Spraying Calendar
Michigan State University Extension Service
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SPRAYING CALENDAR

By A. E. MITCHELL, FRANKLIN SHERMAN III,
and DONALD CATION

MICHIGAN STATE COLLEGE
COOPERATIVE EXTENSION SERVICE
EAST LANSING

E-154. Since a complete re-set was necessary this time anyway, "Spraying Calendar" typography was revised (as well as copy) on 1953 revision. I changed the monotype face to the one Joe and I have since made standard for tabular work ("Cushing Antique" - like Bookman a face naturally a little bolder); also tried to clarify directions where spray schedules offered (1) a choice of two different formulations, and (2) a choice of different chemicals within the same formulation. Art Mitchell reported Dr. Hutson thought it a decided improvement. (For a quick idea, compare the PLUM schedule with the 1952 Supplement attached; some of the other '52 schedules were run from old type and look almost as black in the discarded monotype face.)

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Cooperative extension work in agriculture and home economics. Michigan State College and the U.S. Department of Agriculture, cooperating. D. B. Varner, Director, Cooperative Extension Service, Michigan State College, East Lansing. Printed and distributed under Acts of Congress, May 8 and June 30, 1914.

1953 Spraying Calendar

By A. E. MITCHELL,[1] FRANKLIN SHERMAN III,[2] and DONALD CATION[3]

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

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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.

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 in using an 8x concentration.

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

B. Amount of concentrated spray to be applied to each tree *("gallons per tree")*

C. Spray delivery rate of one side of the sprayer *("gallons per minute")*

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

E. Time required to spray one side of the tree *("time in seconds")*, which would be the same number of seconds as the time required to "pass" the tree

F. Rate of travel at which sprayer should pass the trees, so as to deliver the proper number of gallons of spray per tree ("miles per hour")

B, C and *D* are factors he should know from the conventional dilute spraying practice, and *A* (spray concentration) he must set himself, according to his own particular conditions. The other two can be quickly calculated by using his three known factors and the following formulas:

(1) To find the time required to spray and pass one side of the tree—

$$\frac{B \text{ (gallons per tree)} \times 60}{C \text{ (gallons per minute)} \times 2} = \text{time in seconds } (E)$$

(2) To find the rate of travel for the sprayer—

$$\frac{D \text{ (tree spread in feet)} \times 60}{E \text{ (time in seconds)} \times 88} = \text{miles per hour } (F)$$

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 3.5 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 necessary 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 mechan-

ical spray applicators has resulted in incomplete coverage in some orchards, allowing the buildup of insects in protected, 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 percent 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 com-

mercial 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, prior 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.*

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 sulfate 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, Bordow, 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 percent or less of metallic copper; add 2 pounds of lime to each pound of the copper compound containing more than 25 percent 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 bordeaux, 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 shown promise as a substitute for weak bordeaux and fixed

coppers in controlling blossom blight (fire blight) on apples and pears. 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 the cherry leaf spot fungus, even in low concentrations. Some injury occurs from the use of this material on young, tender foliage at 2 parts per million at the time of Petal Fall; on bearing trees, some fruit dwarfing was observed in using this material during 1951, but no injury was observed in 1952. Abcission of blossoms occurred with applications of actidione in Full Bloom. It appears safe to use actidione at 2 ppm. (0.76 grams in 100 gallons) shortly before, during, or after harvest for control of established leaf-spot infections. A single spray at this time may check the disease for the remainder of the season, but under some conditions a second spray about three weeks later is necessary.

Glyoxalidine—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. Glyoxalidine has performed creditably when used on sour cherries for the control of leaf spot.

Phygon—Phygon XL is a trade name for 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 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.

Captan—(N-trichloromethylthitetrahydrophthalamide)—is sold as Orthocide 406 and Fungicide 406. In the three years of test in the field, this material has given very good control of cherry leaf spot and is a promising protective fungicide for apples. Reports are also available indicating that the use of this fungicide on apples has reduced russeting on susceptible varieties.

Mercury Compounds—The phenol mercurial compounds such as Tag 331, Puratized Apply Spray, Coromerc, and Dynacide are useful

to eradicate newly established infections of apple scab. Sprays containing mercury should be used within 72 hours following an infection-producing rain, when protection from previously applied fungicides is questionable. 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.*

Standard Apple Spray—This is a liquid fungicide with high wetting properties which is being used in Michigan by some growers for control of apple scab.

SULFUR FUNGICIDES

Elemental Surfur—"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 14 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 surfur paste or wettable surfur 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-sulfur, 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 apply 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.

Dry lime-sulfur may be expected to produce all of the types of injury to foliage and fruit that follow the use of liquid lime-sulfur, but 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 4 pounds to 100 gallons of spray.

Acid lead arsenate should not be used on peach or plums, nor in the 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.

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 percent dust has been equally effective, at 20 pounds per acre, against grasshoppers.

Dieldrin—(hexachloro epoxy octahydro dimethane napthalene)—This new insecticide has been tested for two years and has proven

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 percent 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 peaches and apples.

DDT—(dichloro-diphenyl-trichloroethane)—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-percent wettable DDT per 100 gallons of spray. Three applications properly timed also control apple maggot. (See the Apple Spraying Schedules, pages 51, 53.

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 percent. 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 percent. DN compounds should not be used in the same spray mixtures with 3

percent oil emulsions, or in spray mixtures of oil emulsions containing more than 3 percent 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 control 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-percent 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 dis-

solved 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.

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 leaf roller, 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 B (See pages 53-54).

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

Malathon—A proprietary organic phosphate, malathon is a useful insecticide for many insect pests.

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 effective-

ness 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 Orthocide 406 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 Phygon and with ferbam, PEPS reduced the effectiveness of those two materials to control scab on both the fruit and the leaves. These were the findings of field trials for one year only, 1952.

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 percent zinc, and is the "crystal" form; the second contains 25½ percent zinc, and is the "flake" form; the third contains 36 percent zinc, and is the "powdered" form. The 25½-percent 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-percent zinc sulfate and 4 pounds of lime are recommended. If the 36-percent 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.

II. Diseases and Insects on Michigan Fruits

DISEASES: LIFE HISTORIES AND CONTROL PRACTICES

APPLE SCAB

Apple scab is the only serious fungous 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 infected leaves that are present on the ground from the previous season. Ascospores (small seeds) are produced which ripen about the time the first green apple tissue is exposed in the spring. Rain is necessary for spore discharge, and even as little rain as 2/100 of an inch is sufficient to cause some of the ascospores to be shot into the air from the old leaves. The air currents then carry these spores upward into adjoining trees; or the wind may carry the spores long distances, where they can cause infection if they land on green apple foliage under conditions favorable for germination. Ascospores may continue to be discharged as late as 4 to 6 weeks after Petal Fall in some seasons.

The ascospores will germinate and penetrate into the green tissue —if the green tissue is wet, and remains wet long enough after the spore comes in contact with it. The time required for the discharged ascospore to germinate and cause infection depends upon the temperture during the wet period. This relationship is shown in Table 1.

SUGGESTIONS FOR CONTROL

By knowing the temperature from the time the green tissue first becomes wet until it dries again, one can determine 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 during the wet period, or an eradication spray immediately after the wet period. This is particularly so 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

phenol-mercury compounds—kill the fungus after it has entered the apple leaf or fruit tissue; these materials are usually effective for approximately 72 hours after an infection period. Phygon is an eradicative fungicide when used within 50 hours from the beginning of an infection period.

For a protective spray program to be effective, the developing fruit and leaves must be completely covered at the beginning of and during infection periods of wet, rainy weather. By contrast, eradicant materials are applied immediately after an infection period. A spray program including the use of both protective sprays and eradicative sprays is frequently used to good advantage.

Primary apple scab infection is soon followed by the formation of conidia (secondary spores or summer spores) in established scab lesions. The period of expected appearance of 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 about one-half of the time given for ascospore infection in Table 1.

FIRE BLIGHT OF APPLE AND PEAR

SUGGESTIONS FOR CONTROL

The most effective way to control fire blight is to treat the cankers, and cut out any diseased twigs and branches, during the dormant period. At this time there is little danger of spreading the disease with pruning tools. The bark should be removed for 3 inches above and below, and for one 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 signs of injury. In general, cut 12 to 14 inches past the last indication of infection. The 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. Water sprouts should be removed early to prevent the disease from infecting them and getting into the main limbs and trunks.

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.

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.

Zineb has given good results as a replacement for bordeaux in blossom spray for the control of fire blight with less fruit russeting. Like bordeaux it has protective value for the control of apple scab. Zineb is sold as Dithane Z78 and Parzate.

PEAR SCAB

Pear scab is caused by a fungus closely related to apple scab and having a similar life history (see page 23). 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 does not seem to be the best procedure because of the danger of 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.)

BROWN ROT OF STONE FRUITS

Brown rot is the most destructive disease of peach, plum, and sweet cherry. It lives over winter in mummied fruits remaining on the tree or on the ground, and to an unknown extent in small cankers on the twigs. Spores are present in the orchard soon after growth starts, and up until the first frost. The fungus attacks the foliage, blossoms, twigs, and fruit. The disease is most familiar as a fruit rot. The rather firm rot is first seen as a small brown spot, but soon involves the entire fruit. Powdery, light-brown or gray masses of spores may appear on the rotted areas. The rotted fruits frequently remain attached to the twigs, appearing as dried or mummied fruits.

In reality, a mummy is largely composed fungous tissue. This mummied mass of fungus lives over winter, hanging on the trees and masquerating as a dried fruit. When wet with spring or summer rains at moderate temperatures the fungous tissue becomes active, producing millions of spores. These masses of dusty spores are readily disseminated by wind and air currents. Those mummies which fall to the ground and become partially buried produce mushroom-like fruiting bodies which ripen and give off additional clouds of spores at blossom time. In seasons when wet weather prevails during blossoming, the brown rot fungus infects and kills the blossoms. The blighted blossoms remain on the tree twigs, hanging limp and blasted. They become gummy and sticky in damp weather and are the source of additional masses of brown rot spores at ripening time.

The fungus grows into the twig through the stem of the blossom, causing a small canker. These cankers produce spores the following year during long periods of wet weather.

BROWN ROT OF PEACH

Recent serious losses from the brown rot disease are fully appreciated. 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. Peach growers must get better control of this disease to realize a steady and substantial market demand.

This disease is characterized by large numbers of spores which are produced from several sources. Late summer sprays do not give adequate control when heavy spore-loads are 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. Brown rot has also been increasingly serious in eastern and other midwestern peach producing areas. A re-evaluation of control practices has resulted from recent experiments.

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.
2. Mummies which fall to the ground and become half buried produce countless numbers of spores from small mushroom-like fruiting bodies during a 2-week period at blossom time.
3. Infected blossoms (blossom blight) stick to the twigs and in the summer produce spores during each wet period 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 on currently rotted fruits on the tree.

Infection possibilities—Open blossoms are readily infected during wet weather. Blossoms are especially susceptible when the pistil is exposed and during the first 5 days after opening. Rain and high humidity are necessary for infection. Green fruits are resistant but can be infected through fresh wounds. Ripe fruits can be infected directly.

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 protection through sprays and sanitation.

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 sanitation is of special value if begun with the first crop in the orchard, and if there is isolation from other orchards. It will take several years to realize the maximum results from sanitation if precautions have lapsed. Many cankers are eliminated through pruning. However, it is impossible from a practical standpoint to locate and prune out all of the cankers resulting from the previous year's blossom infections. Presence of last year's cankers requires a more rigid spray program to prevent blossom blight and 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 that fewer sprays or dusts may accomplish the same control if applied coincident with rainy periods.

Special efforts are necessary to cover the entire surface of all fruits. Sprays must penetrate through to the far side of the tree to cover the inner surfaces. This is best accomplished by fogging the spray through the trees with fine mist and directing the spray stream through open spaces to reach behind obstructing branches. Mechanically operated spray equipment should be regulated to achieve satisfactory coverage. Spreaders should be used in the later cover sprays.

Pruning—Trees should be "pruned" to allow free passage of the spraying and dusting equipment at ripening time at least in one direction. The late sprays are very important in reducing transportation and storage rot. 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 unprotected blossoms at a strategic time. Phygon has given good control of brown rot in the bloom sprays in Illinois and Indiana.

Paste or wettable sulfurs 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 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 have given somewhat better control in certain instances.

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. Ferbam applied previous to picking appears to give superior fruit protection for plums and sweet cherries.

Blossom blight caused by 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 substituted for these materials. 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.

EUROPEAN-BROWN-ROT BLOSSOM BLIGHT ON CHERRIES

Within the past few years, severe blossom blight has been observed in certain 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 observed in mid-June by the dead, brown leaves and flowers which remain attached to the blighted spurs. The causal 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.

SUGGESTIONS FOR CONTROL

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.

Wisconsin recommends a 6-4-100 bordeaux, to which 4 pounds of monocalcium arsenite and 1½ pints of Stanolind Dormant Spray Oil (a product of the Standard Oil Company) is added. California experiments indicate that 3 pounds of monocalcium arsenite alone is sufficient. A protective spray of bordeaux 6-8-100 should be applied also in early bloom. Several sprays of Phygon XL, ½ pound per 100 gallons of spray applied during bloom, have given good control.

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

PEACH CANKER

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. Leave no stubs. Remove all deadwood at pruning time, and make the pruning cuts back to live, active branches which will heal over readily. Check trees again when growth starts to see if any deadwood was overlooked. Remove and burn all prunings promptly. Remove small, cankered branches entirely by cutting back to a live branch.

Surgery—On large limbs or trunks, 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 later in the season cultivation is continued and the cover crop sown, the more canker resulting. Forcing of tree growth by cultivation and fertilization should be accomplished early in the season, and the tree growth checked for early fall maturity by sowing the cover crop early, before July 15. Trees treated in this way are less subject to cankers. This is perhaps more important on the heavy soils where canker is more severe.

CHERRY LEAF SPOT

SUGGESTIONS FOR CONTROL

Cherry leaf spot can be controlled by spraying. Four applications of a copper fungicide—applied at Petal Fall, 2 weeks after Petal Fall, 4 weeks after Petal Fall, and immediately after harvest—have given good control in experimental work now for more than nine years. A few organic fungicides have been developed recently which show promise for control of leaf spot.

The dithiocarbamates, such as ferbam and nabam, have been used successfully by some growers. Crag Fruit Fungicide 341 has had successful usage in the East, and has given good control of leaf spot in several seasons of testing in Michigan.

Thorough applications, especially to the tops of the trees, 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 during the winter; spores are present in the old leaves for a period of 6 to 7 weeks, and are discharged when rains occur. Keeping the foliage covered with a copper 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-percent copper or its equivalent plus 3 pounds of lime, per 100 gallons of spray.

Experimental results with a half-and-half mixture of proprietary copper and elemental sulfur plus lime (1½ to 2 pounds of proprietary copper, 2 to 3 pounds of elemental sulfur, 3 to 4 pounds of lime) showed this mixture to be satisfactory for leaf-spot control on both sweet and sour cherry.

Dithiocarbamates have given good results without injury to sweet cherries for leaf-spot control and are of value against brown rot.

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 both the lower and upper surfaces of the leaves—soon after the characteristic round purple-to-brown spots appear—will check further development of the disease and prevent dropping of many of the infected leaves.

Actidione at 2 parts per million will eradicate active leaf-spot infection. It may be applied just before, during, or after harvest—if development of leaf-spot is noticed.

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 14 days of the Petal Fall spray, and the Second Cover not more than 14 days after the First Cover spray.

Black cherry aphids caused severe injury in some orchards in 1945. When aphid injury was severe, and the trees were sprayed with copper materials, heavy defoliation occurred. This defoliation can be prevented by controlling the aphid early in the season, either with a dormant DN spray or with nicotine sulfate, when the aphids are first noticed in the orchard.

BACTERIAL SPOT OF STONE FRUITS

Bacterial spot is serious on peach and plum. It is controlled by keeping the tree in good vigor, and by correcting arsenical injury which is likely to be severe following this disease. Bacterial spot is most readily seen on leaves and fruit as small, angular, dark-brown dead spots. It is distinguished from arsenical injury by the small size

and darker color of the spots—which on peach leaves do not fall out so readily as those caused by arsenical injury. The infections first appear as small water-soaked spots. Indications of bacterial ooze can frequently be found. Infected leaves may turn yellow and fall during the summer.

SUGGESTIONS FOR CONTROL

Experiments by the United States Department of Agriculture have prompted recommendations of 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. This program is reported to prevent much of the injury, although its effects may be largely the result of reducing arsenical burn. This program is not particularly effective when started later in the season. The disease is sometimes introduced in an orchard on nursery stock, but Michigan nurseries have been generally free from it. 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 the injury from this disease.

CORYNEUM BLIGHT OF PEACH

Coryneum blight is not a serious disease in the main peach-growing sections of Michigan. It can be controlled by a fall application of bordeaux 12-12-100, as soon as most of the leaves have fallen, which usually is about October 15. This spray protects the buds against fall and winter infection. When this spray is applied for coryneum blight, no extra treatment is needed for leaf curl.

One of the most serious phases of the disease is the killing of the fruit buds during periods of wet weather in late fall and winter. Where killing of the buds occurs, there is an abundance of spores produced the next season which may infect the fruit and growing parts of the tree. The disease is characterized by lesions on the leaves, fruits and green shoots. The lesions have a definite red ring around a cream-colored center. Infected leaf tissue falls out leaving a clean, round hole.

PEACH LEAF CURL

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 8-8-100. If applied in the

spring use either 8-8-100 bordeaux, ½ percent Elgetol, or Krenite, or lime-sulfur—5 gallons to 100 gallons of spray. A dormant spray of bordeaux and a compatible proprietary dormant oil applied in the spring will control scale, mites and leaf curl in one application. Home-made oil emulsion with bordeaux can be used for the same purpose.

The leaf curl fungus lives over harmlessly from year to 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 fungus must be destroyed by a dormant spray before the buds break and growth starts in the 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 of diseased trees. They do not spring up spontaneously, but are infectious. The familiar peach diseases are yellows, little peach, and red suture—while the disease previously known as "physiological yellows" of cherry is now known to be of virus origin 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 carries a disease known as "prune dwarf" which shows up in severe form on Italian prune, and produces a disease similar to rosette mosaic on peach.

SUGGESTIONS FOR CONTROL

Viruses cannot be reached and killed with sprays, but control of insect vectors may be of value in reducing the spread of these diseases.

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. *Sprays, fertilizers, or cultural practices have no effect on the disease.*

CONTROL IS DIFFICULT

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. The practice of removing only the seriously infected trees in 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.

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.

"X" DISEASE

SUGGESTIONS FOR CONTROL

"X" disease is well established on chokecherries in Michigan, but the disease does not spread from them to peaches when separated for a distance of 500 feet. This possibly holds true for sweet and sour cherry infection. Eradicate the chokecherries for a distance of 500 feet from peach and cherry orchards by completely grubbing out the chokecherries and all of their roots, or by spraying with a weed killer in early July. Sodium chlorate, with a small amount of calcium chloride added to make it less inflammable (sold under the name of Atlacide)—or a non-inflammable salt, ammonium sulfamate (sold as Ammate)—should be applied at the rate of ¾ pound to a gallon of water until the chokecherry leaves are thoroughly wet. If applied in early July, the spray penetrates the leaves and travels down to the roots, killing them as well. It is not so effective when applied before or after this date.

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 outstanding 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.

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.

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.

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. The new black-rot lesions on the leaves appear as dark brown spots with a definite margin. Small, 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 soon 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 2 to 4 inches long. The Grape Spraying Schedule (see page 62) provides for a complete spray coverage every 10 to 14 days until the berries touch in the cluster.

Formerly, home-made bordeaux—8-8-100 or 6-8-100—was necessary for success in controlling black rot, under severe conditions. Home-made 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 4-4-100 in later sprays.

DEAD ARM OF GRAPES

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. 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. *The first grape spray is important in preventing new infections of dead arm where this disease is prevalent.* Sprays will not control established infections.

INSECTS: LIFE HISTORIES AND CONTROL PRACTICES

APPLE MAGGOT

Apple maggot increased in Michigan orchards in 1952, and is now our Number One apple pest. Growers should be alert to detect and fight this pest which has caused such severe loss.

SUGGESTIONS FOR CONTROL

Apple maggot may be controlled with lead arsenate, DDT, or methoxychlor. Do not fail to add a corrective ingredient if lead arsenate is used for apple maggot control.

The date for the first spray against apple maggot is determined each year by the Department of Entomology. This information is sent out by county agricultural agents, newspapers, and radio stations. Bait traps for apple maggot contain a scant tablespoonful of household ammonia in a quart of soapy water. Traps may be fruit jars, honey pails, coffee cans—in fact any small clean container which can be hung in the tree. (Instructions for making a fly trap which also works in orchards is contained in Michigan Extension Folder F-82.)

The apple and blueberry maggot are the same insect. This native insect is on its "home grounds" in Michigan. Before spraying became general in the 1880's apple maggot, then called "railroad worm" because of its tunnels in the fruit, was the most important orchard pest. At that time livestock feeding in orchards and the use of low-grade apples as "vinegar stock" retarded the spread of this insect. This pest is increasing in Michigan and is now a serious problem in certain areas.

The single generation of flies responsible for maggot-infested apples appears in late June or early in July. They feed by scrubbing the surface of leaves and fruit with their mouth-parts. Feeding continues

about a week before the eggs are laid. No insecticide has killed the maggots after they are in the apples.

Removal of infested fallen apples from beneath the trees before the maggots emerge, destroys the chance of a buildup in numbers.

Begin picking up drops after the third week in July. Summer varieties must be collected twice a week; fall varieties each week; and winter varieties every 2 weeks. Destroy infested apples by piling them in some out-of-the-way corner and then, the following spring, treat with 1 gallon of used crankcase oil for each 10 square feet of pile. Other methods of disposal will occur to orchardists, but one should make sure that such methods destroy the maggot.

APHIDS

Aphid control is necessary on apple, cherry, and sometimes on plums.

With the exception of green aphids on apples, these pests have been controlled by dormant sprays. Organic phosphates will control black cherry aphids if applied when they first appear, as well as all types of aphids on fruit. DN compounds are specific for aphid eggs, and can be applied as dormant sprays. Most DN compounds are not suggested for red mite eggs. Apply at the manufacturers' recommendations.

Combination of DN with oil sprays containing more than 2-percent oil has caused injury.

Metacide, an organic phosphate compound, has given excellent aphid control.

Aphid control by sprays and dusts on trees in leaf requires extremely careful application. Nicotine sulfate (40 percent) 1 pint or its equivalent, plus a suitable wetting agent and 1 pound of lime in 100 gallons of spray is effective for black cherry aphids. As sweet cherries are susceptible to brown rot, sulfur may be included in aphid sprays if necessary.

Green aphids on apples often foul the fruit and injure the new growth in July. This insect can be controlled by organic phosphate or nicotine sprays. DDT when applied for codling moth usually holds this pest under control.

Aphids overwinter on fruit plants as shiny black eggs which hatch just as the buds burst. The reproductive power of aphids is so great

that spraying for them should be on the basis of the history of infestation, rather than on the number of eggs present.

CHERRY FRUIT FLY

State law prohibits sale of cherries infested with fruit-fly maggots. Arsenate of lead, or methoxychlor, applied during the period in which the adult cherry fruit flies are feeding has given control. There is a period of about a week between the time the flies appear and the beginning of egg laying. The spraying dates are announced each year by your County Agricultural Agent.

Cherries for fresh fruit may be protected by 3 sprays at 7-day intervals—using methoxychlor, or 3 pounds of ground derris or cube containing 4 percent rotenone, per 100 gallons of spray. These will leave no harmful residues. Two and one-half-percent rotenone dust will also control the flies if it is thoroughly applied.

Wild chokecherries and pin cherries in close proximity to cherry orchards are believed to be sources of cherry maggots, and should be removed when possible as a safety measure.

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

CODLING MOTH

Codling moths attack apples, pears, and quinces—and occasionally peaches and plums, when interplanted with apples. The moths first appear in the orchard soon after calyx time, and are present in varying numbers until harvest. There are two broods a year in Michigan. The peak of the first brood occurs about June 12-20, and the moths of the second brood appear usually between July 20-August 1. Severity of second brood attack is influenced by the weather during August and early September.

SUGGESTIONS FOR CONTROL

Control consists of sanitary measures—such as destroying overwintering places, banding trees, picking up drops and spraying.

While DDT sprays have simplified the control of this pest in heavily infested orchards, supplementary methods are valuable aids.

The second brood moths always comes from the first brood. Thorough coverage during the entire period in which the first brood worms are actually entering apples is necessary to destroy those worms and prevent further breeding. This involves coverage at the time of the Petal Fall spray, and coverage at short intervals during the period of rapid growth immediately after the Petal Fall spray.

Late sprays (after mid-July) will control codling moth only if the number of larvae surviving the first brood sprays has been kept to a low figure. No material or schedule in July can substitute for the proper applications in June.

Timing of the second-brood codling moth spray is set by the Michigan State College spraying service, and announced through farm publicity agencies.

FRUIT TREE LEAF ROLLER

Fruit tree leaf roller sometimes causes ragged apple foliage about calyx time and shortly afterward. This insect also causes some fruit drop, and large russeted scars in apples at harvest. Fruit tree leaf roller in its destructive form is a green, active, black-headed caterpillar. There is one generation a year, the winter being passed in the egg stage on the twigs and branches of the tree. The rounded egg masses are reddish purple, flattened and about ¼ to ½ inch in diameter.

This insect is cyclic in abundance and has caused little trouble for several years. A thorough application of 6-percent dormant oil kills the eggs.

Recent tests have shown that 1 pound of 15-percent wettable parathion, in 100 gallons of spray, applied when the leaves are well out will destroy this leaf roller.

GRAPE BERRY MOTH AND GRAPE LEAFHOPPER

Insofar as spraying is concerned, grape berry moth and leafhopper are considered together. The program suggested is designed to take care of both insects.

Grape berry moth has three generations each year. The first brood appears about the time grapes bloom. Michigan growers are familiar with its little webs in the bunches at that time. The second brood appears just as the berries are touching in the bunches. The time of the third brood (usually August 10-25) is announced by county

agricultural agents in the grape-growing section. Working the soil towards the vines, and leaving it undisturbed until after July 1, covers many berry moth pupae and thereby reduces the insect population.

Grape leafhoppers move into the vineyards about a week before bloom. Several generations are produced before frost. When leafhoppers are not controlled soon after grapes set, it is difficult to do so later.

Use of properly designed covered booms improves control of grape insects and diseases by insuring better coverage. A combined oil, arsenical, and nicotine program has given excellent control of grape berry moth and leafhopper. Nicotine is an excellent material for use against leafhopper and also a good control for grape berry moth. DDT has given improved control of berry moth, leafhopper and rose chafer on grapes.

The first grape berry moth spray should be applied when the new shoots are 4 to 6 inches long. See the Grape Spraying Schedule (page 62) for other required sprays.

GRASSHOPPERS

Grasshoppers in Michigan orchards are the result of one brood, which usually hatches in June from eggs laid the previous season. These young grasshoppers can be killed readily and cheaply in late June or early July by sprays of calcium arsenate, 5 pounds in 100 gallons of spray applied to the ground cover.

Or a poisoned bait consisting of 25 pounds of bran or millfeed, 75 pounds of sawdust, and 4 pounds of sodium fluosilicate—mixed with enough water to make a stiff mash—can be used at the rate of 15 to 20 pounds per acre. If sodium fluosilicate is not available, 5 pounds of white arsenic or 5 pounds of paris green may be substituted for it. This bait can be spread with an end-gate seeder, a bait spreader or by hand. (The Department of Entomology at Michigan State College will furnish plans for building a bait spreader on request.)

One pound of *actual* chlordane, three-tenths of a pound (0.3 pound) of the gamma isomer of benzene hexachloride, or 1 pound of *actual* toxaphene per acre—applied as a dust or a spray—have given good control. This means you must use a sufficient quantity of a diluted material when making up a mixture for application, to equal the actual quantity recommended. (For example, if you've purchased

a 5-percent chlordane dust, 20 pounds of this material is equal to 1 pound of *actual* chlordane.) Parathion sprays are also highly effective against grasshoppers. Chlordane should not be used on forage to be consumed by animals.

LEAFHOPPERS

Leafhoppers are small, yellowish-white, sucking insects able to run forward or sideways. Their four roof-like wings and agile movements distinguish them readily from other insects commonly found on apples.

Several kinds of leafhoppers attack fruit trees in Michigan. Certain types of leafhoppers cause whitish areas on the leaves, others cause the leaves to curl downward at the edges. This type of injury is often confused with aphid injury.

Leafhoppers in orchards are controlled by DDT at the time of the first or second cover spray on apples. Nicotine sulfate has also been used successfully.

MINEOLA MOTH

This potential cherry pest is a native insect that has caused anxiety to the cherry industry since its appearance in northern orchards in 1950. It passes the winter as a minute hibernating larva, in a small silken case in the 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. There are two full generations each season, following the over-wintering larvae which feed on the buds. The larvae of these two summer generations bore into the cherries, some of them at picking time. Larvae entering the fruit near picking time have been found in processed cherries.

Tests with insecticides, and observations in infested orchards, have shown that dormant sprays using DN compounds and parathion sprays applied at Green Tip, Pre-Blossom, and in the Petal Fall sprays result in effective commercial control of mineola moth.

MITES

Two species of mites are causing trouble in Michigan orchards. They are the European red mite and the so-called "two-spotted mite"

(red spider). The European red mite and its eggs are reddish. Eggs are laid all over the trees and pass through the winter there. The two-spotted mite and its eggs are greenish in color. This mite does not pass the winter in the egg stage, but as an adult mite. Some hide beneath the bark, but many others hide about the base of trees and in any ground trash. The two-spotted mites live on many plants found in the orchard cover. Females of both mites lay many eggs. A new generation develops each 30 days.

Weather conditions determine the rapidity of mite build-up. Hot, dry weather greatly favors build-up of mites and injury by them. Certain varieties of apples and plums especially suffer. Vigorously growing trees are not affected by a moderate mite infestation in the same degree as are less vigorous trees. Be alert to detect mites on susceptible fruits; when the foliage on your trees show mite injury, it is time to stop them.

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

SUGGESTIONS FOR CONTROL

Thoroughly applied dormant oil sprays and certain DN sprays will kill all the European red mite eggs which are wetted.

Infestations of the two-spotted mite require summer applications. This is also true for outbreaks of European red mite in the growing season. Parathion has given excellent control of mites on foliage. Dilute DN 111 has given control in many cases. Summer oil, 1 percent, (when used without sulfurs) has also been effective. Certain proprietary rotenone compounds kill mites. When DN 111, summer oils, or rotenone are used, three or more applications are usually necessary. Parathion may give control with one spray, but sometimes two or more applications will be required.

Sulfur deposits on the foliage increase danger of injury from oils and DN compounds in summer applications.

There are several specific miticides sold by manufacturers of insecticides. These have appeared to be effective against mites when used as recommended by the manufacturer.

PEACHTREE BORER

Peachtree borers girdle trees at the ground level. The borers spend the winter beneath the exuded gum about the base of the tree and emerge as moths from late June to August.

DDT treatment has proven effective against this pest. (See Peach Spraying Schedule, page 56.)

In using DDT better results will follow if special applications are made. Cut the pressure on the spray rig to about 150 pounds and apply a solution of 3 pounds of 50 percent wettable DDT in 100 gallons to the trunks from crotches to the ground. The application should thoroughly drench the trunk and area near the ground line. Two applications are suggested, the first about July 10—followed by a second application after 12-14 days.

The peachtree borer is controlled by the use of paradichlorobenzene (PDB) applied about September 1 in a ring around the base of the tree. The crystals are then covered with a mound of soil. This mound should be removed after 30 days to avoid injury.

Use 1 ounce of PDB for a tree 6 years or older; ¾ ounce for a 5-year-old tree, ½ ounce for 4-year-old tree.

Trees planted less than 3 years should not be treated with PDB crystals.

Ethylene dichloride emulsion is not recommended for borer control under Michigan conditions.

LESSER PEACHTREE BORER

The lesser peach borer attacks peach trees in any injury that may occur in the crotches and on the larger limbs and branches. This insect is a close relative of the true peachtree borer. It may be controlled by applications of 1 pound of 50 percent wettable DDT with 1 pound of 15 percent wettable parathion in 100 gallons of spray. *These applications must be applied earlier in the season than the treatment for the true peachtree borer.*

PEAR PSYLLA

The pear psylla is a jumping plant louse. The adults pass the winter in and around the orchards—usually on the tree in bark crevices—and become active early in the spring. Pear-psylla adults can be seen almost any time in winter on warm bright days. The small,

yellowish eggs are usually laid before the buds burst. There are several generations each season. The small pinhead-sized yellow nymphs live on the leaves in tiny pools of excreted honey-dew.

SUGGESTIONS FOR CONTROL

Pear psylla can be controlled by dormant oil sprays in March and early April before egg laying begins. Many growers have applied this spray too late. Thorough spraying is imperative. All parts of the tree must be covered.

When psylla is not controlled by dormant oil, it is necessary to use a foliage spray. Nicotine sulfate and 3 quarts of summer oil, or parathion at the rate of 1 pound of 15 percent wettable material in 100 gallons of spray, gives effective control. Repeat the application in 10 days if control is not obtained.

PLUM CURCULIO

Plum curculio first attacks fruits just before or after blossoming. The young fruits drop, as a result of injury from larval feeding. From late July to harvest-time, adult curculios cause further injury by puncturing the fruit in feeding, and by spreading brown rot. There is one generation a year in Michigan. The long life of the adults (10-15 months) is responsible for the extended period of attack. A curculio emerging in July feeds until cold weather, hibernates for the winter in or near the orchard, and emerges the following spring to cause damage again. Each female curculio may lay approximately 300 eggs, and may blemish a like number of fruits. Disposal of thinnings, destruction of over-wintering places, and proper spray applications are necessary to control this pest.

SUGGESTIONS FOR CONTROL

The first spray application to control curculio is applied when the adults begin to feed. This is usually after two or more days with temperatures averaging 55° F. Two additional sprays at 10-day intervals should control this pest.

Present practices of sod and semi-sod orchards with mulching material beneath the trees encourage the survival of curculio. While this pest has but seldom been observed to cause economic damage in Michigan peach orchards it sometimes does cause severe loss to apples, cherries, and particularly to plums. The curculio 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. Dieldrin, methoxychlor, EPN-300, and arsenate of lead kill this pest.

RED-BANDED LEAF ROLLER

The red-banded leaf roller is a pest which has been present in Michigan for a long time, but has not caused serious damage until the general substitution of DDT for lead arsenate in the control of the codling moth. When lead arsenate is used in the Pink, Petal Fall, First Cover, Second Cover and again in July for apple maggot control—the injury caused by the red-banded leaf roller is usually reduced to a low figure. Parathion (See Apple Spraying Schedule B, page 53f) results in good control of this pest. For the second brood DDD (TDE) has given good control, and 3 pounds of 50 percent wettable DDT is effective.

To prevent losses from red-banded leaf roller always requires wiping out most of the first brood with the early sprays. Success 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.

ROSE CHAFER

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

Use 1½ pounds of 50 percent wettable DDT per 100 gallons, or a 10 percent DDT dust, to control rose chafer. Apply when the first rose chafers appear. Parathion is also an effective material.

SCALE INSECTS

Scale insects are usually not a problem in Michigan, especially when DDT or parathion are used in summer sprays. These materials both kill the young crawlers of scale and prevent scale infestations.

San Jose scale lives over winter as a nymph (young scale). As this insect kills trees, it is important to keep this pest in mind at all times. Infested trees have a scurfy, unhealthy appearance, purplish discoloration beneath the surface of the bark, and tiny reddish blotches on the fruit. Heavy infestation kills branches or the entire tree, and the fruit may be blemished.

Oystershell scale resembles a miniature oystershell. The "shell" covers about 100 eggs which hatch in June. Oystershell scale is present in many orchards, but is of little importance in orchards south of Manistee. Oystershell scale sometimes causes damage in the northern counties.

A soft brown, turtle-shaped lecanium scale on peaches has caused concern in several areas of Michigan. It is almost completely wiped out by a single thorough application of 1½ pounds of 15 percent wettable parathion in 100 gallons. This application should be made when about 25 percent of the eggs beneath the female scale have hatched. The time is set by the Michigan State College Spray Service.

Most scale insects likely to occur on Michigan fruit trees are readily controlled by sprays containing 3-percent actual oil. However, 4 percent oil is required for control of oystershell scale.

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 these beetles may emerge from a brushpile of prunings in the 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 percent DDT plus 1½ pounds of 15 percent wettable parathion in 100 gallons. A spray of 6 pounds of BHC (6% gamma) in 100 gallons has killed bark beetles in infested prunings and dead trees. *This 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.

Spraying the ground beneath the trees and the trunks has proven an effective control. Materials which have been effective are 2½ pounds of 40 percent chlordane, 2 pounds of 50 percent wettable DDT, or 5 pounds of BHC (6 percent 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 caterpiller is controlled easily with either 3 pounds of lead arsenate, 1½ pounds of 50 percent wettable DDT, or 1½ pounds of 15 percent wettable parathion per 100 gallons of spray—if it is applied when the insects are first detected.

III. Spraying Schedules for 1953

The schedules on the pages following have been completely revised since the 1951 edition of the Spraiyng Calendar. They represent the current recommendations of Michigan State College as to general control practices best suited to Michigan conditions. But, again, fruit growers throughout the state should adjust the schedules according to their specific orchard conditions to achieve the most effective spraying program.

Spraying schedules for the major tree-fruits are given first (pp. 51-61). Suggestions for disease-and-insect control on a number of the small-fruits follows (pp. 62-67), roughly in order of their commercial importance at the present.

The attempt has been made to clarify a point which has proved troublesome to some growers in the past. A brief italicized direction tries to make it unmistakable as to: (1) where only one basic formulation is recommended, but with a choice as to which of certain materials may be used; and (2) where there is a choice of more than one spray formulation to accomplish the same purpose.

APPLE SPRAYING SCHEDULE "A"

(*Using LEAD ARSENATE and DDT*)

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	3% actual oil (emulsified) or DN compounds	Red mite, scale, rosy aphid, bud moth

Note: This application is *usually not necessary* under Michigan conditions, except when bud moth or rosy aphid is a problem. These two insects are controlled at that time with DN compounds.

GREEN TIP to DELAYED DORMANT	*Use ONE of following—* 2 gallons lime-sulfur 6-10 pounds sulfur paste 5-6 pounds wettable sulfur	Scab

Note: The period from GREEN TIP to FIRST COVER is the crucial time for scab control. All newly expanded foliage and blossom parts must carry a coating of protective fungicide at the beginning of rainy periods or receive an eradicative fungicide within 50 to 72 hours after the start of foliage wetting. Eradication fungicides include liquid lime-sulfur, proprietary mercurial compounds, and Phygon. Phygon and lime-sulfur are also used as protectants. Proprietary mercuries have little or no protective value. The number of fungicide applications necessary to control scab will vary with the materials used, and the number and distribution of wetting periods, while there is danger of scab infection. The protective applications indicated in this "Spraying Schedule" are related to growth and development of the leaves and fruit. In some years certain of these sprays will not be necessary, while in other seasons added applications will be required for control of scab.

PRE-BLOSSOM PERIOD *PRE-PINK*	*Use ONE of following—* 2 gallons lime-sulfur 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 1½ pounds ferbam	Scab

Note: If curculio, bud moth or rosy aphids are present, add ½ to 1 pound of 15% parathion. *Do not use lime-sulfur and parathion together in the same spray tank;* lime reduces the effectiveness of parathion. Ferbam used before SECOND COVER on Golden Delicious and Jonathan in some seasons has caused serious fruit russeting, especially when combined with parathion.

PINK	*Use ONE of following—* 2 gallons lime-sulfur 6-10 pounds sulfur paste 1½ pounds ferbam *Plus* 3 pounds lead arsenate	Scab Red-banded leaf roller, curculio

Note: Add 1 pint 40% nicotine sulfate plus a wetting agent, if rosy aphids are present.

IN BLOOM	When necessary to control scab during the bloom period, use *either* 6-10 pounds of sulfur paste, 5-6 pounds of wettable sulfur, or 1½ pounds of ferbam per 100 gallons of spray. If fire blight (blossom blight) is a problem at this time use 2-6-100 bordeaux, or proprietary copper compounds, at manufacturers' directions.

(*Continued on next page*)

(APPLE SPRAYING SCHEDULE "A"—continued)

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
PETAL FALL	*Use ONE of following—* 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 1½ pounds ferbam *Plus* 3 pounds lead arsenate	Scab Red-banded leaf roller, curculio, codling moth
FIRST COVER (7-10 days after Petal Fall)	*Use ONE of following—* 5-8 pounds sulfur paste 4-5 pounds wettable sulfur 1½ pounds ferbam *Plus* 3 pounds lead arsenate	Scab Red-banded leaf roller, curculio, codling moth

Note: Sulfur paste used after FIRST COVER may cause sulfur burn, especially under warm humid conditions. Phygon should not be used after FIRST COVER.

SECOND COVER (7-10 days after First Cover)	*Use EITHER—* 1 pound ferbam, *or* 4 pounds wettable sulfur *Plus* 2 pounds lead arsenate, *and* 1 pound 50% wettable DDT	Scab Red-banded leaf roller, curculio, codling moth
THIRD COVER (10-14 days after Second Cover)	*Use EITHER—* 1 pound ferbam, *or* 4 pounds wettable sulfur *Plus* 2 pounds lead arsenate, *and* 1 pound 50% wettable DDT	Scab Red-banded leaf roller, curculio, codling moth
FOURTH COVER (Time to be announced)	¾ pound ferbam *Plus* 3 pounds lead arsenate	Scab Apple maggot, codling moth

Note: If mites are a problem or if they became a problem at the time of late applications, add ½ to 1 pound 15% parathion per 100 gallons to spray mixture. Or use miticides such as DiMite, EPN 300, Aramite, TEPP at manufacturers' directions. The fungicide may be omitted in this spray application on scab resistant varieties, such as Jonathan, or on susceptible varieties when scab is completely controlled. However, if ferbam is omitted, substitute in its place zinc sulfate 1 pound and lime 4 pounds as a safener for lead arsenate.

FIFTH COVER (10 days after Fourth Cover)	¾ pound ferbam *Plus* 3 pounds lead arsenate	Scab Apple maggot, codling moth

Note: The fungicide may be omitted on scab-resistant varieties or, if scab is completely controlled, on scab-susceptible varieties such as McIntosh and Red Delicious. However, if ferbam is omitted, substitute in its place zinc sulfate 1 pound and lime 4 pounds as a safener for lead arsenate.

SIXTH COVER (Time to be announced)	1½ pounds 50% wettable DDT	Codling moth

Note: If mites are a problem replace ½ pound 50% DDT with ½ pound 15% parathion, or use commercial miticides at manufacturers' directions with 1½ pounds 50% wettable DDT. If red-banded leaf roller is a problem, or becomes a problem as late as 10 days before commercial harvest, use DDD (which is also called TDE) at manufacturers' directions.

To convert quantities of 50% wettable DDT to equivalent quantities of 75% wettable DDT, multiply by 0.67. *Example:* 1½ pounds of 50% DDT x 0.67=1.005, or 1.0 pounds of 75% DDT.

APPLE SPRAYING SCHEDULE "B"

(Using PARATHION and DDT)

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	3% actual oil (emulsified) or DN compounds at manufacturer's directions	Red mite, scale, Rosy aphid, bud moth

Note: This application is usually not necessary under Michigan conditions, except when bud moth or rosy aphid is a problem.

GREEN TIP to DELAYED DORMANT	*Use ONE of following—* 2 gallons lime-sulfur 6-10 pounds sulfur paste 5-6 pounds wettable sulfur	Scab

Note: The period from GREEN TIP to FIRST COVER is the crucial time for scab control. All newly expanded foliage and blossom parts must carry a coating of protective fungicide at the beginning of rainy periods or receive an eradicative fungicide within 50 to 72 hours after the start of foliage wetting. Eradication fungicides include liquid lime-sulfur, proprietary mercurial compounds, and Phygon. Phygon and lime-sulfur are also used as protectants. Proprietary mercuries have little or no protective value.

PRE-BLOSSOM PERIOD *PRE-PINK*	*Use ONE of following—* 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 1½ pounds ferbam *Plus* ½ to 1 pound 15% wettable parathion	Scab Rosy aphid

Note 1: Ferbam used *before* SECOND COVER on Golden Delicious and Jonathan *has caused serious fruit russeting,* especially when used with parathion.

Note 2: It is almost impossible to control rosy aphids after they have rolled the leaves. Make an effort to control them at this time. More than ½ to 1 pound of 15% wettable parathion per 100 gallons may cause injury on McIntosh, Snow, Early McIntosh, Kendall, Cortland, and other varieties related to McIntosh.

PINK	*Use ONE of following—* 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 1½ pounds ferbam *Plus* ½ to 1 pound 15% wettable parathion	Scab Red-banded leaf roller, curculio, rosy aphid
IN BLOOM	When necessary to control scab during the bloom period, use 6-10 pounds of sulfur paste, or 5-6 pounds of wettable sulfur, or 1½ pounds of ferbam per 100 gallons of spray. If fire blight (blossom blight) is a problem at this time use 2-6-100 bordeaux, or proprietary copper compounds at manufacturers' directions. Parzate or Dithane-Z78 at 1½ pounds in 100 gallons of spray is also useful in controlling blossom blight, and should give little to no fruit russeting.	
PETAL FALL	*Use ONE of following—* 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 1½ pounds ferbam *Plus* ½ to 1 pound 15% wettable parathion	Scab Red-banded leaf roller, curculio

(Continued on next page)

(APPLE SPRAYING SCHEDULE "B"—continued)

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
FIRST COVER (5-7 days after Petal Fall)	*Use ONE of followig—* 6-10 pounds sulfur paste 5-6 pounds wettalbe sulfur 1½ pounds ferbam *Plus* ½ to 1 pound 15% wettable parathion	Scab Red-banded leaf roller, curculio
SECOND COVER (5-7 days after First Cover)	*Use EITHER—* 1-1½ pounds ferbam, *or* 4-5 pounds wettable sulfur *Plus* ½ pound parathion *Plus* 1 pound 50% wettable DDT	Scab Red-banded leaf roller, curculio, codling moth
THIRD COVER (10-14 days after Second Cover)	*Use EITHER—* 1 pound ferbam, *or* 4 pounds wettable sulfur *Plus* ½ pound 15% wettable parathion *Plus* 1 pound 50% wettable DDT	Scab Red-banded leaf roller, curculio, codling moth
FOURTH COVER (Time to be announced)	¾ pound ferbam *Plus* 3 pounds lead arsenate	Scab Apple maggot

Note: The fungicide may be omitted in this spray application on scab-resistant varieties, such as Jonathan, or on susceptible varieties when scab is completely controlled. However, *if ferbam is omitted,* substitute in its place 1 pound of zinc sulfate and 4 pounds of lime as a safener for lead arsenate.

FIFTH COVER (7-10 days after Fourth Cover)	¾ pound ferbam *Plus* 3 pounds lead arsenate	Scab Apple maggot

Note: The fungicide may be omitted on scab-resistant varieties, or if scab is completely controlled on susceptible varieties such as McIntosh and Red Delicious. However, *if ferbam is omitted,* substitute in its place 1 pound of zinc sulfate and 4 pounds of lime as a safener for lead arsenate.

SIXTH COVER (Time to be announced)	1½ pounds 50% wettable DDT	Codling moth

Note: If mites are a problem, replace ½ pound of 50% wettable DDT with ½ pound of 15% wettable parathion, or use commercial miticides at manufacturers' directions with 1½ pounds of 50% wettable DDT. If red-banded leaf roller is a problem, or becomes a problem as late as 10 days before harvest, use DDD (which is also called TDE) at manufacturers' directions.

To convert quantities of 50% wettable DDT to equivalent quantities of 75% wettable DDT, multiply by 0.67. *Example:* 1½ pounds of 50% DDT x 0.67 = 1.005, or 1.0 pounds of 75% DDT.

PEAR SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	3% actual oil (emulsified)	Psylla, scale, red mite

Note: Dormant oil *will not* give satisfactory control of psylla, unless applied early in spring before egg laying begins. This spray may be omitted for the control of scale when DDT foliage-sprays are used. Psylla may be controlled during growing season as soon as it appears with 1 pound of 15% wettable parathion. Red mites may be controlled also during growing season with one or more applications of ½ pound of 15% wettable parathion, or commercial miticides.

PRE-BLOSSOM (When blossom buds of clusters begin to separate)	*Use EITHER—* 3-8-100 bordeaux, *or* 1½ pounds ferbam *Plus* 3 pounds lead arsenate	Scab, leaf spot Curculio

Note: Supplemental PRE-BLOSSOM sprays may be needed to control scab, depending on occurrence of rainy periods.

SPECIAL BLIGHT SPRAY (When necessary)	*Use ONE of following—* 2-8-100 bordeaux Proprietary copper compounds at manufacturers' directions 1½ pounds Dithane-Z78 1½ pounds Parzate	Fire blight

Note: Where fire blight is a problem, apply first spray when a quarter to a half of the blossoms are open, followed by a second application when approximately three-quarters of the blossoms are open.

PETAL FALL	*Use EITHER—* 1½ pounds ferbam, *or* 2-8-100 bordeaux *Plus* 3 pounds lead arsenate	Scab, leaf spot Curculio, codling moth
FIRST COVER (Two weeks after Petal Fall)	(Use the same chemicals suggested for PETAL FALL)	Scab, leaf blight, leaf spot
SECOND COVER (Two weeks after First Cover)	*Use EITHER—* 1½ pounds ferbam, *or* 2-8-100 bordeaux *Plus EITHER—* 1½ pounds of 50% wettable DDT with ferbam, *or* 2 pounds of 50% wettable DDT with bordeaux	Scab, leaf blight Codling moth

Note: If psylla becomes a problem, replace ½ pound of 50% wettable DDT with 1 pound of 15% wettable parathion.

THIRD COVER (Two weeks after Second Cover)	*Use EITHER—* 1 pound ferbam, *or* 2-8-100 bordeaux *Plus EITHER—* 1½ pounds of 50% wettable DDT with ferbam, *or* 2 pounds of 50% wettable DDT with bordeaux	Leaf blight Codling moth
FOURTH COVER (Time to be announced)	(Use the same chemicals suggested for THIRD COVER)	Leaf blight Codling moth

PEACH SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT (Before buds start to swell)	*Use EITHER—* 6-6-100 bordeaux, *or* 5 gallons lime-sulfur	Peach leaf curl

Note: Bordeaux may be used to control peach leaf curl any time after leaf drop in the Fall, during Winter, or *before* buds swell in early Spring. Lime sulfur is suggested for peach-leaf-curl control only in later Winter and early Spring.

LATE PINK (When first blossoms open)	*Use EITHER—* 2 gallons lime-sulfur, *or* ¼ pound Phygon and 4 pounds wettable sulfur	Brown rot (blossom blight)
EARLY BLOOM (When 25% of blossoms are open)	*Use ONE of following—* 2 gallons lime-sulfur ¼ pound Phygon and 4 pounds wettable sulfur 6-10 pounds sulfur paste 5-6 pounds wettable sulfur	Brown rot (blossom blight)

Note: When wet, humid conditions favorable for brown rot development occur during bloom, apply added applications of sulfur paste or wettable sulfur as often as necessary. Sulfur dusts applied during and immediately after rainy periods will protect blossoms from brown rot.

PETAL FALL	½ pound 25% wettable Dieldrin	Curculio

Note 1: 1½ pounds of 15% wettable parathion, 1 pound EPN-300, 3 pounds methoxychlor, or 2 pounds of lead arsenate may be used in place of Dieldrin. The *approximate residual* life for these insecticides is as follows: parathion 4-5 days, EPN-300 5-7 days, methoxychlor 7 days, and lead arsenate 10-14 days. If lead arsenate is used, be sure to include 4 pounds of zinc sulfate and 4 pounds of lime as a safener. If the period from PETAL FALL to SHUCK FALL is prolonged, the residual life of the insecticides other than dieldrin must be considered. Dieldrin at this time should remain effective until the SHUCK FALL spray.

Note 2: Sulfur may be omitted from this spray except when brown rot (blossom blight) has been a problem.

SHUCK FALL	*Use EITHER—* 6-10 pounds sulfur paste, *or* 5-6 pounds wettable sulfur *Plus* ½ pound 25% wettable Dieldrin	Brown rot, peach scab Curculio, tarnished plant bug

Note: Any insecticide used at PETAL FALL for curculio should be included again at this time. Also, recognize the residual time of the insecticide used to determine when additional sprays are needed. If lead arsenate and safener are used, add 1½ pounds of 50% wettable DDT for tarnished plant bug.

FIRST COVER (Two weeks after Shuck Fall)	*Use EITHER—* 6-10 pounds sulfur paste, *or* 5-6 pounds wettable sulfur *Plus* 1 pound 25% wettable Dieldrin	Peach scab, brown rot Curculio, tarnished plant bug

Note: Parathion, EPN-300, methoxychlor or lead arsenate and safener as suggested at PETAL FALL may be substituted for Dieldrin. If lead arsenate and safener are used, add 1½ pounds of 50% wettable DDT for control of tarnished plant bug.

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
SECOND COVER (4-6 weeks after First Cover)	1½ pounds 50% wettable DDT	Oriental fruit moth

Special: Peachtree Borer and *Lecanium Scale.* To control *peachtree borer*—Spray trunks of trees below the crotches and especially at ground line, using gun and reduced pressure with either 3 pounds of 50% wettable DDT or 2 pounds of 15% wettable parathion per 100 gallons. Follow with a second spray in 12-14 days. To control *lecanium scale*—Spray when scale is in the crawler stage, with 1½ pounds of 15% wettable parathion per 100 gallons. The timing of the sprays for these two pests will be announced through the Michigan State College spraying service and your County Agricultural Agent.

THIRD COVER (Approximately on month before harvest)	*Use EITHER—* 6-10 pounds sulfur paste, *or* 5-6 pounds wettable sulfur *Plus* 1½ pounds 50% wettable DDT	Peach scab, brown rot Oriental fruit moth
FOURTH COVER (7-10 days after Third Cover)	*Use EITHER—* 6-10 pounds sulfur paste, *or* 5-6 pounds wettable sulfur *Plus* 1½ pounds 50% wettable DDT	Brown rot, peach scab Oriental fruit moth

Note: If DDT is used after this spray on peaches to be sold on the market for fresh consumption, *DDT residue on the fresh fruit may be excessive.*

FIFTH COVER (7-10 days after Fourth Cover)	*Use ONE of following—* 6-10 pounds sulfur paste 5-6 pounds wettable sulfur 2 quarts lime-sulfur, added to *either* 3 pounds of wettable sulfur *or* 4 pounds of sulfur paste *Plus* Wetting agent	Brown rot
SIXTH COVER (7 days before harvest)	(Materials suggested are same as given for FIFTH COVER)	Brown rot
SEVENTH COVER (Just before harvest, if needed)	(Materials suggested are same as given for FIFTH COVER)	Brown rot

To convert quantities of 50% wettable DDT to equivalent quantities of 75% wettable DDT, multiply by 0.67. *Example:* 1½ pounds of 50% DDT x 0.67 = 1.005, or 1.0 pounds of 75% DDT.

PLUM SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT (Just before growth starts)	3% actual oil (emulsified)	Scale, red mite

Note: This spray is not usually necessary under Michigan conditions, since parathion sprays hold scale in check. Also, mites may be controlled during the growing season when they appear.

PRE-BLOSSOM (Just before flower blossoms open and as leaf buds burst)	*Use the following—* 1½ pounds 15% wettable parathion, with a wetting agent added *—OR Use* 3 pounds lead arsenate, *with* 4 pounds zinc sulfate *and* 4 pounds hydrated lime	Curculio

Note: 1 pound of EPN-300, or 3 pounds of 50% wettable methoxychlor, may be used *in place of* the 1½ pounds of 15% wettable parathion or the 3 pounds of lead arsenate with safeners for curculio control.

PETAL FALL (When most of petals have fallen)	*Use ONE of following—* 1½ pounds ferbam 5-6 pounds wettable sulfur 6-10 pounds sulfur paste *Plus EITHER—* 1½ pounds 15% wettable parathion, with a wetting agent added, *or* 3 pounds lead arsenate	Leaf spot Curculio

Note: If sulfur paste or wettable sulfur is used with lead arsenate, add 4 pounds of zinc sulfate and 4 pounds of lime to prevent arsenical injury. *Never use zinc sulfate and lime in same spray tank with ferbam.* Ferbam is a safener for lead arsenate.

FIRST COVER (10-14 days after Petal Fall)	(Use the same chemicals suggested for *PETAL FALL*)	Leaf spot, brown rot

Note: (See Note under PETAL FALL spray)

SECOND COVER (14 days after First Cover)	1½ pounds 50% wettable DDT	Leafhopper
THIRD COVER (One month before harvest)	*Use ONE of following—* 1½ pounds ferbam 5-6 pounds wettable sulfur 6-10 pounds sulfur paste	Brown rot, leaf spot

Note: If mites are numerous add ½ pound of 15% wettable parathion per 100 gallons of spray, or use commercial miticides.

FOURTH COVER (7-10 days before harvest)	(Use the same chemicals suggested for *THIRD COVER*)	Brown rot

SOUR CHERRY SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	DN compounds at manufacturers' directions	Case-bearer, Mineola moth

Note 1: This DN application may be advisable in orchards north of Oceana County, where case-bearer or mineola moth is a problem. Case-bearer may be controlled with 1 pound of 15% wettable parathion up to FIRST COVER. Mineola moth is best controlled with a dormant spray of a DN compound at the same strength as suggested for bud moth on apples. If mineola moth is not controlled with a DN application, spray again using 1½ pounds of 15% wettable parathion per 100 gallons as soon as observed. Continue with parathion where suggested for curculio control.

Note 2: In orchards where European brown rot is a problem, a dormant spray of 3 pounds of monocalcium arsenate per 100 gallons of spray, applied 2 weeks before buds break, gives effective control.

PRE-BLOSSOM (When first blossoms open)	6-8-100 bordeaux	European brown rot (blossom blight), leaf spot

Note: This application may be needed in certain orchards when weather is favorable for brown rot (blossom blight) development, and if the orchard has a brown rot history. Also, this application should be followed by sprays of sulfur paste or wettable sulfur, or by sulfur dust, during the bloom period if rainy, wet weather continues to prevail. Phygon may be used throughout the bloom period in place of bordeaux or sulfurs.

PETAL FALL	0.75 pound *actual* copper, using fixed copper *Plus* 3 pounds hydrated lime *Plus* 2 pounds lead arsenate	Leaf spot Curculio

Note 1: Ferbam, nabam, Crag Fruit Fungicide 341 or captan may be substituted for fixed copper and hydrated lime in the PETAL FALL and COVER SPRAYS. These organic fungicides should be used as suggested by the manufacturer.

Note 2: 1½ pounds of 15% wettable parathion, 1 pound of EPN-300, or 3 pounds of 50% wettable methoxychlor may be used in place of the 2 pounds of lead arsenate for curculio control. If mineola moth is a potential pest, parathion used to control curculio in place of lead arsenate will aid in keeping this insect in check.

FIRST COVER (10-14 days after Petal Fall)	(Use the same materials suggested for PETAL FALL)	Leaf spot Curculio

Note: If black aphids appear, either nicotine sulfate, parathion, or Metacide may be used for control. A wetting agent used with nicotine sulfate or parathion will increase the effectiveness of either chemical against black aphid.

SECOND COVER (10-14 days after First Cover)	(Use the same materials suggested for PETAL FALL)	Leaf spot Curculio
THIRD COVER (Cherry maggot spray)	(Use the same materials suggested for PETAL FALL. See Note 1)	

Note: The timing of this spray will be announced by your County Agricultural Agent. *Lead arsenate* or *methoxychlor* as suggested for curculio will control cherry maggot. ***Do not use parathion or EPN-300 to control cherry maggot.***

(*Continued on next page*)

(SOUR CHERRY SPRAYING SCHEDULE—continued)

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
AFTER-HARVEST COVER (Immediately after harvest)	*Use the following—* 4-6-100 bordeaux *—OR Use* 0.75 pound of *actual* copper, using fixed copper *Plus* 3 pounds hydrated lime	Leaf spot

Note 1: If slugs are present, add 2 pounds of lead arsenate per 100 gallons.

Note 2: Actidione at 2 parts per million (0.76 grams per 100 gallons) is an excellent AFTER-HARVEST fungicide for the control of leaf spot. It also appears to be very effective for the control of leaf spot on non-bearing trees, when applied at intervals of 3-4 weeks during the growing season beginning with FIRST COVER. *Actidione applied to bearing trees early in the season may injure the fruit.* However, an application of actidione may be used just before or during harvest, if a leaf spot epidemic is developing.

SWEET CHERRY SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	DN compounds at manufacturers' directions	Black aphids

Note: Black aphids may be controlled during the growing season as soon as they appear either with 1 pint of nicotine sulfate; 1 pound of hydrated lime and a wetting agent; *or* with ½ pound of 15% wettable parathion and a wetting agent per 100 gallons of spray. *Do not use parathion later than 3 weeks before harvest.*

PRE-BLOSSOM (When first blossoms open)	6-8-100 bordeaux	Brown rot (blossom blight), leaf spot

Note: This application is needed if weather favors development of brown rot (blossom blight) and leaf spot, *and* if the orchard has a brown rot history. During bloom, if weather is favorable for brown rot infection, it may be necessary to use added protective sprays of sulfur paste or wettable sulfur, or sulfur dusts. Also, Phygon may be used throughout the bloom period in place of sulfurs.

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
PETAL FALL (When ¾ of petals have fallen)	*Use the following—* 1½ pounds ferbam 2 pounds lead arsenate Wetting agent *—OR Use* 0.37 pounds of *actual* copper, using fixed copper 3 pounds hydrated lime 3 to 4 pounds wettable sulfur or paste 2 pounds lead arsenate	Leaf spot, brown rot Curculio

Note: Curculio has increased as a pest in cherries. The substitution for lead arsenate of 1½ pounds of 15% wettable parathion; 1 pound of EPN-300; or 3 pounds of methoxychlor per 100 gallons of spray has given improved control. (Substitutes are listed in the order of their effectiveness against curculio.)

FIRST COVER (14 days after Petal Fall)	(Use the same spray chemicals suggested for PETAL FALL)	Leaf spot, brown rot Curculio
SECOND COVER (14 days after First Cover)	(Use the same spray chemicals suggested for PETAL FALL)	Leaf spot, brown rot Curculio
THIRD COVER (Cherry maggot spray)	*Use the following—* 1½ pounds ferbam 2 pounds lead arsenate Wetting agent *—OR Use* 5 to 6 pounds wettable sulfur 2 pounds lead arsenate *—OR Use* 8 to 10 pounds sulfur paste 2 pounds lead arsenate	Brown rot, leaf spot Cherry maggot

Note 1: Methoxychlor, at the rate of 3 pounds per 100 gallons of spray, may be substituted for lead arsenate to control cherry maggot.

Note 2: The time of this application will be announced by your County Agricultural Agent.

FOURTH COVER (7-10 days after Third)	(Use the same spray chemicals suggested for THIRD COVER)	Brown rot, leaf spot

Note 1: The use of 3 pounds of methoxychlor per 100 gallons of spray, or rotenone at the manufacturers' directions, in place of lead arsenate will eliminate the hazard of excessive arsenical residue on harvested fruit.

Note 2: Ferbam in this spray will leave an objectional black residue on light-colored varieties.

Note 3: 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.

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
Note: Grape flea-beetle 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)	*Use ONE of following—* 1½ pounds ferbam 1½ pounds *actual* copper, using fixed copper 4 pounds hydrated lime 6-6-100 bordeaux *Plus EITHER—* 1½ pounds 50% wettable DDT with ferbam, *or* 2 pounds 50% wettable DDT with fixed copper or bordeaux	Black rot (For mildew see Note 1) Berry moth
SECOND COVER (Just as blossoms are opening)	(Use the same chemicals suggested for FIRST COVER)	Black rot Berry moth, rosy chafer
THIRD COVER (Immediately after fruit set)	(Use the same chemicals suggested for FIRST COVER)	Black rot Berry moth, leafhopper, rose chafer
FOURTH COVER (10 days after Third Cover)	(Use the same chemicals suggested for FIRST COVER)	Black rot Berry moth, leafhopper, rose chafer
FIFTH COVER (Just before berries begin to touch in clusters)	(Use the same chemicals suggested for FIRST COVER)	Black rot Berry moth, leafhopper, rose chafer

Note 1: *Ferbam gives only partial control of downy mildew* and *little control of powdery mildew on grapes.* For this reason, fixed copper or bordeaux is suggested for the AFTER-BLOSSOM spray on varieties susceptible to mildew—such as Fredonia, Niagara, and Delaware. Growers using ferbam on the Concord variety for the control of black rot, should substitute fixed copper or bordeaux sprays in place of ferbam immediately when downy mildew appears.

Note 2: In vineyards where black rot was severe in 1952, the first spray to control black rot should be applied when the shoots are 2- to 3-inches long.

Note: For the control of mildews, see Note 1 under FIRST COVER.

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Note 2: If grape berry moth is not controlled early in season, a late application to include *either* 3 pounds of 14% fixed nicotine *plus* a wetting agent, or 1½ pounds of 50% wettable DDT, per 100 gallons of spray is suggested. DDT should not be used after the FIFTH COVER on grapes to be sold for fresh market, or for making jellies and jams because excessive DDT residue may result. The time to apply this spray will be announced by your County Agricultural Agent.

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.

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL

The grower should determine by his observation the kinds of pests in his own planting and the need for spraying.

A dormant spray of Tag 331, at ½ pint per 100 gallons applied thoroughly (200 gallons per acre), showed promise in 1951 and 1952 tests for the control of leaf blight on the Robinson and Dunlap varieties. Severe injury and killing of old leaves resulted, but these leaves were replaced by new ones and there was no apparent injury to the crowns.

FIRST COVER (4-5 days after first spittle bugs hatch)	1 pound 15% wettable parathion	Spittle bug

Note: 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 ⅓ to ½ pound of 25% wettable lindane for 100 gallons of spray.

SECOND COVER (10 days after First Cover or before berries are ⅓ grown)	1 pound 15% wettable parathion	Spittle bug, leaf-roller

Note 1: 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 2: 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 3: Methoxychlor emulsion (Marlate—2MR), when used in 1952 tests at one quart per 100 gallons of spray, gave 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.

RASPBERRY SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
GREEN-TIP or DORMANT	*Use the following—* 12½ gallons liquid lime-sulfur *—OR Use* 1 gallon DN compounds (Elgetol or Krenite)	Anthracnose

Note 1: One thorough spray application at the time of GREEN-TIP *using liquid lime-sulfur* often gives sufficient control of anthracnose. Severe infestations require additional cover sprays.

Note 2: DN spray of Elgetol or Krenite is applied *when the canes are strictly dormant.* Liquid lime-sulfur spray is applied *when the leaves are ½ inch long, before they become fully expanded.*

PRE-BLOSSOM (7-10 days before blossoms open or when new canes are 6-8 inches long)	1½ pounds ferbam 3 pounds lead arsenate	Anthracnose, leaf spot Sawfly, raspberry fruit worm

Note 1: In wet seasons it may be desirable to apply a second application of ferbam before blossoms open, if infestation of anthracnose is severe.

Note 2: Past experience of growers will indicate the need for control of sawfly and raspberry fruit worm. These insects are not present in many plantings. When they are not present, lead arsenate may be omitted from this spray. If aphids are present, add ½ pound of 15% wettable parathion per 100 gallons of spray. *Do not use parathion during bloom nor later than 2 weeks before harvest.* Parathion may be used after harvest.

FIRST COVER (As soon as petals have fallen)	1½ pounds ferbam	Anthracnose, leaf spot

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.

Note 3: Where spur blight on red raspberries is a problem, this disease may be controlled by spraying the new canes when they are 10-12 inches high with 1½ pounds of ferbam per 100 gallons of spray. This spray should be followed with a second application 10 days later.

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 weeks of harvest.* After harvest, sprays or dusts of parathion may be applied to destroy blackberry leaf-miner.

(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.*

BLUEBERRY SPRAYING SCHEDULE

DISEASE CONTROL

Two diseases are of primary importance to Michigan blueberry growers: mummy berry, and blueberry "stunt".

MUMMY BERRY is recognized by the grey-cream color of the infected berries, which are worthless. The amount of mummy-berry infection in certain plantations warrants control measures. The mummy-berry fungus carries over the winter on the ground or lodged in the crowns of the plants as old, infected berries. Raking or cultivating *before* growth starts in the spring prevents the formation of the tiny mushrooms that produce the spores. Spraying the ground with Elgetol or Krenite, using 1 gallon in 100 gallons of spray—or Premerge at the rate of 1½ quarts per 100 gallons of spray—will also kill the mushroom-type fruiting bodies to reduce reinfection. The spray is applied just before growth starts in the spring, using approximately 500 gallons per acre. *Note:* It is necessary to wet the entire surface of the ground and the crown of the plants for effective control.

BLUEBERRY "STUNT" is a virus disease which is not curable. Infected plants should be removed as soon as the disease is recognized to be blueberry "stunt".

INSECT CONTROL

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
FIRST COVER (Immediately after bloom or as soon as curculio is active)	3 pounds 50% wettable methoxychlor	Curculio

Note: When using dust, apply 30 pounds of 5% methoxychlor dust per acre.

SECOND COVER (10 days after First Cover)	(Use the same chemicals suggested for FIRST COVER)	Curculio, fruit worm
THIRD COVER (10 days after Second Cover)	(Use the same chemicals suggested for FIRST COVER)	Fruit worm
FOURTH COVER (When fruit fly appears)	1½% rotenone dust used at the rate of 25 pounds per acre	Fruit fly

Note: The time to make this application will be announced by your County Agricultural Agent.

CURRANT AND GOOSEBERRY SPRAYING SCHEDULE

APPLICATION	MATERIALS TO MAKE 100 GALLONS OF SPRAY	TO CONTROL
DORMANT	*Use the following—* DN compounds *—OR Use* 3% oil emulsion	San Jose scale

Note: A dormant spray is not necessary unless San Jose scale is present. The grower may determine the presence of this pest and the need for spraying by observations.

FIRST PRE-BLOSSOM (As soon as leaves unfold)	*Use the following—* 3-4-100 bordeaux 1 pound parathion (15% wettable) *—OR Use* 0.75 pound *actual* copper, using fixed copper 3 pounds hydrated lime 1 pound 15% wettable parathion	Leaf spot Imported currantworm

Note 1: The following amounts of fixed copper are required to give 0.75 pounds of *actual* copper per 100 gallons of spray: Tennessee 26—2 15/16 pounds; Tennessee 34—2¼ pounds; Cupro K—3⅛ pounds; Copper A—1¾ pounds; Spraycop 340—2⅛ pounds; Spraycop 530—1 7/16 pounds; Coposil "50"—1½ pounds; Basi-Cop—1½ pounds.

Note 2: Lead arsenate using 2 pounds per 100 gallons of spray may be used in place of parathion in this spray, and in the following spray, to control currantworm.

SECOND PRE-BLOSSOM (2 weeks after First Pre-Blossom, before blossoms open)	(Use the same spray chemicals suggested for FIRST PRE-BLOSSOM spray)	Leaf spot Imported currantworm

Note: During years favorable for rapid vegetative growth and flower development, blossoms may open 7 to 10 days after applying the FIRST PRE-BLOSSOM spray. If this happens, *delay applying* the so-called SECOND PRE-BLOSSOM spray until *after blossoming,* and as soon as fruit has set. If this second spray is applied *after* blossoming, use the combination of fixed copper, hydrated lime and parathion as given for the first. *Do not use lead arsenate.*

FIRST COVER (2-3 weeks after bloom)	0.75 pounds *actual* copper, as fixed copper 3 pounds hydrated lime	Leaf spot*

Note 1: See Note 1 in FIRST PRE-BLOSSOM spray.

Note 2: If currantworm or gooseberry fruit worm appear, spray immediately with rotenone or pyrethrum at manufacturers' directions. Do not use a spray chemical at this time which will have toxic residues on the fruits at harvest time.

*If *leaf spot* is present at harvest time, apply an "after-harvest" spray. Use 3-4-100 bordeaux or fixed copper, as suggested for FIRST COVER.

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PRECAUTIONARY STATEMENT ON THE USE OF SPRAY CHEMICALS

All spray chemicals are POISONS! Some are hazardous to the operator in preparing and applying them; some are toxic to plants. Some are hazardous to consumers, because of possible toxic residues, and a few are hazardous because of a tendency to contribute flavor contamination to foods, or feeds. Accordingly, all precautions given should be observed fully.

The rapid development of new and more effective spray materials has led to a greater realization of their toxicity hazards—particularly when they are used on food or feed crops. Federal regulatory agencies evaluate both the acute and chronic toxicity of spray chemicals; when necessary, tolerances are established for residues in or on foods. The occurrence of such residues, in quantities greater than the tolerances established, is considered as contamination and the products may be confiscated.

All spray chemicals sold in interstate commerce have been registered and labeled under Federal regulations, for specific use. The labels also include the hazards from improper handling. *Read the labels.* They contain the most accurate information currently available on the use of these chemicals.

The amounts given on the label are for the practical control of different pests; those amounts are designed to minimize the toxicity hazard to man and animal. *Do not use more spray chemicals than are suggested; and do not apply them at times when such applications will lead to dangerous residues.*

Only those spray chemicals and the uses which are Federally registered have been included in the *1953 Spraying Calendar.*

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