



3. special report 21
1966

SEVERAL INSECTS AND DISEASES are potentially damaging to an apple crop. To obtain clean fruit of a high grade it is necessary to carry out an intensive and thorough spray program.

Growers not prepared to spray at regular intervals throughout the growing season will not be successful orchardists. A successful spray program requires precise information on apple pests and the chemicals for their control, reliable equipment, and a skillful and intelligent spray operator.

To help achieve adequate control of the insects and diseases of apples, this publication provides the commercial apple grower with (1) the most recent recommendations and regulations for the use of insecticides, fungicides, miticides, and bactericides for pest control on apples, and (2) a schedule to be followed which, under normal conditions, will result in an acceptable measure of control of the insects and diseases that might damage their crops.

These recommendations are made in compliance with the current regulations for use described by the Food and Drug Administration, the U.S. Department of Agriculture, and the Minnesota State Department of Agriculture. Since these regulations change from time to time it is necessary that the pesticide applicator refer to the *current* edition of this publication and check the *current* label on the pesticide container before using any material suggested. An effort is made to inform commercial growers of any regulation changes that occur during the growing season.

Reference to commercial or trademarked materials does not imply endorsement by the Minnesota Agricultural Extension Service, and failure to mention a product does not imply criticism. Directions in this guide and on container labels should be read, understood, and followed carefully in order to control pests effectively and avoid unlawful residues on the fruit after harvest.

2. Agricultural Extension Service ■ University of Minnesota



ed
t of
bera-
St.
2-65

RECOMMENDATIONS FOR INSECT AND DISEASE CONTROL

Troublesome insects of Minnesota orchards: Apple maggot, codling moth, mites, plum and apple curculios, aphids, oystershell scale, leaf roller, cankerworm, and leafhoppers.

Diseases of Minnesota orchards: Major—apple scab, cedar-apple rust, and fireblight. Others—frogeye leafspot, sooty blotch of fruits, and flyspeck of fruits. Virus diseases are also a problem in apples, but these diseases are not discussed in this publication.

The following guide shows: (1) The chemicals that are effective for controlling major diseases and insects of apples, (2) the times that spray applications are normally required, and (3) the pests that may be troublesome at each spray date.

This is only a suggested spray schedule; existing orchard conditions determine the exact spray schedule to be used. This guide is intended for commercial growers only. Consult Extension Pamphlet 184, "The Home Fruit Spray Guide," for information on pest control in home orchards.

NOTES REFERRED TO IN TABLES ARE ON PAGE 5

FUNGICIDES FOR DISEASE CONTROL ON APPLES

| Disease | Fungicide | Range of dosage (amount of formulation per 100 gal. water) | Limitations (days before harvest) | Remarks |
|---|---|--|---|--|
| Apple scab (See note 1) | captan 50WP* | 1½ to 2 lb. | NTL† | |
| | dodine 65WP* | ¼ to ½ lb. | 7 days | Do not use treated apples in the manufacture of apple pomace for use in livestock feeds. |
| | folpet 50WP | 1 to 2 lb. | NTL | Summer sprays. |
| | Glyodin | 1 qt. | NTL | 3 lb. actual per acre through petal fall; 1.8 lb. actual per acre as cover spray. |
| | lime sulfur | 2 gal. liquid or 8 lb. dry | NTL | Prepink spray. |
| | methyl mercury hydroxyquinolate | label directions | Through petal fall only | See note 1. |
| | phenyl mercuri ethylene-diamine | label directions | Through petal fall only | See note 1. |
| | phenyl mercuri monoethanol ammonium lactate | label directions | Through petal fall only | See note 1. |
| | phenyl mercuri acetate | label directions | Through petal fall only | See note 1. |
| | maneb + zinc | 2 lb. | NTL | May inhibit mite buildup. |
| Cedar-apple rust (See note 2) | thiram 50WP (Thylate) | 2 lb. | NTL | |
| | ferbam 76WP* | 2 lb. | 7 days | Do not use on Golden Delicious. |
| | thiram 50WP | 2 lb. | NTL | |
| | zineb 75WP* | 2 lb. | NTL | |
| Sooty blotch and flyspeck (See note 4) | maneb + zinc | 2 lb. | NTL | |
| | Niacide M | 2 lb. | NTL | |
| | captan | 1½ to 2 lb. | NTL | Postharvest dip or spray, 0.12% solution (see note 6). |
| | ferbam | 2 lb. | 7 days | Do not use on Golden Delicious. |
| Fireblight (See note 3) | zineb | 2 lb. | NTL | |
| | Bordeaux mixture | ½-2-100 | | ½ pound copper sulfate and 2 pounds hydrated lime in 100 gallons of water. |
| | copper sulfate | | | Do not apply after delayed dormant spray. |
| | streptomycin | 50 to 100 ppm | | Do not apply after fruit is visible. |

* Preference for these chemicals

†NTL: no time limitations

INSECTICIDES FOR INSECT CONTROL ON APPLES

| Insect | Insecticide | Tolerance, parts per million (p.p.m.) | Limitations (days before harvest) | Remarks |
|---------------------------|----------------------------|---------------------------------------|-----------------------------------|---|
| Aphids | azinphosmethyl (Guthion) | 2.0 | 15 days | |
| | carbophenothion (Trithion) | 0.8 | 30 days | |
| | diazinon | 0.75 | 14 days | |
| | DN-289 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| | Elgetol 318 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| | ethion | 2.0 | 40 days | |
| | malathion | 8.0 | 3 days | |
| | parathion* | 1.0 | 14 days | |
| | phosphamidon* (Dimecron) | ..... | 60 days | |
| Apple maggot (See note 5) | azinphosmethyl (Guthion) | 2.0 | 15 days | |
| | carbaryl (Sevin) | 10.0 | 1 day | |
| | DDT | 7.0 | 30 days | |
| | diazinon | 0.75 | 14 days | |
| | lead arsenate | 7.0 | 30 days | Remove excess residue at harvest time. Do not graze livestock on treated areas. |
| Cankerworms | methoxychlor | 14.0 | 7 days | |
| | carbaryl (Sevin)† | 10.0 | 1 day | Carbaryl is toxic to bees. |
| | DDT | 7.0 | 30 days | |
| | lead arsenate | 7.0 | 30 days | Remove excess residue at harvest time. Do not graze livestock on treated areas. |
| Codling moth | azinphosmethyl (Guthion) | 2.0 | 15 days | |
| | carbophenothion (Trithion) | 0.8 | 30 days | |
| | DDT | 7.0 | 30 days | |
| | diazinon | 0.75 | 14 days | |
| | lead arsenate | 7.0 | 30 days | Remove excess residue at harvest time. Do not graze livestock on treated areas. |
| Leafhoppers | DDT | 7.0 | 30 days | |
| | diazinon | 0.75 | 14 days | |
| | malathion | 8.0 | 3 days | |
| | methoxychlor | 14.0 | 7 days | |
| Mites | azinphosmethyl (Guthion) | 2.0 | 15 days | |
| | carbophenothion (Trithion) | 0.8 | 30 days | |
| | chlorbenside (Mitox) | 3.0 | 7 days | |
| | chlorobenzilate | 5.0 | 14 days | |
| | diazinon | 0.75 | 14 days | |
| | dicofol (Kelthane) | 5.0 | 7 days | |
| | DN-289 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| | Elgetol 318 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| | ethion | 2.0 | 40 days | Do not apply more than four times during fruiting period or at rates higher than 2.5 lb. actual per acre. |
| | Genite 923 | ..... | Prebloom or dormant | |
| | Morestan | ..... | Prebloom or postharvest only | |
| | parathion* | 1.0 | 14 days | |
| phosphamidon (Dimecron)* | ..... | 60 days | | |

INSECTICIDES FOR INSECT CONTROL ON APPLES (continued)

| Insect | Insecticide | Tolerance, parts per million (p.p.m.) | Limitations (days before harvest) | Remarks |
|-------------------------|--------------------------|---------------------------------------|-----------------------------------|--|
| | tetradifon (Tedion) | 5.0 | | No more than 3 applications after petal fall at rates of 2.5 lb. actual per acre. |
| Oystershell scale | ovex | 3.0 | 30 days | |
| | DDT | 7.0 | 30 days | For use when crawlers are present. |
| | diazinon | 0.75 | 14 days | For use when crawlers are present. |
| | DN-289 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| Plum and apple curculio | Elgetol 318 | ..... | Prebloom or dormant | Recommended for dormant sprays. |
| | ethion | 2.0 | 40 days | For use when crawlers are present. Do not apply more than 4 times during fruiting period and at rates higher than 2.5 lb. actual per acre. |
| | azinphosmethyl (Guthion) | 2.0 | 15 days | |
| | dieldrin | 0.25 | 45 days | Dieldrin is toxic to bees. |
| | Red-banded leaf roller | azinphosmethyl (Guthion) | 2.0 | 15 days |
| Red-banded leaf roller | diazinon | 0.75 | 14 days | For use as a dormant spray. |
| | DN-289 | ..... | Prebloom or dormant | For use as a dormant spray. |
| | Elgetol 318 | ..... | Prebloom or dormant | Do not apply more than 4 times during fruiting period and at rates higher than 2.5 lb. actual per acre. |
| | ethion | 2.0 | 40 days | |
| | TDE | 7.0 | 30 days | |

* Highly toxic. † Do not use carbaryl (Sevin) in period from bloom until 30 days after bloom. Carbaryl may thin fruits.

APPLE SPRAY SCHEDULE

| Timing | Insect problems | Disease problems | Remarks |
|---|---|--|---|
| 1. Dormant spray (before buds show silver tips) | Aphids, mites, oystershell scale, leaf roller eggs | None | Use an emulsifiable dormant oil or DN-289 or Elgetol 318; or dormant oil plus diazinon or ethion as labelled. |
| 2. Delayed dormant spray (before leaves are out ½ inch) | Aphids (if they appear) | Apple scab | See note 1. |
| 3. Prepink spray | Cankerworms, mites, aphids | Apple scab, cedar-apple rust | Use when an extended period between delayed dormant and pink spray. See notes 1 and 2. |
| 4. Pink spray (when fruit buds show pink at tips) | Cankerworms, mites, aphids | Apple scab, cedar-apple rust | See notes 1 and 2. |
| 5. Blossom spray | None (protect bees) | Apple scab, cedar-apple rust | Do not apply mercury sprays. Do not apply insecticides during bloom period—protect bees. See notes 1 and 2. |
| 6. Petal fall spray (after ¾ of petals have fallen) | Curculio, codling moth, red-banded leaf roller, mites, aphids | Apple scab, cedar-apple rust | Guthion may be used instead of dieldrin at this stage if an additional application is made during first-cover spray. See notes 1 and 2. |
| 7. First cover spray (5 to 7 days after petal fall or when fruit is ¼ inch in diameter) | Red-banded leaf roller, curculio, codling moth, mites, aphids, oystershell scale (crawlers) | Apple scab, cedar-apple rust | Mercury must not be used after petal fall. See notes 1 and 2. |
| 8. Second cover spray (7 to 10 days after first cover) | Codling moth, leafhoppers, mites, aphids, oystershell scale (crawlers) | Apple scab, cedar-apple rust | See notes 1 and 2. |
| 9. Third cover spray (7 to 10 days after second cover) | Codling moth, mites, aphids, leafhoppers | Apple scab, cedar-apple rust | Rust may no longer be a threat after June 15. See notes 1 and 2. |
| 10. Additional sprays (when maggot flies have started to emerge) | Apple maggot, mites, aphids, leafhoppers | Apple scab, Sooty blotch of fruit, and flyspeck of fruit | Observe time limitations for chemicals used. See notes 1, 4, and 5. |

NOTES

1. Controlling scab infections

Apple scab is controlled primarily by preventive spraying—a suitable fungicide covers the foliage and fruit throughout the time when infection can occur. Entry of the scab organism into the plant tissues is prevented. During long rainy seasons trees are not adequately protected and penetration and establishment of the scab organism (infection) occurs. Hence, the scab organism has to be "burned out" with a chemical such as a mercury fungicide (use one-half strength when it can be applied within 40 hours after the start of an infection period and full strength within 72 hours) or dodine (Cyprex).

The effectiveness of the mercury fungicide can be fortified when used in combination with captan but rarely will both be used at full strength. The amount of each material to be used will be controlled by the cost of the chemicals and the severity of conditions favoring scab infection.

Mercury fungicide is approved for use through petal fall but should not be used during the bloom period. (Mercury fungicide can be toxic to bees.)

Dodine (Cyprex), a local systemic fungicide, can penetrate short distances into apple tissues and destroy some established infections. It should be a logical replacement for mercury fungicide in bloom stage. The manufacturer recommends using $\frac{3}{4}$ pound of dodine 65W per 100 gallons of spray for controlling scab after possibility of an infection during a rainy period. Although the timing will vary with temperature, dodine should be applied within 36 hours of the beginning of the rain or wet period.

In a scab-protection schedule, the manufacturer recommends $\frac{1}{4}$ to $\frac{1}{2}$ pound dodine 65W per 100 gallons of spray at 5- to 7-day intervals, or as needed to maintain scab control from prebloom through first-cover applications. Use $\frac{1}{8}$ to $\frac{1}{4}$ pound dodine in subsequent cover sprays as needed. Do not apply within 7 days of harvest.

Freezing or near-freezing temperature, particularly when accompanied by slow drying conditions, injures fruit or predisposes the fruit to chemical injury. Do not apply dodine 65W immediately before, during, or immediately after the occurrence of such conditions.

2. Control of cedar-apple rust

Cedar apple rust overwinters on eastern red cedar trees and on closely related species. Infection of the apple occurs during spring when spores are carried to the apple leaves and fruits from the gelatinous spore horns on galls of infected red cedar trees. The disease is controlled if all red cedar trees within one-half mile of the orchard are eliminated. Varietal differences in susceptibility to the disease occur.

Varieties tolerant to this disease should be considered for planting where cedars in the vicinity of the orchard cannot be eliminated. Fungicides can effectively control this disease. Ferbam and zineb are recommended. Begin spraying at the pink stage and continue through first cover (about mid-June). It is during this time that successive crops of gelatinous spore horns are produced on infected cedars.

Ferbam and zineb also control scab, but are generally inferior to captan or dodine. Continue to use a scab fungicide at full strength when controlling cedar-apple rust. Do not use ferbam on Golden Delicious.

See Plant Pathology Fact Sheet No. 4, "Cedar-Apple Rust" for additional information.

3. Control of fireblight

Fireblight is a bacterial disease of apples, pears, and occasionally other fruits. It is one of the most difficult diseases to control, since no reliable method for preventing or eradicating the disease is known. Infection can occur in the blossom period and at any time that new growth occurs on the trees.

The disease is spread by insects (including bees), wind, and rain. Infection occurs most readily under warm, moist conditions and on trees making vigorous growth. Control recommendations emphasize cultural methods, sanitation, and a chemical spray program. Varieties vary in their susceptibility to the disease, and considerable trouble can be eliminated by planting varieties that show a resistance to fireblight.

CULTURAL METHODS FOR CONTROL: Encouraging lush growth increases the susceptibility of trees to fireblight. When fireblight threatens an orchard, any cultural practice that encourages hardening of the tissues will reduce the threat of the diseases. Thus it is helpful to reduce nitrogen fertilization, allow grasses and orchard floor vegetation to consume excess moisture by reducing tillage or mowing to the minimum, and minimize maintenance pruning.

ORCHARD SANITATION: Pruning out infected branches reduces the source of inoculum for the following growing season. The preferred time to do this pruning is late fall or early winter. If the pruning operation is delayed until late winter or early spring it is advisable to disinfect pruning tools between pruning cuts. Use formaldehyde, denatured alcohol, or liquid household bleach mixed with equal parts of water.

The pruning cut on infected branches should be made 6 inches below the lowest canker. Pruning should be hauled from the orchard and burned before bud break in the spring. *Note: Pruning does not assure that an orchard will be free of fireblight the following year.*

CHEMICAL METHODS FOR CONTROL: There is some evidence that copper or antibiotic sprays give a measure of control of the blight of the flowers and spurs if the materials are applied before the infection spreads. A $\frac{1}{2}$ -2-100 Bordeaux mixture ($\frac{1}{2}$ pound copper sulfate, 2 pounds hydrated lime, and 100 gallons water) or streptomycin at 50 to 100 p.p.m. are recommended. Apply either material in four applications at 4-day intervals starting at pink stage.

Caution—Bordeaux mixture is incompatible with many other pesticides.

Note: Chemical control has never approached a full control of fireblight disease. The decision to use either or both of these materials will depend on the cost of the chemicals, the amount of inoculum present, the favorability of weather conditions for fireblight infection, and the potential loss to the crop.

4. Control of sooty blotch and flyspeck

These two diseases occur as black or brown spots on the surface of apple fruits and reduce the market value of the fruit. Sooty blotch and flyspeck generally are both found on the same fruits and their control methods are similar. The spray program for controlling

scab normally provides control. But if these diseases have been a problem or if prolonged wet cool weather occurs, especially toward the end of the growing season, additional protective measures should be taken. Add either ferbam or zineb to the spray mixtures. Do not use ferbam on Golden Delicious.

5. Controlling apple maggots

To control apple maggots, all foliage and fruit surfaces must be covered with a suitable insecticide from the time the maggot flies emerge until they cease to be present in the orchards. During the first 2 weeks of July, watch for announcements on farm radio programs and in local newspapers that the flies have started to emerge; or contact your county agricultural agent. Information on activity of maggot flies is made available to these sources by the Division of Plant Industry, Minnesota Department of Agriculture.

The first maggot spray should be applied as soon as the initial emergence is detected. A threat of severe apple maggot damage requires a series of maggot sprays at 7- to 10-day intervals. Of the suggested materials for apple maggot, DDT, Guthion, diazinon, or carbaryl (Sevin) may give up to 10-day protection.

Suggested time intervals between sprays should be shortened during certain weather and growing conditions that will (a) hasten the removal of spray materials or (b) result in the exposure of unprotected plant tissues during critical periods of disease infection or insect infestation.

Be especially mindful of tolerance limitations. The last spray must be applied early enough to avoid excessive residue on or in the fruit at harvest. Residues can be a difficult problem on early varieties.

See Entomology Fact Sheet No. 20, "The Apple Maggot," for additional information.

6. Postharvest dip or spray

A postharvest dip or spray to reduce certain types of rotting of stored fruits may be used on apples being prepared for market. The maximum permissible dosage is a 0.12-percent suspension of captan fungicide (2 pounds of 50-W per 100 gallons of water). Some new formulations of captan with a higher percentage of active ingredient will leave a less distinct residue. Follow label directions.

7. Spray guide for young apple trees

Young trees are injured if you fail to control damaging insects and diseases. Cankerworms and tent caterpillars may be abundant in early spring and require control; apply DDT as in the pink spray. Treehoppers are controlled with DDT in late July, or as soon as the insects first appear. Repeat 2 weeks later. When grasshoppers become numerous they should be controlled with malathion or diazinon. Aphids may be controlled with malathion, parathion, azinphosmethyl (Guthion), diazinon, or phosphamidon as they appear.

Apple scab and cedar-apple rust are troublesome. Where rust is a problem, follow recommendations for controlling rust on bearing trees. Scab is a problem during periods of high humidity and when the foliage is wet for extended periods of time. Under these conditions and during spring growth it is advisable to protect the foliage with a suitable fungicide.