PEST CONTROL

AND RELATED ORCHARD PRACTICES IN COMMERCIAL FRUIT PLANTINGS

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Contents

Spray Service Reports

The Spray Service Reports are periodic releases giving timely information on insects, diseases, and other orchard conditions. These reports are prepared by the Illinois Cooperative Extension Service and the Illinois State Natural History Survey. They are mailed via first class, stamped mail to insure rapid delivery. The reports are free but the charge for stamps is $2.00. If you would like to receive these reports, send $2.00 to the Department of Plant Pathology, 218 Mumford Hall, Urbana, Illinois 61801. Make checks payable to the University of Illinois.

THE BATTLE against insects, diseases, and other pests in Illinois orchards must be fought every year. To help in the fight, various experimental agencies are constantly working out better methods of pest control. This circular brings together the latest suggestions from the Illinois Agricultural Experiment Station and the Illinois State Natural History Survey. You may need to adjust these suggestions to suit your own conditions — *but don't experiment with untested materials and methods.* To do so may mean disaster.

Pest-control measures are so closely linked with other operations that they cannot be easily separated. This circular includes the practices recommended for quality fruit — not just adequate pest control. For efficient operation, orchard practices must be well organized. You are urged to study the following pages carefully in order to cope better with the many problems that face you as a specialist in agriculture.

SOME BASIC STEPS IN PEST CONTROL

Continue Sanitation Practices

With the general use of organic insecticides and fungicides and the increased cost of hand labor, many growers are omitting sanitation practices. This is a mistake. It is difficult to grow a high-quality crop when one depends entirely upon chemical treatments. The following practices should be observed.

For insects and mites

1. Carefully examine the top third and inner parts of the tree. These are the areas where insect and mite infestations often begin. You can cut the cost of sanitation and chemical control measures by concentrating efforts on these areas.

2. Store used fruit containers and limb props in a closed building or at least 5 miles from the orchard. Screen the packing shed if it is near the orchard. These measures keep the adult insects from returning to the orchard next season.

3. Collect and burn or chop all prunings and other debris. Destroy broken crates and containers, discarded sacks, large weed stems, corn stalks, and other overwintering sites of larvae.

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4. Destroy or control insects on wild host plants near the orchard. If such host plants are on neighboring property, ask your neighbor for his cooperation.

5. Keep trees thinned out by annual pruning.

6. Jerk current season's watersprouts in early summer.

For disease control

1. Prune out fire blight infections as they appear. Cut at least 6 inches below the last point of visible infection. Between each cut, sterilize shears in a solution of 1 part Clorox and 4 parts water. A convenient method is to saturate a sponge with the Clorox solution and swab the shears between cuts.

2. Remove all dead wood from trees. Be careful not to leave pruning stubs. They die back and are a source of black rot and botryosphaeria rot inoculum. The ends of broken branches should not be left jagged. Either smooth them or remove the entire branch.

Insect Traps Can Help

Insect traps are now available for codling moth, Oriental fruit moth, red-banded leaf roller, and apple maggot. They are useful in deciding when sprays are needed, but they cannot be relied upon as control measures. The traps are made of wax-coated paper with a sticky inside surface for catching insects.

Apple maggot traps are yellow because that color is attractive to the flies. A food attractive to apple maggot flies is used for bait. Maggot traps must be rebaited every two weeks.

Traps for codling moth, Oriental fruit moth and red-banded leaf roller are white and are baited with a pheromone (female sex hormone) contained in a rubber cap. The cap looks like the eraser on a pencil. The hormones are specific and will attract only the male moths of a certain species. The pheromone for codling moth is called Codlemone; for Oriental fruit moth, Orfamone; and for red-banded leaf roller, Redlamone.

The rubber caps all look alike. They should be stored in labeled glass jars in the refrigerator. In the field the cap will attract male moths for 6 to 8 weeks.

Both the pheromone and food traps are effective and dependable. They provide an accurate monitoring device for detecting the first appearance of a brood, the intensity and duration of that brood, and the invasion of insects from outside sources.

Place traps in areas where the first insects of a brood are most likely to appear. Traps for any one species should be 300 yards or more apart. The traps should be checked regularly and the results recorded. With experience you should be able to adjust your insecticide

applications according to information obtained from the traps. With better timing fewer sprays may be needed,

Control General Orchard Pests

Grasshoppers

Grasshoppers occasionally become troublesome in orchards. They are especially harmful to newly planted trees, but they may also feed on the foliage and fruit of older trees. They often hatch in dense grasses along streams, ditches, and fence rows, or in wooded undergrowth. Large numbers of young hoppers can usually be found in these areas in spring and early summer, before they move out into orchards. The most economical time to control them is when they are young and concentrated in small areas.

Cicadas

Cicadas have either a 13- or 17-year life cycle. During most of this time they remain in the soil in the nymph stage. Adults emerge from the soil at about the third cover period and spend a week or so in trees before the females begin egg laying. They slit the bark on small branches and deposit eggs in the slit, thus damaging the trees.

The emerging adults can migrate short distances, flying with the wind. Control may be difficult if the orchard is next to a wooded area where cicadas are emerging. Fruit trees should be sprayed every 3 to 7 days while eggs are being laid. If the cicadas are not migrating from outside the orchard, less frequent applications of insecticide may be sufficient. (See Supplement A to this circular for suggested insecticides.)

Mites

European red mites overwinter as eggs deposited in late fall on roughened areas on the underside of twigs or small limbs. A few eggs can start populations large enough to damage an orchard. Overwintering eggs begin hatching when trees are in the early pink stage and finish by mid-bloom. Newly laid eggs appear soon after petal fall.

Spotted mites overwinter as mature females under loose bark or under ground litter, often in large groups. They appear as orange masses to the casual observer. They spin webs loosely around themselves, the webs serving to waterproof the mass. During pink and early bloom they come out of hibernation and begin feeding on the leaves nearest the tree trunk. By the first cover period, they start laying eggs and spreading farther into the tree.

Spotted mites migrate upward for more favorable food while European red mites migrate in all directions. Mites are easily disseminated by wind. When high populations force them to the top and outer portions of the trees, they will be blown downwind.

The most important predators of plant-eating mites are predatory mites. These predatory mites overwinter in the same locations as the spotted mites and sometimes live with them. They are similar in size to spotted mites, but are a whitish color during the winter. They emerge from hibernation at the same time as the spotted mites. During the summer they are straw-colored and generally move faster than other mites. They grow and reproduce most rapidly when red and spotted mites are abundant. When red and spotted mites are scarce, the predatory mites suffer accordingly. Some survive by feeding on pollen or other vegetative matter if they can't find their normal prey.

Control. High populations of red and spotted mites result from various circumstances, such as hot, dry weather; pesticide schedules which destroy predators; improper dosage and timing of miticides; incomplete coverage; varietal susceptibility; and winds. Control problems differ from orchard to orchard, and each grower must adjust his control measures accordingly.

A prebloom oil spray is suggested for red mite control. If red mites have been a serious problem, the oil spray should be followed by a miticide in the pink stage. Prebloom sprays are not usually needed for spotted mites.

Later in the season, miticides may be applied as needed. Since high populations often develop in small portions of the orchard, growers learn to watch and apply control measures before the mites spread throughout the orchard.

These points need to be emphasized:

1. Chlorinated hydrocarbon insecticides are no longer suggested as foliage sprays. They kill predatory mites.
2. Red mites, spotted mites, and predatory mites are all becoming resistant to the commonly used organic phosphate insecticides.
3. Pesticides are recommended in dosages large enough to control high populations of pests. If adequate control has been obtained, these dosages may be reduced, encouraging predator development.
4. Studies show that mites may lose their tolerance to a specific miticide if that miticide has not been used for several years.

The application of miticides as soon as mites appear is probably the most popular program for mite control. If you have been successful with this approach without excessive applications, you may wish to continue. A more modern approach, however, is to try utilizing the mite predators by avoiding the use of materials that destroy them. This approach is called an integrated program.

Even in an integrated program, miticides may be necessary. The orchard must be checked closely for mites all season. It is particularly important to check for red mites from the second through the fifth cover. If the mite population averages three to five adults per leaf in any season, the full miticide dosage should be applied. From mid-season

on, one to three adult mites per leaf can be tolerated for several days. If mites vary from one-third to one per leaf, the miticide dosage may be adjusted to one-fourth to one-half of normal. Insecticide dosages may also be reduced.

Apple tree borers and bark beetles

Apple tree borers are seldom a problem in well-managed orchards.

The roundheaded apple tree borer usually burrows in the base of the trunk from 2 inches below the ground to a foot or more above.

The flatheaded apple tree borer works higher on the trunk and sometimes infests the branches. It usually locates on the sunny side of the tree. Weakened trees are especially susceptible, so the best protection is to keep the trees vigorous. If the borer is known to be present, shading exposed trunks and branches will help prevent infestation.

In recent years the dogwood borer (or pecan borer) has been found with increasing frequency on apple trees of all ages. The larvae and the type of injury are similar to those of the lesser peach tree borer (below). However, the dogwood borer larvae and the injured areas are smaller. Apple trees do not ooze gum like the stone fruits, so the only evidence of the dogwood borer is the sawdust from the tunnels that appears on the bark. The larvae feed where the bark is rough or where injuries have occurred, especially in spots not reached by regular orchard sprays. Interstem trees, trees where the graft union is above ground, and trees with injured trunks are especially vulnerable.

Bark beetles usually attack only weakened trees or branches, although they are occasionally found on healthy trees. Good tree vigor is usually the only control measure needed. Low tree vigor may be corrected by pruning, fertilizing, providing proper soil drainage, and controlling the many insect and disease pests such as scale and apple scab.

The insecticides applied in the cover sprays usually control roundheaded, flatheaded, and dogwood borers and bark beetles adequately if the spray material covers the bark of the trees. In problem areas (such as injured or interstem trees, or spots on the bark which are not well covered by regular sprays), a special phosphate insecticide spray may need to be applied with a hand gun.

Peach tree borers

Three borers — the peach tree borer, the lesser peach tree borer, and the American plum borer — attack nectarine, plum, and cherry trees, as well as peaches. Many scaffold limbs, and even entire trees, may be lost when borers invade areas where the bark has been damaged.

The peach tree borer infests the inner bark of the tree trunk within 6 inches of the ground level. The lesser peach tree borer and the American plum borer infest the inner bark of the entire tree at any point where the newly hatched larvae can be protected by deep cracks or dead bark. Exudations from wounds and cankers are especially attractive to

moths as egg-laying spots. Pruning cuts should be made so that they will heal rapidly.

Lesser peach tree and American plum borer moths begin emerging by May 1 in southern Illinois and by June 1 in northern Illinois. Peach tree borer moths begin emerging about a month later in both locations. Moths of all three species may be present until the end of September. They are usually most numerous between mid-July and mid-August.

Regular control sprays applied with air blast sprayers usually do not give adequate control of borers. Special sprays applied to the trunk and major branches with a high pressure hand gun are suggested.

The number of special sprays and the timing of the sprays should be adjusted according to the seriousness of the borer infestation. For light infestations, a spray applied about June 15 and a second one applied during the last week of July may be sufficient.

For moderate infestations, three sprays applied about June 15, July 15, and August 15 are suggested. When infestations are heavy, or when severe winter injury has occurred, four sprays are suggested. Apply them about June 1, June 25, July 20, and August 15.

Thoroughly spray the bark of the trunk and major branches. Give special coverage to wounds, rough bark areas, crotches, and areas where gum is exuding.

In special situations such as when borer populations are high in a few trees or when large wounds might girdle limbs or trunks, hand-cleaning to the live bark may be considered to immediately stop further feeding damage. Hand-cleaning should be done between bud break and bloom. Wounds heal most rapidly at this time. Painting or spraying the cleaned wound with an asphalt tree wound dressing or an effective insecticide will keep it from being reinfested. (For specific insecticides for controlling peach borers see the current Supplement B to this circular.)

Mice

Meadow mice are a constant threat to orchards throughout Illinois. Prairie mice and pine mice are not so widely distributed, but they can cause serious damage where they become established. All three species may be found in the same orchard.

Trapping with common snap traps aids in identifying the species and in monitoring the size of the population. Set the traps at right angles to the surface runs and cover the traps lightly with grass clippings.

Pine mice have short tails that are about the same length as the hind foot. Meadow mice and prairie mice have long tails that are about twice the length of the hind foot. Distinguishing between meadow mice and prairie mice is difficult. The fur on the stomach of meadow mice is grey, whereas on prairie mice it is buff color.

Meadow mice live mostly above ground in the orchard cover but they may make shallow tunnels for nesting. Their surface trails are readily visible. They damage trees by eating the bark on the trunks near or slightly below ground level. They seldom eat bark from the roots. Trees may be partially or completely girdled.

Prairie mice live both above and below ground. Like meadow mice, they may eat the bark on the trunk. But they may also eat small roots and the bark of larger roots as do pine mice.

Pine mice live in underground burrows and make extensive underground tunnel systems. They journey above ground only occasionally. They eat small roots and bark from the larger roots. They usually do not damage the trunk.

When pine mice are suspected, look for small entrances into their underground burrows and tunnels. The entrances are usually partially covered with grass clippings and fallen leaves, and may be hard to see. Remove the litter to expose the entrances.

Control. A great aid in controlling meadow mice and prairie mice is to destroy their cover, exposing them to owls, hawks, cats, foxes, skunks, and other predators. Close mowing with rotary mowers is recommended, especially before or immediately after harvest.

Also eliminate grass and weeds in a 2-foot-radius circle around the trunk. This can be done by using herbicides[1] or by hand hoeing in the fall.

Tree guards constructed from ¼-inch mesh hardware cloth may be used. To be effective against meadow mice the guards must enclose the trunk from several inches below ground level to about 12 inches above ground level (18 inches if protection from rabbits is needed).

Cultural practices must be supplemented with poison bait applications to insure adequate control of meadow and prairie mice. Grain treated with zinc phosphide makes a good bait. A mixture of cracked corn and oats is more effective than corn alone. Broadcast application at a rate of 6 to 10 pounds per acre is suggested for commercial orchards. Apply between October 15 and November 15 on a sunny, calm day, when the mice will be active.

Poison grain may also be used for spot treatment whenever meadow mouse activity is noted. Another effective bait for spot treatment is fresh apple cubes treated with zinc phosphide. Cut apples into ½-inch cubes and add 1 level teaspoon of zinc phosphide per quart of cubed apples. Use three or four cubes per tree.

Meadow and prairie mouse damage is usually greatest during the winter, when other food is scarce. However, damage can occur at other times. Check for mouse damage throughout the year.

[1] See publication H-659, available from the Horticulture Department, 124 Mumford Hall, Urbana, Illinois 61801.

Pine mice seldom feed on the surface of the ground, thus surface baiting as suggested for meadow and prairie mice is not effective. Bait must be placed in the burrows or in artificial trails.

Machine-baiting with a tractor-mounted trail builder is the most effective method of treating large areas infested with pine mice. The trail-builder constructs artificial trails just below the soil surface and places bait in these trails. Use zinc-phosphide-treated grain. Make artificial trails along both sides of the tree row at the drip line of the trees. Good sod and reasonably moist earth are necessary to make good trails. It is essential that the trail builder be properly adjusted for existing soil conditions and the tractor be operated at a slow speed to avoid tearing the sod.

For spot treatment of smaller infested areas, place zinc-phosphide-treated grain in entranceways to underground burrows.

All three species of mice may move into the orchard from adjacent areas, especially if these areas are wasteland with heavy cover. Baiting these areas will greatly reduce the danger of reinfestation in the orchard.[1]

CAUTION: When mixing or handling baits, work outside and avoid breathing zinc phosphide dust. Wear gloves when handling and distributing baits. Afterward, carefully wash hands and utensils. Store toxicants, baits, and contaminated gloves in a safe, well-ventilated place.

TIPS FOR USING PESTICIDES

Most Pesticides are Poisonous

Some pesticides are hazardous to the operator; some are toxic to plants; some may leave toxic residues that are dangerous to consumers; and a few are hazardous because they tend to contaminate the flavor of foods or feeds. So be sure to observe strict precautions when using pesticides.

To learn the hazards of a specific pesticide, *read the label* on a current season's pesticide container. All pesticides sold in interstate commerce have been registered and labeled under federal regulations. The label contains the most accurate information that was available on specific uses and hazards of a material at the time of printing.

Use Current Pest Control Suggestions

Spray schedules have not been included in this circular. They are printed separately and revised each calendar year. Supplement A gives apple spraying suggestions. Supplement B gives spraying suggestions

[1] For more information on mouse control, see publication FWS 303, available from the Horticulture Department, 124 Mumford Hall, Urbana, Illinois 61801.

for peaches and other stone fruits. Current copies of these publications may be obtained from your County Cooperative Extension Office or from the Publication Office, 123 Mumford Hall, Urbana, Illinois 61801.

Careless Use of Pesticides Invites Death

The organic phosphates parathion, Systox, and Trithion are especially dangerous chemicals. Though other organic phosphate materials are not as dangerous as these three, all phosphates have an additive effect, and repeated exposure to them can cause health problems.

When using organic phosphates follow these precautions:

1. **Be extremely cautious when using with oil,** as oil causes the skin to absorb more organic phosphate.

2. **Do not spray from the inside of the tree.**

3. **Secure a respirator that has been officially approved** for use with organic phosphates. The following respirators are suggested:

Respirator R-6058, Cartridge No. R-58
American Optical Co., Southbridge, Massachusetts 01550

Respirator 93938, Replacement Filter Cartridge No. 93939
Mine Safety Appliance Co., 400 Penn Center Blvd.,
Pittsburgh, Pennsylvania 15235

Agritox Respirator, Cartridge Filter Pkg. R705
Wilson Products, Inc., Box 622
Reading, Pennsylvania 19603

4. **Use the mask** to protect lips, nose, and mouth from accumulating residue, especially while preparing spray mixtures. Wear the mask while spraying in the orchard whenever there is danger of inhaling the pesticide.

5. **When spraying, inform someone** of your location and time schedule so he can monitor the spraying operation and provide help in case of an accident or illness.

6. **Stand out of the drift** when putting spray powders into a tank or when filling a duster — even when you are wearing the proper mask.

7. **Do not wash spray material through the screen** into the tank. Sift it in quickly with the screen removed.

8. **Do not breathe dust or powder.**

9. **Dust with the wind** and be careful of the turns at the ends of the rows. A duster or sprayer operated by one man with controls at the tractor is safer than the manually operated, two-man outfit.

10. **Keep a pail of water and soap handy** when loading sprayer. Wash hands thoroughly after each contact with the material and before touching the lips, eyes, etc., or eating any food.

11. **Do not smoke** while spraying or dusting pesticides.

12. **Take a hot bath** or shower and put on clean clothes when through spraying each day.

13. **If clothes becomes accidentally soaked, remove them immediately,** take a hot bath or shower, and put on clean clothes.

14. **Always store pesticides in original containers with the original label.**

Atropine is the emergency antidote for organic-phosphate poisoning. Keep a supply of atropine tablets on hand (1/120 grain or 0.5 mg.). You will need a doctor's prescription to get them. Never take atropine or similar drugs until AFTER warning symptoms appear. Symptoms of organic-phosphate poisoning include headache, blurred vision, weakness, nausea, cramps, diarrhea, and discomfort in the chest. If you feel any symptoms while spraying with an organic phosphate, quit spraying, take two atropine tablets at once, and go to a doctor.

If you handle organic phosphate insecticides regularly, you should go to your doctor periodically for blood cholinesterase determinations.

Rating of Materials for Toxicity

The list on page 13 indicates how various insecticides and miticides compare in their toxicity to man. It does not necessarily include only those suggested for use. The ranking is approximate. The information has been derived from many different sources and no standard comparative method has been applied to all materials. Thus the list should serve only as a relative guide.

The materials are ranked in two ways — for oral and for dermal toxicity. Oral toxicity results from intake through the mouth and nose in swallowing or breathing. Dermal toxicity results from pesticide contact with the eyes or skin. A material may be higher in one type of toxicity than in the other. Dieldrin, for example, rates below Guthion in the oral intake column, but is higher in the skin contact column.

In general, the oral intake rating is probably the more important. It is not difficult to protect the skin, but it is difficult to keep the mouth and nose covered at all times. Exercise the utmost care when using these chemicals.

Protect Honey Bees From Toxic Materials

Pollination by bees is essential in producing commercial crops of apples and some other fruits. Growers, beekeepers, and pest control operators must cooperate to keep honey bee losses at a minimum while providing necessary pest control.

Many of the pesticides suggested in this circular are highly toxic to honey bees and other beneficial insects. Some materials, including

INSECTICIDES AND MITICIDES RANKED IN ORDER OF DECREASING TOXICITY TO WARM-BLOODED ANIMALS, INCLUDING MAN

(Inclusion of a material in this list does not indicate suggested use)

Oral toxicity (by intake)		Dermal toxicity (on the skin)
	Very high toxicity	
Phosdrin		Phosdrin
Parathion		Systox
Endrin		Parathion
Guthion		Endrin
Trithion		Trithion
Phosphamidon		
Dieldrin	**High toxicity**	
Ethion		
Thiodan		Dieldrin
		Thiodan
		Phosphamidon
	High toxicity	**Moderate toxicity**
Nicotine		
Diazinon		Ethion
		Guthion
	Moderate toxicity	Nicotine
		Galecron or Fundal
Morocide		Cygon
Galecron or Fundal		Diazinon
Imidan		
Cygon		**Low toxicity**
		Kelthane
	Low toxicity	Morocide
		BHC
Sevin		Morestan
Kelthane		Lead arsenate
Lead arsenate		Ovex
Karathane		Omite
Plictran		Imidan
Malathion		Plictran
BHC		Sevin
Ovex		TDE
Omite		Malathion
TDE		Gardona
Gardona		Karathane
Tedion		Tedion
Acaralate		Acaralate

several that are low in toxicity to humans, are especially toxic to bees and should not be used when bees are visiting the blossoming trees or when their hives are located in the orchard.

If you must use pesticides when bees are present, choose materials that are least toxic to them. Spray at the safest times for bees — that is, when they are not flying because of darkness or cool temperatures. Keep spray materials from drifting into bee hives, onto other crops or weeds in bloom, or into sources of drinking water for bees. Many bees

can be killed by residue on dandelions in orchards in the spring, and on clovers in the summer when the trees are not in bloom. Whenever you must apply materials hazardous to bees on attractive blossoms, notify the beekeeper in advance so that he may move, cover, or otherwise protect his bee colonies.

Some materials, such as ethion, Systox, and Trithion, are toxic to bees only 3 to 5 hours after application. Other compounds, especially many chlorinated hydrocarbons and Sevin, are hazardous to bees for several days. When applied as a pink spray in warm weather, they may kill bees during the bloom period. The danger periods for some materials are as follows:

Material	*Days*	*Material*	*Days*
Diazinon, parathion	1	Guthion	2-4
Cygon	1-2	Imidan	4-7
Malathion, phosphamidon	2	Sevin	4-7

For further information, see Illinois Extension Circular 940, "Pesticides and Honey Bees."

Getting Good Fruit Finish

Obtaining good fruit finish on apples is a perennial problem in Illinois because of our variable weather patterns. Roughness of the skin, commonly called russet, is most likely to occur on Golden Delicious but sometimes affects other varieties. Though russet does not affect the flesh, it detracts from the appearance of the fruit, thus reducing its value.

Weather conditions alone can cause russet, but most russet results from a combination of weather conditions and spray programs. Certain chemicals are more likely to cause russet than other chemicals when applied during certain weather conditions.

The most critical period for russet development is between the pink-bud and the third cover spray. But the period from the fourth cover spray until harvest is also important.

Here are some precautions for getting good finish:

1. Do not apply the bloom, calyx, or first two cover sprays within 24 hours before a predicted freeze, during a freeze, or within 24 hours after a freeze. Almost any chemical will damage fruit if used during these weather conditions. Glyodin and Cyprex are especially dangerous in freezing or near-freezing weather. To be completely safe, do not spray when temperatures are below 45°F., particularly in the lower elevations of the orchard.

2. Do not use any copper materials (bordeaux mixture, insoluble coppers) except during the dormant and delayed dormant periods.

3. Do not apply cover sprays in the heat of the day. Never spray when the temperature is above 90°F. During the late spring and sum-

mer, spraying at night, in the early morning, or after 4:00 p.m. is suggested.

4. Do not use sulfur in any form when the temperature is 85°F. or above.

The above suggestions apply to all varieties but are most pertinent for Golden Delicious. Three additional precautions should be taken for this variety:

1. Do not use urea for foliar feeding.

2. Select fungicides that are least likely to cause injury. Captan, Dikar, Polyram, and zineb are the best suggestions.

3. Use lead arsenate as the only insecticide in the calyx spray. The organic phosphates are more likely to cause injury at this time.

If disease, insects, or mites should become critical during any period when spraying might cause russet, then you will have to decide which is the lesser of evils.

Low-Volume Spraying

The modern trend in orchard spraying is toward low-volume sprays. This system of spraying reduces costs for materials and labor and improves fruit finish. It also conserves the orchard water supply.

Several types of low-volume sprayers are available. Although they vary in general operation, they all produce the same end results: High concentrations of chemicals are applied to the trees in small quantities with very small droplet sizes. This gives the spray distribution necessary for good control. Most growers having these machines are using concentrations of up to 20X.

Conventional sprayers may be adjusted for low-volume spraying. This requires renozzling, proper calibration, and an adjustment in travel speed. Concentrations used with converted conventional sprayers

EQUAL DOSAGE TABLE FOR AIRBLAST SPRAYERS ON 20-FOOT APPLE TREES

(From the Pennsylvania State University U-Ed 8-313)

Concentrate	Gal. spray/40 ft. of full-row coverage	Gal./min. output for 2 sides of sprayer	Min. to discharge 500 gal.	Gal./acre at 2 mph			
				40-ft. row	35-ft. row	30-ft. row	25-ft. row
1	14.7	64.7	7.7	400	457	534	640
3	4.0	17.6	28.4	109	124	145	174
4	3.0	13.2	37.9	82	93	109	131
6	2.0	8.8	56.8	55	62	73	87
8	1.5	6.6	75.8	41	47	54	65
10	1.2	5.3	94.7	33	37	44	52
30	.4	1.8	285.1	11	12	15	17

are usually in the 3X to 6X range. You will need to adapt these suggestions to your situation.

Although wind affects coverage of both dilute and low-volume spraying, it is probably more important in low-volume spraying because of the small droplet size. However, low-volume spraying, by cutting down refill time, greatly reduces the total time required for spraying. This enables growers to get their spraying done during periods of little or no wind.

The table on page 15 gives information on setting up different low-volume programs for conventional airblast machines. An important consideration is the relationship between chemical concentration and gallon-per-minute discharge. If the chemical concentration is at 3X, or 3 times normal, then the discharge per minute would theoretically be one-third of normal. But, to save materials, renozzling can reduce the discharge even more. As shown in the table, at 1X (dilute or full coverage), a sprayer is nozzled to discharge 500 gallons in 7.7 minutes, but at 3X, new nozzles have reduced output so that it requires 28.4 minutes to discharge 500 gallons. This is less than one-third the normal discharge and represents a saving of about 18 percent in the amount of chemical applied. The entire table has been devised to effect a similar saving at any concentration.

Traveling speed is another important consideration. For trees 20 feet high, the speed should be 2 miles per hour. For smaller trees, like peach or small apple trees, speed may be increased to 2½ to 3 miles per hour.

CONTROLLING PESTS ON APPLES

This section tells the apple pest problems to watch for during the various stages of growth and discusses methods and materials for controlling them. Specific pesticide suggestions are given in Supplement A to this circular.

With a current copy of Supplement A, this circular, the Illinois Fruit Calendar, orchard records, and your previous spraying experience, you can plan a basic schedule for each block.

Keep observing your orchard for pest problems, subscribe to and use the weekly Spray Service Report, and attend local and state orchard meetings.

Dormant to green tip. The major insect and mite pests are scale, European red mite eggs, and aphid eggs. Other pests may be present but they usually do not require special attention at this time.

Superior oil is suggested for scale insects and red mites. It has a high percentage of paraffin, which kills these pests by suffocation. Since

oil's killing action is by suffocation rather than by toxicity, thorough coverage of each scale insect and red mite egg is necessary for control. Thorough coverage is thus the most important consideration in oil spraying. The calmer the day, the better the coverage will be.

Two gallons of oil per 100 gallons of dilute spray is full dosage. As the scale insects start to grow and the red mite eggs near hatching they are easier to kill. At the tight cluster stage, 1 gallon of oil is sufficient. The addition of phosphate insecticides to oil sprays does not increase the kill of scale insects or red mite eggs.

Oil is not very effective against aphid eggs. A systemic phosphate should be added to one of the sprays during the green tip to tight cluster stage for aphid control.

Sulfur and Dikar are not compatible with oil. Where mildew is a problem and sulfur or Dikar is needed for control, oil should be applied in the dormant stage. Sulfur or Dikar can then be applied as the green tips appear. See the half-inch green to tight cluster section for more information on mildew control.

As a clean-up spray copper sulfate may be combined with oil or used alone in the strictly dormant stage. This is primarily an aid in fire blight control but may also help control Botryosphaeria, black rot, and blotch. After the buds begin to swell, copper sulfate may cause injury. Do not combine copper sulfate with dinitro or phosphate materials.

An 8-8-100 bordeaux-oil combination is also a good clean-up spray and acts in the same manner as copper sulfate alone. It will last longer as a residue than copper sulfate and is less likely to cause injury. It is most effective when applied during the silver tip period.

In the green tip spray, Cyprex or Benlate should be applied for scab control. Sulfur, Dikar, or Benlate should be applied for mildew if necessary. Benlate had an experimental label for apples in 1972, and is expected to receive full label clearance in 1973.

Half-inch green through tight cluster spray. *Insects and mites.* A systemic phosphate should be applied once for aphid control if it was not included in the green tip spray. It will also reduce leaf rollers.

The oil sprays discussed in the dormant to green tip section may be continued, if they do not conflict with the use of certain fungicides. To avoid leaf injury do not apply oil after, with, or just before captan, sulfur, Dikar, or Karathane. Oil is compatible with Cyprex, Benlate, and ferbam. If oil is being used at this time a mix should be made in a glass jar to test compatibility. Always add the other materials first and keep the mixture agitated while adding oil. Oil may be reduced to 1½ gallons per 100 gallons of dilute spray at half-inch green and to 1 gallon in the tight cluster period.

Diseases. Where powdery mildew is a problem on susceptible varieties, oil should not be applied during the half-inch green to tight cluster stages. For suggestions on applying oil where mildew is a problem, see the discussion under dormant to green tip sprays.

Powdery mildew, a relatively new disease in Illinois, can be serious on Jonathan, Rome Beauty, and Golden Delicious. It decreases fruit quality and reduces yields. It overwinters in the buds, making them more susceptible to winter injury and causing many of them to die during the winter. If not controlled, powdery mildew becomes more serious each year.

Sulfur is the most effective material for powdery mildew. Karathane and Dikar (which contains Karathane) also are effective and are useful during the summer when high temperatures prevent the use of sulfur. Benlate shows promise for mildew control.

The program for mildew control must start in the green tip stage. This is when the overwintering mildew spores start to grow and infect the new leaf tissue. And the program must be continued with regular control sprays into July. Mildew is the opposite of scab in that it spreads more rapidly during dry weather than it does during wet weather. Thus during dry weather mildewcides must be applied even though scab control materials are not needed.

As with all disease control materials, thorough coverage is necessary for adequate control. Mildew is usually most prevalent in the tree tops where good coverage is difficult to obtain. Once established in the tree tops, mildew can spread rapidly to other parts of the tree as the season progresses. Special effort in spraying the tree tops may be needed.

Scab is a problem throughout Illinois and control must be established in the prebloom sprays. Cyprex and Benlate are the most effective materials against scab. Captan and Dikar also give good control. Sulfur applied for mildew gives some protection against scab.

Problems with scab control are usually associated with wet weather. Weekly sprays during the prebloom period should protect adequately against scab. During prolonged wet spells when spraying is difficult or impossible, dusting is suggested. Dusts containing sulfur, captan, or Cyprex are available.

Pink (when the buds are pink but no blossoms have opened). *Insects and mites.* If a systemic phosphate was used in one of the earlier sprays for aphids, insect control will not usually be needed in the pink spray. However, curculio adults will be emerging from trashy areas, and a few rows of apples next to timber, overgrown fence rows, and similar spots may need to be sprayed with a phosphate.

Avoid poisoning honey bees and other pollinating insects. During warm weather there is not much time between pink and early bloom.

Diseases. Scab and mildew control programs must be continued and rust control must be started. For rust either zineb, Dikar, or Polyram is suggested.

Where mildew is a problem, you may choose either Dikar alone, Polyram plus sulfur, or captan plus zineb plus sulfur. Where mildew is not a problem sulfur may be omitted. Zineb is a weak bactericide and may reduce early fire blight infection.

On Jonathan and other fire-blight-susceptible varieties, streptomycin should be started in the late pink spray. See the fire-blight discussion under bloom sprays.

Bloom sprays. Frequently, a fungicide spray is needed during periods of prolonged bloom. However, some fungicides are toxic to pollen and will hinder fruit-set. Thus, it is important to select fungicides that will control scab, rusts, and powdery mildew without injuring pollen. The combination of sulfur and zineb is suggested. Neither of these materials has demonstrated toxicity for pollen and they control the diseases. They are not toxic to pollinating insects.

On varieties susceptible to fire blight, bloom sprays of streptomycin should be applied as needed. The blossom blight phase of this disease is usually erratic and unpredictable in Illinois. Since it can be controlled by streptomycin, this material should be used when conditions are optimum for disease development. Because of the cost, however, streptomycin should not be used if it is not needed.

Temperature and moisture conditions during blooming are not the only climatic factors that determine whether blossom blight infections will occur. It is now thought that prebloom freezing temperatures may reduce infections by killing a high percentage of viable bacterial cells.

Bacteria in a canker multiply as the tree develops in the spring. At approximately the pink bud stage, bacterial ooze can be found on the surface of the cankered area. This is the source of inoculum (bacteria) that infects the blossoms. However, a sudden freeze will destroy a high percentage of these bacterial cells. A reduction of viable cells means less likelihood of blossom infection.

After a freeze, the "degree days" required for the bacteria to again reach a potentially dangerous inoculum is computed from 65°F., the minimum temperature for growth of the organism. Should the maximum daily temperature reach 70°F., this would equal five degree days (70°F. − 65°F. = 5 degree days).

Observations indicate that 30 degree days are adequate for the bacteria to again reach a dangerous population level. For example, two days of a maximum temperature of 80°F., or three days of 75°F., or six days of 70°F. following a freeze would each provide the heat units necessary for a serious blossom blight infection.

At temperatures above 86°F., however, the bacteria do not develop. Thus fire blight infection will not occur either when the temperature remains below 65°F. or when it rises above 86°F.

The following points will aid in understanding the fire blight disease:

	Temperature	*Moisture*
For blossom infection	At least 30 degree days between latest freeze and early bloom – plus – Maximum temperature of 70°-80°F. during early bloom.	Adequate rainfall during prebloom period – plus – Very light rain and high humidity during early bloom.
For no blossom infection	Freeze close to bloom and less than 30 degree days between latest freeze and early bloom – or – Maximum temperature lower than 65°F. or higher than 86°F. during early bloom.	Drouth preceding and during bloom – or – Excessive moisture during early bloom.

Calyx and first cover. The calyx and first two cover sprays may be critical in obtaining good fruit finish (page 14). Apply the calyx spray when three-fourths of the petals have fallen and the first cover spray 7 to 10 days later.

Insects and mites. Leaf roller eggs will be hatching. Curculio adults will be making feeding punctures and egg-laying punctures on the young fruit. Codling moth adults will be emerging and laying eggs. A phosphate insecticide should be included in both the calyx and first cover sprays except on Golden Delicious. Imidan is weak on leaf roller control. For calyx sprays on Golden Delicious, see pages 14 and 15.

If aphids persist, use a systemic phosphate in addition to the phosphate insecticide.

Diseases. Protection against scab, rusts, blotch, powdery mildew, and frog-eye diseases must be included in these sprays.

On Jonathan and other susceptible varieties, protection against the twig blight phase of fire blight should be started. Use streptomycin, preferably applied alone, when humidity is high and the spray will dry slowly. These conditions are most likely to occur between 10 p.m. and 3 a.m. Daytime sprays of streptomycin are not very effective. Use 50 ppm of streptomycin if the temperature is 65°F. or above and 100 ppm if it is below 65°F. at the time of application. Apply streptomycin on a 7-day schedule into July.

Remaining cover sprays. See the discussion on getting good fruit finish on page 14. The second, third, and fourth cover sprays are normally 7 to 10 days apart. This is a critical period for control of several insects and diseases.

By the fifth cover, pest control should be well established and spray intervals can often be extended to 14 days. Adjustments in spray intervals should be made according to weather conditions, the threat of pest infestation, and your past experiences. The twig blight phase of fire blight is an exception. (See the discussion on twig blight control in the calyx and first cover section.)

Insects and mites. Scale crawlers usually begin appearing about the time of the third or fourth cover sprays. Where scale was a problem the previous year, parathion is suggested as the phosphate insecticide. Parathion is more effective than Imidan and Guthion against scale crawlers.

Mites are likely to become a problem during this period. (See the discussion on mites, page 5.)

Apple maggots pose a serious threat in the northern half of Illinois. Maggots infest apples during June, July, and August. For control, a phosphate insecticide is needed every 14 days during this time. Special attention is necessary when unsprayed host fruit is nearby. Effective traps are now available. They help in timing maggot control sprays.

Diseases. Fungicides should be continued throughout this period. Rust diseases will continue to infect leaves and fruit through the third cover.

Protection against powdery mildew will be needed into early July. Infection after bloom is mainly on the new shoots. The buds on infected shoots then provide a wintering-over place for the mildew fungus.

Other diseases to watch for are late scab, sooty blotch, flyspeck, bitter rot, and botryosphaeria rot (bot rot). Where bot rot has been a problem, Phaltan is suggested as the fungicide in the fifth and remaining cover sprays.

PEACHES, NECTARINES, AND APRICOTS

A specific spray schedule for peaches, nectarines, and apricots is given in Supplement B to this circular. The following paragraphs tell what pests to watch for at the different spray periods.

Dormant spray. Pests needing attention during this period are peach leaf curl, scale insects, European red mite eggs, and valsa canker.

The dormant spray is the only chance to prevent peach leaf curl from infecting the new leaves developing later in the spring. Any good fungicide will give control, but Cyprex is suggested because it is com-

patible with superior oil. For curl control the fungicide must be applied before the leaf buds break.

Oil gives good control of scale insects and European red mite eggs in dormant or delayed dormant sprays up to the pink stage. Both of these pests can seriously damage peach trees. Peaches are more susceptible to damage from oil than are apple trees. Therefore, oil should not be applied when the temperature is likely to drop to 32°F. within 24 hours after application. (See the discussion on oil, page 43, and the section on dormant sprays for apples, page 16.)

Valsa canker (perennial canker) may be partially controlled by a fungicide immediately after leaf fall. This helps to protect the leaf scars from infection during the late fall. A 4-6-100 bordeaux is suggested since there is little chance of plant injury at this time. Valsa canker is more serious on some varieties than others. Rio-Oso-Gem, for example, is more susceptible than Redhaven.

Pink, early bloom, and full bloom sprays. The pink spray is for control of catfacing insects such as the tarnished plant bug. These pests are attracted to open blossoms. They feed on the base of the flower, which causes catfacing, then leave the orchard when bloom is over. Since spraying an insecticide during bloom will kill bees, the pink spray should be applied at least 2 days before the first blossoms open. Bees work the inside of the open flower, which is free from insecticide, whereas catfacing insects work the base of the flower, which is covered with insecticide.

The bloom sprays are for brown rot control. Both ascospores and conidial spores of the brown rot fungus are present for blossom infection. Two sprays are suggested, one in early bloom and one in full bloom.

Oriental fruit moths start emerging during bloom and begin laying eggs before bloom is over. Plum curculio also begin emerging during bloom. Normally neither insect requires control during bloom.

Petal-fall through cover sprays. *Insects and mites.* Normally, insecticide sprays will be needed every 14 days from petal fall until after the second brood curculio emerges in early July. After this period insecticides may not be needed.

Stink bugs will be present from late bloom through harvest. They are a major cause of catfacing after bloom. Another cause is curculio feeding and egg-laying punctures. The most serious catfacing injury occurs during bloom through shuck-split. As the fruit grows larger, injury is less severe. Curculio also are a major cause of wormy fruit.

Oriental fruit moth eggs begin hatching near petal-fall time. The first generation feeds inside the tender terminal growth of the new shoots. As the larvae approach maturity the tips wilt and later die. The number of wilted tips is a good indication of the amount of infestation.

Oriental fruit moths have four generations each year. The second, third, and fourth generations attack the fruit as well as the terminal shoots. The third brood appears in early July along with the second brood of curculio.

San Jose and Forbes scale crawlers begin appearing soon after the second cover spray. Using a magnifying glass and a sharp-pointed knife or needle, check any known scale infestations. If you find any live scales, take special care to thoroughly spray infested areas with an insecticide, such as parathion or diazinon, which is effective against scale crawlers. Both species have several overlapping generations per year. Once scale crawlers begin appearing, they will continuously increase in number all season if they are not controlled.

Terrapin scale sometimes infests peaches. The adults are brownish insects shaped like a terrapin. A black fungus grows on the drippings (honeydew) that they leave on the branches, foliage, and fruit. During the dormant season blackened branches are easy to spot. In early June check infested trees for the presence of small, soft-bodied terrapin scale crawlers on the undersides of the leaves. Systox, a systemic phosphate, is especially effective against these crawlers because in their early life stages they feed mainly on the leaves. Parathion and diazinon are also effective.

Mites are especially difficult to manage on peaches. They usually do not build up until July or August, when many varieties are ready or almost ready for harvest. Harvest restrictions seriously limit the choice of miticides. Several miticides are not labeled for peaches at all.

Where red mites were a problem the previous season, an oil spray during the dormant or early growth stage is suggested. And during May and June red mites and spotted mites must be suppressed and predator mites encouraged. Do not use chlorinated hydrocarbon insecticides or Sevin.

Diseases. From petal fall into early July a fungicide should be applied every 14 days for brown rot and scab control. Sulfur is suggested for both diseases during the time that scab-control sprays are needed. The scab fungus has a 45-day incubation period, thus regular sulfur sprays are needed up to 40 days before harvest. If not controlled, scab will markedly degrade fruit.

Benlate is also reported to be effective against peach scab. It should be used on a trial basis only for scab until it has proved to be effective in Illinois.

The first bacterial spot infections may occur during the first cover period if the weather is warm and rainy. In this event, the Cyprex-captan mixture should be used. Either sulfur or Benlate should be added for scab during the time it is needed.

Preharvest fungicides. During the last 2 weeks before harvest, peaches soften and become increasingly susceptible to brown rot. Thus, it is important to spray a fungicide at frequent intervals prior to harvest.

For a discussion of borer control, see page 7.

Determining Peach Insect Populations

Tarnished plant bugs, stink bugs, and curculios migrate into the orchard each year from the outside. You can determine their prevalence by making counts on trees in the border rows, starting early in the season. Spread a white cloth under the tree to catch the insects, bump the scaffold limbs sharply with a rubber-cushioned pole, and count the insects immediately after they fall. Do this to the same trees twice a week and keep a record of the counts. This will help you compare and evaluate the effectiveness of control measures.

Insect populations can also be estimated by detecting which insects cause the most damage to fruit. Good places to watch for insect damage during early season include any crab apple, plum, or domesticated cherry fruit that is unsprayed and close to the orchard.

With a few seasons' practice, you can examine fruit injury during early season in surprisingly little time. By walking through any block or by watching the fruit closely during hand-thinning, you will be able to estimate the populations of pests in your orchard. To determine the times of year when control is weakest, examine a few fruit throughout the block before harvest, or check the types of injury on cull fruit at the grading table.

Virus Diseases of Peaches

Peach yellows, peach rosette, phony peach, and yellow-red virosis are virus diseases of peaches that are known to be present in Illinois. Since peach yellows is often harbored in the plum, where the symptoms are inconspicuous, wild plums should not be left growing near peach orchards. Yellow-red virosis is primarily a disease of chokecherry, but it may spread to peaches. All chokecherries within half a mile of peach orchards should be destroyed. The common wild black cherry does not carry this virus.

A peach disease known as stem pitting, which may be caused by a virus, has been found in the eastern states in recent years and was discovered in Illinois in 1969. No vector has been discovered. The stem-pitting symptom occurs below ground level and the disease kills the trees. Remove and destroy such trees immediately.

If you suspect virus diseases, write the State Nursery Inspection Service, 1506 E. Roosevelt Rd., Wheaton, Illinois 60187.

PLUMS

The spray schedule for plums is given in Supplement B to this circular. The pests to watch for in the different spray periods are given in the following paragraphs.

Delayed dormant. Plums are subject to two virus diseases, rosette and yellows. The only way to control these diseases is to remove all infected trees promptly.

Black knot, a fungus disease, may be controlled by culling out the knots during two consecutive winters. All twigs with knots should be removed and destroyed. Knots may be cut out of large limbs, thus saving the limbs. It is sometimes helpful to spray as indicated in the schedule for plums (see Supplement B to this circular). Apply fungicides to infected trees as the buds begin to swell.

Use 2 gallons of superior oil for European red mites and scale insects (see the discussion under peaches). The scale insects that attack peaches also attack plums.

Petal-fall through second cover. Apply fungicides for control of brown rot and black knot.

Plum curculio is the main insect problem. Curculio feeding greatly increases the danger of brown rot. If no source of reinfestation is near, two or three sprays 7 to 10 days apart will normally give good control. More sprays may be needed, however, if native plums or other host plants are near the orchard.

Additional covers. Brown rot control is most important at this time. Curculio may need control again when the second generation of adults appears. This happens in early July in the southern part of the state. Trees should be examined closely for red mites at about the third cover. Mite control should be the same as suggested for peaches.

CHERRIES

The following paragraphs give general information about pests on cherries. For a specific spray schedule, see Supplement B to this circular.

Dormant. Scale insects do not often become a problem on cherries. If live scale insects can be found, superior oil should be applied at 2 gallons per 100 gallons of water at about the time the buds begin growing.

First and second cover. Brown rot and leaf spot are the two main diseases of cherry. Cherry leaf spot causes loss of leaves and is sometimes so severe that the tree dies. Since the organism winters over in the dead leaves under the tree, raking and burning leaves in the late fall is advisable.

Plum curculio and aphids should be controlled by a phosphate insecticide during this period. It will also stop other insects that occasionally attack the fruit, as well as borers that attack twigs and branches. Compare the notes on these insects under apples.

Additional sprays. Slugs may attack the leaves, removing the green surface. Branch and trunk borers should be controlled as suggested for all stone fruit trees.

PEARS

Pears have not been grown extensively in Illinois because of fire blight. However, streptomycin has now been approved for fire blight control and can be used at 100 ppm up to 30 days before harvest. Although this development is not likely to stimulate a new pear industry, fruit growers may become mindful of pears as a potential source of income. Even with the approved use of streptomycin, one should not plant highly susceptible varieties.

Pear leaf spot, a fungus disease, can be controlled with a moderate fungicide program.

Pear psylla, the most important insect on pears, has not been a serious problem since the development of organic phosphate insecticides. (See Supplement A to this circular.)

GENERAL MANAGEMENT PRACTICES

Tree Nutrition

A great deal of judgment is needed in managing the nutritional status of fruit trees, especially in applying nitrogen. Growth, as well as production and fruit quality, is a useful indicator of nutritional status. Average length of terminal growth on apple trees should be 6 to 10 inches; on peach trees, 12 to 20 inches. If the average does not fall within these ranges, both fertilizing and pruning practices should be modified. Leaf analysis also helps in managing fruit tree nutrition.[1]

Nitrogen. The "rule of thumb" nitrogen suggestion for apple trees is 1 ounce of actual nitrogen (3 ounces of 33-percent ammonium nitrate) per year of tree age up to 1 pound of actual nitrogen per tree. For peaches, the suggestion is 2 ounces of actual nitrogen (6 ounces of 33-percent ammonium nitrate) per year of tree age up to 1 pound of actual nitrogen per tree.

[1] Leaf samples should be taken between July 15 and August 15. For information about the leaf analysis service, write to the Department of Horticulture, 124 Mumford Hall, Urbana, Illinois 61801.

For example, the suggested amount for an 8-year-old apple tree is 8 ounces of actual nitrogen or 24 ounces (1½ pounds) of 33-percent ammonium nitrate; for an 8-year-old peach tree, 16 ounces of actual nitrogen, or 3 pounds (48 ounces) of 33-percent ammonium nitrate.

The amount of nitrogen applied should be adjusted according to the vigor and performance of the tree, the variety, and the amount of pruning. Increase the amount of nitrogen for weak trees and reduce the amount for vigorous trees. Pruning has the same effect as nitrogen fertilization on fruit trees. When heavy pruning is done, reduce the amount of nitrogen applied.

Excess nitrogen increases fruit size, but it delays maturity and seriously reduces color, sugar content, flavor, shelf life, and storage life. It also increases the amount of pruning required and delays hardening off of the trees in the fall, making them more susceptible to winter injury.

Nitrogen should preferably be applied to the soil in early spring, 4 to 6 weeks before bloom. If necessary, urea sprays may be used on red varieties to supplement soil fertilization, although urea may reduce fruit finish. Some growers have successfully combined urea with other spray materials. To minimize the effect on finish, however, it is best to apply urea as a separate spray. Urea sprays should be applied during the period from pink to 30 days after petal fall. Use up to 5 pounds of urea per 100 gallons. Do not use urea sprays on yellow apple varieties or on peaches and other stone fruits.

Phosphorus. During four years of the leaf analysis program for commercial orchards, no leaf samples have been found low or deficient in phosphorus. Illinois soils apparently supply adequate amounts of phosphorus for normal fruit tree growth without the addition of phosphorus fertilizer. If soil tests show low phosphate levels, the cover crop may need phosphate fertilization.

Potassium. About one-third of the leaf samples from commercial peach orchards and about one-fourth of the leaf samples from commercial apple orchards have been deficient in potassium.

Harvested fruit removes considerable quantities of potassium. Each 100 bushels of apples or peaches contains about 10 pounds of potassium oxide (K_2O). Prunings also remove sizable amounts of potassium. Therefore, periodic maintenance applications of potassium are advisable.

For peaches, a maintenance application of potassium should be made annually. On soils with low available potassium (below 200 pounds per acre by soil test), apples should also receive an annual maintenance application. If the soil has more than 200 pounds of potassium per acre, apples should receive maintenance amounts every other year. Check the nutrition conditions by leaf analyses.

Potassium should be applied to the soil rather than the leaves, since the leaves do not absorb appreciable quantities of this nutrient. Either muriate of potash (0-0-60) or sulfate of potash (0-0-50) may be used. Potassium may also be applied in mixed fertilizers if the rates are adjusted to apply amounts equivalent to the rates suggested below.

A general suggestion for apples is 1 pound of muriate or sulfate of potash per tree for young trees, 2 pounds per tree for dwarf or semi-dwarf trees in full production, and 4 pounds per tree for standard trees in full production. Or apply 150 to 200 pounds per acre broadcast.

For peaches, apply 1 pound of muriate or sulfate of potash per tree for young trees and 2 pounds per tree for trees in full production. Or apply 150 to 200 pounds per acre broadcast.

Boron is the minor element most likely to become low in Illinois apple orchards. So far, leaf analyses do not indicate a shortage of boron on peaches in Illinois.

For apples, a soil application of 20 pounds of borax per acre every 3 to 5 years is suggested. Do not exceed this rate, as too much boron is toxic to plants.

Boron may be applied as a spray instead of to the soil. Add 1 pound of boric acid or sodium pentaborate per 100 gallons of spray to the pink and first cover sprays.

Apply fertilizers to the soil 4 to 6 weeks before bloom. Spread under the drip of the branches. If the fertilizer is spread over the entire orchard floor, increase the quantities applied by one-fourth to one-third.

Soil reaction (pH) affects fruit trees indirectly through its effects on the availability of several soil nutrients. In strongly acid soils (pH below 5.0), the availability of phosphorus is reduced and the solubility of iron, aluminum, and manganese is increased so much that they may become toxic to plants. The pH of orchard soil should be kept in the 5.5-to-7.0 range through applications of agricultural lime.

Spray materials and fertilizers applied to fruit trees may cause the soil under the trees to become more acid. In testing for pH it is advisable to test samples taken under the trees separately from samples taken from the aisles. The soil under the trees may be more acid and thus require more lime than the aisles.

Young apple trees sometimes develop a condition called "measles" (internal bark necrosis) when the soil pH is 5.5 or below. Red Delicious trees are especially susceptible. Some growers have prevented or reduced the symptoms of measles by watering each tree with 5 gallons of a solution of 40 pounds of hydrated lime in 100 gallons of water.

Chemical Fruit Thinning of Apples

Chemical fruit thinning of apples enables growers to overcome the alternate bearing habits of some varieties and to improve the size and quality of the fruit in years of heavy set. The materials suggested are NAA (naphthaleneacetic acid), Amid-Thin (naphthaleneacetamide) and Sevin. Suggested materials and dosages for the different varieties are given in tabular form.

On Lodi, Wealthy, Melba and Transparent, a combination of NAA and Sevin applied at petal fall usually gives better results than either material alone. On Golden Delicious some growers have had good results with the combination of NAA and Sevin applied at the normal time for applying NAA on Goldens.

On Starkrimson and other spur-type Red Delicious strains, NAA has occasionally caused problems with pigmy fruit. Instead of dropping off, these seedless pigmy fruit remain on the tree until harvest, growing to about one-fourth normal size. Where pigmy fruit is a problem, Sevin should be used for thinning.

When NAA is the only thinning agent applied, its absorption and effectiveness are greatly increased by use of the surfactant Tween 20.

SUGGESTED THINNING SPRAYS FOR DIFFERENT APPLE VARIETIES

Variety	Materials	Timing
Lodi Melba Transparent Wealthy	NAA, 10 ppm —plus— Sevin 50W, 2 lb. per 100 gal.	At petal fall
Duchess McIntosh Jonathan Lodi Summer varieties not listed elsewhere	Amid-Thin, 50 ppm	
Golden Delicious Rome Beauty	NAA, 8.75 to 11.25 ppm —plus— Tween 20, ¾ pt. per 100 gal.	When king fruit is 10 to 13 mm. in diameter
Jonathan McIntosh Red Delicious[a] Turley Grimes Golden	NAA 3.75 to 6.25 ppm —plus— Tween 20, ¾ pt. per 100 gal.	
Red Delicious[a]	Sevin 50W, 1 to 2 lb. per 100 gal.	18-21 days after full bloom

[a] Red Delicious includes red sports and spur types but does *not* include Summer Delicious.

The concentration of NAA can roughly be cut in half if Tween 20 is used. Tween 20 helps to counteract the variable effects of weather conditions on the absorption of NAA. Thinning actions thus become uniform and reliable, and the danger of overthinning is reduced.

The combination of NAA, Sevin, and Tween 20 has not been thoroughly tested and is not suggested. Nor is the combination of Amid-Thin and Tween 20 suggested. Tween 20 does not appreciably affect the activity of Amid-Thin.

Because of variable growing conditions, NAA sprays are timed according to fruit size rather than days after full bloom. NAA is most effective on fall and winter varieties when most of the fruits are 8 to 10 millimeters in diameter; the king blossom fruit is 10 to 13 millimeters; and the smallest fruits are less than 8 millimeters.

Fruits should be measured either early in the morning or late in the evening. They tend to shrink during the day and grow at night. Starting a few days after petal fall, select a measuring time, measure fruits every day at the same time, and record the results. Measure each variety separately.

Thinning sprays should be applied separately from other sprays. Use dilute concentrations with full coverage of the tree parts to be thinned. NAA usually gives most reliable results when the temperature is between 70° and 75°F. and drying conditions are good. Amid-Thin, in contrast, gives best results under slow drying conditions (on damp, cloudy days, at dusk, or at night).

Frost or freezing temperatures injure apple leaves and cause them to absorb thinning chemicals more readily. Overthinning may result. If fruit needs thinning soon after a frost, or if the leaves show visible damage (such as crinkling or distortion) from an earlier frost, reduce concentrations by 25 percent.

Old trees are harder to thin than young ones. Vigorous trees are harder to thin than weak or low-vigor trees of the same age. The greater the number of seeds set per fruit, the more resistant the apples are to thinning chemicals. The suggestions in this section are for trees in an average and desirable condition with adequate pollination and seed set. You should modify the suggested concentrations to fit conditions in your orchard.

Since tree and pollination conditions do vary among orchards, among blocks within an orchard, and from year to year, you should keep detailed records of thinning operations and their results. These data provide the most accurate information for making intelligent chemical thinning decisions.

Thinning Peaches

Under Illinois conditions, mechanical methods are suggested for thinning peaches. The registration for NPA (Nip-A-Thin) as a chemi-

cal thinning material on peaches has been cancelled. CPA [(2-(3-chlorophenoxy)-propionic acid)] is still registered for thinning peaches, but field tests with CPA in Illinois have not given desirable results.

Peach fruits go through a stage just before pit hardening when they are loosely held on the tree and can be easily jarred from the tree. Fruits tighten when the pits start to harden. Thinning should be done during the "loose" period.

The loose period usually starts 1 or 2 weeks after shuck-off or about 5 or 6 weeks after full bloom, depending on weather conditions. It does not last very long so you should be ready to concentrate on thinning operations when it develops.

To find the start of the loose period, jar a few branches every 2 or 3 days starting a week after shuck-off. Strike small branches (about ½ inch in diameter) a sharp blow with the heel of the hand or with a short piece of stiff rubber hose. When some of the peaches fall readily, they are loose and ready for mechanical thinning.

Mechanical equipment. The largest and fastest machine for mechanical thinning is the tractor-mounted trunk shaker. Experienced operators can shake more than one tree a minute with this machine. But trunk shakers may damage the bark on the trunk if they are not properly adjusted and skillfully operated.

Branch shakers utilizing either pneumatic or hydraulic power are available from several manufacturers. These units are attached to a power source and are positioned onto the branches by the operator.

The "Kentucky bumper" is a sturdy 3½-foot pole with one end heavily padded. Branches are struck a sharp blow with the padded end. Branches up to 2½ inches in diameter can be thinned with the Kentucky bumper.

A pole thinner can be made by attaching a 15- to 18-inch piece of stiff rubber hose to one end of a 4- to 7-foot long lightweight pole such as a broom or hoe handle. The pole thinner works best on small branches. Also, on willowy, drooping branches, clusters of fruit can be thinned with light blows on the clusters.

The trunk shaker, branch shaker, and Kentucky bumper remove the most fruit in the least amount of time. However, they do not do a completely uniform job. They will adequately thin the stiffer branches but may not thin the willowy ones. Touch-up thinning with poles is therefore needed, but this goes much faster than pole-thinning the entire tree.

Hand thinning. Fruit can be thinned by hand up to harvest time. But hand thinning requires so much labor it should be used only in emergency situations or as a final touch-up of earlier thinning methods.

Spacing. A general rule in thinning is to remove fruit until the remaining peaches are an *average* of 5 to 7 inches apart. Early-maturing

varieties usually need more severe thinning than later varieties to obtain adequate size at harvest.

Bringing Young Apple Trees Into Bearing

With normal care, young dwarf and semi-dwarf apple trees should begin bearing commercially profitable crops in their fourth or fifth year. Standard trees require a longer period. Golden Delicious and Jonathan trees usually start bearing without any special treatments. Red Delicious trees are vigorous growers, so they frequently need encouragement to initiate bearing. One or more of the following measures are suggested.

1. **Stop fertilizing applications** to help slow down growth.
2. **Use branch spreaders** to position branches into a 45° angle growth pattern (Fig. 1).
3. **Score the trunk** 3 to 6 weeks after normal bloom date. Using a sharp knife, cut through the inner bark completely around the tree just below the lowest branch. Make a clean, smooth cut and do not loosen the bark at the edges of the cut (Fig. 2).

The growth regulator, Alar, is helpful in initiating bloom the following year. Apply 2 pounds of 83-percent Alar per 100 gallons (2,000 ppm) 7 to 14 days after normal bloom date. Alar can be used in combination with branch spreading, scoring, and no fertilizer.

Preventing Premature Bearing

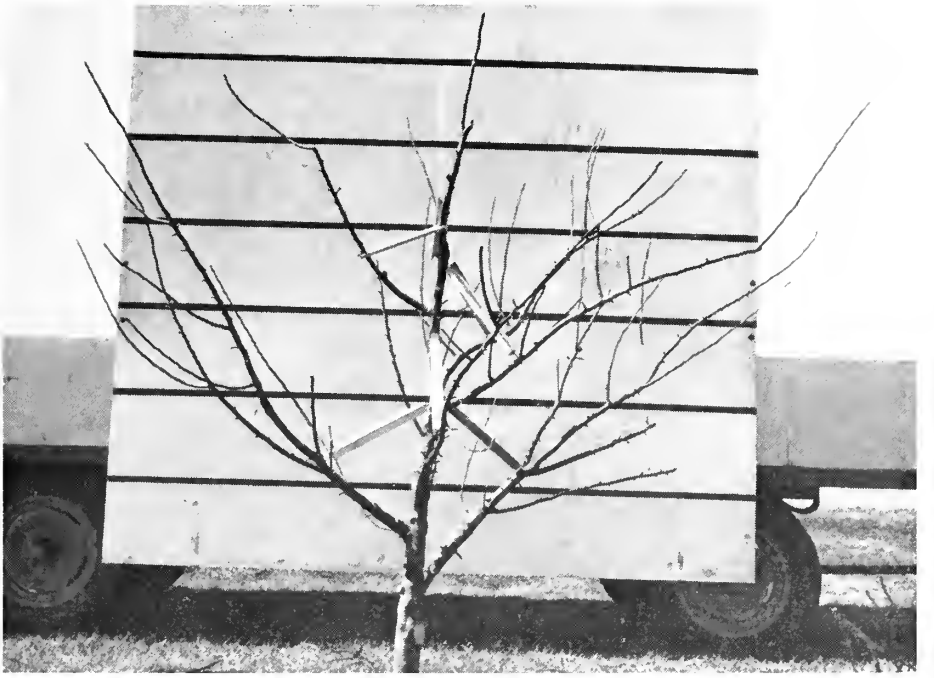
Young Golden Delicious and Jonathan trees sometimes set fruit before they are large enough to produce profitable crops. This premature fruiting should be prevented because it reduces tree growth. The general rule is that 2 pounds of apples reduce total shoot growth about 3 feet.

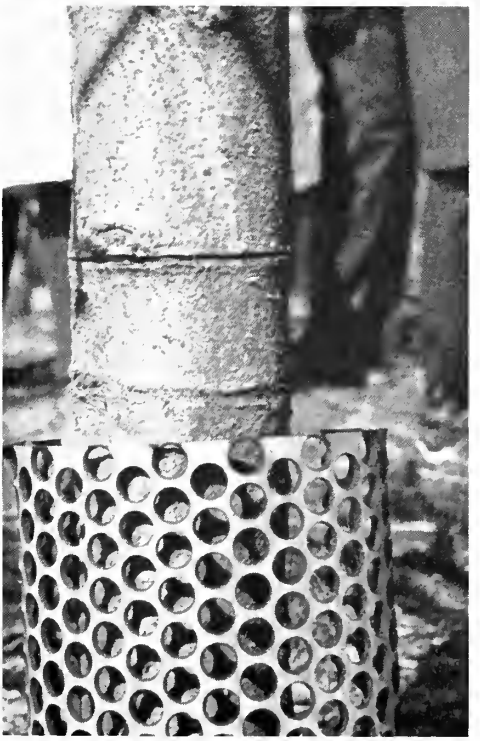
Spray with 2 pounds of Sevin per 100 gallons of water at petal fall, or remove the apples by hand.

Preventing Preharvest Drop of Apples

The onset of preharvest drop of apples is affected by size of the crop, soil moisture, temperatures, and damage to the leaves by mites. Under average conditions the drop usually starts about 7 to 10 days before normal harvest date. Drop may occur earlier when the weather is hot and dry, when the leaves are damaged by mites, and when the trees are weak or have a heavy crop.

Chemical growth regulators effectively reduce preharvest drop on healthy trees, permitting greater flexibility in harvest operations and usually improving the appearance and quality of the fruit. None of





Above. A 3-year-old spur-type Red Delicious on seedling roots, after spreading and pruning. Spreading the branches improves tree shape, reduces the amount of pruning needed, and encourages early bearing. The spreaders are 1 x 1-inch hardwood of varying lengths with sharpened nails in each end. (Fig. 1)

Left. Trunks of vigorously growing young trees which are tardy in bearing may be scored to induce flower formation. Scoring is most effective if done about 3 weeks after full bloom, but it will give some results if done as late as 6 weeks after bloom. Both scoring wounds on this young Delicious tree have healed. The lower wound is about 2 years old. It effectively initiated bloom the following spring, but frost killed the flowers. The tree was scored again about 3 weeks after bloom, so the upper wound is about 1 year old. (Fig. 2)

the materials is very effective on weak trees or on trees affected by mites or drouth.

NAA (naphthaleneacetic acid) takes effect in 2 to 4 days and is effective for about 7 to 10 days. Use 10 ppm for summer varieties, 15 ppm for fall varieties, and 20 ppm for winter varieties. Two applications are authorized, if needed. If applied according to directions, NAA should not hasten maturity.

2,4,5-TP (2,4,5-trichlorophenoxy propionic acid) takes effect in about 7 days and is effective for about 20 days. It may accelerate ripening if applied too early or if the weather is hot. Do *not* apply on summer varieties or on Grimes Golden. Do *not* use more than one application of 10 ppm on Golden Delicious. 2,4,5-TP is most useful on fall and winter red-fruited varieties. Use 10 to 15 ppm on Jonathan and Red Delicious and 20 ppm on Winesap and Rome Beauty.

A combination of 10 ppm of NAA and 10 ppm of 2,4,5-TP has given both quick and long-lasting effects on fall varieties without appreciably modifying maturity.

Alar (succinic acid 2,2-dimethyl hydrazide) has the longest drop-preventive effect. One application of 1,000 ppm 60 to 85 days before normal harvest date will usually hold the fruits of red fall and winter varieties on the tree. In a few instances, however, Alar has not given adequate drop control. If Alar-treated apples start to loosen, either NAA or 2,4,5-TP may be applied.

For McIntosh, Alar is the most effective material available. Alar is *not* suggested for varieties ripening before McIntosh. Nor is it suggested for Golden Delicious or Grimes Golden because of the danger of uneven color development.

Do not use Alar on weak trees or on trees low in vigor. Late application of Alar may result in excessive carryover effects the following season. This may cause Red Delicious fruit to become more flattened in shape.

Besides acting as a stop-drop, Alar delays maturity about 5 days, increases red color and firmness, and increases storage life. Its use on red varieties going into storage is suggested since early harvest date is not important.

Apply preharvest drop-preventive sprays separately from other sprays. Dilute sprays with full wetting are suggested, but concentrate sprays can be successful if the amount of material applied is correctly calibrated. Apply when the temperature is between 65° and 75°F. and when rain is not expected for 12 hours.

Apple Scald and Its Control

Scald is a noninfectious, physiological disease that develops in apples during storage. It is very difficult to cope with, since we do not

know its exact nature. Apples that are picked too immature and put into cold storage may — or may not — develop scald. Another potential cause of scald is cooling apples too rapidly when they are first put into cold storage. Scald may also develop if storage temperatures should accidentally drop below 28°F., even for a short time.

Two materials are available for scald control. Used properly under normal conditions, either one will control or significantly reduce scald, but neither can be guaranteed to prevent scald if conditions are not normal. Even if these materials are used, utmost care should be observed in maintaining, as near as possible, ideal picking, handling, and storage conditions.

DPA (diphenylamine) may be applied in one preharvest spray within 7 days of harvest (picking date), but no later than 36 hours before harvest. It may be most effective if applied as close to the 36-hour limit as possible.

Ethoxyquin is another no-scald chemical. It is suggested as a preharvest spray, within 2 days of harvest.

Since it may be difficult to time the preharvest spray properly, either material may be applied as a *post-harvest* dip, spray, or drench. *Read label* for correct information for use.

ORCHARD CHEMICALS

Chemical Formulations

Agricultural chemicals are formulated in many different ways, depending on their intended use. Package labels are a most valuable source of information about the chemicals. Labels should always be read carefully before the chemical is used. The most important chemical formulations are described below.

Wettable powders are the most commonly used formulations for control of orchard pests. The active ingredient in wettable powders may be either soluble or suspendible in water and may vary in amount from 15 to 95 percent, depending on the chemical involved. Parathion, for example, is a 15-percent wettable powder and sulfur is usually about 95-percent active. How much formulation to apply depends on the amount of active ingredient.

Some chemicals are prepared for use as "water-flowable" or "aqua" formulations. They are sometimes called slurries or pastes. Such formulations generally give excellent control of pests. They may be 50-percent active in water and they suspend well. Unless they dry out before they are used, they handle easily. If they do become dry, they are difficult to rewet.

Emulsifiable concentrates are formulated by dissolving a chemical in either an oil or alcohol base solvent and conditioning the solu-

tion to mix with water. They are usually more economical to use than wettable powders per unit volume of chemical. When these formulations are added to other chemicals, compatibility problems may be increased.

Granular preparations are mainly used for controlling soil insects. They are not used in sprays.

Dust formulations are of many types. Most of the common insecticides and fungicides have been prepared as dusts. Some preparations contain both an insecticide and a fungicide. Dusts are to be applied only in the dry form because they are not wettable.

Microcapsules are a new type of preparation. Insecticides are put in capsules and formulated as slurries or water suspensions. The capsules reduce the use hazard by coating the chemicals. The chemicals are released from the capsules slowly, which extends the effectiveness but does not change the harvest restrictions. We expect to use them the same as other formulations.

Fungicides and Bactericides

Benlate (50-percent benomyl) is formulated as a 50-percent wettable powder. A new fungicide with a wide range of fungus toxicity, it is both protective and curative in action. It is most effective against apple scab, powdery mildew, and many of the summer diseases. It is not effective against apple rust diseases and its kickback action on apple scab has not been determined. Benlate is compatible with oil. Excellent disease control and mite suppression have resulted from the use of 2 ounces of Benlate with 2 quarts of superior oil per 100 gallons. Benlate alone also gives some mite suppression. It is expected to receive full label clearance for apples and pears in 1973.

Benlate is extremely effective against brown rot of stone fruits and has shown effectiveness against peach scab. It has full approval for use on stone fruits, and can be used in post-harvest dips at the rate of 8 ounces per 100 gallons.

Bordeaux mixture is a combination of copper sulfate, hydrated lime, and water. A 4-6-100 bordeaux mixture consists of 4 pounds of copper sulfate, 6 pounds of lime, and 100 gallons of water. Various strengths of bordeaux mixture can be used depending upon the need. A weak bordeaux mixture — such as ½-1-100 or ¼-½-100 — can be used for blossom blight on Jonathan. But even this weak a mixture may cause severe russet, and it may not be too effective against fire blight.

As a dormant spray the copper sulfate may be used at 4 pounds per 100 gallons. As a delayed-dormant treatment an 8-8-100 bordeaux

mixture is suggested. A 4-6-100 bordeaux mixture can be used on peaches for peach leaf curl. A treatment of copper sulfate, 4 pounds, followed immediately by 6 pounds of hydrated lime, is suggested on peaches about October 15 in southern Illinois to reduce carryover of the bacterium that causes bacterial leaf spot. Sometimes this treatment is effective and sometimes not, depending upon the weather in the spring. If you have a serious infection and become desperate you may want to try this program.

Captan is available for orchards as a 50-percent wettable powder. The full-strength rate is 2 pounds in 100 gallons of water. It is also formulated as a 7½-percent dust.

Captan causes a minimum of plant injury and is especially favored for use on russet-susceptible apple varieties such as Golden Delicious. It is effective against a large number of apple diseases including scab, flyspeck, sooty blotch, bitter rot, and botryosphaeria, but will not control powdery mildew or rust. It has been used for years against brown rot disease on stone fruits. It is compatible with all pesticides except those that are alkaline and oily. (Do not use with oil or apply immediately after an oil spray. Do not apply oil upon a captan residue.)

Cyprex (dodine) is formulated as a 65-percent wettable powder. For full strength, it is recommended at ½ pound in 100 gallons. If a serious scab epidemic is not expected, ⅜ pound in 100 gallons is adequate. Cyprex is most effective against apple scab and cherry leaf spot and can both eradicate and prevent these diseases. The material is also used with captan to reduce bacterial spot on peaches (see page 23).

Cyprex is compatible with all pesticides except alkaline materials such as lime. It is now commonly used with oil in a delayed dormant spray. However, cyprex-oil mixtures are not compatible with wettable powder formulations of ferbam, malathion, Sevin, zineb, captan, or sulfur.

Do not use more than 0.325 pound of actual ingredient in 100 gallons of water immediately before, during, or immediately after freezing or near-freezing temperatures. Low-volume sprays higher than 5X are not suggested. Peaches have been injured from combinations of Cyprex, captan, and emulsifiable concentrate insecticides.

Dichlone, when marketed as a 50-percent wettable powder, should be used at ¼ pound in 100 gallons. It is also available as a sulfur-dichlone wettable powder and as a 7½-percent dust. It is excellent for inhibiting the germination of fungus spores but has no residual effect. At 90°F. or above, it may be toxic to plants. In Illinois it is used mainly for control of brown rot blossom blight on peaches; it is the most effective material for this purpose. Some growers have found a sulfur-dichlone dust effective as a supplement to the regular apple scab spray early in the spring.

Dikar is a new fungicide which contains Karathane and a maneb-zinc ion complex (Dithane M-45). Dikar is used at 2 pounds in 100 gallons. At this concentration Dikar contains the equivalent of ½ pound of Karathane and 1½ pounds of Dithane M-45. It has been designed as an all-purpose fungicide and is effective against all of the important apple orchard fungus diseases, including powdery mildew, apple scab, quince and cedar-apple rusts, and frog-eye leaf spot. It is also a mite suppressant and does not russet Golden Delicious.

Ferbam is a protective fungicide marketed as a 76-percent wettable powder. Recommended rate of use is 2 pounds in 100 gallons. Ferbam is particularly effective against cedar-apple rust, quince rust, and apple blotch. It is compatible with all orchard sprays except those containing lime and copper. It is synergistic with sulfur — that is, the two materials enhance each other's effectiveness. Ferbam is considered toxic to some russet-susceptible varieties.

Glyodin is a liquid protectant fungicide. When used alone, the rate is 1 quart in 100 gallons. It is effective against apple scab, sooty blotch, and flyspeck, and it also suppresses red mites. Because of its excellent wetting and sticking properties, it is frequently combined with other fungicides and insecticides. When glyodin is used in this way, the rate is 1 pint in 100 gallons. Glyodin is compatible with all common orchard insecticides and fungicides, and has been found to increase the effectiveness of some materials such as captan.

Karathane (dinocap) is a 25-percent active wettable powder used for powdery mildew control at the rate of ½ pound in 100 gallons. It is used primarily in the summer when sulfur is likely to be toxic to trees.

Lime sulfur is an eradicant and protectant fungicide available in both liquid and dry form. The liquid form is recommended at 2 gallons in 100 gallons of water, and the dry form at 8 pounds in 100 gallons. Because lime sulfur can damage trees, its use has steadily declined in the last 15 years. However, a number of growers still use it on apples in the prepink spray, since it is relatively inexpensive and is effective against apple scab.

Phaltan (folpet) is a 50-percent wettable powder that is used at the rate of 2 pounds of formulation in 100 gallons. Chemically it is closely related to captan but is slightly more toxic both to fungi and to plants. Phaltan will defoliate peaches at 2 pounds of formulation in 100 gallons. Its effectiveness in controlling botryosphaeria rot on apple has brought it notice. Where this disease is a problem, Phaltan is suggested in the fifth and succeeding cover sprays. Phaltan at this time of year will not injure fruit.

Polyram is a new fungicide which has a wide spectrum of ac-

tivity against many fungus diseases. It effectively controls apple scab, blotch, the rusts, sooty blotch, flyspeck, bitter rot, etc. An 80-percent wettable powder of polyethylene polymer, it is used at 2 pounds in 100 gallons of water early in the season, and at 1½ pounds in the cover sprays. It has given excellent finish on Golden Delicious. It will not control powdery mildew. See label for the latest use restriction.

Streptomycin is available in many different powder formulations. It is the only effective treatment for the fire blight disease on apple and pear. It can be used up to 100 ppm and can be applied up to 50 days of harvest. Streptomycin should not be combined with other materials. It works very well in low-volume sprays (see page 15). Recently it has been effectively applied with overhead irrigation sprinklers.

Sulfur, a protectant fungicide, is available as microfine wettable powder. Recommended rate, when it is used alone, is 6 to 8 pounds in 100 gallons. (Paste forms of sulfur are still available commercially, but are not generally used because they are inconvenient to handle.) Sulfur is now recommended at half strength (3 to 4 pounds in 100 gallons) in combination with half strength of an organic material. This combination is very effective against apple scab and also gives protection against powdery mildew infection. As the weather gets warm, sulfur is omitted from the spray and if powdery mildew control is still needed other materials should be used.

Sulfur is the mainstay in the control of peach diseases and is recommended throughout the season except just before harvest. It is especially important in the early cover sprays to control peach scab.

Thiram is formulated as a 65-percent wettable powder recommended at 2 pounds in 100 gallons. This protectant fungicide is effective against many diseases such as apple scab, apple blotch, and cedar-apple and quince rusts. It may also reduce botryosphaeria infections. It gives excellent finish on russet-susceptible varieties such as Golden Delicious. Thiram is compatible with all common fungicides and insecticides.

Zineb, a protective fungicide, is usually formulated as a 75-percent wettable powder. Recommended rate is 2 pounds in 100 gallons. It is effective for the rust diseases and many of the summer diseases on apple such as black rot, sooty blotch, and flyspeck. Zineb plus captan, each at half strength, is one of the most popular apple orchard fungicides. Since zineb is compatible with all orchard chemicals, it may be used almost anywhere in the apple spray schedule. On peaches it helps to control bacterial spot.

The effectiveness of fungicides and bactericides against common orchard diseases is given in tabular form on page 46. Always read the label before using.

Insecticides and Miticides

Nonsystemic insecticides

Diazinon, an organic phosphate, is formulated as a 50-percent wettable powder for fruit. This moderately long-lasting chemical controls a very wide range of pests. It is useful on apples for codling moth, aphids, and scale insects. It is weak against red-banded leaf roller and apple maggot. Use hazard is moderate.

Ethion, an organic phosphate, is formulated as a 25-percent wettable powder and with plant spray oil. It is effective against codling moth but has been mainly used for mite control in late cover sprays and with early oil sprays. Where Ethion has been used several seasons, mites have become resistant. This chemical is moderately long-lasting and has a moderate use hazard.

Guthion (azinphosmethyl) is an organic phosphate which is formulated as a 50-percent wettable powder for orchard use. It has given outstanding control on most fruit pests, and acceptable control on nearly all the others — it is weak against San Jose scale. Mite pests, however, have become strongly resistant where Guthion has been used for several seasons, and predatory mites are also resistant. Guthion is slow-acting on tarnished plant bugs and should be applied 2 days before bloom on peaches. Residual toxicity is moderately long; use hazard is moderate.

Imidan, an organic phosphate, is a broad spectrum insecticide for use on apples, pears, and peaches. It is formulated as a 50-percent wettable powder. The dosage rate is 1 to 1½ pounds of the 50W formulation. The high rate is suggested for plum curculio. Imidan is weak against red-banded leaf roller and San Jose scale. It has a low use hazard.

Malathion, an organic phosphate, is formulated as a 25-percent wettable powder and in several emulsifiable concentrates. Because it is effective against a wide range of insect pests, it has been successfully used alone in apple spray programs. It is weak against high populations of curculio and red-banded leaf roller. It is short-lasting and has a very low use hazard.

Parathion, an organic phosphate, is formulated as 15-percent and 25-percent wettable powders and in several liquid concentrations. It has been used for many years on fruits, where it is still effective against most insects. Parathion is the most effective insecticide against San Jose scale during the growing season. It has a moderately short residual effect and a very high use hazard. A formulation in microcapsules reduces the use hazard and lengthens the effective period against insects. It may russet apples in early season.

Phosdrin (mevinphos) is formulated as an emulsifiable concentrate with 2 pounds of active ingredient per gallon. It is effective against a wide range of pests, including mobile mites and all stages of the red-banded leaf roller. Residual effect is very short — 1 to 3 hours. This chemical is therefore useful when high populations of pests must be controlled immediately before or during harvest.

Sevin (carbaryl) is a carbamate that is effective against a wide range of insects. It is especially effective against periodical cicada. One pound of 50-percent wettable powder in 100 gallons of water controls codling moth and green aphid. Two pounds are required for most other insects. When Sevin is used in a series of sprays, a miticide should also be used as high mite populations often accompany its ues. To avoid thinning apples, do not apply Sevin until 25 days after bloom. Use hazard is low.

Thiodan (endosulfan), a chlorinated hydrocarbon containing sulfur, is formulated as a 50-percent wettable powder or as an emulsifiable concentrate with 2 pounds of active ingredient per gallon. It gives outstanding control of peach tree borers and will also control aphids, spittlebugs, and stink bugs. The material is persistent and has a moderate use hazard.

Trithion (carbophenothion), an organic phosphate, is formulated as a 25-percent wettable powder and as several liquid concentrates. It has given good control of aphids and mites, but wherever it has been used for any length of time, mites show strong resistance. It is moderately long-lasting and has a high use hazard.

Systemic insecticides

These are all organic phosphates and are absorbed into the leaves, moving through the plant with the water in the plant. Systemic materials are absorbed most efficiently by young tissue and should be applied only in early season. They are effective against sucking insects and are moderately effective against some chewing insects that feed on rapidly growing tissue. Control of aphids is particularly outstanding and does not depend on good coverage.

Cygon (dimethoate) is formulated as an emulsifiable concentrate with 2.67 pounds of active ingredient per gallon and as a wettable powder. It is absorbed very quickly into leaf tissue and is moderately effective against codling moth, curculio, and mites. It is very effective against aphids. Although use hazard is low, the chemical has a strong odor. Residual effect is moderate — about 3 days.

Phosphamidon is formulated as an emulsifiable concentrate containing 4 or 8 pounds of active ingredient per gallon. It is moderately effective against codling moth and curculio and very effective against

aphids. The chemical is quickly absorbed into leaf tissue and use hazard is moderate. Residual effect is moderate — 2 to 3 days.

Systox (demeton) is formulated as a 26.2-percent emulsifiable concentrate, with 2 pounds of active ingredient per gallon. The primary use is against aphids, mites, leafhoppers, and leaf miners. Its persistence (it lasts 8 to 12 days) has made it the most effective systemic chemical against mites. It has a very high use hazard and a strong, penetrating odor.

Miticides

Acaralate (chloropropylate), a chlorinated hydrocarbon, is formulated as an emulsifiable concentrate. A moderately persistent chemical, it is effective against spotted and European red mites, but does not kill predatory mites. It is suggested for mid- or late-season use. When mite populations are high, use the high rate suggested on the label, or use two consecutive applications at a lower rate. Several incompatibilities are listed on the label.

Galecron and **Fundal** are chlorophenyl formamidines formulated as 4-pound-per-gallon emulsifiable concentrates and 95-percent soluble powders. They are effective against all stages of mites although the killing action is slow. They are also effective against eggs of caterpillars and aphids. Both persistence and use hazard are moderate. Galecron and Fundal both kill the predatory mites at the same rate as other mites.

Kelthane (dicofol), another chlorinated hydrocarbon, is a long-lasting chemical that is formulated as a 35-percent wettable powder for fruit. It has given excellent control of a wide range of mite species, but resistance has developed in many orchards. Since Kelthane can be applied within 7 days of harvest on apples and 14 days on peaches, it is still useful in late season where mites are not highly resistant. If it is not used for at least three seasons after mites have become resistant, it might become somewhat effective again for a short time. It may also be used when spotted mites need to be held back until predatory mite populations increase.

Morocide (binapacryl) is a dinitro material formulated as a 50-percent wettable powder. It is moderately persistent, with good effectiveness against all stages of spotted mites and moderate effectiveness against red mites. It is also active against powdery mildew. This material can be combined with oil as a dormant spray but should not be combined with emulsifiable concentrates or used before, with, or soon after oil applications on foliage. The main suggested use is for mites during mid-season. A series of sprays in early to mid-season controls mites and helps to control mildew, but also kills a high percentage of predatory mites. Use hazard is moderate.

Morestan is a heterocyclic carbonate formulated as a 25-percent wettable powder. It is effective against all stages of mite pests without destroying predatory mites, and is active against powdery mildew. Morestan may cause fruit spot, but this danger is reduced if drying conditions are good and if other materials are not combined with it. This material has moderately long persistence and a low use hazard.

Oil is discussed below.

Omite is an organic sulfur compound formulated as a 30-percent wettable powder. It is effective as a contact chemical on all stages of mite pests and does not destroy predatory mites. Omite has been safe on fruit and can be used late in the season. It is moderately persistent and has a low use hazard.

Ovex is also an organic sulfur material and is formulated as a 50-percent wettable powder. It is effective only against the egg stage of mites. Excellent coverage and consecutive close applications are necessary for good mite control. This chemical is moderately persistent and has a very low use hazard.

Plictran is a hydroxal tin compound formulated as a 50-percent wettable powder. At full dosages, it kills all stages of both red and spotted mites; at low dosages, it suppresses these mites effectively. It does not kill predatory mites. Use hazard is low.

Tedion (tetradifon) is another organic sulfur and is formulated as a 25-percent wettable powder and an emulsifiable concentrate with 1 pound of active ingredient per gallon. The emulsifiable concentrate is much more effective than the wettable powder at similar dosages. Since the mite kill is very slow, adult mites may not be killed, but their eggs will not be viable. Tedion should be used against low populations or in combination with a chemical which kills more rapidly. Strong resistance has developed where Tedion has been used for three seasons or more. It is moderately long in persistence and has a very low use hazard. It is safe on predatory mites.

The effectiveness of insecticides and miticides against common orchard pests is given in tabular form on page 47.

Oils

Oils are useful in early season. They are economical to use and easy to handle, they have little use hazard, and as far as we know, no pests have developed resistance. The oils now being widely used are known as "superior" oils.

While specifications for superior oils have not been legally established, the major suppliers follow standards which have been developed by the New York State Agricultural Experiment Station, Geneva, employing methods published by the American Society for Testing Materials. These standards are given in the following table.

STANDARDS FOR SUPERIOR OILS
Developed by the New York Agricultural Experiment Station

Property	60-second superior oil	70-second superior oil	100-second superior oil
Saybolt Universal Viscosity at 100°F., seconds[a]	56-62	66-74	90-120
Gravity, API (minimum)[b]	34	33	31
Unsulfonated residue (minimum)[c]	92	92	90
Pour point °F. (maximum)[d]	20	20	30
Distillation at 10 mm. Hg, °F. (50% point)[e]	408 ± 10 (645 ± 8)	425 ± 12 (670 ± 10)[f]	A relatively narrow distillate portion of petroleum
10%-90% range (maximum)	80 (75)[f]	95 (90)[f]	

[a] ASTM methods D445-61 and D446-53 to be used. [b] ASTM method D287-55 to be used. [c] ASTM method D483-61T to be used. [d] ASTM method D497-57 to be used. [e] ASTM method D1160-61 to be used. [f] ASTM method D447-59T to be used.

Viscosity is a measure of the rate of oil flow. The gravity test provides an index to the amount of paraffin in the oil when related to viscosity and the unsulfonated residue. Unsulfonated residue (UR), a measure of refinement, indicates the percentage of stable chemicals that are not toxic to the plant. Many of the superior oils have UR's of 94 to 96 — higher than specified in the table. The pour point indicates the lowest temperature at which an oil will pour freely. The temperature range of distillation limits both the number of chemicals and the size of the chemical structures in the oil. Viscosity and UR specifications are usually given on superior oil labels. Superior oils are more efficient than other oils in smothering insects because they have more of the effective paraffins and fewer of the undesirable hydrocarbons.

For oils not classified as superior oils the label usually lists the percentage of petroleum oils only. These oils are usually labeled as dormant oils, and they may vary widely in chemical content. This variation makes it risky to use them after bud-break.

On a dilute basis, 2-percent oil is enough to control scale insects and European red mite eggs during the dormant period. The dosage may be gradually decreased to 1 percent in the early pink stage, when European red mite eggs begin to hatch and scale insects begin to grow. This dosage is also effective on hatched mites and on other insect forms. But here the control efficiency depends more upon coverage than upon dosage.

If possible, oil should be sprayed under reasonably calm conditions or with the wind. Spraying with the wind usually means that opposite sides have to be sprayed at different times. One or both sides may require respraying to insure complete coverage. A second application

gives some increase in control even when both applications are made under calm conditions.

Used alone, the 70-second superior oils may be applied with little harm to the plant until temperatures get above 80°F. However, complicated pest-control programs for fruit trees greatly limit oil use. Most pesticides are conditioned by various solvents, emulsifiers, and diluents which cause incompatibilities with the oil. The following pesticides are considered to be compatible when mixed singly with superior oil: Benlate, Cyprex, zineb, Polyram, ferbam, and most of the wettable powder insecticides recommended during the dormant to prepink stage. When more than one of these pesticides are to be used together, however, a trial mix should be made in a glass jar. If the mixture is not smooth and uniform, then the materials should be considered incompatible. The oil should always be added with agitation after other pesticides have been mixed in the tank and before the tank is completely filled with water. Do not allow the mixture to stand without agitation before spraying.

After leaves appear, oil should not be applied to trees shortly before, with, or soon after sulfur, captan, or the organic dinitros — Karathane, Dikar, and Morocide. The use of these materials directly after oil may injure the leaves.

Growth Regulators

Amid-Thin (naphthaleneacetamide) is used as an apple-thinning agent, mainly for summer varieties.

Alar (succinic acid 2,2-dimethyl hydrazide) is marketed as an 85-percent wettable powder. It is used to initiate fruit bud formation and to prevent preharvest drop of apples.

CPA [2-(3-chlorophenoxy)-propionic acid], specially formulated for chemical thinning of peaches, is marketed under the trade name Fruitone CPA.

NAA (naphthaleneacetic acid) is marketed as 3½- and 7-percent wettable powders. It is used on apples for chemical thinning and for preventing preharvest drop.

Sevin (carbaryl) is an insecticide which has fruit-thinning action on apples from petal fall to 25 days after petal fall.

Tween 20, a surfactant, increases the absorption of NAA. It has a slight fruit-thinning effect on apples.

2,4,5-TP (2,4,5-trichlorophenoxypropionic acid) is formulated both as a herbicide (Silvex) and as a preharvest drop preventive for apples (Color-set, Color-fix, etc.). Do not confuse 2,4,5-TP with 2,4,5-T (2,4,5-trichlorophenoxyacetic acid), which is a brush killer.

EFFECTIVENESS OF FUNGICIDES AND BACTERICIDES AGAINST ORCHARD DISEASES, 1963[a]

(This list is not to be used as a group of recommended chemicals)

Materials in 100 gallons of water	Effectiveness of materials on											
	Apple scab	Bitter rot	Black rot	Apple blotch	Botryo-sphaeria rot	Peach brown rot	Flyspeck, sooty blotch	Peach leaf curl	Peach scab	Powdery mildew	Rust diseases	Rhizopus
Benlate 50W, 8 oz.[b]	G	O	O	O	O	G	O	O	G	G	NG	NG
Botran 50W, 2 lb.	NG	O	NG	O	NG	M	O	O	O	O	O	G
Bordeaux (see label)	G	G	G	G	M	O	G	G	O	G	P	O
Captan 50W, 2 lb.	G	G	M	P	M	G	G	G	P	NG	NG	O
Copper (Fixed), see label for dosage	G	G	G	G	M	O	G	G	O	G	P	O
Cyprex 65W, ½ lb.	G	P	P	P	P	NG	G	G	M	NG	P	NG
Dichlone 50W, ½ lb.	M	NG	NG	NG	NG	G	G	G	G	NG	NG	NG
Dikar, 2 lb.	G	M	M	G	O	O	G	O	O	G	G	O
Ferbam 76W, 2 lb.	M	G	M	G	O	M	G	G	M	NG	G	O
Glyodin, 1 qt.	G	M	M	NG	O	P	G	P	P	NG	NG	O
Karathane 25W, ½ lb.	NG	NG	NG	NG	NG	NG	NG	NG	NG	G	NG	O
Niacide M, 2 lb.	G	G	M	G	NG	G	G	G	NG	NG	G	O
Phaltan 50W, 2 lb.	G	G	G	P	G	O	G	G	O	NG	NG	O
Polyram 80W, 2 lb.	G	G	M	G	NG	O	G	O	O	O	G	O
Sulfur, 8 lb.	G	NG	NG	NG	NG	G	M	G	G	G	NG	NG
Thiram 65W, 2 lb.	M	O	O	G	O	M	M	G	NG	NG	G	M
Topsin 75W, ¾ lb.[b]	G	O	O	O	O	G	O	O	O	M	O	O
Triarimol, 2 oz.[b]	G	O	O	O	O	G	O	O	O	G	O	O
Zineb 75W, 2 lb.	G	M	M	G	P	O	G	O	O	NG	G	O

G — Good; M — Moderate; P — Poor; NG — No Good; O — Not recommended or no information.

[a] There are only two bacterial diseases of concern to the orchardist: fire blight and bacterial spot. Fire blight is best controlled by streptomycin 50 to 100 ppm. Bordeaux mixture (1½-1-100) is sometimes used effectively. Bacterial spot of peach is not controlled by any chemical when the season is favorable for its development.

[b] Benlate is approved on all stone fruits but not on apples and pears as of November, 1972. Topsin is not approved on anything as of November, 1972. Triarimol is not approved on any crop as of November, 1972. Read label before use.

EFFECTIVENESS OF CERTAIN INSECTICIDES AND MITICIDES AGAINST ORCHARD PESTS AND PREDATOR MITES

(This list is not to be used as a group of recommended chemicals)

Materials in 100 gallons of water	Effectiveness of materials on										
	Aphids	Apple maggot	Codling moth	European red mite	Spotted mites	Predator mites	Oriental fruit moth	Plum curculio	Red-banded leaf roller	Scale	Cat-facing insects
Acaralate (2 lb./gal.), 2 pt.	NG	NG	NG	M	M	NG	NG	NG	NG	NG	NG
Cygon (4 lb./gal.), ½ pt.	G	NG	P	P	P	M	NG	M	P	M	NG
Diazinon 50W, 1 lb.	G	M	G	P	P	P	G	M	P	G	NG
Ethion 25W, 2 lb.	M	P	M	P	P	M	NG	NG	NG	M	NG
Fundal 95SP, ½ lb.	NG	NG	M	G	G	G	NG	NG	NG	O	NG
Galecron (4 lb./gal.), 1 pt.	NG	NG	M	G	G	G	NG	NG	NG	O	NG
Gardona 75W, ⅔ lb.	NG	M	G	NG	NG	M	NG	G	M	P	NG
Guthion 50W, ⅝ lb.	M	G	G	NG	NG	P	G	G	G	P	M
Imidan 50W, 1½ lb.	M	G	G	P	P	P	G	G	P	P	M
Kelthane 35W, 1 lb.	NG	NG	NG	M	M	NG	NG	NG	NG	NG	NG
Lead arsenate, 3 lb.	NG	M	P	NG	NG	NG	NG	M	P	NG	NG
Malathion 25W, 2½ lb.	G	M	M	P	P	P	M	P	M	G	P
Morestan 25W, ½ lb.	NG	NG	NG	G	G	NG	NG	NG	NG	NG	NG
Morocide 50W, 1 lb.	NG	NG	NG	M	G	G	NG	NG	NG	NG	NG
Omite 30W, ½ lb.	NG	NG	NG	M	M	NG	NG	NG	NG	NG	NG
Ovex 50W, ½ lb.	NG	NG	NG	M	M	O	NG	NG	NG	NG	NG
Parathion 15W, 2 lb.	M	M	G	P	P	P	G	G	M	G	M
Phosdrin (2 lb./gal.), 1 pt.	G	NG	P	M	M	M	NG	NG	G	M	NG
Phosphamidon (4 lb./gal.), ½ pt.	G	NG	P	P	P	P	NG	NG	NG	M	NG
Plictran 50W, ¼ lb.	NG	NG	NG	G	G	NG	NG	NG	NG	NG	NG
Sevin 50W, 2 lb.	M	M	G	NG	NG	G	G	M	M	M	G
Systox (2 lb./gal.), ¾ pt.	G	NG	NG	M	M	M	NG	NG	NG	G	O
TDE 50W, 2 lb.	NG	P	P	NG	NG	O	NG	NG	G	NG	NG
Tedion (1 lb./gal.), 1 pt., or 25W, 1 lb.	NG	NG	NG	M	M	NG	NG	NG	NG	NG	NG
Thiodan 50W, 1 lb.	G	NG	NG	NG	NG	M	NG	NG	NG	NG	M
Trithion 25W, 1 lb.	M	NG	M	P	P	M	P	NG	P	M	NG

G — Good; M — Moderate; P — Poor; NG — No Good; O — No information.

Urbana, Illinois February, 1973

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, *Director*, Cooperative Extension Service, University of Illinois at Urbana-Champaign.

5M—2-73—23449

1977
ILLINOIS COMMERCIAL SPRAY SCHEDULE

Apples, Pears, Plums, Cherries, Peaches, Nectarines, and Apricots

D. B. Meador, Extension Specialist in Horticulture
Ronald H. Meyer, Entomologist, Illinois Natural History Survey
Roscoe Randell, Extension Specialist in Entomology
Stephen M. Ries, Plant Pathology
Malcolm C. Shurtleff, Extension Specialist in Plant Pathology

SUPPLEMENT TO CIRCULAR 1073

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN COLLEGE OF AGRICULTURE COOPERATIVE EXTENSION SERVICE
IN COOPERATION WITH ILLINOIS NATURAL HISTORY SURVEY

Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. JOHN B. CLAAR, Director, Cooperative Extension Service, University of Illinois at Urbana-Champaign. The Illinois Cooperative Extension Service provides equal opportunities in programs and employment.

January, 1977 (2700—1-77—36452—gm)

APPLES

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
DORMANT TO GREEN TIP		
Scale insects, aphids, and red mites	SUPERIOR OIL, 2 gal.	Thorough coverage is the most important factor. Varieties susceptible to powdery mildew should be sprayed in dormant if a mildewicide is to be used in ½-inch stage.
Scab	DIFOLATAN 4F, 5 qt. — or — DIFOLATAN 4F, 3 qt.	Application at the 5-qt. rate during silver tip but before ¼-inch green should control scab until calyx (or about 6 weeks, depending on rainfall). Difolatan will not control mildew or the rust diseases; therefore, these diseases on susceptible varieties will need additional control measures beginning at pink bud. On these cultivars the 3-qt. rate or an alternate fungicide (see green tip) is suggested. Application later than ¼-inch green tip can produce leaf injury.
Fire blight, black rot, and blotch	COPPER SULFATE, 4 lb. — or — 8-8-100 BORDEAUX	Mostly for varieties susceptible to fire blight. Use the copper sulfate during dormancy; the bordeaux-oil is best at silver tip. Difolatan, copper sulfate, and bordeaux are compatible with superior oil.
GREEN TIP THROUGH TIGHT-CLUSTER		
Aphids	Systemic phosphate insecticide — plus —	Pests tolerant to currently used pesticides are appearing. Therefore we recommend alternating pesticides in the spray program and using labelled pesticide mixes.
Scab, powdery mildew	CYPREX 65W, ⅜ to ½ lb. — or — CYPREX 65W, ¼ lb., and Microfine wettable SULFUR, 5 lb. — or — DIKAR, 2 lb., and TRITON B1956, 3 oz. — or — BENLATE 50W, 2 to 3 oz., and CAPTAN 50W, 1 lb.	On varieties susceptible to powdery mildew use Dikar, Benlate-captan, or include sulfur with Cyprex. It is important to provide trees with protective fungicides at 7-10 day intervals throughout this period. Scab and mildew control must begin at green tip. Triton B1956 is a wetting agent, which increases the effectiveness of Dikar against powdery mildew. Use 2 oz. of Benlate for normal conditions and 3 oz. during severe scab pressure to deactivate scab. If Benlate is used without captan, double the rates. Benlate, especially at the higher rates, may reduce fruit finish.
PINK BUD		
Curculio, leaf roller	GUTHION 50W, ⅝ lb.	Only necessary if curculio or leaf roller is severe.
Scab, powdery mildew, cedar-apple rust	DIKAR, 2 lb., and TRITON B1956, 3 oz. — or — BENLATE 50W, 2 or 3 oz., and MANZATE 200, or DITHANE M-45, or POLYRAM 80W, 12 oz. — or — CYPREX 65W, ¼ lb., and Microfine wettable SULFUR, 5 lb., and a rust fungicide	If Difolatan, 3-qt. rate, was used, now is the time to apply additional scab sprays. Rust control must start in this spray. Manzate 200, Dithane M-45, Polyram, Zineb, and Ferbam are good rust fungicides. Ferbam may affect fruit finish of Golden Delicious if used after calyx.
For fertilizing	SOLUBOR, 1 lb.	This prevents a deficiency of boron, which affects pollen germination. If ground applications of boron are made, eliminate foliar application. See Circular 1073, page 28.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
EARLY-BLOOM		
Fire blight	STREPTOMYCIN, 50 or 100 ppm	On susceptible varieties start streptomycin when the first blossoms open. Continue at 4-day intervals through bloom. Above 65° F. use 50 ppm; below 65° F., or when mixed with fungicides, use 100 ppm. Streptomycin uptake is enhanced by Regulaid, a spreader activator, at 1 to 2 pints per 100 gal.
Scab, powdery mildew, and cedar-apple rust	Same as for PINK BUD	Fungicide applications are not recommended at full bloom as many injure pollen and may interfere with fruit set. However, during prolonged bloom, scab, mildew, and cedar-apple rust may need control.
CALYX AND FIRST COVER		
Codling moth, leaf roller, curculio, aphids	IMIDAN, 1½ lb. — or — GUTHION 50W, ⅝ lb. — plus either —	Apply calyx spray when ¾ of the petals have fallen, and first cover, 7 to 10 days later. Imidan may be weak for leaf roller control.
Scab, cedar-apple rust, blotch, powdery mildew, frog-eye, quince rust	POLYRAM 80W, 2 lb. — or — DIKAR, 2 lb., and TRITON B1956, 3 oz. — or — BENLATE 50W, 2 or 3 oz., and MANZATE 200, or DITHANE M-45, or POLYRAM 80W, 12 oz.	The Difolatan 5-qt. rate needs supplementing for scab control in these sprays and in all following sprays. Since Polyram will not control powdery mildew, choose another fungicide on mildew-susceptible varieties. If quince rust has been a problem and the weather is wet, increase the rust fungicide to the full label rate.
Fire blight	STREPTOMYCIN, 50 or 100 ppm, depending on temperature (see early bloom)	For control of twig blight, start in the first cover with *night* applications every 7 days. Discontinue after July 15. Apply only to varieties susceptible to fire blight.
For thinning	See Circular 1073, page 29.	Summer varieties are best thinned at petal-fall. Fall and winter varieties are best thinned according to fruit size, preferably when king fruit is 10 to 11 millimeters in diameter.
For bitter pit and Jonathan spot	CALCIUM CHLORIDE, 3 lb. — or — CALCIUM NITRATE, 5 lb.	This helps prevent bitter pit on Red Delicious and Jonathan spot on Jonathan. Apply three sprays: one each in May, June, and July in southern and central Illinois and in June, July, and August in northern Illinois. Add 3 oz. of surfactant. DO NOT use low-volume application. It is safer to apply calcium separately, but several growers have successfully mixed calcium materials with insecticides and fungicides. Calcium chloride is preferred on Jonathan and vigorous Red Delicious trees because it does not contain nitrogen.
For fertilizing	SOLUBOR, 1 lb.	Add to the first or second cover spray if there is no ground application of boron. See Circular 1073, page 28.
	UREA (45 percent N), 5 lb.	Use as needed in the first and third cover sprays. Do not use on Golden Delicious.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
COVER SPRAYS (remainder of the season)		
All insects, diseases, and mites	GUTHION 50W, ⅝ lb. — plus either — POLYRAM 80W, 1½ lb. — or — DIKAR, 2 lb., and TRITON B1956, 3 oz. — or — BENLATE 50W, 2 oz., and CAPTAN 50W, 1 lb.	As needed at 10- to 14-day intervals after the first cover. Alternate phosphate insecticides are Imidan, Zolone, malathion, parathion, or diazinon. Parathion, encapsulated parathion, and diazinon are outstanding for San Jose scale. Red mites may need suppression through this period. Northern Illinois growers should be aware of apple maggot in late August. If cicadas are laying eggs, spray with Sevin 50W, 2 lb. per 100 gal. water, every 7 days. Also use Sevin if young grasshoppers are in or near young orchards. Dithane M-45, 1½ lb., or Manzate 200, 1½ lb., is an alternate fungicide. Rust and powdery mildew control should continue through third cover. Phaltan should be started at fifth cover where Botryosphaeria rot may be serious.
GROWTH REGULATOR SPRAYS		
To delay harvest	ALAR, 1 lb.	Apply 60 to 85 days before normal ripening date to McIntosh, Jonathan, and later varieties.
To advance harvest	ETHREL, 1 pint, and NAA, 10 ppm, and 2,4,5-TP, 10 ppm	Apply one to two weeks before desired harvest date to Jonathan and spur-type Red Delicious. Apply as a dilute spray with thorough coverage. Stop-drop materials must be applied with Ethrel.
To prevent preharvest drop	See Circular 1073, pages 32 through 34.	Alar applied to delay harvest acts as a stop-drop preventative. NAA and 2,4,5-TP may be applied when apples start to drop.

PEARS

DELAYED DORMANT		
Pear psylla, scale insects, leaf spot	SUPERIOR OIL, 2 gal., and FERBAM 76W, 2 lb.	Apply just before buds begin to open.
BLOOM		
Fire blight	STREPTOMYCIN, 100 ppm	Three sprays 4 days apart, starting with the first blossoms. May be applied during the day for effective control. Be sure to continue on late blossoms.
CALYX THROUGH COVER SPRAYS		
Codling moth, curculio, leaf spot, scab	GUTHION 50W, ⅝ lb., and CAPTAN 50W, 1½ lb., or FERBAM 76W, 1½ lb.	Start calyx spray as soon as the petals have fallen and continue at 12- to 14-day intervals for at least 3 covers. Later, apply Guthion alone if psylla nymphs are visible on water sprouts.
Fire blight	STREPTOMYCIN, 100 ppm	Start at about the first cover and continue at 7-day intervals until about July 15. More effective if applied at night and used alone.

PLUMS

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
DELAYED DORMANT		
Scale insects, red mites, black knot	SUPERIOR OIL, 2 gal.	Apply before buds begin to open. The oil controls scale and mites. Prune out and burn all black knots during the dormant period.
PETAL-FALL THROUGH SECOND COVER		
Curculio, brown rot	GUTHION 50W, ⅝ lb., and BENLATE 50W, ½ lb. — or — CAPTAN 50W, 2 lb.	Apply a spray every 10 to 14 days for three times, starting at petal-fall. Add a miticide if needed. For borer control follow the suggestions given under peaches. Alternate fungicides.
ADDITIONAL COVERS		
Brown rot	BENLATE 50W, ½ lb. — or — CAPTAN 50W, 2 lb.	Start these sprays about 3 weeks before harvest and apply about every 7 days. Alternate fungicides.

CHERRIES

DORMANT		
Scale insects	SUPERIOR OIL, 2 gal.	Apply before the buds open.
FIRST AND SECOND COVER SPRAYS		
Brown rot, cherry leaf spot, curculio, slugs	GUTHION 50W, ⅝ lb. — plus either — CYPREX 65W, ½ lb. — or — BENLATE 50W, ½ lb.	Start right after the shucks have fallen with the first cover. Apply a second cover spray 10 days later. Alternate fungicides.
ADDITIONAL SPRAYS		
Cherry leaf spot	CYPREX 65W, ½ lb. — or — BENLATE 50W, ½ lb.	Apply immediately after harvest. One or two sprays should be adequate. Spray more if there is more evidence of yellow leaf. A phosphate insecticide may be needed if insects attack leaves. Borers should be controlled as suggested for peaches. Alternate fungicides.

See also section on peaches, nectarines, and apricots for suggested borer sprays.

PEACHES, NECTARINES, APRICOTS

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
DORMANT		
Scale insects, red mites, leaf curl	SUPERIOR OIL, 2 gal., and 6-6-100 BORDEAUX — or — Liquid LIME SULFUR, 5 gal. — or — FERBAM 76W, 2 lb.	The oil controls scale and mites; the fungicide prevents the development of leaf curl. Thorough coverage BEFORE buds start to swell in the spring is critically important for control of leaf curl.
PINK BUD		
Tarnished plant bug, curculio, oriental fruit moth	GUTHION 50W, ⅝ lb. — or — SEVIN 50W, 2 lb.	Apply when buds show pink. *Must not be applied when any blossoms are open, as this will kill honey bees.*
EARLY TO FULL BLOOM		
Brown rot blossom blight	BENLATE 50W, 6-8 oz. — or — Microfine wettable SULFUR, 3 lb., and DICHLONE 50W, ¼ lb.	Try to make two applications, one in early bloom and one in full bloom. *Do not use insecticides after first blossoms open.* Fungi tolerant to currently used fungicides (Benlate) are appearing. Therefore we recommend alternating fungicides in the spray program and using suggested fungicide mixes.
PETAL-FALL THROUGH COVER SPRAYS		
Curculio, oriental fruit moth, stinkbugs, red-banded leaf roller, and catfacing insects Brown rot and peach scab	GUTHION 50W, ⅝ lb. — or — IMIDAN, 1½ lb. — plus either — BENLATE 50W, 6-8 oz. — or — Microfine wettable SULFUR, 6 lb.	Parathion, encapsulated parathion, and diazinon are alternative insecticides and are especially effective against San Jose scale. For terrapin scale control, either add Systox to the regular spray when needed or use diazinon. Where peach scab has been a problem, continue sulfur or Benlate up to 40 days before harvest; after this period, another fungicide may be used. Sulfur and Benlate are the only fungicides that will control peach scab. A complete application is needed about every 14 days through this period. Normally, insecticides are not used after the first 2nd-brood curculio spray. Watch harvest restrictions. See borer control section.
Bacterial spot	CAPTAN 50W, 1 lb., and CYPREX 65W, ½ lb.	When warm, rainy weather prevails during early to mid-summer, bacterial spot may become serious. The combination of captan and Cyprex added to the cover sprays helps alleviate the problem.
To advance harvest	ALAR, 1½-2 lb.	Apply as a dilute spray with full coverage just before pit hardening, when the peaches loosen and can be mechanically thinned. Alar advances harvest 3 to 5 days and promotes uniform ripening.

APPLICATION AND PURPOSE	MATERIALS, RATE PER 100 GALLONS OF WATER	SPECIAL SUGGESTIONS
PREHARVEST AND POSTHARVEST FUNGICIDES		
Brown rot	BENLATE 50W, 6-8 oz. — or — CAPTAN 50W, 2 lb. — or — BOTRAN 50W, 2 lb.	Brown rot becomes increasingly important as fruit begins to ripen; therefore, begin a 7-day spray schedule starting 4 weeks prior to harvest. Benlate, captan, dichlone, and sulfur all control this disease. Alternate fungicides and observe harvest restrictions. Botran is specific for *Rhizopus* rot and is best added to the hydrocooler water as a postharvest dip.
Rhizopus rot		
BORER CONTROL		
Peach borer, lesser peach borer, American plum borer	THIODAN 50W, 1½ lb. — or — GUTHION 50W, ⅝ lb. — or — LORSBAN 4E, 1½-2 pt.	Make two to four applications but adhere to harvest restrictions on the different varieties. July and August are the critical months. Thorough coverage of all wounds and gummy areas of all major branches is essential. This spray *must* be applied with a hand gun instead of the mist-blower type sprayer. Apply to peach tree trunks up to scaffold limbs.

MITE CONTROL: It is important to avoid using insecticides that are toxic to predatory mites. If phosphate insecticides will kill plant-feeding mites, they will also kill predaceous mites. Miticides, however, may be more selective, and the following miticides can be used without killing predatory mites: ACARALATE, KELTHANE, MORESTAN, OMITE, OVEX, PLICTRAN, TEDION, and VENDEX. The miticides CARZOL and MOROCIDE will kill all mites. Some fungicides, such as DIKAR and KARATHANE, give mite suppression and allow good predatory mite survival. BENLATE suppresses both types of mites. Where red mites have been a problem, use oil in the dormant spray.

RESTRICTIONS ON PESTICIDES USED ON TREE FRUITS: The following restrictions are those in effect as of December 1, 1976. Growers are urged to follow directions on the manufacturer's current label at all times. When mixing several pesticides in the same tank, use the time restriction of the longest interval.

Pesticide	Number of days between last application and harvest				
	Apples	Pears	Cherries	Peaches	Plums
Acaralate	14	14	...	...	...
Benlate	0	0	0	0	0
Bordeaux	0	0	0	0	0
Botran	...	...	1	1	1
Captan	0	0	0	0	0
Carzol	7	7	...	...	...
Copper sulfate	0	0	...	...	...
Cyprex	7	7	0	15	...
Diazinon	14	14	...	...	...
Difolatan	A	A	...	...	...
Dikar	21	21	...	...	...
Dithane M-45	21	21	...	...	...
Ferbam	7	7	0	21	7
Guthion	15	15	15	21	15
Imidan	7	7	7	14	7
Karathane	21	21	...	45	...
Kelthane	7	7	7	14	7
Lannate	8	...	...	...	...
Lime sulfur	0	0	0	0	0
Lorsban	...	...	...	14	...
Malathion	3	3	3	7	3
Manzate 200	21	21	...	...	...
Mesural	...	...	7D	21E	...
Morestan	B	B	...	...	...
Morocide	60D	60D	...	...	...
Omite	7D	7D	...	14C	28C
Ovex	...	...	...	7	...
Parathion	14	14	14	14	14
Phaltan	0	...	...	...	...
Phosphamidon	30	...	...	...	...
Phygon (dichlone)	...	...	3	7	3
Plictran	14E	14E	...	E	E
Polyram	15	...	...	...	...
Sevin	1	1	1	1	1
Streptomycin	50	30	...	...	...
Sulfur	0	0	0	0	0
Systox	21	21	...	30	30
Tedion	0,E	0,E	0,C	0,C	0,C
Thiodan	...	...	21C	30C	7C
Thiram	0	...	...	7	...
Trithion	30	30	...	...	...
Vendex	14D	14D	...	...	...
Zineb	15	7	7	30	B

... Not recommended.
A. Dormant application up until ½-inch green.
B. Do not apply when fruit is present — apply prebloom or postharvest.
C. Not more than 2 applications to fruit.
D. Not more than 3 applications to fruit.
E. Not more than 4 applications to fruit.