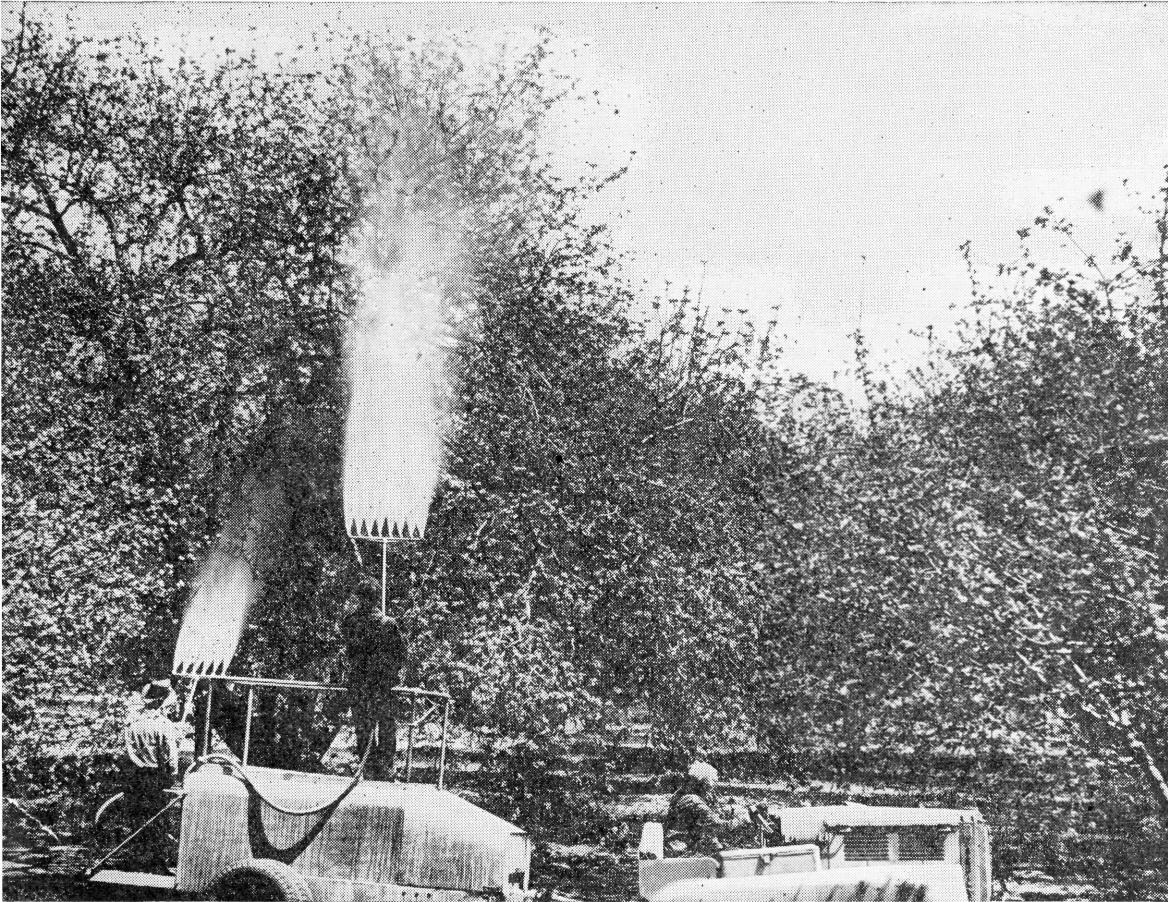


SPRAYING CALENDAR

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

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SPRAYING CALENDAR

E. J. RASMUSSEN, RAY HUTSON, AND DONALD CATION

1. The directions given in this publication are intended for dealing with conditions which favor moderately severe infestations of disease and insects. Weather conditions, diseases and insects present, amount of disease infection, varieties, vigor of trees, and methods of application should all be considered in the spraying program. To plan an economical and effective spraying program, a grower should be familiar with the life history of the common insects and diseases in his locality; the conditions which favor their development; the kinds of spray materials and their uses; and the susceptibility of kinds and varieties of fruits to insect, disease, and spray injury.

SPECIAL INFORMATION

Every season hundreds of packages without written information are received by the various departments concerned with plant production and protection. Conversely, hundreds of letters telling of packages are received without the packages.

Prompt attention to such requests can be rendered only in case both letter and package are plainly marked to show their connection and reach us together. Describe conditions fully, state previous treatment, and if diagnosis of trouble is desired send material to show typical injury.

Always attach letter to the package, place your name and address upon it. Address the package and letter to Michigan State College, East Lansing, Mich.

Because of the small change necessary in recommendations in any one year it has been deemed advisable to revise the spraying calendar every two years instead of yearly. Any minor changes seeming necessary will be published as a supplement.

SAVE YOUR CALENDAR

Such knowledge will mean a substantial saving in spray materials and labor, and an increased production in the orchard. For example: In the control of apple scab, if rains occur frequently during the pre-bloom and calyx periods, liquid lime-sulphur will be most satisfactory since it sticks better than other materials and is capable of killing the scab organism two to three days after infection takes place. On the other hand, under less favorable conditions for scab development a wettable sulphur would be preferred since it causes less injury. Another example is in the use of an arsenical in the pre-bloom sprays. It is likely that the use of lead arsenate is unnecessary every year in all of the pre-bloom sprays. These sprays are principally for the control of scab and unless curculio, canker worm, or budmoth is a serious problem a poison in only one of these sprays should be necessary.

Varying the spray schedule to meet the susceptibility of the variety should also be considered when possible. Certain varieties such as McIntosh may require more sprays for scab control than Wealthy or Grimes Golden. Some varieties such as Jonathan and King are susceptible to arsenical injury. On such varieties the use of an arsenical corrective in the cover sprays or the substitution of one of the fixed nicotine compounds for lead arsenate will reduce arsenical injury.

Timeliness and thoroughness of application are as important in control of diseases and insects as the materials used.

Probably more orchardists fail because of poor coverage than for any other reason. All the fruit and foliage must be covered with a thin film of spray material. It makes no difference how this is accomplished—whether by light applications at frequent intervals or by moderately heavy sprays at longer intervals. A good thing to remember is that it does not pay to economize on spray materials if they are needed. Vigor of trees also is a factor which should be considered in modifying the spray schedule. A moderately vigorous orchard is less subject to spray injury than a weak one and sometimes less susceptible to disease infection. For instance cherry leaf-spot is more difficult to control in orchards of low vigor. On the other hand oriental fruit moth and peach canker cause more injury to over-vigorous trees. Cultural practices which will maintain a moderately vigorous condition in the orchard will help to simplify the spray program.

2. **Spray Injury.** Over-spraying, too frequent applications, a material used improperly, or even standard materials used in the regular way may cause injury. Severe injury may be just as serious as failure to control because of too little spraying. Spray injury may cause loss of foliage, increased transpiration, excessive dropping of fruit, dwarfing of fruit, or it may affect the color of the fruit. Injury to buds, bark and wood may also occur. The type of injury varies with the different kinds of fruit and with the material used. Some of these injuries may be evident only in the year during which they occur, others are likely, if severe, to affect the future vigor and productiveness of the tree. It is evident, therefore, that the trees must be properly sprayed to prevent injury by insects and diseases but that excessive and improper spraying should be avoided.

3. **Arsenical Injury.** Peaches and certain varieties of apples and plums are very susceptible to arsenical injury; leaves, wood and fruit often being badly injured by arsenical sprays and dusts. In general,

dusting causes less injury than spraying as formerly practiced, but many severe cases of injury have also resulted from dusting. Recent investigations in Michigan and other states have enabled research workers to develop two combinations of spraying materials that are much safer than those formerly recommended. One is a combination of iron sulphate (ferrous sulphate) and hydrated lime and the other a similar combination of zinc sulphate and hydrated lime, to be used with acid lead arsenate, or acid lead arsenate and a sulphur spray. One of these should be used whenever acid lead arsenate is present in a peach spray. Iron sulphate is somewhat cheaper and dissolves more readily than zinc sulphate. Iron sulphate and lime mixture is satisfactory for use on peaches but not on apples. Basic lead arsenate does not require a corrective.

4. **Spray Residues.** The United States Department of Agriculture and the State Department of Agriculture have established tolerances for residues of arsenic, lead, and fluorine, on fruit that goes into interstate shipment and there is also a tolerance on arsenic that must be met when fruit is exported. Residue removal is made more difficult by the inclusion of oil with lead arsenate in the cover sprays. A modified program will be necessary in those orchards where the fruit will not be washed. With other fruits, precautions may be necessary and the recommendations for each fruit should be studied carefully in this connection. No guarantee can be made that any recommended treatment will not cause excessive residue, but the information is the best available.

5. **Dusting.** The dusting method has many distinct advantages over spraying. The original investment for dusting equipment is much less, and the depreciation and maintenance costs are lower. It is sometimes possible to use the lighter dusting equipment on soft ground where it is not possible to travel with a sprayer. An orchard may be covered much more rapidly with dust than with spray, which is a marked advantage, especially with large acreages. Many growers, who do not dust exclusively, do so as an emergency treatment to finish quickly an application that cannot be completed before an expected infection period, with available spraying equipment. Lower labor costs are incident to the more rapid application. An easily available supply of water is not a factor in dusting.

Another marked advantage of dusting is that little injury to fruit and foliage usually occurs when appropriate materials are used. The use of copper dusts on some fruits may be followed by injury to both fruit and foliage. With peaches, the presence of lime is necessary in dusts containing lead arsenate.

One of the disadvantages of the dusting method is that there is no material known that can be recommended for some of the dormant applications. The cost of materials is almost always greater than for spraying. It is frequently more difficult to find weather conditions favorable for dusting than for spraying. Wind often interferes, and temperatures and humidity are sometimes important. However, the difficulty of finding favorable weather conditions is probably compensated for, in part at least by the greater speed of application.

Many insects and diseases, in fact the majority affecting the peach in Michigan during the summer period, may be satisfactorily controlled

by dusting. For certain kinds of aphids, leafhoppers, and other insects, nicotine dust may be used to advantage, but there are other pests for which dusting is not always satisfactory.

The most important troubles for which dusting is likely to be used in Michigan are apple and pear scab, leaf-spot of the cherry and plum, curculio and brown-rot on stone fruits, codling moth on apples and pears, and for certain insects and diseases of the grape. In many instances, but not always, excellent results in the control of these troubles have followed the use of dust. The failures usually have occurred in seasons in which the disease to be controlled has been present in epidemic form, or, in districts where some insect, such as the codling moth, has been persistently severe. Under such conditions, it is apparently easier to obtain satisfactory control with spraying than with dusting. If dusting is employed under these conditions, it will probably be necessary to deviate from the regular schedule recommended for spraying in order to get the greatest benefit from the dusts.

The best information available concerning the control of scab and leaf-spot indicates that an application of dust should be made just before each predicted period of rain that may cause infection and spread of these diseases. If rains recur at frequent intervals, the dust application should be repeated accordingly. For the control of codling moth, dust has sometimes given excellent results, but in districts where this insect is a serious pest, it has not been demonstrated that dusting as usually done will afford satisfactory protection.

Difficulty is sometimes encountered with the use of arsenical dusts in the poisoning of honey-bees because the dust drifts onto the blossoms of cover-crop plants in the orchard, of wild plants in or near the orchard or to the blossoms of clover or other farm crops in adjacent fields.

To repeat, dusting has some marked advantages over spraying, but it also has some obvious disadvantages. Whether any particular grower should dust or spray, should be determined largely by a balancing of the advantages against the disadvantages as they apply to his orchard. This will involve many considerations such as the acreage to be covered, the relative prevalence of insects and diseases, the susceptibility to disease of the varieties grown, the spraying equipment and labor supply available, and the water supply. In some instances, dusting may be the best procedure for the growing season applications, or the grower may prefer to take some chance of failure in order to avail himself of the advantages of the dusting method. In other cases, dusting may be substituted advantageously for spraying for part of the applications, or used as a supplement to spraying when it is not possible, with the available spraying equipment, to complete an application ahead of an expected infection period. There are, however, many growers who should adhere to the standard spraying practice. This is especially true of small growers whose operations are not extensive enough to justify the outlay necessary for both types of equipment and of all growers who do not care to follow up their control measures in the very careful way that is often necessary with dusting.

SPRAYING MATERIALS

Spraying materials are divided into fungicides, insecticides, and accessory materials.

Fungicides

6. **Lime-sulphur.** Recommendations in this bulletin for the use of lime-sulphur always refer to commercial concentrated solution. Most of the commercial products test 32 to 33 degrees Baume, and all dilutions recommended herein are based on that strength of concentrated solution. Lime-sulphur contains calcium polysulphides which are soluble and caustic. The immediate solubility and caustic action kills certain fungous spores which are just germinating or partially established. The polysulphides break down, leaving a coating of finely divided sulphur which then gives a protective action similar to that of the wettable sulphurs. Lime-sulphur is conceded to adhere better and give greater protection than wettable sulphurs. Lime-sulphur is more likely to cause injury than wettable sulphurs. Lime-sulphur is also an insecticide and kills San Jose scale when used as a dormant spray at a dilution of 12½ gallons to 100 gallons of spray.

7. **Dry Lime-sulphur.** Dry lime-sulphur is, essentially, liquid lime-sulphur from which the water has been removed. A "stabilizer" is usually added to prevent extreme breaking down, during the dehydration process, of the sulphur compounds which go to make up lime-sulphur solution. Dry lime-sulphur varies in its exact composition from the liquid form, but in general, the two products are similar except that the one is a dry powder and the other a solution. Both depend on the sulphur and sulphur-bearing compounds in them for their value.

Dry lime-sulphur, when substituted for the liquid concentrate, should be used in proportions that will give active ingredients approximately equal to those contained in the recommended amount of the liquid. Chemical analyses and field experiments have shown that 4 pounds of the dry lime-sulphur are approximately equal to 1 gallon of the liquid lime-sulphur. To determine the amount of dry lime-sulphur required simply multiply the recommended number of gallons of liquid lime-sulphur by 4 and the result will be the number of pounds of dry lime-sulphur necessary to give equivalent results. For further discussion of the concentrations of lime-sulphur to use, refer to Section 35, page 18. This recommendation is based on experience with apple scab only and may not be found to apply for all diseases. Furthermore, there is undoubtedly enough variation between different brands of dry lime-sulphur so that the rule cannot be considered as absolute and unvarying.

Dry lime-sulphur may be expected to produce all the types of injury to foliage and fruit that follow the use of liquid lime-sulphur, but the injury often is less serious than with the liquid lime-sulphur when the two are used at equivalent strengths. Dry lime-sulphur is not recommended for scale insect control.

8. **Wettable Sulphurs.** Wettable sulphurs are composed of finely divided or pulverized sulphur incorporated with a wetting agent. The fineness of division is attained by several processes. The resulting product is sold in a dry powder form or as a paste such as Flotation sulphur paste. The adhesiveness and fungicidal effectiveness of sulphur

as a spray is within limits dependent upon the fineness of division or size of the sulphur particles. Thus the grains of sulphur in 325-mesh dusting sulphur are about $1/500$ of an inch, while the flotation sulphur paste and some of the better dry wettable sulphurs are largely composed of grains between $1/5,000$ and $1/25,000$ of an inch in diameter. Size is sometimes expressed in microns. A micron is $1/25,000$ of an inch.

Wettable sulphurs do not possess the immediate caustic properties of freshly applied liquid lime-sulphur nor do they adhere so well, and for these reasons they are not so efficient in killing fungi. Wettable sulphurs are far less injurious to fruit and foliage and for that reason only are they used to replace lime-sulphurs. Provided wettable sulphurs are used more frequently than liquid lime-sulphur or with accurate timing, they will adequately control apple scab and other fungous diseases of apples. The use of wettable sulphurs in apple sprays is increasing. The extent one can safely substitute wettable sulphurs for liquid lime-sulphur depends on the seriousness of the scab situation, the season, the variety, the spray equipment and the grower. Some growers successfully use wettable sulphurs for all the scab sprays. Such growers have spray machinery of ample capacity for quickly covering their orchard. They observe the weather and make sure their trees are covered before a rain and between protracted rainy spells during the critical scab period (between delayed dormant and first cover).

A better procedure for the average grower is to use lime-sulphur for the early sprays, substituting wettable sulphur in the first cover spray and possibly in the petal-fall spray if the main scab spore discharge has occurred in the pre-bloom period and scab is well under control. Wettable sulphur sprays may be of considerable value as a full bloom spray if the blossom period is unusually long and scab weather is imminent. This spray would be especially appropriate if wettable sulphurs had been used in the pink spray. Wettable sulphurs may be used advantageously on some of the varieties less susceptible to scab but subject to foliage injury and russetting of the fruit. Wettable sulphurs are especially valuable as peach sprays because they are not injurious to peaches at temperatures below 100 degrees F. and are adequate to control brown rot and scab, the two general injurious peach diseases controlled by spraying. They are also used for the control of brown rot on sweet cherries and plums, but are not recommended to control leaf-spot on cherries. In general, 4 or 5 pounds of the better dry wettable or 8 to 10 pounds of the paste sulphur are equivalent to one gallon of liquid lime-sulphur in the control of apple scab. The average dose recommended is 5 to 6 pounds of dry wettable sulphur or 8 to 10 pounds of paste.

9. **Bordeaux.** Bordeaux is made from copper sulphate (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 sulphate 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 sulphate,
6 pounds hydrated lime,
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 sulphate may be obtained in several grades as to 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.

10. Preparation of Bordeaux. There are several methods for preparing bordeaux. The one in most common use today is the "Instant Bordeaux" method. It has replaced the old stock solution method because it is more convenient to make and the mixture is entirely satisfactory. One precaution should always be remembered in making bordeaux. Never mix concentrated solutions of copper sulphate and lime. Such a mixture is coarse and does not adhere well to the fruit or foliage. The 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 a good grade of chemical hydrate or spray lime. (See section 29.) The copper sulphate should be 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 $\frac{1}{4}$ to $\frac{1}{3}$ 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 with water.
4. Dissolve the copper sulphate in a pail and pour slowly on the strainer with the water running into the tank.

Allow about 2 minutes for the two solutions to mix and react in the tank.

5. Add lead arsenate or nicotine sulphate at this time if either is to be used. Fill the tank with water and apply. Keep the agitator in operation continuously after copper sulphate has been added.

11. Proprietary Copper Compounds. Proprietary copper compounds are spray materials containing a low-soluble copper. For the control of some diseases they can be substituted for bordeaux. The following materials listed alphabetically are some of those used in experimental work for leaf-spot control on cherry in Michigan: Basicop, Bordow, Coposil, Cupro K, Grasselli's Compound A, Oxobordeaux, Spraycop, Tennessee 26. None of these has fungicidal properties superior to those of bordeaux, but some cause less injury and dwarfing of sour cherry and are recommended where lime-sulphur or bordeaux have not been found satisfactory. They should be used according to the manufacturer's recommendations.

The value of these materials for use on apples has not been established.

Insecticides

12. Calcium Arsenate. A substitute for lead arsenate sometimes used on apple trees to avoid lead residue is calcium arsenate. Its

physical characteristics and general appearance are much like those of lead arsenate. It contains more arsenic than lead arsenate, but pound for pound, is considerably less effective in codling moth control. If used without a corrective, injury is likely to occur.

13. **Lead Arsenate.** Acid lead arsenate has been the standard stomach poison for orchard spraying for many years. Unless otherwise indicated, any reference to lead arsenate refers to this form.

The use of a corrective will reduce arsenical injury. The zinc sulphate-lime mixture (See Sec. 33) should always be used with lead arsenate when applied on peaches and plums. The zinc sulphate-lime mixture when used on apples as recommended in the apple schedule has not caused russetting in experimental work which would lower the commercial quality of the fruit.

Basic lead arsenate has been introduced into Michigan for use on peaches, which are susceptible to arsenical injury.

Basic lead arsenate, while less likely to cause injury, is less effective. Three pounds of basic lead arsenate are commonly used to replace two pounds of acid lead arsenate. Basic lead arsenate is used without correctives and observations during 1939 indicated the 3-pound dosage to be effective against curculio.

14. **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 are above the tolerance for arsenic. Zinc sulphate-lime (See Sec. 33) used as a corrective has been found satisfactory with this material.

15. **Nicotine Sulphate.** The standard commercial form of nicotine used for orchard spraying is nicotine sulphate. This should contain 40 per cent of actual nicotine, and all recommendations made in this bulletin are based on this strength. Nicotine sulphate appears on the market under several trade names. Any of them should give satisfactory results in the orchard if diluted so as to give the required amount of actual nicotine.

Formerly home-made nicotine sprays have been recommended, but their use has never become general. Their nicotine content and, consequently, their insecticidal value vary greatly so that uniform results cannot be expected from their use. Because of difficulties in making, and uncertainty of results following the use of home-made nicotine extracts, the standard commercial products are recommended for general use.

16. **Fixed Nicotine.** Several materials containing nicotine in "fixed" form are marketed. These compounds apparently 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 such residues as make washing necessary.

17. **Sodium Dinitro Cresylate.** This is a recently introduced water-soluble dormant material which kills aphid eggs and San Jose scale. It should be applied in the dormant period only.

OIL SPRAYS

18. There are two general classes of oil sprays—miscible oils and oil emulsions. In general, the miscible oils are factory-made products, while the emulsions are often home-made, although several commercially-made emulsions are now available. Some of the factory-made products contain additional toxicants such as various nitric acid derivatives of phenol and cresol rhodanates and nicotine. An oil emulsion consists of oil that has been mixed with water and some emulsifying agent and then treated mechanically to break the oil into fine globules or particles that remain in suspension in the water. The stock emulsions with which fruit growers are familiar contain oil, emulsifier, and water. These emulsions, before being applied to the tree, are diluted in the sprayer tank with water.

A miscible oil is generally a mineral oil combined with some material that makes it miscible or mixable with water. The preparation usually appears much like oil alone. It usually contains little, if any, water. A properly made miscible oil, when added to water, mixes readily and forms a milky white emulsion. There are certain advantages and disadvantages inherent to both classes of oil sprays (See Section 23).

It is of course necessary to determine first if oil is necessary for the control of the pests in question. Growers should study the specific instructions for each fruit to determine if an oil spray is needed. Oils are recommended specifically or optionally for the control of pear psylla, scale insects, fruit tree-leaf-roller, European red mite, clover mite, cherry casebearer, raspberry mite, codling moth and certain grape insects. The type of oil used as the base of miscible oils and oil emulsions should be determined by whether the spray is to be applied during dormant or growing season.

19. **Dormant Oils.** The oils used for making miscible oils and oil emulsions for use in the dormant period may vary considerably in their properties. For dormant spraying, the oil should have a viscosity of at least 100 seconds (Saybolt at 100 degrees F.) and 60 to 70 per cent unsulphonated residue. Oils used for pear psylla control should have a viscosity from 175 to 250 seconds. These specifications apply to oils used for home-made emulsions and to the oils which are the basis of factory-made products. The recommendations are not absolute as there are commercial products available that have given satisfaction, although they do not meet these specifications in all respects. Oils used for home-made emulsions for dormant spraying are usually of the type ordinarily called lubricating oils. Oils for use in gasoline engines and automobile motors are not recommended. If desired, more specific information will be furnished on request.

20. **"D N Oils".** Dormant oils containing as added toxicants nitric acid derivatives of phenol have proved effective against aphid eggs and San Jose scale. Oils containing these materials are commonly referred to as "D N oils" and should be applied only in the dormant period.

21. **Miscible Oils.** The miscible oils are comparatively permanent, that is, they can be kept for reasonably long periods before diluting.

without any separation of the ingredients. They are not likely to be broken down by freezing and are relatively simple to use. They are stable in all ordinary kinds of water. Most of them are not compatible with lime-sulphur, and, with these, serious difficulties will follow if any lime-sulphur is present in the sprayer. The manufacturer's instructions should always be carefully followed, especially in regard to protection and freezing and mixing with other materials. The miscible oils are generally effective for the common insects, but, for special purposes, there is considerable variation between the different brands. Their cost is higher than that of home-made emulsions, but the final cost is determined by the price per gallon and the rate of dilution.

22. Oil Emulsions. The emulsions commonly used are of two types, the soap emulsions and the cold-pumped or cold-mixed emulsions. Directions for preparing the home-made cold-pumped emulsions will be found in Sections 24-25. The properties of these two classes of emulsions vary considerably.

Comparing the home-made emulsions with the proprietary oils, the home-made emulsions are effective and much cheaper. They are less convenient to use and store, and greater care is necessary when diluting them to avoid the release of free oil. It may also be necessary to clean the sprayer tank at intervals to remove any accumulation of oily sludge. The choice between proprietary oils and home-made emulsions is largely a question of balancing cost against convenience.

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

Peaches and pears should not be sprayed with oil in the fall and there seems 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.

Do not apply oil when rain or snow is likely to follow quickly, or when the temperature is below 40 degrees 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-sulphur, other sulphur sprays or bordeaux and where the use of lime-sulphur precedes or follows an application of oil. The cold-pumped emulsions are relatively safe in this respect but it is not definitely established that injury never follows.

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 San Jose scale, red mites and pear psylla have not been observed to cause any injury from spring dormant applications. Precautions concerning the use of higher concentrations are stated in Section 46.

24. Cold-pumped Emulsions. For growers who care to make their own emulsions, the cold-pumped or cold-mixed emulsions are generally

more satisfactory. Copper sulphate and lime, casein spreader and other materials may be used as emulsifying agents.

25. Bordeaux Emulsions. The combination of copper sulphate and lime is very satisfactory as an emulsifier. The formula and method of preparation follow:

Prepare the copper sulphate and lime as stock solutions. Convenient proportions for this purpose are "1 pound to 1 gallon" for the copper sulphate and "1½ pounds to 1 gallon" for the hydrated lime.

For each 100 gallons of a given concentration, proceed as follows: (Use stock solutions of the strength indicated in the preceding paragraph.)

Materials	For each 100 gal. of spray with actual oil content of		
	3 per cent	6 per cent	8 per cent
Place in sprayer in this order			
1. Water.....	¾ gal.	1½ gal.	2 gal.
2. Copper sulphate (stock solution).....	3 pt.	3 qt.	1 gal.
3. Hydrated lime (stock solution).....	3 pt.	3 qt.	1 gal.
4. Oil.....	3 gal.	6 gal.	8 gal.

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

For a 200-gallon tank use twice the amounts indicated, for a 300-gallon tank use three times and for a 400-gallon tank use four times the indicated amounts. 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 sulphate 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 tank is empty. **MAKE CERTAIN THAT THE CONCENTRATED EMULSION IS ALL OUT OF THE HOSE BEFORE ANY SPRAY IS APPLIED TO TREES.**

This emulsion must be continuously agitated. If lack of agitation the appearance of free oil; throw out 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
1. Water.....	7½ gal.
2. Copper sulphate (stock solution).....	3¾ gal.
3. Hydrated lime (stock solution).....	3¾ gal.
4. Oil.....	30 gal.

To dilute this stock emulsion, fill the sprayer about one-fourth full with water, and, with agitator in motion, add the stock emulsion. The amount to use can be determined by reference to Section 26. 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.

26. Diluting and Using Emulsions. Emulsions prepared according to this formula contain approximately 66⅔ per cent 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 Per Cent of Oil

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

To make sure 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.

27. Summer Oils. Oils used for applications 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 degrees F.) and 92 to 100 per cent for unsulphonated residue. The manufacturer's instructions should be carefully read before attempting to dilute any summer oil spray.

28. Tar, and Tar and Oil Sprays. Tar sprays consist of certain liquid fractions obtained in the distillation of coal-tar treated to render them miscible with water. These sprays were developed for dormant use

against aphids. Certain disadvantages of the tar sprays led to the development of the tar and oil sprays, which in many cases consist of the tar products referred to, combined with petroleum oil and an emulsifier. The tar sprays kill aphid eggs and case-bearers on contact. Tar and oil sprays, chiefly because of the oil content, will control scale and mite, in addition to aphid and case-bearers. Tar, and tar and oil sprays will kill some bud-moth larvae. Directions for the use of tar, and tar and oil sprays are furnished by the manufacturer. **TAR, AND TAR AND OILS ARE TO BE APPLIED ONLY DURING THE DORMANT PERIOD.** Tar, and tar and oil sprays burn the face and hands. When these materials are being applied, horses should be protected as well as the operator, from injury.

ACCESSORY MATERIALS

29. **Spraying Lime.** Hydrated lime is the only form of lime generally available for spraying purposes in Michigan. 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. Brands 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 sulphate-lime and iron sulphate-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 Correctives

30. The use of stickers with wettable sulphurs and low-soluble copper materials is still in the experimental stage. 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.

Spreaders or wetting agents, such as soaps, are helpful in increasing the effectiveness of such spray materials as nicotine sulphate. In the control of aphids and leafhoppers, wetting of the insects is necessary.

Soaps, fish oil, soybean oil, summer oils, and materials containing casein and lime are common materials used as spreaders. Several commercial "spreaders" are sold under various trade names and are recommended by spray material companies to be used with their products.

31. **Precautions in the Use of Spreaders.** Spreaders should be used only with materials with which they are compatible. Only a small amount is necessary of some spreaders. Adding more than the required amount may cause excessive runoff. Some spreaders are injurious to plants when used at too high concentrations.

Correctives

32. **Iron Sulphate-lime Mixture.** For each 100 gallons of spray use 4 pounds iron sulphate, 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 sulphate, 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. Continue to add water with agitation and add the hydrated lime in any convenient way.

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

33. **Zinc Sulphate-lime Mixture.** A 2-4-100 zinc sulphate-lime mixture is recommended to prevent arsenical injury on apple; a 4-4-100 zinc sulphate-lime mixture to prevent arsenical injury on peach and plum; an 8-8-100 zinc sulphate-lime mixture for bacterial spot of peach.

Zinc sulphate-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 sulphate 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, or sulphur if required.

There are three forms or grades of zinc sulphate on the market. They vary in amount of zinc and water present. The first grade contains $22\frac{1}{4}$ per cent zinc and is the crystal form; the second contains $25\frac{1}{2}$ per cent zinc and is the flake form; and the third contains 36 per cent zinc and is the powdered form. The $25\frac{1}{2}$ per cent 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 sulphate 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 $25\frac{1}{2}$ per cent zinc sulphate and 4 pounds of lime are recommended. If the 36 per cent grade is used, then slightly less than 3 pounds of the zinc sulphate should be added to 4 pounds of lime. Zinc sulphate-lime mixture is an excellent corrective for use with zinc and calcium arsenate when applied on apples.

When lime-sulphur or wettable sulphurs are used with this mixture the sulphur should be added after the acid lead arsenate.

Compatibility of Spray Materials for Summer Use

34. Compatibility is the property of two or more spray materials of mixing without undergoing any reaction which will materially reduce their effectiveness for disease and insect control or increase their injurious effect on the plant.

In general, the following combinations are recommended. It is to be remembered that weather conditions, vigor of tree, variety, kind of fruit, method of application, amount of infection, all influence the effectiveness of disease and insect control and amount of injury to the host by any combination of spray materials.

Lime-sulphur. Liquid lime-sulphur, or dry lime-sulphur when used at concentrations stronger than 1 gallon of the liquid or 4 pounds of the dry can be used with lead or zinc arsenate under most conditions. Nicotine sulphate, and wettable sulphurs are safe to use with lime-sulphur. Lime-sulphur should never be mixed with oils, copper fungicides, or soap.

Wettable Sulphurs. Wettable sulphurs can be combined with lime-sulphur, copper fungicides, acid or basic lead arsenate, zinc arsenate, nicotine sulphate, fixed nicotine, or soaps. They should not be used with oils or calcium arsenate.

Acid Lead Arsenate. Acid lead arsenate may be safely used with most materials. It should not be combined with weak concentrations of lime-sulphur (less than 1 gallon of lime-sulphur in 100 gallons of water or 4 pounds of dry lime-sulphur) or certain soap compounds.

Basic Lead Arsenate. Basic lead arsenate is compatible with all spray materials.

Bordeaux. Bordeaux may be added to wettable sulphur, lead arsenate, zinc arsenate, calcium arsenate, oils, nicotine sulphate, and the proprietary copper compounds. It should not be used with lime-sulphur, fixed nicotines, or soaps.

Proprietary Copper Compounds. Proprietary copper materials are compatible with bordeaux, wettable sulphur, nicotine sulphate, lead arsenate. Some are compatible with fixed nicotines. **They should not be mixed with lime-sulphur.**

Summer Oil Sprays. Summer oils may be mixed with bordeaux, proprietary copper compounds, lead or zinc arsenate, nicotine sulphate, and fixed nicotine. They are not safe to use with any of the sulphur materials nor should oils be used preceding or following a sulphur 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 Sulphate. Nicotine sulphate is compatible with all spray materials. For best results in heavy infestations of aphids or leafhoppers, a special application of nicotine sulphate plus a soap or other activator is advisable.

Fixed Nicotine. Fixed nicotines may be used with oils, some of the proprietary materials, wettable sulphur, nicotine sulphate, and acid lead arsenate. High alkaline materials liberate the nicotine and therefore are not effective when used with lime-sulphur, bordeaux, lime or soaps. Sulphur is dangerous when used immediately preceding or immediately following oil.

Lime. Lime aids in delaying arsenical injury, and is sometimes used with lead or zinc arsenate especially in the cover sprays on apples. It is recommended with proprietary copper compounds to reduce copper injury to 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 early injury and defoliation which may result in some seasons. Lime is not recommended with fixed nicotine sprays or with oils.

Zinc Sulphate. Zinc sulphate should always be used in combination with lime when applied to peach, apple, or cherry trees. The zinc sulphate-lime mixture should always be used on peach and Japanese plums when acid lead arsenate is applied.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF APPLE DISEASES

35. **Apple Scab.** Apple scab may be a factor of importance in nearly every one of the early growing season applications. It is impossible to name any one application that is most important in all seasons or in all districts in any particular season. The most important applications vary from year to year, according to the weather, which is difficult to predict accurately. The spores of the apple scab fungus develop over winter in the old leaves on the ground. These spores produce the first or primary infections. These spores are usually ripe at the time of the green tip stage of the fruit buds and may be discharged by degrees during rains, from the green tip stage until several weeks after petal fall.

Spores are discharged only during rains and can germinate and infect only following rain and periods of wet foliage. Infection occurs following rain when the foliage has been wet four hours at 68 degrees F. A somewhat longer period of wet foliage is necessary at lower or higher temperatures. The infections do not become visible until 8 to 21 days have elapsed. For best results the trees should be covered with spray before rains. Almost any fungicide, either dust or spray, will stop scab if applied within a 24-hour period after infection has occurred. Liquid lime-sulphur is more efficient in this regard and stops scab infection within 48 to 72 hours after infection has occurred. If rains occur during the night on unprotected foliage a dust or wettable sulphur spray applied the next day should prevent infection. Lime-sulphur applied within the next two and sometimes three days should accomplish the same results. Primary spore discharges and infections may occur during only a few rainy periods or over a long series of rainy periods, varying with the seasons.

Pre-blossom applications are usually the key to successful control and should be made regularly as recommended. This does not mean

that later applications are of less importance, but it does mean that if the peak of infection occurs during the early period, successful control is almost impossible if the pre-blossom treatment has not been thorough. Successful scab control involves thorough coverage and timely applications. To be protected, keep the young leaves covered before infections occur. The apple scab schedule as recommended is devised to give the greatest margin of safety for the majority of growers for the control of this disease in epidemic years. Even more frequent applications may be necessary under unusual conditions. It is recognized that it is possible and even desirable for many growers to make radical departures from the so-called standard recommendations. These departures may consist of lower concentrations of liquid lime-sulphur or dry lime-sulphur in part or all of the applications; of the substitution of some other material such as wettable sulphur in part or all of the applications; the omission of sprays during long dry spells, providing adequate attention is given to weather reports and if equipment is available to cover quickly. Growers using weaker materials are usually prepared to spray oftener during critical periods. These changes are made solely for the purpose of reducing injury to foliage and fruit.

Caution: Weak concentrations of liquid lime-sulphur with lead arsenate sometimes cause considerable foliage injury, especially where less than one gallon of liquid lime-sulphur or four pounds of dry lime-sulphur are used in combination.




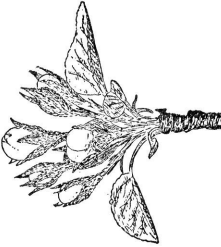
A full bloom spray of wettable sulphur may be of value when the blooming period is unduly prolonged and wet. Arsenate of lead should not be included while the trees are in blossom and the bees are working. Experience indicates that wettable sulphur is sometimes of advantage in the second cover if primary spore discharges continue late. Due consideration must be given to the use of oil following an application of sulphur. (See section 34.)

Fungicides in sprays after the first cover are usually unnecessary and complicate the codling moth spray program. Lime-sulphurs and wettable sulphurs are also more likely to injure with approaching warm weather, and copper sprays may russet the fruit at this time. Late fungicide applications especially complicate a fixed nicotine program. Sulphurs are incompatible with the oils commonly used with nicotine sprays. Alkaline materials such as lime-sulphur, lime, or bordeaux liberate nicotine rapidly, thus destroying the residual effect necessary for codling moth control. Because of those reasons, control scab before the first cover spray.

Summer Sprays for Apple Scab

When the early season program has controlled scab, late summer applications of fungicides are unnecessary. Only in exceptional seasons are conditions favorable for the spread of scab in late summer. Fruit and leaves are more resistant at that time and about three days of continuous moisture are necessary for infection. Late infections which may appear as storage scab are occasionally troublesome on R. I. Greening, McIntosh, and Winter Banana. For some situations a late summer fungicide is advisable, but in general the benefits from summer application are doubtful. Bordeaux in late summer has not been known to russet in Michigan but interferes with normal coloring. Copper


APPLES

STAGE OF GROWTH	APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
	1. DORMANT. Complete before green tips appear.	Lime-sulphur, 12½ gal. in 100, tar, and oil or an oil spray. Refer to Sections 6 and 18 to 29 for specific instructions.	Scale insects, mites and leaf rollers. Lime-sulphur will control scale. Oils will control scales, mites and leaf rollers. Tar sprays and D N sprays will control aphids. Tar and oil, and D N and oil will control aphids, mites and scales.	The dormant application of oil is necessary for the control of mites and leaf-rollers and will also control scale. Lime-sulphur may be used if scale only is to be controlled. Refer to Sections 18 to 29 for specific instructions.
	2. DELAYED DORMANT. Apply in a well developed green tip stage, when leaf tips are ¼ to ½ inch in length.	Lime-sulphur, 2½ gal., lead arsenate,† 3 lb., nicotine sulphate, 1 pt., and water to make 100 gallons.	Scab, aphid, and bud moth. Omit the nicotine sulphate if a dormant application of *D N or tar, and oil has been made.	This is the best period for the control of aphid, if this has not been effected by dormant applications, and the lime-sulphur that is necessary with the nicotine will prevent early infection of apple scab. Lead arsenate is partially effective against bud moth. Refer to Sections 47 and 48 for special instructions for the control of aphids.
	2a. PRE-PINK. Begin soon after the delayed dormant condition and complete as soon as possible.	Lime-sulphur, 2½ gal., lead arsenate,† 3 lb., and water to make 100 gallons.	Scab, curculio, and bud moth. If aphids have not been controlled by this time nicotine should be added as satisfactory aphid control cannot be expected later than the pre-pink application.	Apply the pre-pink on the more susceptible varieties and on all varieties when conditions seem very favorable for scab development, or in seasons when bud development is spread over a long period. Still another application for scab control between the pre-pink and pink applications may be desirable under extreme conditions.
	3. PINK. Begin to apply as soon as most of the buds have separated in the clusters and complete before the blossoms open.	Lime-sulphur, 2 gal., lead arsenate, 3 lb.,† and water to make 100 gallons.	Apple scab, curculio and other chewing insects.	This application is important for scab control. The lead arsenate is of value for the control of chewing insects, as well as increasing the fungicidal value of the lime sulphur. Do not use lead arsenate after the blossoms begin to open. Bees may be poisoned and pollination of early bloom reduced.
		These applications are the most important for scab control.		
				

THIS SCHEDULE WILL MAKE RESIDUE REMOVAL NECESSARY.

*D N. See Sections 17 and 20.

†The use of lead arsenate is unnecessary in all pre-blossom applications, but at least one spray of lead arsenate prior to calyx is advisable.

	<p>4. PETAL-FALL (CALYX). Should be made when most of the petals have dropped and after bees have quit working in the bloom.</p>	<p>Lime-sulphur, 1½ gal., lead arsenate, 3 lb., nicotine sulphate, 1 pt., and water to make 100 gallons.</p> <p>Nicotine sulphate may be omitted if red bug is not prevalent.</p>	<p>Scab, codling moth, curculio, other chewing insects in red bug.</p> <p>Wettable sulphur may be substituted at this time.</p>	<p>Spraying should not begin until most of the petals are off and there are no bees working in the trees, but should be completed as soon as possible. Refer to Section 49 for the control of red bug.</p>
	<p>5. FIRST COVER. Seven to ten days after petal-fall.</p>	<p>Wettable sulphur, 4 to 6 lb., lead arsenate, 3 lb., and water to make 100 gallons.</p>	<p>Codling moth, curculio, lesser apple worm and scab.</p>	
	<p>*5a. SECOND COVER. Seven to ten days after application 5.</p>	<p>Lead arsenate, 3 lb., zinc sulphate-lime (See Sec. 33), and water to make 100 gal.</p>	<p>Codling moth, curculio, lesser apple worm and scab. If apple scab is prevalent, the use of wettable sulphur may be advisable at this time.</p>	<p>WARNING. IMPORTANT</p> <p>Govern use of lead arsenate during the summer by the prevalence of codling moth. Read carefully Section 4 and 41.</p>
	<p>*5b. THIRD COVER. Ten to fourteen days after 5a.</p>	<p>Lead arsenate, 3 lb., zinc sulphate-lime (See Sec. 33), and water to make 100 gal.</p>	<p>Codling moth, lesser apple worm and curculio.</p>	<p>If fruit is not to be washed, refer to Section 42.</p>
	<p>*5c. FOURTH COVER. Two weeks after 5b.</p>	<p>Lead arsenate, 3 lb., zinc sulphate-lime (See Sec. 33), and water to make 100 gal.</p>	<p>Codling moth, lesser apple worm and curculio.</p>	
	<p>*6. SUMMER GENERAL ATION. Exact time to be determined each year, usually about Aug. 1.</p>	<p>Lead arsenate, 3 lb., zinc sulphate-lime (See Sec. 33), and water to make 100 gal. Add wettable sulphur 4 to 6 lb. if needed for scab control.</p>	<p>Codling moth, curculio and scab.</p>	<p>The exact time of this application is determined by the Entomology Department and announcement is made through county agents.</p>
	<p>7. Two weeks after Application 6 and if necessary make one or two more applications at two weeks intervals.</p>	<p>Lead arsenate, 3 lb.</p>	<p>Codling moth and curculio.</p>	

IF FRUIT IS NOT TO BE WASHED, REFER TO SECTION 42.

*If conditions have been especially favorable for development of apple scab and it has not been controlled a fungicide may be applied in any of the cover sprays. Read Sec. 35.

oxychloride, copper ammonium silicate and red oxide of copper caused no noticeable injury on McIntosh, Spy or Ben Davis applied with fixed nicotine at 10-day intervals beginning August 1, during 1939. There was no development of late scab on the unsprayed trees and no conclusions on control could be reached. The fungicides used did not retard the extension of established lesions.

36. **Fire Blight.** A spray of bordeaux 2-6-100 applied when 50 per cent of the blossoms are open sometimes gives control of blossom blight and has not given conspicuous injury to date. It would be recommended only on susceptible varieties under conditions where blossom blight is generally serious in most years. Special instructions for the control of fire blight will be sent by the Botany Department upon request.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF INSECTS ON APPLES

37. **Codling Moth.** Fruit growers have, for a long time, put practically all their fighting strength against the codling moth into a spraying program. In many orchards, this gives such good control that there cannot be the slightest doubt that an adequate spraying program provides a dependable means of fighting this pest, especially since it can be combined with the sprays for fungous diseases. It becomes increasingly apparent, however, that with the residue situation and a large codling moth population, growers in some localities are not getting enough apples free from codling moth injury. **Codling moth control depends entirely on success in fighting the first brood. Control of the first brood is brought about by the systematic practice of supplementary measures followed by thorough and timely applications of effective spraying materials. Effectiveness of any material for codling moth control can be increased readily by shortening the interval between sprays to seven days during June.**

Supplementary Measures. The proper disposal of culls and drops, elimination of orchard trash, destruction of larvae about packing-houses and equipment, and the scraping and banding of trees have been successfully employed against the codling moth under conditions of heavy infestation. Before the advent of spraying for control of codling moth in 1878, these so-called supplementary measures were relied upon for the production of clean apples. The only comparatively new idea about those mentioned is the use of a material to impregnate the bands, and even this has several years of successful use. None of these supplementary measures requires any large outlay of time or cash. Moreover, most of the operations can be completed in the off-season.

38. **Banding.** Codling moth banding consists of placing about the trunk of the tree, which previously has been scraped, a band 2 inches wide. The larvae seek shelter beneath the band when preparing to pupate, or to winter. The bands should be upon the trees by the time

Control the First Brood. Stop codling moth by scraping, banding, care of crates, packing and storage rooms, cull piles and by frequent and thorough early spraying.

larvae start leaving the apples—mid-June in southern Michigan and proportionately later in more northern counties. The bands are usually placed about two feet from the ground but may be placed at any convenient height. There are two kinds, treated and untreated. The band which was formerly used in greatest quantity was made of untreated burlap and necessitated visits every two weeks for the purpose of killing the larvae. These visits must be made or untreated bands are worse than no bands at all.

Refrain from banding smooth-barked trees or limbs, with chemically treated bands and place bands at a different place each year on any tree. Failure to observe these precautions has resulted in injury to trees.

Treated bands may be purchased or made at home. Instructions for making bands will be sent by the Entomology Department, Michigan State College, East Lansing, upon request.

Control the First Brood. Five wormy apples in one tree in July may be followed by an epidemic of "stung" and wormy apples before harvest.

39. **Scraping.** Careful scraping consists in the removal and destruction of all the bark flakes on the trunk and larger limbs. This can be done with a hoe, but a triangular tool, such as a mowing-machine section mounted on a stout handle, or some similar device, must be employed to get into the crevices. Do not leave scrapings about the base of the tree, because codling moth larvae on such scrapings will survive in large numbers. Many growers make an apron of burlap or other handy material, which is placed on the ground about the base of the tree before beginning to scrape. This automatically collects the scrapings, which can be kept in baskets for burning. Special care must be exercised in scraping the trunk at the ground line, and just below, as these are favorite winter places for codling moth larvae. The best results will be obtained if scraping is completed before blooming time.

40. **Spraying Methods.** Success from spraying for codling moth depends largely upon the thoroughness with which the material is applied. That is true with any effective material. The spraying should be done in such a manner that all surfaces of every leaf and apple in all parts of the tree will be covered with spraying material. To accomplish this will usually require that the inside portion of all trees be sprayed from the ground. Spray should be directed also from the top of the sprayer or from a tower to insure complete coverage on the outer portions

and tops of the trees. This practice should start with the First Cover application and should be continued with all succeeding codling moth sprays. The use of lime-sulphur in this manner is likely to be followed by excessive injury and for that reason a wettable sulphur is recommended for the First Cover application. If a fungicide is needed later than this, a wettable sulphur may be used.

Control the First Brood. One per cent of wormy apples in July is too much.

41. **Spray Residue.** The amount of spray residue present on fruit at harvest is governed by many factors. The relationship of some of these factors is not well known, but it is certain that there is a definite correlation between the amount of poisonous residue at harvest and the use of insecticides containing lead, arsenic, and fluorine during mid- and late summer. The frequency and timing of such applications should be determined largely by the prevalence of codling moth. Growers, therefore, should study carefully the status of codling moth in their orchards and spray accordingly.

There are many orchards in the state where it is possible, because of a low population of codling moth, to control this insect with a small number of applications and with little or no danger of excessive residue. In some districts, however, codling moth control is a serious problem and frequent and heavy applications during mid- and late summer may be necessary. Growers are advised to spray to the extent that is necessary to give satisfactory control. This practice may make necessary the removal of the excessive residue which is likely to be present, but any effort to avoid excessive residue by limiting the use of effective materials in heavily infested orchards is likely to result in wormy apples.

Schedule to Avoid Excessive Residue

42. Although there may be occasional exceptions, available analyses indicate that usually lead arsenate may be used on winter varieties in the petal-fall and first cover applications and zinc or calcium arsenate in the calyx and first and second cover applications without resulting in residues beyond present tolerances.

The only materials which have proved effective for the remainder of the season without excess residue and other complications are the nicotine compounds. Oil-nicotine sulphate has been in THE SPRAYING CALENDAR several years. It is effective, but the necessity for and cost of applications of oil (2 quarts) and nicotine sulphate ($\frac{3}{4}$ pint) at 8-day intervals has discouraged many people from using it.

The fixed nicotine compounds developed during the last few years and tested extensively in Michigan and other apple-growing areas apparently meet most of the requirements as a replacement for lead arsenate and washing. Factory-processed fixed nicotines have given consistently good results over the last four seasons without visible or illegal residues, and **without injury** and at a cost strictly comparable with lead arsenate plus washing costs.

Fixed nicotine when used at 10-day intervals in experimental plats and by many growers have given as good control as did lead arsenate at 10-day intervals.

Fixed nicotine is incompatible with lime-sulphur.

Fixed nicotine is compatible with some fixed copper compounds. Some brands are compatible with wettable sulphurs except when oil is used. If in doubt, consult your county agricultural agent. The foregoing points become doubly important when it is realized that dilute lime-sulphur and other sulphurs are used generally for scab control in Michigan and that the fixed nicotine is more effective when used with oil. The incompatibility of oils with sulphur necessitates scab control prior to the first cover for the best results with fixed nicotine-oil sprays. **If planning to use fixed nicotine and oil, every effort should be made to control scab prior to beginning the fixed nicotine-oil program.** During 1935 and 1937, bad scab years, McIntosh trees in the fixed nicotine tests which had no fungicide after the first cover showed no scab on fruit or foliage at harvest or afterward, control being effected by timely and thorough applications preceding the first cover.

The following combination arsenical and fixed nicotine schedule for codling moth control is suggested for Yellow Transparent, Duchess, and other early ripening varieties:

Petal-fall—lead or zinc arsenate 3 pounds with lime-sulphur 1½ gal.

First cover—10 days after petal fall, zinc arsenate 3 pounds plus 4-6 pounds wettable sulphur.

Second cover—seven days after first cover. Fixed nicotine, using material according to manufacturer's recommendation. Oil in this application may cause burning.

Third cover—seven days after second cover. Fixed nicotine according to manufacturer's recommendation, and may include oil.

Fourth and fifth covers may be applied according to circumstances at 7-10 intervals and may include oil.

The value of the seven-day interval in the second and third covers lies in maintaining coverage during the period of the fruit's **most rapid growth.**

Fungicides may be included but consult your county agricultural agent if in doubt as to the proper material to use.

For standard varieties of apples the following schedule of arsenical and fixed nicotine sprays is suggested:

Petal-fall—lead, calcium, or zinc arsenate plus lime-sulphur 1½ gallon.

First cover, 10 days after petal-fall—lead or zinc arsenate (See Sections 3 and 33) plus 4-6 pounds wettable or flotation sulphur.

Second cover, 7 days after first cover—fixed nicotine according to manufacturer's recommendation. Remember that oil on foliage covered with sulphur may cause burning.

Third cover, 7 days after second cover—fixed nicotine according to manufacturer's recommendation. Oil may be used in this application and all subsequent sprays safely.

Spray at 10-day intervals after the third cover until first brood activity ceases. Usually two sprays of fixed nicotine for second brood with the deposit built by the sprays for first brood will protect the

crop, although in heavily infested orchards or in long seasons an additional spray may be necessary.

The object of the 7-day interval between the first and second cover is to prevent early entries from which a second brood may develop. At the time these sprays are applied the fruit surfaces may **double** between applications at 7-day intervals. Every effort must be made **to cover the tops of the trees** for it has been shown many times that the upper portions of the trees usually contain a greater percentage of wormy apples than the lower parts.

43. Dormant Spraying. The necessity for the dormant application should be determined by the prevalence of insects that may be controlled at that period. Dormant treatment is recommended for the control of the European red mite and the fruit tree leaf-roller. Treatment for scale insects should be made in the dormant period if oil is used, but lime-sulphur may be used for scale insects in either the dormant or delayed-dormant. If the European red mite is to be controlled, an application of an oil spray, which at the same time, will control scale insects, is recommended. The serious prevalence of the fruit tree leaf-roller requires treatment with an oil spray, which of course will satisfactorily control the mites and scale. Each grower should study his conditions in order to know what insects are prevalent in serious numbers and then use the minimum concentration necessary to give satisfactory results. Refer to the succeeding sections for specific recommendations. Growers desiring to control rosy aphids on apples and black cherry aphids on cherry in the dormant period may use a tar, tar and oil, nitro-phenol or nitro-cresylate spray. Tar and oil sprays also control scale and mites but are not recommended for leaf-roller. (See Sec. 19 and 28.) Nitro phenols when combined with oils control scale and mites when used in sufficient concentration.

44. San Jose and Oystershell Scales. The San Jose scale is more numerous at present than for years. A close search should be made for it during the winter or early spring. The Department of Entomology will identify specimens upon request.

Oystershell scale is not so commonly a pest in orchards as is the San Jose scale but is of local importance at times.

Lime-sulphur, $12\frac{1}{2}$ gallons in 100 gallons of spray applied late in the dormant or in the delayed-dormant period will control San Jose scale. Dry lime-sulphur is not recommended for scale control. The same result is obtainable through the use of a dormant oil spray containing 3 per cent of actual oil. Oystershell scale can be controlled by the use of oil sprays containing 4 per cent of actual oil. (See Sections 18 to 29 for a full discussion of oil sprays.) Use commercial oils at dilutions recommended by the makers. Tar and oil sprays will also control scale insects. (See Section 28.)

45. Fruit Mites and Clover Mites. Three species of mites, and perhaps more, attack apples and other fruits in Michigan: the common red spider, the clover mite, and the European red-mite. Fortunately, the spraying treatment for the red mite and clover mite is identical and therefore it is not imperative that the grower distinguish between them except to remember that the European red mite is the one most capable of damaging the trees. All Michigan fruit trees are subject

to attack by one or all of these extremely tiny eight-legged pests. Warm, dry weather is favorable to the mites, while cold dashing rains help to keep them in check.

The most successful attempts at control have followed the application of oil sprays during the spring dormant period and consist of one of the commercial spraying oils or of home-made lubricating oil emulsions. Use the home-made emulsions with 3 per cent of oil (See Sections 24, 25 and 26). If a commercial spraying oil is used, follow the recommendations of the makers. Tar and oil sprays will control red mites. (See Section 28.) Spray with extreme care so that each tiny twig will be coated, especially on the under side, as well as the limbs and trunk. Observe precautions noted elsewhere under the caption of oil sprays, (Refer to Section 23). The dormant spray is intended as a destroyer of the eggs. Summer applications are not so satisfactory and therefore the principal effort should be expended in making the dormant spray effective.

46. Leaf-Roller. The leaf-roller is an active, naked caterpillar, which rolls the leaves of the apple and other fruits, lives in this shelter, and feeds on the leaves and fruit. The winter is passed in the egg stage on the bark, and these eggs may be killed most easily by an application of an oil-emulsion late in the dormant period. Use home-made oil emulsion, diluted to give 6 per cent actual oil in the spray. (See Sections 24, 25 and 26.) This oil must be applied while the trees are dormant. If commercial oils are used, follow the makers' recommendations. Refer to Sections 18 to 28, inclusive, for a full discussion of oil sprays. Some miscible oils do not give satisfactory results, and definite information should be obtained about any particular brand before using it.

There are marked varietal differences in susceptibility to injury from the high concentration of oil necessary to control leaf-roller. Northern Spy is known to be more easily affected than others and the susceptibility increases as the season advances. It seems advisable, therefore, to make this application on Spy trees as an early spring dormant application. There are also marked differences in the effect of home-made and certain proprietary oil sprays. Information is not complete with regard to varietal susceptibility, but normal Baldwin trees are apparently little affected by any dormant application of oil.

Very thorough coverage is necessary. The operator should spray from the ground so as to enable him to direct the spray to the under sides of all branches. With large trees, it is desirable for a second operator to spray from the top of the sprayer or from a tower. It is imperative that all high branches in the center of the trees be covered because the greatest number of eggs are found there.

Avoid Over-spraying. The use of lead arsenate in the pre-blossom applications is a valuable supplement to the oil treatment. All wood which is pruned from the trees before spraying should be gathered and burned before the spray is applied, and tanglefoot bands may be placed around the trunks of the trees as an added precaution to prevent larvae from pruned twigs on the ground from crawling up into the trees. Tar and tar-oil sprays are not recommended for leaf-roller control.

47. Aphids. Three common aphids, besides the woolly-aphid, work in the tops of apple trees—the bud-aphid, the rosy aphid, and the green

apple-aphid. All these pests winter as eggs on the trees. Aphids may be controlled while in the egg stage by a dormant application or in the delayed dormant after they hatch. The bud-aphid hatches first but most of the eggs of all three aphids are hatched by the time that the trees reach the delayed dormant stage. The critical time for aphid control, after the insects have hatched, is at the delayed dormant period before the aphids have increased in numbers through new generations and when they have the minimum of protection from foliage and blossoms. Spray as indicated in the apple schedule for the delayed-dormant application. If scale insects are to be sprayed for at this time, increase the amount of lime-sulphur to 12½ gallons. If for any reason the aphid treatment is not made in the dormant or delayed dormant period, it should be applied not later than the pre-pink. Spraying later than the pre-pink is unsatisfactory for the control of the rosy aphid and the early broods of the green aphid.

The method of application, when spraying for aphids with nicotine, is important. **Complete each tree, or at least each row, as a unit, before going to the next.** Large trees with dense low-hanging limbs can be covered only when part of the spraying is done from the ground. Use high pressure and a good volume of delivery. Complete and thorough coverage is required. Favorable spraying weather often does not prevail at this period but best results are obtained on the more quiet and warm days.

Since it is impossible to predict the seriousness of aphid infestation, which is strongly influenced by weather conditions, spraying for the control of the rosy aphid and the early broods of the green aphid in the dormant or delayed dormant should be considered as a part of the annual spraying program on varieties susceptible to aphid attack. Because aphids do not cause serious injury every year in all parts of the state, or in any particular orchard, growers become lax in their control operations; the result is that orchards not sprayed regularly every year for aphids almost invariably suffer badly when conditions become favorable for aphid development and injury. Because of those conditions, it seems unwise for the operator of a productive orchard of susceptible varieties to omit aphid control measures.

Tar, tar and oil, or D N (dinitro-ortho-cyclo-hexylphenol), sodium dinitro-phenol, sodium-dinitro cresylate sprays may be used for aphid control but the application should be made while the trees are strictly dormant. See Sections 17-20.

48. Summer Infestation of Aphids. The treatment just outlined, if properly made, should insure satisfactory control of rosy aphids for the season and of green aphids for the early part of the season. In case green aphids become troublesome during the summer, spray with nicotine sulphate added to one of the regular summer sprays or as a special application. Use nicotine sulphate, 1 pint to 100 gallons of spray with the addition of one of the following: 4 pounds hydrated lime; 4 pounds laundry or potash fish-oil soap or one of the special nicotine activators now available. If it is desirable to use a fungicide at the same time, a wettable sulphur may be added. Unsightly deposits resulting from summer infestations of green apple-aphids may be removed by including 25 pounds of hydrated lime in 100 gallons of spray.

Freshly mixed nicotine dust containing 2 per cent of actual nicotine

is preferred by some growers. If factory-mixed dust is used, 3 per cent of nicotine is desirable. Repeated applications of fixed nicotine as used for codling moth control seemingly control summer infestations of aphids.

49. **Redbug.** Two species of redbug infest apples in Michigan. Both pass through the winter buried in the bark in the egg stage. Nicotine sulphate applied just after the eggs hatch serves best to control both species. The petal-fall spray is the best time for this application.

50. **Apple Maggot.** This insect is becoming more common. The maggots leave the apples after they fall to the ground. **The removal and destruction of all infested apples must be carried on if permanent reduction in the numbers of apple maggots is desired.** Pick up all drops from summer varieties twice a week, from fall varieties weekly, and from winter varieties once every two weeks after July 15, and destroy them at once. Feeding the apples to livestock, putting the apples in sacks and submerging them in water or burying them at least two feet deep, are some of the ways of disposing of them. Pouring used crank-case oil over infested drops at the rate of 1 gallon to 10 square feet of pile surface will also prevent the adult emergence. The pile should not be under a tree and the oil may be applied any time before June 1 of the following year. Apply arsenical sprays with or without a fungicide on the dates determined annually by the Department of Entomology. These dates can be obtained through the county agricultural agent. The destruction of neglected apple and thornapple trees in the vicinity of orchards will help in controlling apple maggot.

51. **Curculio.** The well known plum curculio, which is responsible for the tiny dot and crescent-shaped scars on our tree fruits, hibernates under fallen leaves and trash. The destruction of all trash after cold weather arrives disposes of very many of these insects, and the liberal use of lead arsenate in the early routine sprays, beginning with the pre-pink application, will accomplish much toward their control. The curculio feeds, in early spring, on opening buds and on developing foliage.

The development of the curculio in the infested fruits continues after the fruits have dropped or have been removed by thinning. Hence, the disposal of "drops" and "thinnings" by feeding to livestock, crushing or burial beneath at least 18 inches of well-packed soil will reduce the infestation and consequent loss.

52. **Leafhoppers.** Leafhoppers are pests in many orchards. The typically discolored fruit and leaves and curled edges of the leaves associated with leafhopper injury are readily apparent only with heavy infestations, which may also result in stunting of new growth. The damage is caused by the feeding habits of these small insects, which are commonly seen rising in clouds from the trees when disturbed. Since these insects have sucking mouth parts the damage is caused by their feeding on the internal portions of the leaves. No arsenical spray affects them. They usually make their appearance during the month of May and the indications are usually such that the magnitude of the infestation can be judged by the first of June. If indications are such as to denote heavy infestation the insects can be controlled by thor-

oughly spraying with nicotine sulphate (1 pt. in 100 gal.) in Application 5.

53. **Climbing Cutworms.** Refer to special instructions in Section 94.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF DISEASES ON PEARS

54. **Pear Scab.** Bordeaux is recommended for general use on pears because it has certain marked advantages over other materials. It does not injure the leaves and there is no apparent interference with their functioning. There are also definite indications that orchards regularly sprayed with bordeaux do not suffer so severely from fire-blight as those in which bordeaux is not used. A definite disadvantage of bordeaux, with some varieties at least, is the fact that it causes russetting of the fruit. This is undesirable on Bartlett and possibly other smooth-skinned varieties but is probably an advantage with Bosc and possibly other varieties.

Lime-sulphur has been generally used in certain parts of the state apparently with satisfactory results, but the use of this material in the after-blossom applications does not seem to be the best procedure. For those who prefer that material, it is suggested that they use lime-sulphur at the rate of 2½ gallons or preferably 2 gallons with water to make 100 gallons in the pre-blossom applications and to reduce the concentration in the after-blossom applications somewhat, or if scab is believed to be well under control to substitute one of the less injurious sulphur sprays in the after-blossom applications.

If lime-sulphur or other sulphur material is used during the summer, an application of "summer oil" for psylla should not follow a sulphur application within two weeks, nor be followed by one of sulphur until a similar period has elapsed. Because of this complication, every effort should be made to bring scab under control by the early sprays so as to avoid the use of a fungicide during mid- and late summer if oil sprays are to be employed.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF INSECTS ON PEARS

55. **Codling Moth and Spray Residue on Pears.** Codling moth is generally not so serious a problem with pears as with apples, and in most parts of the state it usually may be controlled without danger of excessive residue. Information regarding residue on pears is very meager, but it is believed that lead arsenate may be used in the petal-fall and first cover applications without causing excessive residue. If the codling moth infestation is such that further spraying is necessary and the fruit is to be washed, the schedule outlined on pages 24 and 25 should be followed. If, however, washing equipment is not available or it seems desirable to avoid washing, summer oil emulsion and nicotine sulphate or fixed nicotine should be used (See Sections 15-16 and 42). To obtain with oil and nicotine the degree of protection afforded by the indicated schedule of lead arsenate, will require from

six to eight applications beginning with Application 5A. The oil and nicotine application remains effective only for seven or eight days. The number of applications should be determined by the prevalence of codling moth, but should be held to as few as possible because of the cost and danger of injury to the trees. Summer oil emulsion, $\frac{1}{2}$ gallon, and nicotine sulphate, $\frac{3}{4}$ pint, with water to make 100 gallons, is the recommended strength. This treatment should also control pear psylla.

56. **Pear Psylla.** For the control of pear psylla, use a dormant early spring application of home-made oil emulsion containing 3 per cent of actual oil. This oil should have a viscosity of 175 to 250 seconds (Saybolt at 100° F.). Home-made oils can be emulsified either with bordeaux or other suitable emulsifier. Refer to Sections 18 to 28 inclusive, for specific information about the making and use of oil emulsion. Bordeaux is most frequently used as the emulsifying agent. Several miscible oils and prepared oil emulsions are available and, in some instances, have given satisfactory results. Most of these preparations, however, are made from oils of lower viscosity than are desirable for best results. Dilute these materials according to the maker's instructions.

This application should be made in the early spring just before the adult psyllas have begun to lay eggs on the pear trees. In order to be sure of covering the branches before egg laying begins, apply the oil spray with the first suitable weather in March or early April, regardless of the number of psyllas on the trees. In the southern counties of the state, the oil will usually need to be on in March, and further north as early as weather permits.

It is imperative that all parts of the trees be covered and this is accomplished best when the spraying is done from the ground as well as from the tank. Spray all shoots or suckers from the crown or roots, or, better still, cut and remove them from the orchard. It is also advisable to spray all interplanted and adjacent fruit trees of other kinds.

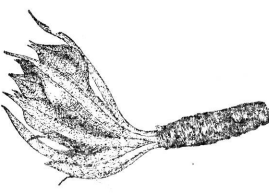

The use of oil-nicotine sprays, as recommended for codling moth control (refer to Sections 15, 16, 42) should also control infestations of pear psylla.

57. **Pear-leaf Blister-mite.** This pest is best controlled by an application of lime-sulphur after the buds have begun to swell. Fairly good control can be obtained with the same material in the delayed dormant period. If scale insects are also to be controlled (which will not be necessary if the early application of oil has been used for psylla) dilute $12\frac{1}{2}$ gallons of lime-sulphur with water to make 100 gallons. If scale is not present, the concentration may be reduced to 10 gallons of lime-sulphur with water to make 100 gallons. If applied in the delayed dormant period, the treatment will also be effective against pear scab and may be substituted in lieu of bordeaux at that time. A thorough treatment is usually effective for two or three or more years.

58. **Climbing Cutworms.** Refer to special instructions in Section 94.

59. **Fire-blight.** Upon request, special instructions for the control of fire-blight will be sent by the Botany Department, Michigan State College.

PEARS

STAGE OF GROWTH	APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
	1. DORMANT. Apply with the first good spraying weather in March or early April.	Oil emulsion, 3% heavy oil, or a commercial oil spray.	Psylla, scale insects and mites.	For the control of pear psylla use an oil spray as an early spring application before egg laying begins. Apply with the first good spraying weather. Refer to Section 56 for specific instructions.
	2. DELAYED DORMANT, or PRE-PINK. Latter stage is shown at left.	Bordeaux, 3-8-100. Refer to Sections 9 and 10 for instructions for making bordeaux.	Scab, leaf-blight, and curculio.	This application is good insurance on all susceptible varieties.
	3. PINK. Apply when the buds have separated in the clusters but before the blossoms have opened.	Bordeaux, 3-8-100 and lead arsenate, 3 lb. in each 100 gallons. Refer to Sections 9 and 10 for instructions for making bordeaux.	Scab, leaf-blight, curculio, and bud moth.	This application should always be made in districts where scab is prevalent and everywhere on varieties such as Flemish Beauty. In many parts of the state, however, scab is seldom serious on most varieties. In such cases measures for its control may not be necessary.
	4. PETAL-FALL or CALYX. Apply when most of the petals have dropped and after bees have quit working in the bloom.	Bordeaux, 2-8-100 and lead arsenate, 3 lb. in each 100 gallons of spray. See Sections 9 and 10.	Scab, leaf-blight, codling moth, curculio and other chewing insects.	

THIS SCHEDULE WILL MAKE RESIDUE REMOVAL NECESSARY. IF FRUIT IS NOT TO BE WASHED, REFER TO SECTION 41, 42 AND 55.

5. FIRST COVER. Two weeks after petals fall.	Bordeaux 2-8-100 and lead arsenate, 3 lb. in each 100 gallons of spray.	Codling moth, curculio, and other chewing insects, scab and leaf-blight.	Bordeaux may be omitted if scab and leaf-blight are not present. Refer to Section 56 for the summer treatment of psylla.
5a. SECOND COVER. Two weeks after Application 5.	Lead arsenate, 3 lb. and water to make 100 gallons.	Codling moth and curculio.	<p>WARNING. IMPORTANT</p> <p>Govern the use of lead arsenate during the summer by the prevalence of codling moth. Read carefully Section 55.</p>
5b. THIRD COVER. Two weeks after Application 5a.	Lead arsenate, 3 lb. and water to make 100 gallons.	Codling moth and curculio.	
6. SUMMER GENERAL ACTION. Time determined the same as for apples.	Lead arsenate, 3 lb. and water to make 100 gallons.	Codling moth and curculio.	

See Section 54 for possible variations in materials for scab control.

Bordeaux may be used at this time on varieties very susceptible to scab. Read carefully Section 55.

QUINCES

APPLICATION	MATERIALS	TO CONTROL
DORMANT APPLICATION. If scale insects, mites, or leaf-rollers are prevalent, spray as indicated for these insects under apples.		
1. PRE-BLOSSOM. After leaves are well started.	Bordeaux, 3-5-100 and lead arsenate, 3 lb. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects.
2. PETAL-FALL. Just after petals fall.	Bordeaux, 3-5-100, and lead arsenate, 3 lb. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects.
3. Two weeks after Application 2.	Bordeaux, 3-5-100, and lead arsenate, 3 lb. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects.
4. Two weeks after Application 3, and repeat in 8 days if codling moth infestation is heavy.	Summer oil emulsion, $\frac{3}{4}$ gal., nicotine sulphate, $\frac{3}{4}$ pt., and water to make 100 gallons. Refer to Sections 27, 4 and 41.	Curculio, codling moth and other chewing insects.
5. SECOND GENERATION. Spray at the time recommended for the second generation of codling moth on apples, and repeat at 8 day intervals as long as necessary.	Summer oil emulsion, $\frac{3}{4}$ gal., nicotine sulphate, $\frac{3}{4}$ pt., and water to make 100 gallons. Refer to Sections 27, 4 and 41.	Curculio, codling moth and other chewing insects.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF DISEASES ON CHERRIES

60. **Special Application for Brown-rot.** An application of sulphur on sweet cherries, one week or ten days before harvest, will prevent brown-rot, allow a longer harvesting season and protect the fruit during shipment. A dust is preferable because it leaves no noticeable residue on the fruit. Use sulphur with 5 to 10 per cent of hydrated lime or other "fluffer".

Sprays at this time, especially liquid lime-sulphur or copper materials with lime may stain the fruit. Wettable sulphur sprays are the least objectionable and are advised if a duster is not available. Wettable sulphurs are used at the rate of 5 to 8 pounds in 100 gallons of water.

61. **Cherry Leaf-Spot.** Cherry leaf-spot is caused by a fungus which lives over winter in the old leaves on the ground. About the time of petal fall the spores developing in the old leaves become mature. During rains these spores are discharged and carried by air currents to the young foliage on the trees. Under favorable conditions (rainy weather) the spores germinate and grow into the leaf tissue, causing infections from which additional spores are produced. This disease can be controlled by spraying.

Within recent years several proprietary copper compounds have appeared on the market. A list of these materials is given in Section 11. Most of these compounds have been used extensively in Michigan during the last three years. Experimentally they have given better control of cherry leaf-spot than did lime-sulphur when used similarly under severe conditions. The results obtained by growers have not been so consistent as those obtained in experimental work. Improper timing and poor coverage, rather than the materials used, appear to be associated with poor control. Observations in commercial orchards throughout the state, however, show that as a rule where the proprietary copper materials were used there was less leaf-spot infection than where liquid lime-sulphur was applied. Proprietary copper materials have been superior to liquid lime-sulphur in leaf-spot control, and have not caused the dwarfing of fruit and injury which has been consistently associated with strong bordeaux. It seems advisable to continue to recommend the use of proprietary copper sprays on sour cherries or a weak bordeaux. Weak bordeaux has given more injury under drouth conditions. (See Section 63.)

The addition of an equal amount of lime to most of the proprietary materials containing 25% copper and double the amount of those materials containing more than 25% is recommended. An addition of 1 pound of zinc sulphate (25% zinc) and 1½ pounds of lime has corrected injury with basic copper sulphate (Basicop) as well as when large amounts of lime were used. The zinc sulphate-lime mixture has been limited to two years trials with basic copper sulphate, but has not been tried adequately with other materials.

Proprietary copper compounds do not stick so well as bordeaux. Too much confidence should not be placed on the amount of protection remaining after prolonged rainy periods. **Those materials must be used with the same timeliness and thoroughness as lime-sulphur.**

SOUR CHERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT.	Oil, or tar sprays (refer to Sections 18 to 28.)	Oil will control leaf-roller and case-bearer. Tar sprays will control case-bearer.	Instructions for control will be found in Section 68 for case-bearer and Section 46 for leaf-roller.
2. PETAL-FALL. When most of the petals have dropped.	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate, 2 lb., and water to make 100 gallons. See Sections 11 and 63.	Leaf-spot, brown-rot, curculio, and slugs.	This application is important in checking the first infections of leaf-spot.
3. FIRST COVER. Should be completed within two weeks after petal-fall.	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate, 2 lb., and water to make 100 gallons. See Sections 11 and 63.	Leaf-spot, brown-rot, curculio, and slugs.	Lead arsenate should not be used later than this before harvest, except on fruit that will go to the canning factory and will be thoroughly washed.
4. SECOND COVER. Should be completed within two weeks after Application 3.	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate, 2 lb., and water to make 100 gallons. Omit lead arsenate unless fruit is going to canning factory or can be washed. See Sections 11 and 63.	Leaf-spot, brown-rot, curculio, and slugs.	Omit lead arsenate unless fruit is to go to canning factory or can be washed.
4a. SPECIAL. For the control of cherry maggot.	Refer to Section 66 for information concerning a special application for the control of cherry maggot in canning cherries.	Refer to Section 66 for information concerning a special application for the control of cherry maggot in canning cherries.	Watch for special announcement on cherry maggot. See Section 66.
5. AFTER HARVEST. Immediately after the fruit is harvested.	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate, 2 lb., and water to make 100 gallons. See Sections 11 and 63.	Leaf-spot and slugs.	

SPECIAL. On young growing trees extra applications may be necessary until growth is completed. Refer to Section 66 for special information on maggot control.

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

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

SWEET CHERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT.	Lime-sulphur, oil, tar, tar and oil, or *D N. See next column.	Scale insects, (see Section 44). Leaf-roller, (see Section 46). Case-bearer, (see Section 68). Aphid (see Sections 17, 20 and 28.)	
2. PETAL-FALL. Just after petals have fallen.	Lime-sulphur, 2 gallons, lead arsenate, 2 lb., and water to make 100 gallons. Or Proprietary copper compound plus lime. Use manufacturer's recommendation. See Section 64.	Leaf-spot, brown-rot, curculio and slugs. (See Section 65 for aphid control.)	Avoid spraying sweet cherries during periods of high humidity and high temperature.
3. TWO-WEEKS. Two weeks after Application 2.	Lime-sulphur, 2 gallons, lead arsenate, 2 lb., and water to make 100 gallons. Or Proprietary copper compound plus lime according to manufacturer's recommendation.	Leaf-spot, brown-rot, curculio and slugs. (See Section 65 for aphid control.)	Lead arsenate should not be used later than this (before harvest) except on fruit that will go to the canning factory and will be thoroughly washed.
4. FOUR-WEEKS. Two weeks after Application 3.	Lime-sulphur, 2 gallons, lead arsenate, 2 lb., and water to make 100 gallons. Omit lead arsenate unless fruit is to go to canning factory or can be washed. Or Proprietary copper compound plus lime.	Leaf-spot, brown-rot, curculio, slugs, and maggots. (See Section 65 for aphid control, and Section 66 for maggot control.)	Omit lead arsenate unless fruit is to go to canning factory or can be washed.
4a. SPECIAL. For the control of cherry maggot.	Refer to Section 66 for information concerning a special application for the control of cherry maggot in canning cherries.		
5. BROWN-ROT. About one week before picking.	Sulphur dust or spray of wettable sulphur.	Brown-rot.	See Section 60.

RESIDUE REMOVAL. Instructions will be furnished on request to the Department of Horticulture.
*D N. See Sections 17 and 20.

62. **Lime-sulphur for the Control of Cherry Leaf-spot.** Where lime-sulphur is consistently applied with thoroughness and timeliness so that overwintering disease inoculum is reduced to a minimum, it is possible for some growers to obtain satisfactory control. To control with lime-sulphur, it may be advisable to apply an extra pre-bloom spray, shorten the interval between applications to 10 days and include four or five sprays before harvest, depending on weather conditions. The after-harvest spray should be applied as soon as possible. **Never apply lime-sulphur on foliage which has had a previous copper spray as severe injury is certain to result.** Wettable sulphurs are not recommended for control of cherry leaf-spot.

63. **Bordeaux Sprays for Sour Cherries.** Bordeaux will control leaf-spot better than any other known spray material. It has, however, caused serious injury and dwarfing of fruit when used at concentrations of 4-6-100 or stronger in a four-spray schedule, especially in dry seasons. Since weather conditions cannot be predicted, the high concentrations are not safe under Michigan conditions. Recent experimental work tends to show that a 3-4-100 bordeaux is the maximum strength necessary to use on sour cherries for leaf-spot control in Michigan.

Bordeaux 2-3-100 seems to control leaf-spot as well as the recommended concentrations of proprietary copper materials. It has caused no significant dwarfing of fruit and little injury except in years of drouth. All bordeaux sprays may cause serious defoliation in late summer under drouth conditions, consequently they should not be used on trees growing in soils that are subject to drouth. If for any reason, the sprays have not been applied thoroughly and on time, an application of bordeaux 3-4-100 will be the most satisfactory one to check an established infection. It should be remembered that once a copper material has been applied it is not safe to resume use of lime-sulphur. Otherwise serious defoliation may follow.

64. **Copper Compounds for Spraying Sweet Cherries.** Experimental results for the last two years show that proprietary copper compounds when used with lime on sweet cherry for leaf-spot control have been satisfactory and caused but little injury. Under drouth conditions such as those that occurred at East Lansing in 1939 the proprietary copper-sprayed trees showed less defoliation than did trees sprayed with lime-sulphur. The value of proprietary copper compounds for brown rot control has not been established. For the control of brown rot, a wettable sulphur is compatible with and can be added to the copper compound, or special applications of wettable sulphur can be made during the critical periods.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF INSECTS ON CHERRY

65. **Black Cherry Aphid.** This insect is often a serious pest on sweet cherries though of less importance to other groups. Activity starts with the new growth. The leaves are curled, growth is stunted, and the fruit may drop or become fouled with the honey-dew excreted. The curling of the leaves makes thorough spraying necessary. The

information on control of black cherry aphid indicates that the best means of control, besides dormant sprays, is 1 pint of nicotine (See Sec. 15) plus 4 pounds of cheap soap or soap flakes in 100 gallons of water applied as a thorough drenching spray as soon as aphids are observed. The soap or soap flakes can be dissolved only in hot water and, unless dissolved, trouble will result from clogging the screens of the sprayer. Various liquid soaps and other nicotine activators which are very efficient for use with nicotine sprays are marketed. Black cherry aphid has been controlled repeatedly by nicotine dusts applied at first appearance of the insects.

The success of sprays or dusts applied for control of black cherry aphid depends upon getting the application on the trees before the leaves are badly curled. If the leaves become badly curled, it is almost impossible to eradicate the black cherry aphid.

A dormant application of tar, tar and oil or DN sprays (See Sections 17 and 20) may be used to control black cherry aphids. If, for any reason, an infestation develops after such an application, it may be controlled by the previously outlined treatment with nicotine sulphate.

66. Fruitflies. There are two species of cherry fruitflies common in Michigan. These fruitflies produce footless and headless maggots, about one-fourth inch long, which feed inside the fruit. They are usually almost straight in form while the larvae of the plum curculio, which is even more commonly found in ripening cherries, has a small head and a body usually bent in a curve. The egg of the cherry fruitfly is laid in a slit cut in the young fruit in mid-June and early July. For canning cherries which are to be thoroughly washed, apply one or more applications of arsenate of lead, using 2 pounds to 100 gallons of spray. If necessary to control brown-rot or leaf-spot, include a fungicide as recommended in Sections 60 and 61.

The exact spraying dates for cherry fly maggot are determined annually by observations made by the Department of Entomology and supplied to county agricultural agents in the western cherry canning belt. Approximate dates can be supplied for other places if desired. Apply to your county agricultural agent for the observed dates.

67. Climbing Cutworms. Refer to special instructions in Section 94.

68. Cherry Casebearer. While the cherry casebearer is a comparatively new pest, experimental work indicates that it can be controlled in the dormant season without injury to the trees. Proprietary oil and tar sprays used according to the manufacturers' recommendations and home-made oil emulsions at 8 per cent give excellent control of this pest. Most of the cherry casebearers spend the winter upon the twigs of the outer three or four feet of the branches. This makes it essential that this part of the tree be sprayed thoroughly, as only those insects hit will be killed. Great care should be exercised in spraying cherry trees with the heavy concentrations of oil necessary for control of the cherry casebearer, particular care being exercised to see that cherry trees are in the dormant stage when the spray is applied. It will be well also to observe the usual precautions regarding oil sprays (See Section 23).

PEACHES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT. Apply in early spring before growth starts.	Lime-sulphur, 5 gallons, and water to make 100 gallons for leaf-curl alone. If scale is present, increase lime-sulphur to 12 1/2 gallons. If mites are present, use an oil spray with a fungicide. See Section 75.	Leaf-curl, scale insects and mites. If mites are present refer to Section 75.	To insure control of leaf-curl this application should be made before growth starts. If mites are prevalent an oil spray is also necessary. See Section 75 for special instructions.
2. After the blossoms have dropped and the last of the "shucks" are falling.	DUST with arsenate of lead* lime dust containing 5% lead arsenate, or SPRAY with lead arsenate, 2 lb., in 100 gallons iron sulphate-lime or zinc sulphate-lime spray. See Sections 3, 32 and 33.	Curculio. Refer also to Sections 1 and 80.	If the arsenate of lead-lime dust is not available, an 80-5-15 sulphur-arsenate of lead-lime dust may be used, although the use of sulphur at this time is not essential. When spraying with acid lead arsenate on peaches, do not use more than 2 lb. in 100 gallons of spray.
3. About two weeks after No. 2.	DUST with 80-5-15, sulphur-arsenate of lead-lime dust, or SPRAY with wettable sulphur 4 to 10 lb., and lead arsenate, 2 lb., in 100 gallons of iron sulphate-lime or zinc sulphate-lime spray. See Sections 3, 32 and 33.	Curculio, scab and brown-rot. Refer to Sections 3, 32 and 33.	This spray is important to check the early development of scab and brown-rot.
4. About one month before the fruit ripens.	DUST with sulphur (with fluff), or SPRAY with wettable sulphur 4 to 6 lb. See Section 8.	Brown-rot and scab. See Section 69.	Do not use lead arsenate at this time unless absolutely necessary. This period is the most important time to control brown-rot.
4a. One week after No. 4.	Sulphur-oil-lime dust. See Section 76. Or spray with wettable sulphur, 4-6 lbs.	Oriental fruit moth and brown-rot.	
4b. Two weeks after No. 4.	Sulphur-oil-lime dust. See Section 76. Or spray with wettable sulphur, 4-6 lbs.	Oriental fruit moth and brown-rot.	
5. One week to ten days before the fruit ripens.	DUST with sulphur (with fluff), or SPRAY with a wettable sulphur, 4 to 6 lbs. See Section 8.	Brown-rot. See Section 69.	On many varieties this application is often important to retard rot development during or after harvest.

CAUTION. Study carefully Section 77. Use P. D. B. or E. D. F. about September 15 for peach borer. See Section 77.

*Basic lead arsenate does not require a corrective on peaches. See Section 13.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF DISEASES ON PEACH

69. **Brown Rot of Peach.** Brown rot may attack the fruit, blossoms or twigs. It may cause heavy losses in the orchard, considerable loss in transit, and disappointment to the consumer. This disease can be controlled by thorough spraying and sanitation.

Brown rot fungus lives over winter mostly on mummies (infected peaches which have dried up) hanging on the tree and half-buried mummies on the ground. In the spring the mummies on the ground which are partially buried, produce small mushroom-like fruiting bodies which ripen and discharge their spores about peach blossom time. The mummies hanging on the trees also produce dusty masses of spores during wet spells at any time in the summer. For sanitary reasons knock all the mummies to the ground after the crop is harvested. Rake the rotted fruit far enough away from the trunk to reach the zone of cultivation. Disk or cultivate before bloom to disturb the half-buried mummies and prevent the formation of fruiting bodies.

70. **Control of Brown-rot by Spraying.** Standard varieties such as Hale, Elberta, and South Haven are somewhat resistant to blossom blight. Susceptible varieties such as Dewey, Prolific and Rochester should be given a special spray when the blossom buds show pink. To control fruit rot, curculio must be controlled first because rot follows heavy infestations of this insect. Fruit becomes increasingly susceptible as it approaches maturity. **The late sprays or dusts beginning one month before ripening and just previous to picking are very important in the control procedure.** Additional sprays or dusts sandwiched between these are necessary during wet, muggy weather occurring in the ripening period. Peach trees should be set at greater distances or pruned to allow room for the spraying or dusting machinery to go between trees at ripening time and allow for spray manipulations. In closely planted orchards a semi-portable stationary spray outfit may be the solution of this problem. Graders with brushes should be supplied with sulphur dusting equipment to protect the bruised fruit and prevent rot in transit. The wettable sulphur sprays or sulphur dusts will prevent brown rot if applied before infection occurs.

71. **Bacterial Spot.** This disease is most readily seen on leaves and fruit as small angular dark brown spots. It is distinguished from arsenical injury by the small size and rougher margin of the spots which do not fall out as readily as those of arsenical injury. Bacterial spot begins as a small water-soaked spot. Indications of bacterial exudate can frequently be found. This disease was serious in a few orchards in 1938 and 1939. Experiments by the U. S. D. A. have prompted recommendations of five or six sprays of zinc sulphate-lime, 8-8-100 (See Sec. 33) beginning with the petal-fall spray and repeat applications at 10- to 14-day intervals. This program is reported to prevent much of the injury but has not received experimental attention in Michigan because the disease has not been generally present. Vigorously growing trees are less severely attacked. Fertilization and tree vigor keeps the disease in check.

72. Coryneum Blight. *Coryneum* blight is serious in many orchards in certain areas in the state. On green shoots, leaves, and fruits, the characteristic circular lesions are readily identified by the red ring or margin surrounding the gray or cream-colored center. Defoliation and shot holing accompany severe cases. Death of individually affected buds and gumming usually accompany the lesions on twigs. Bordeaux 16-16-100 applied in the fall about October 15 or about the time of leaf fall has effectively controlled this disease. This application will also control leaf curl. A second bordeaux spray, 8-12-100, should also be applied in the spring late in the dormant period in serious cases of the disease.

73. Peach Canker. Peach canker is a fungous disease affecting the twigs, branches, and trunks of peach trees. Cankers may occur on any part of the twigs, branches, and trunk, and are common in the crotches.

The disease organism gains entrance to the host through winter-injured wood, pruning wounds, dead twigs, and brown rot cankers. Practices which will prevent winter injury, control brown rot and keep trees in a moderate growing condition, together with proper pruning methods, are steps in treating this disease.

PRUNING—

1. It is best to delay pruning until about March 1, and then the older trees should be pruned first, leaving the younger trees until last. Earlier pruning may spread the disease.

2. Prune young trees lightly. Older trees need heavier pruning, the amount depending on the crop prospects.

3. No stubs should be left in pruning.

4. It is important to remove all dead wood at pruning time. If any is overlooked it should be removed not later than the end of June. This can be done at thinning time.

5. Remove all prunings from the orchard and burn as soon as possible.

6. Trim out cankers and coat exposed surfaces with an antiseptic.

WINTER INJURY—

Winter injury is more likely to occur most seriously on vigorous trees which were permitted to grow late in the season. Approximately 18 inches of terminal growth on young trees and 12 inches on bearing trees is satisfactory. Fertilize the trees so they will maintain the proper growth and no more. Stop cultivating and sow a cover crop in young orchards late in June, and in bearing orchards not later than July 15.

SPRAYING—

The brown rot organism which causes decay of the fruit often infects the twigs, and these lesions in turn may permit the entrance and development of canker. Spray carefully to control brown rot. Also, remove all fruits showing brown rot infection before the disease has a chance to spread to the twigs.

The results of experimental spraying to control peach canker are limited and inconclusive. No noticeable differences could be noticed in any of the plots sprayed last season with several kinds of fungicides compared with plots of unsprayed trees.

TREATING CANKERS—

The cankers should be trimmed out to live healthy bark and the exposed areas painted with a mild disinfectant such as shellac, kolofog, or Corona wound dressing. The lower end of the wound should be trimmed to a point to help healing and avoid collection of moisture. The cankers will heal more readily if treated the latter part of May or in June when the wood is growing rapidly.

74. Leaf Curl. One application of strong fungicide during the dormant period controls leaf curl. This disease can be controlled by proper fall spraying. It is suggested to those who care to practice fall spraying that bordeaux, 8-12-100, be used after the leaves have dropped.

Bordeaux will not control scale insects, or red mite. Where oil is used to control San Jose scale or red mite in the dormant period, bordeaux can be included in this spray for the additional control of leaf curl (See Sec. 75). Lime-sulphur, 5 gallons in 100 gallons of spray or stronger, will control leaf curl and if used for that purpose should be applied in the spring before the buds swell. Leaf curl infections occur only during a limited period while the buds are opening in the spring. The disease must be controlled before infection occurs. Foliage applications are of no value after the disease becomes established.

74a. Peach Virus Diseases. See Section 85.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF INSECTS ON PEACHES

75. European Red Mite. This pest overwinters in the egg stage (Sec. 45). If the minute red eggs of this mite are present, the application of an oil spray containing 3 per cent actual oil is necessary. A complete and thorough coverage is necessary if all eggs are to be killed. Since it is always desirable to spray peaches for the control of leaf curl, it is desirable to combine a fungicide with the oil spray. The home-made bordeaux emulsion can be used with bordeaux. To make a 3 per cent oil spray with fungicidal value, add 4½ gallons of home-made oil emulsion to 100 gallons of bordeaux (8-12-100). This can best be accomplished by first making the emulsion in the sprayer and then pumping the emulsion into a separate container. Then make the bordeaux in the sprayer in the usual way (Sections 9 and 10) and finally, when the tank is nearly full, add the oil emulsion. Keep agitator in operation at all times. This 3-per cent oil and bordeaux combination may be used in the dormant period to control red mite, San Jose scale and leaf curl in one spray application. Fungicides for the control of leaf curl may be added to proprietary oils according to the manufacturers' recommendations. Oil sprays or oil-fungicide combinations should be applied in the spring only.

76. Oriental Fruit Moth. This insect is most successfully fought by its parasites which have been introduced into most peach-growing sections and are being added to, each year by new introductions. Injury to the twigs is sometimes conspicuous but causes no permanent harm to the tree, although it provides a point of infection for peach

canker. Oriental fruit moth has four generations in Michigan but it is usually the third generation before the fruit is attacked. This commonly occurs about the season of Elberta ripening. Peaches ripening after Elberta are likely to be infested.

Early cultivation reduces the population of oriental fruit moth as most of them go through the winter on mummies or on pieces of weeds beneath the tree. Treatment with paradichlorobenzene (P. D. B.) for peach borer kills some oriental moth.

Insecticidal treatments for oriental fruit moth have never been so effective as for curculio and other insects attacking peaches.

The best insecticidal treatment tried to date has been weekly applications of $\frac{1}{2}$ pound per tree of a dust consisting of 60 pounds sulphur, 5 pounds of oil, and 35 pounds of lime or talc. The treatment should begin about one month before picking. This dust may be mixed at home or purchased from one of several companies.

77. Peach Borers. These insects are larvae of moths. They tunnel between bark and wood of crown, trunk, and upper roots of peach and some other trees. Treatment with paradichlorobenzene (P. D. B.) is the accepted method of control. Prepare the ground by removing weeds, grass, and debris from near the crown of the tree. Do not loosen soil. Remove most of the gum which may be present. Distribute the crushed crystals in a narrow ring about the crown, not nearer than one inch, nor more than two inches away from the crown. Use one ounce on trees six years old or more, $\frac{3}{4}$ ounce on trees 5 years old and $\frac{1}{2}$ ounce on trees 4 years old. Do not use paradichlorobenzene on trees until they have been in the field for three years. Cover lightly with soil, being careful not to disturb the ring of crystals. Apply late in August or about the first of September. Paradichlorobenzene (P. D. B.) does not work well when the temperature of the soil at 4 inches depth falls below 60 degrees F.

Heavy clay soils have a tendency to retain the fumes of paradichlorobenzene. With such soils, the mounds should be withdrawn in three or four weeks and the trees mounded again with fresh soil.

In case one does not wish to use paradichlorobenzene, he may dig out the larvae in spring or fall.

During the last 3 years, application of paradichlorobenzene dissolved in a miscible oil and applied as a spray has been tried successfully on young trees. This is accomplished by dissolving 2 pounds of paradichlorobenzene in 1 gallon of miscible oil and diluting to 30 gallons and then spraying about the base of the young trees. Since at this dilution each gallon of solution contains approximately one ounce of paradichlorobenzene it is possible to apply small dosages easily. One to two quarts, depending upon the age of the tree is the proper dosage. This treatment has not worked so efficiently on older trees as the standard crystal treatment.

Ethylene dichloride emulsion is available commercially for peach borer control. It has the advantage of being effective at lower temperatures than P. D. B. and no subsequent treatment after application is needed. Use according to manufacturer's directions.

78. Lesser Peach Borer. The lesser peach borer, which is often confused with its relative, the peach borer, works in the trunk, crotch and large limbs of the peach tree. The presence of these insects in

such locations is shown by masses of gum and frass which are often very noticeable because of their size and number. The application of paradichlorobenzene in raw cottonseed oil any time between September 1 and April 15 will control these pests. It should not be applied, however, when the temperature is 50° F., or below, as the material will crystallize. Painting the mixture upon the infested areas after removal of the gum will kill practically all of the borers, while painting without removal of the gum will kill about 90 per cent. This mixture consists of one pound of paradichlorobenzene dissolved in two quarts of raw cottonseed oil.

79. **Climbing Cutworms.** Refer to special instructions in Section 94.

80. **Curculio.** In peach plantings where curculio is of importance as a pest, clean-up measures will aid materially in its control. The use of heavy arsenical applications on peach trees causes burning. Clean-up measures which can be applied to the peach orchard are the same as those described in Section 51 for apple orchards, with the addition of proper disposal of the thinnings, which normally include curculio-infested peaches. All thinnings and drops should be thrown out into the space between the rows, so that the sun shines upon them. Then the heat of the sun will destroy most of the curculios which would otherwise develop.

81. **Black Peach Aphid.** This pest is a dark, shiny plant louse that works both in the tops and on the roots of peach. It starts out in localized areas in peach orchards. In the tops, it may be killed by the usual nicotine sprays. On the roots, it is very resistant and no satisfactory control method is now known. When "dead spots" due to this insect appear in the orchard remove the trees from those areas and seed the land to clover for several years before resetting to peaches.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF DISEASES OF PLUM

82. **Sanitary Measures for Brown Rot Control.** Brown rot of plum, the same disease as found on the peach and cherry, is controlled primarily by spraying, but thinning of the fruit and certain sanitary measures will help greatly. The fruit should be thinned soon after the June drop so that the plums will not touch when ripe. Rot will spread more easily from one plum to another if they touch. All "mummied" fruits from the previous season should be removed from the tree, raked from the ground and destroyed. They are sources of reinfection. **Curculios must be controlled as brown rot follows their injury** (See Sections 80, 51). See Sec. 70 for instructions on brown-rot sprays for stone fruits.

83. **Black Knot.** Plum or cherry orchards in which this disease is present should be inspected in the late fall or early spring before spore dissemination takes place, and all knots removed and burned. A single inspection and treatment each year will, in most cases, give control. If the disease is well established on a very susceptible variety, more frequent pruning of diseased parts may be necessary. A dormant spray

PLUMS

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT. Apply just before growth starts.	Lime-sulphur, 12½ gallons, and water to make 100 gallons, for scale insects, or 3% oil for mites or scale.	Scale insects and mites.	Whether or not this application is necessary will depend on the prevalence of mite eggs or scale.
2. PRE-BLOSSOM. Just as leaf buds burst and before blossoms open.	Lead arsenate* 3 lb. plus corrective. (See Sections 3 and 33) and water to make 100 gallons.	Curculio.	Curculio coming out from hibernation feed on the opening buds. This application is important.
3. PETAL-FALL. Just after the petals have fallen.	Wettable sulphur 4 to 6 lb. and lead arsenate, 3 lb. plus corrective. (See Sections 3 and 33) in 100 gallons.	Curculio, leaf spot and brown-rot.	This spray is important for leaf-spot, brown-rot, and curculio.
4. TWO-WEEKS. Ten days to two weeks after No. 3.	Wettable sulphur 4 to 6 lb. and lead arsenate, 3 lb. plus corrective. (See Sections 3 and 33) in 100 gallons.	Curculio, leaf spot and brown-rot.	The number of early summer applications necessary will depend on the prevalence of leaf-spot and curculio. Leaf-spot is not serious in some districts.
5. LATE SUMMER. About one month before harvest.	Wettable sulphur, 4 to 6 lb. in 100 gallons. See Section 8.	Brown-rot and leaf spot.	This is an important application in the control of brown-rot.
6. SPECIAL. One week to ten days before harvest.	Sulphur dust (with small percentage of a filler) or a non-staining spray. (See Section 8.)	Brown-rot.	This application is very important to prevent the development of rot as the fruit ripens and during transit.

*Basic lead arsenate does not require a corrective. See Section 13.

of lime-sulphur or oil-bordeaux will eliminate many spores of black knot. The usual summer sprays also help check new infection. See Section 75 for instructions on oil-bordeaux.

84. **Bacterial Spot.** Refer to Section 71.

85. **Virus Diseases.** Peach yellows, little peach, and a new peach virus known as rosetted-mosaic can also affect plum trees. On some varieties these diseases may be present but the symptoms are masked. A plum leafhopper can transmit these diseases from plums to peaches. All plum trees in peach districts should be regarded with suspicion. Remove any unprofitable plum trees and plum thickets as a sanitary precaution. All remaining plum trees should be sprayed with nicotine sulphate, 1 pint in 100 gallons of water, about 3 weeks after petal-fall, or include this material in Application 4. This application will eliminate the leafhoppers.

SUPPLEMENTARY DIRECTIONS FOR CONTROL OF INSECTS ON PLUMS

86. **Red Mite.** Plums are frequently infested with red mites. The treatment is the same as that recommended for the apple. (Refer to Sec. 45.)

87. **Curculio.** In plum plantings where curculio is of importance as a pest, clean-up measures will aid materially in its control. Clean-up measures which can be applied in the plum orchard are the same as those described in Section 51 for apple orchards, with the addition of proper disposal of the thinnings, which normally include curculio-infested plums. All thinnings and drops should be thrown out into the space between the rows, so that the sun shines upon them. The heat of the sun will destroy most of the curculios which would otherwise develop.

88. **Aphids.** The foliage of plums, especially of the growing tips, is often seriously attacked by aphids. Their control can best be accomplished by spraying as indicated for cherry aphids in Section 65.

89. **Climbing Cutworms.** Refer to special instructions in Section 94.

SUPPLEMENTARY DIRECTIONS FOR GRAPES

90. **Black-Rot.** This disease develops best in rather warm, rainy weather and usually becomes established early in the season in a seemingly insignificant way in the form of spots on the leaves. If weather conditions continue favorable, it spreads from there to the fruit and may cause heavy loss. Black-rot does not develop in epidemic form every year and in the non-epidemic years grapes free from rot can be grown with the use of little or no bordeaux. This condition leads many growers to become lax in their spraying operations and they omit one or both of Applications 1 and 2 with the result that rot may develop seriously under favorable conditions if the primary or early infection has not been prevented. Some experienced growers feel they can pre-

GRAPES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. When shoots are 4 to 5 inches long.	Bordeaux, 8-12-100. Lead arsenate, 3 lb. plus 3 qt. summer oil. See Sections 9 and 10 for instructions for making bordeaux.	Black-rot, downy mildew, berry moth, and dead-arm.	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. Refer to Section 90 for further discussion of black-rot.
2. Just as the blossom buds are opening.	Bordeaux, 8-12-100, and calcium arsenate, 3 lb. plus 3 qt. summer oil in each 100 gallons of spray. (Refer to Sections 9 and 10 for instructions for making bordeaux).	Black-rot, berry moth, downy mildew, and rose-chafer.	If rose chafer is present, use 5 lb. 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.	Bordeaux, 8-12-100, and calcium arsenate, 2 lb. in each 100 gallons of spray. Use casein-lime or casein-bentonite spreader.	Black-rot, downy mildew, berry moth, and rose-chafer.	If rose chafer is very bad or berry moth very plentiful, make this application four days earlier.
4. Two weeks after full bloom.	Bordeaux, 8-12-100, and calcium arsenate, 2 lb., in each 100 gallons of spray. Use casein-lime or casein-bentonite spreader.	Black-rot, downy mildew, and berry moth (See Section 92).	This application is imperative for berry moth control, as the use of an arsenical at a later date, as formerly advised, no longer seems justified because of danger of excessive residue.
5. About the time the berries begin to touch, or just before first leaf-hoppers acquire wings.	Bordeaux, 4-6-100, and nicotine sulphate, 1 pint, with casein-lime as a spreader.	Black-rot, downy mildew, and leaf-hopper.	This application should be made if black-rot and mildew threaten. Usually the first application for leafhopper control may be made at this time. (See Section 93). Omit the nicotine sulphate if hoppers are not present in injurious numbers.

dict whether rot will develop, and they govern their spraying operations accordingly. Experience has shown that such predictions are not always reliable. Therefore, there is only one safe general procedure to insure satisfactory control of black-rot, and that is to make Applications 1 and 2 regularly every year. These applications also prevent many new infections of the dead-arm disease.

91. **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 well below the last visible sign of the dry heart rot in the trunk at pruning time, 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.

92. **Grape-Berry Moth.** This insect was especially destructive during the last 2-3 years.

Thorough spraying in all applications using arsenicals is necessary for control of berry moth. The residue situation is such that the schedule is arranged to concentrate all arsenicals into the period when they will be most effective.

The danger of residue places an added importance upon supplementary measures. Destruction of weeds, accumulations of leaves in the vicinity of woodlands, gullies, low places, hollows, and fence rows will aid in controlling berry moth.

The most important single clean-up measure that can be applied is to turn under all vineyard refuse as early in the spring as possible and leave it **undisturbed** except for very shallow cultivation until late June or July regardless of weed growth. Information at hand indicates that plowing to the vines is more effective than plowing from them.

93. **Grape Leafhopper.** Spray in exactly the same manner as outlined for the control of berry moth. It is necessary to hit the under sides of the leaves. Use nicotine sulphate with bordeaux, as indicated in Application 5; or, if bordeaux is not needed, use nicotine sulphate, one pint in 100 gallons of water, with 1½ pounds of casein-lime. If dust is preferred, use 2-per cent nicotine in hydrated lime. Apply dust at night while air is not stirring. Use freshly mixed, hot dust. If cold dust is used, a higher percentage of nicotine is required. This application should be made just before the first nymphs acquire wings.

94. **Climbing Cutworms.** In common with ordinary cutworms, the species having the climbing habit feed at night and are most numerous in or near grass sod. All cutworms are likely to be more numerous during a cold, wet spring. The attack comes early in the season. The worms ascend the plants and feed on buds, young leaves, blossoms, or young fruits. In the case of trees, a narrow band of tree-tanglefoot spread with a paddle around a trunk or large limbs is all that is required. With grapes, the trunk and the wires on both sides of the posts should be treated with tanglefoot.

In newly set plantings, the tanglefoot should be applied to a strip of paper, which is wrapped around the trunk. Poison bran-bait should

be scattered on the ground beneath the branches to supplement the bands and to prevent the worms from gnawing the bark just below the bands. About two handfuls scattered thinly about each plant in the evening will be sufficient. If scattered in such a way that no lumps are left the danger to other animals is negligible.

Formula for Bran-Bait

20 pounds wheat bran
1 pound white arsenic
 $\frac{1}{2}$ gallon molasses
2 ounces amyl acetate of good grade (banana oil)
Water to moisten

Add molasses and poison to 5 or 6 quarts of water and stir all ingredients together and add enough more water to moisten thoroughly. Success depends largely on the thoroughness of the stirring.

A greatly improved bait can be made by dissolving 32 pounds of caustic soda (lye) in $8\frac{1}{2}$ gallons of water and then stirring in and dissolving 100 pounds of white arsenic. This makes a stock solution of arsenite of soda containing approximately 8 pounds of arsenic to the gallon. In preparing bait, add 1 quart of the stock solution to 10 gallons of water and 2 gallons of cheap molasses, use this mixture to moisten 100 pounds of bran, and then stir in 3 ounces of banana oil.

95. **Flea Beetle.** The grape flea beetle formerly was a serious pest in this state but the regular routine sprays which are usually applied in Michigan vineyards have proved very effective in controlling it.

The beetles, which hibernate under rubbish, attack the opening buds. Later, the adults and larvae feed together on foliage and on fruit. When the beetles are especially plentiful, burn rubbish late in the fall, and spray the vines with 4 pounds of lead arsenate in 100 gallons of water or bordeaux just as the leaf-buds are bursting.

96. **Grape Rootworm.** The adult of the grape rootworm is a reddish brown beetle, covered with short gray hairs, and about one-fourth of an inch in length. This beetle eats chain-like holes in the upper surface of the leaves of grapes during June and July and later lays clusters of eggs in the loose bark of the cane. The larvae drop to the soil and work their way to the roots. At this time the larvae are tiny white grubs about two-fifths of an inch long. They pass through the winter as partially grown larvae and complete their growth in late May and early June in earthen cells under ground. Grapes which are sprayed thoroughly for berry moth usually are not attacked. If chain-like punctures appear on the leaves, make a special arsenical application, spraying downward, since root injury is severe if adults escape poisoning.

SUPPLEMENTARY DIRECTIONS FOR CURRANTS AND GOOSEBERRIES

97. **Aphids.** Currants and gooseberries are often attacked by aphids which cause the leaves to curl and sometimes to turn red. Spray as directed in schedule.

98. **Witches'-broom.** One species known as the Houghton goose-

CURRENTS AND GOOSEBERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT. Apply just before growth starts.	Lime-sulphur, 12 1/2 gallons, and water to make 100 gallons, or oils containing *DN as recommended for scale on apples. See Sections 17 and 20.	Scale insects and aphids.	Scale is seldom found on gooseberries, but is often present on currants. Inspect carefully and spray when necessary.
2. When terminal leaves are one-half to one inch in length.	Bordeaux, 8-12-100. (See Sections 9 and 10), lead arsenate, 3 lb., and nicotine sulphate, 1 pint in each 100 gallons of spray.	Leaf-spot, leaf-eating insects, aphids, and four-lined leaf-bug.	This is the critical application for aphid control and thorough work at this time is important. Spray the under sides of the leaves.
3. Soon after the blooming period.	Bordeaux, 4-6-100, (See Sections 9 and 10.)	Leaf-spot and mildew. See Section 99 for control of leaf-eating insects after blossoming period.	The number of summer applications should be governed by the prevalence of leaf-spot and the susceptibility of the varieties grown. If aphids persist, add nicotine sulphate and spray very thoroughly.
4. Ten days or two weeks after No. 3.	Bordeaux, 4-6-100, (See Sections 9 and 10.)	Leaf-spot and mildew. See Section 99 for control of leaf-eating insects.	If currant worms appear refer to Section 99.
5. Just after the fruit is harvested.	Bordeaux, 8-12-100, (See Sections 9 and 10.)	Leaf-spot and mildew.	This is desirable when leaf-spot has not been well controlled in early summer.

*DN = Dinitro-ortho-cyclohexylphenol.

berry aphid produces witches'-brooms or brushy-galls on gooseberry. This louse, whose work is not entirely confined to the Houghton gooseberry, nevertheless prefers that variety to others. The species overwinters on the gooseberry in the egg stage. The eggs hatch in April and May and a spray of nicotine sulphate as recommended in Application 2 is more effective than at any other time, for, while the witches'-brooms develop later in the season, the lice themselves are more plentiful on the currants just after the eggs hatch.

99. **Leaf Eating Insects.** The most common important leaf feeding insect on currants is the imported currant worm. This caterpillar-like larva and practically all others on currants and gooseberries can be killed by pyrethrum dusts or sprays used according to manufacturers' recommendations. If you desire to mix your own dust, shake together equal parts of flour, or talc, or powdered chalk and freshly ground pyrethrum and dust thoroughly. Rotenone dusts and sprays are also effective in controlling currant worms. These materials are effective but kill insects of the size of currant worms slowly. Either may be used without danger of poisonous residue.

100. **Currant Borer.** The currant borer is a moth larva which burrows in the canes of the currants, eats out the pith, and leaves a blackened furrow which causes the death of the cane. The parent moths fly in June and deposit eggs that produce larvae which almost reach maturity by fall. They complete their growth in early spring, pupate in the burrows, and each one produces an adult moth. The infested canes usually start growth in the spring but soon die. Cut out the infested canes, which are indicated by the sickly foliage. Be sure to cut below the bottom of the burrow, and immediately burn all prunings.

RASPBERRIES, DEWBERRIES, AND BLACKBERRIES

101. Use vigorous disease-free plants. Every new planting should be started with vigorous plants which have come from plantings that have a minimum amount of mosaic, curl, streak, and orange rust. The best plants are usually obtained from young fields. Where possible, the plants should be taken directly from the mother plants to the new field.

Remove the old canes, commonly called tails or handles, from black raspberry and dewberry tips before planting. Anthracnose is carried to the new field on the "tails". The removal of these and the covering of all parts of the tips with soil greatly reduces anthracnose in the new planting.

Plant black raspberries at a distance of at least 50 yards from red varieties. Red varieties, especially King and Latham, commonly act as carriers of mosaic viruses which do little damage to reds and may be masked but which cause severe stunting of blacks. Wild red raspberries in the immediate vicinity of black raspberry plantings are also a source of infection. The spread of mosaics to blacks from wild reds is sometimes very rapid, especially if the wild plants are in shaded locations where aphids are abundant.

Rogue older raspberry plantings if the percentage of disease is not too high. Fields more than a year old and having more than 10 per

cent mosaic, streak, and orange rust rarely pay for rogueing. If the percentage is lower, careful rogueing may be of value. No field which is well rogued the first year should show more than one per cent of the plants diseased the second year. Usually, old fields having less than 2 per cent of these diseases can be successfully rogued.

102. **Anthracnose.** Spray black raspberries, King and Latham red raspberries and dewberries for anthracnose. Applications should be as follows:

1. Just as the buds show green. Use 10 gallons of lime-sulphur with water to make 100 gallons. The addition of 1 pound of casein spreader will improve the spray.

2. About one week before the blossoms open. Use bordeaux 4-6-100 (See Sections 9 and 10 for instructions for making bordeaux). Casein spreader, 1 pound in 100 gallons may be used as a spreader. Especial care should be taken to completely cover all new canes with this application.

Usually, red raspberries and blackberries are not sprayed, but they should be treated in the same way if anthracnose develops. Purple raspberries may be sprayed if anthracnose becomes severe.

103. **Borers, Girdlers, and Tree-crickets.** The borers, girdlers, and tree-crickets affecting raspberries over-winter in the canes. The removal of all mutilated or distorted canes in spring and their immediate destruction by fire will eliminate a large proportion of trouble from these pests the first year it is practiced. The continuation of this practice, together with the elimination of wild plants in the vicinity of cultivated raspberry plantings will, in a very few seasons, reduce the population of these insects to the point where they are no longer of importance.

104. **The American Raspberry Beetle.** The small grubs, or worms, occurring in raspberries are the larvae of a brown beetle, about one-eighth inch in length, which first makes its appearance early in the spring about the time the flower buds appear. If raspberries are inspected at this time, it is an easy matter to locate the pests. The best control of these insects to date has been brought about by the use of a dusting mixture of one part calcium arsenate with 19 parts of lime, although almost equally good results have been obtained with a mixture of one part lead arsenate and 9 parts of hydrated lime. Either material should be dusted upon the plants at the first appearance of the beetles, and the plants subsequently kept covered by dusting at intervals until blossoms appear. The inclusion of 3 pounds of lead arsenate in the early fungicidal sprays is also an effective treatment.

105. **Sawflies.** The sawflies affecting raspberries are ordinarily controlled by 3 pounds of lead arsenate to 100 gallons of water or of bordeaux going on at the time they appear. However, late infestations, coming after the fruit has set cannot be treated in this way, because of the danger of residue. Such infestations can be controlled by the use of rotenone or pyrethrum sprays or dusts used according to manufacturers' recommendations. Rotenone preparations are slow-acting poisons and a thorough application is required. Repeat in a week if all the larvae are not killed the first time.

106. **Raspberry Mites.** Injury by raspberry mites causes partial to complete defoliation and seriously disturbs the functioning of the remaining leaves. In addition to the adverse effect upon the crop from this damage attacks are made usually as berries are being picked. Berries covered with mites are not readily sold at a profitable figure. Raspberry mites can be controlled best by spraying, as soon as the leaves show green, with a summer oil emulsion (made from oils of 75-85 seconds viscosity Saybolt and at least 92 per cent unsulphonated residue). A series of three sprays containing one gallon of oil emulsion in 100 gallons of spray, 5 days apart are necessary because of resistant stages in the life history of the mites. If for any reason the early sprays have not been put on the mites can be stopped at any time by the treatment outlined, but it is wise to spray early if infestation has been present the previous year. Raspberries are tolerant to the recommended strength of oils. The removal of spent canes and weeds from an infested patch immediately after harvest and then applying the recommended series of sprays will enable the young plants to make good growth for the next year's crop. Burn all spent canes and weeds as they are removed.

STRAWBERRIES

107. There are several diseases and insect pests that may be found on the strawberry, but, aside from the leaf-rollers and the leaf-spot diseases, spraying is unnecessary or not effective.

108. **Strawberry Leaf-roller.** This is a small greenish caterpillar with a brown head. It draws the leaflet together with the silken thread, feeds on it from within, and causes it to turn brown and die. The adult is a small moth that lays its eggs on the under surfaces of the leaves in early spring. Spraying in early spring, using two pounds of lead arsenate in 50 gallons of spray will prove effective, if applied just before the larvae begin to fold the leaves. Spraying after the leaves are folded will do little or no good. Mowing and burning the leaves after the crop is harvested will destroy the larvae and pupae in the folded leaves. This treatment will also aid in the control of the leaf spots. Old beds that are to be abandoned should be plowed under immediately after the last picking.

If infestation develops when there is fruit upon the plants a rotenone or pyrethrum dust should be used because of the possibility of residue from arsenicals.

109. **Leaf Spots.** These are diseases which are most common and conspicuous on the leaves. They also occur on leaf stalks and on the fruit stems. These diseases reduce the vigor of the plants and, in severe attacks, practically ruin the plantation. In fruiting plantations, spray with 8-12-100 bordeaux (refer to Sections 9 and 10 for instructions for making bordeaux) before blossoming and repeat 10 days or two weeks later. Young plantations or those which are not producing fruit should be sprayed whenever necessary to keep the diseases under control. Mowing and burning the leaves after harvest, the removal of diseased leaves before the plants are set, and the planting of resistant varieties are also methods of control.

SPRAYING YOUNG NON-BEARING ORCHARDS

110. Young non-bearing fruit trees should be kept relatively free from disease and insect injury. It is important that the foliage remain in a good healthy condition if large, early-producing trees are to be grown. The kinds of pests present, the amount of infestation, kinds and varieties of fruit and weather conditions will influence the spray schedule.

111. **Apples.** As a rule young apple trees require less sprays than bearing trees. The common insects attacking young apple trees are scale, red mite, aphids, leafhoppers, canker worms, and climbing cutworms. Apple scab is the important disease to be controlled.

The following sprays are recommended for the average season.

1. Apply when trees are strictly dormant. Use a dormant oil spray. (Sec. 19.) Necessary only if scale or red mite are a problem. If aphid eggs are numerous on the trees a tar oil or D N oil emulsion or sodium dinitro-cresylate may be substituted for the oil spray. The tar oil, D N oil emulsions, or sodium dinitro-cresylate will aid in preventing early aphid injury but will not control later infestations. Apply dormant materials according to manufacturers' directions (See Sections 17, 18, 19, 20, 21).

2. When the leaves are about $\frac{1}{4}$ inch long. For control of scab, aphids and chewing insects.

Apply bordeaux 3-4-100, lead arsenate 2 pounds, nicotine sulphate 1 pint to 100 gallons of spray. If aphids are not present the nicotine is unnecessary. (See sections 9 and 10 for preparation of bordeaux.) Bordeaux is preferred to lime-sulphur because it causes less dwarfing of foliage.

3. About 2 weeks after No. 2.

Use same materials.

4. About 2 weeks after No. 3.

Use same materials.

5. If aphids or leafhoppers become numerous later in the season apply 1 pint nicotine sulphate, plus a good soap or spreader to 100 gallons of water (See Sections 48, 15, 30).

112. **Cherries.** Young cherry trees should be sprayed regularly for the control of leaf spot and slugs. Early defoliation of young trees by leaf spot will stunt the trees severely so that they will be short-lived and under-productive.

1. When trees are dormant. (See Sections 17, 18, 19, 20, 2.)

For control of black cherry aphids and scale apply D N oil emulsion or sodium dinitro-cresylate. Apply to manufacturers' recommendations. This spray is especially important on sweet cherry for the control of aphids. If this spray has been omitted, control of aphids can be obtained by spraying with nicotine and soap soon after the aphids appear. Thorough spraying is necessary.

2. When young leaves are about $\frac{1}{2}$ inch long. (Sections 9, 10, 11.)

For control of leaf spot, leaf-eating insects and slugs, apply bordeaux 3-4-100, lead arsenate 2 pounds to 100 gallons. (See Sections 9 and 10 for the preparation of bordeaux.)

3. Two weeks after No. 2. Use same materials as in No. 2.
4. Repeat application No. 3 at 2-week intervals until terminal growth has ceased.

113. **Peaches.** Young peach trees do not require much, if any, summer spraying because peach trees are attacked by few diseases and insects which are controlled by this method. The common diseases attacking peaches are peach leaf-curl, bacterial leaf-spot, canker, and virus diseases. The important insects are scale, red mite, Oriental fruit moth, and borers. Young peach trees should receive an annual dormant spray of bordeaux 8-12-100 or liquid lime sulphur 5 gallons in 100 gallons of spray for the control of leaf-curl. If scale or mites are present a dormant oil should be added to the bordeaux. This mixture should be applied only in early spring before the buds break. (See Sec. 75.)

If bacterial leaf-spot is a problem, applications at 2-week intervals beginning at petal-fall of an 8-8-100 zinc sulphate-lime mixture should be applied. (See Sec. 33 for preparation of zinc sulphate-lime mixture.) Keep trees in good vigor to resist leaf-spot attack.

Borers cause more damage to peach trees than any other pest. Special attention should be given to controlling this insect. See Sec. 77 for control of borers.

114. **Oriental Fruit Moth.** See Sec. 76 for the control of this insect.

115. **Peach Canker.** This disease has become a problem in the growing of young orchards. Planting disease-free trees, and growing them under the recommended cultural practices will aid in keeping the disease in check (See Sec. 73).

115a. **Virus Diseases** can be controlled only by planting healthy stock. If virus diseases are suspected in the orchard, consult your county agricultural agent. (See Sec. 85.)

Young peach trees should not be sprayed with lead arsenate unless an arsenical corrective is added (See Sec. 33). Arsenicals applied without a corrective will cause serious defoliation and injury to twigs and branches.

116. **Pears.** Young pear orchards should be sprayed similarly to young apple trees. Pear psylla, a specific pest on pears, can be controlled with a dormant oil spray just before the buds break in the spring.

117. **Plums.** Young plum trees may be attacked by scale, red mite, leaf-eating insects, and aphids. Leaf-spot and black knot are the common diseases. (See Secs. 44, 45, 83 and 112.)