Spraying Calendar
Michigan State University Extension Service
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Revised April 1945
56 pages

EXTENSION BULLETIN 154 (Fifth Revision) APRIL 1945

SPRAYING CALENDAR

By E. J. RASMUSSEN, RAY HUTSON and DONALD CATION

Good spraying is more easily done with efficient equipment

MICHIGAN STATE COLLEGE
EXTENSION SERVICE
EAST LANSING

Michigan State College and U. S. Dept. of Agriculture cooperating. R. J. BALDWIN, DIRECTOR, EXTENSION SERVICE, Michigan State College, East Lansing. Printed and distributed under acts of Congress, May 8 and June 30, 1914.

Attention: Experienced Growers

It is recognized that the kinds of pests vary in different orchards and that their abundance also varies from year to year. The recommendations on pages 48 to 55 in this bulletin are intended for dealing with moderately severe disease and insect problems. In other words, they are standard procedures, intended for most growers to be used under average conditions. Unusual weather, susceptible varieties, and extremely severe insect and disease problems require extra applications and supplemental control measures. On the other hand, plantings in which pests have been brought under control may not require all the applications.

Experienced growers can afford to, and should, modify the schedules according to weather conditions; kinds and abundance of pests, and kinds and varieties of fruit in their orchards. However, there are certain minimum schedules which must be followed. There are certain "musts" that even the experienced growers cannot afford to ignore. They are as follows:

For Apples—Scab and codling moth are ever-present, and rigid control measures must be practiced every year. Red mite and rosy aphids may become serious under favorable conditions and control measures should be applied to prevent serious injury if these insects are known to be present in the orchard. Scab can and should be controlled with four pre-bloom, a calyx, and a first and second cover applications. If it is controlled then, later applications of a fungicide may be omitted. The main effort to control codling moth should be directed against the first brood. This includes the period from the calyx through the third cover application. However, it is safe to omit later applications for the control of codling moth only when the first brood has been practically eradicated.

Where apple maggot is a problem, sprays containing an arsenical are needed in July.

For Sour Cherry—A four-spray schedule of a copper material as outlined on page 52, is necessary for the control of cherry leaf spot. Pre-bloom sprays have been of little value on sour cherry where brown rot blossom blight is not a problem. However, be sure that blossom blight is not a problem in your orchard before omitting this application.

For Peaches—A dormant spray of either lime-sulfur or bordeaux should always be applied for leaf curl. There is no other control measure. Plum curculio may not be serious every year, but the injury caused by this pest makes the fruit subject to brown rot infection and three arsenical sprays should be applied for its control. A corrective as outlined on pages 25 to 27, should always be added to sprays containing acid lead arsenate. The severity of brown rot in an orchard is largely dependent upon weather conditions. Weather conditions cannot be predicted accurately far enough ahead so that the forecast can be used as a guide to brown rot control. In orchards where brown rot blossom blight is a problem the pink spray of lime-sulfur should always be applied. To control brown rot on the fruit later in the season, the fruit should be kept covered with sulfur dust or spray for a month prior to harvest.

Careful examination of the orchard for peachtree borer injury should be made every fall. If injury occurs, the trees should be treated with P.D.B.

For Grapes—The pests on grapes for which control practices must be made every year are black rot, grape leaf hopper, and grape berry moth. The schedule outlined on page 55 should give good control if carefully followed. Use a covered boom when spraying grapes.

Thorough coverage is absolutely necessary in all applications on all fruits.

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SPRAYING CALENDAR

By E. J. Rasmussen, Ray Hutson, and Donald Cation

Control of diseases and insects attacking fruits is the most important orchard operation prior to harvest. The effectiveness of the spray program determines to a large extent the amount of marketable fruit produced; consequently, to produce maximum yields of good quality fruit, growers should make a real effort to control the diseases and insects attacking their crops.

The spray schedules in this publication concern the important pests attacking a particular kind of fruit and were prepared to give a commercial control of the various pests as well as to safeguard good yields of good quality fruit if carefully followed.

Other pests of less importance than those mentioned may cause damage in individual orchards and require control measures. For control of such pests, consult your county agricultural agent.

This publication is divided into four sections: (1) Fundamentals of disease and insect control; (2) Descriptions of materials and their uses in pest control; (3) Life histories and control practices for the common diseases and insects; (4) Spray schedules.

FUNDAMENTALS OF DISEASE AND INSECT CONTROL ON FRUITS

Successful control of diseases and insects depends upon a general knowledge of the life histories of the various pests, of the different methods by which they can be controlled, of the spraying and dusting practices, and of the properties of insecticides and fungicides.

Some knowledge of the life histories of the pests found in the locality is necessary for the intelligent application of control measures, since it is through the weak places in the life cycles of the pests that control measures are possible. The codling moth, for instance, lays its eggs upon the surface of the foliage and fruits, and the period from hatching until the young larvae have entered the fruit is the vulnerable period in the life cycle of the pest. The apple maggot fly lays its eggs beneath the skin of the fruit, and the young larvae cannot be poisoned by sprays; consequently, any control measures by spraying must be directed against the adult. Insects live over

winter in different stages of development and in different places. The red mite lives over winter on the tree in the egg stage and can be attacked readily by sprays in the dormant period. The plum curculio lives over winter as an adult in and about the orchard. It can be controlled best by poisonous sprays applied to the fruit and foliage where it is found feeding in the spring.

Plant diseases also vary as much as insects in their life cycles. The peach leaf curl organism lives over winter on the twigs and branches of peach trees. It gains entrance into the leaves after the buds break in the spring. The application of certain sprays in the dormant period to kill the leaf curl organism is the logical approach to control this disease. Apple scab attacks both the fruit and foliage. The first spores usually appear in the orchard soon after the buds break in the spring, and may continue to be discharged from the old leaves for a period of 5 to 6 weeks. The weak place in the life cycle of apple scab is during the time of germination of the spores while they are present on the foliage and fruit. This period of time may be but a few hours; consequently, the best control practice is to keep the foliage and fruit covered with fungicides during the entire infection period of 5 to 6 weeks.

Spraying and dusting are depended upon largely to control disease and insects on fruits. A few insects, such as Oriental fruit moth, and some plant diseases such as cherry yellows and little peach, at present cannot be controlled by spraying. Under certain conditions, where the population of the pest has built up, spraying may not give the desired results. Where this occurs, measures other than spraying may also be necessary.

Relatively few elements and compounds are toxic to disease organisms and insects. Some of these elements and compounds are specific in their reaction to certain pests. A knowledge of the toxic properties present in the various spray materials and their value in control of diseases and insects is essential in planning an efficient spraying program. A few examples on the specificity of spray materials will illustrate the importance of selecting the right materials for the control of a particular pest. DN compounds are toxic to rosy aphid eggs but harmless to red mite eggs in the dormant period. Oils are toxic to red mite but harmless to aphid eggs when applied in the dormant period. DDT is effective against flies, but is of little value in control of mites. Copper fungicides are more effective in controlling leaf spot on cherry than sulfur fungicides.

Spray materials are also specific in their action on plants. Some materials are definitely injurious to certain plants and practically

non-injurious to other plants. Acid lead arsenate, for instance, when used alone will cause serious injury to the foliage, fruit and twigs of peach trees but can be used safely on cherry. Copper fungicides, especially when applied early in the season, cause severe russeting of apple, but seldom cause injury to pear. The pests controlled by various materials are listed under the discussions of individual materials on pages 11 to 27.

SPRAYING AND DUSTING

Successful control of diseases and insects by the application of dusts and sprays depends upon thorough and timely applications of the right materials.

THOROUGHNESS OF APPLICATIONS

Poor spraying is responsible for more failures to control diseases and insects than any other cause. All parts of the tree must be covered and kept covered during periods of attack. Special attention should be directed to the tops of the trees since they are the most difficult to cover and to maintain with a satisfactory spray deposit. Spraying for the control of plant diseases usually can be accomplished by the operator while riding the tank, but spraying for the control of codling moth in heavily infested orchards requires larger quantities of spray solution, some of which must be applied from the ground and directed to the inside of the tree.

The method of spraying from the tank, while driving by, requires large-capacity pumps and nozzles. The amount applied is often overestimated. Tables 1 and 2 show the amounts of spray materials applied to trees set at different distances while the operator is driving at different speeds.

TABLE 1—EFFECT OF TREE SPACING AND RATE OF TRAVEL ON QUANTITIES OF SPRAY SOLUTION APPLIED

The number of gallons of spray applied to one side of a tree while driving by and using a gun delivering 20 gallons per minute.

Speed in MPH	Gallons applied to one side of tree at tree spacing of:					
	16 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.
1.0	3.6	4.5	5.7	6.9	8.0	9.1
1.5	2.4	3.0	3.8	4.5	5.3	6.1
2.0	1.8	2.3	2.9	3.4	4.0	4.5
2.5	1.4	1.8	2.3	2.7	3.2	3.6
3.0	1.2	1.5	1.9	2.3	2.7	3.0

TABLE 2—THE EFFECT OF TREE SPACING AND RATE OF TRAVEL ON QUANTITY OF SPRAY SOLUTION APPLIED

The number of gallons of spray applied to one side of a tree while driving by and using a gun delivering 35 gallons per minute.

Speed in MPH	Gallons applied to one side of tree at tree spacing of:					
	16 ft.	20 ft.	25 ft.	30 ft.	35 ft.	40 ft.
1.0	6.4	8.0	10.0	12.0	14.0	15.9
1.5	4.2	5.3	6.6	8.0	9.2	10.6
2.0	3.2	4.0	5.0	6.0	7.0	7.8
2.5	2.5	3.2	4.0	4.8	5.6	6.4
3.0	2.2	2.7	3.3	4.0	4.7	5.3

Since spraying from the tank (and this method is the one most commonly used in Michigan) is accomplished best by continuous driving it is seen from the foregoing figures that slow speeds and high capacity nozzles are necessary to cover trees requiring 10 or more gallons of spray per tree per application. For instance, when spraying trees requiring 10 gallons of spray, set 25 feet apart, and using a gun delivering 20 gallons per minute, the rate of travel should not exceed one mile per hour, while with trees set 35 feet apart, the rate of travel should not be more than one and one-half miles per hour.

TIMELINESS OF APPLICATION A FACTOR IN SUCCESSFUL DISEASE AND INSECT CONTROL

The control of orchard pests by spraying and dusting depends upon the application of fungicides and insecticides at certain definite periods in the development of the disease or insect. In the control of several pests, such as cherry leaf spot, brown rot, and codling moth, the materials applied are mainly protective—that is, they must be applied before or while the disease organism is exposed on the surface of the foliage, fruit and branches, and before it has gained entrance to the host. All parts of the tree attacked must be kept covered during the danger period. Frequent applications (sometimes at 3- or 4-day intervals) are necessary during the season when growth is rapid and weather conditions are favorable for the development of the pest.

Practices which will aid in improving the timeliness of applications are: using the full capacity of the pump through the nozzle; having the water supply handy so that a minimum amount of time is spent in filling the spray tank; operating the spraying equipment to advantage by working extra hours; applying extra sprays to the

tops of the trees during periods favorable for the development of the pests, and when time is not available for a complete application.

Making use of the full capacity of the spray machine is one of the easiest ways of improving the timeliness of applications. One man, spraying from the tank, can handle a gun delivering 20 to 25 gallons of materials per minute without waste. The average man spraying from the ground, however, would not handle efficiently more than half that amount. Table 3 shows the amount of solution in gallons a gun will deliver through various disk openings.

TABLE 3—CAPACITY OF SINGLE NOZZLE SPRAY GUNS IN GALLONS PER MINUTE

Size of disk diameter in inches	Pressure in pounds					
	300	400	500	600	700	800
4/64	1.4	1.6	1.9	2.1	2.2	2.5
5/64	2.2	2.5	2.8	3.1	3.3	3.5
6/64	3.0	3.4	3.8	4.3	4.6	4.8
7/64	4.0	4.6	4.8	5.3	5.8	6.1
8/64	5.5	6.1	6.9	7.4	8.0	8.5
9/64	6.6	7.5	8.7	9.4	10.1	10.6
10/64	8.3	9.6	10.6	11.5	12.3	13.0
11/64	10.0	10.5	12.1	13.0	13.9	14.7
12/64	11.2	12.7	14.5	15.6	16.7	17.7
13/64	13.1	15.3	17.0	18.6	19.9	21.1
14/64	14.8	17.2	19.2	20.9	22.4	23.7

TABLE 4—CAPACITY IN GALLONS PER MINUTE OF MULTIPLE NOZZLE WITH TWO-NOZZLE ARRANGEMENT EQUIPPED WITH DIFFERENT-SIZED DISKS

Pounds of pressure	Disk opening in fractions of inch				
	2/64	3/64	4/64	5/64	6/64
300	1.05	1.52	2.36	4.1	5.9
400	1.33	1.80	2.72	4.7	6.6
500	1.44	2.00	3.02	5.3	7.4
600	1.60	2.17	3.37	6.0	8.0

To obtain the capacity of a multiple nozzle with 4-nozzle arrangement, multiply the above mentioned capacities by 2; and with an 8-nozzle arrangement multiply the capacities by 4.

SELECTION OF SPRAY AND DUST MATERIALS

Spray and dust materials are often unjustly credited with the failure to obtain satisfactory control of disease and insects. A large number of good spray and dust materials are marketed. Most of the materials manufactured by reliable companies, if applied accord-

ing to the manufacturer's directions, will give commercial control of the pests for which they are recommended.

The pests controlled by the different materials are listed under the particular material described on pages 11 to 27.

When selecting spray and dust materials, consideration should be given to their injurious effects on the plant as well as their ability to control diseases and insects.

Plants, fungi, bacteria, and insects are all living organisms. Any material applied to kill a disease spore or an insect may cause more-or-less injury to the plant. Wrong combinations of spray materials, improper methods of application, or applying spray under certain weather conditions may result in more serious injury and loss of fruit than that caused by pests on unsprayed trees. For example, acid lead arsenate applied to peach trees without the addition of the zinc sulfate-lime corrective may be more serious than the damage caused by curculio on unsprayed trees.

The following precautions will help to reduce spray injury to twigs, foliage and fruit:

Apply sulfurs and DN compounds only when temperatures are below 90° F. Injury from sulfur materials on apples can be nearly eliminated by controlling scab early, and thereby, avoiding the use of sulfur late in summer when temperatures are high.

Allow a period of 10 to 14 days between applications of oil and sulfur sprays. Oils and sulfur are incompatible and should not be mixed when used during the growing period.

Always use the zinc sulfate-lime or the iron sulfate-lime mixture with acid lead arsenate-containing sprays applied to peach and plum trees.

Zinc sulfate-lime mixture used with lead arsenate sprays on apples in the second cover and later sprays will aid in reducing arsenical injury. One pound of zinc sulfate and 4 pounds of lime are recommended for use with each 3 pounds of lead arsenate applied on apple trees.

Use lime-sulfur on apples for scab control only when sprays cannot be applied on time, when weather conditions are favorable for scab infection, or when thorough coverage is impossible. Wettable sulfurs, if properly applied, will give commercial control of scab and larger yields.

Do not use lime-sulfur on apples at intervals of less than 7 days. Lime-sulfur, when applied at too short intervals early in the season, has a serious starvation effect on the tree which results in premature dropping of fruit.

When spraying cherries, never follow a copper spray with a lime-sulfur application. Serious defoliation will likely result. Wettable sulfurs, however, are compatible with copper materials.

SPRAYING MATERIALS AND THEIR USE

Spraying and dusting materials can be classified according to use into 3 groups: (1) fungicides—materials used to control fungous diseases; (2) insecticides—materials used to control insects; and (3) accessory material (adjuvants)—materials used as correctives, stickers, spreaders, activators, flocculators and emulsifiers.

Although there are a large number of spray materials on the market, only a few elements or compounds are toxic to insects and disease organisms. The toxic elements in most fungicides used on fruits are either copper or sulfur. The toxic elements in most insecticides used as stomach poisons are either arsenic or fluorine, while the compounds present in contact insecticides contain nicotine, rotenone, pyrethrum, thiocyanates, dinitro cresols, dinitro phenols, oils, and sulfides.

Fungicides

SULFUR FUNGICIDES

Sulfur fungicides may be divided into three groups: (1) those containing uncombined elemental sulfur, known as wettable sulfurs; (2) those containing sulfur in combination with such elements as calcium, sodium, and potassium, and are called sulfides; (3) those containing sulfur in combination as organic compounds.

Wettable Sulfur—Wettable sulfurs may be used to control scab on apples, brown rot on peach, cherry and plum, and leaf spot on plum and sweet cherry. Because they vary in particle size and amount of sulfur the recommendations made by the manufacturer should be followed. In general, 4 to 8 pounds of the better dry forms are recommended to 100 gallons of spray. Flotation paste contains about one-half as much sulfur as the dry forms and is generally used at the rate of 8 to 14 pounds to 100 gallons of spray. The amount used depends on the kind of fruit and the season. The higher amounts are used in the early applications for scab control on apples and the lower amounts for control of diseases on peach, plum, cherry and the cover applications on apples.

Wettable sulfurs are finely divided or pulverized sulfur to which a wetting agent has been added. The fineness of division is attained by several processes. Some of the common materials which can be used to wet sulfur are gelatin, lime, lime-sulfur, glue, and soybean flour. Recently manufacturers have developed other types of wet-

ting agents, and these are used in the manufacture of the many brands of wettable sulfur. Bentonite sulfur, a product in which sulfur is fused with bentonite is also considered a wettable sulfur in this bulletin. Wettable sulfurs are marketed in paste and dry powdered forms. At present flotation paste, a by-product obtained in the manufacture of artificial gas is the only sulfur available in paste form. The dry powdered forms of wettable sulfurs are sold under a number of tradenames. They vary in the amount of sulfur content and particle size. The adhesiveness and fungicidal value of wettable 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 dusting or wettable sulfur are about 1/500 of an inch in shortest diameter. Flotation paste sulfur and some of the better wettable sulfurs have particles which range in size from 1/3000 to 1/25000 of an inch. Particle size of sulfur is usually stated by the manufacturer in microns. A micron is equal to 1/25000 of an inch. Brands of wettable sulfurs which state particle size as part of the analysis, 8 microns and smaller, contain sulfur which ranges in size from about 1/3000 to 1/25000 of an inch.

Wettable sulfurs do not possess the immediate caustic properties of freshly prepared lime-sulfur nor do they adhere so well. For these reasons they are not so efficient in killing established fungi. It is necessary to apply wettable 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 sulfurs are practically non-injurious to fruit and foliage at normal temperatures. At temperatures above 90° F. sun scald on the fruit and scorch on the foliage may occur. This is especially likely to happen in muggy weather. Wettable sulfurs are safe to use in all applications on peach and plum, and the in-bloom sprays on apple and cherry. They are compatible with bordeaux, lime-sulfur, proprietary copper compounds, lead arsenate, zinc arsenate, nicotine sulfate, fixed nicotine and soaps, but should not be used with oils or calcium arsenate.

Group 2 contains lime-sulfur, and soluble sulfur compounds.

Lime-sulfur—Lime-sulfur is the most important in group 2. It is used as a dormant spray for the control of peach leaf curl and scale insects. It is also used during the growing season to control apple scab and blossom blight on stone fruits under emergency conditions. The concentrations in general use are 5 gallons to 100 gallons of spray for leaf curl; 12½ gallons to 100 gallons of spray for scale insects in

the dormant period, and 1½ to 2½ gallons to 100 gallons of spray as a fungicide in the growing season.

Lime-sulfur is marketed in both the liquid and dry forms. All recommendations in this bulletin for the use of lime-sulfur refer to commercial concentrated solutions testing 32° to 33° Baume. The calcium polysulfides present in lime-sulfur are the toxic portion and 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 wettable sulfurs. Lime-sulfur, because of its caustic property, is more injurious to fruit and foliage than wettable 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 manufacture, decrease in blossom bud formation and lower yields when compared with experimental results with wettable sulfur. Because of its injurious 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 wettable sulfurs are safe to use with lime-sulfur. Lime-sulfur should never be mixed with summer oils, copper fungicides, soap, or DN sprays. Lime-sulfur is compatible with some dormant oils.

Dry Lime-sulfur—Dry lime-sulfur contains some of 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 one 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, and 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.

ORGANIC FUNGICIDES

Within the past few years new types of fungicides have been developed. These fungicides are complex organic compounds. They are highly toxic to fungi and are used at lower concentrations than present materials. The organic fungicides are sold under trade-names or code numbers. They are available only in limited amounts. Many of them are too new to be recommended, may not be uniform in composition (because the process of manufacture is not standardized), and should be considered experimental until more information is available. Some of them show promise as substitutes for material now in use. Two of these materials were used in Michigan in 1944 for control of leaf spot on sour cherry and scab on apple.

Ferric Dimethyldithiocarbamate (Fermate)—This material is dark brown in color, very bulky, and difficult to wet. It was as effective as the proprietary copper compounds in leaf spot control on sour cherry, and as effective as the wettable sulfurs in scab control on apples in 1943 and 1944 in Michigan when used at the rate of 1½ pounds to 100 gallons of spray.

Disodium Ethylene Bisdithiocarbamate (Dithane)—The material is light yellow, less bulky than Fermate, but easier to mix. It gave a commercial control of leaf spot on sour cherry and scab on apples in experimental plots in 1944 in Michigan.

These two organic fungicides are compatible with oil, wettable sulfur, lead arsenate, nicotine sulfate and fixed nicotines.

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 and 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 recommended 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. A 4-6-100 bordeaux will require:

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

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

Copper sulfate may be obtained in several grades, based on size of particles. For convenience in preparation, the rather fine, granular, and pulverized grades are desirable. These grades 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 more dilute the solutions when mixed, the better the quality of bordeaux.

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 24). The copper sulfate should be in the powdered or snow form. These forms go into suspension or dissolve readily in water. To make "instant bordeaux," proceed as follows:

1. Fill the spray tank 1/4 to 1/3 full with water.
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 and 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. Fill the tank with water and apply. Keep the agitator in operation continuously after copper sulfate has been added.

Bordeaux may be added to wettable sulfur, lead arsenate, zinc arsenate, calcium arsenate, oils, nicotine sulfate, and the proprietary

copper compounds. It should not be used with lime-sulfur, fixed nicotines or soaps.

Proprietary Copper Compounds—Proprietary copper compounds are fungicides containing copper in a low-soluble form and are sold under various trade-names. 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' recommendations. 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, wettable sulfur, nicotine sulfate, and lead arsenate. **They should not be mixed with lime-sulfur.**

Insecticides

Insecticides used to control insects attacking fruits may be divided into four groups: stomach poisons, contact insecticides, repellents, and fumigants.

STOMACH POISONS

Stomach poisons are applied to kill insects which feed on the fruit and foliage or upon their surfaces. The stomach poisons in general use include lead arsenate, calcium arsenate, zinc arsenate, and fixed nicotine. Cryolite is used only for specific purposes, such as for the control of apple flea weevil.

Lead Arsenate—Lead arsenate appears on the market in two forms, acid lead arsenate and basic lead arsenate.

Acid Lead Arsenate—Acid lead arsenate has been the standard stomach poison used in Michigan orchards for many years. Unless otherwise stated, lead arsenate referred to in this bulletin is the acid form. Acid lead arsenate is used to control codling moth, apple maggot, plum curculio, cherry fruit fly, canker worm, cherry slugs, strawberry leaf roller, raspberry fruit worms and raspberry saw fly. It is used at the rate of 2 to 4 pounds to 100 gallons of spray.

Acid lead arsenate contains more arsenic, both in the soluble and insoluble form, than does basic lead arsenate and is more effective in insect control. It is also more injurious to foliage and fruit. Acid lead arsenate should not be used on peach or plums or in the late cover spray on apples without a corrective. (See pages 25 to 27.) 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 4 pounds of dry lime-sulfur) or with certain soap compounds.

Basic Lead Arsenate—Basic lead arsenate, because it is less likely to cause injury, may be used on peach and plums to control plum curculio. It is not so effective as acid lead arsenate. Three pounds of basic lead arsenate are commonly used to replace 2 pounds of acid lead arsenate. Basic lead arsenate is used without a corrective, and observations indicated the three pound dosage to be effective against plum curculio. Basic lead arsenate is compatible with all spray materials listed in this bulletin.

Calcium Arsenate—Calcium arsenate is more injurious to fruit trees than lead arsenate. Because of its injurious effect it is not safe to use on any of the fruits except grapes. It may be used on grapes in the usual sprays for the control of berry moth and rose chafer.

Zinc Arsenate—Seven years' tests with zinc arsenate without a sticker have shown this material slightly less effective than lead arsenate. With a sticker zinc arsenate has been as effective as lead arsenate without a sticker. The use of zinc arsenate eliminates lead residue, but apples sprayed with it may have a residue above the tolerance for arsenic. Zinc sulfate-lime used as a corrective has been found satisfactory with this material.

Cryolite—Cryolite contains fluorine. It is more injurious to fruit and foliage than lead arsenate. Its only place in insect control in Michigan orchards is for the control of the apple flea weevil.

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, wettable sulfur, nicotine sulfate, and acid lead arsenate.

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.

Contact Insecticides

Contact insecticides can be divided into two groups: (1) those used to kill insects while the trees are in a dormant condition and (2) those used to kill insects during the growing season.

CONTACT INSECTICIDES FOR DORMANT USE

Dormant Oils—Dormant oils are used to control red mite, scale insects, and pear psylla. The amount of oil in a spray varies from 3 to 4 percent, depending upon the pest to be controlled.

Two sources of dormant oils are available to the grower: proprietary oil emulsions or miscible oils prepared by various companies and sold under trade-names, and cold-pumped or home-made emulsions. The oils used in cold-pumped emulsions are of the type called lubricating oils. Those used for control of red mite and scale insects should have a viscosity of at least 100 seconds (Saybolt at 100° F.) and those used for control of pear psylla should have a viscosity of 170 to 250 seconds.

For growers who wish to make their own oil emulsions, the cold-pumped emulsions are generally more satisfactory. Cold-pumped emulsions are recommended for the control of pear psylla. They can also be used on peaches in combination with 8-8-100 bordeaux where one spray is applied for leaf curl and red mite. To make a 3-percent oil spray combined with bordeaux for fungicidal value first prepare a stock emulsion as described below. Next prepare an 8-8-100 bordeaux as described on page 15, and to this bordeaux add 4½ gallons of the cold-pumped stock emulsion. Keep the agitator in operation continuously until the tank is empty.

Bordeaux Oil Emulsions—Bordeaux is a very satisfactory emulsifier. The formula and method of preparation follow:

Prepare the copper sulfate and lime as two separate stock solutions. Convenient proportions for this purpose are 1 pound to 1 gallon of water for the copper sulfate and 1½ pounds to 1 gallon for the hydrated lime.

For each 100 gallons of a given concentration, use quantities of spray materials as given at top of page 19. (Use stock solution of the strength indicated in the previous paragraph.)

If these quantities are insufficient to permit good agitation, add more water.

QUANTITIES FOR PREPARING DIFFERENT CONCENTRATIONS OF BORDEAUX-OIL-EMULSION

Materials	For each 100 gallons of spray with actual oil content of:		
Place in sprayer in this order	3 percent	6 percent	8 percent
1. Water	¾ gallon	1½ gallons	2 gallons
2. Copper sulfate (stock solution)	3 pints	3 quarts	1 gallon
3. Hydrated lime (stock solution)	3 pints	3 quarts	1 gallon
4. Oil	3 gallons	6 gallons	8 gallons

For a 200-gallon tank use twice, for a 300-gallon tank use three times, and for a 400-gallon tank use four times the amounts indicated. The procedure, step by step, follows:

1. Place the indicated amount of water in the empty sprayer tank. Have the agitator in operation.
2. Add the copper sulfate stock solution.
3. Add the hydrated lime stock solution (always stir before taking from the container).
4. Add the oil.
5. Emulsify by pumping at high pressure (at least 250 pounds) through spray gun or nozzle back into the tank. Continue until the emulsion is creamy in consistency and there is no evidence of free oil.
6. Add water to fill the tank and apply. Keep agitator in operation until the tank is empty. **Make certain that the concentrated emulsion is all out of the hose and pump before any spray is applied to trees.**

This emulsion must be continuously agitated. If through lack of agitation there is an appearance of free oil, discard the emulsion and start over.

If a large quantity is to be made up at a central mixing plant to supply several sprayers, the following formula for stock emulsion may be used:

FORMULA FOR STOCK EMULSION OF BORDEAUX-OIL-EMULSION

Materials (Add to sprayer in this order)	Amount
	gallons
1. Water	7½
2. Copper sulfate (stock solution)	3¾
3. Hydrated lime (stock solution)	3¾
4. Oil	30

To dilute this stock emulsion, fill the sprayer about one-fourth full of water, and, with agitator in motion, add the stock emulsion. The amount to use can be determined by reference to the following section. When thoroughly mixed, fill the tank with water and apply, keeping agitator in motion until the tank is empty. It is not advisable to make up more stock emulsion than will be used the day it is made.

Diluting and Using Emulsions—Emulsions prepared according to this formula contain approximately 66⅔ percent oil. Some commercial emulsions contain about the same amount. To dilute such emulsions, the general rule is that for each 100 gallons of spray the number of gallons of stock emulsion is one-half greater than the stated percentage of oil. A tabular statement of dilutions follows:

TABLE OF DILUTIONS FOR EMULSIONS CONTAINING APPROXIMATELY 66⅔ PERCENT OF OIL

Amount of dilute spray	Amount of stock emulsion to use to make actual oil content of				
	2 percent	3 percent	4 percent	6 percent	8 percent
	gallons	gallons	gallons	gallons	gallons
100 gallons	3	4½	6	9	12
200 gallons	6	9	12	18	24
300 gallons	9	13½	18	27	36
400 gallons	12	18	24	36	48

To make certain that the oil is properly emulsified, mix a pint of the finished emulsion in a bucket of water. If free oil appears on the top within 5 minutes, discard the entire mix.

Precautions in the Use of Dormant Oil Sprays—Application of oil sprays have been safely made under many conditions, but at other times, with conditions apparently very similar, serious injury has followed. To avoid possible spray injury or failure to control pests, certain precautions should be observed.

Complete the application to both sides of the tree before the spray dries. Spraying from different sides on different days will result in excess oil deposit and probable injury.

Peaches and pears should not be sprayed with oil in the fall, and there seemed to be no occasion, under Michigan conditions, to spray apples or any other fruit at that time.

Early spring dormant applications of some miscible oils have caused injury to peach trees, especially those in a low state of vigor.

Do not apply oil when rain or snow is likely to follow quickly, or

when the temperature is below 40° F. or is likely to drop to the freezing point before the spray has thoroughly dried.

Follow carefully the instructions of the manufacturer in respect to the use of oil sprays in combination with lime-sulfur, other sulfur sprays or bordeaux and where the use of lime-sulfur or wettable sulfur precedes or follows an application of oil. The cold-pumped emulsions are relatively safe in this respect, but injury may result from their use.

Dormant oil sprays, properly diluted, are generally safe when used in the dormant period, and it is recommended that the use of all oil sprays of this type should be confined to this period. Oils at the concentration necessary for the control of the San Jose scale, red mite and pear psylla have not been observed to cause any injury from spring dormant applications. **Combinations of oil and DN compounds are not safe at oil concentrations above 2 percent.**

DN Compounds for Dormant Sprays—Dormant DN compounds are used for control of black cherry, rosy and apple aphids, and some scale insects.

Dinitro salts of phenols and cresols (DN) have come to stay as spray materials. These synthetic organic chemicals are, like all members of their class, specific in action and the properties of each can be determined only by trial. DN compounds, for example, kill aphid eggs, but do not kill mite eggs; live aphids are unharmed by DN compounds, live mites are killed.

Apparently, DN compounds are more likely to cause injury with high temperatures. Dormant DN compounds are likely to cause injury when combined with oil in excess of 2 percent (2 gallons per 100). Dormant DN in oil is definitely not recommended for peaches. Dormant DN may injure foliage if applied after buds break.

Dormant DN compounds are applied at the rate of 8 ounces of DN per 100 gallons of spray. This equals 1¼ pounds of a 40-percent or 1 pound of a 50-percent compound.

CONTACT INSECTICIDES FOR USE DURING THE GROWING SEASON

Summer Oils—The greatest use of summer oils in Michigan orchards is in combination with fixed nicotine for codling moth and mite control.

Oils used for application during the growing period should be much more highly refined than those for dormant spraying. Viscosity and unsulphonated residue should be within well defined limits. The limits for viscosity are 75 to 85 seconds (Saybolt at 100° F.) and 92 to 100 percent for unsulphonated residue. Numerous brands hav-

ing those specifications are offered for sale. The manufacturers' instructions should be carefully read before attempting to dilute any summer oil spray. Oils are injurious to fruit and foliage when applied at too high concentrations or at too frequent intervals. Dilutions of 2 to 4 quarts of summer oil are generally recommended. At these strengths, four or more sprays without solids may cause russeting near the blossom end and poorly colored fruit. In addition, foliage on trees of average vigor may be injured.

Summer oils may be mixed with bordeaux, proprietary copper compounds, lead or zinc arsenate, nicotine sulfate, and fixed nicotine. They are not safe to use with any of the sulfur materials nor should oils be used preceding or following a sulfur spray unless 10 days have elapsed between applications. Oil sprays for summer use, such as miscible oils, fish oils, and soybean oil, when used with lead or zinc arsenate, increase the deposit of poison and make it difficult to remove. For this reason, oils are not recommended in combination with arsenicals except in seriously infested orchards where the grower is equipped to wash.

Nicotine Sulfate—Nicotine sulfate is the standard contact spray for use during the growing period for the control of aphids, leaf hoppers, red bug and codling moth. Nicotine sulfate should contain 40-percent actual nicotine, and all recommendations made in this bulletin are based on this 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 or leaf hoppers, a special application of nicotine sulfate plus a soap or other activator is advisable.

DN Compounds for Foliage—DN for foliage (DN111 spray; DND4 dust) is specific for mite control if used in accordance with the manufacturers' recommendation (1½ pounds per 100 gallons of spray; 25-35 pounds of dust per acre). DN111 kills mites within 10 to 12 hours after application. It can be used with arsenicals and is apparently an arsenical corrective. DND4 is dusted on in the usual way.

Applications of DN compounds are most effective about the time of the first or second cover but may be applied whenever mites become numerous on apples provided temperatures, etc., are right.

DN111 on foliage may cause burning when applied with sulfur at temperatures above 80° F. The effectiveness of DN111 is destroyed by lime and alkali. DN111 cannot be used with oil or oil containing material such as factory processed fixed nicotines.

DDT—Publicity on the value of DDT as a fly and louse control has outrun the information available on the application of this promising material to fruit insect control. The limited amounts available for trial indicate that in all probability DDT will control many of our most annoying insect pests. It is definitely not a cure-all and a number of difficulties, particularly as to how it can be mixed with other sprays must be worked out. DDT seems to control codling moth and most fruit insects with a few notable exceptions. Plum curculio and red mite are unaffected; aphids and red mite increase on plots sprayed with it. There is, too, the matter of bee and other pollinating insects in orchards that will have to be studied. The residue question will have to be settled.

REPELLENTS

Bordeaux—3-5-100 bordeaux is a repellent for potato leafhoppers which often cause curled leaves and stunted growth on young non-bearing apple trees. Protection is necessary, beginning the first week in June. 3-5-100 will protect against apple scab at the same time, and if 3 pounds of lead arsenate is added chewing insects such as cankerworms and other caterpillars will be killed. Bordeaux will russet apples; hence, it is not recommended as a potato leafhopper repellent on bearing trees.

Sulfur—Sulfur, page 11, is a good repellent for tarnished plant bug on peaches.

FUMIGANTS

Paradichlorobenzene, PDB—PDB is a white crystalline granular material with a characteristic odor. Applied at ground temperatures around 60° F. (about September 1) about the base of peach trees it slowly volatilizes into a toxic gas. PDB used as indicated on page 44 is the only recommended treatment for 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 peachtree borer in young trees. Two pounds PDB dissolved in 1 gallon of cottonseed oil is used to paint over cankers, thereby killing lesser peachtree borer.

Accessory Materials

Accessory materials are those added to fungicides and insecticides which will 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 arsenical correctives. Lime when used alone with lead or zinc arsenate, especially in the cover sprays on apples, aids in delaying arsenical injury. It is recommended with proprietary copper compounds to reduce copper injury on cherry foliage. It tends to reduce the effectiveness of arsenicals and proprietary copper materials, but the decrease in disease and insect control is usually not so serious as injury from defoliation which may result in some seasons. 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 be added more profitably 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 and 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 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, SPREADERS, WETTING AGENTS AND DEFLOCULATORS

The use of stickers or defloculators with wettable sulfurs and proprietary coppers is still in the experimental stage. The addition of defloculating or deposit-building materials for the purpose of increasing the deposit of sulfur and copper materials on the fruit and foliage requires the use of low-volume spray guns, larger quantities of spray, and a longer time to cover the tree than required by the spraying practices in common use in Michigan. The use of such materials would require changing the method of application now in general use and does not seem practical under present conditions.

The value of stickers and spreaders other than oils when used with lead arsenate for the control of codling moth and plum curculio has not been established. Oil stickers increase the efficiency of lead arsenate but render residue removal difficult.

Spreading or wetting agents, such as soaps are helpful in increasing the effectiveness of such spray materials as nicotine sulfate. In the control of aphids and leaf hoppers the wetting of the insect is necessary.

Soaps, fish oil, soybean flour, soybean oil, summer oils, and materials containing casein and lime are common materials used as spreaders. Several commercial spreaders and stickers are sold under various trade-names and are recommended by spray material companies to be used with their products. Care should be taken when adding spreaders not to use too much. **Adding more than the required amount may cause excessive runoff.** Some spreaders are injurious to plants when used at too high concentrations.

SOYBEAN FLOUR

Soybean flour is recommended by some companies as a sticker and spreader in combination with their products. Soybean flour can be used as a sticker and spreader with a number of materials. A special grade of flour is available for spraying purposes. In general, it should be used at the rate of ¼ pound to 100 gallons of spray. A good method of adding it to the spray mixture is to prepare a thin flour paste before adding it to the solution in the tank.

Correctives

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

IRON SULFATE-LIME MIXTURE

For each 100 gallons of spray, use 4 pounds iron sulfate, 4 pounds hydrated lime, and 2 pounds acid lead arsenate; mix as follows:

1. Begin filling the sprayer with water with agitator running.

2. Sift or shake in gradually the "sugar" iron sulfate, which will dissolve in 1 or 2 minutes. If the crystalline form is used, pour in the stock solution which has been prepared previously.

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

4. Add the acid lead arsenate. Fill sprayer with water and apply. When wettable sulfur is used with the mixture add the sulfur after the acid lead arsenate. It is not known how bentonite sulfur will combine with this mixture. **The use of iron sulfate-lime mixture has proved satisfactory for peaches but not for apples because it interferes with color.**

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; an 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 varieties susceptible to arsenical injury, the zinc sulfate-lime mixture added to the spray will reduce the amount of injury. This material 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; and 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 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 wettable 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.

LIFE HISTORIES AND CONTROL PRACTICES OF FRUIT DISEASES

Anthracnose of Raspberry

Anthracnose can be controlled with one application of liquid lime-sulfur, 12½ to 100, applied when the green tips of the leaves appear and before the leaves have fully expanded. This spray must be thoroughly applied in order to eradicate the fungus at this time. All parts of the crowns and canes must be covered. If control has not been obtained with the above-mentioned application, a spray of bordeaux (4-6-100) applied one week before the blossoms open will protect the young fruit stems, leaves, and canes from infection. If a good, thorough job has been done with the first spray the second one will not be necessary.

Anthracnose is a fungous disease, characterized by oval or circular scabby spots on the canes, spots on the leaves, and lesions on the fruits, and on the stems of leaves and fruits. The injury caused by anthracnose results in weak canes and markedly reduced yields.

Anthracnose is a common disease on black raspberries and dewberries, often causing serious damage. It also attacks some varieties of red raspberries such as Latham and King. A late season attack on Latham results in superficial cream-colored lesions known as gray bark disease. Where this occurs on red raspberry a green tip spray, applied as recommended will give excellent control.

Apple Scab

Control of apple scab is largely dependent on keeping the foliage and fruit well covered with sulfur from the delayed dormant to about 2 weeks after the calyx application. The apple spray schedule as outlined on page 48 has given good control of scab in experimental spraying for the past 3 years. Under favorable conditions growth of foliage, blossoms, and fruit is rapid. Frequent applications (some-

times at 3- to 4-day intervals when using wettable sulfurs) are necessary to protect against scab infection. Two or three extra applications of sulfur during the early infection period will save the use of sulfur in the late cover sprays, avoid complicating the codling moth program, and reduce the amount of injury to fruit and foliage later in the season.

Wettable sulfur or lime-sulfur may be used for scab control. Experimental spraying during the past 3 years has shown that wettable sulfurs, if thoroughly and timely applied, are good substitutes for lime-sulfur. Trees sprayed with the better wettable sulfurs (those with particle size of 8 microns and smaller) produced larger yields of good quality and as free from scab as trees sprayed with lime-sulfur according to the old lime-sulfur schedule.

Growers with adequate equipment to cover their orchard in 3 to 4 days can profitably use a wettable sulfur program on apples. Growers unable to apply timely and thorough applications, either because of inadequate equipment or unavoidable delays, will obtain better control with lime-sulfur.

Thorough coverage of the tops of the trees is of prime importance. During prolonged rainy periods or when extra sprays are needed during the early season, timeliness of application can be improved by doubling the amount of material in the spray and spraying the upper half of the tree. This practice will keep the part of the tree covered which is most likely to become infected.

The apple scab fungus develops in the old leaves on the ground during the winter and early spring. Spores are usually mature when the tips of the buds show green or in the delayed dormant period. Spores may be discharged over a period of 5 to 6 weeks, depending on weather conditions. Rains are necessary for spore discharge and infection. Success in scab control depends on thorough and timely application during the early season, from the delayed dormant through the first cover spray.

Bacterial Spot

This disease is serious on peach and plum. It is controlled by keeping the tree in good vigor and 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 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.

Experiments by the United States Department of Agriculture have prompted recommendations of five or six sprays of zinc sulfate-lime, 8-8-100 (page 26), 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. The spray has not been particularly effective when commenced later in the season. The disease is sometimes introduced in an orchard on nursery stock, but Michigan nurseries have been generally free from this disease. The bacteria overwinter in a few inconspicuous cankers on the twigs and possibly within infected buds. Nitrogen fertilization to promote vigor is suggested. A few growers report results from potash fertilization, but the spasmodic occurrence of the disease may lead to false conclusions on control.

Black Rot of Grapes

Black rot attacks the fruit, leaves, tendrils, and canes. It lives over winter in diseased fruits, leaf stems, tendrils and canes, and spores appear in the vineyard soon after growth starts in the spring.

Black-rot disease is rarely a problem in vineyards that are consistently and properly sprayed year after year. With power spraying, the black-rot fungus does not have a chance to build up a supply of over-wintering spores and the disease is controlled easily even in years favorable for its development. Conversely, if the disease becomes established in the vineyard it is more difficult to control.

The early sprays are very important because the disease is seldom sufficiently controlled after early infections are well established. Begin spraying when the new shoots are 4 to 5 inches long. Spray according to the directions in the regular schedule (page 55), which should give a new coverage, about every 10 days until the berries touch. If the disease is well controlled up to that time, the proprietary copper sprays may be substituted for bordeaux, as they are compatible with the new nicotine schedule for berry moth. Proper timing, thorough coverage, and the right materials will control black rot.

Black rot was present in many vineyards in 1944. Such vineyards should receive thorough and timely sprays this season to avoid large possible losses.

Home-made bordeaux, 8-8-100, especially in the early sprays, is necessary for success in controlling black rot under severe conditions. Home-made bordeaux sticks better and offers greater protection than any other copper spray.

Brown Rot of Stone Fruits

Spraying and dusting are the most important control practices for brown rot. Supplementary measures, such as knocking off the mummied fruit remaining on the trees during the winter, burying or disturbing the mummied fruits on the ground in early spring by cultivation, pruning to allow circulation of air through the trees, thinning the fruits so that no two fruits will touch, and controlling the plum curculio are also worth while practices.

Brown rot is usually 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. Spores are present in the orchard soon after growth starts until frost. The disease 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 of fungous tissue. This mummied mass of fungus lives over winter, hanging on the trees and masquerading 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.

Green fruit is rather resistant to infection although rot may occur following insect injury or bruises. Ripe fruit is very susceptible to attack.

PEACH

Where blossom blight has been prevalent in previous years, liquid lime-sulfur, 2½ gallons in 100 gallons of spray, applied when the blossom buds show pink is necessary for control. **Do not use lime-sulfur later than the pink stage on peaches.**

It is too late for control of blossom blight after it can be seen. Full bloom sprays of wettable sulfur have been of little value.

The critical stage for fruit rot begins one month before ripening time. Spray or dust often in this period if wet weather persists.

Spray or dust with sulfur just before picking. If mechanical brushers (defuzzers) are used, they should be supplied with a sulfur-dusting attachment. An invisible coating of sulfur carried over from orchard sprays or applied as a dust at the grader should be present on the fruit to prevent rot during transit to the consumer.

PLUMS

Brown rot is difficult to control on many varieties of plums. Include sulfur in all the sprays according to the recommended schedule. Spray more frequently than indicated in the spray calendar if rainy weather persists and brown rot is present.

SOUR CHERRIES

Brown rot is not generally a problem on sour cherries and is controlled by sprays scheduled for leaf spot. A pre-bloom spray, just before the blossoms open of wettable sulfur, 5 pounds in 100 gallons of spray, should be applied in orchards which showed blossom blight last season. This special spray may also aid in leaf spot control.

SWEET CHERRIES

Spray just before blossoming with liquid lime-sulfur 2-100 if brown rot of fruit or blossoms has been troublesome. The other sprays indicated in the spraying calendar are effective in controlling brown rot as well as leaf spot. A spray of wettable sulfur or a sulfur dust one week before harvest will permit a longer harvesting season and help the cherries "to hold up" in market.

Cherry Leaf Spot

Cherry leaf spot can be controlled usually 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 for the past nine years.

Thorough applications, especially to the tops of the trees, are necessary. At least 5 gallons of spray is required to cover an average-sized, bearing cherry tree.

The leaf-spot fungus lives over winter in the old leaves on the ground. The fungus develops during the winter, and 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 infections from which summer spores develop and aid greatly in keeping the foliage on the trees throughout the summer. Proprietary copper materials, plus an equal amount of lime, or a 2-3-100 bordeaux, are recommended. Six years' spraying experimental work

on leaf-spot control has shown that the copper materials are more effective than lime-sulfur. Some of the proprietary copper materials used in experimental work for leaf-spot control are: Basicop, Bordow, Cupro-K Grasselli's Compound A, Oxobordeaux, Spray Cop, Tennessee 26, and Tennessee 34. Some of the new organic fungicides also show promise as materials for controlling leaf spot on cherry. None of these materials have fungicidal value equal to bordeaux, but some cause less injury, and for that reason are more satisfactory in most years. They should be used according to manufacturers' recommendations.

Experimental results the past 3 years with a half-and-half mixture of proprietary copper and wettable sulfur plus lime (1½ to 2 pounds of proprietary copper, 2 to 3 pounds of wettable sulfur, 3 to 4 pounds of lime) showed this mixture to be satisfactory for leaf-spot control on both sweet and sour cherry. If copper materials should become scarce, wettable sulfur could be substituted for part of the copper without sacrificing any degree of disease control.

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 number in late infected leaves and increase the difficulty of control the following year. The maintenance of good foliage throughout the season helps to keep the trees in good vigorous condition so as to withstand winter injury.

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.

Spray timing 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.

Coryneum Blight

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.

Dead Arm

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.** It will not control established infections.

Fire Blight

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 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 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 dis-

infecting. 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 preventative 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.

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, etc., 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 dead wood 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 dead wood 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 Dress-

ing, or a black gilsonite-asphalt paint, or one of the water soluble asphalt emulsions sold as grafting compounds. Shellac is a good wound dressing. White lead paint without turpentine is satisfactory.

Cultural Practices—The later in the season that cultivation is discontinued and the cover crop sown, the more canker resulting is a proven rule. 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. This is perhaps more important on the heavy soils where canker is more severe.

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 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 can be used in the same way.

The leaf curl fungus lives over harmlessly from year to year on the waxy coatings 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.**

Pear Scab

Pear scab can be controlled readily on the commercial varieties of pears grown in Michigan as outlined in the spray schedule. An extra pre-bloom 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 with satisfactory results. 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 to 100 gallons in the after-bloom sprays. If scab is believed to be well controlled, wettable sulfur can be substituted for the lime-sulfur in the after-bloom sprays.

Pear scab is caused by a fungus closely related to apple scab and having a similar life history. See page 27. 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 Keiffer is the most resistant.

Virus Diseases of Peach and Other Stone Fruits

Viruses cannot be reached and killed with sprays, but spray con- 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 conditions 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. 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.

Virus diseases cannot be controlled by spraying. These diseases trol of insect vectors may be of value in reducing the spread of these diseases. Peach yellows, little peach and red suture are possibly spread by one insect only, a leafhopper found on plums, Macropsis trimaculata. During early summer the insect is present as a wingless nymph, and can be readily eradicated by one spray of nicotine sulfate applied in mid-June. This spray is advisable in orchards where peach viruses are a serious problem. It is equally important to spray nearby plums.

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 if this disease is present.

"X" disease is well established on chokecherries in Michigan, but the disease does not spread to peaches when separated for a distance of 500 feet from diseased chokecherries. Eradicate the chokecherries for a distance of 500 feet from peach 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 if 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 of the tree, 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 State 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 State Department of Agriculture.

Cherry Yellows

Cherry yellows is a disease affecting sour cherry. Growers should become acquainted with the symptoms of the disease so that they can distinguish it from leaf spot, spray or drought injury. Sprays, fertilizers, or cultural practices have no effect on the disease. 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 local or district basis. The practise of removing only the seriously infected trees in bearing orchards and replanting is not practical because the young 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 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. Defolia-

tion 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, and an outstanding characteristic is yellow leaves with a definite green midrib and veins. Trees which are seriously defoliated show a progressive reduction in spur growth. The fruit is produced on lateral buds. This type of production results in long bare spaces on the twigs with the terminal bud the only growing point. Severely affected trees produce large leaves, light crops, and large fruit. The 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 have one or more large irregular dead areas in the leaf tissue.

LIFE HISTORIES AND CONTROL PRACTICES OF INSECTS

Aphids

Aphid control is necessary on apple, sweet cherry, raspberry, currant, and gooseberry.

Dinitro cresols (DN compounds) are specific for aphid eggs and can be applied in water solutions to dormant fruit plants without danger. DN compounds do not affect red mite eggs. The usual dosage is 8 ounces of DN, which equals 1¼ pounds of a 40-percent concentrate or 1 pound of a 50-percent concentrate per 100 gallons spray.

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

Aphid control on fruit plants in foliage can be accomplished by contact sprays and in some cases by dusts but requires extremely careful application. Nicotine sulfate, 40 percent, 1 pint, or equivalent in 100 gallons of spray, with soap or a commercial spreader and 1 pound of lime, is most commonly used for control of black cherry aphids on sweet cherry. Always remember that sweet cherries are susceptible to brown rot and include sulfur with an aphid spray on this fruit.

Green apple aphids often foul the fruit and injure new growth in July but can be readily controlled by nicotine sprays which at the same time will aid in control of codling moth.

Aphids spend the winter on fruit plants as shiny black eggs which hatch just as the buds burst. The reproductive power of these insects is so great that spraying for aphids should be on the basis of history of infestation rather than number of eggs present.

Apple Maggot

Two sprays of lead arsenate, 3 pounds in 100 gallons, 10 days apart and applied while the adult flies are feeding give excellent control of apple maggot.

The exact date for the first spray against apple maggot is determined each year by the Department of Entomology and the information is sent out by county agricultural agents, newspapers, and radio stations. The date is determined by observation in the field and by the use of bait traps in infested apple trees. 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. This native insect is on its "home grounds" in Michigan. Elderly persons remember that before spraying became general in the 1880's, apple maggot, then called "railroad worm" because of its tunnels in the fruit, was the No. 1 orchard pest. Prior to the advent of arsenical spraying, the pasturing of livestock in orchards and the utilization of low-grade apples as "vinegar stock" retarded spread of the insect. The apple maggot began to return as a pest about the time growers became residue-conscious. At present it is probably more important than ever before.

The single generation of winged flies responsible for maggot-infested apples appear in greatest numbers shortly after July 4 and feed by scrubbing the surface of leaves and fruit with their mouthparts for about a week before laying eggs. Obviously, no insecticide will reach the maggots after they are in the apples.

Since the maggots go from the infested apples into the soil where they over-winter, removal of fallen apples from beneath the trees before the maggots emerge will destroy the chances of a buildup in numbers.

Drops and windfalls must be picked up in a heavily infested orchard. Systematic removal of drops and windfalls in all orchards will reduce the chances of their becoming heavily infested.

To be effective against apple maggot, pickup of drops and wind-

falls should be practiced after the third week in July. Summer varieties must be collected twice a week; fall varieties each week; and winter varieties every 2 weeks, since the maggots develop at different rates depending upon the condition of the apples. The best way to destroy unsalable apples is to pile them in some out-of-the-way corner and then, the following spring after they have rotted down, 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 are effective.

If you have had trouble with this pest be sure to plan to apply an arsenical just after July 4. Notice, also, that in the apple spraying schedule attention is called to an apple maggot spray.

Cherry Fruit Fly

State law prohibits sale of cherries infested by fruit fly maggots.

A spray of lead arsenate, 2 pounds, applied during the period the adult cherry fruit flies are feeding has always 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 determined each year by a scouting system maintained by the State Department of Agriculture and Michigan State College.

Adult cherry maggots are strikingly marked flies which lay eggs on the cherries just as they start ripening. These eggs hatch into larvae which develop inside the cherries and when mature go into the ground when left alone. The larvae 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

DDT gives every indication of offering an excellent control for codling moth. It is, however, unavailable at present for general use. As a consequence, growers must depend for control on the same materials used for the last several years.

In this connection keep in mind that in heavily infested orchards supplementary methods, such as banding the trees, are valuable aids in control.

Spraying, however, must be mainly depended upon to control codling moth. Remember that the second brood always comes from the first brood, and that thorough coverage during the entire period that the first-brood worms are actually entering apples is necessary if these worms are to be prevented from maturing and breeding. This involves coverage at the time of the calyx spray, and coverage

at short intervals during the period of rapid growth immediately after the calyx spray.

The importance of thorough coverage during this period can be readily recognized from the fact that the surface of an apple increases 800 percent during 3 weeks immediately following petal-fall.

Furthermore, later spraying (mid-July and after) will control codling moth only if the number of larvae surviving the first brood sprays is kept to a low figure. "New materials and schedules" cannot substitute in July and August for arsenicals and nicotine in June.

A spraying program for apples embodying the foregoing ideas in codling moth control consists of:

1. Calyx or petal-fall—2 pounds lead arsenate.
2. First cover, 7 days after calyx or petal-fall—3 pounds lead arsenate.
3. Second cover, 7-10 days after first cover—4 pounds lead arsenate.
4. Third cover, 10 days after second cover—3 pounds lead arsenate.

Note the intervals. Note also that ¾ pint of nicotine sulfate per 100 gallons or its equivalent in other nicotines, included in the second and third cover sprays, is one of the best known ways of obtaining better codling moth control without fear of residue. Additional cover sprays at two-week intervals will be needed until the time for the two or more second-brood sprays is announced through county agents.

CODLING MOTH ON PEAR

The spray schedule as outlined for codling moth control on pears is written for the grower who sells his fruit to a cannery. If the fruit is sold on the fresh fruit market, residue removal will be necessary. If no washing equipment is available, the nicotine sulfate-oil spray referred to above, or a fixed nicotine-oil spray, may be substituted for the lead arsenate. Nicotine-oil sprays are effective for only 7 to 8 days. Six to eight applications, beginning with the second cover spray, may be necessary for control. The number of applications should be based on the prevalence of codling moth in the orchard. Apply only the number of sprays necessary for control. Too many sprays containing oil may cause injury.

Kieffer pears are not harvested until late in September or the first half of October, and nearly all of them are sold to commercial canners. Codling moth emerging in September have so thoroughly

infested Kieffer pears in some orchards as to cause the rejection of the entire crop. One or two applications of 3 pounds of lead arsenate in 100 gallons of water in September, will save much of the Kieffer crop going to canneries. Contact your county agricultural agent or the Agricultural Experiment Station, East Lansing, if in doubt about the time of application.

Codling moths attack apples, pears, and quinces, and occasionally peaches and plums when interplanted with apples. They live over winter in the larval stage beneath the rough bark on tree trunk and branches, in rubbish about the orchard and in orchard equipment about the packing house. 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; the moths of the second brood appear usually between July 20-August 1. Severity of second brood attack commonly depends on weather during late August and early September.

Eggs are laid on the surfaces of fruit and foliage and hatch in from 4 to 10 days, depending upon the temperatures. The young larvae enter the fruit either through the calyx cup or eat their way through the skin. Larvae feed upon the flesh of the fruit until full grown, then leave the apple, spin a cocoon, undergo the change from larvae to moths and usually emerge as second-brood moths in late July or early August. Some of the first-brood larvae and all of the second-brood larvae live through the winter.

Control measures consist of sanitary measures, such as destroying over-wintering places, banding, picking up drops and spraying. Spraying constitutes the main reliance for the control of codling moth.

Grape Berry Moth and Grape Leafhopper

Use of properly designed covered booms will improve 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, chiefly because nicotine is an excellent material for use against leafhopper and also a good control for grape berry moth.

The first spray against grape berry moth, consisting of 3 pounds of an arsenical (lead or calcium arsenate) with 3 quarts of summer oil as a sticker, in 100 gallons of spray should be applied when the new shoots are 4 to 6 inches long. A second application of the same materials and dosage should be put on just as the grapes come into bloom. The third spray of summer oil 3 quarts, nicotine sulfate

¾ pint, and 3 pounds lead or calcium arsenate in 100 gallons should go on immediately after bloom. This spray is most important in the control of grape berry moth; consequently a thorough application must be made.

In these applications no mention is made of the fungicide because the insecticides used are compatible with any fungicides used on grapes. Bordeaux, 8-8-100, is suggested.

At least two more applications must go on after the post-bloom spray if control of berry moth and leafhopper is to be satisfactory. Such a program necessitates that the grower decide what program to follow for the rest of the season. Sprays of oil, arsenical, and nicotine applied with bordeaux, may stain the fruit and result in grapes being unsalable on the fresh fruit market.

The grower may wish to change to a fixed nicotine-fish oil soap program; in that case, a proprietary copper fungicide must be used because fixed nicotine is incompatible with bordeaux. Grapes sprayed with this program may be sold for fresh fruit or juice.

In any case, nicotine added to the post-bloom sprays will control the leafhopper and improve the control of berry moth.

Working the soil toward the vines and leaving it undisturbed until after July 1 covers many berry moth pupae and, thereby, reduces the spray-problem.

Insofar as spraying is concerned, grape berry moth and leafhopper are considered together because better control can be obtained in that way.

Grape berry moth has three generations each year. The first brood appears about the time grapes bloom, and Michigan growers are familiar with their little webs in the bunches at that time. The second brood appears just as the berries are touching in the bunches.

Grape leafhoppers move into the vineyards about a week before bloom, and have a succession of generations until frost. If they are not controlled soon after grapes set, it is virtually impossible to do so later.

Leafhoppers

Leafhoppers in bearing orchards are controlled by contact sprays applied at the time of the first cover spray. Nicotine sulfate, 40 percent, 1 pint per 100 gallons of spray, has been commonly used because it fits into the control program so well. It is compatible, and also helps to control codling moth. Shifting to a nicotine program for codling moth controls leafhopper with the exception that sometimes potato leafhopper has accomplished its damage before the shift is made.

Young non-bearing trees suffer greatly from potato leafhopper and are best protected against this pest by bordeaux sprays. A 3-5-100 bordeaux is suggested. This also aids in control of scab.

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 affect apple trees in Michigan. The white apple leafhopper and the rose leafhopper winter as eggs beneath the bark of various plants; the potato leafhopper migrates in each year from wide areas. The first two leafhoppers stipple the leaves, causing them to assume a pale appearance; the potato leafhopper causes the leaves to curl characteristically downward at the edges and to assume at first a yellowish cast and then turn brown. Potato leafhopper injury is often mistaken for aphid injury.

Peachtree Borer

Peachtree borer is readily controlled by the use of paradichlorobenzene (P.D.B.) applied about September 1 in a ring about the base of the tree and covered with a few shovelfuls of soil. Spring treatment is of doubtful value. One ounce is the dosage for a tree 6 years or older; ¾ ounce for a 5-year-old tree; ½ ounce for a 4-year-old tree.

Trees should not be treated until they have been in the field 3 years.

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

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 from late June to late August.

Pear Psylla

1. Pear psylla is best controlled by a dormant oil spray in March or early April before egg laying begins. This application is often applied too late.

2. A home-made bordeaux emulsion, prepared from oil having a viscosity of 175 to 250 seconds (Saybolt at 100°) is preferred. Most commercially prepared oils are of a lower viscosity and will not give as good control as the home-made emulsion. (See page — for instructions on making home-made emulsions.)

3. Spray thoroughly—it is imperative that all parts of the tree be covered.

4. If psylla is not entirely controlled by the application of dormant oil, spray later at its first appearance with ¾ pint of nicotine sulfate and 3 quarts of summer oil in 100 gallons of water, and repeat the application in 10 days if control is not obtained. Thoroughness of application is essential to success in psylla control.

The pear psylla is a jumping plant louse. The adults winter in and around the orchard in bark crevices usually and become active early in the spring. In fact, pear psyllas can be seen almost any time in the winter on bright days. The small yellowish eggs are usually laid before the buds burst. There is a succession of generations, the small pin-point-sized yellow nymphs living in tiny pools of honeydew on the leaves. After psylla becomes established, heavy and repeated spray applications of contact sprays are necessary.

Plum Curculio on Pome and Stone Fruits

Two or three sprays at the time the adults are beginning to feed are necessary. Curculios appear and start feeding after 2 to 3 consecutive days of 75 degrees average temperature. The first spray should follow such a period. Apples and quinces sprayed according to the schedules will have little trouble from curculio. Special attention and, perhaps, extra applications should be given to the first four rows of stone fruit trees near overgrown fence rows, gullies, sloughs, woodlands, buildings, or other suitable curculio over-wintering quarters. Heavy infestations (on the basis of past damage) should have three sprays: (1) at petal-fall; (2) at shuck-fall; and (3) 2 weeks after shuck-fall.

Ordinary curculio infestations are controlled by two arsenical sprays—one at shuck-fall and one 2 weeks later.

Basic lead arsenate, 3 pounds per 100 gallons of spray, has given excellent control of curculio. Acid lead arsenate (the standard or commonly used kind) used on peaches at the rate of 2 pounds per 100 gallons of spray, should never be applied to peaches unless zinc sulfate-lime, 4-4-100, is used with it as a corrective. (See page 26.)

Curculio control is included in the schedules for apples, quinces, peaches, plums, and sweet cherries.

Plum curculio attacks fruits just after they set, causing young fruits to drop as a result of injury either from larval feeding or infection by rots carried by the adult beetle. From late July to harvest-time, adult curculios again cause injury by puncturing the fruit when feeding and by spreading brown rot. There is one generation a year in Michigan, and the long life (10-15 months) of the adults is responsible for the extended period of attack. A curculio emerging in July feeds until cold weather, houses up for the winter

in or near the orchard, and emerges the following spring to cause damage again. Since each female curculio may lay 300 eggs, the value of proper disposal of thinnings, destruction of over-wintering places, and good spray practices should be apparent.

Red Mite

Dormant sprays of 3-percent actual oil content have been used for many years with success against European red mite. Thorough coverage with 3-percent oil in the dormant period is necessary for red mite control. However, in some years and on susceptible varieties such as Delicious and Baldwin even this gives insufficient control and further summer sprays may be necessary. Although 2-percent oil applied with DN compounds has been used for San Jose scale and aphids, it has not satisfactorily controlled red mite. **Three-percent oil and DN combinations are dangerous from the injury standpoint.** Aphid control and red mite control should not be attempted in a single dormant application.

Experimental evidence shows that foliage sprays of either 1-percent summer oil or the proper concentration of the dicyclohexylamine salt of dinitro ortho cylohexylphenol (a DN compound different from the one used against aphids in the dormant spray) controls mites. However, oil is incompatible with sulfur. The DN compound is incompatible with oils and alkalis.

Consequently, the best way of handling the mite problem is to apply a 3-percent dormant oil spray to all the orchard for mites. Following this, additional foliage sprays could be planned for susceptible varieties. A good program might include the summer form of DN with a wettable sulfur in an arsenical schedule; or arsenical up to the third cover spray with a change to a nicotine-oil program. Remember that since sulfur and oil are incompatible scab control must be completed with the first cover if the nicotine-oil program is to be used.

Scab control early in the season will clear the way to mite control. Heavy deposits of sulfur increase the hazard of injury from either DN or oil in hot weather.

Red mite eggs occur any place upon fruit trees. Smaller branches and rough places on the limbs of apple, plums, and peaches are favorite sites. The young mites appear at the time of the delayed dormant spray or soon after, and a new generation is produced in about 35 days. Since each female produces 25-35 eggs, the offspring of a single female mite may reach astronomical figures by midsummer when their damage is commonly seen.

Damage by red mites results from their feeding on the surfaces of the leaves. Bronzing of foliage is the first sign of damage, but severe infestations influence coloration and sizing of fruit by reducing food manufacture in the leaves, even to the extent of partial defoliation.

Rose Chafer

The only protection from rose chafer on peaches and mature apples at present is the use of 25 pounds of lime plus 5 pounds of bentonite sulfur as a sticker in 100 gallons of spray. This same spray will injure young apples and sweet cherries. No more than 15 pounds of lime per 100 gallons of spray should be used on sweet cherries or young apple trees. Four pounds of lead arsenate, plus 1 gallon of molasses in 100 gallons of 8-12-100 bordeaux, have consistently given the best available control of rose chafer on grapes.

Pyrethrum (1-percent pyrethrin content) plus mannitan monolourate 1½ pints to 100 gallons; 1 pound DDT per 100 gallons; and 10-percent DDT dust control rose chafer but are unavailable.

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

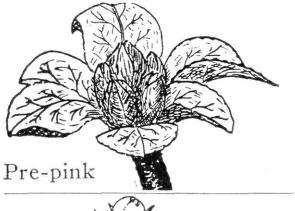
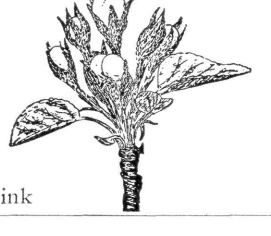
Scale Insects

Scale insects likely to occur on Michigan fruit trees are readily killed or kept in check by sprays containing 3-percent actual oil.

San Jose scale lives overwinter as a nymph. The two generations per year, coupled with its feeding habit, render it a pest to be kept in mind all the time. San Jose scale kills trees. Infested trees have a scurfy, unhealthy appearance, purplish discolorations beneath the surface of the bark, and tiny reddish blotches on the fruit in mild cases. Heavy infestation kills branches or the tree, and the fruit may be heavily encrusted.

Oystershell scale resembles an oystershell. The "shell" covers about 100 eggs which hatch in June providing for spread. Oystershell is present in many orchards, but is of little importance in orchards south of Manistee which receive an occasional oil spray. Oystershell scale is of more importance in the northern counties. Four-percent oil or DN is required for eradication.

APPLE SPRAYING SCHEDULE

Stage of Growth	Stage of growth and application	**Materials to make 100 gallons of spray		Pests controlled
 Dormant	DORMANT. Complete before buds show green	Lime-sulfur 12 gallons; or dormant oil, 3% actual oil; or DN. See pages 12, 18, 21 respectively		Red mite Scale *(1) Rosy aphids See pages 46, 47, 38
 Delayed dormant	DELAYED DORMANT. Apply in well developed green tip stage when leaf tips are ¼ to ½ inch long	Lime-sulfur 2 gallons; or *(2) Wettable sulfur 5 to 8 pounds. Nicotine sulfate 1 pint. See pages 18, 11, 22	These applications are important in scab control	Scab Rosy aphids See page 27
 Pre-pink	PRE-PINK. Just as first leaves are unfolding around blossom buds. Complete as soon as possible	Lime-sulfur 2 gallons; or *(2) Wettable sulfur 5 to 8 pounds. Lead arsenate 3 pounds. See pages 12, 11, 16		Scab Curculio Chewing insects See pages 27, 45
	EARLY PINK. When the center bud shows pink	*(2) Wettable sulfur 5 to 8 pounds. See page 11		*(3) Scab See page 27
 Pink	PINK. Apply as soon as most of the blossom buds have separated, complete before blossoms open	Lime-sulfur 2 gallons; or *(2) Wettable sulfur 5 to 8 pounds. See pages 12, 11		Scab See page 27
	IN BLOOM. When trees are in full bloom	*(2) Wettable sulfur 5 to 8 pounds. See page 11		*(4) Scab See page 27

 Calyx	CALYX. When most of petals have fallen and bees have quit working	Lime-sulfur 1½ gallons; or *(2) Wettable sulfur 5 to 8 pounds. Lead arsenate 2 pounds. See pages 12, 11, 16		Scab Curculio Codling moth See pages 27, 45, 40
	FIRST COVER. 7 to 10 days after calyx	*(2) Wettable sulfur 4 to 6 pounds. Lead arsenate 3 pounds. See pages 11, 16		Scab Codling moth Curculio See pages 27, 40, 45
	SECOND COVER. 7 to 10 days after first cover	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 4 pounds. *(2) Wettable sulfur 4 to 6 pounds. See pages 26, 16, 11	**Codling moth control**	Scab *(5) Codling moth Curculio See pages 27, 40, 45
	THIRD COVER. 10 to 14 days after second cover *(5)	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds. See pages 26, 16		*(5) Codling moth Curculio Apple maggot See pages 40, 45, 39
	FOURTH COVER. 2 weeks after third cover	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds. See pages 26, 16		*(5) Codling moth Curculio Apple maggot See pages 40, 39, 45
	SUMMER GENERATION. Exact time to be determined each year, usually Aug. 1	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds. *(2) Wettable sulfur 4 to 6 pounds. See pages 26, 16, 11		*(5) Codling moth Curculio Apple maggot *(6) Scab See pages 40, 45, 39
	TWO WEEKS AFTER SUMMER GENERATION SPRAY. If necessary make one or two more applications at 2-week intervals	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds. See pages 26, 16		*(5) Codling moth Curculio See pages 40, 45

* Numbers in parenthesis refer to footnotes on page 50. ** Add materials to tank in order given

Thorough Coverage is Essential in All Applications

(1) This is the best time to control red mite which requires a 3-percent actual oil spray. On varieties susceptible to rosy aphids water soluble DN compound, or a 2-percent oil DN mixture may be used. The DN or DN oil mixture will not control red mite. Where both rosy aphids and red mite are a problem a 3-percent dormant oil is recommended for red mite control followed by nicotine sulfate in the delayed dormant for rosy aphids.

(2) Wettable sulfurs are obtainable in the dry-wettable and paste forms. The amounts suggested in the spray schedule are for the dry-wettable forms. If flotation pastes are used double the amounts of the material. The finer particle sized (8 microns and smaller) wettable sulfurs only are recommended for apple scab control.

(3) This spray may be omitted on scab-resistant varieties such as Jonathan, Rhode Island Greening and Wagener.

(4) Do not use lead arsenate in this spray because of danger of poisoning bees.

(5) If fruit is not to be washed, lead arsenate and the zinc sulfate-lime mixture should be substituted after the second cover spray with fixed nicotine, or fixed nicotine and oil.

(6) Sulfur in this application will aid in controlling late scab.

PLUM SPRAYING SCHEDULE

Application	*Materials to make 100 gallons of spray	To control
(1) DORMANT. Apply just before growth starts	Oil 3% See pages 18, 20	Scale insects and mites See pages 47, 46
(2) PRE-BLOSSOM. Just as leaf buds burst and before blossoms open	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds. See pages 26, 16	Curculio See page 45
(3) PETAL-FALL. Just after the petals have fallen	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds. Wettable sulfur 4 to 6 pounds. See pages 26, 16, 11	Curculio, leaf spot and brown rot. See pages 45, 31
(4) TWO-WEEKS. Ten days to two weeks after No. 3	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds. Wettable sulfur 4 to 6 pounds. See pages 26, 16, 11	Curculio, leaf spot and brown rot. See pages 45, 31
(5) LATE SUMMER. About one month before harvest	Wettable sulfur, 4 to 6 pounds. See page 11	Brown rot and leaf spot See page 31
(6) SPECIAL. One week to ten days before harvest	Sulfur dust or wettable sulfur 4 to 5 pounds. See page 11	Brown rot. See page 31

*Add materials to the tank in the order given.

PEACH SPRAYING SCHEDULE

Application	†Materials to make 100 gallons of spray	Dusts substituted for sprays	Pests controlled
(1) DORMANT. Apply in early spring before growth starts	For leaf curl: Lime-sulfur 5 gallons. For scale and leaf curl: lime-sulfur 12½ gallons. For mites or scale: 3% oil. *For mites or scale and leaf curl: 8-8-100 bordeaux plus 3% oil. See pages 12, 18, 18		Leaf curl Red mite Scale See pages 35, 46
(2) PINK. Apply just before blossoms open	Lime-sulfur 2 gallons. See page 12	85-15 sulfur lime dust	Blossom blight Brown rot See pages 30, 30
(3) PETAL FALL. Just after petals have fallen	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 2 pounds** Wettable sulfur 4 to 6 pounds	80-5-15 sulfur-lead arsenate-lime dust	Curculio Brown rot See pages 45, 30
(4) SHUCK FALL. After petals have dropped and most of the shucks have fallen	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 2 pounds.** Wettable sulfur 4 to 6 pounds	80-5-15 sulfur-lead arsenate-lime dust	Curculio Brown rot See pages 45, 30
(5) Two weeks after No. 4	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 2 pounds.* Wettable sulfur 4 to 6 pounds. Nicotine sulfate 1 pint. (See last column). See pages 26, 16, 11	80-5-15 sulfur-lead arsenate-lime dust	Curculio, scab, brown-rot. Nicotine added for virus transmitting leaf hoppers. See pages 45, 30, 36
(6) 1 month before fruit ripens	Wettable sulfur 6 pounds. See page 11	85-15 sulfur-lime dust	Brown rot and scab. See page 30
(6a) 1 week after No. 6	Wettable sulfur 4 to 6 pounds. See page 11	85-15 sulfur-lime dust	Brown rot See page 30
(6b) 1 week after No. 6a	Wettable sulfur 4 to 6 pounds. See page 11	85-15 sulfur-lime dust	Brown rot See page 30
(7) 7 days before harvest	Wettable sulfur 4 to 6 pounds. See page 11	85-15 sulfur-lime dust	Brown rot See page 30

*For combined bordeaux and oil spray, make the bordeaux in the usual way in the tank. When the tank is nearly full, add the correct amount of home-made stock oil emulsion, or any proprietary dormant oil compatible with bordeaux.

**Basic lead arsenate may be substituted for the acid lead arsenate and the zinc sulfate-lime corrective. Basic lead arsenate should be applied at the rate of 3 pounds to 100 gallons of spray.

Iron sulfate-lime mixture may be substituted for zinc sulfate-lime mixture on peaches. See page 25.

†Add materials to tank in order given.

PEAR SPRAYING SCHEDULE

Application	Materials to use	Pests controlled	Remarks
DORMANT. Apply with the first good spraying weather in March or early April	3% heavy oil emulsion See page 18	Psylla Red mite Scale insects See pages 44, 46, 47	An oil spray prepared from oil having a viscosity of 175-250 (Saybolt) will give best results. *Apply early in spring before egg laying begins.* See page 18
PRE-BLOSSOM. When the blossom buds begin to separate in the cluster	Bordeaux 3-8-100 Lead arsenate 3-100 See pages 14, 16	Scab Leaf spot Curculio Bud moth See pages 35, 45	This spray should always be applied in districts where scab and leaf spot are prevalent. In years favorable for scab development an extra pre-blossom spray may be necessary
SPECIAL BLIGHT SPRAY. When ¾ of the blossoms are open	Bordeaux 2-6-100 See page 14	Fire blight Scab See pages 33, 35	This spray is necessary only where fire blight is a problem
PETAL FALL or CALYX. When the last of the petals have fallen	Bordeaux 2-8-100 Lead arsenate 3-100 See pages 14, 16	Scab, Curculio Leaf spot Codling moth, other chewing insects See pages 35, 41	
FIRST COVER. Two weeks after petal fall	Bordeaux 2-8-100 Lead arsenate 3-100 See pages 14, 16	Codling moth Curculio See pages 41, 45	The bordeaux may be omitted if scab or leaf spot are not present
SECOND COVER. Four weeks after petal fall	Lead arsenate 3-100 See page 16	Codling moth Curculio See pages 41, 45	If sold as fresh fruit, this schedule will make residue removal necessary. See page 41
THIRD COVER. Six weeks after petal fall	Lead arsenate 3-100 See page 16	Codling moth Curculio See pages 41, 45	
SECOND BROOD SPRAY. Time determined the same as for apples	Lead arsenate 3-100 See page 16	Codling moth Curculio See pages 41, 45	*The late brood often is responsible for late codling moth injury, especially on Kieffer in September.* See page 41.

SOUR CHERRY SPRAYING SCHEDULE

Application	Materials to make 100 gallons of spray	To control
*PETAL-FALL. When most of the petals have dropped	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lime, 3 to 4 pounds; lead arsenate, 2 pounds. See pages 16, 24	Leaf-spot Brown-rot Curculio and slugs See pages 31, 31
FIRST COVER. Should be completed within two weeks after petal-fall	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lime, 3 to 4 pounds; lead arsenate, 2 pounds. See pages 16, 24	Leaf-spot Brown-rot Curculio and slugs See pages 31, 31
SECOND COVER. Should be completed within two weeks after first cover	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lime, 3 to 4 pounds; lead arsenate, 2 pounds. Omit lead arsenate unless fruit is going to canning factory or can be washed. See pages 16, 24	Leaf-spot Brown-rot Curculio and slugs See pages 31, 31
SPECIAL. For the control of cherry maggot	Information concerning the timing of this application for the control of cherry maggot is sent out by the Department of Entomology. Consult your County Agricultural Agent	
AFTER HARVEST. Immediately after the fruit is harvested	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lime, 3 to 4 pounds; **lead arsenate, 2 pounds. See pages 16, 24	Leaf-spot and slugs See page 31

SPECIAL. On young growing trees extra applications may be necessary until growth is completed.

RESIDUE REMOVAL. Instructions will be furnished on request to Department of Horticulture.

DO NOT follow a copper spray with lime-sulfur for summer applications during the same year.

Consult your county agent for information on special spray for cherry maggot. The exact dates are determined annually by the Department of Entomology.

*If brown-rot blossom blight has been prevalent, apply a pre-bloom spray of lime-sulfur—2½ gallons in 100.

**Lead arsenate not necessary where slugs are not a problem.

SWEET CHERRY SPRAYING SCHEDULE

Application	Materials to make 100 gallons of spray	To control
1. DORMANT.	DN water soluble (Use according to manufacturer's recommendation)	Aphid† See page 38
2. PRE-BLOOM. Just before blossoms open	Wettable sulfur, 4 to 6 pounds	Brown-rot See page 31
3. PETAL-FALL. Just after petals have fallen	Lead arsenate 2 pounds, 1½ pounds 25% proprietary copper compound or 2 pounds of 12½% proprietary copper compound plus 3 pounds of dry wettable sulfur plus 3 pounds lime. See pages 16, 16	Leaf-spot Brown-rot Curculio and slugs See pages 31, 45
4. TWO-WEEKS. Two weeks after Application 3	Same as above	Leaf-spot Brown-rot Curculio and slugs See pages 31, 45
5. FOUR-WEEKS. Two weeks after Application 4	Same as above. Omit lead arsenate unless fruit is to go to canning factory or can be washed	Leaf-spot Brown-rot Curculio Slugs and maggots See pages 31, 40
5a. SPECIAL. For the control of cherry maggot	Information concerning the timing of this application for cherry maggot is sent out by the Department of Entomology. Consult your county agricultural agent	
6. BROWN-ROT. About one week before picking	Sulfur dust or spray of wettable sulfur 4 to 5 pounds or Fermate 1½ pound. See pages 11, 14	Brown-rot See page 31

RESIDUE REMOVAL. Instructions will be furnished on request to the Department of Horticulture.

†If black aphids are not controlled by the dormant application apply a special application as soon as the insect is observed. Use nicotine sulfate 1 pint and a suitable wetting agent such as Dreft 4 ounces to 100 gallons or DuPont spreader or C. P. O. soap at manufacturer's recommendations; 4 pounds of cheap soap flakes may be substituted for the spreader. Include wettable sulfur for brown-rot control.

GRAPE SPRAYING SCHEDULE

Application	*Materials to make 100 gallons of spray	To control	Explanations
1. When shoots are 4 to 5 inches long	Bordeaux, 8-8-100. Lead or calcium arsenate, 3 pounds plus 3 quarts of summer oil. See pages 14, 16	Black-rot Downy mildew Berry moth and Dead arm See pages 29, 42, 33	Applications 1 and 2 are usually very important for rot control in seasons when it develops in epidemic form. They should be made every year as insurance against rot
2. Just as the blossom buds are opening	Same as above	Black-rot Berry moth Downy mildew and Rose chafer See pages 29, 42, 47	If rose chafer is present, use 5 pounds lead arsenate and perhaps a gallon of cheap molasses. This is a critical application for the control of berry moth
3. Immediately after fruit sets	Same as above plus 1 pint of nicotine sulfate 40%	Black-rot Downy mildew Berry moth Rose chafer See pages 29, 42	This application is necessary for berry moth control
4. Two weeks after full bloom	Bordeaux, 8-8-100. Lead or calcium arsenate, 3 pounds plus 3 quarts of summer oil plus 1 pint nicotine sulfate 40% or 3 pounds fixed nicotine (14%) plus ½ pound rosin fish oil soap plus 3 pounds proprietary copper compound. See pages 14, 16, 16, 17	Black-rot Downy mildew Leaf hopper Berry moth and Rose chafer See pages 29, 42	If rose chafer is very bad or berry moth very plentiful, make this application four days earlier Better leaf hopper control follows inclusion of fixed nicotine in this spray
5. About the time the berries begin to touch	Fixed nicotine (14%) 3 pounds plus ½ pound rosin fish oil soap, 3 pounds proprietary copper compound. See pages 17, 16	Black-rot Downy mildew Leaf hopper Berry moth See pages 29, 42	
6. Time determined by observations. Usually around August 15	Fixed nicotine (14%) 3 pounds plus ½ pound of rosin fish oil soap. See page 17	Berry moth See page 42	Particularly valuable in heavily infested vineyards

*Add materials to tank in order given.

Issued, February 1936
First Revision, March 1938
Second Revision, March 1940
Third Revision, March 1942
Fourth Revision, April 1944
Fifth Revision, April 1945