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SPRAYING CALENDAR

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RESIDUE REGULATIONS ARE IN FORCE ON SOME SPRAY CHEMICALS

Pesticides in this publication include the following materials for which residue tolerances now exist:

BHC, lindane, DDT, chlordane, dieldrin, EPN-300, ferbam, glyodin, lead arsenate, methoxychlor, parathion, TDE (DDD), zineb and ziram.

Certain materials such as naphthaleneacetic acid and 2,4-D have been given residue tolerances for the first time. Other chemicals may be expected to be added to this list as information regarding them becomes available. Also, tolerances now in force may be subject to change under the Miller Bill, passed by the 82nd Congress in 1954, which provides for review of residue tolerances if a hardship is created and as more knowledge regarding a chemical accumulates.

Legally, the Miller Bill is an amendment to the Federal Food, Drug and Cosmetic Act of 1938. Functionally, it acts as a bridge between the tolerance-setting agency and the registration agency, providing machinery for rapid and effective cooperation in the establishment of pesticide tolerances on raw agricultural commodities.

If the law operates as anticipated, tolerances will be established by the time a pesticide is on the market. State Extension Service recommendations and industrial recommendations then can be made with knowledge of the tolerances involved, and farmers can apply pesticides with the assurance that they will not create excessive residues if recommendations given on the label of the container are followed.

The chemicals included in this publication, when used as suggested by the label on the container, will not result in excessive residues unless some unforeseen conditions occur which are not evident at the present time.

Notice that certain plant regulators and fungicides are included in the above list of chemicals for which residue tolerances have been established.

1955 SPRAYING CALENDAR

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Much goes into the planning of an economical and effective spraying program. In fruit growing, a successful spraying schedule must be based on a knowledge of (1) the life history of the important insects and diseases likely to be encountered; (2) the various kinds of spray chemicals available, and their proper use; and (3) susceptibility of the different kinds and varieties of fruit to insect, disease and spray injury.

The spraying schedules in this publication are merely guides to aid fruit growers in combating those insects and diseases which may be encountered during a single season. The same insects and diseases are not always present, or economically important, in all orchards. Thus, during any single season spray schedules should be adjusted to fit your specific orchard conditions.

Because of the expanding small-fruit industry in Michigan, the spraying schedules for blueberry, currant, gooseberry, blackberry, dewberry, raspberry, and strawberry have been included. These are in addition to the spraying schedules for tree fruits and grapes which are a basic part of this bulletin.

FUNDAMENTALS OF CONCENTRATE SPRAYING

The term "concentrate spraying," when related to fruit growing, simply means this: The use of spray mixtures more concentrated than those suggested for conventional hydraulic spraying, with the quantity applied per tree made correspondingly less.

The reason for introducing concentrate spraying in Michigan has been twofold: (1) To reduce the cost of pest control, and (2) to improve the quality of fruit by reducing the amount of spray injury.

Airblast machines are necessary for concentrate spraying. The spray discharge of these machines is automatically controlled by the tractor driver, and a certain pre-determined amount of spray chemical is delivered into the tree as the sprayer passes. The discharge of the sprayer, therefore, must be properly designed to give uniform spray-coverage throughout the tree. And the rate of travel past the tree must be coordinated with the rate of discharge of the sprayer, in order to deliver into the tree the amount of spray chemical required for economic pest control.

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DILUTIONS

The dilutions employed in concentrate spraying are referred to as "2x", "3x", "4x", etc. These mean 2, 3, or 4 times the amount of spray chemicals per 100 gallons used in conventional sprays.

For example: In mixing a "4x spray mixture" of sulfur paste ordinarily used at the rate of 6 to 8 pounds per 100 gallons of spray, the 4x mixture would require 24 to 32 pounds of sulfur paste per 100 gallons of spray. But the quantity of 4x spray mixture applied per tree would be reduced correspondingly. That is, if 16 gallons per tree had been a customary dosage in dilute spraying, now only 4 gallons or less of the 4x mixture would be used per tree.

Exactly how far you can safely reduce the quantity of concentrate spray liquid applied (per tree per application) below the equivalent amount of conventional dilute spray liquid, and still obtain economic pest control, is questionable. No definite reduction can be suggested, since the amount will vary for each individual grower. A grower who over-sprays in making dilute applications will certainly be able to reduce the quantity of spray liquid used per tree in concentrate form, more than the grower who now sprays only to the drip point.

It appears unwise to try to save on spray materials when first starting a concentrate spraying program. However, as you acquire experience and confidence, the quantity of *actual* spray chemicals applied per tree can be reduced below the amount used in conventional spraying, without any loss in effective pest control. It is also wiser, in most instances, to start a concentrate spray program with dilutions of 2x, 3x or 4x, using correspondingly less per tree – rather than with the higher concentrations. As the quantity of spray mixture used per tree per application is decreased, it becomes increasingly harder to obtain uniform spray coverage throughout the tree. Thus the risk of poor spray coverage is less in using a 4x concentration than an 8x.

PROCEDURE

In any form of automatic spraying the machine must be of the correct design and size to cover the trees uniformly. Or, the trees must be adapted to the sprayer by pruning. Proper pruning for good spray coverage will result also in a better quality of fruit by increasing size and improving color. At the same time, pruning can cut spraying costs by reducing the amount of spray-liquid required per tree for good coverage.

Growers who plan to use concentrate spraying should be prepared to do some night spraying, since best results are obtained if applications are made when the air movement is less than 7 miles per hour.

As soon as concentrate spraying is decided upon, the grower must establish the following factors:

A. To be determined. Spray delivery rate of one side of the sprayer (*"gallons per minute"*).

B. Amount of dilute spray (*"gallons per tree"*) required to adequately cover each tree.

C. Rate of travel (*"feet per minute"*) at which sprayer should pass the trees, so as to deliver the proper number of gallons of spray per tree.

D. Always is 2 to account for one side of the tree because only one side is sprayed as the machine passes the tree.

E. Spray concentration to be used (*2x, 3x* or *4x*).

F. Average spread of the trees to be sprayed (*"tree spread in feet"*).

Factors *B* (gallons per tree) and *F* (tree spread in feet) should be known from conventional dilute spraying practices. Factors *C* (rate of travel) and *E* (concentration to be used) must be set by the grower. *D* is always "2".

By using the following formula, the spray delivery for one side of the sprays is determined:

$$A = \frac{B \times C}{D \times E \times F}$$

For example, if a grower had a Speed Sprayer and he wanted to change from dilute spraying to concentrate spraying, the formula would be used as follows to determine the new delivery rate of the nozzles of the sprayer:

A = The new delivery rate for one side of the sprayer in gallons per minute, to be determined.

B = The amount of spray per tree used in dilute spraying. We will assume this to be *12* gallons per tree.

C = The rate of travel the grower wishes to use while spraying. We will assume this to be 3 miles per hour or *264* feet per minute. (88 feet per minute = 1 mile per hour. 88 x 3 = 264 feet per minute).

D = Always is *2*. Only one-half the tree is sprayed when passing.

E = The grower wishes to use "4x" concentration thus E = *4*.

F = Average spread of the trees to be sprayed, we will assume to be *30* feet.

Thus the formula will be as follows:

$$A = \frac{12 \times 264}{2 \times 4 \times 30} = \frac{3168}{240} = 13.2 \text{ gallons per minute}$$

The delivery rate for one side of the sprayer should be 13.2 gallons per minute. For 2-way spraying *each side* of the sprayer should deliver 13.2 gallons per minute. This would make a total delivery of 26.4 gallons per minute using the banks of nozzles on both sides of the sprayer.

The rate of travel when spraying will vary, depending upon the size and density of the trees. As a general rule the larger the trees, the slower the rate of travel; and the smaller the air volume of the sprayer, the slower the rate of travel. The average speed used for concentrate spraying will range from 1.5 to 4 miles per hour.

A speedometer is not necessary to check the rate of travel, but it is a reliable method. There are others. A watch can be substituted to determine the number of seconds it takes the sprayer to pass a tree. Then, by knowing the gallons per minute delivered by one side of the sprayer as it passes the tree, it is possible to calculate the number of gallons sprayed *on one side of the tree.* Multiplying that number by 2 will give the gallons of concentrate spray applied per tree per application, spraying the tree on two sides.

The quantity applied per tree may be varied by controlling either the rate of travel or the rate of discharge. The first is done by increasing or decreasing the speed of the sprayer. The second can be done by three different types of adjustment on the sprayer itself – increasing or decreasing the quantity of spray discharged, changing nozzles, or changing the size of the disc openings.

Success in concentrate spraying is associated with the use of good fundamental spraying practices; by the grower having a complete knowledge of the limitations of the method; and by his having a thorough understanding of the limitations of the concentrate sprayer.

Practically all of the spray chemicals listed in the spraying schedules may be applied in concentrated form. However, it has been found that "oil sprays" and "DN compounds" may be applied more safely and effectively in *diluted* form.

Sprayers designed to apply concentrates are now available commercially. Also conventional airblast sprayers may be converted to apply concentrate sprays. However, in such a conversion special nozzles may be required to obtain the desired range in droplet size – 30 to 80 microns – which appears to be desirable for good spray

coverage. Special nozzles, and information for converting an airblast sprayer to a concentrate machine, are available from manufacturers.

FUNDAMENTALS OF DISEASE AND INSECT CONTROL ON FRUITS

Changes in orchard practices, and the use of newer organic spray chemicals, have resulted in the buildup of certain insects previously kept in check by the older spraying practices. Also, the use of mechanical spray applicators has resulted in incomplete coverage in some orchards, allowing the buildup of insects in unsprayed areas of the tree. The importance of spray coverage for protection against injury by insects and diseases cannot be over-emphasized. Proper adjustment of mechanical sprayers, traveling more slowly past the tree while spraying, and pruning to adapt the tree to mechanical methods of spray application contribute to good coverage and economic pest control.

CORRECT USE OF SPRAY MATERIALS

Spray materials, if used incorrectly, are very injurious to plants. Some spray materials may be used safely on certain kinds of fruit, but cause *severe injury* when used on others.

Examples: Copper sprays should not be used on peaches during the growing season. Chlordane has caused severe leaf injury when used on European plum trees for the control of curculio. (The varieties Reine Claude, Green Gage, and Italian Prune fall into this group.) Parathion used on apple varieties of the McIntosh family (such as Snow, Cortland, Melba and Early McIntosh) has caused serious injury to young leaves and fruit – when used in quantities greater than ½ to 1 pound of the 15% wettable parathion per application.

It is very important to consider the compatibility of different spray chemicals when used together, or in successive applications. One spray application composed of incompatible materials may injure fruit and leaves severely enough to cause a partial or complete loss of crop – not only for the current year, but for several seasons.

Excellent compatibility charts are published annually in fruit growers' magazines. Also, reliable compatibility charts may be obtained from commercial spray companies or from the Department of Horticulture, Michigan State College, East Lansing.

A superficial knowledge of spraying practices is very dangerous in fruit growing. For continued success you should know how to combat those pests encountered annually, and what spray materials can be used most effectively and economically to obtain high-quality fruit.

SELECTION OF SPRAY AND DUST MATERIALS

Pest-control chemicals are sometimes unjustly credited with the failure to obtain satisfactory control of diseases and insects. Thoroughly tested materials manufactured by reliable companies will give commercial control of the pests for which they are recommended, if applied according to the manufacturers' directions.

When selecting materials, consideration should be given to any injurious effects on plants, possible residues dangerous to human beings, and the capacity to control diseases and insects.

Plants, bacteria, fungi and insects are all living organisms. Thus any material applied on the plant to kill them may also injure the plant. Wrong combinations of spray materials, improper methods of application, or applying spray chemicals under certain weather conditions may result in more serious injury — and a greater loss of fruit — than is caused by pests on unsprayed trees.

PRECAUTIONS

The following precautions will help to reduce spray injury to leaves and fruit.

1. Avoid the use of DN compounds and sulfur material for foliage sprays when the temperature is 85° F. and is continuing to rise.

2. Oils and sulfurs are incompatible; they should not be used together. (There may be an exception to this in the case of certain especially prepared proprietary compounds containing sulfur.) Allow a 10- to 14-day period between foliage applications containing oil and those containing sulfur. Plan to precede oil sprays with a compatible material, such as an organic dithiocarbomate compound, when possible.

3. Use a corrective, such as zinc sulfate and lime, with all acid arsenate of lead sprays on peaches and plums; and on apples after the Second Cover.

4. Elemental sulfurs, and certain organic fungicides, will give commercial control of apple scab when a complete protective cover is maintained throughout the scab-infection period. Lime-sulfur is best used on apples (after Delayed Dormant) only when protection has not been assured by the use of milder fungicides during weather conditions favorable for scab infection.

5. When a straight Pre-Blossom lime-sulfur spray program is used, application should not be made at less than 5- to 7-day intervals.

6. Never follow a copper spray with lime-sulfur on cherries; serious

defoliation may result. Elemental sulfurs are compatible with copper materials.

7. A combination of ferbam and parathion on Golden Delicious and Jonathan, priod to the Third Cover, has caused fruit russeting under certain weather conditions.

8. Chlordane should not be used on varieties of European plum, because of the danger of severe foliage injury.

9. Phenol-mercury compounds should not be used on apples following an application of ferbam, because of the possibility of severe leaf injury. *Do not use phenol-mercury compounds during hot weather.*

10. Do not use Phygon during hot weather.

I. Spraying Materials and Their Use

Spraying and dusting materials can be classified according to use into three groups: (1) FUNGICIDES – materials used to control fungous diseases; (2) INSECTICIDES – materials used to control insects; and (3) ACCESSORY MATERIALS (ADJUVANTS)—materials used as correctives, stickers, spreaders, activators, flocculators and emulsifiers.

FUNGICIDES

COPPER FUNGICIDES

Copper fungicides are usually divided into two groups: (1) bordeaux; (2) proprietary or low-soluble copper compounds.

BORDEAUX

Bordeaux is used as a dormant spray for peach leaf curl—as a summer spray for control of leaf spot on sour cherry, fire blight and scab on pear, leaf spot on strawberry, anthracnose on raspberry, and black rot and mildew on grape.

Bordeaux is made from copper sulfate (bluestone, blue vitriol), lime, and water. Whenever bordeaux is mentioned in this bulletin, a formula will be found, such as 4-6-100. The first figure always indicates the amount of copper sulfate in pounds, the second figure the amount of hydrated lime in pounds, and the third figure the amount of water in gallons. To illustrate, a 4-6-100 bordeaux will require:

4 pounds copper sulfate,
6 pounds hydrated lime, and
100 gallons water.

(This formula is an example only and should not be considered as a recommendation for any particular use. Refer to the spraying schedules for each fruit for specific recommendations.)

Copper sulfate may be obtained in several forms, based on size of particles. For convenience in preparation the rather fine, granular, and pulverized forms are desirable. These forms are referred to by the trade as "powdered," "snow," and "small and large crystals." The powdered or snow forms are recommended for convenience.

Preparation of Bordeaux—There are several methods for preparing bordeaux. The one in most common use today is the "instant bordeaux" method. It has replaced the old stock-solution method because it is more convenient to make and the mixture is entirely satisfactory. One precaution should always be remembered in making bordeaux: Never mix concentrated solutions of copper sulphate and lime. Such a mixture is coarse and does not adhere well to the fruit or foliage.

The "instant" method requires different forms of materials than the old stock-solution method. The lime used should be of a good grade of chemical hydrate or spray lime (see page 20). The copper sulfate should be in the powdered or snow form. These forms dissolve readily in water. To make "instant bordeaux," proceed as follows:

1. Fill the spray tank with water, one quarter to a third full.
2. With the agitator running, place hydrated lime on the tank strainer and wash through – or mix with water in a pail and pour through the strainer.
3. Fill tank nearly full of water.
4. Dissolve the copper sulfate in a pail; pour slowly through the strainer while the water continues to flow into the tank. Allow about 2 minutes for the two solutions to mix and react in the tank.
5. Add lead arsenate or nicotine sulfate at this time, if either is to be used. Finish filling the tank with water and apply. Keep the agitator in operation continuously after copper sulfate has been added.

Bordeaux may be added to elemental sulfur, lead arsenate, zinc arsenate, calcium arsenate, oils, nicotine sulfate, proprietary copper compounds and DDT. It should not be used with lime-sulfur or fixed nicotine.

PROPRIETARY COPPER COMPOUNDS

Proprietary Copper Compounds are fungicides containing copper in a low-soluble form and are sold under various trade names. The

following have been used on cherries in Michigan: Basicop, Cupro-K, Compound A, Oxobordeaux, Spray Cop, Tennessee 26, and Tennessee 34. Tri-basic and Cuprocide have been used on grape. They can be used to control cherry leaf spot on both sour and sweet cherry, and in late sprays for grape black rot and downy mildew. In general, they are not so effective in disease control as bordeaux, but cause less injury to the fruit and foliage.

Because they vary in copper content they should be used according to manufacturers' recommendation. When used to control cherry leaf spot, add 1 pound of lime for each pound of the copper compound containing 25% or less of metallic copper; add 2 pounds of lime to each pound of the copper compound containing more than 25% of metallic copper.

Some of the proprietary copper materials are almost neutral in their reaction, and can therefore be used with materials such as fixed nicotines and cryolite, which are not compatible with highly alkaline materials. In addition, they are compatible with elemental sulfur, nicotine sulfate, DDT, and lead arsenate. *They should not be mixed with lime-sulfur.*

ORGANIC FUNGICIDES

DITHIOCARBAMATES

Ferbam—(ferric dimethyldithiocarbamate)—is a dark brown to black bulky powder, which is sold under such trade names as Fermate, Karbam, and Ferradow. This material has been used successfully for the control of leaf spot on sour cherries and is as effective as elemental sulfurs for the control of scab on apples. It has given better control of brown rot on plums and sweet cherries than elemental sulfurs, in preharvest applications.

Ziram—(zinc dimethyldithiocarbamate)—sold as Zerlate and White Karbam, is a white, bulky powder similar to the iron salt in physical properties. This material may be used in late sprays on light-colored cherries and plums in place of ferbam for the control of brown rot and leaf spot, to avoid visible residue. Caution should be taken in using Ziram too close to harvest since it may cause disagreeable skin irritations to workers handling the fruit.

Nabam—(disodium ethylenebisdithiocarbamate)—is a liquid fungicide sold under the trade names, Dithame D-14 and Liquid Parzate. When combined in the spray tank with monohydrate zinc sulfate, it

becomes a tank-mixed zineb. This mixture is being used extensively in Michigan for the control of leaf spot on sour cherries.

Zineb—(zinc ethylenebisdithiocarbamate)—is a formulated wettable powder sold under the trade names Dithane Z-78 and Parzate. Zineb has been used as a substitute for weak bordeaux and fixed coppers in controlling blossom blight (fire blight) on apples and pears. Blight control was poor with this material in 1954. It has shown promise also in reducing fruit russet on apples when used as a protective fungicide to control scab.

OTHER ORGANIC FUNGICIDES

Actidione—Actidione is an antibiotic chemical that is exceptionally efficient in killing out established infections of cherry leaf spot fungus, even at low concentrations. Some injury occurs from the use of this material on young, tender foliage at 2 parts per million early in the season at the time of Petal Fall. A single application of actidione is effective against leaf spot for approximately 3 to 4 weeks after which time it may be necessary to repeat the application. Actidione has not been cleared for use on bearing trees before harvest. It does have considerable merit, however, for the control of leaf spot on nonbearing trees and as an After-Harvest spray on bearing trees. The concentration, 2 parts per million is equivalent to 0.76 grams of actidione in 100 gallons.

Glyodin—(2-heptadecylglyoxalidine acetate)—This is a liquid fungicide sold as Crag Fruit Fungicide 341, used on both apples and sour cherries. On apples it has given good results as a protective material for the control of scab. Its use has resulted also in good finish of the harvested fruit of all varieties except Golden Delicious. Glyodin has performed creditably also when used on sour cherries for the control of leaf spot.

Dichlone—Phygon XL is a trade name for dichlone, a naphthoquinone fungicide with both protective and eradicative properties. It is used against apple scab in situations where control has been difficult. It is also used in blossom sprays to control brown-rot blossom blight on peaches, plums, and cherries. Phygon is a strong, irritating chemical and should be handled carefully. Operators who are sensitive to this material can obtain special non-oily ointments to overcome skin irritation. When used on apples, it has given best results in combination with an organic fungicide such as ferbam or captan.

Captan—(N-trichloromethylthiotetrahydrophthalimide)—is sold as Orthocide 50 Wettable and Stauffer's Captan Fungicide. This material has given good control of cherry leaf spot, apple scab, and brown rot of stone fruits. Also, this fungicide has given reduced russeting on susceptible varieties of apples, such as Golden Delicious. By contrast, it has caused leaf injury on Delicious in some orchards when applications have been too heavy and when used with incompatible materials.

Mercury Compounds—The phenyl mercurial compounds such as Tag 331, Puratized Apply Spray, Coromerc, and Phix are useful to eradicate newly established infections of apple scab. Sprays containing mercury at the rate of ¼ to ½ pound, or ¼ to ½ pint of 10% mercury should be used for apples within 36 to 72 hours following an infection-producing rain, when protection from previously applied fungicides is questionable. Actually, these mercuries may have a longer period of action if the temperatures remain low, below 50° F., after the rain. Some growers who have sufficient spray and dust equipment handle at least a portion of their apple scab control program on an eradication basis, rather than by using protective methods. Attempts to eradicate apple scab infection of long standing (2 to 3 weeks) with mercurial compounds have been unsuccessful, and have resulted in severe injury and loss of leaves in some instances. *Mercurial Compounds should not be used after an application of ferbam, or during hot weather.*

Mercury sprays have shown promise, in limited testing, as a dormant application on strawberries for eradicating the leaf blight (Dendrophoma) fungus. Injury and killing of old leaves have resulted from the use of the mercury sprays – but these leaves were replaced by new leaves and were not missed. The dormant application should be made *before new growth is visible.*

SULFUR FUNGICIDES

Elemental Sulfur—"Elemental sulfur" means sulfur in pure form. For disease control, the sulfur is reduced to extremely small particles by mechanical grinding or by other processes. Dry, powdered sulfur is used for dusting crops. Wettable powdered sulfur is elemental sulfur with a wetting agent added, so that the particles of sulfur may be wetted and dispersed in water. Sulfur pastes are finely divided sulfur particles, less than 5 microns, combined with enough water and wetting agent to make a paste. "Bentonite sulfur" is elemental sulfur

fused chemically with bentonite clay; it is considered a form of wettable sulfur in this bulletin.

Proprietary sulfur products vary in particle size and in sulfur content. Thus it is necessary to follow the recommendations made by the manufacturer. In general, 4 to 8 pounds of wettable sulfur are used per 100 gallons of spray. "Flotation paste" contains 32 to 42 per cent elemental sulfur as compared to 95 to 98 per cent elemental sulfur for the common dry wettable form. Flotation paste is generally used at the rate of 8 to 12 pounds of paste per 100 gallons of spray. A sulfur paste common in Michigan is Magnetic 70 Paste. This product contains 70 per cent elemental sulfur and is used at the rates of 5 to 8 pounds per 100 gallons of spray. The amount of sulfur paste or wettable sulfur used per 100 gallons of spray depends on the disease to be controlled and the season. The higher amounts are used early in the season for the control of apple scab, or for the control of brown rot on peach and plum. The lower amounts are used when diseases are more easily controlled, and during those periods favorable for sulfur burn.

The adhesiveness and fungicidal value of wettable and paste sulfurs depend, within limits, upon the size of the sulfur particles and the content of sulfur in the product. The particles of sulfur in 325-mesh sulfur are about 1/500 of an inch in shortest diameter. Paste sulfur and some of the better wettable sulfurs have particles which range in size from 1/3,000 to 1/25,000 of an inch. Particle size of sulfur is usually stated by the manufacturer in "microns." A micron is equal to 1/25,000 of an inch. Brands of sulfur products which state particle size as part of the analysis, 8 microns and smaller, contain sulfur which ranges in size from about 1/3,000 to 1/25,000 of an inch.

Wettable and paste sulfurs do not possess the immediate caustic properties of freshly prepared lime-sulfur, nor do they adhere as well. For these reasons they are not as efficient in killing established fungi. It is necessary to apply these sulfurs at more frequent intervals than lime-sulfur, because they are principally protective in their action against disease organisms. All parts of the fruit and foliage must be kept covered during infection periods.

Wettable and paste sulfurs are practically non-injurious to fruit and foliage at normal temperatures. At temperatures above 85° F., sun scald on the fruit and scorch on the foliage may occur. This is especially likely to happen in muggy weather. Wettable and paste

sulfurs are safe to use in all applications on peach and plum, and the in-bloom sprays on apple, peach, and cherry. They are compatible with bordeaux, lime-sulphur, proprietary copper compounds, most of the organic fungicides, lead arsenate, zinc arsenate, nicotine sulfate, fixed nicotine, DDT, and soaps – but they should not be used with oils or calcium arsenate.

Lime-sulfur—Lime-sulfur is used as a dormant spray for the control of peach leaf curl and scale insects. It is also used during the growing season to control apple scab and blossom blight on stone fruits, under emergency conditions. The concentrations in general use are 5 gallons to 100 gallons of spray for leaf curl, 12½ gallons to 100 gallons of spray for scale insects in the dormant period, and 1½ to 2½ gallons to 100 gallons of spray as a fungicide in the growing season.

Lime-sulfur is marketed in both the liquid and dry forms. All recommendations in this bulletin for the use of lime-sulfur refer to commercial concentrated solutions testing 32° to 33° Baumé. The calcium polysulfides present in lime-sulfur are the toxic portion; they are soluble in water and caustic. The immediate solubility and caustic action of the polysulfides kills certain fungus spores which are germinating or partly established, giving the material some eradicative as well as protective properties. The polysulfides break down soon after being exposed on the leaf surface into finely divided sulfur, which has similar protective action to elemental sulfurs.

Lime-sulfur, because of its caustic property, is more injurious to fruit and foliage than elemental sulfurs. Results from experimental spraying with lime-sulfur applied at the short intervals necessary in early spring for scab control on apples showed severe dwarfing of foliage, reduction in plant food manufacturing, decrease in blossom bud formation and lower yields – when compared with experimental results with elemental sulfur. Because of its effect on plants, it is being replaced with less injurious fungicides.

Liquid lime-sulfur or dry lime-sulfur – when used at concentrations stronger than 1 gallon of the liquid or 4 pounds of the dry – may be used with lead or zinc arsenate under most conditions. Nicotine sulfate and elemental sulfurs are safe to use with lime-sulfur. Lime-sulfur should never be mixed with summer oils, copper fungicides, soap, DDT, or DN sprays. Lime-sulfur is compatible with some dormant oils.

Dry Lime-sulfur—Dry lime-sulfur contains the same ingredients as liquid lime-sulfur. In addition, it contains a stabilizer which is necessary to keep the polysulfides from breaking down during manufacturing. Dry lime-sulfur can be used to control peach leaf curl in the dormant period, but is not satisfactory for control of scale. It can also be substituted for liquid lime-sulfur in the control of apple scab and blossom blight on stone fruits. Dry lime-sulfur varies in its exact composition from liquid lime-sulfur. Chemical analysis and field experiments have shown that 4 pounds of the dry lime-sulfur are approximately equal to 1 gallon of the concentrated liquid lime-sulfur. To find the amount of *dry lime-sulfur* required in a spray solution: multiply the recommended number of gallons of *liquid lime-sulfur* by *4*. The result will be the number of pounds of dry lime-sulfur to give equivalent results.

jury to foliage and fruit that follow the use of liquid lime-sulfur, but

Dry lime-sulfur may be expected to produce all of the types of in-the injury is often less serious, even though the two are used at equivalent strengths. Dry lime-sulfur is compatible with the same materials as liquid lime-sulfur.

INSECTICIDES

Acid Lead Arsenate—Acid lead arsenate has been the standard stomach poison used in Michigan orchards until the introduction of DDT. Unless otherwise stated, lead arsenate referred to in this bulletin is the acid form. It is used in orchards at the rate of 2 to 3 pounds to 100 gallons of spray.

Acid lead arsenate should not be used on peach or plums, nor in Late Cover spray on apples, without a corrective. (See page 22). Acid lead arsenate may be used safely with most materials. It should not be combined with weak concentrations of lime-sulfur (less than 1 gallon of lime-sulfur in 100 gallons of water, or less than 4 pounds of dry lime-sulfur) or with certain soap compounds.

BHC—(benzene hexachloride) is a contact and stomach poison suggested in the Spraying Calendar to control aphids on apples at the time of Pre-Pink and Pink. This material should not be used in bloom or after bloom owing to the possibility of creating an off-flavor of the harvested fruit.

The active portion of BHC is the gamma isomer. Suggested amounts of BHC given in this publication are based on 10% gamma isomer content.

Lindane—This material is a purified form of BHC which is effective against the same pests as BHC. Lindane appears to result in less of the objectionable flavors than does BHC. Lindane has largely replaced BHC for use on fruits.

Chlordane—Chlordane is a chlorine compound that is effective against curculio and sucking bugs on peach. Chlordane should not be applied on fruit within 2 months of harvest. It is also objected to by processors of fruit products. Chlordane is a superior material for control of grasshoppers and cutworms, when used at the strength of 1 pound of actual chlordane in 100 gallons of spray. That quantity is sufficient to cover one acre. A 5% dust has been equally effective, at 20 pounds per acre, against grasshoppers.

Dieldrin—(hexachloroepoxyoctahydrodimethanonapthalene)—This new insecticide has been tested for four years and has proved very effective against the plum curculio. It has a persistent residue and should not be applied after the First Cover spray on peaches.

It is used at the rate of 1 pound of the 25% wettable powder per 100 gallons of spray. The directions on the label should be followed exactly, when it is used. Dieldrin has been granted a label for use on all tree fruits.

DDT — (dichlorodiphenyltrichloroethane) — DDT is still a very effective insecticide. It is used on fruits as a wettable powder and may be combined with other spray materials, except oils and strongly alkaline mixtures. DDT controls codling moth, oriental fruit moth, leafhoppers, many sucking bugs, certain aphids, peachtree borer, and cutworms. It also prevents the buildup of orchard scale insects. Red-banded leaf roller has been checked using 3 pounds of 50% wettable DDT per 100 gallons of spray. Three applications properly timed also control apple maggot. (See Apple Spraying Schedule, page 57).

DDT should not be applied within 1 month of harvest, since that may result in excess residue on the fruit.

Methoxychlor—This material is sold as Marlate and is a close relative of DDT. It has been used as a substitute for lead arsenate to control curculio, codling moth, apple maggot, and cherry fruit fly. It appears more effective than lead arsenate against curculio, but is less effective than parathion for this purpose. It should be used as recommended by the manufacturers. It is available as a wettable powder and as a liquid emulsion.

DN Compounds—DN compounds are effective against aphids, bud moth, and mineola moth as dormant applications. The manufacturers' directions should be followed carefully. Foliage application of DN compounds are now largely supplanted by other materials.

Dormant Oils—Dormant oils may be used to control red mite, scale insects, and pear psylla. In general, the amount of oil in a spray varies from 3 to 4%. Oils should be used at manufacturers' directions. Dormant oils should have a viscosity of (Sayboldt at 100° F.) 90-120 seconds; a minimum viscosity index (Kinematic) of 65; a minimum gravity (A.P.I. degrees) of 28; a pour pint not greater than 30° F., and an unsulfonated residue of above 78%. DN compounds should not be used in the same spray mixtures with 3% oil emulsions, or in spray mixtures of oil emulsions containing more than 3% oil.

Directions for home-mixed emulsions may be obtained from the Department of Entomology, Michigan State College, East Lansing.

At the present time practically all insects that were once controlled by dormant oils can be controlled with the newer insecticides, in foliage applications.

Fixed Nicotine—Fixed nicotines are used principally for the conrol of codling moth. Several materials containing nicotine in "fixed" form are marketed; these compounds retain the poisonous principles over a longer period than other nicotine compounds. When used according to manufacturers' directions, these materials give excellent control of codling moth without leaving such residues as would make washing necessary.

Fixed nicotines may be used with oils, neutral proprietary copper materials, elemental sulfur, nicotine sulfate, acid lead arsenate, and DDT. High-alkaline materials will liberate the nicotine, and therefore fixed nicotines when used as stomach poisons should not be mixed with lime-sulfur, bordeaux, lime, or strong soaps.

Nicotine Sulfate—Nicotine sulfate is a standard contact spray for use during the growing period to control aphids, leafhoppers, red bug and codling moth. Nicotine sulfate should contain 40% actual nicotine, and all recommendations made in this bulletin are based on that concentration. It is applied at the rate of ¾ to 1 pint of the concentrated product to 100 gallons of spray. Nicotine sulfate appears on the market under several trade names. Any of them should give satisfactory pest control if diluted so as to give the required amount of nicotine. Nicotine sulfate is compatible with all spray materials. For best results

in heavy infestations of aphids, a special application of nicotine sulfate plus a soap or other activator is advisable. Use of a spreader-sticker may improve the control.

Paradichlorobenzene, PDB—PDB is a white, crystalline, granular material with a characteristic odor. Applied at ground temperatures of around 60° F. (about September 1) about the base of peach trees, it slowly volatilizes into a toxic gas. PDB is recommended for the control of the peachtree borer. Dissolved in a miscible oil, 2 pounds to the gallon – and diluted with water at the rate of 1 gallon of the miscible oil-PDB mixture to 30 gallons of spray – it can be safely used to control true peachtree borer in young trees. Two pounds PDB dissolved in 1 gallon of cottonseed oil is used to paint over cankers, thereby also killing the lesser peachtree borer. DDT offers an alternate treatment for the control of the peachtree borer.

Demeton—(O-2—[ethylmercopto] ethyl O,O-diethyl thiophosphate) – Demeton, most commonly known as Systox, is a systemic phosphate insecticide suggested for trial in Michigan to control aphids and mites. This material should not be used more than once after bloom, and not later than within 4 weeks of harvest. Demeton appears to give commercial protection for approximately 4 weeks. This compound is highly toxic to man and should be handled and used according to the directions given on the label of the container.

Parathion—(O, diethyl O-p-nitrophenylthiophosphate)—Parathion has been extensively used since 1947 and has given good control of the following pests: mites, red-banded leafroller, aphids, bud moth, pear psylla, curculio, and grasshoppers. Some control is obtained on codling moth and oriental fruit moth. Parathion permits effective foliage treatment against insects that have in the past required dormant sprays. No injury from parathion has been observed on peaches, plums, or cherries. Apples have been injured when used in amounts over the dosages suggested in the Apple Spraying Schedule (See page 57).

HETP and TEPP—HETP (hexaethyltetraphosphate) and TEPP (tetraethylpyrophosphate) are two compounds which have been used commercially against certain insects for several years. Their main value is that they may be applied a few days before harvest without danger from residues.

EPN-300—A proprietary compound, EPN-300 has given good control of mites and is effective against curculio. It should be used as recommended by the manufacturers.

Malathion—A proprietary organic phosphate, malathion is a useful insecticide for many insect pests and is especially effective against aphids. Its period of effectiveness is not longer than 2-3 days.

ACCESSORY MATERIALS

"Accessory materials" are those materials added to fungicides and insecticides to make them less injurious to the foliage and fruit, improve their sticking and spreading properties, or make them more effective in disease and insect control.

SPRAY LIME

Hydrated lime is the only form of lime generally available for spraying purposes in Michigan. Lime is used in the preparation of bordeaux, and in the iron sulfate and zinc sulfate mixtures applied for correcting arsenical injury. When used alone with lead or zinc arsenate, especially in the cover sprays on apples, lime aids in delaying arsenical injury. It is recommended with proprietary copper compounds to reduce copper injury on cherry foliage. It tends to reduce the effectiveness of arsenicals and proprietary copper materials, but the decrease in disease and insect control is usually not so serious as the injury from defoliation which may result in some seasons. Addition of lime to DDT sprays will reduce their effectiveness somewhat. Lime is not recommended with fixed nicotine sprays, except when immediate contact action or other considerations demand it, or with oils.

There are several grades of hydrated lime – "mason's hydrate," "finishing hydrate," "agricultural lime," "chemical hydrate lime," and "spraying lime." The first three mentioned grades are nearly always undesirable for spraying purposes. Special spraying or chemical hydrate lime should be used. *Do not use old lime for spraying purposes.* Lime that is freshly hydrated in the spring should be satisfactory for 10 to 12 weeks, if stored in a dry place and not exposed to the air. Lime carried over from last season can more profitably be added to the soil than put in the spray tank. Brands of lime vary in fineness and physical properties.

Finely ground limes, with the least amount of grit or coarse material, are most desirable. Limes vary in their chemical composition as

well as their physical properties. Lime made from limestone composed almost entirely of calcium carbonate is called "high-calcium lime"; lime made from limestone containing a mixture of calcium and magnesium carbonates is called "dolomitic lime."

High-calcium limes have been generally recommended for spraying purposes in the past. Three years' results on the use of bordeaux for leaf-spot control on sour cherries now show that bordeaux prepared from dolomitic lime is equally as good or better than bordeaux prepared from high calcium lime. It caused less injury to the foliage, less dwarfing of fruits, and was equally effective in leaf-spot control. No significant differences were found between high-calcium lime and dolomitic lime, when used in the zinc sulfate-lime and iron sulfate-lime mixtures as a corrective for arsenical injury on peaches. Any high grade spraying lime appears to be satisfactory for this purpose.

STICKERS

Stickers may increase *deposit* (the amount of spray material that sticks to the tree), or they may increase *retention* (the length of time the spray material sticks to the tree). Small amounts of summer oil added to spray mixtures usually increase both deposit and retention.

The increase in deposit and retention of a fungicide does not always increase the effectiveness of the fungicide to control disease. For instance, PEPS (polyethylenepolysulfide), an adhesive agent sold as Coropeps, definitely improved the effectiveness of Captan to control apple scab, when the fungicide was used at regular dosage and reduced dosage. It gave only slight improvement in the control of apple scab when used in sprays with liquid lime-sulfur reduced to 1 gallon per 100 gallons of spray. When used with wettable sulfur, it gave improved control of apple scab on the fruit – but reduced control on the leaves. Moreover, with dichlone (Phygon) and with ferbam, PEPS reduced the effectiveness of those two materials to control scab on both the fruit and the leaves.

STICKER-SPREADERS

Some materials act as spreaders when wet, and as stickers after they dry. Such "sticker-spreaders" usually increase retention more than they increase deposit.

Like spreaders, stickers are often included by the manufacturer in the formulation of the spray material. Occasionally the use of additional amounts of sticker-spreader is advised. Excessive use of stickers may cause excessive residues at harvest.

FLOCCULATORS

Flocculators and de-flocculators are added by the manufacturer to regulate the degree of clumping together of particles in the spray tank. Under Michigan conditions the addition of more flocculator or de-flocculator in the field is seldom practical.

SPREADERS AND WETTING AGENTS

Years ago, experience indicated that the action of many orchard sprays was improved by the addition of spreaders, or wetting agents. Common materials – such as dried milk, casein, eggs, dried blood, fish-oil soap, laundry soap, soybean flour and lime – were used for that purpose. In recent years synthetic chemicals of the "soapless suds" type have replaced the older spreaders to a large extent.

At the same time, it has become common practice for the manufacturer to add spreaders to the spray materials during the manufacturing process. At present it is seldom necessary for the orchardist to add such materials in the field. Occasionally – if the water is unusually hard, if hard-to-wet plants such as plum fruits are involved, or if hard-to-wet insects such as waxy aphids are involved – it may be helpful to add a *small* amount of spreader to the tank. Too much spreader will cause excessive run-off.

CORRECTIVES

"Correctives" as referred to in this bulletin are materials to be used in combination with fungicides and insecticides to reduce spray injury.

ZINC SULFATE-LIME MIXTURE

A 1-4-100 zinc sulfate-lime mixture is recommended to prevent arsenical injury on apples; a 4-4-100 zinc sulfate-lime mixture to prevent arsenical injury on peach and plum; and 8-8-100 zinc sulfate-lime mixture for bacterial spot of peach.

If arsenicals are used on Jonathan, King, Rhode Island Greening, Ben Davis, or other apple varieties susceptible to arsenical injury, the zinc sulfate-lime mixture added to the spray will reduce the amount of injury. It should be used beginning with the Second Cover application.

Zinc sulfate-lime mixture is prepared as follows:

1. Begin filling the spray tank with water.
2. With the agitator running, add the required amount of previously dissolved zinc sulfate to the water in the tank. Fill until two-thirds full.

3. Wash the required amount of lime through the strainer, or make it into a thin paste and pour into the sprayer.

4. Finish filling the tank and agitate a few minutes before adding lead arsenate.

5. Add lead arsenate, then sulfur if required.

There are three forms or grades of zinc sulfate on the market. They vary in amount of zinc and water present. The first contains 22¼% zinc, and is the "crystal" form; the second contains 25½% zinc, and is the "flake" form; the third contains 36% zinc, and is the "powdered" form. The 25½% grade is the one used in Michigan State College experimental work and on which recommendations in this bulletin are based. If one of the other grades of zinc sulfate is used, the amount should be in proportion to the percentage of zinc present. *For example:* In the standard 4-4-100 mixture, 4 pounds of the 25½% zinc sulfate and 4 pounds of lime are recommended. If the 36% grade is used, then slightly less than 3 pounds of the zinc sulfate should be added to 4 pounds of lime. Zinc sulfate-lime mixture is an excellent corrective for use with all arsenates when applied to apples.

When lime-sulfur or elemental sulfurs are used with the mixture, the sulfur should be added after the arsenate. *Zinc sulfate should never be used without lime when applied to peach, apple, plum, or cherry trees.* The zinc sulfate-lime mixture or the iron sulfate-lime mixture should always be used on peach and plums when acid lead arsenate is applied.

When lead arsenate is used with glyodin on tree fruits, ½ to ¾ of a pound of ferric sulfate is suggested per 100 gallons to be included to guard against possible arsenical injury. The ferric sulfate should be the first material dispersed in the water, followed by glyodin and then lead arsenate.

II. Diseases: Life Histories and Control Practices

TREE FRUIT DISEASES

APPLE SCAB

Apple scab is the only serious fungus disease generally confronting the Michigan apple grower, and good control of scab is necessary for a profitable season. Scabby apples are culls. Also, the fungus, if not controlled, can cause early fruit and leaf drop which may seriously reduce yields.

The apple scab fungus develops during the winter and early spring in the old leaves present on the ground, that were infected the previous season. Ascospores, comparable to small seeds, are produced and are ripe about the time the first green apple tissue is exposed in the spring. Rain is necessary for spore discharge, and enough rain to wet the surface of the leaves is sufficient to cause some of the ascospores to be shot into the air. The air currents then carry these spores upward into adjoining trees; or the wind may carry the spores long distances. They can cause infection, if they land on green apple foliage or fruit, when they stay wet for a relatively few hours. Ascospores may continue to be discharged as late as 2 to 4 weeks after Petal Fall in some seasons, but are usually all gone by First Cover.

The spores (ascospores or conidia) will germinate and penetrate into the green tissue – if the green tissue is wet, and if the spores on the green tissue remain wet long enough. The time required for the discharged ascospore to germinate and cause infection depends upon the temperature during the wet period. This relationship is shown in Table 1.

Primary apple scab infection is soon followed by the formation of secondary spores that are produced abundantly in established scab-bed spots. The time of expected appearance of the secondary spores (called conidia) following primary scab infection, is found in Table 2. After primary infection is once established, it is possible to have both ascospores and conidia present at the same time. The conidia or summer spores are not scattered by the wind, but are spread only by dropping or splashing water. Therefore, conidia reinfect only nearby fruit and foliage. Infection by conidia requires a wet period of about 3 hours less than that given for ascospore infection in Table 1. The 3-hour

lag in ascospore infections is based on the time the ascospores spend floating around in the air.

SUGGESTIONS FOR CONTROL

By knowing the temperature from the time the green tissue first becomes wet until it dries again, one can determine (from Table 1) if infection is probable and judge whether spray materials already applied are adequate for the control of scab. If weather predictions indicate that the wet period will extend beyond the time given for apple scab infection in Table 1, it is desirable to apply a protective cover before or during the wet period, or an eradication spray immediatly after the wet period. Renewed protection or eradication is particularly necessary if the protective cover already present is questionable.

TABLE 1—The approximate number of hours of continued wet foliage required for primary apple scab infection at different air temperature ranges

Air temperature range during wet period	Number of hours continued wet period required for primary apple scab infection
32°—40° F.	48 hours
40°—42° F.	30 hours
42°—45° F.	20 hours
45°—50° F.	14 hours
50°—53° F.	12 hours
53°—58° F.	10 hours
58°—76° F.	9 hours
76°—	11 hours

TABLE 2—The effect of temperature following primary apple scab infection on the length of time required for the development of conidia (summer spores)

Average temperature following primary apple scab infection	Approximate period of time required for conidia (summer spore) development following primary apple scab infection
30°—40° F	18 days
41°—45° F	16 days
46°—50° F.	14 days
51°—55° F.	13 days
56°—60° F.	12 days
61°—65° F.	10 days
66°—70° F.	8 days
71°—75° F.	7 days

To protect against infection of apple scab, protective fungicides such as sulfurs or ferbam must be on the foliage before infection occurs. However, eradicative fungicides—such as lime-sulfur or phenylmercury compounds – kill the fungus after it has entered and penetrated for some distance into the apple leaf or fruit tissue; these materials at full strength are usually effective for approximately 72 hours after the infection has taken place. Phygon is an effective eradicative fungicide when used within 35 hours from the beginning of an infection period and in combination with either ferbam or captan.

The performance expected of the several types of fungicides for scab control is illustrated, for all practical purposes, in Fig. 1. In this diagram the organic mercuries – such as Tag, Coromerc, Phix, and Puratized Apple Spray – are shown as eradicating infections that were established during the three days previous, or approximately 72 hours before the time of application. These organic mercuries are not, however, considered as being reliable for much further continued protection. Lime-sulfur has an eradicative action equivalent to that of the mercuries, but the eradicative action of Phygon is considered to be somewhat less – or for about 48 hours when used at ½ pound per 100 gallons. In addition, lime-sulfur and Phygon leave protective fungicidal deposits. The fungicides such as the wettable sulfurs, ferbam, and glyodin are considered to be protective only, having rather limited or no eradicative properties. Captan is classed as a protectant, but does have eradicative action from 18 to 24 hours based on the prevailing air temperature.

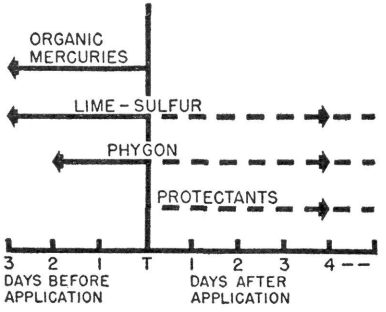

Fig. 1. Approximate periods of control of apple scab by different kinds of fungicides. (T = time of application.) The time to the left of the vertical line indicates the approximate period of eradicative action; that to the right indicates the approximate period of protective action.

For a protective spray program to be effective, the developing fruit and leaves must be covered before an infection period of wet weather. The effective period of protection for the different fungicides is variable, depending on the amount of spray coating washed off by rains and the amount of new unprotected growth developed since the last spray. In general, a protectant spray coating in the prebloom period should be considered insufficient after a period of not exceeding seven days, or after 1 inch of rainfall.

PEAR SCAB

Pear scab is caused by a fungus closely related to apple scab and having a similar life history (see page 24). The disease, when present in the orchard to any extent, is very injurious to young fruits and may cause the complete loss of a crop if not controlled. Varieties vary in their susceptibility to scab. Flemish Beauty, Winter Nelis, and Seckel are very susceptible; Bartlett and Bosc are intermediate; and Kieffer is the most resistant.

SUGGESTIONS FOR CONTROL

Pear scab can be controlled readily on the commercial varieties of pears grown in Michigan, as outlined in the Pear Spraying Schedule. An extra pre-blossom spray may be necessary on scab-susceptible varieties. Bordeaux is recommended as a fungicide on pear because it is effective against scab, compatible with summer oils, and has some value in preventing infection of fire blight.

Lime-sulfur has been generally used in some localities in the state, giving satisfactory control. Use of this material, however, in the after-bloom applications may result in injury – especially when it is followed too closely with a summer oil for psylla control. If lime-sulfur is preferred, it is suggested that it be used at 2 gallons in 100 gallons in spray in the pre-blossom applications. If scab is believed to be well-controlled, elemental sulfur or ferbam can be substituted for the lime-sulfur in the after-bloom sprays. (In Oregon, continued use of ferbam on pears has resulted in higher yields, as compared to continued use of wettable sulfurs.)

FIRE BLIGHT OF APPLE AND PEAR

The bacteria causing fire blight live over winter in hold-over cankers. These bacteria gain entrance through open blossoms, young leaves, and wounds caused by insects or pruning tools.

SUGGESTIONS FOR CONTROL

Control is accomplished by (1) cutting out infected parts and removing the source of bacteria, as much as possible from the orchard, (2) protecting the susceptible blossoms by spraying with bordeaux or antibiotics, (3) reducing the population of sucking insects during an epidemic, (4) keeping trees on the starvation side with a reduced nitrogen supply, and (5) using resistant varieties.

Cutting out infected parts—Regardless of other measures, all blighted parts should be cut out and removed from the orchard dur-

ing the dormant season. When trees are dormant there is no danger of spreading the disease with pruning tools. The bark should be removed for 3 inches above and below, and for 1 inch along the sides of any visible signs of the canker. Blighted twigs and branches should likewise be cut off 3 inches or more below any visible sign of the disease.

Summer cutting of fire blight-infected twigs and branches is a good practice in young orchards. The vigorous growth made by young trees makes them susceptible to the disease. Fire blight spreads rapidly in vigorously growing twigs and branches, and the bacteria may travel through the branches to the trunk in a short time, causing serious injury.

Summer cutting of fire blight is not recommended as a general practice in bearing orchards. It is an expensive operation, time-consuming, and requires experienced help. On the other hand, a small amount of blight may be quickly dispatched by summer cutting. The biggest problem of summer cutting is the uncertainty as to how far the infection extends past the last visible indication of blight. In general, cut 12 to 14 inches past the last indication of infection. During the summer, pruning tools and wounds should be disinfected immediately after each cut. Blighted branches are sometimes broken off without disinfecting. This method has not received experimental analysis, but seems sound, providing dry weather maintains for 3 days after breaking the branches. Water sprouts should be removed early to prevent the disease from infecting them and getting into the main limbs and trunks.

Blossom sprays—A 2-6-100 bordeaux spray applied when one-fourth to one-half of the blossoms are open is valuable as a blight preventive and should be applied on susceptible varieties when the disease is persistent. This spray also has considerable value in preventing scab infection during the full-bloom period.

Bordeaux sprays as weak as ½-½-100 applied oftener during bloom have been as effective in California and have resulted in less russeting.

Zineb has not proved equal to bordeaux for the control of fire blight.

Antibiotic sprays for blossom blight control—Several antibiotic materials will kill or prevent growth of the fire blight bacteria. Streptomycin offers the most promise. At 100 parts per million concentration, streptomycin definitely prevents new infections over a 4-day period, allowing one day back action or eradication and three days of protec-

tion. By preventing many of the infections which are likely to occur during the open-blossom stage, blight may be held down to a negligible amount for the rest of the season. Phenomenal results have been obtained when conditions favored control. Experiments in Michigan in 1954 gave variable results, possibly resulting from infections occuring after the blossom stage was past. Sprays applied at 4-day intervals throughout bloom should prevent almost all blossom infection. Two sprays, one at 20-30 per cent open blossom and another at full bloom have given exceptional results under some conditions and are suggested for trial as a minimum program.

Rains or high humidity when temperatures are above 60° F. appear necessary for blossom infection. Severe blight epidemics have occurred only when these conditions prevailed, according to W. D. Mills of Cornell University who has correlated blight epidemics with weather records in New York. Experiments are yet to determine whether this information can be used as a guide for effective timing of antibiotic applications. More accurate information on timing is desirable, as the limiting factor in the use of these new materials is their present cost.

BROWN ROT OF STONE FRUITS

Brown rot is generally the most destructive disease of peach, plum and sweet cherry. The fungus lives over winter in the mummied fruits that remain on the tree or on those that fall to the ground. The very small cankers, almost undetectable, on 2-year-old wood sometimes produce spores during wet springs. Spores are present in the orchard soon after growth starts and throughout the season. The fungus infects blossoms and fruit and may enter twigs through the stems, killing the twigs and leaves. The disease is most familiar as a fruit rot. The rather firm rot on the fruit is first seen as a small brown spot, but soon involves the entire fruit. Powdery spore masses, of light brown or gray color, finally appear on the rotted areas. The rotted fruits frequently remain attached to the twigs, appearing as dried or mummied fruit.

Mummies in the trees—In reality a mummied peach is filled with fungous tissue. This mummied mass of fungus lives over winter, hanging on the trees and looks as innocent as a dried fruit. With spring or summer rains at moderate temperatures, the fungus tissue in the mummy becomes active, producing millions of spores on the surface of the mummy. These masses of dust-like spores are readily scattered

around by air currents, and so many spores are produced that some are bound to land on susceptible blossoms.

Mummies fallen to the ground—Mummies which fall to the ground and become partially buried, produce mushroom-like fruiting bodies which are ripe and also give off clouds of spores amounting to billions of spores at blossom time.

Blossom blight—When wet weather occurs during blossoming, the brown rot spores infect and kill the blossoms. The blighted blossoms remain attached, hanging limp and blasted. They lose their shape, become gummy and sticky in damp weather and are the source of additional thousands of brown rot spores at fruit ripening time.

At the base of the blossom the fungus enters the twig, resulting in a small twig infection or canker. These cankers sometimes produce spores the following spring and are another source of infection at blossom time.

BROWN ROT OF PEACH

Serious losses from fruit rot are expected during wet harvest seasons. Unless the disease is adequately controlled in the orchard, the losses during transportation, on the market and in the home may be so severe that buyers drop out of the market – and prices drop accordingly.

This disease is characterized by large numbers of spores which are produced from several sources. Late-summer sprays alone did not give adequate control when heavy spore-loads were present. This is especially evident in regard to fruit rot in the hands of the dealer and the consumer, after the fruit has left the grower's premises. Following are the few simple facts the grower should know to carry out control measures intelligently:

Sources of brown rot spores—

1. The previous year's mummies (dried rotted peaches) hanging in the trees produce spores during every wet period in the spring and summer. This is one source of blossom and fruit infection.
2. Mummies which fall to the ground and become half buried produce countless numbers of spores from small mushroom-like fruiting bodies during blossom time only.
3. Infected blossoms (blossom blight) stick to the twigs and during each wet period in the summer produce spores to be deposited on developing fruit.

4. Cankers resulting from the previous year's blighted blossoms are possible sources of spores.

5. Spores are produced also on currently rotted fruits on the tree.

Infection possibilities—Open blossoms are readily infected during wet weather. Blossoms are especially susceptible during the first 5 days after opening. Only a little rain and high humidity are necessary for blossom infection. Green fruits are resistant but can be infected through fresh insect wounds. Ripe fruits can be infected directly but slight bruises or any insect wound gives especially ready entrance to the brown rot fungus.

STRATEGY IN BROWN ROT CONTROL

Protect against brown rot especially during the two susceptible periods (1) when blossoms are first open, and (2) during fruit ripening. Accomplish control through sanitation to keep down the spore load, sprays to keep the spores from germinating, and a good insect control program to prevent wounded fruit.

Sanitation practices—This consists of removing all possible fallen fruit from the orchard and removing mummies from the trees. Disking the ground before blossom time prevents much of the mushroom formation from the half-buried mummies. Continuous removal of rotten fruit is of special value if begun with the first crop in the orchard, and if there is isolation from other orchards. It may take several years to realize the maximum results from sanitation if precautions have lapsed. Complete sanitation is generally practical only for the small, isolated orchards but removing the mummies from the trees is feasible for all growers. It is impossible from a practical standpoint to locate and prune out all of the cankers resulting from the previous year's blossom infections as they are too small to be seen. Presence of last year's cankers requires a more rigid spray program to prevent blossom blight and fruit rot. Presence of blighted blossoms requires a more rigid spray program to prevent fruit rot.

Spray practices—Complete control of blossom blight is now recognized as the best insurance for successful fruit protection later in the season. Four complete sprays during the first 10-day period of opening blossoms generally gives the control desired. It is believed sprays or dusts are most effective when applied just before or during rains or periods of high moisture.

Special efforts are necessary during ripening to cover the entire surface of all fruits. Spreaders should be used in the later cover sprays.

Pruning—Trees should be "pruned" to allow spraying and dusting equipment to get down the row when the trees are loaded and bent over with fruit. The late sprays are very important in reducing transportation and storage rot. Also, open up the trees where necessary to allow complete spray penetration.

Spray materials—Several materials are useful in brown rot control. Lime-sulfur can be used in the Late Pink and Early Blossom sprays. Elemental sulfur or the dithiocarbamates may be applied in Full Bloom. Sulfur dusts applied early in a rain period are of great value in rapidly covering blossoms at a strategic time. Phygon has given good control of brown rot in the bloom sprays in Illinois and Indiana. Good control of curculio, tarnished plant bug and oriental fruit moth are requisites also to final brown rot control.

Paste or wettable sulfurs or captan are indicated for sprays when trees are in full foliage. Lime-sulfur, 2 quarts in 100 gallons of spray, appears to offer slightly superior fruit protection during the late pre-harvest sprays. A combination of 2 to 4 pounds of paste or wettable sulfur and 2 quarts of lime-sulfur has been used in the late sprays with good results. Spreaders used in the late sprays are desirable for complete wetting and coverage of the fruits.

BROWN ROT ON PLUMS AND CHERRIES

SUGGESTIONS FOR CONTROL

The control of brown rot on plums is similar to that on peaches. It is important to thin plums so that no two fruits will touch when ripe. Captan applied previous to picking appears to give superior fruit protection for plums and sweet cherries.

Blossom blight caused by the common American brown rot (*Sclertinia fructicola*) has seriously retarded production of sweet and sour cherries in several localities in recent years. An early bloom spray of bordeaux 6-8-100, and an open blossom application of elemental sulfur sprays or dusts, should be applied to sweet and sour cherries with brown rot histories. Phygon may be used also in bloom. Special sprays are suggested for European brown rot (see below).

Fruit rot is not a serious problem on sour cherries except in some cases of delayed harvesting or following wind whipping. Additional spray protection may be needed in rare instances. Sweet cherries, however, require protection against brown rot during the pre-harvest period. Ferbam plus an oil-type spreader, or Captan alone, are probably the best materials for control of sour cherry fruit rot.

EUROPEAN-BROWN-ROT BLOSSOM BLIGHT ON CHERRIES

Within the past few years, severe blossom blight has been observed in certain northern cherry orchards near the shore of Lake Michigan. This disease is characterized by numerous dead spurs scattered throughout the tree. These dead spurs are readily noticed in mid-June by the dead, brown leaves and flowers which remain attached to the blighted spurs. The casual fungus is *Sclerotinia laxa,* "European Brown Rot". This disease is more destructive in killing blossoms and spurs than in rotting fruit. The fungus can be seen shortly before blossom time as small, cushiony, cottony, white tufts on the dead spurs and bud scales.

Good control of this disease has been achieved by combining eradicative and protective sprays. The eradicative spray should be applied approximately two weeks before the buds break, about April 1 to 15. Experiments indicate that 3 pounds of monocalcium arsenite is best for this spray. Another protective spray of bordeaux 6-8-100 should be applied in early bloom. Several sprays of Phygon at ½ pound per 100 gallons applied during bloom, have given good control also in some experiments.

"Monocalcium arsenite" is available from the Pittsburgh Plate Glass Company, Corona Chemical Division, Milwaukee, Wisconsin, or through their dealers. This chemical is not readily available and should be ordered well in advance of the growing season.

PEACH CANKER *(Valsa leucostoma* and *Valsa cincta)*

Peach canker is caused by a fungus which invades local areas affecting twigs, branches and trunks of peach and other stone fruit trees. The fungus gains entrance through winter injuries, pruning wounds, dead twigs, brown-rot lesions, and the like – and is commonly found in poorly developed crotches. The disease is kept in check by surgery, pruning, and cultural practices which promote early maturity of the tree, prevent winter injury, and promote quick healing of wounds. (*Sprays do not prevent or eliminate cankers.*)

SUGGESTIONS FOR CONTROL

Pruning—Delay pruning until about March 1 or later. Earlier pruning may result in more cankers. Wounds made in fall and winter remain open to infection for longer periods. Canker enlargement and spread occurs during the dormant season. Make pruning cuts close and leave no stubs. This promotes fast healing of wounds. Remove all deadwood at pruning time and make the pruning cuts back to

live, active branches and the cuts will heal over readily. Check trees again when growth starts to see if any deadwood was overlooked. Remove and burn all prunings promptly. Where possible remove all cankered branches entirely by cutting back to a live branch.

Surgery—When the canker does not go over half way around a large limb or trunk, trim out the cankers after tree growth starts. Remove the dead area of the canker and extend the wound into clean live wood, using a knife or chisel. Make the sides of the wound straight and smooth. Bring the wound to a point at the top and bottom for effective healing. Swab the wound immediately with bichloride of mercury solution (1-1000 made by dissolving one half-gram tablet in a pint of water). Coat the wound with a non-injurious wound dressing – such as Corona Wound Dressing, shellac, a black gilsonite-asphalt paint, or one of the water-asphalt emulsions sold as grafting compounds. White lead paint without turpentine is also satisfactory.

Cultural practices—It is a proven rule that the amount of canker is increased the later cultivation is continued into the summer and the longer the sowing of the cover crop is delayed. Forcing of tree growth by cultivation and fertilization should be accomplished early in the season, and the tree growth should be checked for early maturity by sowing the cover crop before July 15. Trees treated in this way are less subject to cankers. This is perhaps more important on the heavy soils where growth is luxuriant and canker is more severe.

CHERRY LEAF SPOT

SUGGESTIONS FOR CONTROL

Cherry leaf spot can be controlled by spraying. Four applications of a fixed copper fungicide – applied at Petal Fall, 10 days after Petal Fall, 20 days after Petal Fall, and immediately after harvest – have given good control in experimental work over a 16-year period.

Ferbam, Crag Fruit Fungicide 341 (glyodin) and captan have given good control of leaf spot in several seasons of testing in Michigan.

Thorough applications are necessary. At least 5 to 7 gallons of spray are required to cover an average-sized, bearing sour cherry tree.

The leaf-spot fungus lives over winter in the old leaves on the ground. The fungus develops in the old leaves during the winter forming spores that are present in the old leaves and ready for discharge during a period of 6 to 7 weeks after growth starts. These spores are discharged only when rains occur. Keeping the foliage covered with a fungicide during this early spore-discharge-period will

prevent the infections from which summer spores develop, and will aid in keeping the foliage on the trees throughout the summer.

Proprietary copper materials plus lime, or 2-3-100 bordeaux, have had extensive testing over a period of years in Michigan and are recommended. The best dosage appears to be 3 pounds of 25% copper, or its equivalent plus 3 pounds of lime per 100 gallons of spray. A mixture of half-and-half proprietary copper and elemental sulfur plus lime (1½ pounds of 25% proprietary copper, 3 pounds elemental sulfur and 3 pounds of lime) gives satisfactory leaf spot control on sweet cherry with less injury than full strength copper alone.

Wettable sulfur alone usually gives poor leaf spot control. Ferbam or captan give good results with no injury to sweet cherry and are of value for controlling both leaf spot and brown rot.

Timing of sprays is especially important in leaf-spot control. The first spray should be applied immediately after most of the petals have fallen. The First Cover spray should be applied within 10 to 14 days of the Petal Fall spray, and the Second Cover preferably 10 days and not more than 14 days after the First Cover spray.

Always apply the After-Harvest spray. This spray is important in preventing late leaf-spot infection, and late summer defoliation. Overwintering leaf-spot spores develop in greater numbers in late-infected leaves, to increase the difficulty of control the following year. The maintenance of good foliage throughout the season helps to keep the trees in a good vigorous condition to withstand winter temperatures.

Cherry leaf spot can be checked after infection has occurred. A thorough application of a copper spray to wet all of the surfaces of the leaves – soon after the characteristic round purple-to-brown spots appear – will check further development of the disease and will prevent dropping of many of the infected leaves.

Actidione at 2 parts per million will also eradicate active leaf-spot infection. However, it has not been approved for use before harvest on bearing trees.

Do not use copper on trees showing severe damage from black cherry aphids as heavy defoliation is likely to result. Ferbam or captan would be preferable under the circumstances.

BACTERIAL SPOT OF STONE FRUITS

Bacterial spot is serious on peach and plum. It is not readily controlled but damage is less to trees in good vigor. Bacterial spot is seen most readily on leaves and fruit as small, angular, dark-brown dead spots. It is distinguished from other injuries by the small size

and angular shape of the spots – which on peach leaves do not fall out readily. The infections first appear as small water-soaked spots. Indications of bacterial ooze can be found occasionally on very close examination of fresh infections. Infected leaves may turn yellow and drop during the summer.

SUGGESTIONS FOR CONTROL

Five or six sprays of zinc sulfate-lime, 8-8-100 (page 22), beginning with the Petal Fall spray and repeated at 10- to 14-day intervals prevents much of the injury. This program is not effective when started later in the season. The bacteria over-winter in a few inconspicuous cankers on the twigs, and possibly within infected buds. Cultural and fertilizer practices which promote tree vigor aid in preventing much of the heavy defoliation resulting from this disease.

PEACH LEAF CURL

The leaf curl fungus lives over harmlessly throughout most of the year on the waxy coating of peach twigs. It attacks leaves in the spring when protracted cold wet periods occur. If the disease becomes established in the leaves, it is too late to spray. The unseen but ever present fungus must be destroyed by a dormant spray before the buds break and growth starts in the spring.

The only control for peach leaf curl is the application of a dormant spray. The spray may be applied either in the fall or spring. If the spray is applied in the fall, use bordeaux 6-8-100 or 1½ to 2 pounds of ferbam per 100 gallons. If applied in the spring, use either 6-8-100 bordeaux, ½ percent Elgetol or Krenite, 1½ pounds of ferbam or 5 gallons of liquid lime-sulfur to 100 gallons of spray.

CORYNEUM BLIGHT OF PEACH

Coryneum blight is a relatively rare disease of peach in Michigan. It has never been found in Berrien or Van Buren counties and has been troublesome in past years in only a few outlying orchards on the fringe of the main peach belt. The fungus produces lesions on the leaves, fruits and green shoots. These lesions have a characteristic definite red ring around a cream colored center. Infected leaf tissue falls out leaving a clean, round hole. The fungus infects fruit buds during the dormant season and the infected area around the dead bud produces copius gum. If the disease is believed present, specimens should be forwarded to the Botany and Plant Pathology Department at Michigan State College for identification. The disease is controlled

by strong bordeaux sprays in the early fall and by ferbam sprays in early spring.

VIRUS DISEASES OF STONE FRUITS

Virus diseases are caused by plant proteins or living organisms too small to be seen with the microscope. They are spread from plant to plant by sucking insects, or continued by propagation using bud wood from diseased trees. The familiar peach diseases are yellows, little peach, and red suture – while the disease previously known as "physiological yellows" of cherry is caused by virus and is now called "cherry yellows." Certain varieties of plums may be symptomless carriers of peach yellows and little peach. Wild chokecherry carries "X" disease of peach and cherry. Damson plum sometimes carries a disease known as "prune dwarf" which reacts severely on Italian prune, and produces a disease on peach similar to rosette mosaic.

VIRUS DISEASES OF PEACH

Peach yellows, little peach, and red suture are possibly spread by only one insect – a leafhopper found on plums, *Macropsis trimaculata.* During early summer this insect is present as a wingless nymph, and can be readily controlled by one spray of nicotine sulfate or DDT applied in mid-June. The spray is advisable in orchards where peach viruses are a serious problem, and should also be applied to nearby plum trees.

Rosette mosaic, a rather rare peach disease, is carried over in the soil. Infected peach trees should be removed but the area should not be replanted to peaches for several years.

CHERRY YELLOWS

Cherry yellows is a virus disease affecting sour cherry. Growers should become acquainted with its symptoms, so that they can distinguish it from leaf spot, spray, or drought injury.

Cherry yellows is sometimes mistaken for leaf spot or for copper injury. The symptoms are yellow foliage, large leaves, premature defoliation, a progressive reduction of spur growth, production of fruit on lateral buds, and reduced yields of large-sized fruit. The production of fruit on lateral buds results in long, bare spaces on the twigs with the terminal bud the only growing point.

Defoliation may occur as early as 2 to 3 weeks after bloom and as late as after harvest. Most of the defoliation occurs during June and early July, and the first leaves formed are the first to fall. The fallen

leaves vary in color from all-green to all-yellow. Most of the fallen leaves, however, are mottled green-and-yellow; an outstanding characteristic is yellow leaves with a definite green midrib and veins. Fallen leaves infected with cherry yellows disease differ from foliage attacked by leaf spot, in that they do not have any purple circular spots or brown dead areas. Cherry yellows occurs on individual trees scattered through the orchard, while leaf spot occurs more uniformly on all trees. Leaf-spot-infected foliage is more of a uniform yellow color and does not have the green midrib and veins.

Copper-injured foliage differs from cherry yellows in that the former occurs later in the season, especially after rainy and foggy periods. Copper-injured leaves are usually light-yellow in color, and often have one or more large irregular dead areas in the leaf tissue.

SUGGESTIONS FOR CONTROL

In orchards where the disease is well-established, the present recommendations are to keep the orchard until it becomes unprofitable, and then remove the entire orchard. If clean-up campaigns are considered, they should be on a community basis. However, clean-ups should be considered for the isolated orchard. The practice of removing only the seriously diseased trees in heavily infected bearing orchards and replanting is not practical – because the replanted trees may become diseased within a year or two. Where only a few trees in an orchard are diseased, they should be removed as soon as discovered. When planting new orchards, purchase trees only from nurseries propagating from disease-free stock. The young orchard should be examined once a week during the months of June and July, and all diseased trees which are found removed immediately.

RING SPOT VIRUS

The ring spot type of virus is a wide-spread contaminant of stone fruits. Trees can carry the virus without showing symptoms and perhaps with little effect on yield. However, a tree with recently acquired ring spot virus displays severe shock symptoms from which it later recovers and resumes its normal habit of growth and fruit production. Shock symptoms are frequently evident first on one side of a tree or in a single limb. Leaves are smaller than normal and many of them show dead spots. The faint yellowish rings surroundings the spots, from which the disease gets its name, are seldom seen. Even blossoms and spurs are sometimes killed. Normal growth develops after the

initial shock. The unaffected limbs will probably show shock symptoms the next year. During shock the yield of a tree drops as few fruits are produced and it may take several years for the tree to resume full normal production.

A few years ago nearly all the cherry trees planted carried ring spot virus and the shock symptoms were rarely seen. With the more recent introduction of virus-free nursery stock, ring- spot shock can be expected more frequently. In Michigan ring spot is most prevalent in cherry trees. The indications are that this virus is not present to any extent in Michigan peach trees.

"X" DISEASE

"X" disease is a virus disease resulting in degeneration of peach, cherry and plum. It first became established in the eastern United States and spread rapidly across the country on chokecherries. In Michigan the disease does not appear to spread to the stone fruits unless they are growing adjacent to diseased chokecherries.

The chokecherry is a low-growing shrub or bush (rarely a small tree) and can be distinguished from the harmless black cherry tree by the size, the character of the bark, the leaves, the time of blossoming and of fruit ripening. Chokecherries have a dull gray-brown bark. Their leaves have more ouststanding veins on the underside than do the black cherries. Chokecherry fruit ripens earlier than black cherry and does not have the persistent calyx found on black cherry. Chokecherries blossom one week earlier than black cherries. Locate and mark the chokecherries when they are in full bloom then eradicate them by sprays in early July.

SUGGESTIONS FOR CONTROL

"X" disease is well established on chokecherries in Michigan, but the disease does not spread from them to peaches or cherries when separated for a distance of 500 feet.

Chokecherries are eradicated by completely grubbing them out, which requires getting rid of all the runner-like roots or by spraying with weed-killing chemicals. If the weed killers are applied in early July, the spray penetrates the leaves and travels down to the roots, killing them as well. Sprays are not so effective in killing the roots when applied before or after this date. Either Atlacide (a combination of sodium chlorate and calcium chloride) or Ammate(ammonium sulfamate) should be applied at the rate of ¾ pound to a gallon of water as a spray to thoroughly wet all of the chokecherry leaves.

VIRUS CONTROL BY TREE REMOVAL PROGRAM AND NURSERY REGULATION

Michigan State College and the Michigan Department of Agriculture are cooperating with the nurserymen to help them produce trees known to be free from virus diseases.

Michigan nurserymen select propagation wood under State Department supervision and inspection, following practices assuring freedom from virus diseases.

There is still a possibility that a small percentage of cherry yellows and ring spot is present from rootstock contamination. Rootstocks used by nurserymen are grown mostly in the western states. Improvement programs on rootstocks are in progress.

It is established by law that growers must remove trees showing evidence of harmful virus disease. Inspection and quarantine for these diseases is under the control of the Michigan Department of Agriculture.

SMALL FRUIT DISEASES

BLACK ROT OF GRAPES

Black rot of grapes attacks the leaves, tendrils, fruit, and canes. The disease carries over on infected plant parts, and black-rot spores are present soon after growth starts in the spring. Black rot first shows itself on the leaves in the form of small brown spots with black margins. The black specks seen in the brown area near the margins of the spots are fruiting bodies. These fruiting bodies exude spores that infect other leaves, tendrils, canes and fruit. Infected fruits shrivel, turn black, and become covered with many small, pimple-like fruiting bodies which are filled with spores.

SUGGESTIONS FOR CONTROL

Black rot is rarely a problem in vineyards which are consistently and properly sprayed year after year. The early sprays are important, because the disease is seldom controlled economically after early infections become established. Begin spraying for black rot when the new shoots are 4 to 6 inches long. The Grape Spraying Schedule (see page 66) provides for a complete spray coverage every 10 to 14 days until the berries touch in the cluster.

Formerly, homemade bordeaux – 8-8-100 or 6-8-100 – was necessary for success in controlling black rot, under severe conditions. Homemade bordeaux sticks better and offers longer protection than the

proprietary copper sprays. Ferbam has been found to control black rot equally as well as bordeaux with less injury, giving better foliage and yields. Ferbam is not as efficient as bordeaux for the control of downy mildew.

DOWNY MILDEW OF GRAPES

Downy mildew on leaves of grapes can be recognized by the irregular shape of the infected areas, which lack a definite margin. Also, a downy, mold-like growth is frequently present on the underside of the lesions. Infected berries become lead-colored and shell off. Sometimes the berries are covered with a white, downy mold. The Concord grape is fairly resistant to downy mildew – but Delaware, Fredonia, Niagara and certain other varieties are susceptible. On mildew susceptible varieties, ferbam may be used in early sprays for the control of black rot, using bordeaux 6-6-100 or fixed copper in later sprays.

DEAD ARM OF GRAPES

This disease is responsible for the great loss of bearing wood in many vineyards. To date, there are no resistant varieties, Niagara is considered the least susceptible and Concord the most. This disease attacks the above-ground parts of the vine, slowly killing the canes. Affected arms show dwarfed, yellow leaves in the early season, but later the vine *appears to recover.*

Actually there are two phases of the dead arm disease (1) infections on the current growth and (2) necrotic lesions in the trunk and arms.

The significance of infected current growth is the overwintering of the fungus in these shoots. The following spring these shoot lesions exude many spores which in turn infect the new seasonal growth, and pruning wounds.

The necrotic lesions are found in pruning wounds and stubs on the trunk or heavier arms. Such infections lead to girdling and eventual death of the arms or even the entire vine.

SUGGESTIONS FOR CONTROL

Good control of shoot infection is possible by applying a *delayed dormant* of liquid lime-sulfur, 10 gallons per 100 gallons of spray. Since the vines are bare at this time, care in application is necessary for thorough coverage. Then continue the spray program with the suggested schedule for black rot control. Sprays will not control established infections.

The normal secondary branches which grow after the bloom period obscure the symptoms of the disease, therefore, diseased vines are difficult to locate at pruning time. Mark the affected vines *early* in the season, remove them or cut them off at pruning time – well below the last visible sign of the dry heart rot in the trunk or preferably at the ground level – and allow a renewal sprout to replace the old trunk.

MUMMYBERRY OF BLUEBERRY

The disease is first noticeable on certain succulent new shoots that wilt, turn brown, and die. The fungus is dormant within berries infected the previous season which have laid on the ground all winter. Early in the spring, the fungus becomes active, forming little mushrooms on the mummied berries. These mushrooms contain spores that shoot into the air and are carried upward by air currents, some of them landing on the new shoots and causing infections. In turn, the blighted shoots become covered with the mold spores which are carried to blossoms and young fruits during wet or rainy conditions. The infected fruit is tan or cream, instead of a normal green, and becomes hard and worthless. There is considerable direct loss, depending on the number of berries infected and further indirect loss as these spoiled berries make picking and sorting more difficult.

It has been observed that the fungus does not overwinter in cankers or blighted shoots in its life cycle. The primary inoculum consists of ascospores discharged from the small mushroom-like fruiting bodies found on fallen berries in the spring when the blueberry plants are breaking dormancy. Primary infection is concerned with new shoot growth. The blighted shoots furnish secondary inoculum which infects the blossoms. If all primary infection could be controlled, there would be no secondary inoculum. Therefore, a control program based on the eradication of the primary inoculum in the spring is suggested in the Blueberry Spraying Schedule (page 70).

STUNT OF BLUEBERRY

Stunt is a virus disease which is not curable. The general effects of the disease are a stunting of basal shoots, abnormal number of short side shoots on bearing wood with small leaves that have yellowish margins. Infected bushes produce small berries of an inferior quality and when ripe adhere tightly to the stems.

Frequent inspection of fields and prompt removal of all bushes showing symptoms of stunt are recommended as the only control measures.

LEAF VARIEGATION OF BLUEBERRY

For years leaf variegation has been considered to be a genetic abnormality. Recently, investigators in New Jersey proved leaf variegation to be of virus origin.

The symptoms of this disease are quite striking; affected bushes bear leaves showing various variegated patterns of yellow, green and red hues. Variegation is evident in June and the leaves turn prematurely red by early fall.

Since leaf variegation is a virus disease the immediate removal of infected bushes from the planting is recommended as a control.

III. Insects: Life Histories and Control Practices

APPLE MAGGOT

Control of apple maggot is obtained by two or more sprays applied after the adult flies emerge. The date for the first apple maggot spray is determined each year by the Department of Entomology. Lead arsenate, DDT, or methoxychlor are effective materials. A corrective ingredient against foliage burn should be used with lead arsenate sprays.

Removal of infested drop-fruits from beneath the trees before the maggots emerge is important since this prevents a build up in numbers. Begin picking up drops after the third week in July. Infested varieties must be picked up each week. Pile the infested fruit in an out-of-the-way spot and then the following spring treat with 1 gallon of used crankcase oil for each 10 square feet of pile. Other methods of disposing of infested fruit will occur to growers, but one should make sure that such methods will destroy the maggots.

Bait traps to determine presence of apple maggots in individual orchards are baited with a scant teaspoonful of household ammonia in a quart of soapy water. Traps may be any small clean container which can be hung in the trees. (Instructions for making an apple maggot trap can be found in Michigan Extension Folder F-82.)

The single generation of flies responsible for maggot-infested apples appears in late June or early in July. The flies feed by scrubbing the surface of the leaves and fruit with their mouth parts. Feeding continues about a week before the eggs are laid. It is too late to control apple maggot after the eggs are laid. The insecticides suggested in the spraying calendar are to destroy adult maggot flies, before they deposit eggs in the fruit.

The apple and blueberry maggot are the same insect and are native to Michigan. Before spraying of orchards became general practice, the apple maggot, often called "railroad worm" because of its winding tunnels in the fruit, was the most important apple pest in Michigan. Damage from apple maggot has increased in recent years and has caused serious loss to some Michigan growers.

APHIDS

Control of most aphids by spraying is accomplished at two periods. The rosy apple aphid and the black cherry aphid may be controlled by dormant sprays which destroy the overwintering eggs. Dormant applications to successfully control aphids must be very thorough. DN compounds are most generally used for dormant aphid sprays. They should be applied at the manufacturer's recommendations.

Some combinations of DN with oil sprays containing more than 2 per cent oil have caused injury. DN-289 and Elgetol-318 are not compatible with spray oils.

The second period when aphids are best controlled is in the pre-blossom sprays. At this time all aphids that are present will be destroyed if wetted by any of the organic phosphates. Nicotine sulfate (40%) at 1 pint with 1 pound of lime in 100 gallons of spray, and a wetting agent will also destroy aphids. Control of aphids always requires very careful and thorough applications.

Rosy apple aphids must be controlled in the dormant or pre-blossom period if damage by this pest is to be prevented.

The green apple aphid often appears in July or later when it fouls the fruit and injures new foliage. Since the green apple aphid is continually migrating from tree to tree and from orchard to orchard, dormant and pre-blossom applications will not protect apples from these mid-summer infestations. The organic phosphates will destroy green aphids when they appear at this time if they are wetted by these materials.

Most of the aphids, which are a problem on fruit, overwinter in the egg stage as shiny black eggs, which hatch just as the buds burst. The reproductive power of these aphids is so great that any of them may become epidermic when conditions are favorable. Spraying for aphid control should be on the basis of the history of infestation in any orchard, rather than on the number of eggs present.

Condition of the trees have much to do with the aphid problem. Trees that are unpruned, with many waterspouts, always encourage

aphid survival and increase. Orchard management of the trees to make possible thorough spray applications is a must for effective aphid control.

CHERRY FRUIT FLY

Control of cherry fruit fly, the insect responsible for maggots in Cherries, is with lead arsenate, or methoxychlor. These protective sprays are applied at the time the adult flies are feeding, before they begin egg laying. The exact spraying dates are announced each year by the Department of Entomology. Lead arsenate is most generally used for cherries that are processed because the residues are removed. Methoxychlor, or rotenone which leaves no dangerous residue is suggested for cherries sold as fresh fruit.

Spray with one of the following when you receive the spray notice.

a. Lead arsenate, 2 pounds in 100 gallons (2 sprays, 10-day intervals).
b. Methoxychlor, 3 pounds in 100 gallons (3 sprays, 7-day intervals).
c. Rotenone, 3 pounds ground derris or cube containing 4% rotenone in 100 gallons 3 sprays, 7-day intervals.

Adult fruit flies are strikingly marked. They deposit eggs inside the cherries just as the fruit begins to ripen. These eggs hatch into maggots which develop and feed inside of the ripening cherries. When mature, the maggots leave the cherries and change into the resting stage (pupa) and remain in the soil until the following June, when they emerge as flies and again lay eggs.

Wild choke and pin cherries in close proximity to cherry orchards are commonly infested with cherry maggots. These have been believed to be a source of contamination. Tests over several seasons, to determine if there is a pass over of fruit fly maggots from wild cherries to cultivated cherries, have so far been negative.

State and Federal laws condemn cherries in orchards found to be infested with cherry maggots. Cherries must be protected from maggot infestations each season.

CODLING MOTH

Control of codling moth is accomplished by sanitary measures such as destroying the overwintering places, banding trees, picking up and destroying infested drops and spraying. While DDT sprays have greatly simplified control of codling moth, supplementary methods of

control remain valuable aids. Lead arsenate was depended on for many years to control codling moth, but requires more frequent applications than the more effective DDT.

Emphasis on control of codling moth should be in the early season sprays, directed against the first brood of codling moths. This involves coverage at the time of Petal Fall and at short intervals during the period of rapid growth immediately after the Petal Fall spray. If these sprays are properly timed and thorough, they may control codling moth so completely that second brood sprays are not required.

The time to spray for the second brood of codling moth is determined by the Department of Entomology and announced through public agencies. Second brood sprays should be applied to all orchards that have wormy apples. While these late (second brood) sprays will never substitute for the first brood sprays they are often necessary where the first brood sprays have failed. Under such conditions sprays are necessary to reduce further codling moth damage to the fruit.

Codling moths attack apples, pears, and quinces and sometimes peaches and plums, when interplanted with apples. The moths first appear in the orchards soon after calyx time, and may be present in varying numbers until harvest. There are two broods each season in Michigan. The peak of moth activity of the first brood occurs from June 12-20, while the second brood moths appear between July 20-August 1. Severity of codling moth attack is greatly influenced by the weather. Hot, dry seasons always result in more injury from codling moth. The season of 1954 favored codling moth and it caused damage in many Michigan orchards.

FRUIT TREE LEAF ROLLER

Control of the fruit tree leaf roller can be obtained with a single application of 1 pound of 15% wettable parathion in 100 gallons of spray, applied when the leaves are well out. Other organic phosphates are also known to be effective against this pest. In the past 6% dormant oils have been used to destroy the overwintering eggs, but such oil sprays may sometimes result in some injury to fruit trees.

Fruit tree leaf rollers are green, active, black-headed caterpillars that cause ragged foliage about calyx time and shortly after. They may also cause some fruit drop and often produce large and deep russeted scars on the apples. There is but one generation each year. The winter is passed in the flattened, reddish purple egg masses, of about ¼ to ½ inch in diameter on the twigs and branches.

Fruit tree leaf rollers are cyclic in abundance and have been generally more prevalent in the northern fruit tree areas of Michigan. They have caused only sporadic injury the past several seasons.

GRAPE BERRY MOTH AND GRAPE LEAFHOPPER

Control of the grape berry moth and the grape leafhopper is considered together, and the spraying program is designed to take care of both insects.

A combined oil, arsenical, and nicotine program is highly effective against both grape berry moth and grape leafhoppers. Nicotine has given good control against the grape berry moth and grape leafhoppers. DDT has given improved control of berry moth, leafhoppers, and rose chafers on grapes. See Grape Spraying Schedule (page 66) for the suggested sprays. The first grape berry moth spray should be applied when the shoots are 4-6 inches long.

Use of properly designed covered booms improves the control of grape pests by insuring better coverage. Emphasis should be placed on the early sprays to control both of these pests.

The grape berry moth has three generations each year in Michigan. The first brood appears about the time the grapes bloom. Infestations are detected at this time by the small larval webs in the forming bunches at this stage. The second brood appears about the time the grapes are touching in the bunches. The third brood (usually August 10-23) is announced by the County Agricultural Agents in the grape growing section.

Grape leafhoppers move into the vineyards about a week before the grapes bloom, and several generations are produced on the grapes before frost. Unless controlled in the early sprays they can build up to great numbers and cause severe loss.

GRASSHOPPERS

Control of grasshoppers in orchards should be in late June or early July. The small hoppers are much easier to kill than if they are permitted to grow larger. Each of the following materials is effective:

a. Calcium arsenate spray, 5 pounds in 100 gallons.
b. Chlordane, 1 pound actual per acre, spray or dust.
c. Benzene hexachloride (0.3 pound of gamma isomer) per acre, spray or dust.
d. Toxaphene, 1 pound actual per acre, spray or dust.
e. Parathion, 15% wettable I pound in 100 gallons.

Be sure to use enough of a diluted material to give the actual quantity suggested per acre.

There is but one generation of grasshoppers each year in Michigan, but there are several kinds of grasshoppers that may do damage in orchards. Grasshoppers are cyclic in their abundance but should be watched by the fruit grower.

LEAFHOPPERS

Control of leafhoppers in orchards has been greatly simplified by the use of DDT in the first or second cover spray on apples. Nicotine sulfate has also given control at this time.

Leafhoppers are small yellowish-white insects that can run forward or sideways. Their four roof-like wings and agile movements distinguish them from other insects commonly found on apples. There are several kinds of leafhoppers on apples and several generations may develop each season. Some leafhoppers cause whitish areas on the foliage while other kinds cause the leaves to turn brown and curl downwards on the edges. This latter injury is often confused with green apple aphid injury. The almost universal use of DDT in orchards has greatly reduced the numbers of all leafhoppers.

MINEOLA MOTH

Control of this potential pest of cherries is obtained with dormant DN sprays which destroy the overwintering larvae.

Parathion sprays at each of the Green Tip, Pre-Blossom and Petal Fall sprays are also effective in preventing infested cherries at harvest.

The Mineola Moth is a native insect which was observed infesting cherries in northern orchards in 1950. It has fortunately not increased in intensity in Michigan cherry orchards. The insect passes the winter as minute hibernating larvae in crotches of twigs and spurs. The best time to detect its presence is in the early green-tip stage, when the larvae feed inside the swelling buds, spinning a silken web around the bud clusters as they feed.

The larvae are chocolate-brown in color and very active. There are two full generations each season, following the over-wintering larvae that feed on the buds. The larvae of the two summer generations bore into the cherries, some of them at picking time. These larvae have been found on the cherry lugs and in a few instances have gotten into processed cherries.

MITES

Control of the European red mite which overwinters in the egg stage may be obtained by thoroughly applied dormant oil sprays or by certain DN sprays.

The "two-spotted mite" (red spider), which is also a prominent orchard pest, is not controlled by dormant sprays, and summer outbreaks of the European red mite may also require summer control measures. All the organic phosphates kill mites wetted by them, and these materials also control other orchard pests.

Specific miticides are available that are designed for mite control exclusively. These materials have given effective mite control when thoroughly applied as recommended by the manufacturer. Growers should be sure when selecting a miticide that it is compatible with other materials they are using at the same time. Read the labels on all materials carefully.

There are two beliefs on how to control mites in orchards. Some growers and entomologists believe that mites should be controlled by preventive sprays applied throughout the season to prevent any mite build up. Other growers and entomologists believe that it is best to let the mites build up and then attack them when the trees show signs of damage. Control of mites can be obtained by both methods with the materials now available.

Weather conditions determine the rapidity of mite build up. Hot, dry weather favors build up of mites and injury by them. Vigorously growing trees are not affected by a moderate mite infestation, while trees low in vigor may show much more damage from mites.

Mite injury first shows as a whitening, bronzing, and crinkling of leaves. Mites and their eggs are more common on the under sides of the leaves. They can be readily seen with an ordinary hand lens. When mites cause serious foliage injury defoliation, poor size and color of fruit and fruit drop may be expected. General reduction of tree vigor will follow, with bud development and fruit production also retarded.

Female mites lay many eggs and a new generation will develop each 30 days. Mites increase tremendously in hot dry weather. Eggs of the European red mite are reddish, while eggs of the two-spotted mite are greenish. The European red mite spends most of its time on the tree, while the two-spotted mite migrates to and from the trees from many plants in the orchard cover.

Training the trees by proper pruning so that the under sides of

the leaves may be wetted by spray applications, is very important in mite control.

PEACHTREE BORER

Peachtree borers are controlled by DDT applied to the trunk below the crotches and at the ground level. Better results will follow if a special application is made to control this pest. The pressure of the spray rig should be reduced to about 150 pounds pressure and a solution of 3 pounds of 50% wettable DDT in 100 gallons should be drenched onto the trunks below the crotches down to the ground level. Two applications are suggested, the first about July 10 – followed by a second application 12-14 days later.

Paradichlorobenzene (PDB), applied about September 1, in a ring about the base of the tree is also effective. Keep the crystals at least an inch from the trunk and then cover the crystals all around each trunk with a mound of soil. The mounds should be removed after 30 days to avoid injury.

Use 1 ounce of PDB for trees 6 years or older; ¾ ounce for a 5-year tree; ½ ounce for a 4-year tree. Do not use PDB for trees younger than 4 years. Use the DDT wash instead.

(Ethelenedichloride emulsion is not recommended for borer control in Michigan.)

Peachtree borers are present in nearly every untreated orchard in Michigan. They girdle the trees at ground level and often limit the life of the tree. The borers spend the winter beneath the exuded gum near the ground level. In the spring they become active, complete their growth and pupate. The moths emerge from late June to August, and lay their eggs on the trunks shortly after they emerge.

LESSER PEACHTREE BORER

Control of this close relative of the peachtree borer is consideerd advisable by some growers. A combination spray of 1 pound of 50% wettable parathion in 100 gallons is effective. *Two applications are suggested and they must be applied earlier in the season than for the peachtree borer.*

Damage by the lesser peachtree borer follows any injury to the crotches and larger limbs and branches. The sprays to be effective must thoroughly drench the crotches and larger scaffold branches.

ORIENTAL FRUIT MOTH

The problem of control of oriental fruit moth in Michigan peach orchards varies from year to year depending upon the overwintering

survival of this insect, the past season's weather and the condition of growth of the trees in an orchard.

Where a grower desires to get the most complete control of this pest, as in the case of whole peaches grown for pickling, it is best to apply at least three early sprays, beginning with Shuck Fall and extending through the "First Cover" application. These applications should include either parathion or DDT.

Control against the second brood is by DDT sprays to be started on July 10-15. Apply 2 sprays to Haven varieties, and 3 sprays to Elberta at 10-12 days intervals. Parathion and malathion can be used nearer to harvest than DDT. Be sure to read the label regarding the use of these phosphate compounds and follow the directions carefully.

Peaches that go to a processing plant may be sprayed as close as 7-10 days before harvest without creating a residue hazard.

There are four generations of the Oriental fruit moth in Michigan. The late individuals of the second and the third generation larvae are the ones that enter the fruit. The number of second generation larvae that enter the fruit depends upon the weather and the condition of the growing terminal twigs of the trees. When twig growth stops and the wood hardens more of the larvae will enter the peaches. The fourth generation develops after the harvest of Michigan peaches.

Keeping the population of oriental fruit moth to a low figure is important. One pair of adults in June can produce two million larvae by September, if all the progeny lives. Spraying with DDT or parathion for the first brood does reduce the numbers, but it is also destructive to the parasites which can only work in the twig infesting larvae. From a strictly economic standpoint there is little evidence that sprays against the first brood of oriental fruit moth pay off on peaches for fresh fruit. As has already been stated, these sprays are advisable in an insurance spray program for peaches to be processed.

PEAR PSYLLA

Dormant oil sprays, thoroughly applied in March and early April, will control pear psylla. This spray must be applied before egg laying begins. It has often been applied too late for satisfactory results.

Foliage sprays of nicotine sulfate and 3 quarts of summer oil, or 1 pound of the 15% wettable parathion in 100 gallons, have given good control. It is necessary to repeat foliage sprays at 10-day intervals when control from one application is unsatisfactory.

The pear psylla is a jumping plant louse. The adults pass the win-

ter in and near the orchards – usually on the trees in bark crevices. They become active on warm days early each spring, and at that time may be seen on the trees. The small yellowship eggs are usually laid before the buds burst. The small pinhead-sized yellow nymphs feed on the leaves, and may be found about the time of Second Cover submerged in tiny pools of their excreted honey dew. There are several generations each season in Michigan.

PLUM CURCULIO

Control of plum curculio is not difficult with present day insecticides but the applications of these materials must be at the proper time and must be thorough.

Dieldrin has proven to be specific for curculio control, but at the present time this material cannot be depended upon to control some of the other pests present in orchards. Parathion and EPN-300 are effective materials for curculio control and also control other orchard pests when applied for the curculio. Methoxychlor, applied at 7-day intervals in four or more applications, has given good curculio control. Lead arsenate, while generally not as effective as the newer materials, has been used for curculio for many years.

To control curculio, the trees must be protected for at least 30 days after Petal Fall on all affected fruits. During this period, the curculio is doing its heaviest feeding and egg laying. Where curculio is a problem, insecticides to destroy them should always be applied in the Petal Fall and First and Second Cover sprays.

Present practices of sod and semi-sod orchards with mulching material beneath the trees encourage the survival of curculios. This insect hibernates in stone fences, stone and brush piles, and in wooded areas adjacent to orchards. The elimination of these situations near the orchard will materially aid in its control.

Curculios emerge form their hibernating quarters over a considerable period of time, often for as long as 30 days. They attack fruits just before and for several weeks after the fruits have set. Some fruits drop as a result of the larvae feeding, while others remain on the trees and develop into misshapen fruit. The female curculio often lays 300 eggs, and may blemish a like number of fruits. Adults of the summer generation do not lay eggs but feed on the fruits until frost. They are considered important in spreading brown rot in peach orchards. These summer curculio hibernate in the fall and emerge the next spring to

again attack fruits and lay their eggs. There is but one generation each year but the adult curculios live for 10-15 months.

Curculios attack apples, pears, plums, peaches, cherries, apricots, and cultivated blueberries, and control measures may be required for them on all of these fruits. Curculio damage has increased in Michigan, particularly in northern cherry orchards during recent seasons.

RED-BANDED LEAF ROLLER

Loss from the red-banded leaf roller can only be prevented by killing most of the first brood by early season sprays. Parathion has given good control of the first brood, when applied in the Petal Fall and early cover sprays (See Apple Spraying Schedule page 57). When a lead arsenate schedule is followed, this poison used in the Pink, Petal Fall, First and Second Cover sprays and then again in July for apple maggot control usually controls the red-banded leaf roller. Where the first brood of red-banded leaf roller has not been controlled by other chemicals, the use of DDD (TDE) has been very effective.

Success with any insecticide can only be had by *very thorough coverage* of both upper and lower surfaces of the leaves, regardless of what type of applicator is employed.

In former years, when orchards customarily received numerous lead arsenate sprays throughout the growing season, red-banded leaf roller damage was infrequent. It has become a common pest in Michigan orchards where DDT has largely replaced lead arsenate.

ROSE CHAFER

To control rose chafers, orchards should be sprayed when the first chafers appear. Use 1½ pounds of 50% wettable DDT per 100 gallons, a 10% DDT dust, or organic phosphate sprays.

Rose chafers spend the winter as white grubs in fairly moist, soddy grassland. Quack grass sod is a favored breeding ground. The female beetles seldom lay eggs in legume sods.

SCALE INSECTS

Scale insects in Michigan orchards are controlled by dormant oil sprays. A spray containing 3% actual oil is effective for most species, with the exception of oyster shell scale, which requires 4% actual oil.

Summer applications of DDT and the organic phosphates kill the crawlers of scale insects and usually the use of these chemicals in the regular spraying schedules keeps these pests in check. The lecanium scale on peach, plums, grapes and blueberries is controlled by a single

application or parathion, applied when about 80% of the eggs have hatched. The time of this application is set by the Michigan State College Spray Service.

San Jose Scale lives over winter as a nymph (young scale). Heavy infestations of this scale will kill branches, sometimes the whole tree, and the fruit may be badly blemished. Infested trees have a scurvy, unhealthy appearance, purplish discoloration beneath the surface of the bark, and there may be many small red blotches on the fruit.

Oystershell scale resembles a miniature oyster shell. The "shell" covers about 100 eggs which hatch in June. Oyster shell scale is present in many orchards, but is usually of little importance in orchards south of Manistee. In the northern countries oyster shell scale has caused damage to fruit trees.

Lecanium Scale is a soft brown, turtle-shaped lecanium scale which attacks peaches, plums, grapes and blueberries in Michigan. This insect is at present found throughout the entire fruit growing areas of Michigan. It can cause a serious blemishing of the fruit by excretion of honey dew which is covered by a black sooty fungus. Lecanium scale can increase rapidly on fruit trees when conditions favor its survival. Heavy infestations may kill branches and sometimes the tree.

BARK BEETLES

Bark beetles prefer trees that have been weakened by some other injury, but when present in great numbers cause serious damage to the terminal shoots of healthy trees. To prevent such damage, all weakened and dead wood should be cut from the orchards and promptly destroyed or removed. Thousands of beetles may emerge from a brushpile of prunings in spring and seriously injure nearby orchards.

Control of the adult beetles in mid June has been reported by a combination spray of 1 pound of 50% DDT plus 1½ pounds of 15% wettable parathion in 100 gallons. A spray of 6 pounds of BHC (6% gamma) in 100 gallons has killed bark bettles in infested prunings and dead trees. *BHC spray is not recommended for trees in the orchard.*

CLIMBING CUTWORMS

Climbing cutworms work mainly during the night, and begin to feed very early each spring. They emerge from their hiding places in the orchard sod each night and climb the trees where they eat out the

buds – often before the buds have opened up. They often cause serious damage to grapes and all fruit trees. To be effective, control measures must be applied promptly when damage first appears.

Tanglefoot barriers, applied as directed by the manufacturers of the preparation, have long been used with success.
slight bruises or any insect wound gives especially ready entrance to

Spraying the ground beneath the trees and the trunks has proven an effective control. Materials which have been effective are 2½ pounds of 40% chlordane, 2 pounds of 50% wettable DDT, or 5 pounds of BHC (6% gamma isomer) in 100 gallons of spray.

TENT CATERPILLAR

A common native insect, tent caterpillar is in a cycle of abundance at the present time. The trend away from early arsenical sprays has permitted this pest to occur in a number of commercial fruit orchards. The tent caterpillar is controlled easily with either 3 pounds of lead arsenate, 1½ pounds of 50% wettable DDT, or 1½ pounds of 15% wettable parathion per 100 gallons of spray – if it is applied when the insects are first detected.

WORMS IN CHERRIES AT HARVEST

"Worms" in cherries have become of increasing concern the past several seasons. In 1950 the mineola moth appeared and produced wormy cherries in some northern Michigan orchards. An infestation of wormy cherries in northern Michigan the past season proved to be larvae of the Peach twig borer and of the Cherry fruit worm. Neither the peach twig borer nor the cherry fruit worm have been pests in Michigan cherries in the past. We do not know if damage from these insects will become more acute, nor if they will extend their present range in Michigan.

Parathion applied in the Green Tip, Petal Fall, and First Cover sprays has controlled the mineola moth. Until the status of these several insects that produce wormy cherries is better known, in the particular areas affected, it appears wise to suggest the use of 1½ pounds of 15% parathion in the petal fall and first and second cover sprays. If mineola moth is suspected or known to be present, a special spray of 1½ pounds of 15% wettable parathion in 100 gallons should also be applied in the Green Tip stage just before the buds open up. This is the safest procedure now known to insure worm-free cherries.

IV. Spraying Schedules for 1955

SPRAY CHEMICALS FOR THE CONTROL OF APPLE SCAB

Protective Fungicides	*Eradicative Fungicides*	*Fungicide Mixtures with both Eradicatives and Protective Properties*
Lime-sulfur	Lime-sulfur	Sulfur, Ferbam or Captan at half-strength combined with ¼ pound of Phygon.
Copper compounds	Mercurial compounds	
Wettable sulfur		
Sulfur paste	Phygon (dichlone)	
Ferbam		Sulfur, Glyodin, Ferbam or Captan at half-strength may be combined with mercurial compounds.
Glyodin		
Captan		
Phygon (dichlone)		

Precautions in Selecting Chemicals to Control Apple Scab

Newly established apple scab infection may be eradicated effectively within 30-36 hours from the beginning of an infection period—using either ¼ pound of dichlone (Phygon) with a protective fungicide at half-strength, or within 72 hours from the beginning of an infection period using full-strength mercury. When mercury is used at half-strength in combination with a protective fungicide, the effective period for eradication is usually reduced to 40-45 hours. However, the period of effective eradication may be somewhat longer for all concentrations of eradicative fungicides, if the temperature during the time of infection is under 50° F. It should be remembered also that liquid lime-sulfur has effective eradicative properties, if used at 2 gallons per 100 gallons of spray within 72 hours from the beginning of the infection period.

In Michigan, mercurial compounds may be most valuable as an emergency measure following rains, when protection against possible apple scab infection is questionable. A protective fungicide should be used with the mercury.

Phygon should not be used later than Petal Fall, because of possible fruit russeting. Fruit russeting has occurred on Golden Delicious in Michigan from the use of ferbam and glyodin. Captan has been the most favorable fungicide for Golden Delicious. Ferbam has also caused fine network-like russeting on Jonathan when used before Third Cover.

Use all materials according to the directions on the container.

APPLE SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
From First Sign of GREEN TISSUE to PRE-PINK (Important to control sepal and early leaf scab)	Either keep covered with protective fungicides before rains according to expanding growth or use eradicative fungicides after rains. Eradicative fungicides and protective fungicides may be combined effectively. Liquid lime-sulfur at 2 gallons to 100 gallons appears a logical choice for this period.
PRE-PINK to BLOOM	Use protective fungicides just ahead of rains or either an eradicative type fungicide or a protective-eradicative fungicide mixture after rains. A protective spray in Full Pink is necessary to avoid the use of eradicative fungicides in Full Bloom. When necessary, 2 pounds of 10% wettable BHC or 1 pound of 25% wettable Lindane or ½-1 pound 15% wettable parathion or 2 pounds malathion per 100 gallons may be included with the fungicides to control *green apple aphids* and *rosy apple aphids.* These insecticides should not be used with lime-sulfur. The use of parathion at this time gives an opportunity to control other insects that may be present.
PERIOD OF BLOOM	For the control of *fire blight* on susceptible varieties, Bordeaux 2-6-100 is most effective with zineb mediocre or second best. However, Zineb may be used without danger of russeting the fruit. The first and most important spray should be applied when 25 percent of the blossoms are open. Two or 3 sprays at 3-to-4-day intervals may be necessary depending on the weather. Both materials also control *scab.* Streptomycin at 50 to 100 parts per million protects against *fire blight* for about 4 days. An ideal antibiotic program has not been worked out. However, a 2-spray program of 100 parts per million when 20-30 percent of the blossoms are open, followed by a second spray of 100 parts per million 4-5 days later in Full Bloom, offers good possibilities of control for the least expenditure. Streptomycin has *no value* for the *control* of *scab.*
PETAL FALL through FOURTH COVER	Mercurial compounds and dichlone (Phygon) *should not* be used later than Petal Fall. Also, sulfur compounds may result in serious sulfur injury if used during periods of warm weather. Beginning with First Cover, the use of organic protective fungicides are suggested in order to avoid foliage injury. Whether to reduce the amount of fungicide below the full strength level will depend upon the variety, the prevailing weather conditions and the presence of *primary scab* infection. Fungicide applications beyond Third or Fourth Cover are for *fruit scab* only and their use should be determined by the susceptibility of the variety, the amount of scab present, and the occurrence of prolonged wet periods. 15% wettable Parathion at ½ to 1 pound or EPN-300 at ½ pound or 50% wettable methoxychlor at 2 pounds per 100 gallons may be used to control *curculio.* A minimum of four applications made at weekly intervals are necessary with these chemicals to

(Continued on next page)

control this pest, when it is a problem on apples. Two applications of 50% wettable dieldrin at ½ pound per 100 gallons will control *curculio*. The first dieldrin spray should be applied at Petal Fall with the second application being made two weeks later. However, dieldrin will only control *curculio* while parathion or EPN-300 will control most of the insects present at this time. Lead arsenate at 3 pounds per 100 gallons may be used also to control *curculio*. However, it is not as effective as the organic insecticides. In case of a heavy buildup of *Red-Banded Leafroller*, 50% wettable DDD or TDE at 2 pounds per 100 gallons will keep this pest in check. *Aphids* are readily controlled with a properly applied aphicide, but remember *green apple aphids* may continue to migrate into the planting. Thus, a single application of any aphicide may fail to control this pest. *Codling moth* control will start at Third Cover or before depending on the season. Announcement of *codling moth* emergence is made by the Department of Entomology, Michigan State College.

15% wettable parathion at ½ pound with 50% wettable DDT at 1 pound or 50% wettable DDT at 1½ pounds per 100 gallons will control this pest and, with the exception of the use of DDT alone, will also be effective against *curculio*. Two applications spaced at intervals of 10-14 days usually control first brood *codling moth*.

MID-SUMMER (July and August) Protection against *late scab* infection (pin-point scab) during any prolonged wet periods on scab-susceptible varieties such as McIntosh, Delicious, Fameuse, Cortland and Northern Spy is usually desirable. Lead arsenate at 2 pounds, 50% wettable DDT at 2 pounds or 50% wettable methoxychlor at 2 pounds per 100 gallons are suggested for control of *apple maggot*. Frequently it is necessary to protect against *apple maggot* until after the middle of August. The effective protective period for a single application of lead arsenate is from 10-14 days, while DDT and methoxychlor are effective for only 5-7 days. Captan at 1 pound or ferbam at ½ pound will act as a safening agent for 2 pounds of lead arsenate. When glyodin is used with lead arsenate, include ½ pound of ferric sulfate per 100 gallons to avoid arsenical injury. These three materials should be added in the tank in the following order: Ferric sulfate followed by glyodin and then lead arsenate. *Mites* may be controlled when necessary using such materials as parathion, EPN-300, Ovotran, Aramite or TEPP as suggested by the manufacturer. *Red-Banded Leafroller* may be controlled whenever necessary with DDD or TDE at 2 pounds per 100 gallons.

PEAR SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
PRE-BLOSSOM (When buds of blossom clusters begin to separate)	To control *scab* and *leaf spot* use either 1½ pounds of ferbam per 100 gallons or 3-8-100 bordeaux when the buds of the blossom clusters begin to separate. Additional sprays using these same materials may be necessary to control *scab* before bloom if rainy periods prevail.
PERIOD OF BLOOM	For the control of fire blight, 2-6-100 bordeaux is the most effective, with zineb mediocre or second best. However, zineb may be used without danger of russeting the fruit. The first and most important spray should be applied when 25 percent of the pear blossoms are open. One or more additional sprays may also be necessary depending on the weather. Both materials also control *scab*. Streptomycin at 50 to 100 parts per million protects against fire blight for about 4 days. An ideal antibiotic program has not been designed at the present time. However, a 2-spray program of 100 parts per million when 20-30 percent of the blossoms are open, followed by a second spray of 100 parts per million 4-5 days later in full bloom, offers a good possibility for control for the least expenditure. Streptomycin has no value for the control of *scab* or well established fire blight.
PETAL FALL **FIRST COVER (Two weeks after Petal Fall)**	To control *scab* and *leaf spot* in both Petal Fall and First Cover, use either 1½ pounds of ferbam per 100 gallons or 3-8-100 bordeaux. In order to control *curculio* add to the fungicide applications either ½ pound of 50% wettable dieldrin or ½ to 1 pound of 15% wettable parathion or ½ pound of EPN-300 or 2 pounds of methoxychlor. A minimum of 4 applications made at weekly intervals are necessary when using the insecticides other than dieldrin to control *curculio*. A single application of dieldrin is effective for 14-18 days.
SECOND COVER (Two weeks after First Cover) **THIRD COVER (Two weeks after Second Cover)**	To control *scab* and *leaf blight* in the Second and Third Covers use either 1½ pounds of ferbam per 100 gallons or 2-8-100 bordeaux. To control codling moth and possible *pear psylla* build up, include 1 pound of 15% wettable parathion with 1 pound of 50% wettable DDT per 100 gallons, with the fungicide applications.
FOURTH COVER (Time to be announcd)	Use either 1½ pounds of ferbam per 100 gallons or 2-8-100 bordeaux to control *leaf blight* and *scab*. Include with the fungicide 1½ pounds of 50% wettable DDT per 100 gallons if ferbam is used, but increase this amount to 2 pounds of DDT if bordeaux is the fungicide to control *codling moth*.

PEACH SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
DORMANT (In the fall after leaf drop or in the spring before buds swell)	Peachleaf curl may be controlled in the fall after leaf drop or in the spring before buds start to swell with 6-6-100 bordeaux or 1½ pounds of ferbam per 100 gallons. Liquid lime-sulfur at 5 gallons per 100 applied in the spring before buds start to swell is effective against leaf curl, and 6 gallons per 100 also controls peach twig borer.
BLOOM	Common brown rot blossom blight must be controlled in Bloom to obtain effective control of *brown rot* on the fruit during and after harvest. Two to 4 sprays are usually necessary beginning at the "popcorn" stage, when the first blossoms are opening, and continuing applications at intervals of 2-4 days depending upon weather conditions until all blossoms are open and protected with fungicide. Use either 2 gallons of lime-sulfur or ½ pound of dichlone (Phygon) or 6 pounds of wettable sulfur or 6 pounds of sulfur paste per 100 gallons in the "popcorn" stage. For subsequent applications, use any of the suggested materials except lime-sulfur. Dusting or spraying with elemental sulfur in the early stages (first 10 hours) of any rain periods has given good results.
PETAL FALL through FIRST COVER	At Petal Fall sulfur sprays may be omitted unless *brown rot blossom blight* has not been controlled, in which case use either wettable sulfur or sulfur paste as suggested during Bloom. For the control of *curculio,* the use of 50% wettable dieldrin at ½ pound per 100 gallons appears most favorable at this time; however, methoxychlor at 2 pounds, or EPN-300 at 1 pound or parathion at 1½ pounds per 100 gallons may be used. The value of a sulfur spray at Petal Fall and Shuck Fall is questionable. However, a sulfur spray to include either wettable sulfur at 5 pounds or sulfur paste at 7 pounds per 100 gallons should be included in First Cover (3 weeks after Petal Fall) to control *peach scab.* To control *curculio,* use 50% wettable dieldrin at ½ pound in Shuck Fall and in First Cover. When using dieldrin to control *curculio* in Shuck Fall and First Cover include either 15% wettable parathion at 1½ pounds or EPN-300 at 1 pound or 50% wettable DDT at 1½ pounds to help control *oriental fruit moth* and other pests. 15% wettable parathion at 1½ pounds, EPN-300 at 1 pound or 50% wettable powder methoxychlor at 2 pounds will control *curculio;* however, the approximate residual life of these compounds is 4 days for parathion, 6 days for EPN-300 and 7 days for methoxychlor as compared to 15-18 days for dieldrin.

SECOND COVER (4-6 weeks after First Cover)

To control second brood *oriental fruit moth* use 50% wettable DDT at 1½ pounds per 100 gallons. Timing of sprays for the control of *peach tree borer, lesser peach tree borer* and *lecanium scale* are determined by the Department of Entomology, Michigan State College and announcements are made by your County Agricultural Agent. For *peach tree borer* spray trunks of trees from below crotches to ground line with a gun and reduced pressure using either 3 pounds of 50% wettable DDT or 2 pounds of 15% wettable parathion per 100 gallons. Follow with a second application in 10-14 days. To control *lecanium scale,* spray infested areas with 1½ pounds of 15% wettable parathion, when scale is in the crawler stage. Proper timing is very important for control. To control *lesser peach tree borer* spray crotches and areas of cankers with 1 pound of 50% wettable DDT plus 1 pound of 15% wettable parathion per 100 gallons.

THIRD and FOURTH COVERS (Approximately one month before harvest and Fourth Cover 7 - 10 days later.)

To control *peach scab* and *brown rot* use either 6 pounds of wettable sulfur or 7 pounds of sulfur paste or 2 pounds of captan per 100 gallons. To control *oriental fruit moth* include 1½ pounds of 50% wettable DDT per 100 gallons. *If DDT is used after Fourth Cover on peaches to be sold on the market as fresh fruit, DDT residue may be excessive.*

PRE-HARVEST COVERS (Beginning 7-10 days after Fourth Cover and repeating every 7-10 days until harvest)

To control *brown rot* use either 6 pounds of wettable sulfur or 7 pounds of sulfur paste or 2 pounds of captan per 100 gallons. Include a wetting agent. Liquid lime-sulfur at 2 quarts per 100 gallons may be used with half-strength wettable sulfur or sulfur paste. On the Amber Gem variety to be used for processing include 1½ pounds of 50% wettable DDT per 100 gallons to control *oriental fruit moth.*

PLUM SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
BLOOM (Early bloom until all blossoms are open)	*Brown rot blossom blight* was common to plums in some orchards in 1954 and may be of concern again in 1955. This disease must be controlled in Bloom to obtain effective control of *brown rot* on the fruit during and after harvest. Two to four sprays are usually necessary beginning at the "popcorn" stage, when the first blooms are opening, and continuing applications at intervals of 2-4 days depending upon weather conditions until all blossoms are open and protected with fungicide. In the "popcorn" stage, use either 2 gallons of liquid lime-sulfur or ½ pound of dichlone (Phygon) or 6 pounds of wettable sulfur or 6 pounds of sulfur paste per 100 gallons. For subsequent applications, use any of the suggested materials except lime-sulfur. Dusting or spraying with elemental sulfur in the early stages (first 10 hours) of any rain period has given good results.
PETAL FALL through FIRST COVER	At Petal Fall and 10-14 days later in First Cover use either 1½ pounds of ferbam or 6 pounds of wettable sulfur or 8 pounds of sulfur paste, per 100 gallons, for the control of *leaf spot.* Include with the fungicide in both sprays, ½ pound of 50% wettable dieldrin per 100 gallons to control *curculio. Curculio* may be controlled with 1½ pounds of 15% wettable parathion, 1 pound of EPN-300, or 2 pounds of 50% wettable methoxychlor per 100 gallons. However, the approximate residual life of these compounds is 4 days for parathion, 6 days for EPN-300 and 7 days for methoxychlor, as compared to 15-18 days for dieldrin.
SECOND COVER (14 days after First Cover)	Include at this time a spray of 1½ pounds of 50% wettable DDT per 100 gallons for the control of *leafhopper.*
THIRD COVER (One month before harvest) **FOURTH COVER (7-10 days before harvest)**	To control *leaf spot* and *brown rot* on the fruit, use either 2 pounds of captan or 6 pounds of wettable sulfur or 8 pounds of sulfur paste per 100 gallons. A second spray using the same materials is necessary approximately one week before harvest to control *brown rot* on the fruit. If mites are numerous at the time of Third Cover, include 1 pound of 15% wettable parathion per 100 gallons or some other commercial miticide with the fungicide application.

SOUR CHERRY SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
DORMANT	Where *European brown rot* has been a problem, make a dormant application using 3 pounds of monocalcium arsenite per 100 gallons approximately 2 weeks before buds break. For orchards north of Oceana County, a DN application as suggested for bud moth may be desirable to control *peach twig borer, case-bearer or mineola moth.* DN compounds may be used with monocalcium arsenite at the time suggested. If *mineola moth* is not controlled with a DN application, spray with 1½ pounds of parathion per 100 gallons as soon as observed.
PRE-BLOSSOM (When first blossoms open)	In orchards with a history of *European* or *common brown rot blossom blight,* use 4-6-100 bordeaux when first blossoms open followed by sprays of either 7 pounds of sulfur paste or 6 pounds of wettable sulfur or ½ pound of dichlone (Phygon) per 100 gallons if rainy, wet weather prevails during Bloom. The suggested sulfur or dichlone applications may be applied either as dust or a spray.
PETAL FALL Through SECOND COVER	For the control of *leaf spot,* spray when ¾ of the petals have fallen with either enough fixed copper to give 0.75 pounds of actual copper plus 3 pounds of hydrated lime, or 1½ pounds of ferbam, or 1 quart of Dithane D-14 plus ¼ pound of monohydrate zinc sulfate, or 1½ pints of glyodin, or 2 pounds of captan per 100 gallons. To control *curculio* include either ½ pound of 50% wettable dieldrin or 3 pounds of lead arsenate per 100 gallons. When glyodin is used with lead arsenate, include ½ pound of ferric sulfate to safen against possible arsenical injury. If *mineola moth* or *case bearer* is present, use 1½ pounds of 15% wettable parathion per 100 gallons in place of lead arsenate or dieldrin which is suggested for control of curculio. Parathion is also effective against curculio. *Black aphids* may be controlled readily when they appear in schedules of lead arsenate or dieldrin by using an aphicide such as 15% wettable parathion at 1 pound, or 50% wettable malathion at 2 pounds, or metacide at ½ pint. The sprays during this period should be applied at intervals of 10-14 days.
THIRD COVER (Cherry fruit fly spray)	The timing of this spray is announced by your County Agricultural Agent based on the emergence of the *cherry fruit fly.* Lead arsenate at 2 pounds or methoxychlor at 3 pounds per 100 gallons is suggested for control of this pest. Methoxychlor is effective for only 7 days against this pest while lead arsenate is effective for 14 days. If *peach twig borer* has been a problem, include 1 pound of 50% wettable DDT with the lead arsenate. To protect against *leaf spot,* include either fixed copper or an organic fungicide as suggested at Petal Fall.
AFTER-HARVEST COVER (Immediately after harvest)	To check developing *leaf spot* and to protect against possible infection, spray immediately after harvest with either 2 parts per million actidione, or 4-6-100 bordeaux or fixed copper as suggested at Petal Fall. If *slugs* are present, include 2 pounds of lead arsenate per 100 gallons.

SWEET CHERRY SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL

DORMANT

Black cherry aphids may be controlled in the dormant period with DN compounds used as suggested by the manufacturer. However, they may be controlled also during the growing season as soon as they appear, either with 1 pint of nicotine sulfate plus 1 pound of hydrated lime and a wetting agent, or with ½ pound of 15% wettable parathion plus a wetting agent, per 100 gallons. Parathion should not be used later than 3 weeks before harvest.

PRE-BLOSSOM (When first blossoms open)

The use of 4-6-100 bordeaux at this time is effective in protecting against both common *brown rot* blossom blight and *leaf spot* infection. This application should be made at the time the first blossoms are opening, and should be followed by sprays of either ½ pound of dichlone (Phygon) or 6 pounds of wettable sulfur or 8 pounds of sulfur paste per 100 gallons if rainy humid weather prevails during bloom. The suggested sulfur or dichlone applications may be applied either as a dust or a spray.

PETAL FALL (When ¾ of petals have fallen)

FIRST COVER (14 days after Petal Fall)

SECOND COVER (14 days after First Cover)

For the control of *leaf spot* and *brown rot* from Petal Fall through Second Cover use either 1½ pounds of ferbam or 2 pounds of captan or 0.37 pounds of actual copper, using fixed copper, plus 3 pounds of hydrated lime plus 4 pounds of wettable sulfur or sulfur paste, per 100 gallons.

For the control of *curculio* use either ½ pound of 50% wettable dieldrin or 1½ pounds of parathion or 1 pound of EPN-300 or 2 pounds of methoxychlor per 100 gallons. Dieldrin has an effective period of 14-18 days while the other insecticides mentioned are effective for only 5 to 7 days. Also to be considered, dieldrin only controls *curculio*. Thus if other insects are present, parathion at 1 pound per 100 gallons should be included with dieldrin, or one of the phosphate compounds should be used against curculio and protection should be provided weekly for a period of 4 weeks.

THIRD COVER (Cherry fruit fly spray)

FOURTH COVER (7-10 days after Third)

For the control of *brown rot* on the fruit use either 2 pounds of captan or 6 pounds of wettable sulfur or 8 pounds of sulfur paste or 1½ pounds of ferbam. Captan appeared to give very favorable results in the control of *brown rot* on sweet cherry fruit in 1954 and is worthy of trial in 1955.

For the control of *cherry fruit fly*, include with the fungicide either 2 pounds of lead arsenate or 3 pounds of methoxychlor per 100 gallons. The time of this application is announced by your County Agricultural Agent based on the emergence of *cherry fruit flies*. The use of methoxychlor or rotenone, at the manufacturer's directions, in the Fourth Cover in place of lead arsenate will eliminate the hazard of excessive lead arsenate residue.

AFTER-HARVEST (May be needed in those orchards with leaf spot history) In sweet cherry orchards with leaf spot history, it may be necessary to apply an "after-harvest" spray. The fixed copper-wettable sulfur combination or ferbam, as suggested at PETAL FALL, should check leaf spot infection. Actidione is a new fungicide giving promising results when used after harvest for the control of established leaf spot. This chemical has also given effective control of leaf spot when used at 2 parts per million (0.76 grams in 100 gallons) throughout the season on young, non-bearing cherry trees. *Do not use actidione with lime,* or *following ferbam.* Lime reduces the effectiveness of actidione, while actidione following ferbam injures sweet cherry foliage.

GRAPE SPRAYING SCHEDULE

Economic control of grape pests is dependent upon good coverage of the plant. A minimum of 100 gallons of spray should be used per acre for FIRST COVER, and a minimum of 150 gallons of spray should be used per acre beginning with SECOND COVER.

TIME	MATERIALS FOR PEST CONTROL
Just before and as the buds start to swell	Grape flea-bettle and climbing cutworms begin to work before and at the time the buds start to swell. These two insects are controlled by 2 pounds of 50% wettable DDT per 100 gallons of spray. A daily check of the vineyard should determine the presence of these insects and the need for spraying.
FIRST COVER (When shoots are 4-5 inches long) **SECOND COVER (Just as blossoms are opening)** **THIRD COVER (Immediately after fruit set)** **FOURTH COVER (10 days after Third Cover)** **FIFTH COVER (Just before berries begin to touch in clusters)**	In vineyards where *black rot* has been a serious problem, the first fungicide spray should be applied when the shoots are 2 to 3 inches long, rather than delay until the shoots have grown to 4 to 6 inches in length. Either ferbam at 1½ pounds, or fixed copper to give 1½ pounds of *actual* copper plus 4 pounds of hydrated lime per 100 gallons of spray, or 6-6-100 bordeaux may be used against *black rot* infection.. However, ferbam *does not* control *downy mildew* or *powdery mildew*. For this reason, fixed copper or bordeaux is suggested for use in the Second, Third and Fourth Cover sprays on the varieties susceptible to *mildews* which are Delaware, Fredonia and Niagara. To control *berry moth, rose chafer* and *leafhopper,* include DDT (50% wettable) at 1½ pounds per 100 gallons with ferbam or at 2 pounds with either fixed copper or bordeaux in each of the 5 cover sprays. If *berry moth* is not controlled early in the season, a late application to include either 3 pounds of 14% fixed nicotine plus a wetting agent, or 1½ pounds of 15% parathion per 100 gallons. DDT should not be used later than Fifth Cover owing to the possibility of excessive DDT residue on the harvested fruit. The time to apply this spray will be announced by your County Agricultural Agent.

RASPBERRY SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
Either at the time of DORMANT or GREEN-TIP	It is necessary to control anthracnose early in the season to reduce primary infection. Use either Elgetol or Krenite at the rate of 1 gallon per 100 gallons of spray while the canes are still *dormant.* Or, use liquid lime-sulfur at 12½ gallons per 100 gallons of spray when the leaves are exposed ½ to ¾ of an inch. One thorough application of liquid lime-sulfur *at this critical stage* often gives commercial control of anthracnose throughout the season.
PRE-BLOSSOM (7-10 days before blossoms open or when new canes are 6-8 inches long)	In plantings where *anthracnose* or *leaf spot* is a serious problem, use 1½ pounds of ferbam per 100 gallons. In wet seasons it may be necessary to include a second application just before blossoms open if *anthracnose* is severe. Include with ferbam at this time 3 pounds of lead arsenate per 100 gallons if either *sawfly or raspberry fruit worm* has been a problem the past season. If *aphids* are present, add ½ pound of 15% wettable parathion per 100 gallons. *Do not use parathion during bloom nor later than 2 weeks before harvest.* To control *spur blight,* a 3-3-100 bordeaux should be used at this time in place of ferbam followed by a second application 10 to 14 days later. Lead arsenate may be included with the bordeaux spray.
FIRST COVER (As soon as petals have fallen)	In wet seasons, it would be desirable to include this application using ferbam at 1½ pounds per 100 gallons to protect the developing fruits and spurs from *anthracnose* infection. After harvest, sprays to control *anthracnose* are usually of little value because late infection occurs on young, terminal portions of the plants which are removed generally by pruning during the dormant season.

Note 1: If sawfly appears immediately before harvest, use rotenone or pyrethrum according to manufacturers' directions.

Note 2: Mites have become a generalized problem in many plantings. A mite control material (preferably one having residual action) in the FIRST COVER spray should give protection in plantings troubled with mites, until after harvest. If mites are present after harvest, use ½ pound of 15% wettable parathion per 100 gallons of spray, or commercial miticides at manufacturers' directions.

STRAWBERRY SPRAYING SCHEDULE

Precautions before planting new strawberry beds:

TO REDUCE WHITE GRUB INJURY—Do not plant strawberries within two years of a sod crop; or treat the soil with a 5% chlordane dust at the rate of 200 pounds per acre. *Do not use chlordane* if the land is to be planted to root crops such as carrots, beets, or potatoes within 3 years after soil treatment. Residues of chlordane in the soil give off-flavors to root crops.

TO AVOID ROOT APHID INJURY—Dip roots and crowns of plants in a solution of nicotine sulfate (½ pint of 40% nicotine sulfate to 25 gallons of water), just before setting the plants in the field.

TIME	MATERIALS FOR PEST CONTROL
DORMANT	Where *leaf* blight has been a problem on such varieties as Dunlap, Red Crop and Robinson, use any of the commercial mercury compounds such as Tag, Puratized Apple Spray, Coromerc or Phix at the strength given on the label to control apple scab. This spray should be applied thoroughly using approximately 200 gallons per acre.
FIRST COVER (when new leaves are emerging from crown)	Spray newly developing foliage with 2 pounds of captan or 1½ pounds of ferbam per 100 gallons to protect against *leaf* diseases and *fruit rots.*
SECOND COVER (4-5 days after first spittle bug hatch) and	Spray developing foliage and fruit with 2 pounds of captan or 1½ pounds of ferbam per 100 gallons to protect against *leaf diseases* and *fruit rots.* Include with these fungicides 1 pound of 15% wettable parathion per 100 gallons to control *spittle bug* and *leafroller.*
THIRD COVER (10 days after Second Cover or before berries are ⅓ grown)	(Use same materials as suggested for Second Cover.)

Note 1: Lindane applied before blossom time is a specific insecticide against spittle bug. *Lindane should not be used* in plantings where the berries are to be cooked in processing. This insecticide is used at the rate of 1/3 to ½ pound of 25% wettable lindane for 100 gallons of spray.

Note 2: If *strawberry root weevil is present,* spray immediately after harvest using 2 pounds of 15% wettable parathion per 100 gallons of spray. It requires at least 200-250 gallons of spray per acre to control strawberry root weevil. This pest is likely to appear in irrigated plantings, or in any planting when the season is wet, just before and during harvest.

Note 3: Leafroller usually appears 5 to 10 days after harvest. If this pest is present, spray with 1 pound of 15% wettable parathion, *or* 4 pounds of Cryolite with 2 quarts of summer oil emulsion, per 100 gallons of spray. A second application may be necessary 10 days after the first to control leafroller. The need for these sprays may be determined by observation.

Note 4: Methoxychlor emulsion (Marlate – 2MR), at one quart per 100 gallons of spray, excellent results in controlling spittle bug on strawberries with no detectable off-flavor. This material may be applied within 2 days of picking time, if necessary.

BLACKBERRY AND DEWBERRY SPRAYING SCHEDULE

The principal insect pests that attack blackberries and dewberries are the following: (a) red-necked cane borer, (b) blackberry leaf-miner; and (c) mites.

(a) The RED-NECKED CANE BORER may be controlled with a spray application of 1½ pounds of 15% wettable parathion per 100 gallons, or a dust application using 25 pounds of 1% parathion dust per acre. The timing of the spray or dust application will be announced by your County Agricultural Agent.

(b) The BLACKBERRY LEAF-MINER may be controlled with a parathion spray or dust, at the concentrations given for the control of the red-necked cane borer. The leaf injury caused by the feeding blackberry leaf-miner is easily seen, and the spray or dust application should be made when the damage is first detected. *Do not apply parathion within 2 week of harvest.* After harvest, sprays or dusts of parathion may be applied to destroy blackberry leaf-minor.

(c) MITES may be controlled when serious on blackberries and dewberries with any material suggested for mite control, preferably one with residual action. Spray chemicals with residual action used for control of mites should not be applied later than 3 *weeks before harvest.* They may be used anytime *after* harvest.

If ANTHRACNOSE is a disease problem, follow the control suggestions given in the Raspberry Spraying Schedule, page 67.

CURRANT AND GOOSEBERRY SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
DORMANT (For gooseberries only)	To control *powdery mildew* on gooseberry, make a thorough application of lime-sulfur mixture using liquid lime-sulfur at the rate of 12½ gallons per 100 gallons of spray. This will aid considerably in reducing primary infection.
FIRST PRE-BLOSSOM (As soon as leaves unfold) **SECOND PRE-BLOSSOM** (2 weeks after First Pre-Blossom, before blossoms open) **FIRST COVER** (2-3 weeks after bloom)	To control *leaf spot,* use 1½ pounds of either ferbam or ziram per 100 gallons in the First and Second Pre-Blossom and First Cover sprays. 3-4-100 bordeaux or fixed copper at the rate of 0.75 of *actual* copper per 100 gallons may be used in place of ferbam or ziram if desired. Include with the fungicide in only the First and Second Pre-Blossom sprays either 1 pound of 15% wettable parathion or 2 pounds of lead arsenate per 100 gallons to control *imported currant worm.* If blossoms open 7-10 days after applying the First Pre-Blossom spray, delay making the Second Pre-Blossom application until after bloom. If *currantworm* or *gooseberry fruit worm* appear at the time of, or after First Cover, spray immediately with rotenone or pyrethrum at the manufacturer's directions.

If leaf spot is present at harvest time, spray immediately after harvest with 1½ pounds of either ferbam or ziram per 100 gallons or with 3-4-100 bordeaux.

BLUEBERRY SPRAYING SCHEDULE

TIME	MATERIALS FOR PEST CONTROL
DORMANT (When buds are swelling)	The control of *mummy berry* is of primary importance to the Michigan blueberry grower. This disease may be recognized at harvest time by the grey-cream color of the infected berries. The mummy berry fungus carries over the winter as old, infected berries on the ground or lodged in the crowns of plants. Raking or cultivating before growth starts in the spring prevents the formation of the tiny mushrooms that produce the spores. To control *mummy berry* by chemical means, spray the entire ground area and crowns of the plants just as the buds are swelling but before they break open. Use Premerge at the rate of 1½ quarts per 100 gallons.
FIRST COVER (Immediately after bloom or as soon as curculio is active) **SECOND COVER (10 days after First Cover)**	To control *curculio* in First Cover, *curculio* and *fruit worm* in Second Cover and *fruit worm* in Third Cover, use 3 pounds of 50% wettable methoxychlor per 100 gallons. Cover the plants well. If a dust is preferred, use a 5% methoxychlor dust applying it at the rate of 30 pounds per acre.
THIRD COVER (10 days after Second Cover)	(Use the same materials in First, Second and Third Cover.)
FOURTH COVER (When fruit fly appears)	To control *fruit fly*, use a 1½% rotenone dust at the rate of 25 pounds per acre. The time of this application will be announced by your County Agricultural Agent.

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