.0	12.1	88
Hawaii	Oct. 13		230	2.95	15.1	13.1	---
Kinsei	Oct. 13	10/19	216	3.21	16.1	13.6	---
NY 75441-67	Oct. 13	9/28, 10/5	258	3.29	16.3	13.0	92
BC 17-30	Oct. 13	10/5	237	3.32	12.5	13.0	95
Hokuto	Oct. 13	10/8, 10/19	302	3.59	15.0	13.1	65
NY 617	Oct. 13	10/5	420	4.03	13.8	13.6	70
Splendour	Oct. 13	10/5, 10/19	206	3.20	16.0	11.8	82
Brock	Oct. 13	10/8, 10/19	302	3.56	15.5	13.5	64
NY 73334-35	Oct. 13	10/5	252	3.32	16.8	11.4	89
NY 75413-30	Oct. 13		205	3.14	15.8	13.7	90
Fantazja	Oct. 13		138	2.73	14.7	12.7	85
NY 752	Oct. 13		275	3.46	14.6	12.3	70
AA 62	Oct. 13		242	3.26	17.9	13.5	---
BC 8C-5-62	Oct. 13		182	3.00	15.2	14.2	82
BC 8K-21-39	Oct. 19		184	2.98	17.9	13.0	84
Natco 24	Oct. 19	10/13	250	3.42	17.1	13.0	85
Coop 29	Oct. 19		196	3.14	17.8	12.2	---
Newtown Seedling	Oct. 19		228	3.33	18.5	12.1	80
Criterion	Oct. 19		185	2.98	13.5	11.2	---
Nittany	Oct. 19		165	2.87	17.5	13.3	75
Reinette Simirenko	Oct. 19		190	3.07	18.4	12.2	---
Florina	Oct. 19		168	2.97	17.4	12.6	83
Braeburn	Oct. 19		185	2.97	20.0	12.3	60
Ambitious	Oct. 19		143	2.80	19.7	13.0	---
Orin	Oct. 19		213	3.06	18.0	14.2	---
NJ 100	Oct. 19		235	3.34	17.5	12.4	---
Suncrisp (NJ 55)	Oct. 19		203	3.06	17.8	14.2	---
Natco 58	Oct. 19		209	3.10	18.9	12.8	71
Natco 3	Oct. 19		260	3.21	16.1	12.2	---

red color. Its red color, prominent white lenticels, and slight scarf skin made it almost indistinguishable from Macoun. The flesh is white, tart, not too sweet, and extremely crisp. This apple had the color to pick on September 8 but flavor and other attributes did not develop until later. Realistically, this apple showed no sign of drop and it could have been picked from the second week in September through the first week in October. Those who tried this apple knew that they would like it before they even tasted it. It was a classic Pavlov's dog response.

New York 75413-30 (**). This very large disease-resistant apple was harvested too early, on September 28. The fruit were quite pitted and the flesh seemed dense and heavy. It was rated quite high for color and attractiveness but quite low for flavor. Judgment must wait for another year, but we were not too impressed this year.

New York 65707-19 (**). This disease-resistant apple is fairly attractive, round, medium sized, and red with small white lenticels and greenish white flesh. The flavor is not strong but the flavor and acidity seemed to vary quite a bit from one fruit to another. On October 13, fruit were dropping. The jury is still out on this one.

New York 75441-67 (*) is a deep-red disease-resistant apple showing some skin russeting or blemishing. The flesh is white, the skin is tough, the flavor OK, but the acidity is so high that even when ripe it is difficult to recommend this one.

New York 73334-35 (**) is a disease-resistant apple with good red color, but its irregular fruit shape detracts from its appearance. Harvest on October 5 was too early while severe drop was noted on October 13. Flesh is whitish green, and the skin is tough. The acid is high, the sugar is low, and the taste is not outstanding. There is a blueberry aftertaste. It was not an outstanding apple this year.

New York 75413-30 (**) is a very attractive, red, disease-resistant apple the looks much better than it tastes. The shape is ovate to conic and ribbed. Flesh is white with a tinge of yellow. Skin has a chalky, odd taste. We rated flavor only fair to good.

Nittany (**). Trees fruited in the first leaf, so the October 19 harvest date may not be representative of future harvests. This apple is fairly good tasting, but it is not as good as Nittany originating from Pennsylvania. We will continue to follow it.

Orin (**) is green apple and is fairly attractive. It is a very sweet, subacid apple with a pleasant, slightly fruity taste. This sweet apple is worthy of further evaluation.

Redfree (***). We used Redfree as another marker in the evaluation process. It is one of the best August apples with a rating of at least *** now. It rates very high in red color, attractiveness, flavor, and overall. Even though it is a disease-resistant apple it can stand on its own merits. It will not store for a long time.

Reinette Simirenko (**) has a very distinctive green color, similar to an immature Granny Smith. Flesh is whitish green. Flavor is somewhat tart with a distinctive but spicy taste. At the time of our sample, flesh was still green and soluble solids were only 12.2. We believe that this apple was not ripe at the time of harvest, even though it did taste reasonably good. The taste and condition of Reinette Simirenko was excellent following several weeks in regular air storage. This cultivar warrants further evaluation.

Rubinette (*). The blotchy red-pinkish-brown color make this apple rather unattractive. Also, the large lenticels give the impression of russet. This apple is fair to good tasting but the acidity and astringency detract from its flavor. We are not very excited about Rubinette.

Sansa (**↑) is a fairly attractive medium sized apple. We were very impressed with the flavor, texture, crispness, and aroma. We consider Sansa one of the jewels this year. It matures at about the time of Sunrise, and when compared with Sunrise, Sansa is the clear winner. It tastes Gala-like but it ripens fully two weeks before Gala. We did not have enough fruit to evaluate it fully, but it is one apple that we will be looking forward to eating next year.

Senshu (**). The blotchy or burned reddish brown stripes on this medium sized apple make it somewhat unattractive. It has prominent calyx lobes and a swelled pedicel at the attachment like Gala. It has unusual orange-yellow flesh. It is a very good tasting apple. It is not too sweet with a slightly spicy flavor. Overall, this cultivar was rated quite high.

Shamrock (**↑) was evaluated over a three week period and it had acceptable quality over the whole time. It did not received the highest marks for flavor but the ratings were consistently good. In mid-September, it tastes green and Granny-like. Others who were offered this apple seemed to liked it. We believe that it is a good apple that fills a niche for a green apple in September and October. There is no other green apple that we have tasted that would compete in this market. Storage life is not long. Fruit soften in storage. As it softens, it assumes the taste of a very good McIntosh. We can recommend Shamrock.

Shizuka (**↑) is a large, attractive, yellow apple with a pink cheek, and it has very good flavor. This apple resembles Mutsu in many ways, a fact that is not too surprising given their common parentage. However, it also differs from Mutsu in several important ways. It appears to be more elongated in shape. It ripens about a week before Mutsu. The flesh is finer, less dense, and tastes fruitier than Mutsu.

Mutsu is plagued by Pseudomonas spotting, and we found none on Shizuka. Although vigorous, this will be a grower-friendly tree. Shizuka was a very nice apple that should be evaluated further.

Splendour (**) is one of the most attractive apples evaluated. The fruit is round to conic, a good cherry red, with prominent tan lenticels. We evaluated this starting on October 5. It improved in flavor with subsequent harvests, but it never reached the top of the list in flavor. The flesh is yellow white and the flavor is mild and subacid. The skin is tender, thus it may not be able to stand up in commercial marketing channels. It is a very grower-friendly tree.

Spigold (***). We did not evaluate Spigold formally because we have already decided that this is one of the best apples available. It is large, somewhat unattractive, and tends to bitter pit. We believe that it is destined only for a niche market, but what a wonderful tasting apple! It can be very biennial.

Sumac (**) was one of the first apples to be evaluated in the season. It is small and quite unattractive. We rated flavor quite high, but considering everything, we would prefer AA 63 to Sumac for an apple this early in the season.

Suncrisp™ (New Jersey 55) (**↑). We made our last harvest of most apples on October 19. At that time NJ 55 had fair appearance, a pink red cheek, and a ground color that was still green. It was quite acid and had no better than average taste. The remaining NJ 55 were harvested on November 4. The ground color had changed and it appeared ready to harvest. Although it still tasted a little tart, we rated flavor very high. At that time it was a wonderful tasting apple that appeared to have the potential for quite long storage. Our major reservation about this apple is that we may not have a sufficiently long growing season to mature it properly. I would say that it matures up to a week after Fuji.

Tsugaru Homei (**↓). On September 14 this apple was not highly colored, but it had a red mottling over a pinkish red. It has a shape similar to Spencer. The apple has a good sweet, crisp, juicy, and somewhat spicy taste. When evaluated two weeks later it was cherry red and had developed an extremely sweet spicy flavor. We believe that September 20 may have been an appropriate harvest date. We do not know if it has enough going for it to make it.

Williams Pride (**↑) was one of the best disease-resistant apples evaluated. Fruit is large, red, and irregular in shape, and the skin not smooth. It is only moderately attractive but the taste is mild, subdued, and slightly spicy and good. When ripe the fruit is quite aromatic. Fruit show some bitterpit. People who tasted Williams Pride thought that it was a very good apple. This selection requires further evaluation, primarily to confirm the characterization of its flavor as good.

Yataka (**↑) was an excellent apple again this year. It is truly an early maturing strain of Fuji. It ripens fully two weeks ahead of other Fuji strains and it is ready to eat immediately. It is not an attractive apple, and it is definitely less attractive than strains of Red Fuji. Flavor was rated very high. Off the tree, the taste of Yataka is better than any of the other strains of Fuji. We are uncertain about its storage potential. We rate Yataka quite high.

Yoko (**). This medium-sized red apple has fair to good color and attractiveness. It taste is very sweet and spicy. There is russet in the calyx, similar to Arlet. We do not think that it is outstanding enough to compete with other apples.

Summary

1. Several apples were recognized from the evaluation in 1992 as being clearly superior. These include Arlet, Gingergold, Honeycrisp, Reinette Simirenko, Sansa, and Suncrisp™ (NJ 55). Other apples that fall into this category but they are unavailable to the general pubic for testing at this time. Included in this group are the British Columbia selections BC 9P-14-32, BC 8M-15-10, BC 17-30, and Fantazja.
2. A second group of apples were recognized as not being quite so outstanding, but they were sufficiently good to be given a designation of Honorable Mention. These cultivars include: Akane, Kinsei, Orin, Shamrock, Shizuka, and Yataka.
3. Several disease-resistant cultivars were recognized for their superior quality. This group includes: Alkemene, Florina, NY 75414-1, and Williams Pride. Liberty and Redfree are not included on this list because they already have been recognized as being good and accepted disease-resistant cultivars suitable for commercial planting.

Implementation of the MARYBLYT Model for Fire Blight Control

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New England Fruit Consultants

Fire blight, caused by the bacterium *Erwinia amylovora*, is one of the most destructive and difficult to manage diseases encountered by tree fruit growers throughout the world. Some might argue that apple scab, caused by *Venturia inaequalis*, deserves this honor but with respect to apple scab, there is always next year and the chance to try again. A severe epidemic of fire blight can damage an orchard of susceptible apple or pear trees so severely that there is no next year; that is, the orchard block must be removed.

New England Fruit Consultants (NEFCON) has been observing and studying this disease in Massachusetts, Vermont, and New Hampshire for more than a decade. Overall knowledge of this disease has increased significantly since the early 1980s, much as a result of the excellent work of Dr. Paul Steiner and his colleagues as the University of Maryland. Their development of the MARYBLYT computer model to aid in the control decision making process is enabling us to understand disease development better and to fine tune our disease control strategies. It is not our intention to describe in detail the epidemiology of fire blight as there are many excellent sources already available (see U.S.D.A. Bulletin No. 631, *Fire Blight- Its Nature, Prevention and Control*). Our purpose is to describe our successes and frustrations regarding control, particularly with regard to the MARYBLYT model.

NEFCON has been working with Dr. Steiner and Dr. Daniel Cooley at the University of Massachusetts since the mid-1980s as the fire blight model was being developed. We found that it described disease development accurately as we had observed it but we did not attempt to use it as a control strategy at that point. In the past several years as the model has become commercially available, we incorporated it fully into our fire blight management program. In 1992, we implemented the model in multiple sites in Massachusetts, New Hampshire, and Vermont. Our findings are as follows:

1. The model predicts with extreme accuracy when overwintering canker activity will begin as well as when symptoms of canker blight, blossom blight, shoot blight, and trauma blight will occur. This prediction facilitates detection and removal of blighted tissues if possible (numerous infections are probably best left for winter removal).

2. If bloom phenology and meteorological data are kept judiciously, and Streptomycin sprays are used when the model predicts the risk for blossom blight is high or blossom infection has occurred, problem sites may be cleaned up, or major outbreaks of blossom blight in new sites may be avoided.

3. Although keeping track of bloom and weather data may appear simple, it is important that these be extremely accurate as the model's predictions can only be as accurate as the human input allows it to be. In our experience, we found detailing bloom to be difficult. Most orchards have many different cultivars blooming at different times; an entire bloom period may be several weeks long. Also, many cultivars which are highly susceptible to fire blight produce secondary blossoms (Paula Red, Rome, and Cortland, as well as many kinds of pears). It is possible to have 1/2-inch fruits and open blossoms in the same fruit cluster. It has been our experience that this route is a very common one by which severe epidemics become established. Growers must keep an eye out for these late blossoms in problem areas and be prepared to spray Streptomycin should weather conditions favor infection.

With respect to weather data, daily maximum and minimum temperatures must be entered. Another very important input is wettings, however slight they may seem. In several sites in 1992, the model did not predict blossom blight epidemics which occurred. When we revised the data to reflect dews which likely happened due to extreme temperature drop at night during bloom, the model accurately predicted that infection of the blossoms had occurred and when symptoms would be visible.

4. With prolonged bloom periods and weather particularly favorable to fire blight, the model MAY call for more Streptomycin sprays than should be applied considering Streptomycin resistance manage-

ment. In most years, however, it is unlikely that the model would call for more than three Streptomycin applications, which would be within resistance management guidelines.

5. The complexity of the fire blight disease cycle and the way that symptoms manifest themselves (several different phases showing up within a short period of time) makes it at times difficult to determine what is happening in an epidemic situation. An excellent feature of the model is that data files are created and unusual or unexpected situations may be studied at a later date. We have increased our understanding of how this disease operates significantly by reviewing these files over the years.

6. Although the MARYBLYT model is excellent for monitoring disease development and helpful in cleaning up known problem sites, much of the destructiveness of fire blight is due to its erratic occurrence. If an orchard has had no history of fire blight, there would be no incentive to implement an aggressive control program including Streptomycin sprays. Once a serious epidemic is in progress, it is too late for the model or Streptomycin sprays to be of much help. Repeatedly spraying Streptomycin on a raging epidemic can only favor resistance development and is of questionable value in stopping disease progression.

Where an epidemic of fireblight will occur each year is still the overriding question. We have good tools now available to aid in control decisions, particularly the MARYBLYT program, but where to implement them if a site has no prior history continues to elude us.

7. Our best strategies for fire blight management are as follows:

A. Keep nitrogen levels in check. Pushing young trees with high nitrogen regimens favors lush growth that is highly susceptible to infection.

B. Watch vector populations, primarily aphids, leafhoppers, and pear psylla. Keep them low.

C. Implement a copper program annually in early spring on all pears and susceptible cultivars of apples.

D. Avoid planting trees, if possible, where both scion and rootstock are highly susceptible to fire blight.

E. Follow proper pruning techniques for winter removal of overwintering cankers. Major epidemics are probably best left to run their course in summer infections; a few minor strikes should be removed as soon as they are detected.

F. Implement the MARYBLYT program as part of your regular orchard recordkeeping activities. If any stage of fireblight is detected in the orchard or general vicinity, use the model to time application of Streptomycin sprays in an aggressive control program for at least two successive years.

In conclusion, with diligence and good management techniques it seems possible to obtain satisfactory control of fire blight in most growing seasons. Many questions remain unanswered, however, such as the role of systemically infected, asymptomatic trees in the disease cycle, and where major epidemics will strike from season to season. We are undoubtedly making progress in our understanding of this complex disease. Hopefully, at some point we will achieve the knowledge we need to be successful consistently in its management.

* * * * *

Fish Hydrolysate Fertilizer Should Not Be Applied Foliarly to Apple

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The four- to six-week period following bloom is a critical time for crop development in apples. During this period, the majority of seasonal vegetative growth takes place, and fruit set, return bloom, potential yield, and potential fruit size are determined. Mineral nutrient reserves become depleted, as utilization is greater than root uptake, and nutrients, especially nitrogen, can become a limiting factor to growth, even though soil reserves are adequate.

Foliar sprays of mineral nutrients during this critical period can be beneficial in supplementing ground-applied fertilizers. These applications do not replace the regular ground-applied fertilizer program, they simply fill the gap during the time that demand outstrips supply. Foliar nitrogen applications in particular have been shown to increase fruit set and fruit size when applied at 8 to 12 lbs per acre during this time. Previous studies have shown that foliar urea sprays are a safe and effective method for fertilizing apple (Stiles and Reid, 1991).

Fish hydrolysates, a byproduct of the fishing industry have recently been recommended as an organic nitrogen fertilizer for cranberry (DeMoranville, 1990), apple, and blueberry (Weis and Bramlage, 1992). The fishing industry is interested in developing new uses for this material and in cooperation with the Portland (ME) Fish Exchange, we investigated the feasibility of using fish hydrolysates as a foliar nitrogen source for apple.

Mature Delicious/MM.111 and Golden Delicious/MM.106 apple trees, growing at the University of Maine Highmoor Farm in Monmouth were used for this experiment. "Gulf of Maine" fertilizer, containing 2% N, 4% P, and 2% K was supplied by the Portland Fish Exchange.

Treatments were as follows:

1. Control, no foliar fertilizer.
2. Fish hydrolysate, 3 gallons in 25 gallons of water.
3. Urea, 1.25 lb in 25 gallons of water.

Both fertilizer treatments, calculated to provide the equivalent amount of nitrogen as an application of 12 lb urea/acre, were applied as a dilute spray with a handgun. Three applications, at petal fall (PF), PF+7 days, and PF+14 days, were made on four replications of each cultivar.

Fish hydrolysate fertilizer reduced fruit set of both cultivars (Table 1). Foliar urea increased fruit set and yield of Golden Delicious but had no effect on Delicious. Fruit from fish hydrolysate-treated Golden Delicious trees had higher soluble solids than those from urea-treated trees, and this appears

Table 1. The effects of foliar sprays of fish hydrolysate fertilizer and urea on fruit set, yield, fruit soluble solids, and russeting of Delicious and Golden Delicious apple.

	Fruit set (%)		Yield (kg)		Soluble solids (%)		Russeting[z]	
Treatment	Del.	Gold.	Del	Gold.	Del.	Gold.	Del.	Gold.
Control	73 a[y]	19 b	81 ab	54 b	10.2 a	13.5 ab	1.3 b	1.8 b
Fish hydrolysate	38 b	7 c	64 b	21 b	10.2 a	14.1 a	3.7 a	4.1 a
Urea	64 a	34 a	92 a	128 a	9.8 a	12.8 b	1.0 b	2.0 b

[z] Russeting was rated on a scale of 1=none to 5=100% russeted.
[y] Means within columns not followed by the same letter are significantly different at odds of 19:1.

to be related to the differences in cropping between these treatments. Neither fertilizer affected leaf or fruit mineral nutrient content, fruit size, or fruit firmness at harvest (data not presented).

Russeting is a rough brown netting over the surface of the fruit that occurs when the fruit epidermis is killed. Golden Delicious is an economically important cultivar that is predisposed to russeting, while Delicious is much less sensitive to russeting. Russeting results in loss of grade when fruit are packed and must be kept to a minimum if an orchard is to remain profitable. Fish hydrolysate increased fruit russeting on both cultivars (Table 1). The conductivity of the fish hydrolysate fertilizer was 45.6 mmhos/cm, the equivalent of a 29,000 ppm solution of KCl. It is probably this salt that reduced fruit set and caused the severe russeting. Regardless of the cause, fish hydrolysate reduced fruit set and damaged the fruit and should not be foliarly applied to apple.

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Comparative Effects of Margosan-O (Neem Extract) and Imidan on Plum Curculio and Apple Maggot

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We are continually on the lookout for safe new pesticides that can control some of our key apple pests, such as plum curculio and apple maggot. Extracts of seeds and other parts of neem trees have been used for centuries, even millennia, to control a wide variety of insects in India and other parts of Asia. These extracts appear to be remarkably safe for human consumption as well as environmentally safe. They are known to control insects by acting as insect repellents, antifeedants, or toxicants or by disrupting the growth of insects. Recently, W.R. Grace Company began distributing an extract of neem plants called Margosan-O for use in greenhouses, commercial nurseries, forests, and homes.

Although no extract of neem, including Margosan-O, is yet registered for use on crops for human consumption, we decided to evaluate its effectiveness against plum curculio and apple maggot on apple trees at Hutchins Farm in Concord, MA in 1992. Hutchins Farm grows produce organically and annually contends with moderate to high populations of plum curculio and apple maggot.

Methods Used

Against plum curculio, a treatment of Margosan-O at one gallon per 100 gallons was applied with a mist blower at 300 gallons of water per

Table 1. Comparative effects of Margosan-O (neem extract) and Imidan on plum curculio and apple maggot.

	Injured fruit (%)		
		Apple maggot larval tunnels	
Treatment	Plum curculio stings	On tree	In drops
Margosan-O	62 a*	14 b	42 b
Imidan	16 b	13 b	30 b
Untreated check	63 a	38 a	76 a

*Means in each column followed by a different letter are significantly different at odds of 19:1.

acre to 120 mature, semi-dwarf Liberty and Jonafree trees on May 22 (petal fall), May 26, May 29, and June 2. As a control treatment, Imidan at 1.5 pounds per 100 gallons was applied on May 22 and May 29 to 120 other Liberty and Jonafree trees. Yet, another 120 trees of these varieties remained unsprayed as checks. Sampling consisted of examining 20 fruit per tree on four replicates of eight trees each per treatment on June 8.

Against apple maggot, a treatment of Margosan-O at one gallon per 100 gallons was applied with a mist blower at 300 gallon of water per acre to 60 mature, semi-dwarf Prima and Burgundy trees on July 1, July 8, July 15, and July 22. As a control treatment, Imidan at 1.5 pounds per 100 gallons was applied on July 1 and July 15 to 60 other Prima and Burgundy trees. Yet, another 60 trees of these varieties remained unsprayed as checks. Sampling consisted of examining 10 on-tree and 10 dropped fruit per tree on six replicates of two trees each per treatment on August 19. Fruit were held at room temperature for one week (drops) or four weeks (on-tree fruit) before examining for larval trails in the fruit flesh.

Results

As shown in Table 1, use of Margosan-O failed to provide any detectable reduction in fruit injury by plum curculio compared with untreated check fruit, even though it was applied every three to four days from petal fall to within six days of sampling. Imidan applied every seven days provided reasonable curculio control in the face of the very high population of curculios.

As shown in Table 1, use of Margosan-O resulted in a significant decrease in percent fruit infested with apple maggot larval trails. In fact, it was little different from Imidan in this regard. Neither produced a high level of maggot control, possibly because there was a four-week gap between the last treatment and removal of fruit in sampling for maggot injury.

Conclusion

We conclude that neem plant extract formulated and sold as Margosan-O offers little or no promise for controlling plum curculio but does offer substantial promise for controlling apple maggot. We do not know if its effects on apple maggot were through reduction of fly egglaying punctures in fruit or through prevention of growth of larvae hatching from eggs. Either way, we can anticipate that application of Margosan-O against apple maggot might need to be twice as frequent as application of Imidan to provide equivalent levels of control. We hope in the near future to be able to evaluate Margosan-O against leafminer larvae and leafhopper nymphs. Quite possibly, Margosan-O might soon be registered for agricultural use.

Acknowledgements

This work was supported by a grant from the W.R. Grace Company, to whom we are grateful.

Orchard Mineral Nutrition: Ground-applied vs. Foliar-applied Fertilizers

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Why do apple growers spend time and money spraying fertilizers on foliage when for centuries we have been told that plants take up nutrients from the soil via their roots? They do it in an attempt to improve fruit quality and enhance its storage life. Apple is somewhat unique among fruit crops in that it is able to utilize a range of mineral nutrients through its leaves.

Many new products are available to apple growers for foliar feeding. Sometimes promotional materials suggest that rather dramatic results can be obtained from using these products. One grower recently calculated the expected results for his orchard based on such claims and found that if he would simply use several of these products, his yields would be 3000 bushels per acre with excellent fruit size and virtually 100% packout. This yield is three times that obtained in the best New England orchards and a level of production at which fruit size and quality would be very poor. Such an outcome is impossible of course, and most manufacturers of foliar nutrient products are careful to base their product claims within the realm of possibility. Still, many apple growers are uncertain what role foliar sprays should have in their nutrition plan.

The first step to any orchard nutrition plan is soil and leaf analysis. Before applying any fertilizer in any manner it makes proper sense to determine whether or not there is need for nutrient supplements, which ones are needed, and in what amounts. This information provides the first answers to the ground-applied versus foliar-applied question.

Macronutrients

If leaf and soil analyses indicate the need for nitrogen, phosphorous, potassium, calcium, or magnesium, the cheapest and most efficient way to apply them is by ground application. Soil- applied fertilizers can be applied early in the spring before the busy growing season and with little or no risk of damage to the fruit or foliage. Soil-applied nutrients also follow the natural pathway in the tree to all the locations where growth and development are taking place. By contrast, foliar-applied nutrients are less mobile and stay where they are absorbed.

Micronutrients

Boron, manganese, copper, or zinc can be applied to either soil or foliage; however, foliar applications are more common, because it is easier to spray the small amounts needed than it is to apply them to the soil. Foliar applications allow "direct hits" to the fruit and foliage where supplemental nutrition is needed, and they allow for precision timing. The grower can apply the nutrient at a critical time in the growth stage when it is needed. Foliar fertilizers can harm the fruit and foliage that they contact, so usually, only small amounts are applied this way. Growers should pay particular attention to recommended rates and timings to avoid damage. Refer to the label of the product and the *New England Apple Pest Management Guide* for additional information on rates, timing, and nutrient compatibility in the spray tank. High-grade fertilizers, free from impurities, are needed for foliar application, adding to their cost.

Special Nutrition Problems

If a given nutrient is acutely deficient or if there is a special nutritional problem that is harmful to productivity or fruit quality, a combination of both soil- and foliar-applied nutrients may be justified. Table 1 lists several of the more common examples where supplemental foliar nutrients are used to correct specific problems.

Perhaps the most common special nutritional problem in apple is low fruit calcium. Developing fruits compete with vegetative growth for calcium during the first five to six weeks following bloom. After this time, calcium uptake by the fruit via the tree's vascular system essentially stops.

If soil calcium levels are low, or if vegetative growth is excessive, the fruit may be deficient in calcium, leading to the appearance of cork spot or bitter pit and rapid loss of fruit quality in storage. In

Table 1. Foliar applications for special nutritional problems in apple.

Problem	Problem nutrient	Material	Annual rate/acre[a]	Timing[b]	Comments
Low fruit set, small fruit size	Nitrogen	Urea (45%)	20 lb	P and PF	Not recommended where calcium deficiency disorders are problems.
Bitter pit, poor storing fruit	Calcium	Calcium chloride (80%$CaCl_2$)	15-50 lb	1-7	Do not substitute calcium nitrate. Do not premix calcium chloride with Solubor.
Premature leaf & fruit drop	Magnesium	Magnesium sulfate (11%)	15 lb	PF	May be applied in first or second cover. Compatible with pesticides.
Low fruit set, poor quality	Manganese	Manganese sulfate (24%)	5 lb	D or PH	Apply in spring before growth starts.
Low fruit set, poor quality	Copper	Copper sulfate (22%Cu)	4-6 lb	D or PH	Apply in spring before growth starts.
Fruit pitting, shoot dieback	Boron	Solubor (20.5%B)	4 lb 8 lb	PF & 1 PH	Make two applications of equal rates, but do not exceed 8 pounds per acre per year from all sources.
Shoot dieback, low hardiness	Zinc	Zinc sulfate (89%)	5.5-11 lb	D or PH	Apply before growth starts.

[a]Commercial formulation
[b]D=dormant, P=pink stage, FB=full bloom, PF=petal fall, 1-7=1st through 7th cover sprays, PH=postharvest.
Adapted from *Penn State Tree Fruit Production Guide, 1992-1993* and *Orchard Nutrition Management*, Cornell Coop. Ext. Bul. 219.

cases where fruit calcium is marginal, the symptoms may be apparent only after long periods in storage. If soil calcium levels are low, the soil pH likely is acidic. The cheap, long-term solution to low soil calcium is liming to correct the acidity and to add calcium to the orchard soil; however, regardless of the cause of the fruit calcium problem, foliar calcium sprays are advisable. Foliar sprays of a calcium-containing fertilizer put calcium directly on the fruit where it can be taken up, and will reduce greatly the occurrence of costly blemishes and loss of fruit quality.

Brand Name Products vs. Salts

A large number of products are available for applying foliar nutrients. Table 2 lists some of the foliar calcium products available to the apple grower. It is not possible to discuss the qualities of each individual product in a short forum such as this article, but several comparisons can be made between brand name products versus calcium chloride salts.

Brand name products, when applied to provide the same amount of calcium as provided by calcium chloride are no better or worse in their effectiveness in preventing fruit disorders. Thus brand name products are more expensive sources of calcium; however, brand name products may be safer to fruits and foliage, easier to measure, and more conveniently packaged.

Calcium chloride contains oxide impurities that can increase the pH of the spray solution in the tank, thereby reducing the effectiveness of certain pesticides. If calcium chloride is to be tank-mixed with pesticides, a small amount of vinegar or buffering agent should be added to prevent this problem.

Finally, brand name products may contain other nutrients, which may be beneficial, but only if they are nutrients that currently are needed by the tree. It is up to the individual grower to weigh the pros and cons of each product given his or her situation. Similar considerations result when growers make comparisons between brand name products and salt formulations for other mineral nutrients.

Summary and Tips for Success

Foliar fertilizers are an important tool for applying micronutrients, correcting acute nutrient defi-

Table 2. Calcium materials for use on apples, with labeled rates per acre per application, per acre per season, and per acre per year.

Product name	Percent calcium	Pounds/ gal	Pounds of calcium/ gal or lb	Manufacturer	Product/ A/spray min.-max.	No. of appl.	Total product/ A/season min.-max.	Total calcium/ A/season (lb) min.-max.
CaB	6.0	10.0	0.60	Stoller, Inc. (800-255-9548)	3-6 pints	8	3-6 gal	1.8-3.6
CaB'y	10.0	11.9	1.19	Stoller, Inc. (800-255-9548)	2-4 qt	8	4-8 gal	4.8-9.5
Calcium chloride (77-80% CaC12)	27.8	flakes	0.28	many	1.8-6.2 lb	8	14.3-60 lb	4.0-1 4
Calcium chloride (35% CaC12 liquid)	12.6	11.3	1.42	many	.35-1.24 gal	8	2.8-9.9 gal	4.0-14
Cor-Clear Dry	34.5	beads	0.34	SEGO Intl., Inc. (503-796-0133)	4-8 lb	8	32-64 lb	10.9-21.8
Foliar Calcium Folical	10.0	9.6	0.96	Agrimar Corp. (800-284-9898)	1 gal	6-8	6-8 gal	5.8-7.7
Fung-Aid	10.0	11.9	1.19	Stoller, Inc. (800-255-9548)	2-4 qt	8-15	5.5-8.2 gal	6.6-9.7
Link Calcium 6%	6.0	10.3	0.62	Wilbur-Ellis Co. (509-248-6171)	2-4 qt	4	2-4 gal	1.2-2.5
Mora-Leaf Calcium (94% $CaCl_2$)	34.0	DRY	0.34	Wilbur-Ellis Co. (509-248-6171)	4-8 lb	3-6	12-48	4.1-16.3
Nutri-Cal 8% Calcium Solution	8.0	11.1	0.89	CSI Chemical Corp. (800-247-2480)	1-2 qt	3-8	.76-4.0 gal	.67-3.6
Nutra-Phos 10	10.0	powder	0.10	Leffingwell Div. (800-262-3861)	3-10 lb	2-8	20-40 lb	2-4
Nutra-Phos 12	11.0	powder	0.11	Leffingwell Div. (800-262-3861)	3-10 lb	2-8	20-40 lb	2.2-4.4
Nutra-Phos 24	20.0	powder	0.20	Leffingwell Div. (800-262-3861)	3-10 lb	2-8	20-40 lb	4-8
Nutra-Phos Mg	10.0	powder	0.10	Leffingwell Div. (800-262-3861)	3-10 lb	2-6	20-40 lb	2-4
Nutra-Plus	6.0	10.0	0.60	Custom Chemicides (209-264-0441)	1-3 qt	8-11	2-8.2 gal	1.2-4.9
Pit-Stop Dry Con. Foliar Cal. 32.5%	32.5	dry	0.32	Ag-Chem, Inc. (301-548-2200)	4-8 lb	4-6	16-48 lb	5.2-15.6
Pit-Stop Foliar Calcium 12%	12.0	11.3	1.35	Ag-Chem, Inc. (301-548-2200)	1.5 gal	4-6	6-9 gal	8.1-12.1
Sett	8.0	11.4	0.91	Stoller, Inc. (800-255-9548)	1 gal	8-11	8-11 gal	7.3-10.0
Sorba-Spray Cal.	8.0	10.75	0.86	Leffingwall Div. (800-262-3861)	1-4 qt	4-5	1-5 gal	0.9-4.3
Sorba-Spray CaB	5.0	10.0	0.50	Leffingwell Div. (800-262-3861)	1-4 qt	4-5	1-5 gal	0.5-2.5
Stopit Calcium Concentr.	12.0	10.7	1.28	Shield-Brite Div. (206-827-8717)	2-4 qt	8-11	4-11 gal	5.1-14.1
Tracite Calcium 6%	6.0	10.0	0.60	Helena Chem. Co. (901-748-3200)	3-6 pts	8	3-6 gal	1.8-3.5
Traco Pit-Cal Liquid Calcium	12.0	11.7	1.40	Traylor Chem. Co. (800-348-3361)	0.5-2 gal	7	3.5-14 gal	4.9-19.6
Wuxal Calcium	10.7	13.3	1.42	AGLUKON Div. (800-832-8788)	3-4 pts	5	1.9-2.5 gal	2.7-3.6

Adapted from the *Penn State Tree Fruit Production Guide, 1992-1993*.

ciencies, and solving special nutritional problems, such as getting calcium into apple fruit. For overall economy and tree health, most macronutrients should be soil-applied.

When applying nutrients to apple foliage, the following suggestions will enhance the spray's effectiveness and safety:

1. Think dilute. Apply fertilizers with as much water as is practical. Effectiveness will be aided via thorough coverage and better absorption.
2. Watch the weather. Follow the 80/80 rule : avoid nutrient sprays when temperature or humidity values exceed 80 degrees or 80%, respectively. Following this rule will reduce greatly the risk of fruit or foliage damage.
3. Make sure that your sprayer is calibrated properly and that its nozzles are adjusted to direct an even pattern to the tree canopy.
4. More is not better, more often is better. Do not apply too much at one time. If you wish to apply more of a particular nutrient, consider soil application or repeating the foliar spray at a later date.

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COOPERATIVE EXTENSION SYSTEM POLICY:

Costs and Returns from High Density Apple Plantings During the First Three Seasons

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In the 1989 New England Apple Survey (Autio, 1989), growers stated that 62% of the apple acreage to be planted in 1990-94 would be on dwarfing rootstocks. Since the survey, several acres of dwarf trees have been planted; however, little experience exists with methods of training these trees. Management is much different than for free-standing standard or semi-dwarf trees.

To become familiar with the peculiarities and to obtain accurate data on costs and returns of high-

Table 1. Costs and returns per acre associated with Nicobel Jonagold/M.9 in four training systems. Land preparation costs were derived from White and Demarree (1992) and Fuller et al. (1991). Establishment costs include all those associated with trees, planting, support systems, and initial training (see Autio, 1990). Growing costs, other than those associated with training, were derived from White and Demarree (1992). Training labor and supplies were based on actual assessments from this planting. Picking, storing, packing, and selling costs were derived from Castaldi (1987).

Category	NE Central leader	Slender spindle	Vertical axis	Vertical trellis
Year 1 -- 1990				
Land preparation				
Fertilizer and lime	150	150	150	150
Seed	20	20	20	20
Labor	15	15	15	15
Equipment	38	38	38	38
Establishment	3904	5206	7172	5146
Growing costs				
Fertilizer	55	55	55	55
Spray material	47	47	47	47
General supplies	15	15	15	15
Training labor	14	25	57	5
Other labor	200	200	200	200
Equipment	133	133	133	133
Costs -- Year 1	4591	5904	7902	5824
Net -- Year 1	-$4591	-$5904	-$7902	-$5824

Table 1. Continued.

Category	NE Central leader	Slender spindle	Vertical axis	Vertical trellis
Year 2 -- 1991				
Growing costs				
Fertilizer	55	55	55	55
Spray materials	45	45	45	45
Training supplies	5	23	5	8
General supplies	15	15	15	15
Training labor	10	96	34	29
Other labor	200	200	200	200
Equipment	133	133	133	133
Fruit-related costs				
Picking	2	1	52	0
Storing	3	1	65	0
Packing	3	2	86	0
Selling	1	0	21	0
Costs -- Year 2	472	571	711	485
Returns -- Year 2	21	10	533	1
Net -- Year 2	-$451	-$561	-$178	-$484

density management systems, I established a trial of four training systems at the University of Massachusetts Horticultural Research Center (Belchertown) in the spring of 1990. This trial included Nicobel Jonagold/M.9 trained as a New England central leader, as a slender spindle, as a vertical axis, and on a four-wire vertical trellis. Previously, I published an article which included the various costs of establishment (Autio, 1990). Here, I have continued the discussion of this study, including the costs of managing these trees during the first three growing seasons and the returns obtained from the fruit.

The Systems

New England Central Leader. The NE central leader, simply, is a small central-leader tree (389 trees per acre, 8' x 14'). Minimal pruning has been conducted, including removal only of those branches which inhibited the development of the central leader. Some limb spreading has been done with weights.

Slender Spindle. The slender spindle is typical of a European slender spindle, i.e. a small central-leader tree with a relatively large amount of branch manipulation. Trees are spaced 6' x 14' (519 trees per acre). The new growth of the central leader was headed by half in the first dormant season to encourage lateral development. The central shoot originating from the heading cut was tied to the post in June of the second season, and competing laterals were bent to 90° from vertical with rubber bands. In early July of both the second and third growing seasons, lower laterals were tied to approximately 70°, central laterals were tied to approximately 90°, and upper laterals were tied to 100°. In some cases in 1992, branches which bore fruit in 1991 were tied up to prevent devigoration.

In 1991, a self-tapping sheet-metal screw was drilled into the bottom of the conduit-pipe post, and cotton kite twine was tied from this screw to limbs for positioning. This process was relatively time con-

Table 1. Continued.

Category	NE Central leader	Slender spindle	Vertical axis	Vertical trellis
Year 3 -- 1992				
Growing costs				
Fertilizers	57	57	57	57
Spray materials	118	118	118	118
Training supplies	5	25	5	10
General supplies	15	15	15	15
Training labor	7	182	12	37
Other labor	200	200	200	200
Equipment	133	133	133	133
Fruit-related costs				
Picking	178	251	409	136
Storing	223	314	511	170
Packing	297	419	681	227
Selling	74	105	170	57
Costs -- Year 3	1307	1819	2311	1160
Returns -- Year 3	1840	2596	4227	1405
Net -- Year 3	$533	$777	$1916	$245

suming. In 1992, avis strapping material was used to tie limbs. This 1/2-inch, multi-stranded strapping material was split easily into five pieces of five strands each. The advantage of this material is that it can be tied directly to conduit pipe without the use of a screw and without slipping, therefore making it much easier to use than the previous method.

Vertical Axis. The vertical axis utilizes a tall post to allow unrestricted tree growth to a height where it will fruit out. In this planting, posts extend 10.5 feet out of the soil. Trees were spaced 6' x 14' (519 trees per acre). A number of lateral branches existed on trees at planting, and none were removed and trees were not headed. A small amount of pinching of vigorous, upright shoots was done in June each season. Also in each season, some vigorous limbs were bent with weights in early July.

Vertical Trellis. The trellis used in this planting is seven feet tall and includes four wires, every 18 inches beginning at 24 inches from the soil. Trees were spaced 8' x 14' (389 trees per acre). Trees were headed at approximately 22 inches from the soil. As branches grew, a central leader was chosen, and lateral branches were tied to the lowest wires at approximately 70°. Branches higher up in the canopy were tied at a greater angle.

The Economics

Table 1 summarizes the costs and returns associated with the four treatments used in this trial. During the first season, the primary difference among the total costs related to differences in establishment costs (for details of establishment costs see Autio, 1990). Some differences existed in the amount of labor involved with training, with the vertical axis requiring the most, followed by the slender spindle, central leader, and trellis.

During the second growing season, significantly more labor and supplies were required for the slender-spindle system than the others. The NE central leader was the least intensive and least costly. Ver-

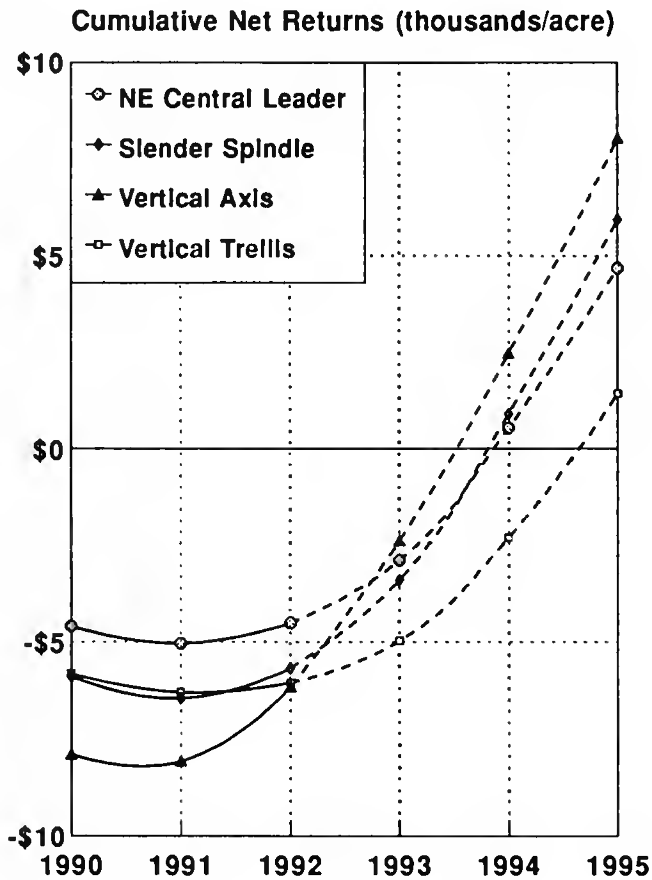

Figure 1. Cumulative net returns of four apple training systems. Dotted lines are projected returns.

tical-axis trees fruited in the second season, yielding about 43 bushels per acre. Overall costs of the vertical axis were increased because of the costs of picking, storing, packing, and selling; however, $533 were returned per acre in the second growing season.

During the third growing season again, the slender spindle required the most labor and supplies to manage. Year three was the first significant fruiting year, with yields of 148, 209, 341, and 113 bushels per acre for the NE central leader, slender spindle, vertical axis, and vertical trellis, respectively. Net returns varied from the low of $245 from the trees on trellis to $1916 from trees trained to the vertical-axis system.

Figure 1 presents the cumulative net returns for these four systems for their first three growing seasons, along with projections for the next three seasons. The most costly system was the vertical axis; however, it yielded sooner than the other systems and is expected to net over $2000 per acre after the fifth growing season. The slender-spindle and trellis systems were similarly costly; however, the slender spindle yielded better in 1992 and is expected to yield more than the trellis for the next few seasons. The slender spindle will pay for itself by the end of the fifth growing season, but the vertical trellis will not pay for itself until the end of the sixth growing season. The least costly system to establish was the NE central leader, but it is not expected to be as profitable as the slender spindle.

Conclusions

Significant differences in costs and returns existed among the four intensive apple-training systems included in this planting. One factor came very much into play in determining what the early returns were from these trees. The early yields on a per-tree basis were negatively related to the degree of pruning which was done at planting. The vertical axis trees were not pruned; therefore, one-year-old wood was retained at planting which set flower buds during the first growing season. Trees yielded in the second season. With no pruning, the canopies of these trees were larger than in the other systems and trees yielded significantly more in the third season. NE central-leader trees, slender-spindle trees, and vertical-trellis trees were all headed at planting, removing all lateral branches and most one-year-old wood and preventing them from setting flower buds during the first season. NE central-leader trees and slender-spindle trees were headed at 34 inches, and trellis trees were headed at 22 inches; the more severe the heading, the lower were the early yields.

A second factor which also has come into play and will continue to be a factor is the planting density. The two systems that have been the lowest yielding on a per acre basis and probably will have the lowest returns for a number of years are at the lowest density (NE central leader and vertical trellis). The highest yielding systems are at the highest density (vertical axis and slender spindle).

Overall, it is clear that any of these systems can be relatively successful. Even the least productive is expected to pay back the initial investment by the end of the sixth season, significantly better than free-standing central-leader trees on M.7. Selection of a system, however, must be based not only on the overall economic considerations but on the grower's interests in, ability for, and commitment to horticultural management, i.e. can and will he or she become more intensively involved with training and other horticultural practices than normally is needed for free-standing trees.

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Costs and Returns from Three Peach Training Systems During the First Three Seasons

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In southern New England, approximately 1000 acres of land are planted to peach trees. Little research has addressed the problems of peach growing, particularly in the area of cultural management. Training systems are an aspect of cultural management that can affect the economic returns of an orchard greatly.

The primary training system used for peach trees in southern New England is a delayed-open-center system. In a tree of this form, the central trunk is dominant early in the life of the tree, and as the tree grows, lower scaffolds grow upward and become equal to or stronger than the central trunk. Ideally, the central trunk should be removed above the lower scaffolds at maturity, leaving an open center tree; however, the central trunk often is left in the tree. The problem that arises from having a central trunk in this type of tree is that light penetration into the center of the canopy is very poor, and over time, productivity declines in a large portion of the tree's interior.

Because of the high value of peach fruit, production efficiency should be a major concern of peach growers. Evaluation of production practices is critical to economic viability. To this end, I established a trial in 1990, including nine replications of Ernie's Choice/Lovell trained to an open center, a central leader, or a delayed open center. The goal of this planting is to evaluate fully the economic viability of these three training systems.

The Systems

Open Center. Open-center trees were spaced 18 by 20 feet (121 trees per acre). Trees were headed

Table 1. Costs and returns per acre associated with Ernie's Choice peach in three training systems. Land preparation costs were derived from White and DeMarree (1992) and Fuller et al. (1991). Establishment costs were derived from actual measurements made during the planting of this trial. Growing costs, with the exception of pruning, were derived from Mizelle and Westberry (1989). Pruning labor costs were from actual measurements from this trial.

Category	Open center	Central leader	Delayed open center
Year 1 -- 1990			
Land preparation			
Fertilizer and lime	150	150	150
Seed	20	20	20
Labor	15	15	15
Equipment	38	38	38
Establishment			
Holes--labor	81	145	81
Holes--equipment	101	182	101
Trees	605	1089	605
Planting labor	48	87	48
Initial pruning labor	16	15	8
Growing			
Fertilizer	25	25	25
Spray material	38	38	38
General supplies	24	24	24
General labor	30	30	30
Equipment	56	56	56
Costs -- Year 1	1247	1914	1239
Net -- Year 1	-$1247	-$1914	-$1239

at planting to leave four small shoots arising from the trunk between 20 and 24 inches from the ground. Each of these shoots was headed to two viable buds. As the trees have developed, shoots growing into the center of the trees have been removed, with either dormant or summer pruning, and outer laterals have been pruned to direct their growth at about 60° from vertical. The goal is to have trees with four major scaffolds growing outward from the trunk in a vase form and reaching a height of approximately eight feet when they have filled their allotted space. In the mature tree, light distribution will be good, and only a small portion in the center of the tree will have too little light to maintain the production of fruiting wood.

Central Leader. Central-leader trees were spaced 10 by 20 feet (218 trees per acre). Very little pruning was done at planting. As trees have developed, scaffolds have been pruned to direct their growth at about 80° from vertical. Upper limbs have been kept short so that the trees have a conical shape. Upright shoots arising from the nearly flat lateral branches have been removed during summer pruning. The goal is to produce small trees that are eight feet tall at maturity with lower laterals that extend no more than five feet from the trunk. With this form, nearly all of the canopy will maintain the potential to produce fruiting wood. With more trees per acre than a standard system, higher early production should be obtained.

Delayed Open Center. Delayed-open-center trees were spaced 18 by 20 feet (121 trees per acre). Very little pruning was done at planting. As the trees have developed, lower scaffolds have been treated much the same as in the open-center trees; however, a central trunk has been maintained. The goal of this system is to have an open-center tree at maturity, but the productivity is higher early in its life, because it has more canopy volume in the form of a central leader. The central leader must be removed before the shading in the center of the tree results in significant reductions in the potential to produce fruiting wood.

Table 1. Continued.

Category	Open center	Central leader	Delayed open center
Year 2 -- 1991			
Growing			
Fertilizer	49	49	49
Spray material	67	67	67
General supplies	35	35	35
General labor	59	59	59
Equipment	51	51	51
Dormant pruning labor	8	10	5
Summer pruning labor	8	15	8
Costs -- Year 2	277	286	274
Net -- Year 2	-$277	-$286	-$274
Year 3 -- 1992			
Growing			
Fertilizer	53	53	53
Spray materials	254	254	254
General supplies	50	50	50
General labor	40	40	40
Equipment	65	65	65
Dormant pruning labor	16	25	14
Summer pruning labor	12	22	12
Thinning labor	8	15	8
Harvest and sales			
Harvest labor	38	89	64
Packaging	24	56	40
Selling	24	56	40
Costs -- Year 3	584	725	640
Returns -- Year 3	709	1675	1191
Net -- Year 3	$125	$950	$551

The Economics

Table 1 presents the costs and returns over the first three growing seasons from this trial. Much of the growing costs were obtained from other sources as described in the caption of the table, but planting costs, training costs, and yields were obtained from this trial. For labor, $8 per hour was used throughout this analysis. Equipment costs were assessed at

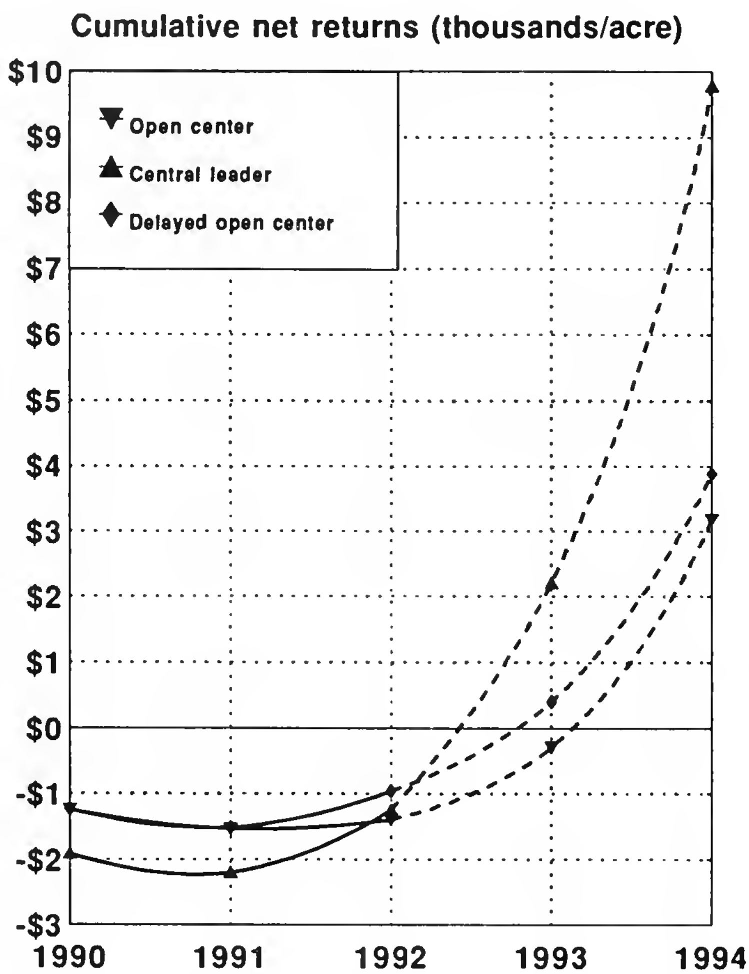

Figure 1. Cumulative net returns of three peach training systems. Dotted lines are projected net returns based on projected costs and returns for 1993 and 1994.

approximately $20 per hour but varied depending on the equipment used. Trees cost $5. Thinning, picking, packaging, and selling were assumed to cost $0.013, $0.04, $0.025, and $0.025 per pound of fruit, respectively. Yields were valued at $0.75 per pound.

For the first three seasons, central-leader trees were more costly to maintain than either of the other systems: total costs were $2108, $2925, and $2153 for the open center, central leader, and delayed open center, respectively. The difference came primarily from the greater establishment costs, which accounted for more than 80 percent of the difference between the central leader and the other systems.

During the third growing season (1992), trees in this trial yielded significantly. Yield per tree was related directly to canopy size, with the delayed open center yielding the most and the open center yielding the least per tree (8, 10, and 13 pounds per tree for the open center, central leader, and delayed open center, respectively). Once tree density was accounted for, the open-center, central-leader, and delayed-open-center systems yielded 945, 2234, and 1588 pounds of fruit per acre, respectively. The returns for the central leader systems were considerably greater than for the other systems.

At this point in the trial, it is possible to say that the additional costs of planting the higher density central-leader system have been compensated for by the higher yields in the third season. Figure 1 presents the cumulative net returns from these systems and shows a projection of cumulative net returns for the fourth and fifth growing seasons (1993 and 1994). For these early years, the central-leader trees should out-produce the other systems because of their higher density of planting, and therefore, likely will net over $2,000 per acre cumulatively by the end of the fourth growing season and nearly $10,000 per acre by the end of the fifth growing season. The other two systems likely will net less than half that amount by the end of the fifth growing season.

This information is not enough, however, to determine the ideal system for growing peaches in southern New England. These trees must be followed to maturity and beyond to determine long-term differences in costs and returns.

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Optimal Positioning of Baited Sticky Red Spheres for Capturing Apple Maggot Flies

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In a previous article [*Fruit Notes* 56(4): 4-6], we reported that a combination of food odor (ammonia) and fruit odor (butyl hexanoate) significantly increased apple maggot fly (AMF) captures on three-inch baited red sticky spheres, thus enhancing the effectiveness of interception traps currently used in the second-level IPM program. Past studies by Reissig (1975) and Drummond et al. (1984) showed that AMF captures on unbaited spheres were influenced significantly by position of spheres in the tree canopy, including height above ground, proximity to fruit and foliage, and distance from the outside edge of the tree canopy. We predicted that these variables would have less influence on AMF captures on sticky spheres baited with food and fruit odor than on unbaited spheres. Here we report on studies testing this prediction.

Materials and Methods

Three experiments were conducted in 1992 in second-level IPM orchards (commercial orchards not sprayed with insecticide after early June). We first investigated the optimal distance of fruit and foliage from spheres not baited or baited with one dispenser of ammonium acetate and one two-dram polyethylene vial of butyl hexanoate (Experiment 1). We next studied the effects of presence vs. absence of fruit within 20 inches of unbaited spheres or spheres baited with the same types of odor as in Experiment 1 (Experiment 2). In Experiment 3, we investigated the influence of height of sphere placement in the tree canopy on the efficacy of spheres not baited or baited with one polyethylene vial of butyl hexanoate.

Experiments 1 and 2 were conducted in Clarkdale Fruit Farm, West Deerfield, MA, which consisted of a mixture of 25-year-old Early McIntosh and Gravenstein trees. The trees were about 12 to 16 feet in canopy diameter. In Experiment 1, we hung four sticky spheres in each of ten trees and removed the foliage and fruit surrounding the spheres to distances of 2, 10, 20, or 40 inches. On five of the trees, we placed one dispenser of ammonium acetate (about 5 grams) and one vial of butyl hexanoate (about 5 milliliters) about six inches from the sphere. Spheres on the other five trees were not baited with any type of odor. In Experiment 2, we placed two sticky spheres in each of 14 trees. On seven of the trees, spheres were baited with ammonium acetate and butyl hexanoate in the same manner as in Experiment 1. Spheres on the other seven trees were not baited. One of the two spheres in each tree was cleared of all fruit within 10 inches. The other sphere was cleared of all fruit within 20 inches. The foliage surrounding each sphere was removed within a constant distance of 10 inches.

Experiment 3 was conducted at the University of Massachusetts Horticultural Research Center, Belchertown, MA, in a block of four-to-five-year-old Liberty trees having a canopy three to five feet in diameter and a height of six to eight. In this experiment, we placed only one sphere (either not baited or baited with one polyethylene vial of butyl hexanoate) on each tree. Spheres were placed in trees at three different heights: upper 1/3, middle 1/3, or lower 1/3 of the canopy. Foliage and fruit within 10 inches of each sphere were removed.

For all experiments, captured male and female AMF were counted and spheres were cleared of all insects captured every two weeks. In Experiments 1 and 2, unbaited and baited spheres were emplaced on July 28 and rotated among trees at each examination (every two weeks) until September 8, when the test ended. Experiment 3 began on July 27 and ended on September 11. Spheres were not rotated among trees.

Table 1. Average number of apple maggot flies captured on baited or unbaited sticky red spheres hung in fruiting trees and surrounded at different distances by foliage and/or fruit (July 28 - September 8, 1992).[z]

	Distance (in) of clearing of		Baited spheres			Unbaited spheres		
Experiment	Foliage	Fruit	Female	Male	Total	Female	Male	Total
1	2	2	14 b	19 b	33 b	9 b	13 b	22 b
	10	10	24 a	35 a	59 a	18 a	29 a	47 a
	20	20	25 a	37 a	62 a	19 a	25 a	45 a
	40	40	16 b	20 b	36 b	14 ab	17 b	27 b
2	10	10	27 a	50 a	77 a	15 a	28 a	44 a
	10	20	19 a	39 b	57 b	15 a	18 b	33 b

[z] Five replicates per treatment type in Experiment 1 and seven replicates in Experiment 2. Values within columns and within experiment followed by the same letter are not significantly different at odds of 19:1.

Results

The results of Experiment 1 (Table 1) showed that for both baited and unbaited spheres, nearly twice as many AMF were captured on spheres with foliage and fruit cleared to a distance of 10 to 20 inches compared with 2 or 40 inches. Baited spheres captured 25 to 50% more flies than unbaited spheres at each distance. A previous study by Martin Aluja showed that fruit odor attracts flies from long distances to a host tree or a portion of a host tree, but once a fly arrives on a tree, it primarily will use vision to find an individual fruit or fruit-odor-baited sphere. Surrounding foliage and fruit which influence the visibility of a fruit-odor-baited sphere would therefore influence the probability of a fly finding the sphere. Until our test here, however, we had no knowledge that addition of food odor would fail to overcome the need for making a sphere conspicuous to AMF.

The results of Experiment 2 (Table 2) indicated that when the surrounding foliage was cleared to a constant distance of 10 inches from a sphere, spheres cleared of all fruit within 10 inches captured 33% (unbaited) and 35% (baited) more flies than spheres cleared of all fruit within 20 inches. Possibly, fruit at 10 to 20 inches from a sphere attracted more AMF (either by visual or odor stimuli) toward the sphere than fruit 20 inches or further did.

Results of Experiment 3 (Table 2) showed that for unbaited as well as baited spheres, spheres placed in the upper 1/3 or the middle 1/3 of the tree canopy captured about three times more AMF than spheres placed in the lower 1/3 of the canopy. Differences in performance of spheres at the lower versus the middle or upper tree positions were greater than differences between baited and unbaited spheres at any height. Differences in AMF captures on both unbaited and baited spheres among different tree canopy heights likely stem from fruit-foraging behavioral patterns of AMF within trees. A recent

Table 2. Average number of apple maggot flies captured on baited or unbaited sticky red spheres hung in fruiting trees at different tree canopy heights (July 27 -September 11, 1992).[z]

	Baited spheres			Unbaited spheres		
Position in the canopy	Female	Male	Total	Female	Male	Total
Upper 1/3	13 a	31 a	34 a	13 a	20 a	32 a
Middle 1/3	21 a	21 a	42 a	12 a	19 a	31 a
Lower 1/3	6 b	7 b	13 b	4 b	5 b	9 b

[z] Fourteen replicates per treatment type. Values within columns followed by the same letter are not significantly different at odds of 19:1.

study by Martin Aluja indicated that fruit-foraging AMF have a propensity to move upward when foraging for fruit and spend more time foraging in the middle and upper part of the tree canopy.

Conclusions

Our findings indicate that the performance of sticky red spheres whether baited or not with synthetic food and fruit odor, is affected strongly by clearing of surrounding foliage or fruit, as well as by height of placement in the tree canopy. Baited spheres capture more flies than unbaited spheres under all conditions. To intercept AMF immigrating into orchards, spheres should be placed in the middle 1/3 or upper 1/3 of the tree canopy and surrounded by as much foliage and fruit as possible except for a 10-inch radius around. This placement will optimize the finding of spheres by AMF within a tree.

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Massachusetts Agriculture

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In 1991, Massachusetts farmers sold $474 million of crop and livestock products, ranking forty-second out of fifty states. Massachusetts ranked number one, however, in cranberry production, number twelve in apple production, and number seventeen in greenhouse/nursery crop production. Table 1 reports the annual cash receipts of selected commodities in Massachusetts.

According to the U.S. Census, the estimated number of farms in Massachusetts increased from 5,400 in 1974 to 6900 in 1991. Table 2 gives the number of farms by county in 1982 and 1987, and Table 3 gives the acreage by county. Approximately 615,000 acres of land are used by Massachusetts farms. The average size of a farm is 100 acres, as compared to the U.S. average of 467 acres. Average

Table 1. Cash receipts in thousands of dollars by selected commodities in Massachusetts. Data were compiled from *Economic Indicators of the Farm Sector -- Financial Summary, 1991*, U.S. Department of Agriculture, Economic Research Service, ECIFS 11-2, March, 1993.

Commodity	1990	1991
All commodities	445,874	475,540
Livestock and products	124,706	120,745
Meat animals	13,750	15,919
Dairy products	70,054	64,977
Poultry and eggs	24,411	23,662
Aquaculture	8,245	8,245
All other livestock	7,725	7,645
Crops	321,168	354,795
Hay	5,037	4,689
Tobacco	13,442	14,571
Potatoes	4,677	4,522
Sweet corn	9,088	9,883
Tomatoes	8,760	6,300
Miscellaneous vegetables	40,000	39,000
Apples	20,337	19,180
Peaches	893	867
Cranberries	62,737	96,818
Other berries	5,345	5,885
Miscellaneous fruits and nuts	1,000	1,000
Maple products	922	1,483
Other field crops	3,700	2,920
Floriculture	35,551	35,364
Nursery and ornamentals	108,000	108,000

Table 2. Number of farms in Massachusetts by counties. Data are from *1987 Census of Agriculture*, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

County	1987	1982	Change (%)
Barnstable	158	123	+28
Berkshire	392	352	+11
Bristol	675	597	+13
Dukes	58	40	+45
Essex	439	372	+18
Franklin	616	521	+18
Hampden	490	392	+25
Hampshire	624	559	+12
Middlesex	569	567	0
Nantucket	12	6	+100
Norfolk	212	205	+3
Plymouth	775	649	+19
Suffolk	5	4	+25
Worcester	1191	1014	+17
Total	6216	5401	+15

Table 3. Land in farms (acres) in Massachusetts by counties. Data are from *1987 Census of Agriculture*, Bureau of the Census, U.S. Department of Commerce, Washington, D.C.

County	1987	1982	Change (%)
Barnstable	*	5,010	--
Berkshire	70,792	73,434	-4
Bristol	42,562	41,883	+2
Dukes	7,314	7,355	-1
Essex	30,940	30,283	+2
Franklin	82,864	79,412	+4
Hampden	46,747	43,835	+7
Hampshire	64,567	63,624	+1
Middlesex	38,709	40,173	-4
Nantucket	*	*	--
Norfolk	13,124	13,398	-2
Plymouth	77,140	80,392	-4
Suffolk	*	*	--
Worcester	134,689	133,612	+1
Total	615,185	612,819	0

* Withheld to avoid disclosing data for individual farms.

Table 4. Farm balance sheet for Massachusetts in millions of dollars. Data were derived from *Economic Indicators of the Farm Sector -- Financial Summary, 1991*, U.S. Department of Agriculture, Economic Research Service, ECIFS 11-2, March, 1993.

Item	1990	1991
Assets	3,553.6	3,407.7
Real estate	3,092.3	2,939.2
Livestock and poultry[z]	57.4	57.9
Machinery and motor vehicles[y]	212.8	214.7
Crops (inventory)	22.6	20.9
Purchased inputs	8.9	8.9
Financial	159.5	166.1
Debt	299.0	295.7
Real estate	115.1	117.9
Nonreal estate[x]	183.9	177.8
Debt/asset ratio	8.4	8.7

[z] Excludes horses, mules, and broilers.
[y] Includes only the farm share for trucks and autos.
[x] Excludes debt for non-farm purposes.

net farm income for Massachusetts is $20,841, while the U.S. average is $17,950. Of greatest significance is the fact that net farm income per acre in Massachusetts averages $208, nearly 5.5 times the U.S. average per acre of $38.

Massachusetts farmers control assets of $3.4 billion, with a debt load of under $300 million (Table 4). This debt-to-asset ratio is among the ten lowest in the nation and is less than half the national average. Massachusetts farmers per year purchase $160 million worth of farm inputs, pay local property taxes of $22 million, employ a hired labor force with a payroll of $77 million, and pay $24 million in interest to Massachusetts financial institutions and other lenders (Table 5).

Finally, Massachusetts farmers provide Massachusetts consumers with food that is locally grown, fresh, wholesome, and reasonably priced.

Table 5. Massachusetts farm income statistics in millions of dollars. Data were compiled from *Economic Indicators of the Farm Sector -- Financial Summary, 1991*, U.S. Department of Agriculture, Economic Research Service, ECIFS 11-2, March, 1993.

Item	1990	1991
Gross farm income	505.4	527.6
Farm marketings of crops	321.2	354.8
Farm marketings of livestock products	124.7	120.7
Government payments	3.0	1.5
Farm-related income	17.2	15.5
Non-cash income[z]	38.0	36.0
Inventory adjustment	1.3	-0.9
Total productions expenses	334.3	336.6
Feed purchased	31.7	30.6
Livestock and poultry purchased	1.4	1.4
Seed purchased	6.8	7.6
Fertilizer and lime	10.1	10.0
Pesticides	9.3	10.3
Fuel and oil	13.3	12.7
Electricity	7.0	7.0
Repair and maintenance	29.0	26.4
Miscellaneous	46.4	53.7
Interest on real estate debt	8.8	8.5
Interest on other debt	15.6	15.4
Contract and hired labor expense	77.3	77.2
Capital consumption (depreciation)	58.9	57.3
Property taxes	21.9	21.7
Net rent to landlords	-3.2	-3.1
Net farm income	171.2	191.0
Returns to operators[y]	158.0	178.7

[z] Includes: value of home consumption and rental value of operator and hired labor dwellings.

[y] Returns to operators is equivalent to net farm income, excluding the income and expenses associated with farm operator's dwellings.

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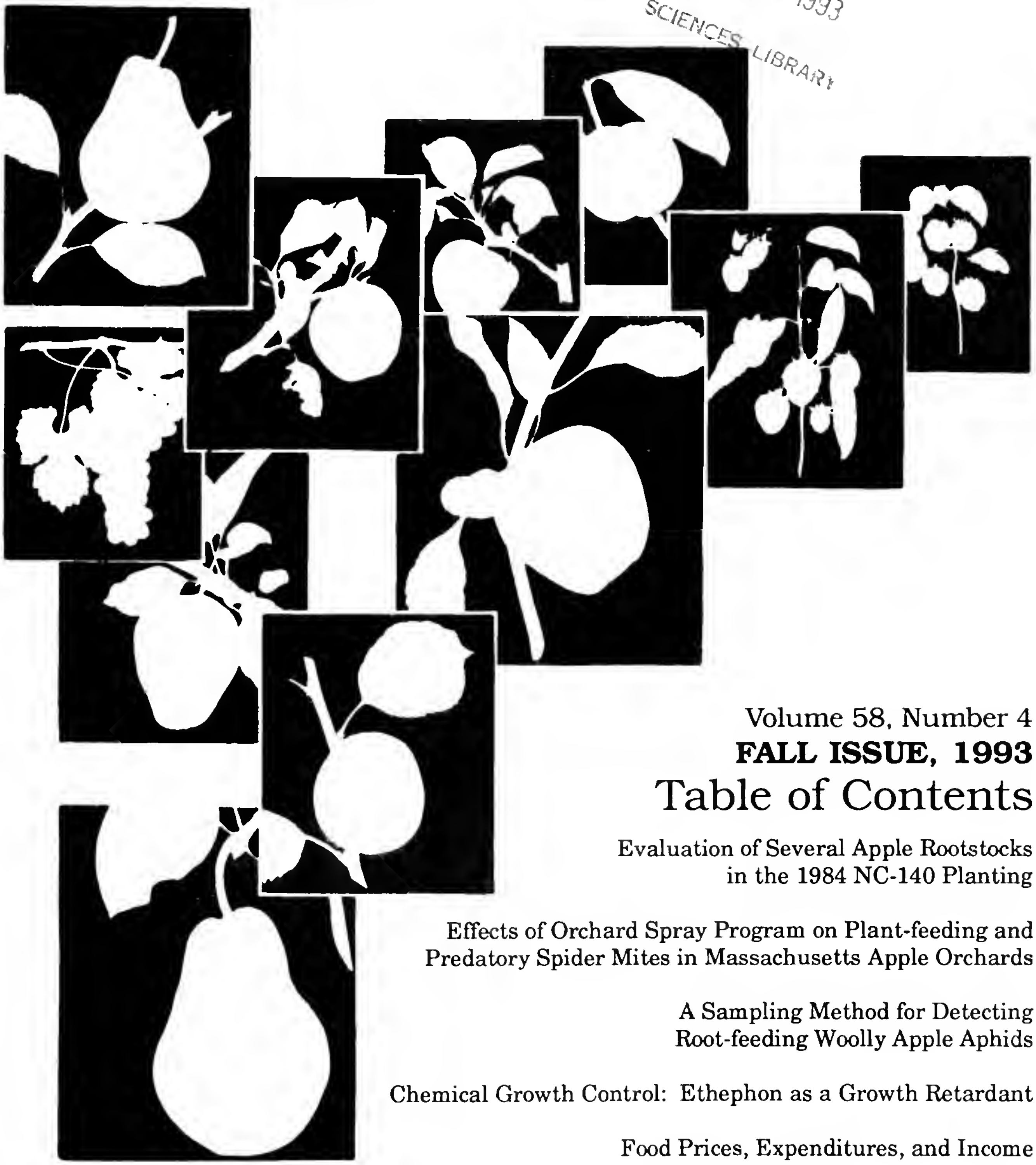

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COOPERATIVE EXTENSION SYSTEM POLICY:

Evaluation of Several Apple Rootstocks in the 1984 NC-140 Planting

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New England apple growers have been planting trees on clonally propagated rootstocks for a number of years. Early plantings were entirely on semidwarf and semistandard rootstocks, usually M.7, MM.106, or MM.111. During the 1970's, some growers experimented with M.9 and interstem trees, and now, several growers are using fully dwarf rootstocks. Until recently, plantings have used a relatively small number of rootstock clones, because only a few clones were available. Now several breeding programs have released rootstocks for trial, including the "Polish Series" from Poland, the "Budagovsky Series" from Russia, the "Ottawa Clonal Series" from Canada, the "Kentville Stock Clone Series" from Canada, the "Michigan

Table 1. Characteristics in 1992 of Starkspur Supreme Delicious trees on several rootstocks in the 1984 NC-140 Cooperative Planting.[z]

Rootstock	Trunk cross-sectional area (in^2)	1992 Yield (bu)	Cumulative yield (bu)	1992 Yield efficiency (bu/in^2)	Cumulative yield efficiency (bu/in^2)	Crop load ($fruit/in^2$)
Bud.9	3.4 efg	2.0 fg	5.6 g	0.57 ab	1.60 ab	57 ab
MAC-1	13.8 bc	5.1 c	11.0 de	0.36 de	0.80 d	37 cd
MAC-39	4.5 ef	2.1 fg	5.8 g	0.43 bcde	1.21 c	36 d
P.1	8.8 d	3.8 de	11.1 de	0.43 bcde	1.31 c	42 cd
P.22	1.2 g	0.4 h	1.5 h	0.30 e	1.29 c	30 d
Seedling	15.8 ab	4.9 c	11.3 cde	0.31 e	0.70 d	30 d
M.4	11.8 c	6.6 a	15.3 a	0.56 ab	1.30 c	62 a
M.7 EMLA	8.1 d	4.4 cd	11.8 bcd	0.62 a	1.62 ab	58 ab
M.26 EMLA	5.5 e	2.5 fg	7.1 fg	0.47 bcd	1.34 bc	41 cd
Bud.490	14.2 abc	5.4 bc	11.8 bcd	0.38 de	0.85 d	35 d
P.2	2.8 fg	1.6 g	4.8 g	0.56 ab	1.69 a	51 abcd
P.16	1.2 g	0.5 h	1.6 h	0.54 abc	1.67 a	53 abc
P.18	16.7 a	6.6 a	14.2 ab	0.40 cde	0.85 d	40 cd
C.6	5.5 ef	2.9 ef	8.6 ef	0.55 ab	1.61 ab	45 bcd
Ant.313	16.3 ab	6.2 ab	13.9 abc	0.39 cde	0.89 d	39 cd

[z] Means within columns not followed by the same letter are significantly different at odds of 19:1.

Table 2. Characteristics in 1992 of fruit from Starkspur Supreme Delicious trees on several rootstocks in the 1984 NC-140 Cooperative Planting.[z]

Rootstock	Soluble solids (%)	Starch index[y]	Watercore index[x]	Date of 1 ppm C_2H_4	Fruit weight (g)
Bud.9	9.8 cd	3.6 abc	1.0 b	10-11 bcd	217 abcd
MAC-1	9.8 cd	2.8 def	1.1 b	10-12 abc	181 f
MAC-39	10.4 b	3.2 bcde	1.3 a	10-11 bcd	232 ab
P.1	10.1 bcd	3.2 bcde	1.1 b	10-11 bcd	203 bcdef
P.22	11.0 a	3.7 ab	1.0 b	10-11 bcd	182 f
Seedling	9.7 cd	2.8 def	1.0 b	10-13 ab	185 ef
M.4	9.6 d	2.6 f	1.0 b	10-12 abc	192 def
M.7 EMLA	10.1 bcd	2.8 def	1.1 b	10-9 d	215 abcde
M.26 EMLA	10.1 bcd	3.3 abcd	1.2 ab	10-9 d	214 abcde
Bud.490	9.6 d	2.9 def	1.1 b	10-14 a	200 cdef
P.2	10.1 bcd	3.3 abcd	1.2 ab	10-11 bcd	225 abc
P.16	10.2 bc	3.8 a	1.0 b	10-10 cd	204 bcdef
P.18	9.8 cd	2.6 f	1.0 b	10-12 abc	191 def
C.6	10.1 bcd	3.1 cdef	1.1 b	10-10 cd	237 a
Ant.313	9.6 d	2.7 ef	1.0 b	10-13 ab	191 def

[z] Means within columns not followed by the same letter are significantly different at odds of 19:1. Soluble solids, starch index, watercore index, and fruit weight were assessed on October 5-6, 1992. Date of 1 ppm C2H4 was assessed with several weekly samples throughout the harvest season.
[y] Starch index: 1 = dense starch staining, very immature; 9 = no starch staining, very overmature.
[x] Watercore index: 1 = no watercore; 5 = severe watercore.

Apple Clone Series" from Michigan State University, and the "Cornell-Geneva (or Geneva) Series" from the New York State Agricultural Experiment Station. In 1984, a trial of a number of these new rootstocks was planted at approximately 30 locations throughout the United States and Canada. One of the plantings is at the University of Massachusetts Horticultural Research Center in Belchertown, Mass. This article will report the results from this planting through its ninth growing season.

In April 1984, Starkspur Supreme Delicious trees on Bud.9, MAC-1, MAC-39, P.1, P.22, seedling, M.4, M.7 EMLA, M.26 EMLA, Bud.490, P.2, P.16, P.18, C.6, or Ant.313 were planted in a randomized complete block design with 10 replications. The soil is a Montauk fine sandy loam. McIntosh and Golden Delicious trees were included in each replication for pollination. All trees were trained as central leaders and supported by a post only when they leaned more than 45° from vertical. All trees received the same fertilizer applications, pest control treatments, and chemical thinning sprays.

Table 1 reports the trunk cross-sectional area, yield, yield efficiency, and crop load of these trees. MAC-1, seedling, Bud.490, P.18, and Ant.313 produced trees of standard size.

Over their first nine years, trees on MAC-1, seedling, or Bud.490 yielded a total of 11 to 12 bushels. Those on P.18 or Ant.313 yielded approximately 14 bushels. P.1, M.4, or M.7 EMLA produced trees in the semidwarf to semistandard category. Trees on M.4 have yielded the most in the trial, more than 15 bushels per tree cumulatively. Trees on P.1 or M.7 EMLA yielded between 11 and 12 bushels cumulatively. Bud.9, MAC-39, M.26 EMLA, P.2, and C.6 produced trees in the dwarf category. In this category, C.6 and M.26 EMLA have resulted in the greatest yields, 8.6 and 7.1 bushels, respectively, per tree on a cumulative basis. The other dwarf rootstocks have resulted in yields between 4.8 and 5.8 bushels per tree. The smallest trees in the planting are on P.22 or P.16. These trees are in the very dwarf category, and they have yielded only about 1.5 bushels per tree cumulatively.

To accurately assess performance of a particular tree, it is important to look not only at size and yield but also at yield efficiency. Efficiency relates yield to tree size and gives an assessment of relative yield per acre. Over the life of the planting, the most yield-efficient trees have been on P.2, P.16, M.7 EMLA, C.6, or Bud.9. M.7 EMLA is the biggest surprise in this group, because in other plantings that we have, it has not been very yield-efficient. The least efficient trees have been those of the standard size category.

Table 2 reports fruit characteristics from this planting in 1992. For the four years that fruit have been assessed, no dramatic, consistent differences have occurred in fruit ripening, but fruit from trees on C.6 often have been some of the largest in the planting, as they were in 1992.

Overall, the most promising new rootstocks in this trial are P.2, C.6, and Bud.9. All are of the dwarf category. P.2 and Bud.9 produce trees similar in size to those produced by M.9, and C.6 produces a tree very similar in size to one produced by M.26. They seem well adapted to our conditions, they were very precocious, and they have continued to be productive for their size. The only concern is with the potential of trees on P.2 or Bud.9 to "runt out." Trees on P.2 or Bud.9 were nearly spur-bound after nine seasons. High productivity likely will not continue unless they are pushed to produce new vegetative growth. This trial, however, is with a spur-type variety. Newer trials include these two rootstocks with more vigorous, nonspur varieties, and I do not expect that they will become spur bound as readily.

We shall continue to evaluate new rootstocks in Massachusetts. We have a planting scheduled for the spring of 1994 which will contain 19 of the newest dwarfing rootstocks, including some from the "Vineland Series," the newest of the "Geneva Series," and a host of M.9 strains from Europe.

* * * * *

Effects of Orchard Spray Program on Plant-feeding and Predatory Spider Mites in Massachusetts Apple Orchards

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Since the inception in 1978 of the University of Massachusetts Apple Integrated Pest Management Program, growers have heard a number of presentations concerning the importance of selecting orchard pesticides based on their impacts on not only the target pest but also beneficial organisms. In recent years, the *New England Apple Pest Management Spray Guide* has contained a table of pesticide toxicities to beneficial species, with data from a number of published studies conducted in Pennsylvania, New York, New Jersey, Virginia, West Virginia, Massachusetts, and Canada.

In 1987, we initiated a study of the effects of orchard groundcover composition on plant-feeding and predatory mites. As a component of this study, we reviewed the spray records of 28 commercial apple orchards in Massachusetts. Spray programs that included carbamate insecticides, pyrethroid insecticides, certain acaricides, or certain herbicides known to be detrimental to predatory mites were classified as "hard" programs. Those that avoided such materials were classified as "soft" programs.

Table 1. Effects of orchard spray program on average percent infestation of apple leaves by phytophagous and predatory mites.[z]

	Leaf infestation (%)			
	1988		1989	
Mite species	"Hard"	"Soft"	"Hard"	"Soft"
European red mite	9.7 a	8.6 b	31.4 a	33.0 a
Two-spotted spider mite	1.0 a	1.0 a	1.7 a	0.3 b
Amblyseius fallacis	1.5 a	1.9 a	1.4 b	2.4 a
Zetzellia mali	0.3 b	4.2 a	0.0 b	3.3 a

[z] Within row and year, means not followed by the same letter are significantly different at odds of 19:1.

Those which used two or fewer applications of benzimidazole fungicides, whose detrimental effects on mite predators are not agreed upon universally, likewise were classified as "soft" programs. Due to seasonal variability of spray programs, blocks were reevaluated yearly and reclassified by the types of pesticide used during the previous production season. In total, the study included 14 orchards using "hard" programs and 14 using "soft" programs.

In 1988, the "hard" program resulted in slightly higher infestations by European red mite than did the "soft" program (Table 1). The relationship, however, varied with sampling date, i.e. for some sampling dates, "hard" programs had more European red mites, and for other dates, "soft" programs had more. Spray program had no impact on the amount of European red mites present in 1989. The lack of a difference in 1989 likely was due to an aggressive spray program directed at mites in "hard" blocks which kept plant-feeding mite numbers comparable to those in "soft" blocks in spite of lower predator numbers.

The "hard" spray program resulted in significantly more two-spotted spider mites than the "soft" program in 1989, but in 1988, there was no difference between programs (Table 1). The first sample in 1989, however, found fewer two-spotted spider mites in the "hard" program orchards than in the "soft" ones. Because of the differences from year to year and the lack of a consistent relationship between programs, even when significant differences were noted, we cannot state conclusively that numbers of two-spotted spider mites were related to spray program in this study.

"Hard" spray programs had a significantly lower proportion of leaves infested with the Phytoseiid predator *Amblyseius fallacis* in 1989, but not in 1988 (Table 1). The relationship between programs, however, again varied with sample date, as with European red mite and two-spotted spider mite. Hence, these results also must be considered inconclusive.

Lack of consistent spray-program effects on European red mites, two-spotted spider mites, and *A. fallacis* may be related to the initial grouping of spray programs, which considered the use of limited applications of potentially toxic benzimidazole fungicides as part of "soft" programs. Other factors independent of spray program, such as low prey numbers in previous years or high overwintering predator mortality in certain orchards, also could have affected predator numbers.

Results were more conclusive in the case of the Stigmaeid *Zetzellia mali*, which was found in significantly higher numbers in "soft" program orchards in both 1988 and 1989 (Table 1). Differences were maintained across all sampling dates in both years. The more consistent results are not surprising with *Z. mali*, because this predator spends its entire life either on the tree or at its base and consequently would be expected to be affected severely by harsh chemical sprays. Differences in time of appearance of *Z. mali* were particularly evident (data not shown), with individuals observed in "hard"-program orchards only in very low numbers on the last sample round in 1988. In 1989, only a single individual was found in a "hard" orchard over all sampling dates.

Although, some aspects of this study were inconclusive, we believe that the results give some confirmation that insecticides, fungicides, and herbicides can affect densities of prey and predatory mites in apple trees. A clear implication of this finding is that growers wishing to enhance the numbers of endemic mite predators should avoid materials which can adversely affect them.

* * * * *

A Sampling Method for Detecting Root-feeding Woolly Apple Aphids

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The woolly apple aphid generally is considered to be a minor pest of apple world-wide, seldom becoming abundant enough to justify chemical control. This aphid is most often found at pruning scars, other wound sites and at the base of petioles on current year's growth. It also feeds on roots of apple trees where it survives the winter and can remain throughout the year. I have been investigating this root-feeding insect and its effects on apple tree growth and production. The research literature contains only a few studies of this problem, and those deal with nursery stock. I found that root-feeding woolly apple aphids reduced tree growth in young nonbearing orchards (Brown and Schmitt, 1990) and caused a significant economic loss in a seven-year-old 'Delicious' orchard (Brown et al., in preparation).

The sampling method that I used in my research was to uproot trees and evaluate the root system. This method is efficient for research but not for pest management programs, for obvious reasons. To determine if some form of treatment is needed, a sampling method must be quick and easy enough to use with minimum training. The method described in this paper is based on woolly apple aphid biology. During spring, first-instar nymphs migrate up the tree from overwintering populations on roots to recolonize above-ground portions of the tree (Hoyt and Madsen, 1960). Trapping these migrating woolly apple aphid nymphs should give an indication of the presence and intensity of root infestation.

A two-inch-wide strip of masking tape was placed around the trunk of apple trees, one to two feet above the ground but below the lowest scaffold limb. The tape was placed on the smoothest section of trunk available. A continuous barrier, about 1/8-inch deep and one-inch wide, of Tangle-trap™ was applied in the center of the masking tape. A portion of the masking tape band was exposed both above and below the Tangle-trap barrier. The trees that were used in this study were planted in 1985 at 308 trees per acre. The block contained Frazier Goldspur, Smoothee Golden Delicious, both on M.7A, and Bisbee Spur Delicious on M.7 EMLA. The orchard was located at the Appalachian Fruit Research Station in Kearneysville, West Virginia, and was managed using standard commercial practices.

Trees were banded to coincide with specific tree phenologies from green tip to first cover. Twenty five trees, selected randomly, were banded at each of four sample periods in 1993, as shown in Table 1. One group of 25 trees was banded for the entire green-tip to petal-fall period. An additional eleven trees with evidence of aphid migration up the tree during bloom were banded at petal fall. At the end of the designated sample periods the bands were removed and field counts of woolly apple aphid nymphs were made. Examination of the tape bands was with the unaided eye, using a hand lens only to verify questionable nymph sightings. On May 25, the trees were uprooted, the number of woolly apple aphid colonies on roots was recorded, and the amount of root galling was evaluated on a scale of 0 to 1. The root gall rating scale incorporated both the proportion of the root system with root galls and the intensity of galling on those roots infested. It can be thought of as the proportion of the root system affected by woolly apple aphids, scored from none (0) to complete infestation (1).

Table 1. Sample periods, trap captures, and root infestations of wooly apple aphids.

Sample date	Tree phenology	Trees with trapped nymphs	Trees with root colonies	Average root rating[z]
April 7-19	Green tip-1/2 inch green	5	3 [y]	0.24 [y]
April 19-27	1/2 inch green-pink	0	--- [x]	--- [x]
April 27-May 10	Pink-petal fall	3	3	0.19
April 7-May 10	Green tip-petal fall	9	12	0.22
May 10-21	Petal fall-first cover	3	8	0.18
May 11-21[w]	Petal fall-first cover	6	7	0.31

[z] Root rating is on a scale of 0 to 1 and reflects the proportion of the root system infested with woolly apple aphids.

[y] Only 16 trees of the 25 sampled were uprooted, 5 with nymphs and 11 without.

[x] Not uprooted because no nymphs were trapped.

[w] Eleven trees that had been sampled in the green tip to petal fall (5) or pink to petal fall (6) sample period.

There were two distinct periods of woolly apple aphid migration from roots to above-ground portions of the tree (Table 1). Few aphid nymphs were trapped between green tip and half inch green; five trees had one nymph each. These nymphs were a different form than nymphs trapped later and non-migrating nymphs found in the summer. These earlynymphs were black and had little wax (the characteristic white woolly covering), whereas the typical form for first-instar nymphs is light purple with a waxy covering over the body and obvious tufts of wax. Because of the small number of trees on which early nymphs were trapped, only 16 trees were uprooted, the five with nymphs and eleven without nymphs. The level of root infestation was the same for trees with and without trapped nymphs. Therefore, trapping for migrating woolly apple aphid nymphs during the green tip to half inch green period would not be a useful sampling method.

No nymphs were trapped during the half inch green to pink sample period. First-instar nymphs were trapped on several trees that were banded during both the pink to petal-fall and the green-tip to petal-fall sample periods (Table 1). In both sets of trees the aphid nymphs appeared to have been trapped recently and were either

Table 2. Relationship of trap captures to root colonies and root infestation rating.

Variable	Number of trees with nymphs	Number of trees without nymphs
Root Colonies		
>0 root colonies	12	12
0 root colonies	3	48
Root Infestation		
>0.21 rating	11	13
≤0.21 rating	4	47

still active or at least had not begun to shrivel. Nymphs in the petal-fall to first-cover sample appeared to have been trapped early in the period and were inactive, darkened, and had begun to shrivel. Eleven trees that had the tape traps removed at petal fall were re-banded to investigate further the timing of migration. In all eleven trees, those that had nymphs trapped on bands prior to petal fall also had nymphs after petal fall, and those that did not have nymphs trapped on bands did not have any after petal fall. From these results, I conclude that the majority of root migration takes place within a few days before and after petal fall. All three samples, therefore, that included petal fall were pooled and analyzed as one sample, because the presence or absence of migrating nymphs, not the number of nymphs, was used as the predictor variable.

From traps on the 75 trees in the pooled sample, fifteen (20%) had first-instar woolly apple aphid nymphs (the median number of nymphs per trap was 8 but ranged from 1 to 2883). Trees that had traps with migrating nymphs had a larger number of root colonies and a more severe root infestation than trees without migrating nymphs (Table 2). For trees on which nymphs were trapped, 80% had root colonies, and 73% had root gall infestation ratings greater than 0.21. For trees without trapped nymphs, only 20% had root colonies and only 22% had root gall infestations greater than 0.21. Further, the mean number of root colonies and root gall infestations were 4.1 and 0.3 for trees with trapped nymphs, respectively, and 0.5 and 0.2 for trees without trapped nymphs, respectively.

Conclusions

The presence of nymphs migrating up the tree from roots during petal fall is an indication of the size of the woolly apple aphid population on the roots of that tree. Masking tape with a Tangle-trap™ barrier was successful in trapping these migrating nymphs. By sampling an orchard, one can estimate the number of trees that have serious woolly apple aphid root infestations by comparing the number of trees with migrating nymphs versus those without. One could also identify portions of an orchard that may have a woolly apple aphid problem and take suitable action: apply insecticides against above-ground feeding aphids which would eventually lower root-feeding populations, delay replanting or plant other crops for a year or two, or apply insect parasitic nematodes, which is a promising potential control method (Brown et al., 1992).

More trials of this sampling method are needed, especially to test regions outside the Shenandoah Valley. This study showed that presence of migrating nymphs indicates trees that are highly likely to have root-feeding aphids. Further trials will enable a more quantitative prediction using the number of nymphs trapped and determination of a treatment threshold number of trees infested per acre. Cooperators are currently being sought in the U. S. and Canada to help refine this sampling method.

Acknowledgements

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Chemical Growth Control: Ethephon as a Growth Retardant

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With the loss of Alar®, the only chemical available for reducing vegetative growth is ethephon. It functions as a growth retardant in the same way that it initiates early ripening: it releases ethylene within the plant tissues after application, and ethylene can retard growth. In 1991 and 1992, we conducted a study to determine the effects of ethephon and a number of mechanical growth-retarding treatments (scoring, ringing, and root pruning) on growth and fruit characteristics. Results from other treatments were discussed previously in *Fruit Notes* [1992, 57(3):1-5,6-9]. Here we report the effects of spring ethephon application.

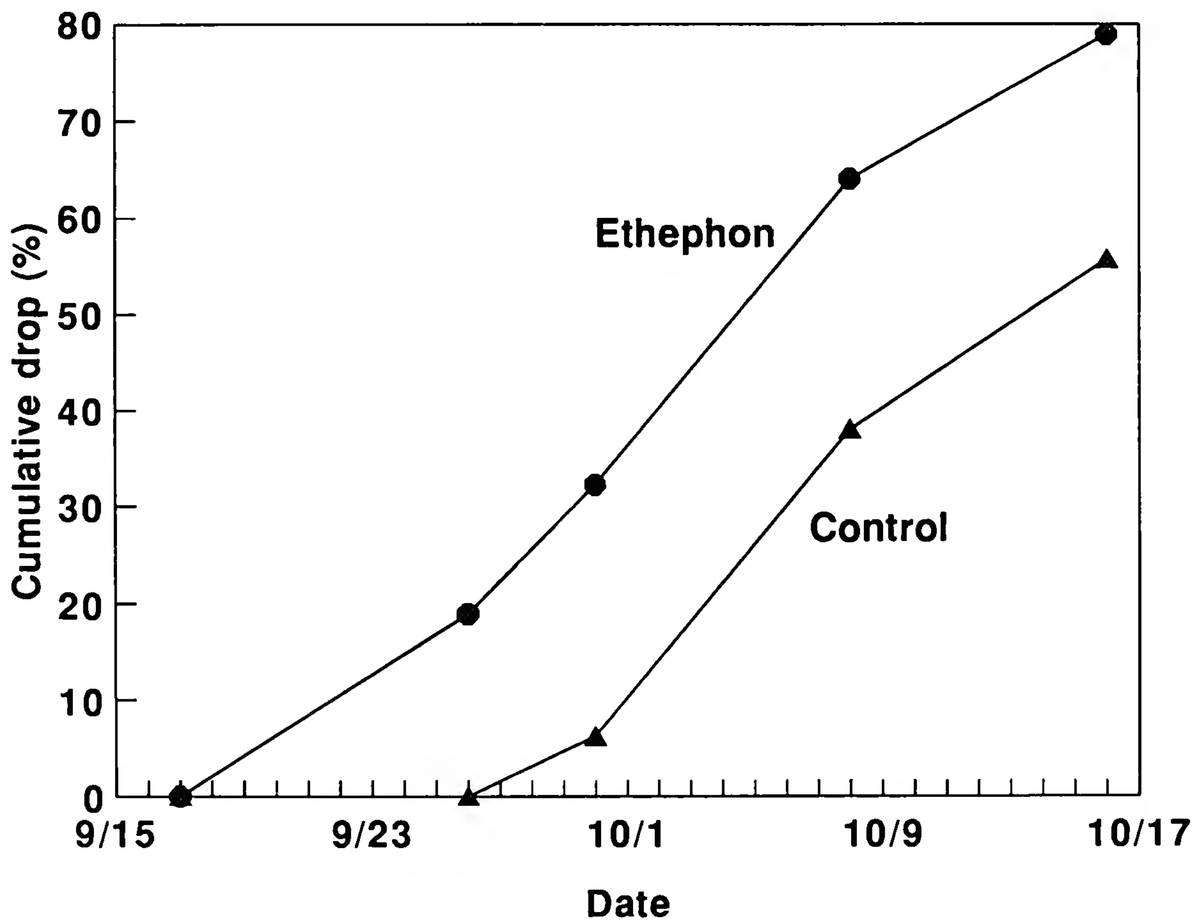

Figure 1. Cumulative drop from control and ethephon-treated Gardiner Delicious/MM.106 trees in 1991. Ethephon was applied at 500 ppm on May 16, 1991.

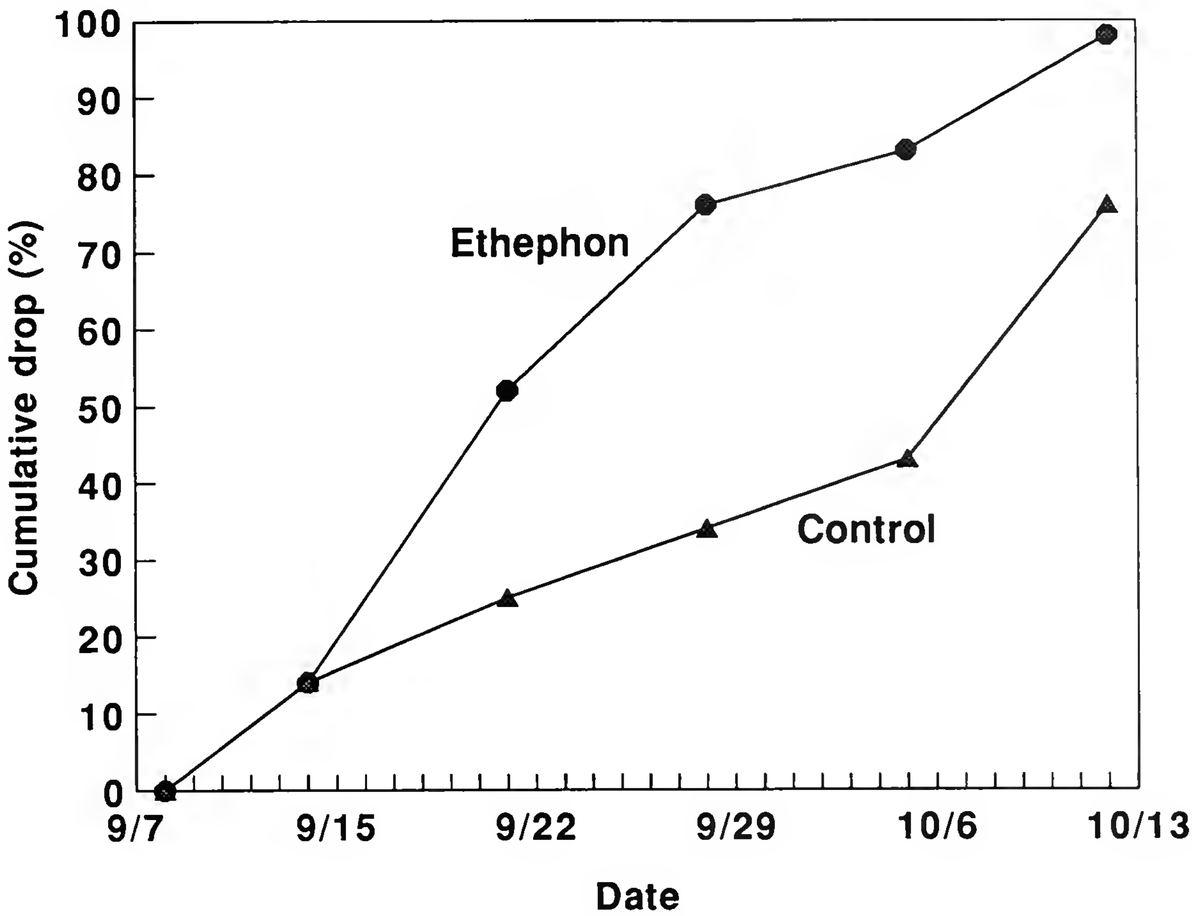

Figure 2. Cumulative drop from control and ethephon-treated Rogers Red McIntosh/MM.106 trees in 1992. Ethephon was applied at 500 ppm on May 26, 1992.

In 1991, mature, vigorous Gardiner Delicious/MM.106 trees were treated with 500 ppm ethephon eight days after petal fall, and in 1992, mature, vigorous Rogers Red McIntosh/MM.106 trees were treated with 500 ppm ethephon four days after petal fall. During the season of treatment, we assessed fruit set, vegetative growth, fruit ripening, fruit drop, and fruit size.

Use of ethephon soon after bloom, as was done in this study, has been shown to thin fruit, and in fact, ethephon is used as a chemical thinner in some locations around the world. In this experiment, however, the ethephon treatment did not thin significantly and had very little effect on fruit set. We all know that chemical thinners do not work every year, and they do not work under all circumstances. The lack of a thinning response from ethephon in this study should not be taken to mean that ethephon will not thin fruit under our conditions. From a practical standpoint, if ethephon is to be used as a growth retardant, the grower must be prepared for a potential reduction in fruit set, even if it likely will not occur in all circumstances.

Research by others has shown that ethephon has only a moderate effect at best on terminal growth reduction. The most noticeable growth reduction comes from preventing spurs from growing into lateral shoots. In this experiment, we measured terminal length, terminal diameter, and the time required for dormant pruning. Not surprisingly, ethephon did not significantly alter terminal growth, but it did reduce the time required for dormant pruning of Delicious by approximatlely 25%, which likely was related to a reduction in the number of lateral shoots produced from spurs.

When used on excessively vigorous, young trees that are essentially nonbearing, ethephon may be very effective at reducing all excessive vegetative growth, but indirectly, since it can stimulate flower bud formation. In this way, the tree can be shifted from a vegetative habit to a bearing habit the year after ethephon application. In our experiment, we were using mature, bearing trees, so this was not a factor.

Very importantly, the effects of spring-applied ethephon were apparent in the fall. Figures 1 and 2 show the fruit drop that occurred from ethephon-treated and untreated trees. Overall, for ethephon-treated trees, drop was nearly double that of untreated trees. Fruit from ethephon-treated trees also ripened sooner (Figure 3), and for McIntosh, they were significantly smaller than fruit from untreated trees (Figure 4).

In conclusion, several points should be understood

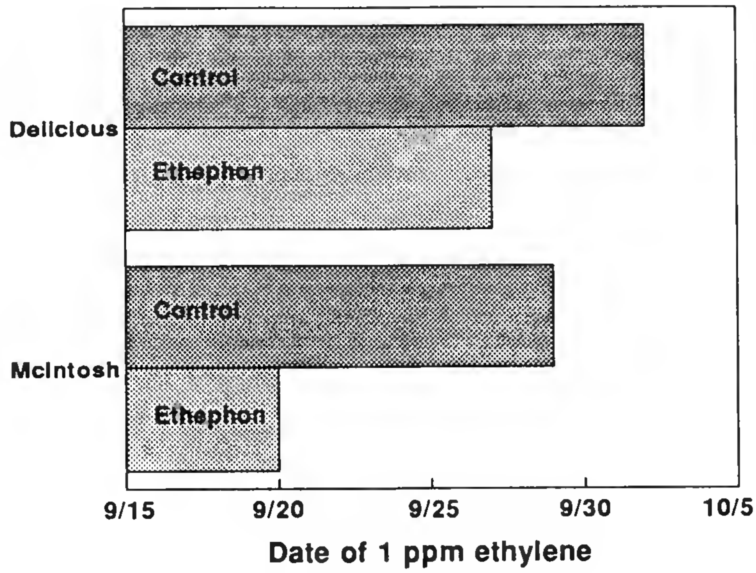

Figure 3. Effects of spring-applied ethephon on the time of ripening of fruit from Gardiner Delicious/MM.106 trees and Rogers Red McIntosh/MM.106 trees.

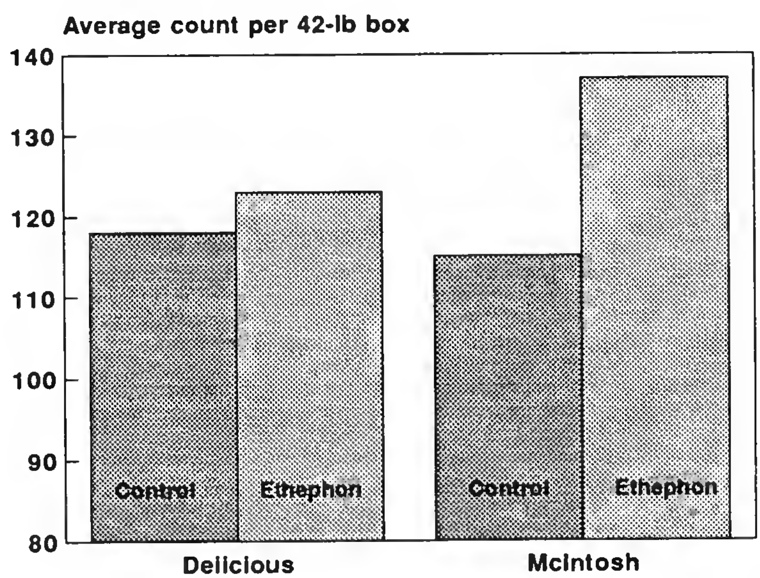

Figure 4. Effects of spring-applied ethephon on size, presented as average counts per 42-lb. box, of fruit from Gardiner Delicious/MM.106 trees and Rogers Red McIntosh/MM.106 trees.

before ethephon is used to retard growth of mature, bearing trees: 1) ethephon is a potential thinner, so significant thinning may result if appropriate conditions exist; 2) extension growth may not be reduced dramatically, but lateral shoot development may be reduced, producing more of a spur-type growth habit and reducing the time required to dormant prune trees; 3) ripening may be advanced and drop may be increased, so plans must be made to harvest ethephon-treated trees earlier than normal; and 4) fruit size may be reduced. The potential reduction in size is of major concern and may negate any positive effects of ethephon treatment on bearing trees.

A strategy that was used with Alar® was to direct the spray into the top, vigorous portions of the canopy. Using this technique, carryover effects and reduction in fruit size were minimized. This approach may not work with ethephon, since it would cause fruit in the top of the tree to ripen earlier than the rest, making harvest troublesome and possibly resulting in damage to lower fruit from upper fruit dropping through the canopy.

For vigorous,nonfruiting trees, ethephon may be more beneficial than for bearing trees. In young trees, its major positive response is to initiate flower bud formation. The season following the ethephon treatment should see enhanced fruit production and, therefore, less vegetative growth.

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Food Prices, Expenditures, and Income

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Have consumer expenditures for food been increasing or decreasing, and if so, by how much? What happens to the consumer's food dollar; what share do farmers get, and how much is absorbed by firms involved in the marketing process? What determines how the consumer food dollar is divided, and do those who receive the largest part of consumer expenditures have the largest profits, or vice-versa?

These questions are among those most frequently asked about the U.S. food system. A recent U.S.D.A. publication (Dunham, D. 1993. *Food Costs ... From Farm to Retail in 1992.* Economic Research Service, USDA, Agricultural Information Bulletin Number 669) contains many of the answers, plus some additional insights into issues such as recent changes in food prices, consumer food expenditures, and the farmers' share. The following discussion addresses the above questions and some other highlights from that publication.

Food Prices and Expenditures

Changes in consumer prices, including food prices, are measured by the Consumer Price Index (CPI) which, in turn, is used as the measure of inflation or changes in the cost of living. In 1991 and 1992, food prices increased less than the rate of inflation — the prices of all consumer goods. In other words, the modest increase in food prices helped to moderate the overall rate of inflation. For 1991 and 1992, the CPI rose by 4.2 and 3.0 percent, respec tively, while food prices rose by only 2.9 and 1.2 percent, respectively.

During the same two years, total consumer expenditures for food increased slightly more (3.6 and 2.3 percent, respectively) reflecting the combined effects of food price increases, population increases, and possible changes in consumption patterns.

In 1991, U.S. consumers spent a total of $492 billion for food, which amounts to $4,367 annually per household of 2.6 persons, or $1,680 per person per year, $37.30 per week, and $4.60 per day. Of that total, 62 percent was spent for food consumed at home and 38 percent away from home.

Consumer Expenditures and Income

For all consumers combined, 1992 food expenditures represented 11.4 percent of personal disposable income, though that percentage varied widely with variations in income levels. Households with disposable income of $5,000 to $9,999 spent 32.6 percent of their income for food, while those whose incomes were $30,000 to $39,999 spent only 15.2 percent for food. At higher income levels, even smaller proportions were spent for food.

The share of consumer disposable income spent for food has, in general, been declining since 1960, when consumers spent 17.5 percent of disposable income for food. In 1970, that percentage had declined to 13.9 percent, in 1980 to 13.5 percent, and 11.7 percent in 1990. Food consumed at home has been the major factor in that decline. In fact, consumer spending for food eaten away from home rose from 3.5 percent of personal disposable income in 1960to 4.4 percent in 1980, and has fallen slightly to 4.2 percent in 1992. Why? The answer is that prices for food away from home have risen more than the prices of food consumed at home and that, year by year, we have been eating an increasing share of our meals away from home, a trend that has slowed somewhat in recent years.

The fact that food expenditures in total have been declining as a percentage of income is a result of incomes increasing more rapidly than food prices, and also a demand for agricultural products that is income inelastic (when income increases by one percent, food expenditures increase by something less than one percent).

The Farm Share

Modestly increasing food prices, which have contributed to the declining share of income spent for food, have occurred partly because of efficiencies and competition in food marketing, but also, because of very slowly increasing farm prices. The farm value of a "market basket" of food purchased by consumers increased by only five percent from 1982 to 1992 - less than one-half of one percent per year. (The "market basket" referred to here is a group of 74 domestically produced food products used by the U.S.D.A. for its food price and cost studies.) In contrast, Massachusetts per capita, personal disposable income increased more than 200 percent from 1980 to 1991: $10,612 to $22,897 (Andrews and McNeel. 1993. Personal income per capita in current dollars by state. 1970-91. p. 244. In: *The Universal Almanac - 1993*).

Over the same time, retail prices for food products increased by 40 percent, resulting in a decline in the farm share of consumer expenditures for the U.S.D.A. "market basket." For example, in 1982, farmers received 35 percent of the dollars spent by consumers for food, as payment for their products. By 1992, that share had fallen to 26 percent.

The farm share of consumer expenditures varies widely among food products. It tends to be greatest for products requiring little packaging, processing, and handling, and vice-versa. Thus, farmers receive a relatively large share (over 50%) of the retail price of products such as eggs, chicken, and beef and 10 percent or less for others such as tomatoes, bread, and corn syrup.

The difference between retail prices and the amount received by farmers for an equivalent amount of product (e.g., it takes an average of 2.4 pounds of Choice grade steer, to produce each pound of beef sold in retail stores) is referred to as the farm-to-retail price spread. The farm-to-retail price spread might be considered the marketing cost (or "marketing margin") for farm products, being absorbed by the labor, packaging, promotion, energy, and other costs involved in the processing and marketing of farm products. In recent years that cost has risen at an average rate of 5.6 percent, meaning that the cost of marketing farm products has been increasing faster than the farm value of those same products.

There are two important points to be made here. First, whether the farm share (or the marketing margin) is increasing or decreasing says very little about the welfare of farmers or the relative profitability of farming vs. marketing. Products sold in retail stores are much different from those sold by farmers, and the cost of creating those differences is included in the farm-to-retail price spread. If, as has been occurring recently, consumers purchase increasing amounts of the more highly-processed products, the farm-to-retail price spread must increase, even if farmers continue to receive the same prices for their products.

Second, there are major differences in the different markets involved that contribute to the fact that farmers often receive lower price increases for their products than do the marketing firms. There is little benevolence in any market; market participants pay what they have to pay to receive needed products and services. In the markets where farmers selltheir products, they usually have less bargaining power than do the buyers to whom they must sell. As a result, farmers tend to be "residual claimants" to returns in the market place.

On the other hand, in the market for inputs such as labor, energy, and packaging materials, marketing firms encounter sellers with bargaining power equal to or greater than their own, and the resulting prices are negotiated or bargained prices. In the market for the final products, marketing firms usually have sufficient marketing power visa-viz consumers, to at least be able to obtain adequately profitable prices.

Who Gets What Part Of The Consumer Food Dollar?

The final question addressed in this article is, where does the consumer food dollar go; who receives what part of it? In 1992, 26 cents of every food dollar spent by consumers was received by farmers. Of the remainder (sometimes referred to as the "marketing bill"), 35 cents was used to pay salaries and wages for the workers involved, and 8 cents, the cost of packaging. Transportation, depreciation, advertising, energy, and rent costs each accounted for 3.5 to 4.5 cents. About 6.5 cents was divided among a large number of costs, including repairs, insurance, professional services, property taxes, and many other items. The remaining 3.5 cents represented before-tax profits.

Consumer Value and Their Food Dollars

In conclusion, it appears that consumers have benefitted from very moderate increases in retail food costs in recent years. Personal disposable incomes have risen at a faster rate than food costs and the percentage of income spent on food has fallen. At the same time the farm share of the consumer's dollar has steadily declined while the farm-to-retail margin has gradually increased.

Do U.S. consumers get a good value for their food dollars? Undoubtedly they do. Could it be better? Of course it could, and it is probably getting better, especially with the increased use of information about nutrition and healthfulness of food products. Do farmers and marketers receive fair values for their contributions? Probably so, at least if you base your conclusion on the availability of adequate supplies of food of adequate quality and in reasonable variety. In addition, most would conclude that food marketing firms receive reasonable, though not extravagant, returns for their investments. The case for farmers is less clear; certainly their profits are not excessive. For U.S. farmers whose major occupation is farming, household net farm incomes in 1991 averaged $10,228 from gross cash farm income of $94,027 and farm assets valued at $491,241 (USDA-ERS. 1993. *Agricultural Income and Finance - Situation and Outlook Report.* Economic Research Service, USDA, AFO-49).

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Fruit Notes

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Fruit Notes

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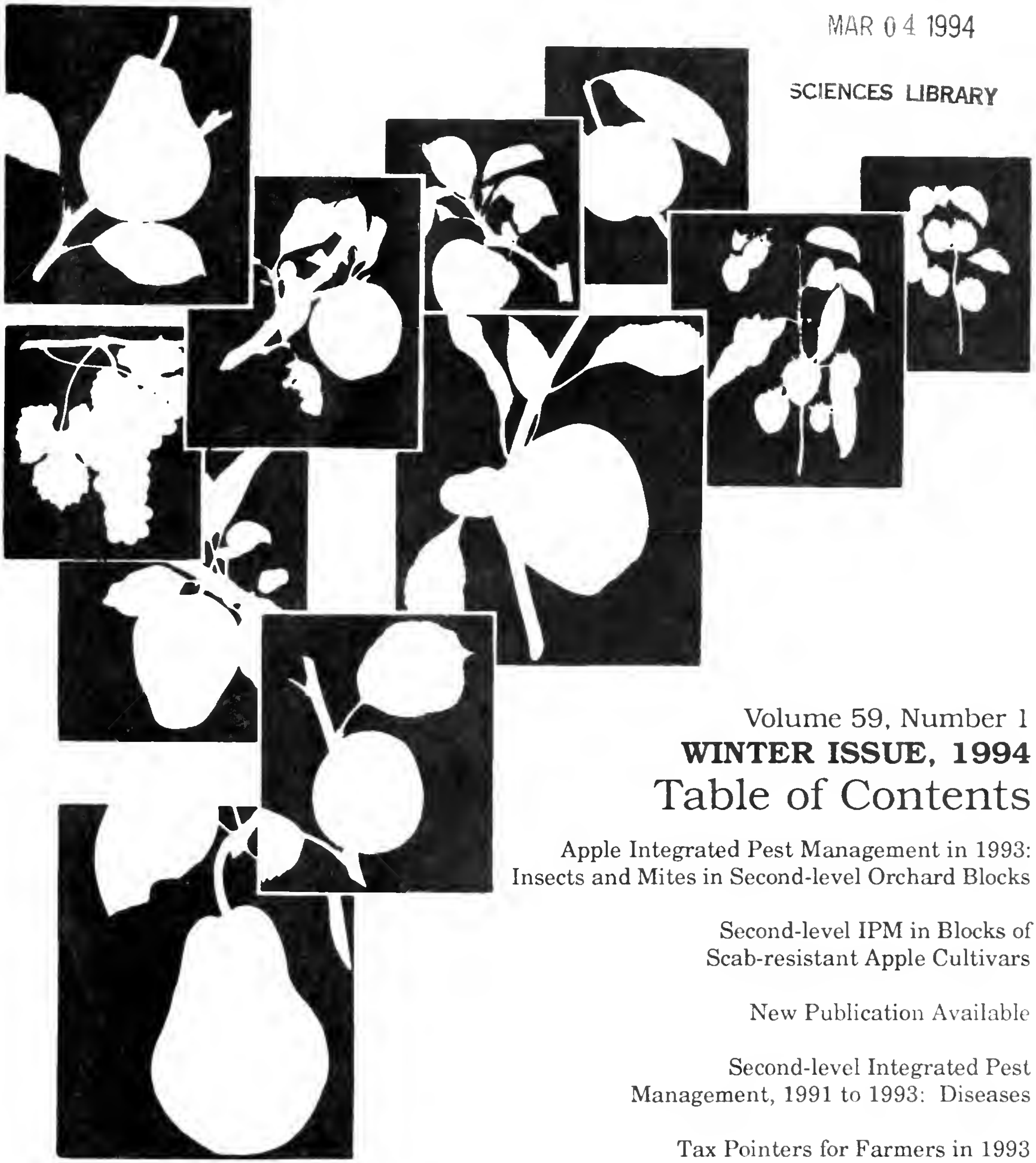

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COOPERATIVE EXTENSION SYSTEM POLICY:

Apple Integrated Pest Management in 1993: Insects and Mites in Second-level Orchard Blocks

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Department of Entomology, University of Massachusetts

For the past two years we have reported results of our ongoing program of second-level IPM trials in Massachusetts apple orchards. Under second-level IPM, orchard management is integrated across all classes of pests: insects, mites, diseases, weeds, and vertebrates, rather than focusing on a single type of pest. Here we report results of the third year of second-level IPM trials on insects and mites in commercial Massachusetts orchards.

Insect and mite management under second-level IPM practices require application of three to four selective insecticide sprays from April to early June to manage tarnished plant bug (TPB), European apple sawfly (EAS), plum curculio (PC), green fruitworm (GFW), and the first generations of codling moth (CM), lesser appleworm (LAW), leafminer (LM), and white apple leafhopper (WALH). Insecticide application to the interior of the block ceases after the final plum curculio spray in early June, hopefully allowing populations of predatory insects and parasitoids to increase to levels sufficient to provide control of summer populations of foliar pests. In **full second-level IPM blocks**, apple maggot flies (AMF) are controlled by perimeter interception traps. In **transitional second-level IPM blocks**, use of AMF interception traps is replaced by perimeter-row spraying with Guthion™ or Imidan™ every three weeks beginning in early July. In both types of blocks, removal of unmanaged apple and pear trees within 100 yards of each block reduces immigration of CM and LAW. Removal of drops during and after harvest discourages buildup of within-orchard populations of AMF, CM, and LAW.

We believe there are at least four distinct potential benefits of employing biologically-based methods as a substitute for insecticides from early June until harvest. These include reduction in insecticide residue on fruit at harvest, reduction in impact of insecticide on areas bordering orchards, reduction in selection pressure leading to pest resistance to insecticides, and buildup of beneficial natural enemies in the absence of insecticide use after early season sprays. For some growers and some intended markets, one or more of these potential benefits could be important in the near future, if not now.

In 1993, we continued work in the same six full and six transitional second-level IPM test blocks used in 1991 and 1992. Each second-level block was matched with a nearby control block that was managed by the grower, using first-level IPM methods.

Early-Season Fruit-injuring Pests

For control of arthropod pests active up to early June, second-level IPM relies on early-season pesticide treatment based on monitoring. We monitored each orchard weekly beginning in mid-April, then biweekly from mid-June through September. Five each of four types of sticky traps were hung in each block to monitor for TPB, LM, and EAS. We examined 100 or 200 leaves or watersprouts per block for LM, LH, aphids, mites, and mite predators. During PC season, scouts examined fruit on perimeter trees for evidence of fresh injury, while growers were urged to do likewise on a daily basis. On the basis of this monitoring, recommendations were made to the grower for treatment of the experimental block.

In second-level IPM blocks (both full and transitional) in 1993, combined injuries from early- season fruit pests were rather similar to those in nearby first-level IPM (grower control) blocks. In both first- and second- level IPM blocks, TPB caused by far the most damage, followed by PC and EAS (Table 1). Due to a lack of alternatives to pesticidal control of early-season fruit pests, both first- and second-level blocks had similar management and therefore similar insecticide use (Table 2). This year saw a marked increase in TPB damage over 1992 in all blocks, though injury due to PC and EAS remained similar.

Table 1. Average percent injury by early-season insect pests in second-level and first-level IPM blocks in 1993.*

Type of block	TPB	PC	EAS	GFW	Total
Full second-level	7.0 a	0.3 a	0.1 a	0.0 a	7.4 a
First-level	6.5 a	0.1 a	0.1 a	0.0 a	6.7 a
Transitional second-level	2.6 a	0.3 a	0.1 a	0.0 a	3.0 a
First level	1.2 a	0.3 a	0.1 a	0.0 a	1.6 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each cultivar present in both second-level and corresponding first level blocks were sampled at harvest. All blocks contained at least 1 of the following cultivars, and some contained up to 3 of these: McIntosh, Cortland, Delicious, Empire, Golden Delicious. Average number of fruit sampled per block = 500. When sampling a cultivar, we examined 10 fruit on each of 20 interior trees and 10 on each of 10 perimeter-row trees (when cultivar present on a perimeter row). TPB = tarnished plant bug; PC = plum curculio; EAS = European apple sawfly; GFW = green fruitworm.

Table 2. Dosage equivalents (spray events in parentheses) of insecticides and acaricides used in second-level and first-level IPM blocks in 1993.*

	Fruit pests		Mites				
Type of block	Before mid-June	After mid-June	Oil	Other miticides	LH	ABLM	Total
Full second-level	2.7 (3.3)	0.0 (0.0)	1.4 (2.5)	1.0 (0.8)	0.2 (0.3)	0.3 (0.5)	5.6 (7.4)
First-level	2.7 (3.3)	1.0 (2.2)	1.0 (2.1)	1.2 (1.3)	0.2 (0.2)	0.0 (0.0)	6.1 (9.1)
Transitional second-level	2.2 (3.2)	0.7 (3.2)	1.1 (2.2)	0.5 (0.6)	0.0 (0.0)	0.2 (0.2)	4.7 (9.4)
First-level	2.2 (3.0)	1.2 (2.8)	1.5 (2.5)	1.7 (1.5)	0.0 (0.0)	0.0 (0.0)	6.6 (9.8)

* LH = leafhopper, ABLM = apple blotch leafminer.

Summer Fruit-injuring Pests: Full Second-level IPM

Odor-baited sticky red spheres were hung every five yards on perimeter apple trees of each full second-level experimental block to intercept immigrating AMF. These were baited with both butyl hexanoate, a synthetic fruit odor deployed in polyethylene vials, and ammonium acetate, a synthetic food odor released through a Consep™ membrane. Traps were cleaned biweekly, based on data from 1992 suggesting a loss of capturing power with increase of length of time between cleanings.

Interception trap captures averaged 5023 in the six full second-level blocks, as compared with 2430 in 1992 and 3562 in 1991, indicating that AMF pressure was exceptionally high in 1993. Even so, captures of AMF on four interior unbaited monitoring traps (indicative of AMF penetration into the block interior) were similar in full second-level blocks and nearby first-level blocks (Table 3). AMF injury to fruit at harvest averaged slightly but not significantly greater in second-level than first-level blocks (0.7 vs. 0.3) (Table 3). The power of interception traps for controlling AMF is illustrated in one full second-level block of 10 acres where more than 21,000 AMF were captured on the traps but less than 1% of McIntosh, Cortland, and Delicious apples were injured by AMF. It should be noted, however, that late-ripening cultivars (e.g., Delicious and Golden Delicious) consistently have proven to be more susceptible to AMF injury than mid- or earlier-ripening cultivars under full second-level practices.

The problem of effective control of AMF in late-ripening cultivars remains a challenging one for us. In one block that suffered 8% AMF injury to Cortlands in late September of 1992, we hung perimeter traps significantly higher in the tree in 1993 than in 1992 in an attempt to increase trap captures of AMF before fruit injury occurred. We found only 1% AMF damage to the Cortlands at harvest this year, though it should be noted that the fruit was

Table 3. Season-long apple maggot fly (AMF) injury and trap captures in second-level IPM blocks and first-level IPM blocks in 1993.*

Type of block	AMF injury to fruit at harvest (%)	Interior monitoring trap captures per trap	Perimeter monitoring trap captures per trap	Interception trap captures per block
Full second-level	0.7 a**	7.7 a	22.9 a	5023
First-level	0.3 a**	11.0 a	10.7 a	---
Transitional second-level	0.8 a	8.4 a	8.8 a	---
First-level	0.4 a	9.7 a	9.7 a	---

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each cultivar present in both second-level and corresponding first-level blocks were sampled at harvest. All blocks contained at least one of the following cultivars, and some contained three of these: McIntosh, Cortland, Delicious, Empire, Golden Delicious. Average number of fruit sampled per block = 500. When sampling a cultivar, we examined 10 fruit on each of 20 interior trees and 10 on each of 10 perimeter-row trees (when cultivar present on a perimeter row).

** Data on AMF injury to fruit from one orchard have been excluded due to excessively high late-season damage to several cultivars in both the second and first-level blocks possibly caused by lack of AMF control methods by grower in surrounding blocks.

picked slightly earlier than in 1992. In other blocks, problems with AMF arose in cases where perimeter rows were comprised of early ripening cultivars, necessitating immediate movement of interception traps to interior trees upon harvest. Due to time constraints we wereunable to move the spheres soon enough after harvest, allowing injury to occur in later-ripening cultivars.

We continue to look for an appropriate method of hanging ammonium acetate membranes that will keep their fluttering motion to a minimum so as not to scare AMF away. This year we attempted to stitch a wire through the top of the membrane packet only to find that the contents drained out within a few weeks.

Table 4. Fruit injury by codling moth (CM), leafrollers (LR), and lesser appleworm (LAW) in second-level and first-level IPM blocks in 1993.*

Type of block	CM	LR	LAW
Full second-level	0.2 a	0.8 a	0.4 a
First-level	0.0 a	1.0 a	<0.1 a
Transitional second-level	0.1 a	0.7 a	0.4 a
First-level	0.0 a	0.2 a	0.0 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. Two hundred fruit of each cultivar present in both second-level and corresponding first level blocks were sampled at harvest. All blocks contained at least 1 of the following cultivars, and some contained 3 of these: McIntosh, Cortland, Delicious, Empire, Golden Delicious. Average number of fruit sampled per block = 500 When sampling a cultivar, we examined 10 fruit on each of 20 interior trees and 10 on each of 10 perimeter-row trees (when cultivar present on a perimeter row).

Fruit injury by CM, LR, and LAW were similar in second-level and first-level blocks (Table 4). CM averaged 0.2% in the second-level blocks while it was 0% in the adjacent first-level blocks. Leafroller injury was up from 1992, averaging 0.8% in second-level and 1.0% in first level blocks. LAW injury also increased, averaging 0.4% in second-level blocks and less than 0.1% in first-level blocks.

No insecticide was applied against any fruit-injuring pest after mid-June. In adjacent first-level blocks growers applied an average of 1.0 dosage equivalents of insecticide against fruit pests after mid-June and sprayed the block an average of 2.2 times (Table 2).

Summer Fruit-injuring Pests: Transitional Second-level IPM

Every three weeks after early June, perimeter row apple trees in transitional second-level blocks were treated with insecticide to control AMF. The block interior remained free of insecticide after early June. AMF injury at harvest averaged 0.8% in transitional second-level blocks and 0.4% in nearby first-level blocks, somewhat higher for both types of blocks than in 1992 (Table 3). Captures of AMF on interior unbaited monitoring traps were similar in transitional second-level blocks and in first-level blocks. Total insecticide used after early June averaged 0.7 dosage equivalents in second-level blocks compared with 1.2 dosage equivalents in first-level blocks (Table 2). The relative similarities between the two sets of blocks may be explained by some growers using exclusively border row sprays for AMF in first-level blocks, mainly due to financial constraints.

CM damage was very low in both types of blocks (0.1% or less). Both LR and LAW injury were somewhat (but not significantly) greater in the transitional blocks (0.7 and 0.4%) than in the first-level blocks (0.2 and 0%) (Table 4).

Foliar Pests and Predators: Full Second-level IPM

In 1992, we reported peak populations of foliar pests; this year we return to season-long averages from time of first to last appearance of the pest on foliage. Hot, dry weather played a major role in inciting higher foliar pest populations in 1993.

Table 5. Seasonal average populations of mites and mite predators in second-level and first-level IPM blocks in 1993. *

Type of block	Mite presence (% of leaves) ERM+ TSM	Af	YM	Ratio of ERM+TSM to Af
Full second-level	22.4 a	0.7 a	4.3 a	32:1
First-level	18.6 a	2.0 a	4.5 a	9:1
Transitional second-level	19.6 a	2.1 a	3.1 a	9:1
First-level	16.2 a	1.0 a	1.2 a	16:1

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. ERM = European red mite; TSM = two-spotted mite; Af = Amblysieus fallacis; YM = yellow mite.

Table 6. Foliar insect pest average population levels in second-level and first-level blocks in 1993.*

Type of block	PLH	WALH	RLH	ABLM	GAA	GAAP	WAA
Full second-level	8.9 a	4.2 a	7.5 a	8.0 a	28.7 a	17.1 a	8.1 a
First-level	6.7 a	4.2 a	2.4 a	17.2 a	27.1 a	13.4 a	7.6 a
Transitional second-level	6.4 a	2.2 a	2.4 a	6.8 a	35.3 a	19.0 a	4.3 a
First-level	6.9 a	1.4 a	0.8 a	4.4 a	28.9 a	10.1 a	4.5 a

* Means in each couplet in each column followed by a different letter are significantly different at odds of 19:1. PLH = potato leafhopper, WALH = white apple leafhopper; RLH = rose leafhopper, ABLM = apple blotch leafminer; GAA = green apple aphid; GAAP = green apple aphid predators: cecidomyiids and syrphids, WAA = woolly apple aphid. PLH, WALH, and RLH data are average percentages based on bi-weekly samples of 100 or 200 fruit cluster or terminal leaves. ABLM data are the average number of mines per 100 leaves based on bi-weekly samples of 100 or 200 fruit cluster or terminal leaves. GAA, GAAP, and WAA data are percentage watersprouts infested based on bi-weekly samples of 200 watersprouts.

Mite populations were high in most orchards, appearing early in the season (Table 5). In several orchards mite problems in second-level blocks may have been inadvertently assisted by our setting aside of small areas (approximately one acre) in the block to be left untreated with dormant oil. This was done in the hope of providing a reasonable food source for early phytoseiid mite predator populations. Unfortunately *Amblyseius fallacis* suffered extremely heavy late winter mortality, and these areas proved useful only for raising large numbers of European red mites. Yellow mite predators were eventually present in large numbers in some orchards. There tended to be little difference, however, in densities of mite predators between full-second-level and first-level blocks (Table 5). *Typhlodemus pyri* obtained from Geneva, New York were released in two blocks in 1992 and again this past summer. Repeated sampling of the release sites leads us to believe that both attempts at colonization were unsuccessful.

Full second-level blocks were treated with slightly higher dosage equivalents of pre-bloom and mid-season oil than nearby first-level blocks (1.4 vs. 1.0) while receiving slightly less other miticide (1.0 vs. 1.2 dosage equivalents) (Table 2). The use of post-bloom miticides in the full second-level blocks was mainly due to a need to regain control over mite populations in the areas that did not receive oil in the spring.

White apple leafhopper populations were equal in both the full second-level and first-level blocks. Potato leafhoppers were slightly, although not significantly, higher in the full second-level blocks. The major leafhopper problem this year proved to be rose leafhopper (RLH) migrating into blocks from bordering wild rosebushes and brambles. In several locations RLH were present in high enough numbers to be a major irritation at harvest, and one full second-level block required late season treatment of insecticidal soap. RLH averaged 7.5 % infestation in full second-level blocks, versus 2.4% infestation in the first-level blocks (Table 6).

Average leafminer populations were lower, although not significantly, in full second-level blocks than in first-level blocks (Table 6). Dimilin™ was used in three of the six full second-level blocks against overwintering LM adults and eggs even though only two of these blocks required a treatment. Late stage tissue mines were collected from each orchard and brought back to the lab for parasitism readings. The average parasitism rate of second generation larvae was 55% in full second-level blocks but only 37% in first level blocks. Research into parasitism of LM continues to be an area of interest in that parasitism appears a potentially very effective means of controlling one of our major foliar pests.

Green apple aphids infested 29% and 27% of the watersprouts in full second-level blocks and in first-level blocks, respectively. Levels of two aphid predators were also similar in both types of blocks, and achieved efficient control of GAA. Levels of woolly apple aphids on watersprouts were also similar in both types of blocks, but were considerably higher than in 1992.

Foliar Pests and Predators: Transitional Second-level IPM

Mite levels were moderate to high in most of the transitional second-level blocks and adjacent first-level blocks. Dosage equivalents of oil averaged 1.1 in second-level blocks and 1.5 in first-level blocks. Other miticide applications averaged 0.5 dosage equivalents in second-level blocks and 1.7 dosage equivalents in first-level blocks. Mid-season miticide application occurred in one second-level block as compared to three first-level blocks (Table 2).

White apple leafhopper and potato leafhopper populations were about the same in second-level and first-level blocks. RLH levels were less of a problem in transitional second-level blocks than in full second-level blocks, possibly becauseperimeter row insecticide applications every three weeks during the summer killed immigrating RLH.

Only one transitional second-level block was treated with Dimilin™ against first generation leafminers. Leafminer numbers were slightly higher in second-level blocks than in first-level blocks, yet the parasitism of second generation larvae was slightly lower (38% vs. 44%). LM levels were similar to those found in 1992.

Green apple aphid infestation levels were somewhat higher in second-level blocks than in first-level blocks, as were both types of aphid predators monitored. In both types of blocks predators were sufficient to provide control of GAA populations. Woolly apple aphid populations were similar in both types of blocks (Table 6).

Conclusions

With regard to full second-level IPM practices that involve substitution of cultural, behavioral, and biological control methods for insecticide use after early June, we conclude the following after three consecutive years of implementation.

(1) No buildup of codling moth or leafroller beyond a level existing in nearby first-level IPM blocks.
(2) Slight buildup of lesser appleworm in 1993.
(3) Slightly greater injury by apple maggot flies, especially in late-ripening cultivars.
(4) No buildup of pest mites under slightly reduced miticide use but insufficient buildup of predatory mites to permit truly substantial reduction in miticide use.
(5) Considerable buildup of parasitoids of leafminers, possibly sufficient to reduce or eliminate need for spray against leafminers.
(6) No buildup of apple aphids, woolly apple aphids, or white apple leafhoppers beyond acceptable levels.
(7) Substantial mid- and late-summer immigration (into some blocks) of rose leafhoppers from nearby rose bushes and brambles, causing excrement spotting of fruit and nuisance to pickers.

With respect to transitional second-level IPM practices that involve no application of insecticide to the block interior after early June but rely on perimeter-row sprays instead of traps for controlling apple maggot flies, we conclude the following after three consecutive years of implementation.

(1) No buildup of codling moth but slightly more injury by leafrollers compared with nearby first-level IPM blocks.
(2) Slight buildup of lesser appleworm in 1993.
(3) Slightly greater injury by apple maggot fly.
(4) No buildup of pest mites under slightly reduced miticide use but not enough buildup of predatory mites to allow much reduction in miticide use.
(5) No buildup of parasitoids of leafminers.
(6) No buildup of apple aphids, woolly apple aphids, or white apple leafhoppers beyond acceptable levels.
(7) No unacceptable immigration of rose leafhoppers during mid- and late-summer.

In sum, transitional second-level IPM offers an advantage over first-level IPM in terms of substantial reduction in pesticide use during summer months. Growers using transitional second-level IPM should, however, keep a careful eye on buildup of apple maggot, leafrollers, and leafminers. In the long run, we believe that if pesticide-treated spheres can be developed and registered as a substitute for sticky spheres to control apple maggot (see accompanying article), full second-level IPM will be as economical to employ and as effective in controlling pests as first-level IPM while offering several distinct advantages outlined in the introduction.

To verify further the advantages and shortcomings of second-level IPM, we plan to evaluate in 1994 the same full and transitional second-level practices in the same blocks used from 1991 to 1993. This will provide four consecutive years of data, which ought to be sufficient for drawing firm conclusions. We also plan to carry out intensive studies on refining those aspects of full second-level IPM that to date have proven to be shortcomings. These include: enhancing the residual effectiveness of pesticide-treated spheres; studying within-orchard movement patterns of apple maggot flies from early- to mid- to late-ripening cultivars; evaluating elimination of rosebushes and brambles near orchards as a means of controlling rose leafhopper; and evaluating the impact of summer applications of benomyl and mancozeb on mite predators, which we now believe may be the principal reason for lack of sufficient mite predator buildup to provide biocontrol of mites in second-level blocks.

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Second-level IPM in Blocks of Scab-resistant Apple Cultivars

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Previously, we have described methods designed to eliminate orchard applications of insecticide and miticide after early June. We have also described our concept of the evolution of integrated pest management (IPM) programs, moving from first level approaches which integrate methods for controlling one class of pests, to a second level which integrates methods for controlling all classes of orchard pests. In 1991, we initiated a second-level IPM program in 12 Massachusetts commercial apple orchards comprised of McIntosh, Cortland, Empire, and Delicious cultivars. Our strategy used pesticides from April to early June against early-season arthropod pests (particularly mites, plant bug, sawfly, and plum curculio), early-season disease pests (apple scab and blossom-end rot) and early-season weed growth beneath the tree canopy. After early June, the strategy called for few if any pesticide applications. Instead, cultural, behavioral, and biological control methods replaced pesticides. We felt that this strategy would allow natural enemies of arthropod pests to increase in numbers and provide biological control (especially of foliar-damaging arthropods), slow rates at which pests develop resistance to pesticides, and reduce potential human risks from pesticide residues on fruit at harvest.

Over the first two years of the program, we saw successes and some problems in all pest areas, but one of the most troublesome areas was disease management. In the second-level blocks, growers used 4.6 fungicide dosage equivalents (DEs) during the primary apple scab season. They also used 2.2 fungicide DEs to control summer diseases, notably flyspeck and sooty blotch. By comparison, in first-level IPM blocks, growers used 4.8 early-season fungicide DEs and 3.0 summer fungicide DEs. While the second-level blocks showed very modest fungicide savings, fungicide use still presented a major impediment in our efforts to reduce pesticide applications, particularly late in the season.

In addition to reducing risk to humans from exposure to pesticide residues, eliminating insecticides and miticides late in the season can assist pest control overall, since these materials oftne destroy natural enemies. Fungicides, however, also can have a negative impact on natural biocontrol. Benomyl is the best example, and has been shown to sterilize predaceous phytoseiid mites (Croft, 1990), and eliminating fungicides from an orchard can stimulate biocontrol (Bower et al., 1993). Furthermore, fungi that infect and kill insects and mites in the natural setting may be inhibited by fungicides (e.g., Loria et al., 1983; Tedders, 1981). Additionally, there appear to be some pesticide impacts on spiders, which may play a role in mite biocontrol (Wisniewska et al., 1993). Therefore, it is worth examining the effect of fungicide reduction or elimination in the orchard.

One approach to fungicide reduction is to use scab-resistant apple cultivars (SRCs). Our experiences (in the Northeast Apple Sustainable Agriculture Research and Education Project and in our own blocks) indicate that SRCs at leastwill allow the elimination of scab fungicides. The degree to which SRCs will allow us to eliminate summer fungicides needs to be determined. However, we sought to test the effects of fungicide elimination in second-level blocks, and in 1993, we added genetic control (host plant resistance) to the tactics of cultural, behavioral, and biological apple pest management. Specifically, we emphasized a second-level IPM approach in three commercial orchards having two-acre blocks of SRCs, primarily Liberty and Priscilla. The SRCs were propagated on M.26 rootstock and planted in 1988.

We also introduced a new technique to tackle another problem: the need to clean red sphere maggot traps frequently. Sticky red spheres have been used in second-level IPM to trap apple maggot flies at the orchard perimeter. For the first time in any commercial orchard, we used pesticide-treated spheres as a substitute for sticky-coated spheres as a behavioral method of controlling apple maggot flies.

Each of the three blocks was divided in half. With respect to arthropods, one half was managed under first-level IPM practices that involved monitoring pest abundance and weather and then applying pesticide as dictated by monitoring information. The other half was managed as follows.

Arthropods

Two applications of superior oil were made before bloom against overwintering European red mite eggs followed by two applications of phosmet or azinphosmethyl against European apple sawfly and plum curculio (one at petal fall in mid-May and one two weeks later in late May). All unmanaged wild apple trees within 100 yards of the block perimeter were cut down as a cultural method of controlling codling moth by reducing or preventing immigration of females from nearby wild host trees (very few codling moth females appear to disperse 100 yards or more within their lifetime under northeastern US conditions). Odor-baited pesticide-treated eight-cm wooden red spheres were hung five to six yards apart on perimeter trees in late June as a behavioral method of controlling apple maggot flies. Two types of odor baits were used: semi-permeable membranes that released the food-type attractant ammonium acetate, and polyethylene vials that released the fruit-type attractant butyl hexanoate. Odor baits were hung a few inches from spheres and released attractive odor over the entire three-month period of trap use. Prior to emplacement, the spheres were dipped in a mixture of 40% latex paint, 44% corn syrup, 15% water, and 1% Cygon (dimethoate). The latex paint allowed dimethoate to be released very slowly on the sphere surface. Periodic tests showed that, provided the sphere surface contained sufficient sucrose as a feeding stimulant, 70% or more of alighting flies died. This was true even in late September, three months after initial treatment with dimethoate; however, rainfall can wash away the corn syrup. Without it, flies did not feed and therefore did not acquire a fatal dose of dimethoate. Hence, we or the growers were obliged to dip each sphere in a 20% aqueous solution of table sugar after every rainfall. Following harvest, drops were removed to decrease within-orchard buildup of codling moth and apple maggot.

Diseases

No fungicide was applied in the SRC blocks. We simply eliminated fungicides from the management program, in spite of the expectation that there would be some damage from flyspeck and sooty blotch. Most trees had not yet reached full maturity and had

Table 1. Numbers of insecticide and miticide treatments and percent arthropod-injured fruit at harvest* in three blocks of scab-resistant cultivars under first-level versus second-level IPM management.

	Number of applications	
Pesticide	First-level	Second-level
Insecticide	4.0	2.0
Miticide	2.0	2.0
	Injured fruit (%)	
Pest	First-level	Second-level
European sawfly	0.2	0.6
Plum curculio	0.3	0.8
Codling moth	0.0	0.0
Lesser appleworm	0.1	0.0
Leafroller	0.3	2.5
Apple maggot	0.1	0.3
Total insect	1.0	4.2

* Four hundred fruit per block were sampled at harvest.

comparatively open canopies that do not show a significant disease response to summer pruning, therefore we did not summer prune the blocks for disease management.

In order to compare disease impacts of the SRC systems and a conventional IPM system, we observed disease incidence in conventional cultivars under normal first-level IPM practices using a block on each of the three farms consisting of conventional cultivars (McIntosh, Cortland, Delicious). We did not compare these blocks to the SRC blocks for management of and damage by arthropod pests.

Table 2. Mean number of fungicide treatments and mean percent disease-injured fruit at harvest* in three orchards comparing three systems: conventional cultivars under first-level IPM; scab-resistant cultivars under first-level IPM; and scab-resistant cultivars under second-level IPM.

	Number of applications		
Pesticide	Standard cultivars first-level	SRCs first-level	SRCs second-level
Fungicide	8.0	0.0	0.0
	Diseased fruit (%)		
Pest	Standard cultivars first-level	SRCs first-level	SRCs second-level
Apple scab	0.1	0.0	0.0
Blossom end rot	0.1	0.0	0.0
Sooty blotch	0.1	7.0	7.3
Fly speck	0.4	5.0	4.1
Total disease	0.7	12.0	11.4

* Four hundred fruit per block were sampled at harvest.

Pesticide Use and Injury

Table 1 shows the mean number of miticide and insecticide treatments applied to each block. Table 1 also shows the mean number of arthropod-injured fruit at harvest. We focus here on fruit injury initiated after early June, the time when second-level IPM practices against insects diverged from first-level IPM practices. Injury by apple maggot was slightly greater and injury by leafroller was substantially greater in second-level compared with first-level blocks. Very little injury by codling moth or lesser appleworm occurred in these blocks. Not shown are fruit injury levels caused by larvae in one orchard that we identified as apple pith moth larvae. This injury was slightly greater in the second-level block, but definitive identification of the larvae (new to us) is pending.

Table 2 shows the number of fungicides applied in the SRC blocks and the conventional blocks, as well as the disease incidence in each block type. Sooty blotch and flyspeck damage far exceeded any other fruit injury in each block type. This result was not surprising, since several observations have shown that in orchards which receive no fungicides in Massachusetts, there will be significant levels of sooty blotch and flyspeck at harvest. In blocks of standard cultivars, fungicide applications greatly reduced sooty blotch and flyspeck damage, but flyspeck remained the most damaging disease.

Table 3 shows mean abundance of principal arthropod pests of the foliage and their principal natural enemies. Notable among pests is the lower average European red mite population but the higher average white apple leafhopper and rose leafhopper populations in the second-level blocks. Notable among natural enemies is the substantially

Table 3. Mean percent sampled leaves* infected with arthropod foliar pests and their natural enemies in 3 blocks of scab-resistant cultivars under first-level vs. second-level IPM management.

	Infested leaves (%)	
Foliar pest	First-level	Second-level
Apple aphids	21	13
Leafminers (2nd gen.)	29	36
European red mites	29	18
White apple leafhoppers	5	10
Rose leafhoppers	2	8
	Infested leaves (%)	
Natural enemies	First-level	Second-level
Aphid predators	7	5
Leafminer parasatoids (2nd gen.)	46	71
Phytoseiid mite predator	4	7
Stigmaeiid mite predator	38	66

* Samples of 200 leaves per block were taken at bi-weekly intervals from mid-June to mid-September.

greater incidence of leafminer parasitoids and mite predators (particularly Stigmaeiid yellow mites) in the second-level blocks.

Conclusions

Our findings in this first year of applying second-level IPM practices to blocks of scab-resistant cultivars indicate promise as well as some potential problems for future application. Among arthropods, the most promising aspectswere the success of pesticide-treated spheres in controlling apple maggot flies, the very low incidence of codling moth and lesser appleworm, and the buildup of leafminer parasitoids and mite predators (particularly yellow mites).

Among diseases, the most promising aspects were (not surprisingly) the absence of apple scab and blossom end rot. The most problematic aspects were buildup of leafroller (exclusively oblique-banded) and flyspeck.

From the perspective of arthropod management, use of pesticide-treated spheres is the key element of second-level IPM. These spheres are far simpler to prepare and maintain than sticky spheres. The only real problem (aside from gaining EPA registration for use) involves the current necessity of dipping the sphere in aqueous sugar solution after each rainfall. This is a rapid process: 10 minutes to remove, dip and re-hang one acre's worth of spheres. But if it is not done almost immediately after rainfall has ended, there is no protection against apple maggot fly invasion. In 1993, there were several unavoidable lapses of a day or two in dipping spheres after rainfall, possibly accounting for the slightly greater amount of maggot injury in second-level blocks. We need to find a new polymer capable of releasing sucrose at a slow rate rather than losing all of the sucrose during rainfall.

With regard to leafrollers and flyspeck, virtually all of the injury in 1993 was restricted to just one of the three orchards. Another of the orchards had almost all of the leafhoppers found; invading rose leafhoppers at harvest were especially troublesome. Perhaps the vegetation surrounding these orchards harbored substantial "inocula" of these two pests. This demands further study.

Our experience in 1993 suggests much promise for applications of low-labor second-level IPM practices in scab-resistant blocks. If we can keep sucrose on pesticide-treated spheres during rainfall and control flyspeck, leafroller, and leafhoppers using habitat management and early-season fungicides, then foliar pests such as mites and leafminer might be controlled solely through natural enemies. As a result growers would no longer need to apply any pesticide in scab-resistant blocks after early June.

Aknowledgements

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New Publication Available

In June, 1993 the Sixth International Controlled Atmosphere Research Conference was held at Cornell University, Ithaca, New York. Presentations at this three-day conference covered recent developments in use of modified (MA) and controlled (CA) atmospheres during storage and shipment of fruits, vegetables, and flowers.

Proceedings of this conference are now available. They are divided into two volumes, totaling nearly 900 pages. The first volume includes biochemical changes that occur during MA and CA, use of MA and CA during transport, recent engineering and equipment developments, and new information on disease and insect control during MA and CA. The second volume focuses on current research on CA storage of specific fruits, vegetables, and flowers. It concludes with three summary sections that present precise, current recommendations for MA and CA conditions for (1) vegetables, (2) apples, pears, and noshi (Asian pears), and (3) other fruits.

These Proceedings are available for $85.00 from the Northeast Regional Agricultural Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701. They are of great value to persons with interest in the application of MA and CA to storage and handling of horticultural crops.

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Second-level Integrated Pest Management, 1991 to 1993: Diseases

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Over the past three seasons, we have been attempting to develop disease-management strategies for apple which will both optimize fungicide use against diseases and integrate pest management across disciplines. The approach relies heavily on monitoring pathogen development for two key apple diseases, using cultural approaches to manage these diseases, and using fungicides which will have the least non-target effects. It is obvious that management of diseases in apples without fungicides is not possible, but we feel that it is possible to improve the efficiency of summer fungicide use by developing a better understanding of and appropriate monitoring techniques for summer disease pathogens, particularly the flyspeck fungus, and such efficiencies, combined with second-level arthropod management methods (e.g., Christie et al., 1992) may reduce the impact that pesticides have on mites and other non-target arthropods (Wisniewska et al., 1993). This article summarizes the results of the program in commercial blocks consisting of scab-susceptible cultivars. Other aspects of the research, dealing with summer pruning for disease management, flyspeck epidemiology, and the effects of the second-level IPM approach in blocks of scab-resistant apples, are reported separately.

Early Season Management

For purposes of disease management, the apple production season can be divided into two parts. These parts coincide closely with the two parts of the season used in second-level arthropod management. For diseases, early season management focuses on apple scab. We have used a delayed sterol inhibitor program (Cooley and Spitko, 1992) enhanced by measurement of potential ascospore dose (PAD). For the purposes of second-level IPM, we have used a threshold of 500 ascospores per square meter (Dr. William McHardy, pers. comm.). PAD data were not available for 1991, because funding was not available in the fall of 1990 when such assessments would have been done.

Table 1. Fungicide use (dosage equivalents) in 1991 through 1993.

Year	Treatment	Total	Primary	Summer
1991	Test	5.9	4.8	1.1
	Check	6.8	5.0	1.8
1992	Test	7.5	4.3	3.2
	Check	8.5	4.5	4.1
1993	Test	6.8	5.3	1.5
	Check	6.6	4.5	2.2
All	Test	6.7	4.8	1.9
	Check	7.3	4.7	2.7

Summer Management

After primary scab season, which usually ends by mid-June, the main diseases concern in apples are the summer diseases, typically sooty blotch and flyspeck. At the

Table 2. Potential ascospore dose (PAD) and scab incidence (%) by block in second-level IPM blocks in 1992 and 1993.

		Block number											
	Year	1	2	3	4	5	6	7	8	9	10	11	12
PAD	1992	2041	37	2578	300	368	19	11	21	183	166	10	0
	1993	6131	14338	2765	1864	1537	2992	30	12	5333	0	0	0
Scab	1992	1.0	0.5	0.5	1.5	0.0	1.0	0.0	0.0	2.0	0.8	0.0	0.5
	1993	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0

beginning of this project, we had limited data suggesting that summer pruningcould reduce or eliminate the need for fungicides in the summer. We have described the results of this work elsewhere (Cooley et al., 1992). We have concluded that summer pruning reduces flyspeck and sooty blotch on trees with dense canopies, but additional measures are necessary to reduce levels below economic thresholds. In 1993, we focused summer fungicide applications on primary inoculum for flyspeck, which was released during June and early July. Our program recommended no fungicides after June in second-level IPM blocks.

Results

From the disease perspective, the terms "full" and "transitional" second-level blocks referred to in other articles was of minor importance, and the data from both are combined here. During the early season, the fungicide use in all blocks generally was the same (Table 1). In 1991 and 1992, similar fungicide use occurred in second-level blocks as in conventionally managed (check) blocks in the primary season. In 1993, somewhat more fungicide was used in primary season in the second-level blocks. There are two factors which contributed to this trend. First, the delayed SI program has received wide-spread adoption in all orchards, which often use first level IPM. This being so, we would expect few differences between checks and second-level blocks in terms of primary season fungicides. Second, in 1993, high levels of inoculum in many second-level blocks led to recommendations for an extra fungicide application near the half-inch green stage, and more frequent use of scab fungicides in general.

Table 2 shows the increase in PAD from 1992 to 1993. Two orchards exceeded the PAD threshold in 1992, and seven exceeded it in 1993. There was no

Table 3. Disease incidence (%) in 1991 through 1993.

Year	Treatment	Scab	Flyspeck	Sooty blotch	Blossom end rot
1991	Test	0.3	4.3	0.3	0.0
	Check	0.7	3.6	0.8	0.3
1992	Test	1.2	4.0	0.1	0.1
	Check	0.6	0.8	0.0	0.1
1993	Test	0.2	6.7	0.1	0.0
	Check	0.1	4.1	0.1	0.1
All	Test	0.6	5.0	0.2	0.0
	Check	0.5	2.8	0.3	0.2

Table 4. Flyspeck incidence (%) in second-level IPM blocks in early and late season harvests in 1991 through 1993.

Year	Treatment	Before 9/15	After 9/15
1991	Test	1.5	22.3
	Check	1.5	18.8
1992	Test	1.3	8.9
	Check	1.3	0.0
1993	Test	0.3	7.9
	Check	0.2	5.0
All	Test	1.0	13.0
	Check	1.0	7.9

correlation, however, between PAD and scab incidence in the blocks. Also, there was no correlation between scab on fruit in 1992 and PAD in 1993, indicating the danger of trying to use fruit scab incidence to predict scab inoculum in the orchard.

Summer fungicide use was higher in the check blocks than in the test blocks (Table 1), with check blocks receiving about 0.8 DE more than the test blocks. Flyspeck, however, was nearly twice as great in the test blocks compared to check blocks, though sooty blotch incidence was similar in both block types (Table 3). There was no correlation between the DEs of summer fungicide and flyspeck. The time of harvest was critical to flyspeck incidence (Table 4). Fruit harvested after September 15 were much more likely to have flyspeck than those harvested before that date. In fact, fruit harvested before September 15 (largely McIntosh) had virtually the same flyspeck incidence in either check or test blocks. In fruit harvested later (Delicious, Cortland, and Golden Delicious), the incidence of flyspeck was higher in test blocks than in checks, but the incidence in either block far exceeded that in the early harvest. From these results, two points stand out. First, our major cultivar, McIntosh, may get only marginal benefit from summer fungicide sprays. Second, minimal fungicide applications will control sooty blotch.

Fungicides present a particularly difficult problem to second-level IPM in apples. The nature of scab, and its potential for severe damage, limit options for further early season fungicide reductions; however, the potential for reducing summer fungicides remains good. We will need to examine the role that alternative hosts,such as brambles and roses, play in providing inoculum for summer diseases. Removing these hosts may make flyspeck management much easier. Relatively little fungicide is needed to control sooty blotch under our conditions. It may be possible to spray late-season cultivars selectively. Alternatively, if early fungicide applications can be used to delay the epidemic, even later season cultivars may be harvested before flyspeck develops. Certainly, weather will also guide fungicide applications in summer. There are many unanswered questions, but the prospect for at least reducing, and possibly eliminating, summer fungicides in Massachusetts appears good.

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Tax Pointers for Farmers in 1993

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Tax advice given below is intended as general advice and is believed to be correct. It does not substitute for a detailed review of the circumstances of an individual taxpayer by a professional tax practitioner.

The Revenue Reconciliation Act of 1993 (1993 RRA), enacted on August 10, 1993 contains a large number of changes to the tax laws. One complication is that some items are retroactive to 1992, some to the beginning of 1993, and some only take effect in 1994. To take advantage of the retroactive changes for 1992, you must submit an amended return (Form 1040X).

General Features

The most publicized aspect of the 1993 RRA is that more of the tax burden will be carried by higher income taxpayers. For example, the new 36% rate applies to married taxpayers filing jointly who have taxable income over $140,000 in 1993. They, as well as all other filers, would also pay a 39.6% rate on taxable income over $250,000. For estates and trusts the new rates affect taxable income over $5,000 and $7,500, respectively, effective January 1, 1993. Some changes affect all income levels. For example, business meals and entertainment expenses that were 80% deductible will only be 50% deductible, effective January 1, 1994. Some expiring laws are reinstated. For example, for estate and gift taxes, the 1993 RRA reinstates expiring law so that the top rates and the $600,000 exemption remain the same.

Health Insurance

If you were a self-employed person in 1992 (or an S-corporation shareholder) who deducted (on line 26 of your 1992 Form 1040) 25% of half of your health insurance premium you may now take 25% of all of your 1992 premium. The 1993 RRA reinstated the deduction retroactive to July 1, 1992. You may file for a refund on Form 1040X. The only exception is if your total medical expenses exceeded the 7.5% floor in your 1992 tax year and you already claimed the rest of the premium as medical expense on your 1992 Schedule A.

Example: Bill is self-employed. Bill and Jane file jointly, with 1992 taxable income of $21,400 and family health insurance premiums of $3000. They deducted $375 (1/2 of 25% of $3000) in 1992. They may now file Form 1040X and deduct a further $375.

In 1993, note that the eligibility for the 25% deduction for the health insurance premium is made on a monthly basis. Also, unless the law is further extended, the deduction will expire on December 31, 1993.

Example: If Jane had worked from November 1, 1992 until March 31, 1993 for an employer who provided subsidized health insurance for her and her family, none of the $3000 premium paid in 1992 would have been deductible on Form 1040. If the same premium was paid in 1993 then the amount allocated to the period January 1 to March 31 is ineligible for deduction on line 26 of Form 1040. The amount deductible is $562.50 (3/4 of 25% of $3000).

Charitable Contributions

Did you make charitable contributions of appreciated property in 1992 or 1993? Taxpayers subject to alternative minimum tax (AMT) may get some relief. Appreciated property is property that has a fair market value that exceeds its basis (which is usually your cost). Under the 1993 RRA, the appreciated amount (the difference between fair market value and adjusted basis) of property (real, tangible, and intangible) donated to a charity is no longer a tax preference item included in computing AMT income. The property must be used for the donee's tax-exempt purpose. The benefit does not apply to donations of inventory, other ordinary income property and short-term capital gain property.

Different kinds of property have different effective dates. For contributions of tangible personal property this potential tax saving is retroactive to July 1, 1992 (and therefore continues prior law).

Example: Earl donated a 10-year old tractor on August 1, 1992 to a charity that ships them to needy farmers overseas. The fair market value was $3,000 and his adjusted basis in the tractor (its cost less depreciation) was $2,000. Earl paid AMT in 1992. He entered $1000 on line 6a of Form 6251. If he still has some AMT liability after the adjustment he will save $240 (The AMT rate in 1992 of 24% on $1000). Earl can now file an amended return (Form 1040X) for 1992 claiming the $240 refund.

From January 1, 1993, the appreciated amount of donated real and intangible property will not be subject to AMT either.

Example: Arthur gave the development rights on a piece of land to an organization whose charitable purpose was to preserve land from development. The rights have a fair market value of $2000. Arthur claims $2000 of charitable deductions on Schedule A (provided his adjusted gross income is sufficient to prevent the percentage limitations on charitable deductions coming into effect). He reduces his basis in the land by $2000. There is no AMT tax preference item.

Effective January 1, 1994, single charitable donations of $250 or more may be deducted (on Schedule A) only if the charity provides you with written substantiation, including a good-faith estimate of the value of any good or service that you provided. If you donated money, you may not rely solely on a cancelled check as substantiation. Separate payments to the same charity (e.g., by withholding from wages) will be treated as separate contributions, even if they aggregate to more than $250.

Section 179 Expensing

The limit on election to expense certain tangible property (Section 179 expensing) is raised from $10,000 to $17,500 for tax years beginning after December 31, 1992. All other provisions remain the same, including reductions in the limit for purchases over $200,000 in any one year and carryover rules. However, the IRS has issued final regulations (T.D. 8455, effective date January 25, 1993) that provide clarification for some of the provisions. The main issue appears to be the need for, or at least desirability of, precise record keeping. If you have to carryover some Section 179 expense deduction, you must select the property or properties to which the carryover is allocated. The selection must be recorded in the year in which the properties are placed in service. If you fail to make and record the selection, the IRS will assume the carryover is apportioned according to cost.

Example: In 1993, Joe purchased a tractor for $20,000 and a baler for $10,000. He elected to deduct $17,500 ($12,500 on the tractor, $5,000 on the baler) but his taxable income was only $7,500 so he carried over $10,000. He recorded the carryover as $5,000 against the tractor and $5,000 against the baler. Had he not done so, the IRS would have assumed two-thirds ($6,667) for the tractor and one-third ($3,333) for the baler.

When only part of the carryover is used in a subsequent year, you must first use up the oldest carryover, but within the year, you may choose.

Example: If Joe purchases another $10,000 machine in 1994 and elects to expense the entire $10,000, he can only use $7,500 of carryover before reaching the annual limit (of $17,500). Assuming his taxable income in 1994 is at least $17,500, he might choose to take the baler carryover first ($5,000) and part of the tractor carryover, leaving $2,500 carryover on the tractor to go forward.

There is no limit on how long Section 179 deductions can be carried forward. However, if a property is sold, exchanged, or given away, unused section 179 carryover must be dealt with.

Example: (no gain or loss) Joe gives his baler to a relative in 1994. He took half-year depreciation in 1993 of $357 (1/2 of 1/7 of $5,000, assuming MACRS straight line depreciation) and $357 in 1994. His adjusted basis for the baler at time of transfer is $4,286 ($5,000 - $357 - $357). He must increase the basis at the time of transfer by the amount of Section 179 carryover ($5,000) and reduce his Section 179 carryover by the same amount. The recipient has an initial basis of $9,286 ($5,000 + $4,286).

Example: (gain on sale) Joe sells his baler in 1994 for $9,500. He has a gain on the sale of $214 ($9,500 - $9,286). His depreciation and Section 179 deduction is $714 (he actually took no Section 179 deduction on the baler in 1993). The amount to be recaptured on Form 4797 is the lesser ($214). Joe's Section 179 carryover is reduced by $5,000.

Purchase and Sale of Livestock

You purchased, transported and vaccinated some young cattle in 1993, intending to sell them in 1994. As a farmer using the cash basis method of accounting, how do you report this? The purchase and transportation are your basis in the cattle, included in your 1994 Schedule F, line 2. Vaccination is a current expense, line 33 of your 1993 Schedule F.

Do you pay self-employment tax on gain or loss from the sale of breeding livestock? Yes, if it is held for sale in the ordinary course of business. Report on Schedule F. No, otherwise. Report in the appropriate part of Form 4797, as follows:

Held less than 12 months (24 months for cattle and horses). Also poultry (unless held for sale in the ordinary course of business)

Part II of Form 4797

Held more than 12 months (24 months for cattle and horses) and (1) purchased and sold at a loss or raised (gain or loss)

Part I of Form 4797

or (2) purchased and sold for a gain (depreciation recapture)

Part III of Form 4797

Example: Robert breeds replacement heifers for his dairy herd. When they are two years old, he selects the number required to maintain his herd and sells the rest. Even if some heifers are sold as breeding livestock, all sales are reported on Schedule F.

Example: Dana breeds replacement heifers. All are added to the dairy herd unless they fail to breed. Those that turn out to be poor milkers are sold. Dana can report all sales on Form 4797, since her intent was to keep them all for breeding.

Investment Interest

Previously, individual taxpayers could deduct investment interest (interest on indebtedness allocable to property held for investment) only to the extent of their net investmentincome for that year. Net investment income generally excluded capital gains, and the disallowed interest expense had to be carried forward. Now there is a faster way to use up the interest carry-forward. Effective January 1, 1993, a taxpayer may elect to include any amount of the net capital gain from Schedule D in investment income. The capital gain transferred to Form 1040 must be reduced by the same amount. For a taxpayer in the 28% marginal tax bracket, the only effect is to use up the investment interest carryover, reducing total taxes in the present year rather than some future year. Higher income taxpayers should take care to elect to include only as much gain as will offset the interest carried forward. Any larger amount would be subject to tax at rates of 31%, 36%, or 39.6%.

Example: Fred and Emily have $10,000 unused investment interest expense from 1992 and $15,000 net long-term capital gains in 1993. On their 1993 return, they elect to treat $10,000 of the gain as ordinary income. They pay tax (maximum rate 28%) on $5,000 long-term capital gain. They deduct the $10,000 investment interest expense on Schedule A.

The following sections are taken from material published by Larry C. Jenkins, Department of Agricultural Economics and Rural Sociology, Pennsylvania State University.

Earned Income Tax Credit (EITC)

The new rules for earned income credit involve only a basic credit; the extra credits for a child under one year of age and for health insurance coverage were eliminated in the 1993 legislation. **Comment:** The new law results in a decrease in benefits in 1994, compared to benefits from the earned income credit in 1992, for a family with one child under one year of age, and qualifying for the supplemental health insurance credit. For such a family, based on earned income of $7,750, the EITC in 1992 would have been $2,151. Under the new rules, the credit is $2,038.

In a departure from previous earned income credit rules, the new law extends the credit to taxpayers with no qualifying children. The credit is available to taxpayers over age 25 and below age 65. For these taxpayers, the EITC is 7.65 percent of the first $4,000 of earned income (for a maximum credit of $306 in 1994). The maximum credit is reduced by 7.65 percent of earned income (or adjusted gross income, if greater) above $5,000. In 1994, the credit is completely phased out for taxpayers with earned income (or adjusted gross income, if greater) over $9,000. This credit is not available on an advance payment basis.

Tax on Social Security Benefits

Prior to the new law, if the sum of modified taxable income plus one-half of Social Security benefits (the sum of the two is called provisional income) exceeded $25,000 for an unmarried taxpayer or $32,000 for a married couple filing a joint return, up to 50% of Social Security benefits were subject to income tax.

Under the new law, taxpayers will be subject to tax on up to 85% of their Social Security benefits, effective for tax years beginning after 1993. The existing rule (as explained in the above paragraph) will continue to apply to taxpayers whose provisional income is less that $34,000 for unmarried taxpayers and $44,000 for married couples filing a joint return. If provisional income exceeds these levels, gross income will include the lesser of:

(a) 85% of the taxpayer's Social Security benefit, or
(b) The sum of:
(1) The smaller of:
(i) the amount included under pre-'93 law, or
(ii) $3,500 for unmarried taxpayers or $4,000 for a married couple filing a join return plus
(2) 85% of provisional income over the new $34,000/$44,000 threshold.

For married taxpayers filing separate returns, gross income will include the lesser of:

(a) 85% of the taxpayer's Social Security benefit, or
(b) 85% of the taxpayer's provisional income.

For purposes of the above calculation, a taxpayer's provisional income (modified adjusted gross income plus one-half of the taxpayer's Social Security benefit) is calculated in the same manner as under pre-93 law.

Without implicating them in any way, I thank Robert Christensen, Department of Resource Economics and Michael Whiteman, Department of Accounting and Information Systems, School of Management, both from the University of Massachusetts, for their helpful comments.

* * * * *

Fruit Notes

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Final Report on the 1980 NC-140 Apple Rootstock Planting: Starkspur Supreme Delicious on Eight Rootstocks

Wesley R. Autio and William J. Lord
Department of Plant & Soil Sciences, University of Massachusetts

Finding the apple rootstock that adapts the best to various conditions, is resistant to pests, gives an appropriate degree of dwarfing, gives the greatest precocity, results in the highest yields, and gives the best fruit quality has been a research and breeding goal for nearly a century. Growers in New England, however, did not begin to look at clonally propagated rootstocks seriously until the 1960's, when the use of semidwarfing rootstocks, such as M.7, began in earnest. During the late 1980's, serious planting of fully dwarfing rootstocks began,

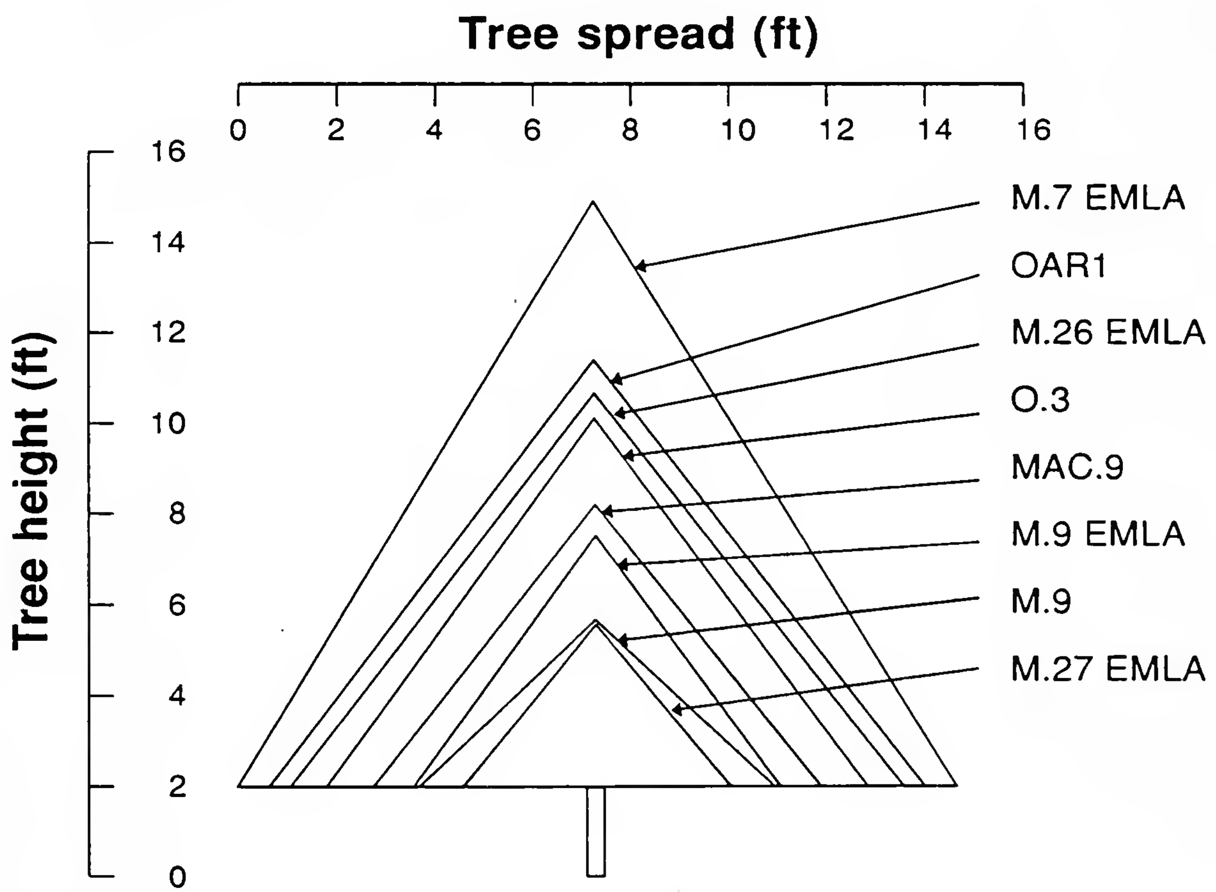

Figure 1. Relative canopy dimensions of Starkspur Supreme Delicious trees on eight rootstocks at the end of the forteenth growing season.

including M.9, Mark, and M.26. Now, more than fifty percent of all trees being planted in New England are on fully dwarf rootstocks. This trend has been seen throughout the apple growing regions of North America. Throughout this period when clonal rootstock material became more important to the apple industry, knowledge of rootstock characteristics became essential.

To help evaluate both new and old clonal rootstock material, the NC-140 Technical Research Committee was established. A group of scientists from various universities across the country formed this committee in association with the U. S. Department of Agriculture. Individuals from five Canadian provinces cooperated in the formation and participate in the execution of the responsibilities of this committee. One of the first major plantings by the committee included Starkspur Supreme Delicious on O.3 (Ottawa 3), M.7 EMLA (the EMLA designation suggesting that the latent viruses were removed from the mother plant), M.9 EMLA, M.26 EMLA, M.27 EMLA, M.9, MAC.9 (later, a virus indexed version was named Mark), and OAR1 (Oregon Apple Rootstock 1). These combinations were included in randomized complete blocks, each with five replications at 27 sites in the U. S. and southern Canada. Most sites removed their plantings after the tenth growing season, i.e. after harvest in 1989. In this article, we report on the Massachusetts portion of this trial, including four years of data beyond the termination of the joint trial.

Materials & Methods

Trees were planted at a spacing of 11.5 x 18 feet in the spring of 1980 at the University of Massachusetts Horticultural Research Center in Belchertown. Trees were trained as central leaders, using minimal pruning. Some containment pruning was required when trees reached maturity. Stakes were added for support only when trees leaned past 45 degrees. Standard pest and fertility management practices were used. Tree size and yield were measured annually; however, trees were not allowed to fruit until the fourth growing season (1983).

Results & Discussion

Table 1 gives the trunk cross-sectional area, height, and spread of these trees after the fourteenth growing season (1993), and Figure 1

Table 1. Size of Starkspur Supreme Delicious trees on eight rootstocks after their fourteenth growing season. Also presented are estimated tree density and spacing.[z]

Rootstock	Height (ft)	Spread (ft)	Trunk cross-sectional area (in^2)	Estimated density (trees per acre)	Estimated spacing (ft)
O.3	10.1 b	11.1 bc	9.8 c	256	10x17
M.7 EMLA	14.9 a	14.7 a	21.3 a	132	15x22
M.9 EMLA	8.2 c	9.2 cd	5.7 de	363	8x15
M.26 EMLA	10.6 b	12.6 ab	14.0 b	191	12x19
M.27 EMLA	5.6 d	5.4 e	1.9 f	726	5x12
M.9	5.7 d	7.2 de	3.1 ef	496	6.5x13.5
MAC.9	7.5 c	8.4 d	8.4 cd	401	7.5x14.5
OAR1	11.4 b	13.4 a	13.6 b	191	12x19

[z] Within column, means not followed by the same letter are significantly different at odds of 19 to 1.

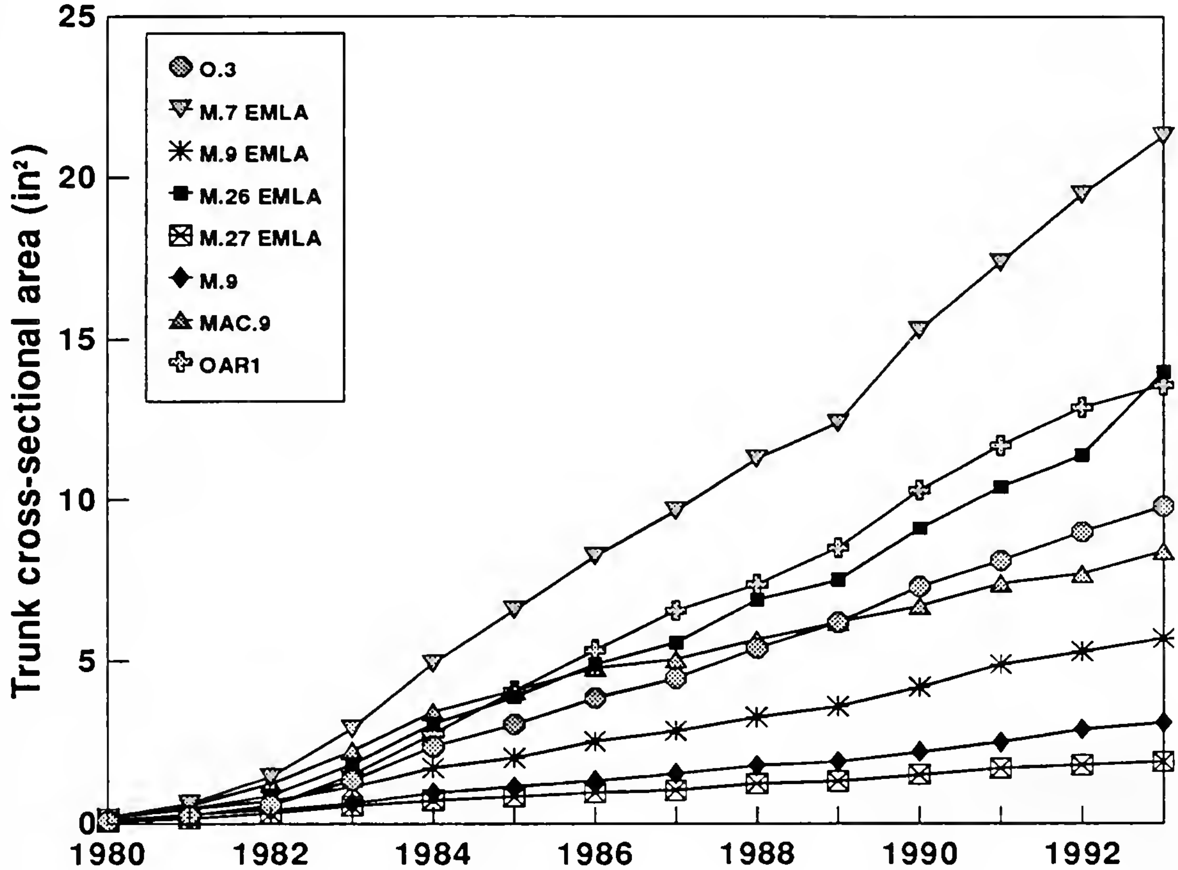

Figure 2. Trunk cross-sectional area of Starkspur Supreme Delicious trees on eight rootstocks from the end of the first growing season through the end of the fourteenth.

depicts the relative canopy dimensions of these trees. M.7 EMLA produced the largest trees. Trees on M.26 EMLA and OAR1 were the next smaller in terms of trunk cross-sectional area, followed by trees on O.3 and MAC.9. Trees on M.9 EMLA were smaller still, and the smallest trees in the planting were on M.9 and M.27 EMLA. Clearly, M.9 and M.27 EMLA were not vigorous enough rootstocks for Starkspur Supreme Delicious, since trees did not reach six feet in height. With a canopy this small, adequate yields are not possible.

Figure 2 plots the trunk cross-sectional area of these trees from 1980 through 1993, and shows that for most trees, there was a relatively constant rate of growth throughout the experiment. MAC.9, however, resulted in a relatively fast growth rate for the first five growing seasons, but for the next nine seasons, had a significantly slower growth rate. In other words, the initial growth rate of trees on MAC.9 was nearly as great as that of trees on M.7 EMLA, but later on, the growth rate was only similar to that of trees on M.9 EMLA. This reduction in growth rate corresponded to the onset of heavy production from trees on MAC.9.

Table 1 also gives estimates of spacing and density for these combinations. For most combinations, the estimated in-row spacing is approximately ninety percent of the tree spread; however, this assessment was not adequate for trees that had filled their allotted space and had required containment pruning. Specifically, the estimated spacing of trees on M.7 EMLA

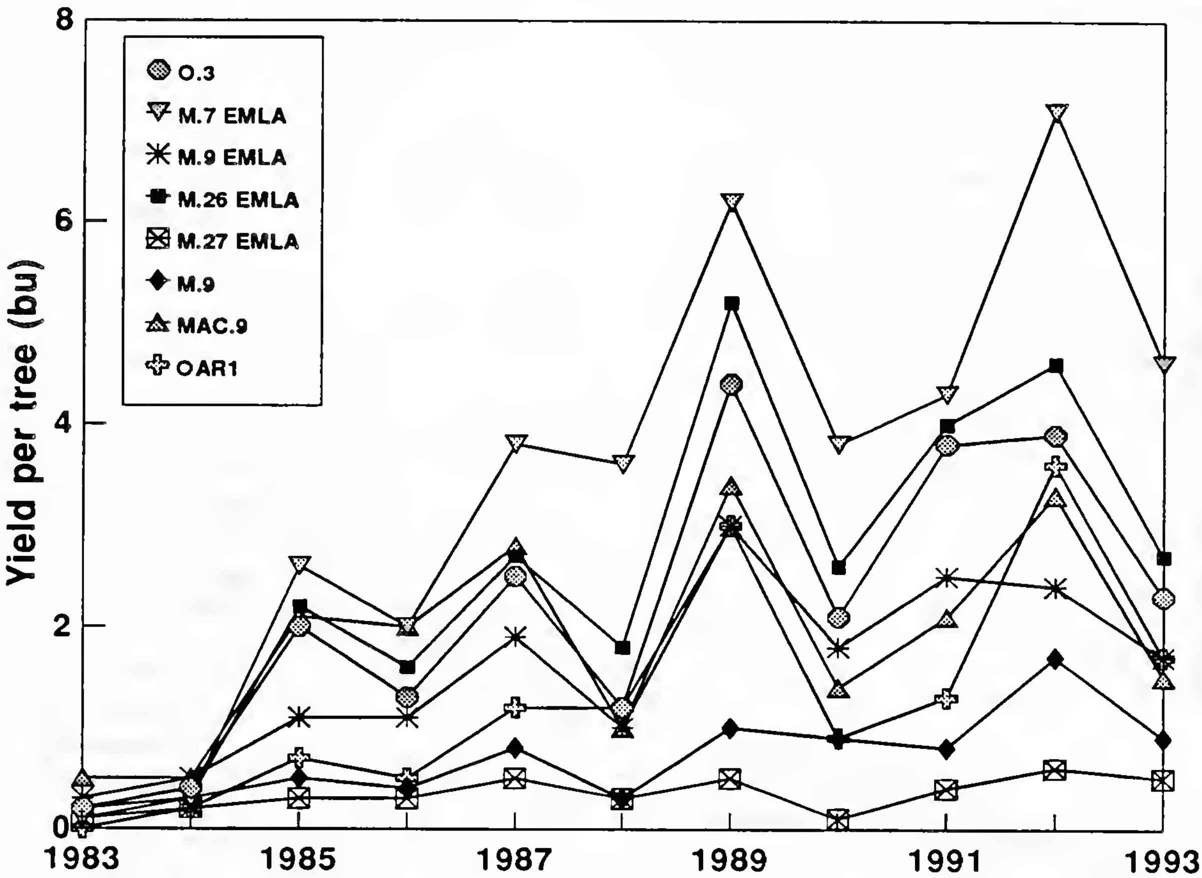

Figure 3. Annual yield per tree from Starkspur Supreme Delicious trees on eight rootstocks.

would be artificially low if based solely on measured spread, since they were kept in a spacing of only 11.5 feet. In other words, measured tree spread in 1993 was an assessment of how much the tree grew beyond the 11.5-feet allotted space in 1993, since it was pruned to 11.5 feet during the previous dormant season. Furthermore, when trees are planted closer together, tree-to-tree competition likely will inhibit growth and spread, resulting in a further reduction in the ideal spacing. Therefore, spacings presented here are meant only to be rough guides to allow for the estimation of per-acre yields.

Annual yield per tree is given in Figure 3. Yield was variable and in somewhat of a biennial cycle, but trees on M.7 EMLA clearly yielded the most per tree with an average yield for the last five years of 5.2 bushels. Trees on M.26 EMLA, O.3, MAC.9, and M.9 EMLA averaged 4.4, 3.3, 2.4, and 2.3 bushels per tree, respectively, over the last five years. Trees on M.27 EMLA averaged only 0.4 bushels per tree. Cumulative yield per tree is presented in Table 2, and relationships among rootstocks were similar to that for the average production discussed above.

More important than yield per tree is yield per acre. Potential yield per acre was calculated on an annual basis using the tree densities presented in Table 1, and these data are plotted in Figure 4. Clearly, this is only a rough estimate but does point to some significant results. Trees on MAC.9 produced very high yields from the sixth growing season on, exceeding 1000 bushels per acre in three years. O.3 and M.9

Table 2. Cumulative yield of Starkspur Supreme Delicious trees on eight rootstocks through their fourteenth growing season.[z]

Rootstock	Cumulative yield (bu) Per tree		Per in² trunk cross-sectional area		Per acre	
O.3	24.0	bc	2.47	b	6140	b
M.7 EMLA	38.3	a	1.80	c	5060	bc
M.9 EMLA	17.3	d	3.08	a	6290	b
M.26 EMLA	27.9	b	2.03	c	5330	bc
M.27 EMLA	3.8	e	1.99	c	2770	d
M.9	7.8	e	2.49	b	3890	cd
MAC.9	20.6	cd	2.43	b	8270	a
OAR1	14.3	d	1.05	d	2730	d

[z] Within column, means not followed by the same letter are significantly different at odds of 19 to 1.

EMLA also were very productive on a per acre basis. Averaged over the last five years, trees on MAC.9, O.3, M.9 EMLA, M.26 EMLA, and M.7 EMLA produced annually 940, 840, 830, 730, and 680 bushels per acre, respectively. Over the same period, trees on M.27 EMLA produced only 310 bushels per acre annually. Table 2 presents cumulative yield per acre. Trees on MAC.9 produced 8270 bushels on a per acre basis over the life of the planting. Trees on M.9 EMLA and O.3 produced 6290 and 6140 bushels, respectively. Trees on M.27 EMLA produced only 2770 bushels per acre, partly because of inadequate canopy height and therefore small bearing surface per acre.

Conclusions

Several conclusions about specific rootstocks can be made from this study. First, however, it must be emphasized that these data were collected from Starkspur Supreme Delicious, a low-vigor cultivar, and some results may have been different with a more vigorous cultivar such as McIntosh. Secondly, some of the conclusions must be tempered by results obtained in other locations.

O.3. This rootstock performed very well. It was relatively precocious, and produced high yields over the fourteen-year life of the planting. Tree size was slightly smaller than M.26 EMLA, so trees were very manageable. Fruit size was large from trees on O.3. Even though most of the trees in this planting were not staked, staking should be considered a requirement with O.3. One problem with O.3 is that it is of limited availability, because it is so difficult to propagate. Specifically, it does notdevelop roots very readily in the stool bed. Some work suggests that this problem may be overcome in the nursery, but has not yet resulted in a significant quantity of O.3. Overall, it is a rootstock very much worthy of trial if you can get it.

M.7 EMLA. This rootstock performed very well with a spur-type Delicious as a scion. It was somewhat more precocious than normally observed. Generally, it was not as productive as O.3, M.9 EMLA, and Mark, but still performed very well. Trees are vigorous and do not lend themselves to high-density planting, but it is probably still the best choice for a free-standing, semidwarf tree.

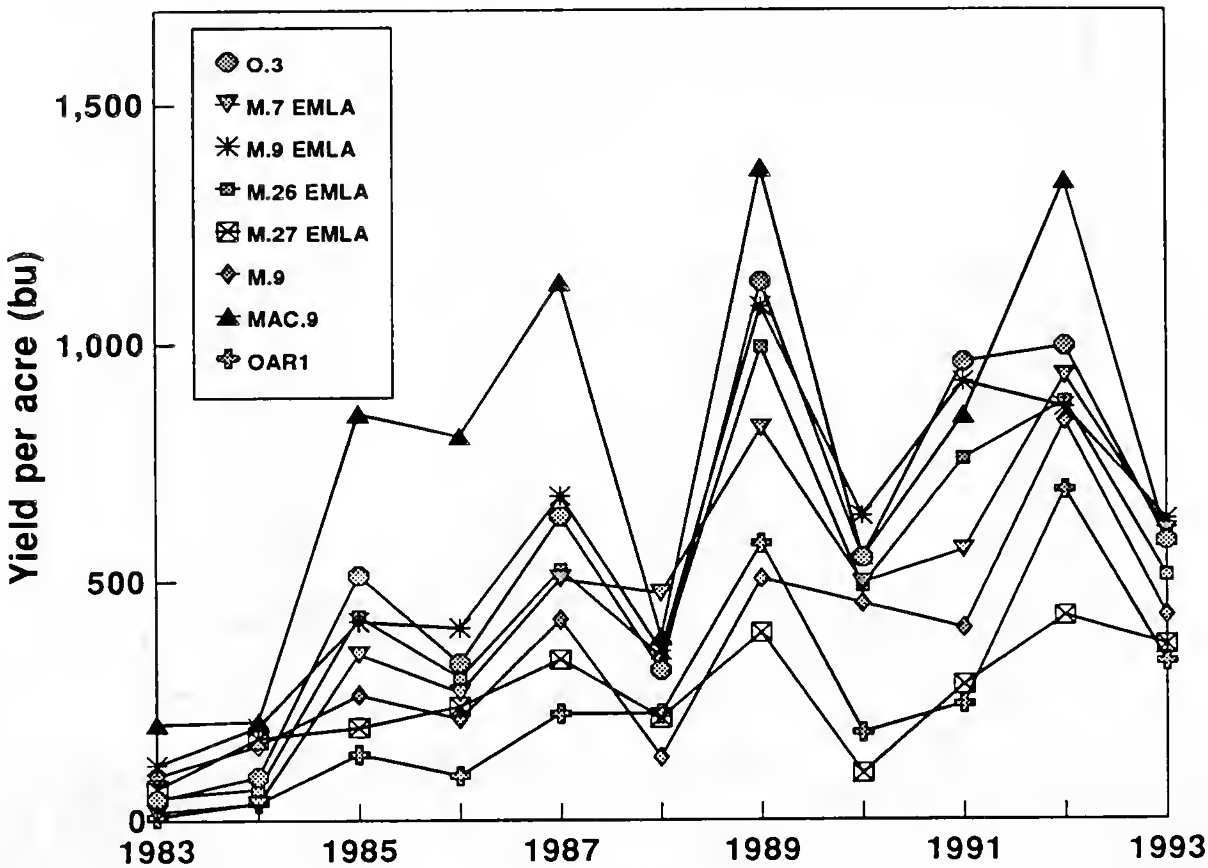

Figure 4. Annual yield per acre from Starkspur Supreme Delicious trees on eight rootstocks.

M.9 EMLA. This strain of M.9 performed very well in this planting. Trees were precocious and productive. Tree size was nearly perfect for this spur-type Delicious, and tree training was almost not required. Fruit size from trees on M.9 EMLA were the largest in the planting in most years. Trees on M.9 EMLA must be supported fully. This strain of M.9 is commonly available and is one of a few strains that you might have received if you ordered M.9 and did not specify the strain. Overall, M.9 EMLA is worth asking for specifically.

M.26 EMLA. Trees on M.26 EMLA performed well, giving relatively high yields. Tree size was at the large end of the dwarf category, but trees were still very manageable. As with all fully dwarfing rootstocks, trees must be staked. If available we would prefer O.3 to M.26 EMLA.

M.27 EMLA. Starkspur Supreme Delicious is too weak to propagate on M.27 EMLA. Trees do not grow sufficiently to attain adequate canopy volume per acre, and they do not grow enough to renew fruiting wood. Trees on M.27 EMLA were "runted out" in just a few years after planting and did not perform well. In other parts of the country, M.27 EMLA has done well with vigorous cultivars and in high-density, fully supported plantings.

M.9. This strain of M.9 is often referred to as "dirty 9", because it has not had latent virus removed from it. It was significantly smaller than M.9 EMLA in this trial and performed similarly to M.27 EMLA. With vigorous cultivars, it is known to perform very well in high-density, fully supported plantings.

MAC.9. This rootstock is very similar to Mark, the only difference being that Mark has been virus indexed. It is thought to perform nearly identically to Mark. In this trial, it was the most precocious and productive combination. Tree size was between M.9 EMLA and O.3. Based on these data, it is the best rootstock in this group; however, it suffers from a few problems. In this planting, it overfruited early, and growth slowed and fruit quality began to decline. It nearly "runted out", but with heavy pruning we were able to restore some shoot growth for renewal of fruiting wood. Other problems have been observed in other locations, particularly related to its sensitivity to drought. At approximately three years after planting, trees develop a noticeable swelling at and below the soil line. The water transport system in this part of the tree is very disorganized (as seen by research in Michigan) and is inefficient in water transport. If moisture is limiting, trees on Mark (or MAC.9) will suffer more than those on other rootstocks. It appears that in locations where water is not limiting, trees on Mark (or MAC.9) perform very well, such as in our trial in Belchertown. The cause of this swelling is unknown, and there is no known cure for the problem, except possibly frequent irrigation. The future of Mark is in great jeopardy because of this problem, and many nurseries have removed most of their Mark stoolbeds. Hopefully, we will not lose a rootstock that can be very good in some locations. It should still be considered seriously for sites that have good moisture levels throughout the season.

OAR1. This rootstock produced a tree similar in size to M.26 EMLA; however, it was not productive and fruit size was very small. There is no reason to consider OAR1 for commercial planting.

Overall, the rootstock picture is changing rapidly. In this trial, M.9 EMLA, O.3, and Mark were the ones that performed best. From the 1984 NC-140 planting, others will be added to the list of good rootstocks, including C.6, B.9, P.2, and MAC.39. A planting will be established this year that includes new potentially good rootstocks, such as B.146, B.469, G.65, and several strains of M.9. As we move into the next century, many rootstocks will be bred and selected; however, it is likely that not much will be gained in terms of productivity. Pest resistance and site adaptability likely will be the major foci of the future breeding programs.

* * * * *

Buildup of Bugs Causes Decline in Effectiveness of Sticky for Capturing Apple Maggot Flies on Red Sphere Traps

Jian Jun Duan, Xingping Hu, Max P. Prokopy, and Ronald J. Prokopy
Department of Entomology, University of Massachusetts

Red spheres coated with sticky (Tangletrap™) have been used for 25 years as effective traps for monitoring apple maggot fly abundance in commercial orchards. Once sticky spheres have been emplaced, a treatment of pesticide is recommended when cumulative captures of maggot flies reach one or two per unbaited trap or five per trap baited with synthetic apple odor (butyl hexanoate). We and others have long suspected that buildup of insects and debris on the sphere surface might cause a progressive decrease in the probability of capturing an alighting maggot fly. In 1993, we evaluated the rate of decline in the power of traps to capture maggot flies.

On June 28, we hung 24 freshly-coated sticky red spheres in optimum positions on apple trees in a commercial orchard. Each sphere was baited with one vial of butyl hexanoate and one packet of ammonium acetate in a manner typical for spheres used in trapping apple maggot flies in second-level IPM blocks. Eight freshly-coated spheres were placed in a cardboard box in a closet at 70°F as checks. After 7, 14, and 28 days, eight spheres on each date were removed from the orchard and likewise placed in cardboard boxes in the closet. In early August, spheres of each treatment were hung in potted apple trees in field cages to test their fly capturing power. Ten flies were released toward the bottom of the tree canopy, which contained a single sphere. The sphere was observed continuously for one hour, after which all flies were removed from the cage. We recorded the number of flies alighting, the number captured, and the number that escaped. We also estimated the percent of the surface area occupied by captured insects. Once a trial ended, we hung up a sphere of the next treatment and released 10 more flies. We did this until all 32 spheres were tested.

As time of sphere exposure in commercial orchard trees increased from 0 to 28 days, the proportion of released flies caught decreased significantly from 49% to 13% (Figure 1A). There was no significant effect of time of sphere exposure in commercial orchards on propensity of flies to alight on spheres (Figure 1B). Of the alighting flies, only 3% escaped from spheres kept continuously in the closet (never emplaced in commercial orchards) compared with 38, 43, and 73% escapees from spheres exposed in orchards for 7, 14, and 28 days, respectively (Figure 1C). As days of exposure in orchard trees increased, the percentage of sphere surface area occupied by captured insects increased significantly from 0 to 16, 24, and 38% after 7, 14, and 28 days of exposure, respectively (Figure 1D).

We conclude from this test that sticky red spheres become progressively less effective in capturing alighting apple maggot flies as the number of insects caught on the spheres increases over time. It appears that under commercial orchard conditions, odor-baited sticky spheres lose nearly half of their maggot fly capturing power after two weeks without cleaning. After four weeks without cleaning, they lose about three-fourths of their maggot fly capturing power. We therefore recommend

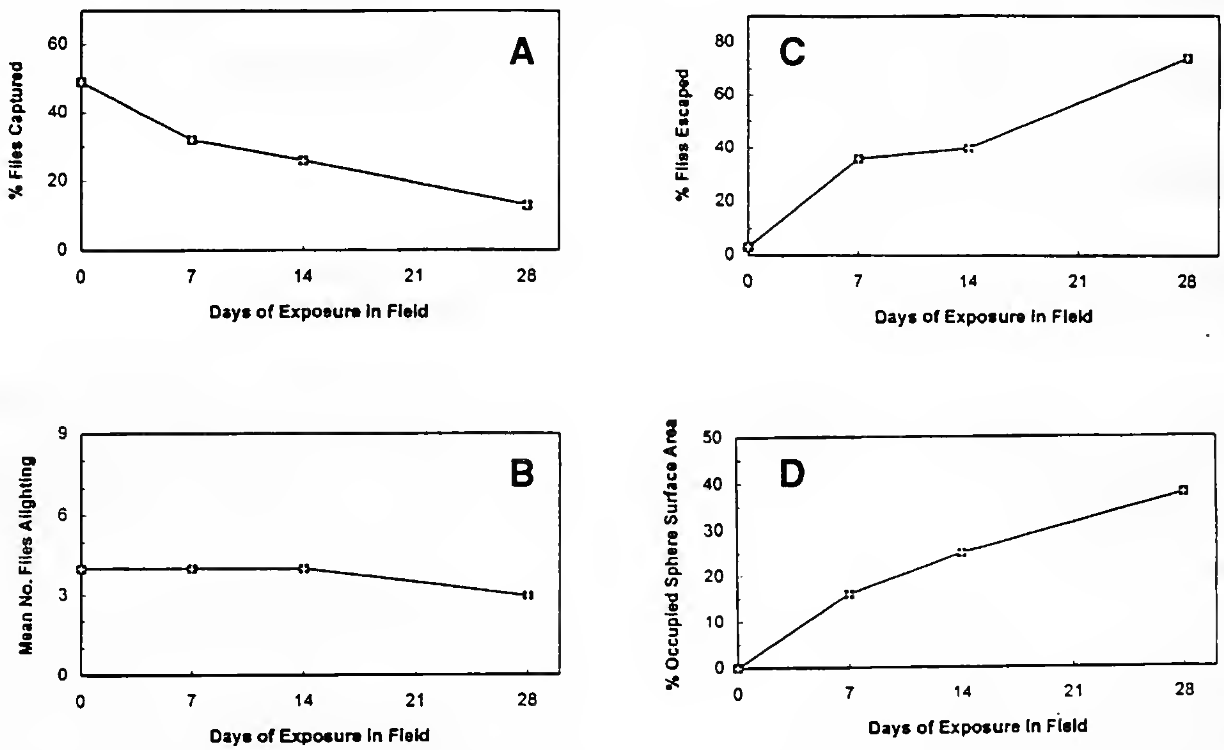

Figure 1. Effects of duration of exposure to weather in a commercial orchard on effectiveness of sticky spheres in capturing alighting apple maggot flies: (A) proportion of released flies captured, (B) mean number of flies observed alighting, (C) proportion of alighting flies that escaped, and (D) mean % of surface area occupied by previously captured insects.

cleaning sticky spheres of insects and debris every two weeks to retain reasonable fly capturing power for either control or monitoring purposes. If spheres are not cleaned, control may fail or thresholds for pesticide treatment would have to be adjusted.

Acknowledgments

The study was supported by grants from the USDA Sustainable Agricultural Research and Education Program and the USDA Northeast Regional IPM Program.

* * * * *

What Species of Predaceous Mites Exist in Massachusetts Commercial Apple Orchards?

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Under favorable orchard pest management conditions, predaceous mites can provide a moderate to high level of control of pest mites such as European red mites and two-spotted spider mites. Reports from New York State clearly suggest considerable variation among different species of predaceous mites in ability to control pest mites. For example, the predator *Typhlodromus pyri* is better able to survive harsh winter temperatures and to provide season-long control of low to moderate pest mite numbers than is the predator *Amblyseius fallacis*. In turn, the latter is better able than *T. pyri* to control rapidly building numbers of pest mites in the summer. A third predator, *Zetzellia mali*, appears rather similar in biology to *T. pyri*, but rather little is known about its ability to suppress pest mites.

In 1977, we conducted a survey of 21 commercial apple orchards scattered throughout Massachusetts to determine the proportion of sampled orchards that contained each of these three species of predaceous mites. We surveyed again in 1993 in 12 different commercial orchards scattered across the state. Samples consisted of 100 leaves taken weekly in each orchard from April through June and 50 leaves taken biweekly from July through September. Leaves were placed in a cooler immediately after picking and returned to the laboratory for predator identification. Identification involved removing the predators from leaves, mounting them on microscope slides, and using taxonomic keys to distinguish between some species on the basis of the number and location of tiny hairs on the body surface.

There was remarkably little change over 16 years in species composition of predators (Table 1). In both surveys, *A. fallacis* was present in 81 to 92% of sampled orchards, *Z. mali* in 30 to 33%, and *T. pyri* in 0 to 8%. The similarity in data patterns across years is even more remarkable given the fact that all orchards sampled in 1977 were different from the ones sampled in 1993.

We conclude that if we want to achieve biocontrol of pest mites with existing predaceous mites in Massachusetts orchards, we ought to pay particular attention to *A. fallacis* and ways of encouraging its buildup. *T. pyri*, which

Table 1. Percentage of Massachusetts commercial apple orchards sampled in 1977 and 1993 containing predaceous mites.

Year	Number of orchards sampled	Species of predator: *Amblyseuis fallacis*	*Typhlodromus pyri*	*Zetzellia mali*
1977	21	81	0	30
1993	12	92	8	33

appears identical to *A. fallacis* even under a powerful hand lens, can not be counted on at this point to provide mite biocontrol in any but a small minority of orchards. In an attempt to establish *T. pyri* in additional orchards, we released hundreds of nymphs and adults (obtained from Geneva, New York) in 1992 and 1993 in two orchards. Unfortunately, there is no evidence to date that these releases have resulted in establishment of *T. pyri*.

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How Beneficial Are Pre-bloom Oil Sprays Against European Red Mites?

Ronald Prokopy, Jennifer Mason, and Xingping Hu
Department of Entomology, University of Massachusetts

For decades, most Massachusetts apple growers have been applying pre-bloom oil sprays against overwintering eggs of European red mites. Just how beneficial to spring and summer mite control are these sprays? Furthermore, does the reduction in number of hatching mites after spraying oil cause our principal mite predator, *Amblyseuis fallacis*, to leave apple trees in search of more prey elsewhere?

To answer these questions, in 1993, we cooperated with commercial growers in conducting a test in two-acre blocks of apple trees in each of nine orchards. Half of each block received no oil or other miticide through May. The other half received two applications of oil: one during half-inch green to tight cluster and the other during tight cluster to early pink. Each application was at a rate of about one gallon of oil to 100 gallons of water, with 100 to 300 gallons of water used per acre. During the third week of May, following egg hatch, 200 leaves per untreated and treated block were examined for presence of motile red mites and *A. fallacis*.

In the untreated blocks, an average of 35% of sampled leaves had motile red mites compared with an average of only 5% in the oil-treated blocks (an 86% reduction in mite numbers). Nearly all untreated blocks required repeat applications of miticide beginning after petal fall. None of the treated blocks required miticide application until July or August. In two sampled blocks that received only a single pre-bloom application of oil, numbers of motile mites were reduced 45% compared with untreated blocks.

No *A. fallacis* were found on any of the blocks in leaf samples taken before oil application began in April or during May, although by August, all of the blocks had at least some *A. fallacis*. Evidently, cold winter temperatures reduced populations of *A. fallacis* to such low levels that it was inconsequential whether or not red mite prey were low or high in numbers in May.

We conclude from these 1993 tests that two pre-bloom applications of oil against red mite eggs pay high dividends in suppressing red mite populations through spring and early summer, and in some years, possibly through the entire growing season.

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North American Strawberry Growers Meet in Ontario

The North American Strawberry Growers Association held its seventeenth annual meeting February 13-16, 1994 in Niagara Falls, Ontario. Over three hundred and fifty members from the United States, Canada, and England gathered to learn the latest information on strawberry production and marketing.

Dave Whittamore of Markham, Ontario was elected President and Susan Butler of Germantown, MD was elected Vice President. Two new directors were elected to the Board: John Dzen of S. Windsor, CT and Mike Reilly of Pittsburg, PA.

The annual meeting followed a one-day program emphasizing bramble culture sponsored by the Ontario Berry Growers Association (OBGA). NASGA's opening session was preceded by a delightful wine and cheese reception hosted by OBGA. The evening program was highlighted by Dr. Tim Ball, Winnipeg, Manitoba, who entertained the crowd with his delightful talk "Whatever Happened to Global Warming?", a factual and fictional discussion of long-term environmental changes.

NASGA was started by growers in 1977 and is run by growers today with over 400 members. Highly committed to improving strawberry production through research, more than 25% of membership dues is allocated to research each year. In 1992, the NASGA Research Foundation was formed to increase funding. This year NASGA received 24 proposals requesting more than $95,000 for strawberry research. The Research Committee recommended funding 17 projects with a total of $34,000. Approximately 55% of the grants were for plant breeding improvements and 40% for pest management studies. NASGA publishes the research journal *Advances in Strawberry Research.*

A 10-day tour to study agriculture and small fruit growing in Europe has been arranged by NASGA. The tour will depart August 21, 1994 for stops in England, Holland, Belgium, Germany, and Switzerland. Reservations are on a first-come first-serve basis and non-NASGA growers/researchers are invited to participate. For information contact Linda Struye, telephone/FAX (414) 921-4784.

The next annual meeting is scheduled for February 12-15, 1995 at the Sheraton Plaza Hotel at the Florida Mall in Orlando, Florida. The North American Bramble Growers will meet February 11-12, and immediately following NASGA, the Fourth National Strawberry Research Conference will be held, which NASGA is pleased to help cosponsor.

For more information about NASGA and its publications, write to Bill & Treva Courter, P.O. Box 160, West Paducah, KY 42086, telephone/ FAX (502) 488-2116.

Promising New Apple Cultivars for 1994

Duane W. Greene and Wesley R. Autio
Department of Plant & Soil Sciences, University of Massachusetts

During the past three seasons, we have evaluated over 100 new apple cultivars. Some of these cultivars are newly named and are available currently, while others are only numbered selections and are not available widely. Last year we reported on all cultivars evaluated in 1992 [*Fruit Notes* 58(2):4-14]. This year we are reporting only on those cultivars that appear to have promise in wholesale operations or fit into a special slot in retail sales operations.

Fruit evaluation began the first week in July and ended the fourth week in October. Where sufficient fruit were available, multiple harvests were made. Fruit were evaluated both objectively and subjectively (similar to the ways reported last year). Ten fruit were harvested from each cultivar one to five times at weekly intervals, and flesh firmness, percent red color (or percent red cheek if the apple was yellow), diameter, and weight were assessed. Fruit also were cut and dipped into iodine solution and starch was evaluated using a generic starch chart developed at Cornell University. The starch chart allowed us to assess taste at times when the fruit were ripening, and it also gave us an idea when fruit should be harvested for storage. Fruit were evaluated for visual and sensory characteristics using a specially designed sheet with subjective rating scales similar to the one described last year. McIntosh was evaluated at four different times and included in this report as a commercial cultivar check.

The Most Promising New Apple Cultivars

Below are listed what we consider to be the most promising new cultivars for New England. They appear in alphabetical order.

Arlet

This apple originated in Switzerland and was introduced in 1983. Arlet was an outstanding apple again this year even though it has several major faults: surface russetting, preharvest drop, and a greasy feel when fruit ripen. Individuals liking a tart apple may select Arlet over Gala, which is harvested in the same season. It is conic, has yellowish white flesh, and a fruity pineapple taste. Firmness is maintained over a long period of time. If a stop-drop chemical is applied, drop can be controlled and fruit will develop a very attractive cardinal red color without losing much firmness. The deep red color more-or-less masks the russet even though as much as 25% of the surface can be russetted. It is one of the best storing apples that was evaluated. Grease that developed on the surface can be washed off easily.

Ginger Gold

Ginger Gold emerged as the best early yellow apple and one of the top apples evaluated. It is a large apple that has a very attractive waxy lemon yellow color and no apparent russet. Ginger Gold can be picked over a long period. Fruit had acceptable flavor and good appearance on August 24, in late Paulared season. Three weeks later the starch rating was only 3.3, with firmness nearly 20 pounds, and fruit were still crisp. Ginger Gold has a pleasant but weak apple flavor. Fruit were harvested weekly and placed in cold storage at four different times starting on August 24. Two months later fruit from all harvest dates tasted mealy and unappealing and firmness had dropped to 13.5 pounds. Ginger Gold should not be considered a long storing apple; however, it is an outstanding apple at harvest and after a short period of storage.

Golden Glory

This limb sport of Smoothee produces a very

Table 1. Laboratory analyses and bloom dates of the most promising new apple cultivars evaluated at the University of Massachusetts Horticultural Research Center in 1993, with McIntosh shown as a reference.

Cultivar	Best harvest date	Also evlauated on:	Weight (g)	Diameter (in)	Firmness (lbs)	Soluble solids (%)	Red color (%)	Starch index*	Bloom time**
Arlet	9/20	9/14, 9/28	186	2.92	17.4	13.8	80	6.4	E
Ginger Gold	9/7	8/24, 9/2, 9/13	283	3.35	21.0	14.0	30	2.2	M
Golden Glory	10/13	10/5, 10/18	244	3.24	16.4	15.5	13	6.3	ML
Golden Supreme	10/4	9/20; 9/27	265	3.28	16.9	13.9	---	6.0	L
Honeycrisp	9/7	9/13, 9/20, 9/27	292	3.47	17.4	14.2	68	4.8	M
NY 429	10/13	---	244	3.37	14.0	12.1	88	---	---
NY 75414-1	10/5	9/20, 9/28	194	3.21	13.1	14.3	96	5.5	M
Sansa	9/13	8/24, 9/2, 9/7	178	2.94	16.3	14.2	84	6.8	ML
Suncrisp	10/18	---	216	3.10	19.3	15.1	40	6.0	ML
McIntosh	9/27	9/7, 9/13, 9/20	202	3.20	13.8	11.6	85	7.0	M

* Starch rating: 1-3 = immature, 4-6 = mature, and 7-8 = overmature.
** Bloom time: E = early, EM = early-middle, ML = middle-late, and L = late.

Table 2. Taste and sensory evaluations of the most promising new apple cultivars evaluated at the University of Massachusetts Horticultural Research Center in 1993, with McIntosh shown as a reference.*

Cultivar	Best harvest date	Also evlauated on:	Attractiveness	Red color	Crispness	Flavor	Overall
Arlet	9/20	9/14, 9/28	5.5	6.7	5.7	7.2	6.6
Ginger Gold	9/7	8/24, 9/2, 9/13	7.7	---	7.9	6.0	7.6
Golden Glory	10/13	10/5, 10/18	7.1	---	5.3	7.1	7.1
Golden Supreme	10/4	9/20, 9/27	9.0	---	5.7	6.7	7.7
Honeycrisp	9/7	9/13, 9/20, 9/27	4.2	4.2	6.4	6.3	6.3
NY 429	10/13	---	7.8	7.5	---	6.1	6.3
NY 75414-1	10/5	9/20, 9/28	7.1	7.1	4.4	6.2	6.7
Sansa	9/13	8/24, 9/2, 9/7	7.3	7.3	7.0	8.9	8.9
Suncrisp	10/18	---	6.7	---	7.1	6.9	6.8
McIntosh	9/27	9/7, 9/13, 9/20	7.2	7.2	6.6	5.8	6.2

* All fruit characteristics were rated on a scale from 1 to 10. Color: 0 = dull and 10 = bright. Attractiveness, flavor, and overall disirability: 0 = dislike and 10 = like. Crispness: 0 = low and 1 = high.

attractive apple and the tree has a somewhat spur-type habit. It produces heavy crops of large attractive apples somewhat regularly, indicating that it may not be as biennial as one would expect. Fruit do russet but they still are very attractive. Although definitely a Golden Delicious type, we would rate this selection higher than either Golden Delicious or Smoothee for appearance, taste, and potential productivity.

Golden Supreme

This chance seedling was discovered in Idaho. We evaluated it for the first time in 1993. It is truly an outstanding apple. It is a very attractive apple with a glossy lemon-yellow russet-free finish and a pink-red cheek. It ripens about seven to ten days before Golden Delicious, but some uneven ripening may force two harvests. It shows some tendency to drop prematurely. Flavor was fruity, sweet and perfumy, with a taste of licorice. The tree is spur-type and upright, and some reports indicate that it may not be too productive. This apple is unsurpassed for appearance and flavor.

Honeycrisp

This Minnesota selection is the result of a cross between Honeygold and Macoun. Many Honeycrisp trees will be planted in the next few years because it has outstanding storage potential and fruit following regular air storage have 'explosive crispness'. Fruit harvested on September 14 with firmness of 17.8 pounds still had firmness above 17 pounds at the end of January in air storage. Honeycrisp is a very large apple but its not too attractive, because color is slow to develop and is striped rather than blush. Quality at harvest is good but not exceptional, and the longer Honeycrisp stays in storage the better it looks compared with other cultivars. Honeycrisp fruit from Massachusetts were included in a replicated taste evaluation at the Mid-Atlantic Fruit Variety Showcase in West Virginia in January. Numerically, Honeycrisp was judged to be the best tasting apple and statistically it was equal to Fuji and Braeburn. Over the past four years Honeycrisp on M.26 has been the most productive apple in our cultivar evaluation plots. It produced over 1.5 bushels per tree in the fourth leaf.

NY 429

This very large burgundy-red apple is from the New York breeding program. It has very good quality and the flesh is creamy white. Even when cropped very heavily, fruit will size to 3.25 inches or larger. It may be biennial if not thinned. Trees are very productive. NY 429 is already in commercial production in the Hudson Valley of New York and prices of $20 per bushel were reported in 1993 in the Apple Report for the Massachusetts Department of Food and Agriculture. NY 429 will be named soon.

NY 75414-1

This cultivar is the best disease-resistant apple from New York. It is medium large, red, and a Macoun look-alike. Scarf skin may be a problem in some areas but in New England it is a plus because it is also a characteristic of Macoun. It is attractive, somewhat tart, and very crisp. Taste is Macoun- and McIntosh-like. Trees are vigorous and nonspur.

Sansa

This outstanding apple is the result of a cross between Gala and Akane. It was one of the highest rated apples, regardless of the season of harvest. Fruit were attractive, very crisp, aromatic, sweet, and the flavor was subtly spicy at first but it soon developed into a fully flavored apple with pineapple, banana, and licorice taste. Sansa did not drop and it could have been harvested over a three-week period (the three weeks prior to Gala). It stored for up to two months. Although it softened, it maintained flavor, unlike Gala which maintains firmness and crispness but loses the essence of the flavor that makes it Gala. Fruit were of medium size. Sansa is the best tasting apple that ripens before McIntosh. The first commercial plantings will go in the ground in 1995.

Suncrisp (NJ 55)

This cultivar produces medium to large late-season yellow apples. Finish on this apple was not very good but the striped orange-red cheek over lemon-yellow ground color is distinctive and somewhat attractive. Fruit is conic with a crisp yellow flesh. The acidity is quite high at harvest but the sharpness and tartness mellow in storage. Flavor is excellent. It is a very good apple to help spread out the harvest season and it has good storage potential.

Table 3. Laboratory analyses and bloom dates of the most promising new apple cultivars with local or niche market potential evaluated at the University of Massachusetts Horticultural Research Center in 1993.

Cultivar	Best harvest date	Also evlauated on:	Weight (g)	Diameter (in)	Firmness (lbs)	Soluble solids (%)	Red color (%)	Starch index*	Bloom time**
ArkCharm	8/12	8/5, 8/9	246	3.30	15.9	13.0	77	---	ML
MonArk	8/19	8/12	239	3.29	16.3	12.0	71	---	M
Nittany	10/18	---	154	2.75	19.5	13.8	77	7.1	L
Shamrock	9/27	9/13, 9/20, 10/4	179	3.04	17.5	12.7	34	3.9	ML
Splendour	10/13	10/18	241	3.24	20.1	13.3	88	2.9	L
Williams Pride	8/19	8/12	164	2.95	15.7	11.3	94	---	ML

* Starch rating: 1-3 = immature, 4-6 = mature, and 7-8 = overmature.
** Bloom time: E = early, EM = early-middle, ML = middle-late, and L = late.

Table 4. Taste and sensory evaluations of the most promising new apple cultivars with local or niche market potential evaluated at the University of Massachusetts Horticultural Research Center in 1993.*

Cultivar	Best harvest date	Also evlauated on:	Attractiveness	Red color	Crispness	Flavor	Overall
ArkCharm	8/12	8/5, 8/9	4.8	4.2	3.8	5.6	5.1
MonArk	8/19	8/12	5.3	5.5	4.7	5.6	5.8
Nittany	10/18	---	6.7	6.7	8.0	6.7	7.0
Shamrock	9/27	9/13, 9/20, 10/4	5.2	---	5.2	6.4	6.2
Splendour	10/13	10/18	7.2	7.1	4.6	6.7	6.8
Williams Pride	8/19	8/12	6.0	7.0	4.0	5.9	6.2

* All fruit characteristics were rated on a scale from 1 to 10. Color: 0 = dull and 10 = bright. Attractiveness, flavor, and overall disirability: 0 = dislike and 10 = like. Crispness: 0 = low and 1 = high.

Apples Worthy of Limited Planting

Some apples may not be recommended for extensive planting but they have some outstanding characteristics that make them appropriate to plant for niche markets. We feel that the following group of apples are worthy of consideration for limited planting.

Akane

Akane continues to be a cultivar that we favor. It is extremely attractive and few apples have the flavor and aroma of Akane. It ripens during the first two weeks of September. It develops deep cherry red color before it is ready to harvest, so it frequently is harvested immature and tart. When allowed to ripen, it has excellent flavor. It may be a shy bearer.

ArkCharm (AA 18)

This large blotchy red apple from Arkansas ripens a little before Jerseymac and Paulared. Fruit is tarter than sweet but fruit quality is quite good. Storage life is rather short but it is one of the best apples for the season.

Monarch (AA 44)

This cultivar is another blotchy cherry-red apple from Arkansas. Quality is very good for this season. It has a good perfumy taste but because of extensive preharvest drop, few may reach the proper stage of maturity without the use of a stop-drop treatment. Acidity is quite high. It ripens slightly before Paulared, but it is superior to Paulared in taste.

Nittany

Very little is heard about this open pollinated seedling of York. It is fairly attractive, oblong, and light cherry red. It ripens late, in Rome Beauty season. It has a good sweet-tart flavor that we rated very high. Although some Nittany are grown in Pennsylvania, we believe that we can grow a more attractive and perhaps a better Nittany in southern New England. It is a vigorous tree and fruit suffer from calcium problems.

Shamrock

This cross between a spur Golden Delicious and a spur McIntosh is not reported to have high quality, but we feel that it is versatile and a potentially valuable cultivar. It tastes Granny Smith-like if picked just prior to McIntosh season. The quality is at least as good as the Granny Smith apples found in the store at this time of year. If allowed to stay on the tree until late September or early October it develops a very good McIntosh taste. We feel that it is the best green apple in the season. The tree is grower-friendly, a semi-spur type, precocious, and it is not biennial.

Splendour

This late-ripening red apple is from New Zealand. It is attractive and has very good flavor, but the skin is so thin that it cannot withstand the rigors of packing, handling, and long-distance shipping. The tree is a semi-spur and very grower-friendly. It is a parent of the new generation of apples from New Zealand and British Columbia.

Williams Pride

This disease-resistant apple ripens with Paulared but the quality is superior to Paulared. Fruit are large, red, and somewhat irregular in shape and the skin is not smooth. White lenticels are prominent. Fruit is aromatic and flavor is mild but fruity and lively.

We have several other cultivars under test that we feel have the potential to go all the way to the top, although they are not commercially available yet. The most promising from the list are: BC 8M 15-10, BC 17-30, Fantazja, and NJ90.

Suggestions for Use of the New Postbloom Thinner Accel®

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Department of Plant and Soil Sciences, University of Massachusetts

Chemical thinning of apples continues to be one of the most important management activities. It is required nearly every year to assure adequate fruit size at harvest and to encourage repeat bloom the following year. Carbaryl and NAA are the two most commonly used thinners. Both have their faults. Orchardists frequently are reluctant to use carbaryl because of the potential detrimental effect that it can have on mite predators, and it is a relatively weak thinner. When used alone, often it is not potent enough to thin adequately. NAA is stronger, but it also has several detrimental effects. Overthinning is possible if either cloudy or hot weather immediately follows application. It can retard fruit growth, even when used according to label directions. Under these conditions, NAA may not increase fruit size, even when it causes significant thinning. This lack of size increase is emerging as a major problem associated with NAA. Finally, NAA cannot be used on some cultivars because it causes pygmy fruit.

In the 1980's benzyladenine (BA) was found to have chemical thinning capabilities. Since then, researchers have demonstrated repeatedly that BA is a consistent and effective thinner with some unique properties that may make it the postbloom thinner of choice. Accel® recently was approved as a chemical thinner on apples. Accel is an altered Promalin™ formulation, but the primary active thinning component is BA. The purpose this article is to explain some of the characteristics of BA that make it a unique thinner, and to make suggestions for successful use of BA when applied in the Accel formulation.

General Effects of Accel

Thinning Activity

BA can thin over a wide range of concentrations, starting from as low as 25 ppm. Undesirable side effects may be noted if it is applied above 150 ppm; however, label restrictions on the active ingredient per acre make it unlikely that too high a concentration will be applied. BA has been applied in heavy set years and in light set years, and the thinning response to varying concentrations is linear. Although concentrations as low as 25 ppm can be effective, 50 to 100 ppm generally are required to do an effective job.

Comparison with other Chemical Thinners

BA has been compared with NAA and carbaryl in several thinning trials in Massachusetts. It thins as consistently, if not more consistently, than either NAA or carbaryl when applied at the proper time and at an appropriate temperature. The activity of chemical thinners differs from year to year, depending on weather and other factors; however, when applied at the appropriate tree row volume, 75 ppm BA thins McIntosh comparably to 1 lb/100 gal carbaryl (50% WP Sevin) and 6 ppm NAA. BA has been shown to have no detrimental effects on mite predators, a problem frequently associated with the use of carbaryl. When applied alone, BA does not have the negative effects of NAA, such as leaf epinasty, reduced fruit size, or pygmy fruit.

Return Bloom

One of the primary reasons for thinning is to assure adequate return bloom. BA appears to be quite effective at stimulating flower bud formation, and therefore, BA compares favorably with NAA and carbaryl at stimulating return bloom. In some years, BA will enhance flower bud formation beyond that which would be promoted by the level of fruit thinning that it causes.

Time of Application

BA can thin over a three-week period. It will thin modestly when applied at full bloom to petal fall, but fruit are most susceptible to BA and it is most effective when it is applied at the 8- to 10-mm stage of fruit development (14 to 18 days after full bloom). Once fruit reach about 20 mm and trees experience several days of sunny weather in the 80's, no thinner, including BA, will thin.

Spray Coverage

Good and uniform spray coverage is important. Translocation and redistribution of foliarly applied BA is limited. Further, research has shown that BA must come in direct contact with the spur leaves for fruit in that cluster to be thinned. BA application directly to the young fruit will increase fruit size and flesh firmness at harvest but will not influence fruit abscission.

Fruit Effects

Perhaps the biggest advantage that BA has over other chemical thinners is its effects on fruit.

Fruit Size

Generally, chemical thinners increase fruit size by lowering fruit numbers, thus reducing competition for metabolites among the remaining fruits. Although BA enhances size by reducing competition, it also causes increased fruit size independent of and in addition to this effect. This effect on fruit size independent of thinning is unique to BA. BA is especially effective at increasing fruit size on McIntosh-type cultivars such as McIntosh and Empire.

Flesh Firmness and Sugars

It is rare for chemical thinners to increase flesh firmness because they usually increase fruit size, and there is an inverse relationship between fruit size and flesh firmness. BA, however, increases flesh firmness approximately half of the time, even though it also increases fruit size. Because BA is a cytokinin (a group of plant hormones) it likely increases flesh firmness by increasing the number of cells in an apple. Also, BA increases the sugar content of fruit about half the time. Thinners can increase sugar because they increase the leaf-to-fruit ratio.

Red Color and Fruit Asymmetry

If used at high concentrations, BA can reduce red color and increase fruit asymmetry. Given the label restrictions per acre per application, we do not believe that either one of these situations is likely to occur.

Cultivars

BA is not equally effective on all cultivars. BA is especially effective on Empire and McIntosh and extremely useful on Jonamac, Rome, Idared, and Golden Delicious.

Recommendations for the Use of Accel*

Accel is the first step by Abbott Laboratories to make BA available as a thinner on apples. It is not a perfect product, but it is a start. It is an altered Promalin formulation so GA_{4+7} is included, but it is present only at 1/10 the level found in the original Promalin formulation. Also, on the present label is a limit of 35.6 fluid ounces of Accel (20 g active ingredient, ai) per acre per application, and this level may limit its effectiveness when used on large trees that have a high tree-row-volume requirement.

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* *Please see the end of this article for a discussion of a pending label change.*

Concentration

Twenty five ppm in a dilute spray is the minimum concentration to get any thinning response. If the tree row volume of a block requires 200 gallons per acre in a dilute spray, the label would allow only a concentration of 26 ppm (at 35.6 fluid ounces of Accel or 20 g ai/acre) to be used. Furthermore, in situations where aggressive thinning is necessary and the tree row volume is only 100 gal/acre, the desired level of thinning may not be reached with the use of BA alone, since the label will allow only a concentration of 53 ppm (at 35.6 fluid ounces of Accel or 20 g ai/acre). In these situations, additional thinning strategies may be necessary.

Accel should be applied in 50 to 200 gallons of water per acre. Applications in volumes less than 50 gallons per acre may result in poor coverage.

Cultivars

Use Accel on responsive cultivars first until you feel comfortable and until you see how it performs in your orchard. Responsive cultivars include Empire, Rome, McIntosh, and Idared.

Time of Application

If using a single application of Accel, apply at the 8 to 10 mm stage (3/8 in), from 12 to 18 days after full bloom.

The label allows up to two applications of Accel per season. The research has not yet been done to determine the specific effects of multiple applications, so proceed with caution. If two applications are made, do not exceed a total of 71.2 fluid ounces of Accel (40 g ai) per acre for the season. With two applications, the first should be applied at the 5-mm fruit stage, and the second should be applied at no later than the 10-mm stage.

Combinations with other Thinners

BA has been used effectively in combination with NAA on McIntosh. The response was additive; however, Accel interacts with NAA on Delicious to produce small and pygmy fruit. Therefore, the label specifically states that NAA should not be used in any Accel thinning program. Where aggressive thinning is required, carbaryl should be included in the thinning program. We have tank mixed BA with carbaryl successfully. The thinning response was additive. The label does not prohibit tank mixing with carbaryl but the practice is discouraged.

Weather

Attention to temperature is critical for effective thinning with Accel. It should be applied only when the temperature is 65°F or higher. Ideally, the temperature should rise into the 80's within three days following application. If warm temperatures do not follow the application, thinning results are likely to be disappointing. Cloudy weather following application, like warm temperature, may increase the thinning response.

Label Change Pending

There is a label change pending for Accel as this issue goes to press. There are two significant changes that may occur. The rate of Accel per application may be increased to 53.5 fluid ounces (30 g ai) per acre, and the total per season may be increased to 107 fluid ounces (60 g ai) per acre. This change must be noted, because overthinning may occur of McIntosh, Idared, Rome, and Empire if the new maximum rate is used and tree row volume reqires less than 100 gallons per acre for a dilute spray.

Conclusions

In this first season of commercial use, use Accel cautiously and follow label directions. Use it first on a responsive cultivar, and do not apply it unless temperature conditions are appropriate.

* * * * *

Fruit Notes

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Fruit Notes

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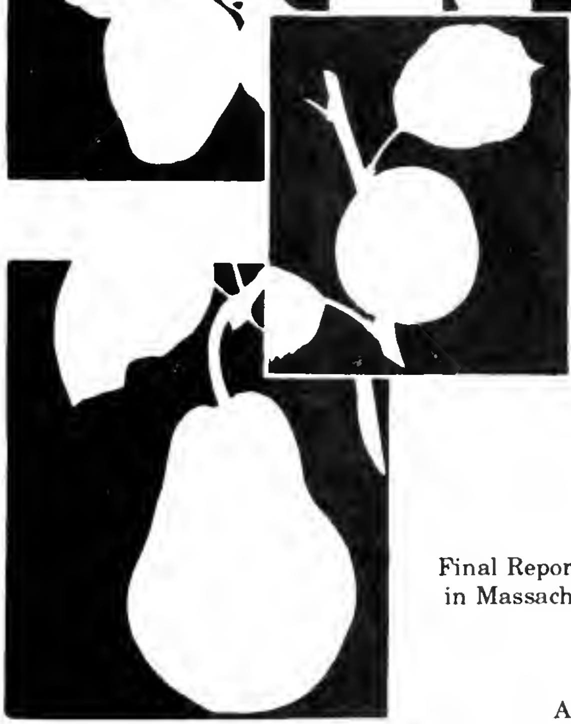

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Fruit Notes

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COOPERATIVE EXTENSION SYSTEM POLICY:

Could Bacteria in Nature be Detoxifying Compounds for the Apple Maggot Fly?

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Insects are exposed, almost continuously, to a variety of harmful compounds. Adults and larvae may come into contact with harmful synthetic chemicals, such as pesticides, or harmful natural compounds, such as plant allelocompounds (plant substances that often protect it against pests). Insects may be exposed to these harmful compounds either through contact or through feeding. Either way, the mechanisms for ridding these poisons from the body are important survival processes. These processes, referred to as detoxification mechanisms, involve enzymes (proteins that facilitate chemical reactions) which alter the structure of the compound and make it more excretable (less toxic). This can be achieved by removal or addition of a chemical group.

Generally, pesticides applied by growers are in amounts that overwhelm the insect's ability to detoxify them. As time goes on, the pesticide on plants is broken down by sunlight, wind, rain, and other natural processes. Eventually, residues may reach concentrations where the insect can survive ingestion or contact. With repeated exposure, the insect may evolve to handle effectively a toxin in concentrations earlier found to be lethal, i.e. develop pesticide resistance.

The apple maggot fly, *Rhagoletis pomonella*, typically is controlled by two or three applications of azinphosmethyl (Guthion™), an organophosphate that is a potent inhibitor of cholinesterase, an enzyme responsible for normal nervous system functioning. Azinphosmethyl also is used to control other orchard pests such as codling moth. Although no information exists to date regarding resistance to azinphosmethyl for the apple maggot fly, resistance has been reported for codling moth.

Mechanisms of insecticide resistance traditionally have been examined using genetic techniques focused on resistant individuals and creation of models of gene flow between resistant and susceptible insects. Less attention has been paid to the potential involvement of bacteria either within or on host plants or within insects in the development of insecticide resistance.

Interestingly, enzymes in bacteria capable of converting toxic compounds into less toxic compounds that are more easily excretable include the same enzymes that insects themselves use in detoxification. In fact, many bacteria can detoxify compounds internally or secrete enzymes responsible for metabolizing foreign compounds into their surrounding environment. Numerous reports exist on the abilities of certain species of bacteria to degrade and detoxify a variety of compounds, including azinphosmethyl and plant allelocompounds.

Here we report on studies designed to determine if bacteria associated with the apple maggot fly could degrade, and subsequently detoxify, azinphosmethyl and plant allelocompounds likely to be consumed by this insect.

Materials & Methods

Pesticide degradation and detoxification. *Enterobacter agglomerans*, a bacterium found to inhabit both the gut of the apple maggot fly and apple leaf surfaces in nature, was added to sterile preparations of azinphosmethyl at a concentration typical of one sprayed by a grower. The bacteria/pesticide solutions and sterile pesticide solutions (void of any bacteria) were incubated at 73°F for 3 days. Cholinesterase was extracted from apple maggot flies and mixed with the bacteria/pesticide solutions to determine whether or not azinphosmethyl still was capable of reducing cholinesterase activity after exposure to the bacteria. Also, small amounts from each sample were fed to 25 apple maggot flies and mortality values were recorded at 24- and 40-hour intervals. Additionally, the solutions were analyzed for degradation products of azinphosmethyl. The experiment was done twice.

Plant allelocompound degradation and detoxification. We also studied four allelocompounds considered to be toxic to apple maggot and typically found in the habitat of apple maggot flies. They were: naringenin, phloridzin, caffeic acid and cinnamic acid. Each solution was inoculated with *Enterobacter agglomerans* and incubated at 87°F for 24 hours. Sterile solutions also were incubated along with the bacterial solutions. Degradation of each compound was measured by changes in pH (a typical phenomenon associated with degradation) and by the presence or absence of degradation products. Also, small amounts from each solution were fed to 10 flies individually, and mortality values were recorded after 12 days.

Results

Mixing cholinesterase extracted from apple maggot flies with azinphosmethyl resulted in low to no cholinesterase activity (14.8 active units). However, activity of cholinesterase was 10 times greater when mixed with azinphosmethyl in which bacteria had grown for three days (144.1 active units). The higher value indicates that cholinesterase activity was not inhibited as much in the bacterial solution and therefore, the pesticide was less effective. We found that loss of effectiveness was the result of chemical alteration of azinphosmethyl by bacteria

Forty hours after a 48-hour-old solution of bacteria and pesticide was fed to apple maggot flies, only three of 50 flies were dead. In contrast, when flies were fed the sterile pesticide solution, 47 of 50 were dead after 40 hours. Fifty flies serving as controls were fed only water. All were alive after 40 hours.

In the allelocompound solutions that contained bacteria, we saw changes in pH (indicative of chemical changes) which were not observed in the sterile solutions, and we were able to detect degradation products in the bacterial solutions that were not present in the sterile solutions. Therefore, bacteria also degraded the plant allelocompounds. When apple maggot flies were fed sterile solutions of the four allelocompounds, all were dead after 12 days; however, when solutions inoculated with bacteria were fed to the flies, none died.

Conclusions

Our laboratory findings indicate that *Enterobacter agglomerans* possesses the ability to degrade and subsequently detoxify azinphosmethyl and certain plant allelocompounds that normally are toxic to apple maggot flies. This finding is an important first step in establishing the contribution of bacteria toward detoxification of harmful compounds encountered in nature by this and other insects.

We are continuing our work in this area by studying (1) precisely how the bacteria degrade toxic compounds, (2) how fly longevity and fecundity are affected by detoxification, and (3) if detoxification mechanisms inherent to flies are enhanced by degradation processes of bacteria. Further comprehension of ways insects handle chemicals in the environment should contribute to pest management programs. Such knowledge also may lead to creation of new ways to decrease or eliminate pesticide crops or on spray equipment. For example, it is conceivable that a bacterial or enzymatic preparation could be sprayed on trees before harvest so that the residues may be decreased or eliminated through detoxification. Envision also, after completion of spraying, a tablet containing bacteria that one drops into the spray tank and a few hours later, the equipment is free from any pesticide. These are exciting possibilities.

Acknowledgments

We thank George MacCollom of the University of Vermont for supplying apple maggot flies during the early stages of this work (which took place at the University of Vermont), Evan Thackaberry (also of the University of Vermont) for his assistance with visualization of pesticide degradation products, and Sylvia Cooley for technical assistance with plant allelocompound-fly mortality studies. This work was supported in part by the National Agricultural Pesticide Impact Assessment Program Grant #92-34050-7268 and USDA National Research Initiative Competitive Grant #893715.

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A New Book on Tree Fruit Nutrition

In February, 1992, a shortcourse on the Management of Tree Fruit Nutrition was held in Wenatchee, Washington. The proceedings from that conference have been published by *Good Fruit Grower* and is available for purchase.

The book consists of 22 generally easy-to-read chapters and totals over 200 pages. It begins with three general chapters on fruit tree growth and development, root development and physiology, and soil characteristics. This base is followed by 12 chapters on minerals and approaches to meeting their needs in trees and fruit. There are also three chapters on diagnosing nutritional needs in orchards, and a chapter on fertilizer effects on water quality. Finally, the book concludes with three chapters on fertigation. Eighteen different authors contributed to the shortcourse and the proceedings.

This is an outstanding reference for fruit growers, and will certainly become a standard reference on nutritional problems in orchards. Copies can be obtained from the *Good Fruit Grower*, P.O. Box 9219, Yakima, WA 98909. Cost is $15.00 plus $3.50 for shipping. We strongly urge growers to obtain a copy and to refer to it often.

Some Thoughts on Depreciation

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Depreciation may be the most misunderstood topic in financial management. It is probably the most complicated exercise in the development of the business financial statement, and it is a critical element in preparation of income tax returns. In fact, the complexity of IRS rules and some computational methods can obscure the concept that underlies depreciation and lead to a misunderstanding of true costs and business profitability.

Depreciation is an annual non-cash expense that reflects the amount by which an asset decreases in value due to use, age, and obsolescence. It applies only to assets like buildings, machines, and breeding animals, as well as to improvements like roads, bridges, fences, and drainageways that have useful lives of more than one year. Depreciation recognizes the fact that these assets can wear out with use. That is, eventually they become so worn that they become useless or repair costs become excessive.

Depreciation also occurs through aging. Even without use, wooden or rubber components can rot, metal can rust or become brittle and break, and plastic can lose strength and crack. Assets also can become obsolete as new technology is developed to perform the same tasks more efficiently and at lower cost, or if the asset is no longer relevant to the nature of the business (e.g., a milking machine becomes obsolete if the dairy herd is sold).

While depreciation is a non-cash expense, there is a "day of reckoning" that comes when the asset must be replaced. One might consider the annual depreciation amounts as money to be put in a reserve account to accumulate until the day when the asset is replaced. In theory, the business then will have the capital accumulated to replace the asset with little or no need to incur new debt. More often, however, no such reserve account exists.

One sometimes observes situations where the annual income statement of a business shows a low or even negative net income and there is a suggestion of insolvency. One might immediately ask how the operator can continue in business and take care of family living expenses if net income is negative. One explanation is that depreciation is subtracted as a cost in the income statement. It's important to recall that depreciation is a non-cash expense. Since depreciation is a non-cash cost, that amount actually is available from cash flow for debt repayment, other business expenses, and for family living costs.

Another answer might be that past earnings in the form of savings are being depleted in order to meet costs and debt obligations. Still another explanation could be that additional debt is being incurred that allows the business to continue and family living expenses to be met. This situation can continue until the time of reckoning when depreciable assets must be replaced. Even though replacement might be possible from borrowed funds, it may be difficult to convince lenders that theyshould make the loan when past income statements show low or negative net income.

Complicating the subject of depreciation are the IRS procedures relating to depreciation. For tax purposes, depreciation is a deductible expense of the business just as if it were a cash cost. Regulations define what kinds of assets may and may not be depreciated. They also establish acceptable methods of calculating depreciation and stipulate recovery periods (the number of years over which different classes of property may be depreciated). Once a particular method has been established for an asset you cannot change to another method, but you can use different methods for different assets.

It's not the purpose of this article to describe depreciation methods and procedures. Rather, only a few points will be made concerning depreciation and tax liability. First, the amount of depreciation taken on business assets can affect tax liability substantially. Second, the selection of the method of depreciation for property can affect tax liability not only in the current year but also in future years (e.g., accelerated methods reduce tax liability in early years of ownership and increase liability in later years as compared with straight line methods). It should be noted that depreciation calculations may have little actual relation to the depreciation costs that relate to wear, aging, and obsolescence of the assets of a particular business. For example, a single purpose farm building with integrally installed equipment can become obsolete or worn out in less than the 10-year recovery period for the IRS General Depreciation System (GDS) regulation. On the other hand, the GDS time period for most farm machinery is seven years. Yet for practical purposes, a fully depreciated tractor (one with a "book value" of zero) may retain its essential usefulness for two or more decades and, therefore, still have real value as an asset.

What this means is that depreciation values can overstate or understate the actual asset value. When assets last longer than the recovery period, the result is an income statement which understates actual net farm income and overstates production costs. In situations, however, where rapid technological innovation causes assets to become obsolete more quickly than the guideline recovery period, the result is an overstatement of net incomes and an understatement of true costs. It often is argued that, since the business typically has a set of different types of assets acquired at different times, these under- and over-statements "wash". That is, they tend to balance out and approximate the real value for the entire set of assets.

There also are implications for the net worth statement for the business. Assets may be valued according to market value or cost value. Using cost valuation one would use the "book value" or depreciated value for the asset. Very often the market value of the asset is greater than the book value, especially when accelerated depreciation methods have been used. As a result, net worth may be understated and the solvency position of the business will be lower than is actually the case. This, in turn, may have a negative impact on the ability of the owner to obtain needed credit for the business. For this reason, when seekingadditional credit, the potential borrower might find it more advantageous to present the lender with a net worth statement with assets stated in market value terms.

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Effects of Low Temperature, Ripening, and Light on Scald Susceptibility of Apples at Harvest

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Many factors influence scald susceptibility of apples, including cultivar, orchard locality, weather, harvest maturity, and storage conditions. For example, Cortland and Delicious are very susceptible, McIntosh is moderately susceptible, and Empire and Gala seldom if ever develop scald. Also, it has long been recognized that fruit generally become less susceptible as they become more mature. Among weather conditions, preharvest temperature is especially important, with cool temperatures before harvest reducing scald susceptibility. Another potentially significant factor is light, since scald is usually more prevalent on the green (shaded) portion of a fruit than on the red (sunlit) portion, and fruit from the interior of the tree usually are more susceptible than ones from the exterior.

We have been attempting to predict scald susceptibility from preharvest temperature records, using hours below 50°F as our temperature indicator. In attempting to apply such a predictor to orchard conditions, however, it is important to understand how much some of the other key factors contribute to changes in scald susceptibility, for if they are major contributors, they must also be included in a predictor system to avoid potential errors in predictions.

Consequently, we conducted a three-year study (1988 through 1990) of the effects of preharvest hours below 50°F, fruit maturity, and light intensity on scald susceptibility of Cortland and Delicious apples grown at the University of Massachusetts Horticultural Research Center, Belchertown.

Three experiments were conducted. In the first, both Cortland and Delicious were harvested at three or four weekly intervals in each year, and stored at 32°F for 20 weeks, with scald being evaluated after an additional seven days at room temperature. Preharvest temperatures were recorded continuously in an enclosed shelter in the orchard, so hours below 50°F after August 1 could be counted at each harvest date. Fruit maturity at harvest was measured both by internal ethylene content of the fruit and by their average starch score, obtained by staining 10 fruit per sample with an iodine-potassium iodide solution and comparing their stain intensity to standard charts, with one indicating complete staining (very immature) and nine indicating no staining (very mature). With each succeeding harvest date, fruit were more mature, as shown by increasing starch index and increasing internal ethylene content (Table 1). In all but one instance, however, fruit from each succeeding harvest date also had experienced more hours below 50°F, so later harvest represented a combination of both riper fruit and more preharvest exposure to cool temperatures.

After 20 weeks at 32°F plus one week at room temperature, scald development was quite variable among samples (Table 1). In general, scald decreased with later harvest but there were exceptions; for example, scald did not decrease from the September 15 to the September 22 harvests in 1989 on Cortland. Also, scald susceptibility on corresponding dates in different years was not always comparable; for example,

Table 1. Changes in scald susceptibility of apples harvested at weekly intervals in three years.

Year	Harvest date	Hours below 50°F	Starch index[z]	Ethylene concentration (log ppm)	Scald (%)
Cortland					
1988	Sept 13	73	1.2	-1.13	71
	Sept 22	102	2.0	-1.00	36
	Sept 29	134	4.0	-0.65	11
	Oct 6	187	5.0	0.15	4
1989	Sept 15	62	1.0	-1.06	99
	Sept 22	62	1.7	-0.86	99
	Oct 4	152	4.7	0.08	29
1990	Sept 17	21	1.3	-0.97	98
	Sept 24	79	1.5	-1.19	78
	Oct 3	127	4.3	0.23	46
	Oct 11	150	6.8	2.08	49
Delicious					
1988	Oct 1	160	1.3	-1.57	12
	Oct 8	232	1.6	-2.52	2
	Oct 13	365	1.9	-1.16	2
1989	Sept 29	125	1.4	-0.71	83
	Oct 5	170	2.6	0.32	72
1990	Sept 21	62	1.2	-1.54	94
	Sept 26	104	1.6	-0.96	88
	Oct 3	127	3.2	-0.26	69
	Oct 11	150	5.5	1.18	51

[z]1 = very immature; 9 = very mature.

Delicious harvested October 1, 1988 developed 12% scald, while ones harvested on October 3, 1990 developed 69% scald,even though the 1990 fruit were somewhat more mature than those in 1988.

In a second experiment, Cortland apples were sprayed in August with ethephon to induce ripening before they had experienced substantial amounts of preharvest cool temperatures. In 1989, only 500 ppm ethephon was applied, but in 1990 both 250 and 500 ppm were used. Both concentrations caused fruit to ripen in early September. In 1989, some hours below 50°F were recorded before the harvests, but in 1990 none had occurred, so any effect of treatment on scald in 1990 should have been due entirely to more advanced maturity. In both years, ethephon treatment significantly reduced scald after storage (Table 2); however, differences usually were small. In particular, in 1990 when fruit ripened in the absence of any hours below 50°F, all samples developed scald on more than 90% of the fruit. Ethephon sprays have been reported to reduce scald on Granny Smith and Delicious in several parts of the world, but clearly under our conditions, ethep-

Table 2. Effects of ethephon on ripeness at harvest and on scald development on Cortland apples after storage. Ethephon was applied on August 16, 1989 and on August 20, 1990.

Harvest date	Ethephon (ppm)	Hours below 50°F	Starch index[z]	Ethylene concentration (log ppm)	Scald (%)
1989					
Sept 6	0	52	1.2	-1.05	87
	500		7.4	2.00	81
Sept 13	0	62	1.3	-0.64	96
	500		8.4	2.13	67
1990					
Sept 1	0	0	1.0	-2.35	97
	250		4.8	1.86	90
	500		5.9	2.08	92
Sept 6	0	0	1.3	-1.82	99
	250		7.3	2.12	91
	500		6.9	1.95	96

[z]1 = very immature; 9 = very mature.

hon treatment was not effective on Cortland, as Windus and Shutak (*J. Amer. Soc. Hort. Sci.* 102:715-718) also reported in 1977.

The third experiment was designed to test the importance of light intensity on scald susceptibility. In 1989 and 1990, Cortland apples were enclosed individually in brown kraft paper bags in mid-to-late August, and kept in these bags until they were harvested. Bags had almost no effect on fruit temperature. Each year two harvests were made. Bagging did not affect fruit maturity significantly in either year (Table 3); however, it resulted in fruit with greater scald susceptibility, and differences usually were quite large. Thus, under our conditions severe reduction of light intensity increased scald susceptibility, but it should be noted that even bagged fruit were becoming less scald susceptible with later harvest, indicating that bright light is not required in order for the maturity and temperature factors to affect scald susceptibility.

These results showed that under our conditions preharvest temperature was the most important factor affecting scald susceptibility of Cortland and Delicious apples. In Figure 1, all three years of data were used to illustrate this effect. For Cortland, scald susceptibility began to decline when the fruit had experienced slightly less than 100 hours below 50°F between August 1 and harvest. By about 150 hours, susceptibility had fallen to the point where 40 to 50% of fruit scalded, and as they approached 200 hours, only about 10% scalded. Delicious required about 25 more hours below 50°F to reach these same levels of susceptibility.

The effects of temperature differences among different harvests and years can be seen in Table 1. For example, in 1989 no loss of scald susceptibility of Cortland occurred when harvest was delayed from September 15 to 22, and it can be seen that temperatures were continu-

Table 3. Effects of bagging on ripeness at harvest and on scald development after storage of Cortland apples. Fruit were bagged August 21 to 25, 1989 and August 13 to 14, 1990.

Harvest date	Treatment	Hours below 50°F	Starch index[z]	Ethylene concentration (log ppm)	Scald (%)
1989					
Sept 18	Control	62	1.3	-1.18	95
	Bagged		1.6	-1.27	100
Oct 2	Control	147	5.1	-0.21	27
	Bagged		4.4	0.02	90
1990					
Oct 1	Control	107	3.2	-0.07	31
	Bagged		3.4	0.24	62
Oct 9	Control	150	6.4	1.21	13
	Bagged		6.0	1.41	42
Significance[y]					
1989	Bagging		NS	NS	*
	Hours below 50°F		***	NS	**
1990	Bagging		NS	NS	*
	Hours below 50°F		***	**	NS
	Bagging x Hours		NS	NS	NS

[z]1 = Very immature; 9 = very mature.
[y]NS = not significant; * = odds of 19:1; ** = odds of 99:1; *** = odds of 999:1.

ally above 50°F between these dates. In Delicious, there was almost no scald in 1988 even though fruit were quite immature; this was a very cool year, and 160 hours below 50°F had been recorded by the first harvest date. Harvest of Delicious on similar dates in 1989 and 1990 resulted in much more scald development than in 1988, and in these years fewer hours below 50°F had been recorded by the harvest dates than in 1988.

Clearly, maturity and light also played roles in loss of scald susceptibility by the apples, since ethephon treatment reduced scald and bagging increased it. The results with ethephon (Table 2) are interesting in that in 1989, when some hours below 50°F had been recorded before harvest, ethephon reduced scald more than in 1990, when no hours had been recorded. This suggests that cool temperature increased the effect of ripening (or vice versa) in reducing scald susceptibility, that is, that temperature and ripening worked together in reducing scaldsusceptibility. Nevertheless, cool temperature clearly was the more important factor in this relationship.

How important light is in this relationship cannot be measured by our results, since we used nearly complete light exclusion by bagging the fruit. Yet, it is likely that reducing scald susceptibility is one more reason for encouraging light penetration into the tree interior, for

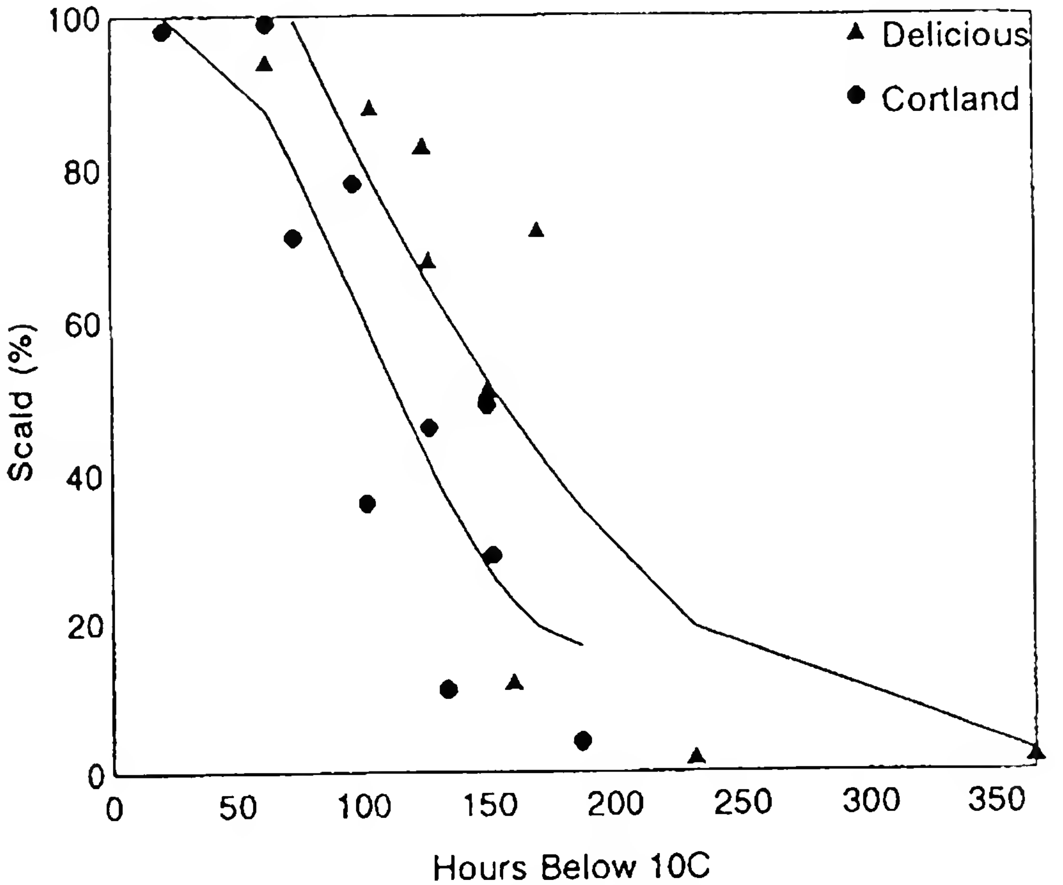

Figure 1. Calculated changes in scald susceptibility (percent of fruit that develop scald after storage) with increasing hours below 50°F between August 1 and fruit harvest date.

example, by summer pruning. Shaded fruit probably require more cool temperature and ripening to become less scald susceptible than do exposed fruit.

Our results show how rapidly scald susceptibility can change during the harvest period, and that cool temperature is the most important factor in this change. In Figure 1 you can see that if a couple of days occur when the temperature is almost continually below 50°F, scald susceptibility can drop dramatically; this situation commonly occurs in early October in Massachusetts. Conversely, if the temperature remains constantly above 50°F for a period of time, little or no loss of scald susceptibility will occur, even though the fruit may ripen substantially.

We are attempting to develop a practical, reliable predictive system so that growers can estimate at harvest how scald susceptible their fruit are, and determine their scald control method according to need. At Belchertown, just counting hours below 50°F at harvest has worked well. In other regions, however, it is not as effective, which raises questions about the relationships between temperature and scald in "unusual years" in Massachusetts. The results here show that maturity and light also can be important factors, and we hope to have a much clearer picture of scald predictions in the near future.

Final Report on the 1984 NC-140 Cooperative Apple Rootstock Planting in Massachusetts: Starkspur Supreme Delicious on Fifteen Rootstocks

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Dwarfing rootstocks clearly are part of the future of the apple industry in New England. At a time when production costs often are not exceeded by returns, apple growers must take advantage of all opportunities to reduce costs or increase returns. Dwarfing rootstocks may al-

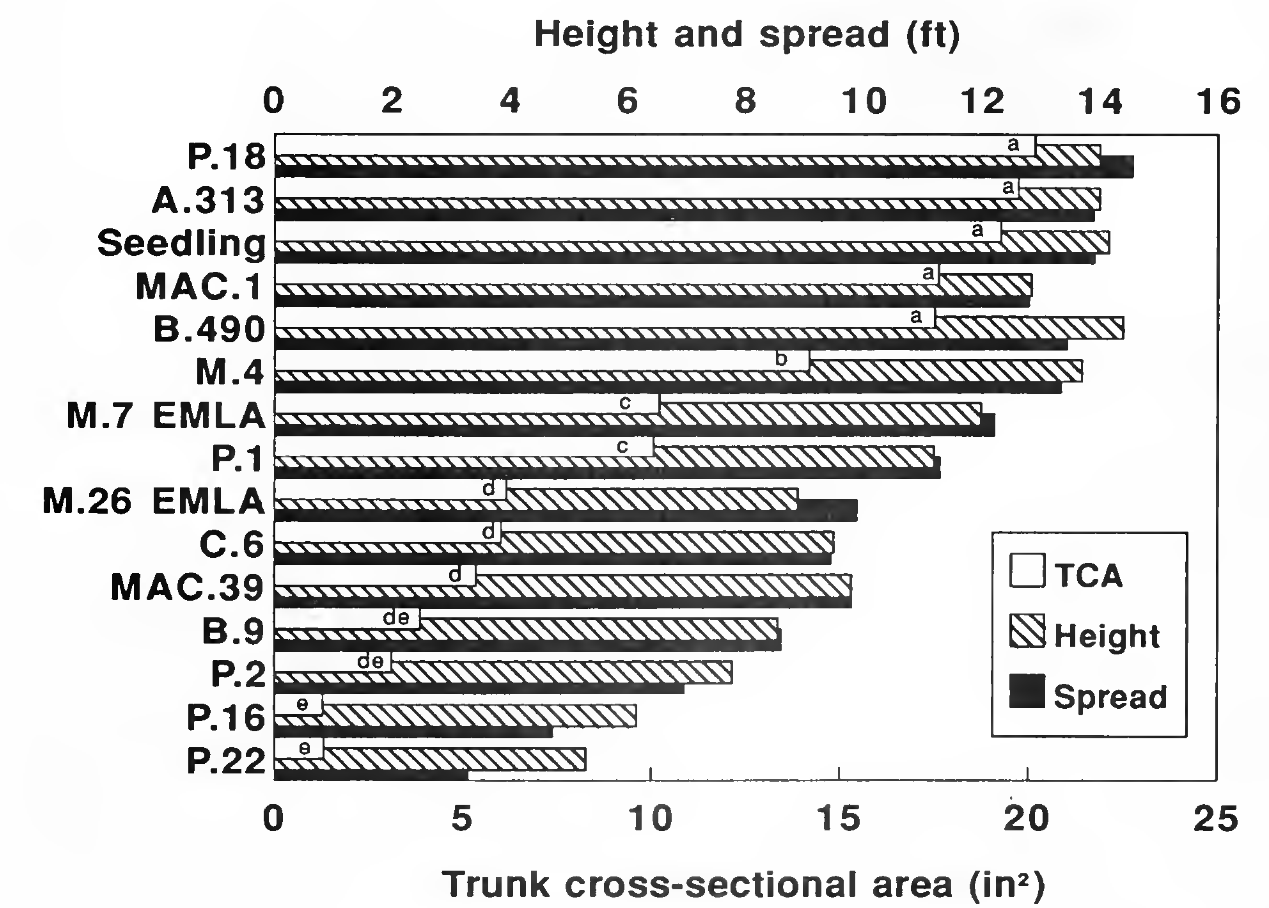

Figure 1. Trunk cross-sectional area, height, and spread of Starkspur Supreme Delicious trees on various rootstocks after 10 growing seasons. Trunk cross-sectional area means are significantly different at odds of 19:1 if bars do not contain the same letter.

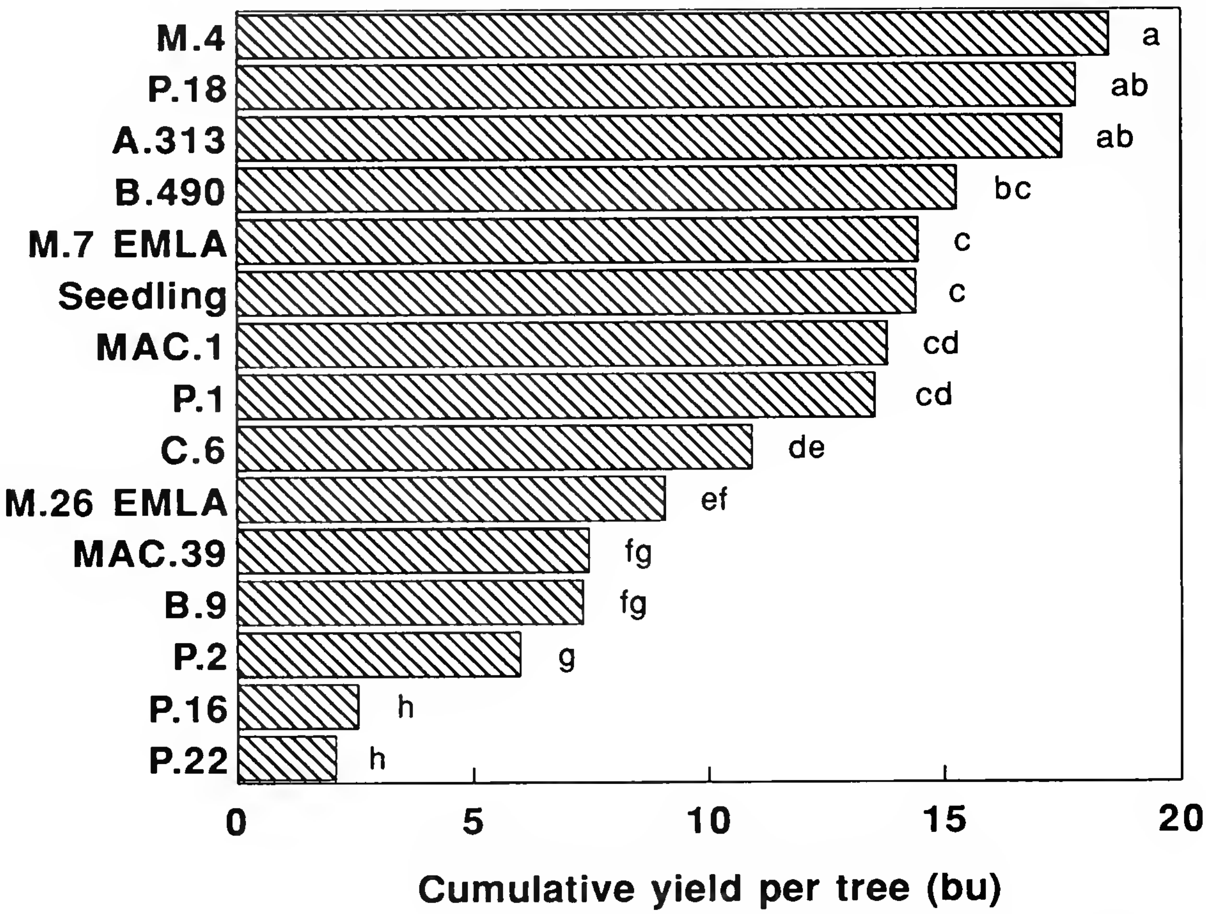

Figure 2. Cumulative yield (per tree, 1987-93) of Starkspur Supreme Delicious trees on various rootstocks. Means are significantly different at odds of 19:1 if bars are not followed by the same letter.

low both. Quicker return on the investment of establishment, potentially higher yields, higher packout because of better light penetration into the canopy, less pesticide needed to treat each acre, and lower labor needs for harvesting and pruning all make dwarf trees a very desirable alternative when compared to semidwarf or standard trees.

In the last issue of *Fruit Notes*, I gave the final report of a rootstock trial that began in 1980 as part of a cooperative planting of the NC-140 Technical Research Committee. In this article, I will detail the final report of the Massachusetts portion of the 1984 NC-140 Cooperative Apple Rootstock Planting.

Materials & Methods

Starkspur Supreme Delicious trees on B.9 (Budagovsky 9), B.490, MAC.1 (Michigan Agricultural College 1), MAC.39, P.1 (Polish 1), P.2, P.16, P.18, P.22, M.4 (Malling 4), M.7 EMLA, M.26 EMLA, C.6, A.313 (Antonovka 313), and domestic seedling were planted at a spacing of 12 x 18 feet at the University of Massachusetts Horticultural Research Center in the spring of 1984. Trees were trained as central leaders using minimal pruning and limb spreading as needed. Containment pruning was required for many of the larger trees. Stakes were added for support only when trees leaned more than 45 degrees. Standard pest and fertility management practices were used.

Tree size and yield were measured annually; however, trees were not allowed to fruit until the fourth growing season (1987). In 1989, 1990, 1992, and 1993, periodic harvests of four fruit per tree were made throughout the harvest season for the assessment of internal ethylene concentrations. Single harvests of ten fruit per tree were made on October 3, 1990, October 3, 1991, October 5-6, 1992, and October 11, 1993 for the assessment of soluble solids concentration, starch loss, and watercore development.

Tree Size and Productivity

Figure 1 reports the average height, spread, and trunk circumference of trees from this planting. Due to the need for containment pruning of trees that exceeded the 12-foot spacing, height and spread do not present an accurate picture of trees on P.18, A.313, seedling, MAC.1, B.490, M.4, M.7 EMLA, or P.1. Trunk cross-sectional area likely is a more accurate measure of relative tree size. These trees broke into a few distinct size groupings. Standard-sized trees were produced by P.18, A.313, seedling, MAC.1, and B.490. M.4 resulted in semi-standard trees. M.7 EMLA and P.1 produced semi-dwarf trees. M.26 EMLA, C.6, and MAC.39 resulted in large dwarf trees, and P.22 and P.16 produced subdwarfs. B.9 and P.2 produced trees intermediate in size to these last two categories.

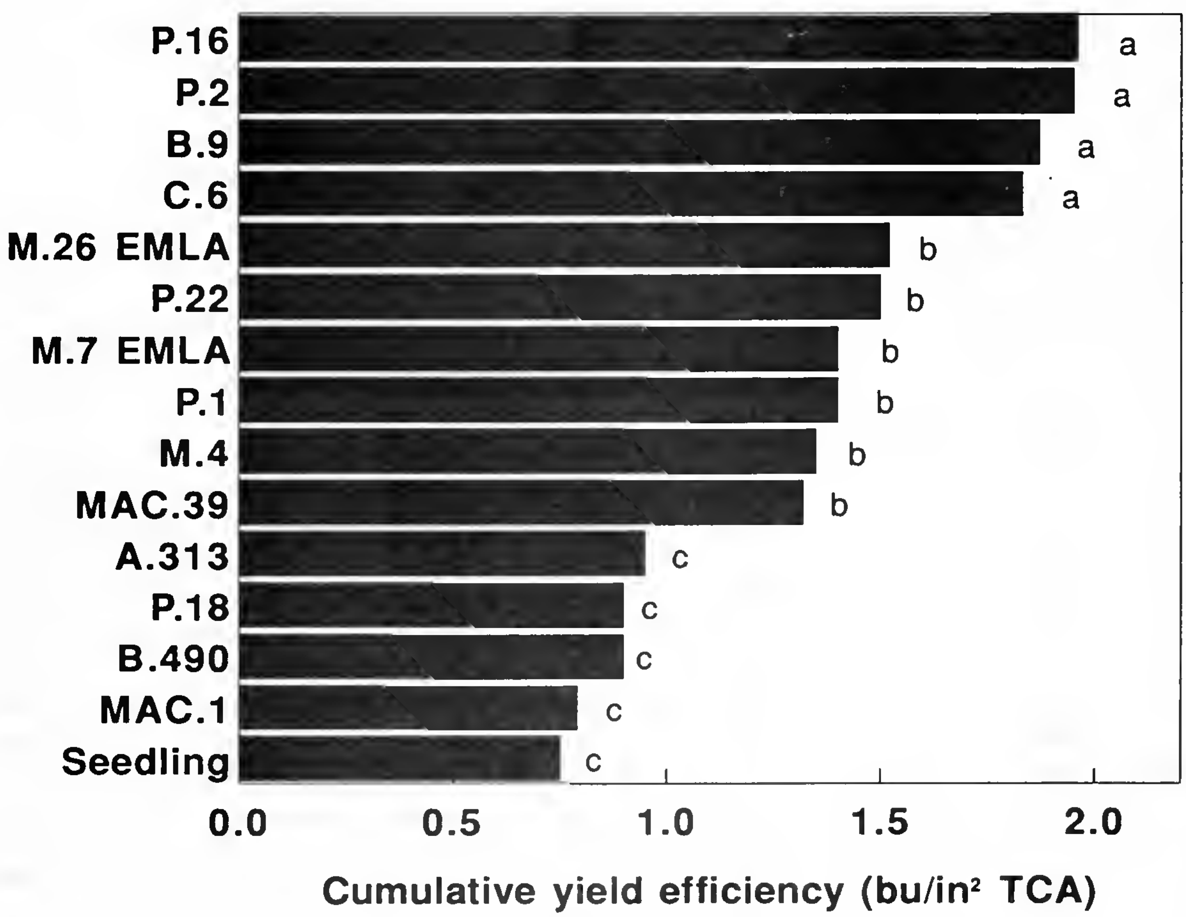

Figure 3. Cumulative yield efficiency (1987-93) of Starkspur Supreme Delicious trees on various rootstocks. Means are significantly different at odds of 19:1 if bars are not followed by the same letter.

Yield per tree (Figure 2) roughly correlated with tree size, with the largest trees producing the most fruit and the smallest trees producing the least. It is more important, however, to compare potential yield relative to tree size, i.e. more smaller trees can be planted per acre, which may or may not result in more overall yield. Yield efficiency is a somewhat accurate assessment of relative yield potential. It presents yield per trunk cross-sectional area. Figure 3 gives cumulative yield efficiencies for trees in this planting. The rootstocks break clearly into three groups. The most efficient trees were on P.16, P.2, B.9, or C.6. The least efficient were on A.313, P.18, B.490, MAC.1, or seedling. Trees on M.26 EMLA, P.22, M.7 EMLA, P.1, M.4, or MAC.39 were intermediate in efficiency. A less accurate method for assessing potential yield uses estimates of planting density based on tree spread (Table 1). In this planting, more containment pruning was used for the largest trees than for the smallest, so potential planting densities were very rough estimates, particularly for the largest trees. Multiplying density by yield per tree gives potential yield per acre. Figure 4 plots yield per acre by year from 1987 through 1993. Figure 5 gives potential yield per acre on a cumulative basis over the seven fruiting years of these trees. The results were similar to those obtained when comparing yield efficiencies among rootstocks. The highest yields per acre may be expected from trees on C.6, P.2, P.22, B.9, or M.26 EMLA. The lowest may be expected from trees on P.18, A.313, B.490, MAC.1, or seedling.

Table 1. Projected spacing and tree density of Starkspur Supreme Delicious on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts.

Rootstock	Spacing: Between trees	Spacing: Between rows	Number of trees per acre
P.18	17	24	107
A.313	17	24	107
Seedling	17	24	107
MAC.1	16	23	118
B.490	16	23	118
M.4	15	22	132
M.7 EMLA	14	21	148
P.1	13	20	168
M.26 EMLA	9	16	303
C.6	8.5	15.5	331
MAC.39	8.5	15.5	331
B.9	7.5	14.5	401
P.2	6.3	13.3	520
P.16	3.9	10.9	1025
P.22	2.8	9.8	1587

Fruit Ripening

Knowledge of the effects on fruit ripening is a critical component of rootstock evaluation. The potential for advancement or delay in ripening must be known so that harvest can be managed appropriately. If the delay or advancement is predictable, it may be beneficial to use it to expand the harvest season.

To assess the effects of rootstock on ripening, internal ethylene, soluble solids (sugars) concentration, watercore development, and starch loss were measured in fruit from this planting. Ethylene is a gaseous hormone present in all plants, but is very important to ripening in a number of fruits. Ethylene is a trigger of ripening and during the course of ripening, it increases many fold in apple fruit. It is possible to track ripening of apples by measuring ethylene concentration in the core cavity. Table 2 reports the date in 1989, 1990, 1992, and 1993 when the average internal ethylene concentration reached one ppm. Results were not entirely consistent from year to year, but a few rootstocks were consistently either in the lowest or highest category. Specifically, fruit from trees on B.9, MAC.39, M.7 EMLA, M.26 EMLA, or P.16 consistently were among the first few to reach one ppm internal ethylene. Fruit from trees on seedling, M.4, B.490, P.18, or A.313 consistently were among the last to reach one ppm internal ethylene.

Internal ethylene is one of the most accurate measures of the progress of ripening; however, it

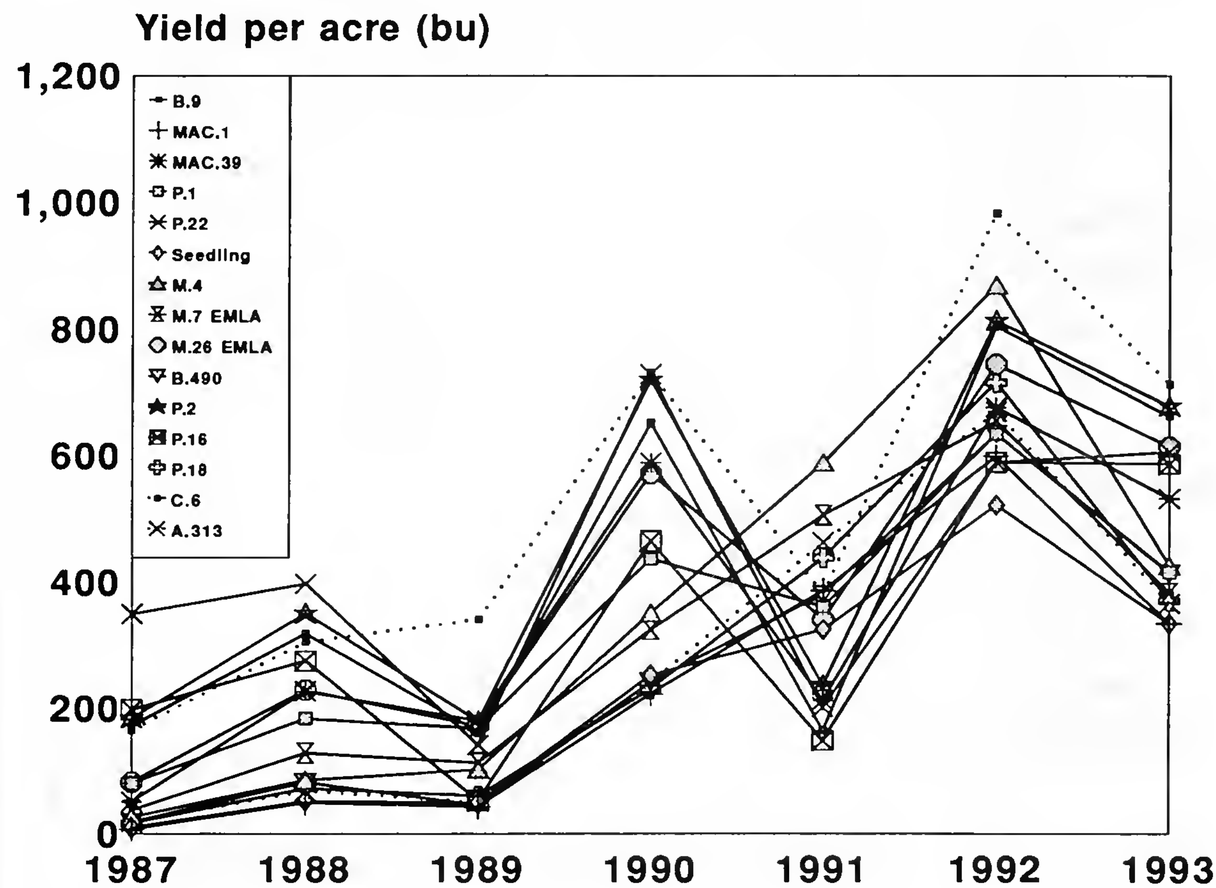

Figure 4. Yield (per acre) of Starkspur Supreme Delicious trees on various rootstocks from 1987 through 1993. Estimates of appropriate spacings were used to calculate potential yield on a per-acre basis.

is necessary to assess additionally other characteristics to get the most accurate picture of the difference in ripening. Soluble solids (or sugars) generally increase in concentration during the course of ripening as the result of the breakdown in starches. Table 3 give the soluble solids concentration of fruit from these trees in 1990, 1991, 1992, and 1993. Fruit from trees on B.9, MAC.39, P.22, P.2, or P.16 consistently were among those with the highest levels of soluble solids. On the other hand, fruit from trees on MAC.1, seedling, M.4, M.7 EMLA, B.490, P.18, or A.313 were consistently among the lowest.

Starch breakdown is measured easily by staining cut apples with an iodine-potassium iodide solution. Iodine stains the starch blue, leaving a distinctive pattern. This pattern changes during ripening in a regular way and can be compared to a standard chart to assess the progress of ripening. The index used in this study ranged from one to nine, with one staining densely and nine not staining at all. The index, therefore, increases during the course of ripening. Table 4 reports starch index values from this study for 1990, 1991, 1992, and 1993. Fruit from trees on B.9, P.22, P.2, or P.16 consistently were among the highest for starch index; whereas, fruit from trees on seedling, MAC.1, M.4, A.313, or P.18 consistently were among the lowest.

As starch breaks down to sugar, osmotic imbalances may occur in the flesh of apples

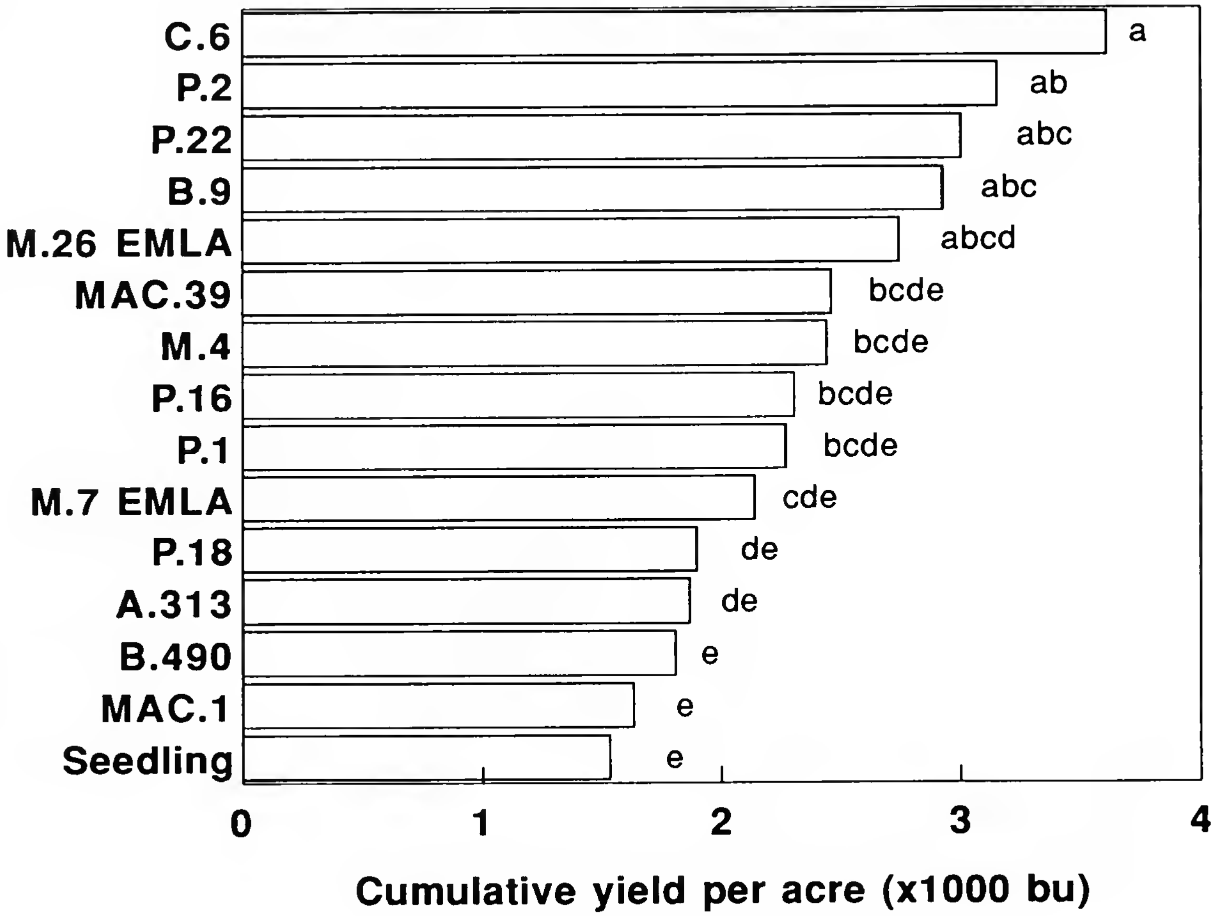

Figure 5. Cumulative yield (per acre, 1987-93) of Starkspur Supreme Delicious trees on various rootstocks. Estimates of appropriate spacing were used to calculate potential yield on a per-acre basis. Means are significantly different at odds of 19:1 if bars are not followed by the same letter.

which result in the development of watersoaked areas. This disorder is referred to as watercore. Watercore generally becomes more severe as ripening progresses. Table 5 reports watercore index values from this study for 1990, 1991, 1992, and 1993. The index used ranges from one to seven, with one representing no watercore and seven representing severe watercore. Fruit from trees on B.9, MAC.39, P.22, P.2, or P.16 consistently were among the ones with the most watercore when there were differences. Fruit from trees on seedling, M.4, B.490, or P.18 were consistently among the lowest.

Taking all of these characteristics into consideration, it appears that B.9 and P.16 consistently advanced ripening. MAC.39, P.2, and P.22 were less consistent but also may have resulted in an advancement of ripening. Seedling, M.4, and P.18 delayed ripening. B.490 and A.313 were less consistent but also may have delayed ripening. MAC.1, P.1, M.7 EMLA, M.26 EMLA, and C.6 were either intermediate in their effects on ripening or were inconsistent.

It is important for the grower to note the potential effects that rootstocks can have on apple ripening. In this planting, however, those effects were variable and unpredictable, preventing them from being exploited to expand the harvest season. Hopefully, other rootstocks will be found that have more predictable effects.

Table 2. Date when the average internal ethylene concentration of Starkspur Supreme Delicious fruit reached one ppm. Fruit were from trees on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts. Means were adjusted for the effects of crop load.[z]

Rootstock	1989		1990		1992		1993	
P.16	--		--		10/9	cd	10/4	ef
M.26 EMLA	9/23	d	10/7	c	10/9	d	10/5	ef
B.9	9/24	cd	10/6	c	10/11	abcd	10/5	ef
M.7 EMLA	9/24	cd	10/5	c	10/9	cd	10/7	cde
C.6	9/27	bc	10/6	c	10/9	cd	10/9	bc
P.1	9/25	bcd	10/6	c	10/11	abcd	10/9	bcd
P.18	9/27	bcd	10/6	c	10/11	abcd	10/9	bcd
P.2	--		10/13	b	10/10	abcd	10/6	def
P.22	--		10/21	a	10/10	bcd	10/3	f
MAC.39	9/26	bcd	10/6	c	10/11	abcd	10/7	cde
B.490	9/26	bcd	10/6	c	10/13	a	10/9	bcd
Seedling	--		--		10/13	ab	10/8	bcd
MAC.1	9/28	ab	10/6	c	10/12	abc	10/7	cde
M.4	10/1	a	10/6	c	10/12	abcd	10/10	ab
A.313	--		--		10/13	ab	10/13	a

[z] Means within a column not followed by the same letter are significantly different at odds of 19:1.

Table 3. Soluble solids concentration (%) of Starkspur Supreme Delicious fruit from trees on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts. Means were adjusted for the effects of crop load.[z]

Rootstock	1990		1991		1992		1993	
P.22	10.7	ab	13.7	ab	10.8	a	12.7	a
MAC.39	10.3	abc	13.3	abc	10.3	b	12.4	abc
B.9	10.8	a	13.2	bc	9.8	bcd	12.4	ab
P.2	10.5	abc	13.8	a	10.0	bcd	11.9	bcd
M.26 EMLA	10.6	ab	13.1	c	10.0	bcd	12.1	bc
P.16	--		13.3	abc	10.2	bc	12.2	bc
C.6	10.6	ab	12.8	cd	10.0	bcd	11.5	d
P.1	10.5	abc	12.6	de	10.0	bcd	11.8	cd
MAC.1	9.9	d	11.8	gh	9.7	cd	12.2	abc
M.4	10.0	cd	12.3	ef	9.6	cd	12.0	bcd
M.7 EMLA	10.2	bcd	12.0	fg	10.0	bcd	11.8	cd
B.490	9.8	d	--		9.5	d	11.9	bcd
Seedling	--		--		9.5	d	11.8	cd
A.313	--		--		9.5	d	12.0	bcd
P.18	9.8	d	11.4	h	9.7	cd	11.9	bcd

[z] Means within a column not followed by the same letter are significantly different at odds of 19:1.

Table 4. Starch index values of Starkspur Supreme Delicious fruit from trees on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts. The starch index used ranged from one to nine, with fruit rated as one having almost complete starch staining and those rated as nine having no starch staining. Means were adjusted for the effects of crop load.[z]

Rootstock	1990		1991		1992		1993	
P.22	4.5	a	4.1	a	3.7	ab	5.2	a
P.16	--		4.1	a	3.8	a	4.4	bc
P.2	3.9	b	3.9	a	3.2	abcd	4.6	b
B.9	3.9	b	3.5	abc	3.5	abc	4.0	bcd
M.26 EMLA	3.4	bc	3.7	ab	3.3	abcd	4.4	bc
P.1	3.4	bc	3.0	cd	3.2	abcd	4.6	b
MAC.39	3.7	bc	3.5	abc	3.1	bcde	4.2	bcd
C.6	3.3	bc	3.2	bcd	3.1	bcde	4.3	bcd
M.7 EMLA	3.6	bc	3.2	bcd	2.8	de	4.2	bcd
B.490	3.4	bc	--		2.9	cde	4.3	bcd
MAC.1	3.4	bc	3.1	cd	2.8	de	4.1	bcd
A.313	--		--		2.7	de	4.3	bcd
P.18	3.5	bc	2.9	d	2.5	e	4.0	bcd
Seedling	--		--		2.8	de	3.8	cd
M.4	3.2	c	2.8	d	2.5	e	3.7	d

[z] Means within a column not followed by the same letter are significantly different at odds of 19:1.

Table 5. Watercore index values of Starkspur Supreme Delicious fruit from trees on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts. The watercore index used ranged from one to seven, with fruit rated as one having no watercore and those rated as seven having severe watercore. Means were adjusted for the effects of crop load.[z]

Rootstock	1990		1991		1992		1993	
P.16	--		2.5	ab	1.1	a	4.3	a
MAC.39	1.1	a	2.4	abc	1.4	a	3.2	bc
B.9	1.1	a	2.3	abc	1.1	a	3.5	b
P.2	1.2	a	2.3	abc	1.2	a	2.9	cd
P.22	1.0	a	2.3	abc	1.1	a	3.0	c
P.1	1.1	a	2.5	a	1.2	a	1.8	fg
M.26 EMLA	1.1	a	2.0	bcd	1.3	a	2.8	cd
M.7 EMLA	1.1	a	2.1	abcd	1.2	a	2.4	de
MAC.1	1.0	a	1.9	cd	1.2	a	2.3	c
A.313	--		--		1.1	a	2.2	ef
C.6	1.1	a	2.3	abc	1.1	a	1.7	gh
B.490	1.0	a	--		1.1	a	1.9	efg
P.18	1.0	a	1.8	d	1.1	a	1.9	efg
Seedling	--		--		1.1	a	1.6	gh
M.4	1.0	a	2.1	abcd	1.1	a	1.3	h

[z] Means within a column not followed by the same letter are significantly different at odds of 19:1.

Table 6. Fruit size, presented as the number of fruit per 42-lb box, for Starkspur Supreme Delicious trees on various rootstocks in the 1984 NC-140 Cooperative Planting in Massachusetts. Fruit size was adjusted to account for differences in crop load.[z]

Rootstock	1988		1989		1990		1991		1992		1993	
C.6	80	a	77	ab	76	a	108	a	75	a	90	ab
MAC.39	82	ab	73	a	78	a	113	a	77	ab	86	a
P.2	86	abc	81	abcd	76	a	109	a	78	abc	88	ab
B.9	88	abcd	82	abcd	78	a	109	a	81	abcd	88	ab
M.26 EMLA	86	abc	83	abcd	82	abc	107	a	82	abcd	88	ab
M.7 EMLA	93	bcde	81	abcd	87	abcd	102	a	81	abcd	91	ab
P.16	96	cde	83	abcd	82	abc	103	a	86	bcde	91	ab
P.1	88	abcd	82	abcd	86	abcd	106	a	86	bcde	102	bc
P.22	92	bcde	79	abc	81	ab	100	a	97	e	114	c
M.4	102	de	93	d	85	abcd	105	a	90	de	93	ab
Seedling	106	e	91	d	78	a	108	a	95	e	96	ab
P.18	93	bcde	82	abcd	108	e	99	a	92	de	91	ab
B.490	95	cde	87	bcd	93	cd	102	a	88	cde	88	ab
MAC.1	103	e	90	cd	90	bcd	107	a	96	e	90	ab
A.313	96	cde	87	bcd	95	de	102	a	92	de	91	ab

[z] Means within a column not followed by the same letter are significantly different at odds of 19:1.

Fruit Size

Fruit size is a very important determinant of financial return for the apple grower. In this study, fruit size was assessed annually from 1988 through 1993 (Table 6). Effects of rootstock on fruit size varied somewhat from year to year, but some rootstocks were more consistent in their effects than others. Fruit from trees on C.6, MAC.39, P.2, B.9, or M.26 EMLA always were among the largest; whereas, fruit from trees on A.313 or P.18 were among the smallest. The potential effects that a rootstock can have on fruit size should be factored into the rootstock selection process.

The Winners

Standard sized trees are no longer economically viable alternatives for orchard planting. Semidwarf trees are quickly losing their economic viability, because of labor requirements for harvest and management, fruit quality, and return on investment. As mentioned in the introduction, growers must move to dwarf trees to enhance the viability of their businesses. In this planting, trees on the various rootstocks ranged from standard sized to subdwarf. The rootstocks that have the most potential based on their effects on tree size are M.26 EMLA, C.6, MAC.39, B.9, P.2, P.16, or P.22, from the largest to the smallest, respectively. All result in what would be considered dwarf trees. As a general category, the dwarf trees outperformed other trees in the planting. In terms of potential productivity (taking into account yield efficiency and the potential yield per acre), C.6, P.2, and B.9 performed the best in the planting . These three also resulted in fruit in the largest category each year when there were differences related to rootstock. Trial plantings of C.6, P.2, and B.9 should be established by growers to determine further their suitability for New England conditions.

O' Say Can You See Mite Predators in Apple Orchards?

Ronald J. Prokopy, Xingping Hu, and Jennifer Mason
Department of Entomology, University of Massachusetts

Most apple growers recognize the importance of spider mites as potential pests and predatory mites as potential beneficials in orchards. We in fruit research and extension often advise growers to scout trees both for predatory mites and pest mites before deciding whether or not to apply a miticide. The ratio of predatory to pest mites frequently is used as one of the bases for a spray decision. If there are one or more predators to every five pest mites, then there is reason to believe that predators can provide effective control without pesticide treatment. Making such a determination through scouting sounds simple enough, but in fact, it is quite demanding. Sampling a representative set of leaves in the orchard is difficult, but even more difficult is seeing predatory mites and distinguishing them from pest mites or mites that are neither friend nor foe.

Here, we report on a study conducted in 1993 in which mite predator abundance on tree leaves assessed in the field by IPM scouts compared with mite predator abundance on tree leaves taken to the laboratory and examined under a microscope by a skilled mite taxonomist.

Materials & Methods

We sampled leaves an average of 12 times (May to September) from a second-level IPM test block and an adjacent first-level IPM check block in each of 12 orchards, for a total of 298 sample events. For each event, we picked 10 leaves at random from each of 20 trees. All 10 leaves from each tree were examined immediately by one or another member of the six-member IPM scouting team using an Optivisor (3x power). Five of these leaves (chosen at random) were placed immediately in a cooler and returned the same day to a refrigerator at 40F in our laboratory, where soon afterward they were examined under a microscope (15x power). In all, 59,600 leaves were examined in the field and 29,800 in the laboratory. We did not count every predator seen. Rather, we recorded the percentage of leaves in each 100-leaf batch that had predatory mites.

Results

Of all sampled leaves, only 0.8% were observed to have phytoseiid mite predators (ivory-colored *Amblyseuis fallacis* or ivory colored *Typhlodromus pyri*) by IPM scouts in orchards compared with 3.5% under a laboratory microscope (Table 1). For stigmaeid mite predators (yellow-colored *Zetzellia mali*), percentages were 2.2 and 5.5, respectively.

Among the 298 batches of sampled leaves, 17.9% were classified by both IPM scouts and lab exam as having phytoseiids present, 9.8% were classified by lab exam but not by IPM scouts as having phytoseiids, and 4.8% were classified by IPM scouts but not by lab exam as having phytoseiids (Table 2). For stigmaeid

Table 1. Percent of all sampled leaves observed as having mite predators by IPM scouts in orchards versus by examination under a microscope in the laboratory.

Type of predator	IPM scouts	Laboratory microscope
Phytoseiid	0.8	3.5
Stigmaeid	2.2	5.5

Table 2. Percent of the 298 sampled leaf batches for which IPM scouting and laboratory microscopic examination did and did not agree on presence or absence of mite predators in the batch.

Type of predator	IPM absent, lab absent	IPM present, lab present	IPM absent, lab present	IPM present, lab absent
Phytoseiid	67.5	17.9	9.8	4.8
Stigmaeid	63.5	19.8	9.5	7.2

mite predators, corresponding percentages were 19.8, 9.5, and 7.2. Remaining batches were classified by both IPM scouts and lab exam as having no predators.

Conclusions

Our findings indicate that the presence of predatory mites was detected more often under a microscope than by IPM scouts, particularly in the case of phytoseiids. In fact, among all leaves examined, phytoseiids were detected more than four times as often and stigmaeids more than twice as often under a microscope than by IPM scouts.

At least three factors may have contributed to this pattern of results. First, the greater magnifying power of a microscope may have facilitated detection of small, newly-hatched predators that are difficult to detect using an Optivisor or hand lens. Second, at least six IPM scouts were involved over the growing season in examining leaves for mites in orchards, and there may have been substantial variation among these scouts' ability to detect and identify predators. In contrast, the same person performed all of the examinations under the microscope. Third, there may have been some redistribution of predators among leaves during transport to the laboratory, possibly resulting in the spread of predators to a greater proportion of leaves. We believe, however, that this factor was minor compared with the first two factors.

Regrettably, our findings suggest that a grower (who might be less skilled than an IPM scout in identifying mite predators) cannot rely on his or her counting of mite predators using a hand lens or Optivisor as providing an accurate assessment of the level of predators actually present. New York state IPM personnel have recognized this shortcoming and have created a tripartite sampling procedure for pest mites that excludes the need to sample for and identify mite predators. A slightly modified version of this procedure for use by Massachusetts growers is described in detail in the *1994 March Message to Massachusetts Fruit Growers*.

In sum, we will continue to sample for mite predators in our monitored test and check IPM blocks but recommend that growers use caution in interpreting their mite predator monitoring results. Predators could be more abundant than meets the eye.

Acknowledgments

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* * * * *

Apple Orchards in Switzerland: Differences Small and Large

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Since the beginning of 1993, when I left the University of Massachusetts, I have worked as a tree fruit research entomologist for the Swiss Federal Institute of Technology in Zurich. Since I also had experience with orchards in northeastern U.S.A., I have found the differences in orchards and pest management between the U.S.A. and Europe to be quite fascinating. European agriculture offers some features which I feel could improve American pest management, and certainly some other features which should not be emulated! Most of my comments pertain in particular to Switzerland, but are more or less applicable to neighboring countries as well.

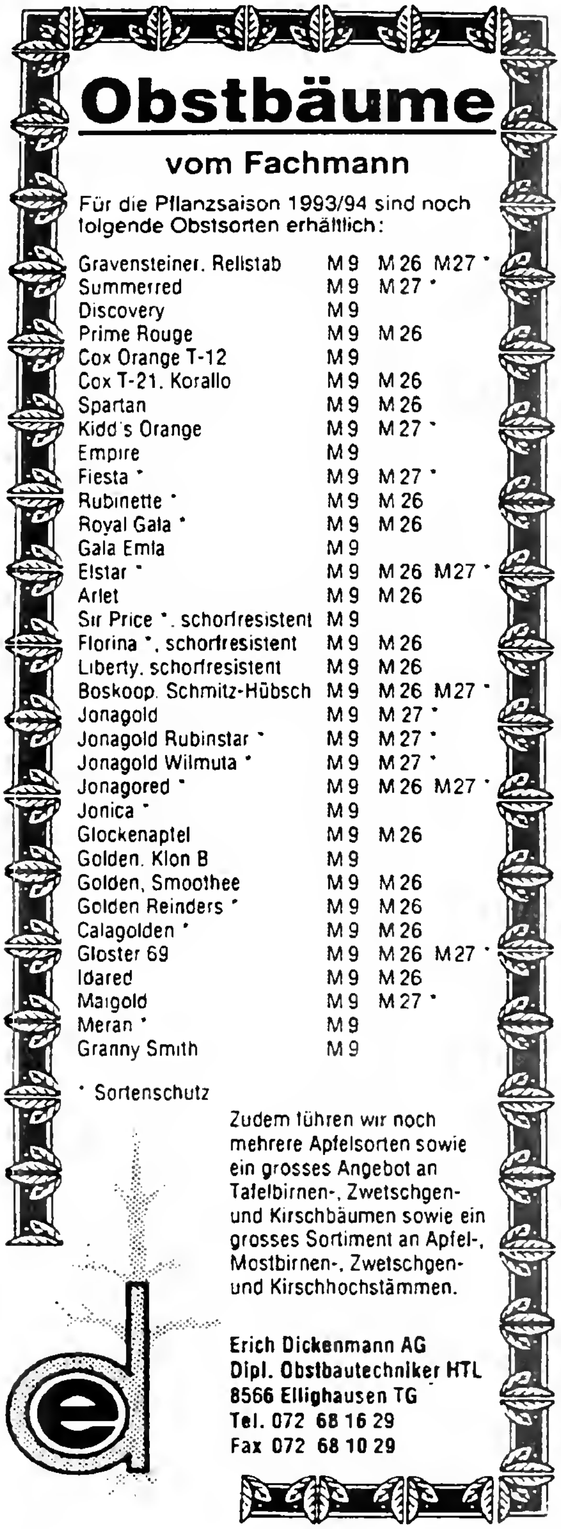
Small-scale and Intensive

One of the most striking features of orchards in Switzerland is their small size, both in stature and in area. For the fresh market, dwarf rootstocks are the rule, and very high-density plantings (around 1000 trees per acre) are trellised and on rootstocks such as M.9 and M.26. Fresh-market cultivars differ from those in the U.S.A. In Switzerland, Golden Delicious is the single most abundant cultivar, accounting for about 25% of the acreage; other important cultivars are Idared, Maigold, Jonagold, Boskoop, Glocken, Gloster, Gravenstein, and Jonathan. Gala is being planted widely, but Cox Orange Pippin is not so common, although it is a leading cultivar in Holland and Great Britain. In Switzerland, the orchard acreages for any one farmer generally are small, family-owned, and often part of mixed farming including especially dairy cattle, sheep, and field crops. Government policy encourages diversified, intensive small farms which include animal husbandry.

Big Money, Big Trees

That is it for the small things. Two features, though, loom large: subsidies in the form of direct government payments, and the presence of large numbers of more-or-less unmanaged, high-stemmed (standard) apples and pears in the landscape. The Swiss people consider both their agriculture and their "Kulturlandschaft," or culturally-influenced landscape, to be a part of the national heritage. Agriculture is subsidized strongly. Because of changes in Swiss law made last year, payments to growers are based now on acreage and desirable management practices (including crop rotation and integrated production), rather than quantity of harvest marketed. This is allowed by the so-called "Green Box" of GATT, under which member countries can encourage environmentally-sound practices through financial incentives. The Swiss economy is also highly regulated, aiding marketing associations in the formation of cartels that then fix quite high prices for agricultural and other goods. This combination of subsidies and quasi-monopoly marketing results in food prices that are among the highest in the world. This may not be something to wish on the consumer, perhaps, but farming is more profitable!

Now for the other large thing. Large pear and apple trees abound in this landscape, and are considered not only scenic but ecologically valuable. Most are minimally managed, and the apples and pears are harvested for cider. The pears thrive, thanks to the (until now)absence of fire blight. But the problem for pest management of fresh-market apples and pears is that these high-stemmed trees are great refuges for



Typical offerings from a Swiss nursery. Note abundance of cultivars on M.9 and M.27.

pests, particularly codling moths, and diseases. Not only is one not allowed to just cut them down, but the federal government rewards farmers for planting more! So the proposal of Ron Prokopy to eliminate untreated apples within 100 yards of commercial orchards, to reduce greatly codling moth colonization, would be viewed as heresy in Switzerland.

Pest and Pesticide Differences

The pest complex of European apple orchards varies from country to country, but in general the major insect pests are tortricids (codling moth and others), and aphids, particularly *Dysaphis* species, relatives of the rosy apple aphid. Relatively selective treatments are available to suppress these key pests, resulting in an enormous decrease in mite problems. These selective treatments include IGRs (insect growth regulators), primarily diflubenzuron (Dimilin™), fenoxycarb (Insegar™), and teflubenzuron (Nomolt™) for tortricids. All tortricid species are not equally susceptible. Species-specific viral preparations are available for codling moth and summer fruit tortrix (*Adoxyphes orana*). These require three to four applications against each generation of codling moth, and superficial injury may occur nevertheless because of delayed mortality of the young larvae.

Pirimicarb (Pirimor™) is a selective aphidicide (with some action against other piercing-sucking insects) registered worldwide for about 20 years, except in the U.S.A. It is extremely valuable not only in apples but in crops such as cole crops where aphids can be controlled without upsetting biological control of other pests. The availability of selective insecticides has reduced some pest problems, but it has increased others. Broad-spectrum insecticides against codling moths previously also suppressed other tortricids. Non-selective treatments directed against aphids often reduced populations of apple sawfly (the same one found in North America) and other early-season pests to below economically-damaging levels. Now, more research is necessary to address these previously unimportant pest problems.

Full-page advertisement by Migros Supermarket (largest Swiss grocery chain) in the *Tages Anzeiger*, the largest daily newspaper in Switzerland. Text reads: *Apple growing for the Migros-Sano program is regularly brought under close scrutiny. This assures an early knowledge of pests. And gives us the opportunity, to eliminate the problem with mild treatments and lower doses. For the benefit of nature and the environment! You can recognize apples from Migros-Sano-Production by this [orange and green] symbol: ["Aus naturgerechtem Anbau" = from agriculture which is fair to nature].*

Luckily for European growers, apple maggot and plum curculio are not (yet) present, and therefore both are quarantine pests.

IPM: Moving Forward

A major difference in European apple IPM (known as IP or Integrated Production, encompassing more than just pest management) from that in the USA is that since at least three decades ago, the orchard working group of the International Organization of Biological Control (IOBC, Western European section) has taken a lead role in development and implementation of provisional treatment thresholds for the region, which now are fairly consistent among different countries. These thresholds first allowed reduction in use of broad-spectrum insecticides, which now have been replaced largely with more selective materials, resulting in a double benefit to predators and parasites, especially phytoseiid predatory mites. The

IOBC recently has proposed a comprehensive set of IP guidelines for grower certification, which will work through supervised participation of grower groups at national and provincial levels. These would include fertilization, soil management, restrictions on size of monocultures, and other guidelines, in addition to regulation of pest management practices. The specifics for individual crops, however, are still in process.

Another major difference relates to the awareness of IPM on the part of the consumer. Supermarkets and strongly-coordinated grower associations have promoted IPM awareness. I will address this story, and more about specific pest-management innovations, in future articles.

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Fruit Notes

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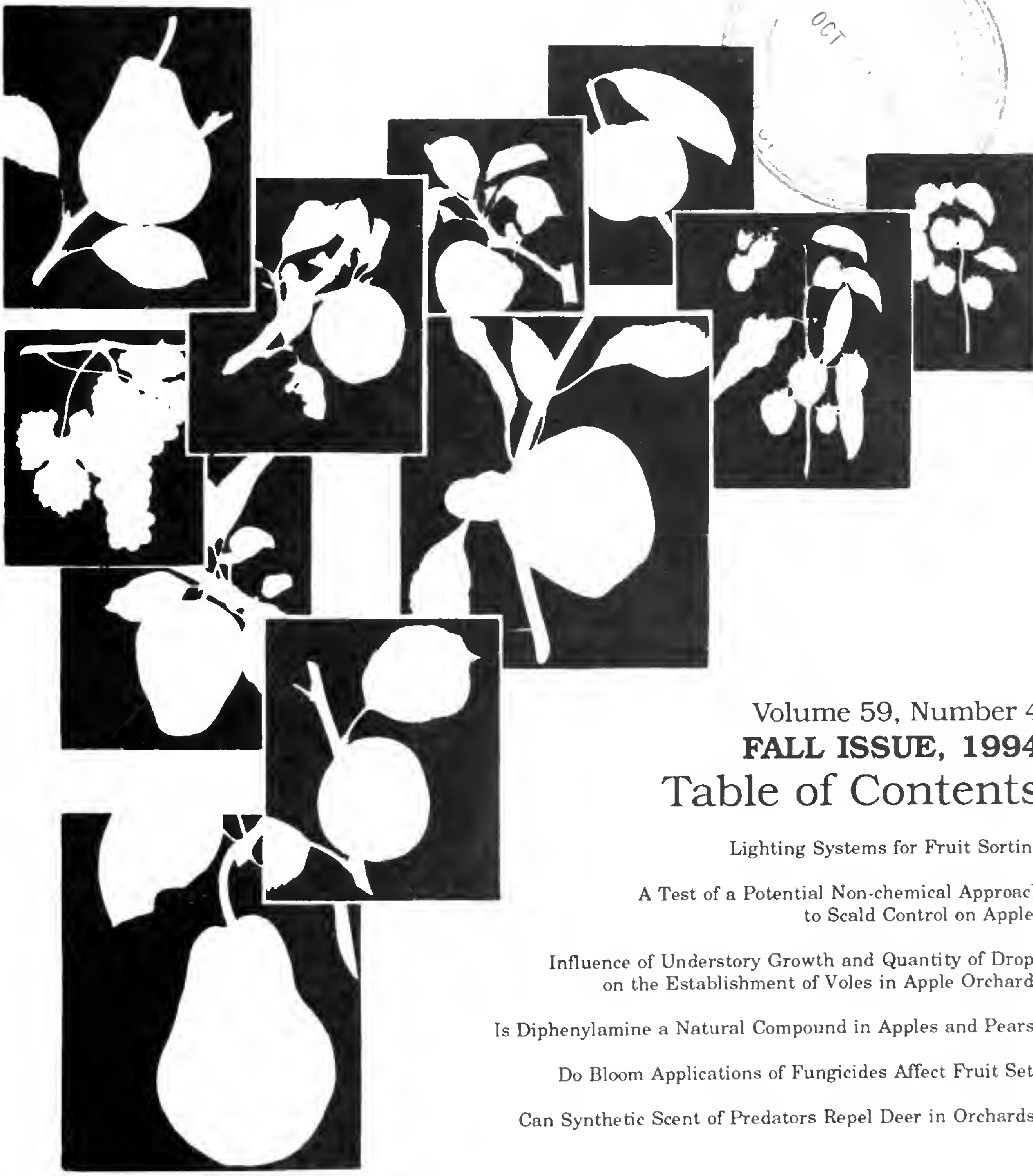

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COOPERATIVE EXTENSION SYSTEM POLICY:

Lighting Systems for Fruit Sorting

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This article is modified from one that appeared in the Washington State University Tree Fruit Postharvest Journal, *Vol. 5, No. 1, which was modified from Michigan State University -- Cooperative Extension Service Agricultural Information Series, AEIS 618, January, 1994.*

Fruits and vegetables are inspected prior to most processing or packing operations. While some sorting is accomplished with optical or electronic technology, much sorting is done by manual visual inspection. Each worker must look at a few hundred items each minute and accurately discard those that are unacceptable. Good lighting conditions are required to perform this task.

Sorting table lighting may not currently match the specific task for which it is intended. Specific guidelines for lighting system design in fruit and vegetable sorting and packinglines in the U.S. do not exist. Manufacturers of packingline equipment have left lighting decisions up to the individual operation.

Sorting table lighting must have both adequate intensity and color quality to enhance or reveal defects rather than to obscure or mask them. Improper lighting design promotes worker fatigue and eye strain, resulting in poor sorting efficiency. Studies of several operations involving inspection of a range of commodities have shown that many lighting systems are not adequate for the required task. These studies suggested that improved sorting results could be expected if relatively inexpensive changes in illumination sources, illumination intensities, and background colors were adopted in sorting areas.

Principles of Lighting and Color

Two common uses of lighting are (a) general area lighting, and (b) task lighting. General area lighting's purpose is to illuminate a room or building for general activity. This type of lighting is usually mounted in the ceiling or well above the floor area. Task lighting is much more specific and is concentrated in an area to enhance the ability to perform a task. Task lighting is the primary concern of this article which focuses on the task of manually sorting fruits and vegetables.

Three major components interact in the process of visualizing a "color":

1. light energy from a lamp or light fixture;
2. color reflectance potential of a fruit, called spectral reflectance; and
3. sensitivity of the eye to color, called receptor sensitivity.

For example, to "see" the color red there must exist a light source containing red color light, a surface which can reflect the red light and a receptor sensitive to reflected red light.

Light Energy

Light energy, or a source of light, is required to produce the actual visible color light which the eye can detect. The natural light source is the sun which produces all visible colors in addition to energy outside the visible spectrum (ultraviolet, infrared, etc.). Colorsproduced by artificial light are influenced by tube coatings, such as phosphor in fluorescent tubes, gases, or other components contained in filament bulbs. Artificial light sources are rated by:

1. Color temperature; black body temperature generation;
2. CRI: Color Rendering Index; and
3. CPI: Color Preference Index.

These ratings are explained briefly in the footnotes of Table 1.

Of the three major components in visualizing color, light energy is the one most easily controlled. The important factor relating to artificial light is the spectral irradiance curve for a given light source. A spectral irradiance curve is a measured representation of a given light source showing the amount of specific light energy or color contained in the source over the spectrum of colors. Spectral irradiance curves are generally available from lamp manufacturers. The spectral irra-

Table 1. Artificial lighting characteristics and visual effects on common produce colors, 1992.*

Light source (fluorescent tubes)	Mfgr	Rel cost	Color temp	CRI	CPI	Rel light	Visual effect on specified color: Maroon	Red	Green	Brown	Blue	Purple	Yellow
SP-30	1	1.8	3000	70	80	105	E	E	B	E	D	E	E
SPX-30	1	5.9	3000	82	100	105	E	E	B	E	D	E	E
Ultralume-30	2	3.7	3000	85	100	105	E	E	B	E	D	E	E
Warm White	2	1.3	3000	53	37	102	E	E	D	E	D	D	E
Warm White Deluxe	2	2.1	3000	79	90	68	E	E	D	E	D	E	E
Optima-32	3	4.9	3200	82	---	81	E	E	B	E	D	E	E
Natural	2	3.1	3400	81	93	66	E	E	E	D	E	E	W
Cool White	2	1.0	4100	67	58	100	D	D	E	W	E	D	W
SPX-41	1	6.5	4100	82	100	103	E	E	E	W	E	E	W
Cool White Deluxe	2	3.2	4200	89	94	70	E	E	D	D	E	E	D
Colortone-50	1	3.2	5000	90	92	70	E	E	E	W	E	E	W
Ultralume-50	2	4.1	5000	85	100	105	E	E	E	W	E	E	W
Optima-50	3	5.2	5000	91	---	81	E	E	E	W	E	E	W
Vita-Lite Plus	3	5.7	5500	91	---	100	E	E	E	W	W	E	D
Daylight	2	1.7	6500	79	72	83	D	D	E	W	E	D	W
Colortone-75	1	4.2	7500	95	97	64	E	E	E	W	E	E	W

*Manufacturer: 1 = General Electric; 2 = Phillips; 3 = Duro Test.
Rel cost: Relative bulb cost ratio to Cool White.
Color temp: Lamp appearance in degrees Kelvin.
CRI: Color Rendering Index = effect the light source has on appearance of colored objects, 100 = perfect appearance.
CPI: Color Preference Index = how well people recognize colors in that light, 100 = perfect recognition.
Rel light: Relative initial lumen/watt output as a percentage of Cool White.
Visual effect of tube on specified color: B = brownish cast; D = darker; E = enhanced; W = whitish cast. Cool White effects are relative to midday diffuse outdoor light, other tubes are relative to Cool White.

diance for a light source can be altered with various types of "filters" covering the lamp. These include undesirable coatings of dust and dirt.

Spectral Reflectance

Spectral reflectance of an object is basically the "color" of the object -- the ability of a fruit to reflect certain colors of light in the presence of natural light. In fruits, the chlorophyll, anthocyanin, or other natural pigments dictate the item's color. The apparent color of an item can be altered by changing the light source or by incomplete color receptor capability. Some defective and nondefective measurements for the same commodity vary in their reflectance over the entire spectrum while others either vary only in certain regions of the spectrum or they vary little at all.

Many defects that need to be detected on fruits and vegetables are of brown or grayish color. One might assume, therefore, that simply finding the light source with the most energy in the color regions making up the brown color would be ideal for all applications. The objective in selecting the best light source for a given task, however, is to light a commodity with a source that will accentuate the color difference between the sound tissue and the defects. For example, if we wish to find brown discoloration on red cherries, then we want to use an inspection light of a color that will accentuate brown against the normal red color of the cherry. The key is to find a color of inspection lighting that will make the defects show up the most, i.e., to make the commodity look its worst.

Receptor Sensitivity

The third component in perceiving a color is the receiving or sensing of the light. In this case, the human eye is the receptor. There is no adjustment to the human eye. The only variability is in the individual's sensitivity to the color and quantity of the light. Sensitivity decreases with age and this should be a consideration during lighting design.

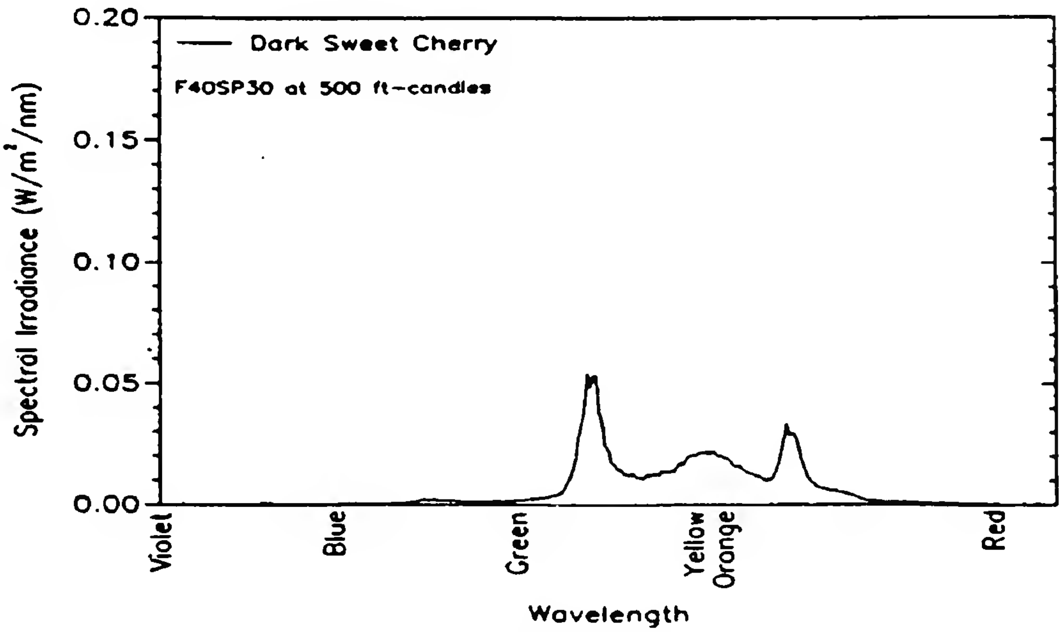

Figure 1a. Perceived color based on spectral irradiance, reflectance curves, and receptor sensitivity (Brown et al., 1993).

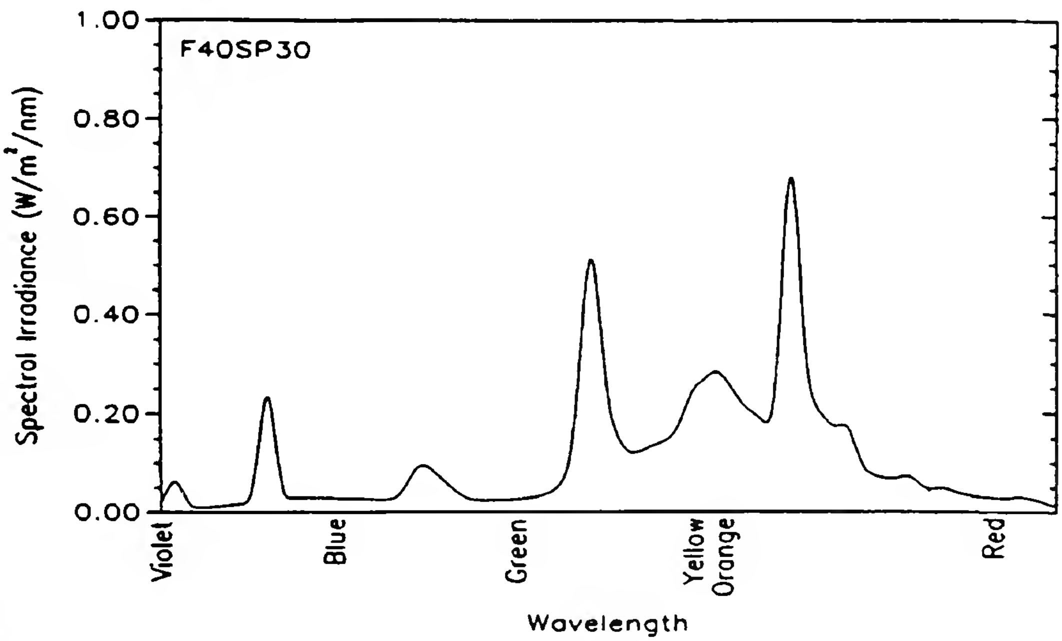

Figure 1b. Spectral irradiance curve of SP-30 lights.

Perceived Color

Figure 1 demonstrates the combining of all components (spectral irradiance, reflectance curves, and receptor sensitivity) which affect color perception. The perceived color is termed the "total spectral energy distribution" and is the product of the spectral irradiance x spectralreflectance x human eye sensitivity or response. The goal of the lighting design is to have "peaks" in the distribution at the wavelengths or colors of the commodity and at the defect color, thus resulting in a good perceivable contrast. Figure 1a shows the peaks in the perceived color of a dark red cherry, and Figure 1b shows that these same peaks are strong in light from an SP-30 light, so a good match exists.

Performances of Commercially Available Light Sources

Theoretically the product of the spectral irradiance, spectral reflectance, and eye sensitivity should provide the information to design a proper lighting scheme. USDA-ARS researchers at Michigan State University evaluated several commercially available light sources. They measured individual spectral irradiance, using color chips to subjectively analyze and compare performance in color perception tests. Table 1 summarizes their findings and provides technical and relative cost information. Results indicated that the "image" curves resulting from the combination of spectral reflectance x spectral power x eye sensitivity generally agreed with the subjective/visual results for the test with the color chips and real produce items.

The ability to recognize differences between good and defective areas on produce was lowest under Cool White (CW) light, which was very similar to that for CW Deluxe, Warm White, Warm White Deluxe, Daylight, Natural, Optima 32, Optima 50, C-50, and C-75. Consequently, these lights should not be used for task lighting in fruit and vegetable inspection areas. U.S. federal energy standards may eliminate CW and similar type fluorescent lamps by 1995 because they do not meet proposed efficiency levels. Fluorescent tubes of 8-foot lengths of all types also are scheduled to be removed from production.

Visual color comparisons suggested that although the SP-30 light had a low color rendering index (CRI), it performed better than higher CRI fluorescent lights for the visual sorting of most fruits and vegetables. The relative light output of the SP-30 lamp is among the highest tested. Its relative cost is only 1.8 times that of CW. These factors indicate that it should be an appropriate choice for most sorting operations when both sorting performance and lighting cost are considered (Figures 1a and 1b). Note how the spectral irradiance curve of SP-30 closely matches the perceived cherry color.

Except for metal halide, the high intensity discharge (HID) lights were undesirable for produce sorting as they severely darkened most colors. Tests will be necessary using metal halide light to determine if sorting performance is acceptable. Tungsten halogen quartz (quartz) light also produced good color recognition and enhanced ability to see brown-colored defects on dark-colored produce. Both metal halide and quartz lighting will be more costly than SP-30 fluorescent lighting. More specific discussion of the tests will not be covered here but can be found in the cited reference.

Requirements of Light Intensity

The average illumination intensity needed on produce items for effective visual sorting seems to be in the range of 250 to 500 foot-candles, based on the reactions of workers 20 to 70 years old. The lower intensity seems adequate for light-colored (high reflectance) produce, and the higher intensity for dark-colored (low reflectance) produce. The actual light intensity may need to be adjusted, depending on the design considerations discussed below. Insituations where kinds or varieties of produce covering the entire color range must be inspected on the same packing line, the low and high intensity levels should be selectable by the sorting workers. This easily can be accomplished by using four-tube fluorescent fixtures wired so that either the two outside tubes or all four tubes can be turned on. The amount of light falling upon a surfce can be measured with commercially available light (foot-candle) meters.

Design Considerations

Several physical design characteristics will impact on sorting efficiency and overall worker attitude and performance.

Background color of sorting surface (belt). Reflected light energy from the sorting surface should not be greater than that from the produce. Use belts

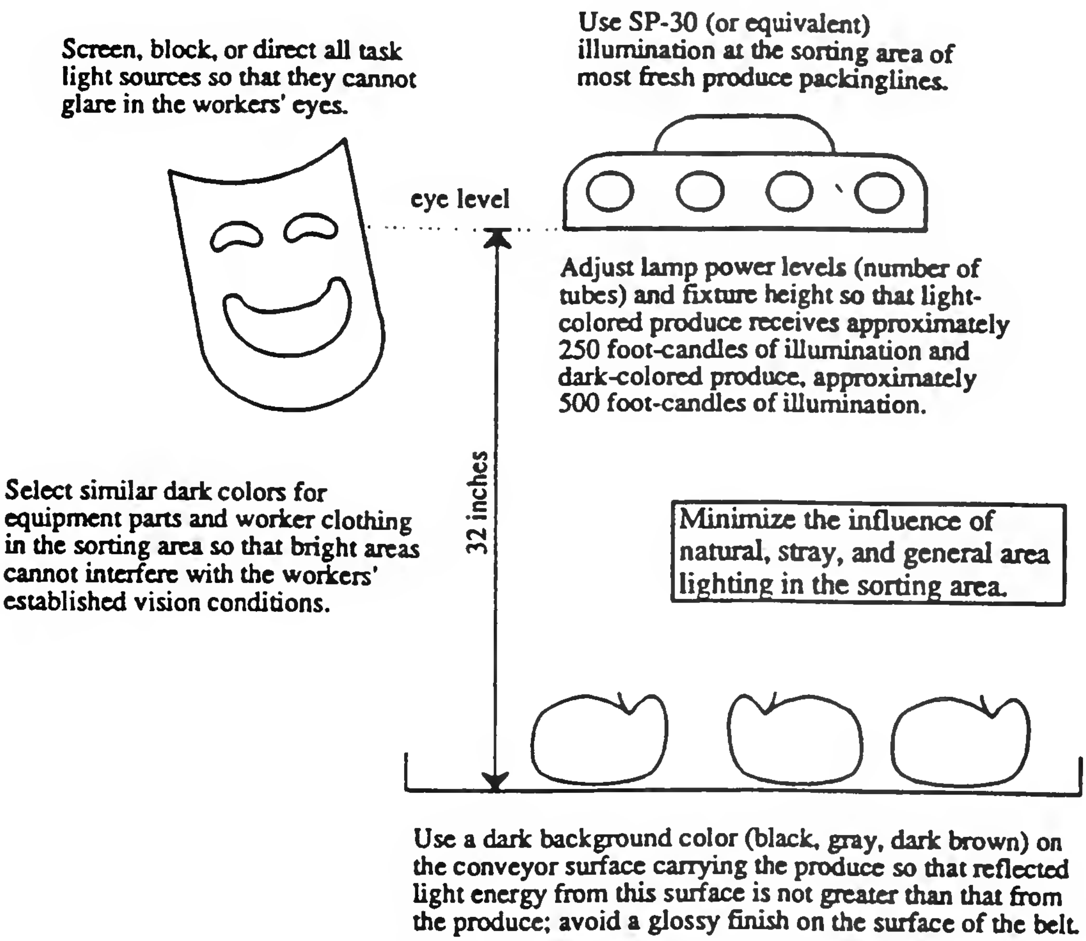

Figure 2. Primary design and management criteria for lighting at sorting areas.

which are black or dark gray, but not glossy finish.

Surrounding colors.
Surfaces near sorting areas and the clothing of inspection personnel should not be bright or highly reflective and should not cause glare.

Placement of fixtures.
Placement should be such that the light source will not be directly in the sorters' eyes, i.e., unshielded, or too low so as to obstruct the sorters' view or the sorting surface. The fixture also must be placed at such a height as to provide the proper level of light at the sorting surface. This will depend on the amount and type of light used and the considerations mentioned above. For an SP30 light, this height will be about 32 inches above the sorting surface, as shown in Figure 2.

Type of lighting.
Light type should be appropriate for the sorting task and the colors involved. Area lighting also should be considered as it can have negative impacts on the color evaluation and on eye-strain.

For more information, the following references are listed.

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A Test of a Potential Non-chemical Approach to Scald Control on Apples

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Scald Development on Apples After Storage is a Threat

There is risk of scald development during and following long-term storage on a number of important apple cultivars. Since the 1960's this risk has been minimized by prestorage application of diphenylamine (DPA), an antioxidant that has proven to be very effective in scald control. Today, however, some markets will not accept DPA-treated apples because they have been treated chemically, so alternatives to DPA are being sought.

Numerous non-chemical scald-control procedures have been proposed, but none are as easy to apply or as reliable as the use of DPA. The most effective probably is low-oxygen controlled atmosphere storage, where O_2 is kept near or below 1%. It is used for commercial scald control in some parts of the world; however, in the Northeast we are unable to use low-O_2 storage because the risk of fruit fermentation is excessive.

One non-chemical procedure that has been tested is warming of fruit after a short time at low temperature. In New Zealand, Dr. Chris Watkins and I found that when Granny Smith apples were warmed at 70°F for five days after they had been at 32°F for two weeks, warming was as effective as DPA in preventing scald development. Subsequent tests indicated that this warming time and temperature was about optimum for scald control on Granny Smiths. In 1992, we tested this warming procedure on Cortland and Delicious in Massachusetts, and found that it caused significant fruit ripening and gave little or no scald control. However, we had used fruit that were immature and extremely scald susceptible, so the treatment might have given better results if the fruit become less scald susceptible.

It is likely that as fruit become less scald susceptible, scald becomes easier to control. We found several years ago that as Cortland and Delicious become less scald susceptible, lower concentrations of DPA become effective in controlling scald. It is our hypothesis that at lower levels of scald susceptibility, non-chemical control measures may be as effective as DPA. The problem is how to determine at harvest when fruit have relatively low scald susceptibility. However, we have found that in Massachusetts, preharvest hours below 50°F is a reasonably reliable indicator of scald susceptibility on Cortland and Delicious (see *Fruit Notes* 59(3):6-10). Therefore, it is conceivable that by monitoring preharvest temperature, a grower could know when DPA is necessary for scald control, and when a non-chemical procedure might be used instead.

Experimental Procedures

In 1993, the Maine State Pomological Society provided funding for a test of this concept. Fruit for the study were provided from the University of Maine's Highmoor Farm, and treatments, storage, and fruit evaluations were done at the University of Massachusetts Horticultural Research Center (HRC).

Three cultivars were tested: McIntosh, Cortland, and Delicious. Fruit were harvested from the same trees when 75, 119, 150, and 200 hours below 50°F had been recorded at Highmoor Farm. Harvest dates were September 20 and 27 and October 1 and 5. All three cultivars were harvested on these dates. Maturity was assessed by using a starch test within one day of harvest, and by measuring ground color and firmness after transport to the HRC. Within a week of harvest, one set of one-bushel samples of each cultivar was dipped for two minutes in DPA (1000 ppm for McIntosh, 2000 ppm for Cortland and Delicious). After two weeks at

Table 1. Effects of warming and DPA treatments on scald development on apples grown at Monmouth, Maine.

Harvest date	Starch score[z]	Firmness (lbs)	Ground color[y]	Percent scald			Scald score		
				Control	Warming	DPA	Control	Warming	DPA
				McIntosh					
20 Sept	2.5	17.4	4.5	8	46	1	1.1	1.3	1.4
27 Sept	4.4	17.3	4.1	2	12	2	1.0	1.0	1.0
1 Oct	5.2	14.5	2.7	1	7	1	1.1	1.0	1.0
5 Oct	6.3	13.9	1.8	1	6	1	1.0	1.0	1.0
				Cortland					
20 Sept	2.0	18.1	4.3	9	79	1	1.1	1.1	1.0
27 Sept	1.5	17.3	3.6	64	75	33	1.0	1.1	1.0
1 Oct	2.4	14.8	1.9	33	80	22	1.0	1.1	1.0
5 Oct	3.7	14.3	1.8	33	66	18	1.0	1.0	1.0
				Delicious					
20 Sept	2.0	18.4	---	86	48	6	2.1	1.4	1.3
27 Sept	2.8	18.5	---	31	10	1	1.3	1.2	1.0
1 Oct	2.9	17.5	---	17	2	9	1.5	1.9	1.1
5 Oct	2.8	17.5	---	14	1	5	1.1	1.0	1.1

[z]1 = Very immature; 8 = Very mature.
[y]5 = Very green; 1 = Very yellow.
[x]1 = 1 to 10%; 2 = 11 to 33%; 3 = 34 to 67%; 4 = >67% of fruit surface affected.

32°F, a second set of samples was transferred to 70°F for five days and then returned to 32°F. A third set of samples was not treated in any way and served as controls.

McIntosh and Cortland were kept at 32°F for 22 weeks, and Delicious for 25 weeks. At the end of storage all samples were kept at 70°F for 7 days and then evaluated for scald, measuring its intensity on the scale of 1 = 1 to 10%, 2 = 11 to 33%, 3 = 34 to 67%, and 4 = more than 67% of the fruit surface affected.

Results

Results of the experiment are shown in Table 1. As expected, McIntosh ripened the most during the harvests and Delicious ripened the least, but in all cultivars, changes took place. After storage, little scald developed on any of the control McIntosh, but considerable amounts developed on Cortland and Delicious. DPA was very effective in controlling scald on McIntosh and Delicious, but was only partly effective on Cortland. Warming had two opposite effects: it reduced scald on Delicious, but it markedly increased scald on McIntosh and Cortland.

Discussion

As expected, as preharvest hours below 50°F increased, scald susceptibility of Delicious decreased, although the rate of decrease was somewhat more rapid than we have usually seen. We have not attempted to construct a predictive curve for McIntosh because scald has occurred too infrequently in our tests. However, our predictive curve for Cortland is similar to that for Delicious, and the data for controls in Table 1 do not fit that curve. The first harvest should have produced nearly 100% scald, but produced only 9% scald. We have seen this happen before occasionally on early-picked fruit, and do not know what causes it to occur. Of more concern was the failure of scald to fall to very low levels with more than 150 hours below 50°F (the final two harvests of Cortland). Not only did the scald susceptibility not decline as expected, but these fruit also failed to respond fully to 2000 ppm DPA. (It is possible that an unusual form of scald developed, one that was not as controllable by DPA.) In our attempts to predict scald susceptibility, we are more concerned about underpredicting than about overpredicting scald, because in the former case a grower might experience serious financial losses. Thus, we are continuing to try to refine our scald prediction system.

The effects of warming on scald control on Delicious were just as we hypothesized. Warming reduced scald at all harvests, but only when susceptibility was relatively low did warming provide satisfactory scald control. For McIntosh and Cortland, however, instead of reducing scald, warming clearly increased it. We have not seen this result in previous tests. The fact that all three cultivars were produced in the same orchard, harvested on the sameday, treated simultaneously, and stored in the same room shows that response to warming can be very different among cultivars. We believe that the opposite results seen here among cultivars are related to the fact that McIntosh and Cortland produce much more ethylene than Delicious, and ethylene has complex effects on scald development.

These findings illustrate the risk involved in attempting to use a non-chemical scald-control procedure. Under the conditions of this experiment, using the predictive curve to determine when to rely on warming for scald control would have been a resounding success for Delicious. However, the predictive curve was not adequate for Cortland, and warming was never effective on Cortland or McIntosh.

Whether or not warming is a suitable scald control procedure is not yet clear. Noticeable ripening can occur during warming, and it would entail major logistical problems to change fruit temperatures. However, the objective of this study was to use warming as an example of a non-chemical procedure applied in conjunction with scald prediction, and from this viewpoint it can be seen that at this point in time, it's a very risky approach, one that we cannot recommend.

* * * * *

Influence of Understory Growth and Quantity of Drops on the Establishment of Voles in Apple Orchards

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When abundant, meadow voles and pine voles can cause severe damage to the bark or roots of apple trees, sometimes causing tree mortality. Growers are well aware that problems with voles can be especially great during winter.

Under second-level IPM, a strong effort is made to integrate pest management practices across all classes of pests, including vertebrate pests such as voles. We report here on the effects on vole establishment of two IPM practices directed mainly at other kinds of pests. The first practice concerns management of understory growth (weeds) by mowing or herbicide application. In particular we wondered whether or not allowing understory growth to remain at a substantial height during autumn months would encourage vole establishment. The second practice concerns picking up drops during and after harvest. This practice is directed primarily at reducing emergence from drops of pest insect larvae such as apple maggot, codling moth, and lesser appleworm. Reduction in larval emergence from drops translates into reduced numbers of larvae overwintering within the orchard and hence reduction in threat to next year's crop. We wondered if allowing large numbers of drops to remain beneath orchard trees during autumn months would lead to vole establishment.

Methods

In August of 1992 and August of 1993, we placed an asphalt roofing shingle (11 x 36 inches) beneath each of 10 perimeter-row apple trees in each of 12 second-level IPM test blocks and each of 12 nearby first-level IPM check blocks. The shingles were spaced evenly around the perimeter of a block. In October of each year, we lifted each shingle and examined the ground beneath for signs of vole establishment, either a trail or a hole into the earth. At the same time, we measured the height of grass or other foliage beneath the tree and categorized the number of drops in a range from few to many.

Results

There was no detectable difference in average plant height or average number of drops between second-

Table 1. Height of understory cover during October in relation to proportion of shingles that showed evidence of vole activity. Blocks represent a first-level and a second level block in each of 12 orchards in both 1992 and 1993, with years treated separately.

Number of orchard blocks	Height of cover (in)	Shingles with vole activity (%)
11	0-5	10
5	6-10	24
10	11-15	36
14	16-20	39
8	21-25	48

Table 2. Amount of drops on the ground during October, 1992 and 1993, in relation to proportion of shingles that showed evidence of vole activity.

Number of orchard blocks	Estimated amount of drops	Shingles with vole activity (%)
9	Few	43
11	Few to Medium	45
14	Medium	32
11	Medium to Large	33
3	Large	30

level and first-level IPM blocks. Such lack of difference suggests that growers were applying understory management and drop pick-up practices equally to both types of blocks, even though our recommendation called for more intensive management of the second-level blocks.

As shown in Table 1, there was a marked tendency toward increasing incidence of vole establishment with increasing height of grass. Orchards treated with herbicide or in which height of understory growth did not exceed 5 inches at time of sampling in October showed an average incidence of 10% of the shingles with vole activity, which we consider to be a comparatively non-damaging population level. In contrast, orchards in which understory growth exceeded an average of 21 inches showed an average incidence of 48% of the shingles with vole activity, a potentially very damaging population level.

As shown in Table 2, there was no clear relationship between number of drops and incidence of voles. If anything, vole establishment beneath shingles tended to be slightly greater in blocks with fewer drops than in blocks with greater numbers of drops.

Conclusions

We conclude form this two-year study that growers who maintain understory plant growth at a low height during autumn months have a much better chance of escaping establishment of voles than growers who do not. This conclusion may be particularly applicable to meadow voles. Many factors can affect the number of voles immigrating into an apple orchard during autumn and becoming established beneath the trees. For example, a high abundance of alternate food such as acorns might tend to discourage vole immigration into orchards. But in years when alternate food is sparse or in locales where orchards closely border woods containing many oak or evergreen trees, growers could substantially lower the risk of vole invasion by frequent mowing.

Acknowledgments

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Is Diphenylamine a Natural Compound in Apples and Pears?

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For over 30 years, dipping fruit in diphenylamine (DPA) before storage has been the standard commercial procedure to control superficial scald (scald) development on apples during and after long-term storage. However, this procedure is controversial since it constitutes a chemical treatment, and legally, DPA must be considered as a food additive. Some countries have banned treatment with DPA, and some prohibit importation of DPA-treated fruit. In the U.S. and Canada, DPA is permitted and the maximum residue of 10 ppm should never be exceeded if DPA is applied correctly. Nevertheless, many American markets will not accept DPA-treated fruit because they have been chemically treated.

In 1984, a report was published (Karawya and Wahab. *J. Natural Products* 47(5): 775-780) that DPA was found in relatively high concentrations as a natural product in mature onions, and that it was effective in lowering blood sugar levels in diabetics. The report also showed data that DPA was a natural product in tea. In that same year, a report of the Food and Agriculture Organization of the United Nations ("Pesticide Residues in Food - 1984") stated that there "...is reasonable evidence that diphenylamine occurs naturally in apples though the level appears to be at or below 1 mg/kg (ppm)." No data to support this statement were cited, but in studies of DPA residues on apples, controls almost always contain measurable amounts of DPA.

We became interested in this question when what appeared to be DPA was detectable, even though no DPA had been applied, during our measurements of materials in apple peel that might be associated with scald development. In 1993, the Massachusetts Fruit Growers' Association provided us with a grant to pursue this question, and results of our study are reported here.

In April, 1993 10-fruit samples were taken from bins of apples stored at the University of Massachusetts Horticulture Research Center (HRC), Belchertown. Five cultivars were sampled, and fruit were extracted in hexane. The extract was tested for presence of DPA using gas chromatography and mass spectroscopy, employing selected-ion-monitoring for maximum sensitivity. Results are shown in Table 1. All samples gave positive indication of DPA in their peel, ranging from 0.03 to 0.13 ppm, despite the fact that none had been treated with DPA after harvest.

DPA is somewhat volatile, so to test for the presence of DPA residues in the rooms at the HRC, one-square-foot areas of walls and doors in three different

Table 1. DPA concentration in hexane extracts of apples stored 6 to 7 months in 0°C air. April, 1993.

Sample	DPA (ppm fr. wt. of fruit)
Blank	<0.01
Delicious	0.03
McIntosh	0.03
Golden Delicious	0.13
Empire	0.13
Cortland	0.10

Table 2. DPA concentrations in freshly harvested fruit. 1993.

Cultivar	Immature Weight (g)	Immature DPA (ppm fr.wt.)		Mature Weight (g)	Mature DPA (ppm fr.wt.)
McIntosh	440	0.002	(9/22)	1382	0.002
			(10/7)	1190	0.001
Cortland	659	0.002		1620	0.001
RI Greening	319	0.003		1190	0.002
Empire	316	0.007		1147	0.002
Delicious	430	0.003		1396	0.003
Golden Delicious	510	0.004		1641	0.001
Anjou pear	---	---		2334	0.001

rooms were swabbed with dry cotton balls that had been pre-rinsed in hexane. The swabs were then extracted in hexane, which was monitored for DPA. All samplings produced DPA residues on storage surfaces, ranging from 0.4 to 13.1 ug/meter^2 of surface. Thus, DPA in apple peel could have been the result of contamination from residues in the storage.

To eliminate this possibility, 10-fruit samples of fruit were taken directly from trees at the HRC in August, 1993 while fruit were immature. The same four cultivars tested out of storage were sampled from the trees, and also fruit were taken from an organically-grown treeof Rhode Island Greening. Fruit again were sampled from these trees when they were mature. In addition, McIntosh were sampled again when they were overmature, and Anjou pears were sampled at maturity. All of these samples were extracted in hexane immediately after harvest, and the extracts were frozen until analysis. All samples exhibited the presence of DPA (Table 2), although the concentrations were about one-tenth those found in stored fruit. It is interesting to note the increase in fruit weight between the two harvests, without a reduction in DPA concentration, which indicates that the material continued to accumulate as the fruit grew.

These results strongly supported the suggestion that DPA is a natural product in apples... and also in pears. However, for additional confirmation, two more tests were run. First, a McIntosh extract was spiked with a minute amount of authentic DPA to make sure the method was recovering and measuring DPA. Spiking doubled the DPA measurement, with a 61% recovery of added DPA, so the procedure is capable of extracting and measuring DPA.

A more rigorous evaluation of the procedure was made by producing a derivative of DPA, i.e., attaching another molecule to it, and separating and measuring the derivatized molecule. This procedure is a test to see if it is truly DPA that was being measured. Derivatization produced three different ions: DPA plus the derivatizing substance, DPA plus part of the derivatizing substance, and DPA with a single proton removed from it. Using authentic DPA, these ions were in a ratio of about 1.0:0.6:0.3. When fruit extracts were derivatized, the three ions were not present in that ratio, raising doubts that we truly were measuring DPA.

To test this further, 10-fruit samples of Delicious apples, from the same tree, that had and had not been dipped in DPA before storage were taken from storage in March, extracted, derivatized, and measured. The DPA-treated fruit contained 10 times as much derivatized DPA as did the non-treated fruit, and in the treated fruit the ion ratio was 1.0:0.6:0.3, indicating that it was DPA that was being measured. In the non-treated fruit, the ratio was about 1.0:0.3:0.2, just as we found in the freshly harvested fruit.

That result reaffirmed that at least part of what we were measuring as "DPA" in apple extracts probably was something very similar to DPA, but not DPA itself. This does not mean that apples and pears do not contain natural DPA. If only half of the derivatized material in the Delicious extract was DPA, it could produce the ion ratio that was obtained. Therefore, our results leave unanswered the question, "Is DPA a natural compound in apples?" Clearly, something very similar to DPA is produced, and possibly some of what we were measuring was DPA.

There is an important ramification of this study. Clearly, DPA or DPA-like compounds are being measured on fruit that have not been treated with this chemical. It is present at harvest and accumulates during storage, since our fruit out of storage showed 10-times the concentrations of the fruit picked directly off the tree.

DPA is a somewhat volatile compound, and the abundant residues we measured on the walls of our storage rooms show that there is likelihood of contamination of untreated fruit with DPA from the atmosphere in the storage or possibly from contact with bins and other equipment. Large quantities of DPA are used in industry as an antioxidant/stabilizer. For example, rubber products commonly contain DPA. Thus, fruit may absorb some DPA directly or indirectly from industrial products. If a test of fruit indicates the presence of DPA, its source could be any or all of the following:

1. DPA application.
2. Contamination from residues in fruit storages, containers, or equipment.
3. Contamination from industrial use of DPA.
4. A natural product in apples that while not being DPA, is being measured as DPA.
5. Possibly, natural-product DPA in the fruit.

Therefore, measurement of "DPA" in fruit is not proof that fruit were treated with DPA. There apparently is no such thing as "zero DPA" in apples. Conclusions must be based on the quantity of DPA present in the fruit, not on its absolute presence.

In conclusion, we have not resolved the question of whether or not DPA is a natural product in apples and pears. Small quantities of something very similar to DPA, and possibly of DPA itself, is/are naturally occurring, but remain to be identified. However, we have shown clearly that conclusions drawn from DPA residue analyses must be based on quantities measured, not on its presence in the fruit. An analysis showing the presence of DPA in fruit is not positive evidence of DPA application to the fruit.

Do Bloom Applications of Apple Fungicides Affect Fruit Set?

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We reported previously [*Fruit Notes* 56(4):18-19, 1991] that researchers in Great Britain found that the fungicide captan may be toxic to apple pollen, and thereby reduce fruit set. Since then, a test in Virginia has shown similar reductions in fruit set, apparently caused by captan applied at bloom. Furthermore, growers have on occasion speculated that sterol-inhibiting fungicides reduce fruit set. In the work reported here, we asked two questions. First, does captan or the sterol-inhibiting fungicide, fenarimol, applied at bloom reduce fruit set? Second, does captan or fenarimol interact with oil or copper to reduce fruit set?

In 1992, mature McIntosh/M.7 apple trees were selected at the University of Massachusetts Horticultural Research Center in Belchertown. In the first experiment, six limbs of similar blossom density were selected per tree. Three of the limbs were treated with copper hydroxide (Kocide 50 WP, 2 lbs/100 gal.) at tight cluster. Each of the three limbs treated with copper hydroxide and each of the three not treated with it were sprayed with captan (Captan 50 WP, 2 lbs/100 gal.) or fenarimol (Rubigan 1.6 EC, 12 oz./100 gal.) or left untreated. A second experiment was identical except that oil (1 gal./100 gal.) applied at tight cluster replaced the copper hydroxide treatment. For both experiments, fungicide applications began when the primary blossoms were expanded completely, and captan and fenarimol applications continued at seven- or ten-day intervals, respectively, until mid-June. Treatments were applied to the drip point using a handgun. After June drop was complete, final fruit set was counted on each limb.

In the first year of study, captan and fenarimol, with or without oil or copper hydroxide application, did not

Table 1. Fruit set following various treatments in 1992 and 1994. Within an experiment, no significant differences were found among treatment means.

Treatment	Fruit set (number/cm^2)
1992, Experiment 1	
Check	3.8
Captan	5.7
Fenarimol	6.7
Copper hydroxide	5.7
Copper hydroxide plus captan	5.8
Copper hydroxide plus fenarimol	5.1
1992, Experiment 2	
Check	5.8
Captan	8.3
Fenarimol	6.8
Oil	4.9
Oil plus captan	5.3
Oil plus fenarimol	4.6
1994 Experiment	
Check	4.2
Captan at king bloom	5.3
Captan at king bloom + 1 day	5.6
Captan at king bloom + 2 days	4.4

alter fruit set significantly (Table 1). The results from Great Britain were very specific in terms of time of sensitivity to captan, possibly explaining some of the lack of effect that we observed.

In 1994, we conducted an additional experiment to study the specific timing of captan application. Mature Marshall McIntosh/M.26 trees were selected and blocked according to blossom density. Within each block, one tree was treated with captan (Captan 50 WP, 2 lbs/100 gal.) when king blossoms were expanded fully, one was treated one day later, and one was treated two days later. A fourth tree was left untreated. Other than these captan treatments at bloom, all trees were managed similarly. After June drop was complete, final fruit set was counted on two limbs per tree.

The different timings of captan application did not result in any significant reduction in fruit set (Table 1). Therefore, none of our experiments confirmed the results of studies conducted in Great Britain and Virginia. We can only speculate that our growing conditions in 1992 and 1994 did not interact with captan in a way that caused reduced fruit set. Clearly, New England apple growers should not be overly concerned that captan will reduce fruit set on McIntosh.

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Publications Available

Two publications recently released by Agriculture and Agri-Food Canada should be of interest to many readers of *Fruit Notes*. One is titled "Techniques for controlled atmosphere storage of fruits and vegetables" (Research Branch Technical Bulletin 1993-18E), and it is a brief general review of the techniques currently in use for CA storage. The second is titled "Postharvest disorders of apples and pears" (Publication 1737/E), and it is a detailed review and update on postharvest physiological disorders of these fruit, including numerous photographs of the disorders. Both of these publications can be obtained without cost by sending your request to:

The Librarian
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Kentville, Nova Scotia B4N 1J5 CANADA

Can Synthetic Scent of Predators Repel Deer in Orchards?

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There is a growing number of studies suggesting that predator odors are repellent to potential prey. Repellency appears to stem at least in part from chemical constituents of predator urine or feces. Deer can be very troublesome pests in apple orchards, especially during winter months, when they chew apple buds and twigs. Cougars and other large members of the cat family are among predators which deer fear the most. We report here on a small pilot study that we conducted to evaluate potential repellency to deer of synthetic odor of cougar feces.

Materials and Methods

The odor consisted of a 50:50 mixture of 3-propyl-1,2-dithiolane and 2-propylthietane, encapsulated in polymeric plastic fibers to provide slow release. Both components of this mixture are present in cougar feces. Together, they convey a strong sulfur-like stench vaguely similar to the smell of a skunk but more pungent. The odorous fibers are still in a developmental stage, not yet available commercially. They were provided to us by Phero Tech Inc. of Delta, British Columbia.

In November of 1992 and December of 1993, we hung 4 fibers on each of 25 perimeter-row apple trees at Rice's fruit farm in Wilbraham, Massachusetts. Each tree with fibers was separated by three perimeter-row trees without fibers, the middle tree of which served as the check tree. Ten twigs on each treated and check tree were examined for signs of deer injury just before emplacement of fibers and again one to three months afterward.

Results and Conclusions

The data in Table 1 show there was little if any repellent effect of the odorous fibers against deer feed-

Table 1. Percent of sampled twigs showing evidence of feeding by deer in plots of apple trees with and without synthetic odor of cougar feces.

Test	Sampling time	Injured twigs in trees (%) With odor	Injured twigs in trees (%) No odor
1	November, 1992*	0	1
	January, 1993	36	37
	February, 1993	38	40
2	December, 1993*	3	2
	January, 1994	11	5

*Samples taken just prior to odor emplacement.

ing on apple trees in Rice's orchard. We were disappointed in this finding, especially because in a 1993 study, the fibers had shown strong repellency for as long as 3 months against deer feeding on Sitka spruce seedlings in a plantation in McClinton, British Columbia.

Several factors may have been responsible for the lack of repellency in our study. First, the number of fibers used (four per tree) may have been too few to provide effective repellency, although employment of more than four per tree would have been too expensive for practical commercial use. Second, the fibers may emit too little odor under cold winter weather temperatures in New England to be effective against deer. Perhaps they are better suited for use under warmer West Coast winter conditions. Third, the deer at Rice's may have been so hungry for winter food that hunger compromised their instinctive fear of cougars.

Despite this lack of encouraging result, we firmly believe that improved knowledge of the chemical ecology of predators of orchard pests such as deer and voles will some day lead to development and formulation of blends of predator odor that will indeed effectively repel these orchard vertebrate pests, just as synthetic plant and insect odors are now being used effectively in managing orchard insect pests.

Acknowledgments

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