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SPRAYING CALENDAR

By W. C. Dutton, Ray Hutson, and J. H. Muncie

CLIMBING CUTWORM INJURY

AGRICULTURAL EXPERIMENT STATION
MICHIGAN STATE COLLEGE
Of Agriculture and Applied Science

SECTIONS OF HORTICULTURE, ENTOMOLOGY, AND BOTANY

East Lansing, Michigan

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By W. C. DUTTON, RAY HUTSON, AND J. H. MUNCIE

1. The directions given in this publication are intended for dealing with moderately severe cases of insect or disease infestation. In special cases, more drastic measures than those recommended may be necessary. This situation may be met by making more applications, by increasing the concentration of the materials used, or even by the use of a special material. In other instances, it may be possible, because of special spraying methods, relatively light infestations, or relatively resistant varieties, to reduce the number of applications or to lower the concentration of the materials or to make some changes in the selection of materials. However, it is suggested that any departures from these schedules be made only after a careful study of local conditions has clearly indicated the advisability of the change. Such modification or adjustment of the spray schedules to meet particular conditions is necessarily something that must be determined by the individual grower.

2. *Spraying is Insurance.* Spraying, in general, is insurance; insurance against loss from attack by insects and disease. It has been stated in Section 1 that modification in the spraying treatment may be possible and even desirable in some cases but growers should realize that there is usually a minimum treatment which must be used regularly if satisfactory results are to be expected. Diseases, such as scab, leaf-spot, and rots do not develop in epidemic form every year, nor do aphids, psylla, leaf-rollers, berry moths, and other insects appear in really serious numbers each season. Some growers gain a feeling of false security because at such times it is usually possible to grow fruit without injury even though certain applications have been omitted or delayed, the concentration of the materials has been lowered, or even some ingredients have been omitted. Disastrous results often follow the continuance of such practices, as it is impossible to accurately predict when most of the diseases will develop in epidemic form or when certain insects will appear in seriously injurious numbers. Each grower should determine what the minimum spray treatment should be for his special case. Factors to be considered are prevalence of insects and diseases, susceptibility of varieties, the productiveness of the orchard, and the final value of the crop.

Growers should realize also that the mere routine following of the spraying schedules given in this publication does not insure satisfactory results. The real responsibility lies with the grower himself, for success depends largely on correct timing of treatments and thoroughness of application, and the proper method of application for the particular insect or disease in question. The exercise of good judgment in modifying or increasing the treatments to meet local, varietal, or seasonal conditions is imperative, and the ability to do this successfully comes only from experience and careful study.

3. *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, excessive dropping of fruit, or dwarfing of fruit; or it may effect the color. Injury to 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.

4. *Spray Residues.* The United States Department of Agriculture has established a tolerance for arsenical residue on fruit that is sold in the United States and there is also a tolerance that must be met when fruit is exported. Satisfactory methods for the removal, by washing, of this residue from apples and pears have been developed and are being used extensively in Michigan. Where washing equipment is available, growers need not be concerned about excessive residue on apples and pears. A possible exception to this may arise from heavy and repeated applications of oil-lead arsenate sprays. 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 presented is the best available.

5. *Special Information.* To obtain special information concerning spraying or the identification and control of pests, address the Michigan State College, East Lansing, Michigan. Describe conditions fully, state previous treatment, and if diagnosis of trouble is desired, send material to show typical injury. More prompt attention is usually possible if the letter is attached to the package containing the material. Be sure to place name and address on the package.

Spraying Materials

6. *Lime-Sulphur.* Recommendations in this bulletin for the use of lime-sulphur always refer to the commercial concentrated solution. Most of the commercial products test 32 to 33 degrees Baumé and all dilutions recommended herein are based on that strength of concentrated solution.

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 analysis and field experiments have shown that four pounds of the dry are approximately equal to one gallon of the liquid. To determine the amount of dry required, simply multiply the recommended number of gallons of liquid by four and the result will be the number of

pounds of the dry necessary to give equivalent results. For further discussion of the concentrations of lime-sulphur to use, refer to Section 35. This recommendation is based on experience with apple scab only and may not be found to hold 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. It is, however, the only safe general recommendation that can be made at the present time.

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.

8. *Lead Arsenate.* All recommendations in this bulletin for the use of lead arsenate refer to the powder or dry form of the ordinary or "acid" lead arsenate. If the paste form is used, the amount should be doubled as it contains approximately 50 per cent water.

9. *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.

In times past, 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.

10. *Derrisol.* Derrisol is a comparatively new material in America. Field trials indicate that it possesses considerable merit for the control of the summer brood of the green apple aphis, but nicotine is to be preferred when used in the delayed dormant or pre-pink application for the control of the rosy aphis and the early brood of the green aphis. Its use is not advised for the control of pear psylla. Its principal merit seems to be that it is not poisonous to warm-blooded animals. It is especially useful on ripening fruits such as raspberries and blackberries, on which it would be dangerous to use arsenicals or poisonous contact sprays.

11. *Mixing Combined Sprays of Lime-Sulphur, Lead Arsenate, and Nicotine Sulphate.* The method used in mixing these materials may have more or less effect on results, but it is not possible to lay down any rule that is best under all conditions. Where the water supply is in or adjacent to the orchard, mix the lead arsenate with water until in a milky condition, and pour into the tank which is partly filled with water; or, empty the dry lead arsenate on the tank strainer and wash through with water. The agitator should be in operation. When the tank is nearly full, add the lime-sulphur and lastly the nicotine sulphate if it is used. Always have the agitator in operation when adding lead arsenate and keep in operation until the tank is emptied.

If the sprayer must be drawn a considerable distance before spraying is begun, it is advisable to add the lead arsenate in the orchard just before spraying is started. The use of lead arsenate and lime-sulphur

which have been mixed for two or three hours or longer is inadvisable as injury is likely to follow.

12. *Bordeaux.* Bordeaux is made from copper sulphate (blue stone, blue vitrol), lime, and water. Wherever 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.

Copper sulphate may be obtained in several grades as to size of crystals. For convenience in preparation, the rather fine, granular and pulverized grades are desirable.

Lime is available in two forms: "quick" or "lump lime" and hydrated lime. All formulae for making bordeaux, in this bulletin, call for **hydrated lime.** If "quick" lime is used, reduce the amount to two-thirds that specified for hydrated lime in the formula. Many kinds of lime are undesirable for spraying purposes. Information about limes will be given on request.

13. *Preparation of Bordeaux.* There are many methods for making bordeaux, but two only will be given here: One involving the use of stock solutions; and the other, the "instant" method, in which pulverized or powdered copper sulphate is used.

Stock Solution Method. When bordeaux is to be used in quantities, a stock solution of copper sulphate and possibly of lime should be prepared in advance. The copper sulphate is dissolved at the rate of one or two pounds per gallon of water. Fill a 50-gallon wooden barrel, preferably one with wooden hoops, nearly full of water. To make a "one pound to one gallon" stock solution, suspend 50 pounds of copper sulphate in a clean "gunny" sack so that the bottom of the sack is in the water a few inches. The sulphate will usually dissolve in a few hours after which, fill the barrel with water to make a total of 50 gallons. Keep the barrel covered to prevent evaporation. To make a "two pounds in one gallon" stock solution use 100 pounds of copper sulphate. This will require longer to dissolve but is more economical of storage space. If quick lime is used it should be slaked to a paste and covered with water in barrels or in troughs made for this purpose. It is essential to know how many pounds of lime are in each gallon of the paste. When hydrated lime is used it may be mixed with water a little in advance of the time to be used; or it may be emptied onto the tank strainer and washed into the tank.

There are several good ways of combining the ingredients of bordeaux; a very satisfactory method is as follows:

Put the required amount of stock solution of copper sulphate into the sprayer tank nearly full of water. Dilute the required amount of lime stock so that it will pour and strain easily, and, with agitator running strain it into the sprayer tank. Another commonly used method is to empty the hydrated lime onto the tank strainer and wash it through as the tank is filled, or with stream from the spray gun. Finally, fill the tank to capacity with water. If lead arsenate is to be used, add it at this

time. Nicotine sulphate, when used with bordeaux, should be added lastly.

"Instant Bordeaux Method." Another method used extensively recently involves the use of pulverized or powdered copper sulphate. This does not have to be made up into a stock solution as it dissolves quickly, with agitation, in the sprayer tank. A satisfactory procedure follows:

1. Fill sprayer tank about one-fourth to one-third full with water.

2. With the agitator in operation, place the pulverized copper sulphate on the tank screen and wash through, and continue to add water until the tank is nearly full. Allow about two minutes for the copper sulphate to dissolve.

3. Place hydrated lime on the tank strainer and wash through, or mix with water in pail or tub and pour through tank strainer.

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

14. *Dry-Mix Sulphur-Lime Spray.* One of the commonly used sprays for summer applications on peaches and Japanese plums is dry-mix sulphur-lime spray, a mechanical mixture of sulphur, hydrated lime and casein spreader or some other wetting agent. This material is often called simply "dry-mix" and should not be confused with dry lime-sulphur which is an entirely different substance.

Dry-mix can be prepared by the grower. Instructions will be furnished on request. It is also available from many manufacturers of spraying materials and is frequently sold under a trade name. The composition is generally indicated on the container.

When lead arsenate is used with dry-mix on peaches add eight pounds more of hydrated lime to each 100 gallons of spray. Refer to Section 54 for special precautions concerning the use of lead arsenate on peaches.

15. *Wettable Sulphur.* For certain applications on peaches and plums where lead arsenate is not to be used, hydrated lime is undesirable because of its tendency to stain the fruit. For this purpose dry or paste sulphurs that have been treated to make them wettable are available. They contain little or no lime.

Wettable sulphurs and sulphur pastes are prepared by many spray material manufacturers and usually are sold under various trade names. It is not practicable to determine experimentally the value and limits of safety of each of these materials but most of them are probably safe if properly used. It is not advisable to use them on peaches in connection with lead arsenate unless 16 pounds of hydrated lime are added to each 100 gallons of spray. Less lime is necessary on apples.

16. *Limitations in use of Dry-Mix and Wettable Sulphur.* These materials have been used quite extensively on apples and pears for the control of scab. While it is true that excellent results have been obtained in some seasons and with certain varieties, the fact remains that dry-mix and wettable sulphur are not effective under severe conditions nor with highly susceptible varieties. Their general use, therefore, should be confined to summer applications on peaches and Japanese plums.

Oil Sprays

17. Much interest has been shown in the use of oil sprays of various kinds. 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. An oil emulsion consists of oil that has been mixed with water and some emulsifying agent and then treated mechanically to break the oil up into very 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 very 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.

It is, of course necessary to determine first if oils in general, or some oil in particular, are necessary for the control of the insects in question. Growers should study the specific instructions for each fruit to determine if an oil spray is needed. Oils are specifically recommended only for the control of pear psylla, fruit-tree leaf-roller, the European red-mite, cherry case-bearer, and as optional for the control of scale insects.

18. *Miscible Oils.* The miscible oils are mostly 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 from 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.

19. *Oil Emulsions.* The emulsions commonly used are of two types, the boiled soap emulsion (usually made according to the so-called Government formula), and the cold-pumped or cold-mixed emulsions. Directions for preparing the home-made emulsions will be found in Sections 21 to 24. The properties of these two classes of emulsions vary considerably.

The boiled soap emulsion, if well made, remains stable for several months while the home-made cold-pumped emulsions should be used the same day they are made and preferably at once. The soap emulsion may be broken down by freezing which occurs at about 15 degrees F. Freezing is not important with home-made cold-pumped emulsions as they should not be stored. Lime-sulphur will break down the common soap emulsion but does not so affect emulsions made with casein spreader, or other stable emulsifier. There is also evidence that the use of the common soap emulsion, soon after or just before an application of lime-sulphur,

may cause injury. Hard water does not break down the cold-pumped emulsion but the water may have to be treated if the common soap emulsion is used. The soap emulsion may be made ahead of time and stored, but more equipment is necessary for making it than for the cold-pumped kinds. With the cold pumped emulsions, relatively less equipment is necessary but they must be made up at the time the spraying is done.

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.

20. *Precautions in the use of 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.

A. 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.

B. Early spring dormant applications of some miscible oils have caused injury to peach trees.

C. 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.

D. Follow carefully the instructions of the manufacturers 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 a miscible oil. An application of common soap emulsion should not follow one of lime-sulphur or other sulphur spray closer than two weeks or be followed by lime-sulphur or other sulphur spray in less than one week. The cold-pumped emulsions are safer in this respect but it is not definitely established that injury never follows.

E. Oil sprays, properly diluted, are apparently safe in the dormant and late-dormant periods of the apple and are often used without injury at the delayed-dormant stage but severe injury from their use in the latter period has occasionally developed, and furthermore, there is evidence that the combination of these materials with some fungicides, in the delayed-dormant period, is particularly dangerous. Inasmuch as oils are not recommended for the control of apple aphids it is deemed advisable to complete applications of oil before any green tips have appeared.

Formulae and Methods for Making Emulsions

21. *Boiled Soap Emulsion.* Fruit growers may make their own soap emulsion, but this practice is not generally followed or advised in Michigan. Detailed instructions, however, will be furnished on request. Soap emulsions made according to the Government Formula are available and there are also commercially made soap emulsions that are not broken down by hard water, or by the usual strength of lime-sulphur.

22. *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. Information concerning desirable types of oils will be furnished on request.

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

Materials	Basic formula	For large quantity
1. Oil	1 gal.	30 gal
2. Copper sulphate	2 oz.	4 lbs.
3. Hydrated lime	3 oz.	6 lbs.
4. Water, with the stock solutions of copper sulphate and lime, to make	½ gal.	15 gal.

Prepare the copper sulphate and lime as stock solutions as indicated in Section 13. Convenient proportions for this purpose are "one pound to one gallon" for the copper sulphate and "one and one-half pounds to one gallon" for the hydrated lime.

The formula just given shows the proportions of oil, emulsifier and water for each gallon of oil and for a large quantity. For each 100 gallons of a given strength proceed as follows, using stock solutions of the strength indicated in the preceding paragraph:

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

For a 200-gallon sprayer 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 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.**

If a large quantity is to be made up at a central mixing plant to supply several sprayers, the formula for large quantities may be used. 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 25. 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 the emulsion much in advance of the time it will be used.

24. *Casein Emulsion.* Casein spreader is sometimes used as the emulsifier. The basic formula and that for a large quantity follows:

Materials	Basic formula	For large quantity
1. Oil	1 gal.	30 gal.
2. Casein spreader	2 oz.	4 lbs.
3. Water	½ gal.	15 gal.

For each 100 gallons of spray of a given concentration proceed as follows:

Materials	For each 100 gal. spray with actual oil content of		
Add to sprayer in this order:	3 per cent	6 per cent	8 per cent
1. Water	1½ gal.	3 gal.	4 gal.
2. Casein spreader	6 oz.	12 oz.	16 oz.
3. Oil	3 gal.	6 gal.	8 gal.

PROCEDURE

1. Put the indicated amount of water in the sprayer tank.

2. With the agitator in operation, add the casein spreader and allow thorough mixing.

3. Add the oil.

4. and 5. Emulsify, dilute and apply as indicated for bordeaux emulsion (Section 23).

25. *Diluting and Using Emulsions.* Emulsions prepared according to these formulae contain approximately 66 2-3 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 66 2-3 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 gals	3 gal.	4½ gal.	6 gal.	9 gal.	12 gal.
200 gals	6 gal.	9 gal.	12 gal.	18 gal.	24 gal.
300 gals	9 gal.	13½ gal.	18 gal.	27 gal.	36 gal.
400 gals	12 gal.	18 gal.	24 gal.	36 gal.	48 gal.

The cold-pumped emulsions can be used in most Michigan waters without breaking down but with the ordinary soap emulsions it may be necessary to add one pound of caustic soda or lye to each 100 gallons of water before putting in the stock emulsion. This "breaks" or softens the water. Another commonly used method is to make a weak bordeaux, ½-¾-100, (refer to Secs. 12 and 13) and then to add the stock emulsion. If the properties of the water are not known, a test should be made with small quantities of water and emulsion to determine if free oil separates and comes to the top. This indicates a breaking down of the emulsion and the water should be softened as just described.

If the emulsion breaks down after dilution in the sprayer tank, the entire mixture should be discarded.

26. *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 when it is not possible to get through 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, ahead of 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 temperature 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, leaf-hoppers, 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 have usually 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 very 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 or not 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.

APPLES

STAGE OF GROWTH	APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
	1. DORMANT. Complete before green tips appear.	Lime - sulphur (dormant strength) or an oil spray. Refer to Sections 29 to 32 for specific instructions.	Scale insects, mites and leaf-rollers. Lime-sulphur will control scale insects, but oil will also control scale and is necessary for mites and leaf-roller.	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 29 to 32 for specific instructions.
	2. DELAYED DORMANT. Apply in a well developed greentip stage, when leaf tips are ¼ to ½ inch in length.	Lime-sulphur, 2½ gallons, lead arsenate, 3 lbs., nicotine sulphate, 1 pt., and water to make 100 gallons.	Scab, aphids, bud moth and curculio.	This is the best period for the control of aphids, and the lime-sulphur that is necessary with the nicotine will prevent early infection of apple scab. Lead arsenate and nicotine sulphate are effective against bud moth and lead arsenate against curculio. Refer to Sections 33 and 34 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 gallons, lead arsenate, 3 lbs., and water to make 100 gallons.	Scab, curculio, and bud moth If nicotine was not used in the delayed dormant, it should be added at this time, 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 cluster and complete before the blossoms open.	Lime - sulphur, 2½ gallons, lead arsenate, 3 lbs., and water to make 100 gallons.	Apple scab, curculio and other chewing insects.	This application is very 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.

SPECIAL PROCEDURE TO AVOID FOLIAGE INJURY. Refer to Section 36 for a method of procedure where it is desirable to reduce foliage injury

APPLES—Continued

	4. PETAL-FALL (CALYX) Should be made when most of the petals have dropped and after bees have quit working in the bloom.	Lime - sulphur, 2½ gallons, lead arsenate, 3 lbs., nicotine sulphate, 1 pt., and water to make 100 gallons. Nicotine sulphate may be omitted if red bugs are not prevalent.	Scab, codling moth, curculio, other chewing insects and red bug.	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 37 for the control of red bug.
	5. TEN DAYS or TWO WEEKS. Should be completed by two weeks after petal-fall.	Llme - sulphur, 2½ gallons, lead arsenate, 3 lbs., and water to make 100 gallons.	Codling moth, curculio, lesser apple worm and scab.	
	5a. Two weeks after Application 5.	Lead arsenate, 3 lbs., and water to make 100 gallons.	Codling moth, curculio, lesser apple worm and scab. If apple scab is prevalent and terminal growth is continuing lime-sulphur may be necessary at this time.	WARNING. IMPORTANT Govern use of lead arsenate during the summer by the prevalence of codling moths. Read carefully Section 27.
	5b. Two weeks after 5a.	Lead arsenate, 3 lbs., and water to make 100 gallons.	Codling moth, lesser apple worm and curculio.	
	6. SUMMER GENERATION Exact time to be determined each year, usually about Aug. 1.	Bordeaux, 3-5-100, and lead arsenate 2 or 3 lbs. in each 100 gallons of spray.	Codling moth, curculio and scab.	The exact time of this application is determined by the Entomology Department and announcement is made through county agents. Use 3 lbs. of lead arsenate if fruit is to be washed, but reduce to 2 lbs. if fruit is not to be washed.
	7. Two weeks after Application 6.	Lead arsenate, 3 lbs., and water to make 100 gallons.	Codling moth and curculio.	This application is not necessary in many orchards and should never be made unless fruit is to be washed.

Supplementary Directions for Apples

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 fungus 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.

Supplementary Measures. The proper disposal of culls and drops, elimination of orchard trash, the destruction of larvae about packing-houses and equipment, and the scraping and banding of trees have been successfully employed against the codling moth under similar circumstances. Before the advent of spraying control for 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 require any large outlay of time or cash. Moreover, most of the operations can be completed in the off-season.

Banding. Codling moth banding consists in placing about the trunk of the tree, which previously has been scraped, a band four or more inches wide. The larvae seek shelter beneath the band when preparing to pulpate, or to winter. The bands should be upon the trees by the time 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 used in greatest quantity in former times 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.

Beta-naphthol bands four inches wide require about one pound of beta-naphthol dissolved in one and one-half pints of lubricating oil (diamond-paraffin grade) per 50 feet of single-faced corrugated paper band. They are made as follows. The required beta-naphthol and oil are placed in a dish-pan, wash-tub, or other container, and heated until the beta-naphthol is dissolved. The rolled bands are then dipped into the solution, removed, and allowed to drain. Two sticks laid across a pan or tub form a convenient rack for this purpose and saves the drippings.

All the materials used in these bands catch fire readily, hence their manufacture is best carried on out-of-doors. Furthermore, the chemicals are irritating and should be handled with gloves and the fumes should not be breathed. A breezy day is the best time to prepare the bands. Stand on the windward side of the container and dip the flat side of the paper rolls into the melted materials by means of strings tied to each side and guided by a long stick.

Scrapings. 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 scraping 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. Especial care must be exercised in scraping the trunk at the ground line, and just below, as these are favorite wintering-places for codling moth larvae. While mid-June is the proper time for banding in southern Michigan, the best results will be obtained if scraping is completed before blooming-time.

San Jose Scale. Possibly because of the weather conditions the San Jose scale has been reported from more places and in larger numbers than for several years past. During 1931 fruit showing reddish spots caused by this pest have been sent in on numerous occasions. All orchards must be examined for the presence of this insect early in the spring, and, if live scales are readily found, the spraying program modified to include an application for this pest. The Department of Entomology will determine specimens on request. Details as to the sprays that can be used against San Jose scale will be found in Section 30 of this bulletin.

27. *Spray Residue.* The amount of spray residue present on fruit at harvest is governed by many factors. The relation of some of these factors is not well known, but it is certain that there is a definite relation between the amount of residue at harvest and the frequency of the use of lead arsenate or other arsenical 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 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 arsenical residue which is likely to be present, but any effort to avoid excessive residue by limiting the use of arsenicals in heavily infested orchards is likely to result in wormy apples.

The substitution of oil for lead arsenate in the second generation applications has not always resulted in the arsenical residue being below the legal tolerance.

28. *Spreaders and Stickers.* The value of spreaders and stickers when use with lead arsenate for the control of codling moth has not been established. Furthermore, their use makes lead arsenate more persistent so that the danger of excessive residue is increased. It is evident,

then, that they should not be used unless fruit washing equipment is available.

29. *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 will, at the same time, control scale insects is recommended. The serious prevalence of the fruit-tree leaf-roller calls for treatment with an oil spray, which will of course be satisfactory for 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.

30. *Scale Insects.* The scale insects most likely to be found on the apple in Michigan are the San Jose scale and the oyster shell scale. San Jose scale may be controlled by a late-dormant or delayed-dormant application of 12½ gallons lime-sulphur diluted with water to make 100 gallons, or an oil emulsion, containing from two to three per cent of actual oil, may be substituted for the lime-sulphur. See Sections 17 to 25 inclusive for a full discussion of oil sprays. Commercial oils should be diluted according to the manufacturers recommendations.

The oyster-shell bark-louse offers a more serious problem since the winter is passed in the egg stage and the eggs are hard to kill. Oil sprays, however, are very efficient, when used at the proper strength.

31. *Fruit Mites and Clover Mites.* Three species of mites, and perhaps more, affect apples and other fruits in Michigan; the common red spider, the clover mite which has always been with us, 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 too critically except to remember that the European red mite is the one most capable of damaging the trees. All of our 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 consisting of one of the commercial spraying oils or of home-made lubricating oil emulsions. Use these home-made emulsions with three per cent of oil (see Section 25). If a commercial spraying oil is used, follow the recommendations of the makers. 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 20). The dormant spray is intended as a destroyer of the eggs. Summer applications of nicotine and dilute lime-sulphur are not so satisfactory and therefore the principal effort should be expended in making the dormant spray effective.

32. *Leaf-Roller.* The leaf-roller is an active, naked caterpillar which rolls the leaves of the apple and other fruits, lives in their 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 in the **late dormant period.** Use home-made oil-emulsion, diluted to give eight per cent actual oil in the spray, (see Section 25). This oil may be applied while the trees are dormant. If application is not completed by the time the buds begin to swell, reduce the concentration to six per cent, but this should not be used after green tips appear. If commercial oils are used, follow the makers' recommendations. Refer to Sections 17 to 25 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.

Very thorough application 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 tree be covered because the greatest number of eggs are found there. 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.

33. *Aphids.* Three common aphids, aside from the woolly-aphids, work in the tops of apple trees; the bud-aphis, the rosy-aphis, and the green apple-aphis. All these pests winter as eggs on the trees. The bud-aphis hatches out first but most of the eggs of all three are hatched by the time that the trees reach the delayed-dormant condition. The critical time for aphid control 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. Use lime-sulphur, 2½ gallons; nicotine sulphate, one pint; lead arsenate, 3 pounds; and water to make 100 gallons. Plum curculio and bud moth are particularly active at this stage of development. Lead arsenate should be added for their control. The lime-sulphur is desirable because it increases the effectiveness of the nicotine and at the same time it is effective for apple scab. 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 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-aphis and the early brood of the green-aphis.

The method of application, when spraying for aphids, is very important. Complete each tree, or at least each row, as a unit before going to the next. Large trees with dense low-hanging limbs are best sprayed with one operator on 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 aphis infestation, which is strongly influenced by weather conditions, spraying for the control of the rosy-aphis and the early brood of the green-aphis in the delayed-dormant should be considered as a part of the annual spraying program. The fact that aphids do not cause serious injury every year in all parts of the state, or in any particular orchard, tends to make growers lax in their control operations, with the result that orchards which are not sprayed regularly every year for aphids almost invariably suffer badly when conditions become favorable for aphid development and injury. Because of these conditions, it seems unwise for the operator of a productive orchard of good varieties to omit the aphid control treatment in the delayed-dormant period.

34. *Summer Infestation.* The treatment just outlined, if properly made, should insure satisfactory control of rosy-aphis for the season and of green-aphis for the early part of the season. In case the green-aphis 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 in 100 gallons of spray with the addition of one of the following: 25 pounds hydrated lime; 4 pounds of laundry or potash fish-oil soap or one of the special nicotine activators now available. (With the special activators, the amount of nicotine sulphate may be reduced to ½ pint in each 100 gallons of spray.) If it is desirable to use a fungicide at the same time, the nicotine sulphate, 1 pint in 100 gallons, may be added to bordeaux, 3-5-100, or to lime sulphur. The lime in the bordeaux when used with nicotine sulphate, could be advantageously increased to 25 pounds and the same amount of lime could be used with the lime-sulphur. The bordeaux should not be used earlier than four weeks after petal-fall, because of danger of russeting. Very heavy application is essential to success in the control of summer infestations of aphids and for that reason lime-sulphur in such sprays is probably the least desirable combination because of the danger of injury to foliage during mid-summer, especially when the trees are heavily sprayed and the temperature high.

Derrisol, one pint in 100 gallons, seems to be satisfactory at this time, but its use is not advised for the delayed-dormant treatment. Freshly mixed nicotine dust containing two per cent of actual nicotine is preferred by some growers. If factory mixed dust is used, three per cent of nicotine is desirable.

35. *Apple Scab.* Apple scab may be a factor of importance in nearly every one of the growing-season applications. It is impossible to name any one application that is most important in all seasons or in all orchards. The period of greatest spread is determined by weather conditions. It is true, however, that the pre-blossom applications are the key to successful control in many seasons, and they should be made regularly as recommended. This does not mean that later applications can be considered as of less importance as they often are as essential as the earlier ones, but it does mean, if the peak of infection occurs in the early period, that successful control is almost impossible if the pre-blossom treatment has not been thorough.

Extra applications may be necessary under some conditions, as indicated in the spraying schedule. The extent to which extra applications

are advisable should usually be determined by the susceptibility of the variety in question, the prevalence of scab, the production of new and unprotected foliage, the productiveness of the orchard, and the final value of the crop.

Another variation that is sometimes practiced, but often with much risk, is the omission of the fungicide from Applications 5 and 6. To omit the fungicide is safe only if scab has been completely controlled by the earlier applications. This risk is often taken without bad results, even though the orchard be not entirely free from early scab, simply because weather conditions do not become favorable for the spread of scab later in the season. All applications should be included unless careful study indicates that their omission is entirely safe. If there is any question, the only safe procedure is to follow the regular schedule.

The concentration of the lime-sulphur is often varied from the standard recommendation, and in many cases, with satisfactory results. The safety of this practice is affected largely by the factors mentioned in the preceding paragraph. There are other conditions also that may be important in the successful use of the lower concentrations. Dosage, or rate of application, is important. Extra applications at critical times are also important. In fact, if heavy or frequent spraying is practiced, it is not only possible but probably desirable to lower the concentration of the lime-sulphur after the petal-fall application. Such changes, however, must be determined from experience by each grower. With weak materials careful timing of applications is of greater importance than with standard strength as the residual and other effects of the lower concentrations is not so great.

36. *Modified Lime-Sulphur.* Injury to the foliage of the apple following the use of lime-sulphur and lead arsenate, is often a serious problem. Many attempts have been made to overcome this difficulty but most substitutes are so unsatisfactory in some respects that they have not come into general use. Investigations, the object of which is to develop a material that can be used with relative safety and still give satisfactory control of scab, have been in progress for several years. As a result of this work, a procedure has been developed that is suggested for the use of apple growers who have experienced difficulty with foliage injury. This will reduce the injury resulting from the combination of lime-sulphur and lead arsenate, but will not prevent true lime-sulphur injury that often develops in hot or humid weather. This consists of the use of a modified lime-sulphur-lead arsenate mixture for Applications 4 and 5 (and for 5a if fungicide is necessary at that time) and of bordeaux for Application 6.

FOR APPLICATIONS 4, 5 and 5a INCLUSIVE, proceed as follows:

1. To the partly filled sprayer tank add 1¼ pounds iron sulphate for each 100 gallons of spray. With varieties that have very tender foliage, or that are not highly susceptible to scab, the iron sulphate may be increased to 2½ pounds for each 100 gallons. Iron sulphate is also known as copperas or ferrous sulphate. **NEVER USE BLUE VITROL OR COPPER SULPHATE IN THIS MIXTURE.** The iron sulphate should be dissolved previously in a stock solution at the rate of one pound to one gallon of water, or if the "sugar" or granulated grade is used, it may be added directly to the tank with agitation.

2. Add the lead arsenate with the agitator in operation.

3. When the tank is nearly full, pour in 2½ gallons of lime-sulphur for each 100 gallons of dilute spray. Keep the agitator in operation.

This mixture is black and because of this color it is possible to determine easily when the trees are covered. The residue on the tree turns finally to a rust color.

FOR APPLICATION 6 use bordeaux, 3-5-100. Refer to Sections 12 and 13 for instructions for making bordeaux. Add the lead arsenate to this in the usual way.

The lime-sulphur-iron sulphate mixture is not advised for Application 6 because of the danger of staining the fruit. The use of weak bordeaux overcomes this difficulty largely, and when applied so late in the season will not cause russeting.

This modified lime-sulphur is probably slightly less effective for scab control than the regular lime-sulphur and it is possible that further investigations may lead to improvements in the combination. It is offered, however, at this time because a remarkable reduction in some types of foliage injury follows its use.

37. *Red-Bug.* Two species of red-bug 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.

38. *Apple Maggot.* The apple-maggot or "railroad worm" is the larvae of a true fly which lays eggs in slits cut in the flesh of the fruit. The winter is passed underground and the adults fly from mid-June until late fall. They continue to lay eggs until frost. The maggots refuse to leave the fruit until it falls to the ground but usually leave the apples and burrow into the ground very soon afterward. Remove apples daily, within a few hours after they fall, and bury deeply, under two feet or more of compact soil. Apply extra arsenical sprays, with or without lime-sulphur, on the dates determined annually by the Department of Entomology. This date can be obtained through the county agent. Repeat two weeks later. The immediate destruction of fallen fruit, by hand or by farm animals, is of utmost importance.

39. *Curculio.* The well known curculio, which is responsible for the tiny dot and crescent-shaped scar on our tree fruits, hibernates under fallen leaves and trash. The destruction of all trash after cold weather sets in disposes of very many of these insects; and the liberal use of lead arsenate in the early routine sprays, beginning with the delayed dormant 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 live stock, crushing or burial beneath at least 18 inches of well packed soil will reduce the infestation and consequent loss.

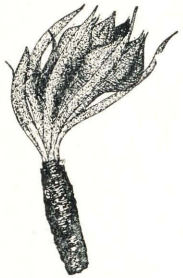
40. *Leaf-Hoppers.* Leaf-hoppers are a pest in many orchards. The

typically discolored fruit and curled edges of the leaves associated with leaf-hopper 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 mouthparts, 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 they can be controlled by thoroughly spraying with nicotine sulphate (1 pt. in 100 gal.) in Application 5.

41. *Climbing Cutworms.* Refer to special instructions in Section 69.

42. *Fire-Blight.* Special instruction for the control of fire-blight will be sent on request.

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 44 for specific instructions.
	2. DELAYED DORMANT, or PRE-PINK. Latter stage is shown at left.	Bordeaux, 3-8-100 and lead arsenate 3 lbs. in each 100 gallons. Refer to Sections 12 and 13 for instructions for making bordeaux.	Scab, leaf-blight, curculio and bud moth.	This is good insurance against scab on any susceptible variety and should everywhere be made on Flemish Beauty or other similarly 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 lbs., in each 100 gallons. Refer to Sections 12 and 13 for instructions for making bordeaux.	Scab, leaf-blight, curculio and bud moth.	This 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. Just as the petals are falling.	Bordeaux 2-8-100, and lead arsenate, 3 lbs. in each 100 gallons of spray.	Scab, leaf-blight, codling moth, curculio and other chewing insects.	

PEARS—Continued

	5. Two weeks after petals fall.	Bordeaux 2-8-100, and lead arsenate, 3 lbs. in each 100 gallons of spray.	Codling moth, curculio, other chewing insects, scab and leaf-blight.	Bordeaux may be omitted if scab and leaf-blight are not present. Refer to Section 44 for the summer treatment of psylla.
	5a. Two weeks after Application 5.	Lead arsenate 3 lbs. and water to make 100 gallons.	Codling moth and curculio.	WARNING. IMPORTANT Govern the use of lead arsenate during the summer by the prevalence of codling moth. Read carefully Section 43.
	5b. Two weeks after Application 5a.	Lead arsenate, 3 lbs. and water to make 100 gallons.	Codling moth and curculio.	
	6. SUMMER GENERATION. Time determined the same as for apples.	Lead arsenate 2 lbs. and water to make 100 gallons.	Codling moth and curculio.	Bordeaux may be used at this time on varieties very susceptible to scab. Read carefully Section 43.

Supplementary Direction for Pears

43. *Spray Residue on Pears.* Codling moth is generally not as serious a problem with pears as with apples and in most parts of the state it may usually be controlled without danger of excessive arsenical residue. There are some districts, however, where codling moth is a factor of importance on pears, and if the trees are not well sprayed there is likely to be difficulty. Pears are often apparently free from codling moth when picked and packed, but show a serious degree of infestation by the time they have fully ripened. Where this condition prevails, it is evident that Application 6 is desirable on all varieties of the season of Clapp and Bartlett; and on later varieties still another application may be needed. The use of lead arsenate in Application 6 or at any later period will undoubtedly cause excessive residue on many varieties. Special attention should be given to Applications 5, 5a and 5b in order to reduce the infestation to the lowest possible point.

44. *Pear Psylla.* For the control of pear psylla use a home-made oil emulsion containing three per cent of actual oil. Use a rather heavy oil such as Enarco spray oil, Atlantic Red Engine, or other similar heavy oil in making the emulsion. It may be emulsified either with casein spreader, bordeaux, or soap. Refer to Sections 17 to 25, inclusive, for specific information about the making and use of oil emulsions. Casein spreader and bordeaux are most frequently used as the emulsifying agents. Several miscible oils and prepared oil emulsions are available and, in general, may be expected to give satisfactory results. Dilute these materials according to the makers' instructions.

This application should be made in the early spring just before the adult psylla 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. 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 the so-called "summer oils" seems to be a satisfactory treatment for the control of summer infestations of pear psylla. Information concerning their use is not as yet complete but there is evidence that oil should not be used at the petal-fall period and possibly not at the two-weeks period. Apply any time after Application 5 when honey-dew is first evident. Use two gallons of emulsion in each 100 gallons of spray. However, if the dormant oil treatment has been properly made, there should be no necessity for early summer application of oil or possibly for any summer treatment at all. Procedure should be determined entirely by necessity. Not all summer emulsions are equally safe and effective. Specific recommendations will be made on request.

The use of summer oils for psylla control may complicate the arsenical residue problem since oil causes the lead arsenate to persist on

the fruit. This would be especially true if lead arsenate were used later than Application 5.

45. *Pear-Leaf Blister-Mite.* This insect is best controlled by an application of lime-sulphur after the buds have begun to swell. Fairly good control can be secured 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 12½ gollons 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.

46. *Climbing Cutworms.* Refer to special instructions in Section 69.

47. *Fire-Blight.* Special instructions for the control of fire-blight will be sent upon request.

SOUR CHERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT.	Oil or tar wash (refer to Section 51a)	Leaf-roller and case-bearer.	Instructions for control will be found in Section 51a for case-bearer and Section 32 for leaf-roller
2. PETAL-FALL. Just after the petals have fallen.	Lime-sulphur, 2½ gallons, lead arsenate, 2 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio and slugs.	This application should be completed by the time the shucks are falling. See note for special instructions for canning cherries.
3. TWO-WEEKS. Should be completed within two weeks after petal-fall.	Lime-sulphur, 2½ gallons, lead arsenate, 2 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio and slugs.	See special note on canning cherries for the use of arsenate of lead.
4. FOUR-WEEKS. Should be completed two weeks after Application 3.	Lime-sulphur, 2½ gallons, lead arsenate, 2 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio, slugs and maggots.	See special footnote concerning the use of lead arsenate on canning cherries. 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.
. SPECIAL. For the control of cherry maggots.	Refer to Section 50 for information concerning a special application for the control of cherry maggots in canning cherries.		
5. AFTER HARVEST. Just after the fruit is harvested.	Lime-sulphur, 2½ gallons, lead arsenate, 1 lb., and water to make 100 gallons.	Leaf-spot and slugs.	This is desirable to prevent the development of leaf-spot and slugs.

SPECIAL. If leaf-spot has become established in the orchard it is desirable to shorten the interval between applications. If shoot growth is not complete at the time of Application 4, spray again with lime-sulphur alone in 10 days, or with lead arsenate if necessary for cherry maggots.

CANNING CHERRIES. Applications 2, 3 and 4 should contain 2½ lbs. of lead arsenate to each 100 gallons of spray when the fruit is to go to the canner. This additional poison is intended to improve the control of curculio.

SWEET CHERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT.	Lime-sulphur, 2½ gallons, nicotine sulphate, 1 pt., water to make 100 gallons.	Cherry aphids, (see Sec. 49). Scale insects, (see Sec. 30). Leaf-roller, (see Sec. 32). Case bearer, (see Sec. 51a).	An especial effort should be made to time this application accurately. Refer to Section 49.
2. PETAL FALL. Just after petals have fallen.	Lime sulphur, 2 gallons, lead arsenate, 2 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio and slugs.	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 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio and slugs.	
4. FOUR WEEKS. Two weeks after Application 3.	Lime-sulphur, 2 gallons, lead arsenate, 2 lbs., and water to make 100 gallons.	Leaf-spot, brown-rot, curculio, slugs and maggots.	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.
4a. SPECIAL. For the control of cherry maggot.	Refer to Section 50 for information concerning a special application for the control of cherry maggot on canning cherries.		

Supplementary Directions for Cherries

48. *Special Application for Brown-Rot.* An application of sulphur dust may be made on sweet cherries, one week or ten days before the fruit is picked. Use sulphur with 5 to 10 percent of hydrated lime or other fluffer. Apply the material thoroughly but lightly in order to insure thorough covering and to avoid staining the fruit.

49. *Black Cherry Aphis.* This insect is often serious on sweet cherries and of lesser importance to other groups. They start their activities with the new growth in the spring and curl the leaves, hiding in the protection of the curled leaves. Growth is stunted and the fruit may drop. Spray with 40 per cent nicotine sulphate, one pint in 100 gallons of water to which has been added 2½ gallons of lime-sulphur. Apply just as the buds swell but before they burst. Drench every twig, spur, and water sprout or sucker with the spray.

Summer infestations of black cherry aphids are very hard to control after the leaves on the branch tips have begun to curl. Therefore, it is necessary that in orchards where black cherry aphids are commonly a pest, a very sharp lookout be kept for the appearance of the first aphids. When black cherry aphids first appear in the orchard, they can be controlled by a thorough drenching application of one-half pint nicotine in 100 gallons, combined with one of the activators now on the market. Nicotine dust has been used by some growers. Either of these methods requires very thorough application, and if the insects have succeeded in curling any number of the tips a repetition of the treatment will be necessary before control is secured.

50. *Fruit-Flies.* There are two species of fruit-flies common in Michigan. These fruit-flies produce footless and headless maggots, about one-quarter 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 fruit-fly 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, put one or more applications of arsenate of lead, using 2½ pounds to 100 gallons of spray. If necessary to control brown-rot or leaf-spot, include 2½ gallons of lime-sulphur for sour cherries or 2 gallons for sweet cherries.

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

51. *Climbing Cutworms.* Refer to special instructions in Section 69.

51a. *Cherry Case-Bearer.* While the cherry case-bearer is a comparatively new pest, experimental work to date indicates that it can be controlled in the dormant season without injury to the trees. Proprietary oils and tar-washes used according to the manufacturers' recommendations and home-made emulsions at 8 percent give excellent control of this pest. Most of the cherry case-bearers 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 very 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 case-bearer, 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 20).

QUINCES

APPLICATION	MATERIALS	TO CONTROL
1. PRE-BLOSSOM. After leaves are well started.	Bordeaux, 3-5-100, and lead arsenate, 3 lbs 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 lbs. 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 lbs. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects.
4. Two weeks after Application 3.	Bordeaux, 3-5-100, and lead arsenate, 3 lbs. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects.
5. SECOND GENERATION. Spray at the time recommended for the second generation of codling moth on apples.	Bordeaux, 3-5-100, and lead arsenate, 2 lbs. in each 100 gallons.	Black-spot, curculio, codling moth and other chewing insects. 2 lbs. only of lead arsenate should be used at this time.

DORMANT APPLICATION. If scale insects, mites, or leaf-rollers are prevalent, spray as indicated for these insects under apples.

PEACHES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT. Apply in early spring before growth starts.	Lime-sulphur, 7 gallons, and water to make 100 gallons for leaf-curl alone. If scale is present, increase lime-sulphur to 12½ gallons. If mites are present, use an oil spray.	Leaf-curl, scale insects and mites. If mites are present refer to Section 52.	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 52 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 lbs., hydrated lime 16 lbs., and water to make 100 gallons.	Curculio.	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 lead arsenate on peaches, do not use more than 2 lbs. in 100 gallons of spray.
3. About two weeks after No. 2.	80-5-15, sulphur-arsenate of lead-lime dust, or spray with 25 lbs. dry mix, 2 lbs. lead-arsenate, 8 lbs. fresh hydrated lime, and water to make 100 gallons. (See Sections 14 to 16.)	Curculio, scab and brown-rot.	This is important to check the early development of scab and brown-rot.
4. About one month before the fruit ripens.	Sulphur dust (with fluffer), or spray with dry-mix or a wettable sylphur.	Brown-rot and scab.	Do not use lead arsenate at this time unless absolutely necessary.
5. One week to ten days before the fruit ripens.	Sulphur dust (with fluffer,) or dry-mix or a wettable sulphur. (See Sections 14 to 16.)	Brown-rot.	On many varieties this application is often important to retard rot development during or after harvest.

CAUTION. Study carefully Section 54.

Supplementary Directions for Peaches

52. *European Red-Mite.* This pest over-winters in the egg stage (Section 31). If the minute red eggs of this mite are present, the application of an oil spray containing 3% actual oil is indicated. 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 the fungicide for leaf-curl with oil spray for mite control. The home-made casein and bordeaux emulsions are compatible with lime-sulphur and bordeaux. It should always be remembered however, that the bordeaux used for emulsifying the oil is not sufficient to control leaf-curl. This necessitates the use of the regular 8-12-100 mixture if bordeaux is to be used for leaf-curl. In the Peach Schedule, lime-sulphur is recommended at the rate of 7 gallons in 100, for leaf-curl control, but when it is to be combined with an oil spray, not more than 5 gallons in 100 gallons should be used.

Most commercial oil sprays are compatible with some fungicide but the manufacturers recommendations should be followed in this connection.

53. *Fall Spraying for Leaf-Curl.* Leaf-curl can be controlled by proper fall spraying and it is believed that this practice can usually be followed with safety. It is not recommended however, without qualification, as fall applications of lime-sulphur have caused injury in a few instances. It is suggested to those who care to experiment with fall spraying, that lime-sulphur, 7 gallons, with water to make 100 gallons, or bordeaux 8-12-100 be used after the leaves have dropped.

54. *Arsenical Injury.* The foliage and wood of the peach are very readily injured by arsenicals. In order to avoid injury as much as possible, the following precautions should be observed.

1. Use the minimum possible number of lead arsenate applications. One application, (No. 2), is sufficient in many orchards and two applications, (Nos. 2 and 3), should be the limit in all orchards unless it is known definitely that more are necessary.

2. Use not more than five per cent of lead arsenate in a dust, (see formula in peach schedule), nor more than two pounds in 100 gallons of spray.

3. Always add lime when lead arsenate is used either in dusts or sprays. (See schedule, also Sections 14 and 15, for use of dry-mix and wettable sulphurs with lead arsenate. When used with wettable sulphur, more lime should be added than with dry-mix.)

4. Applications of arsenical dusts should be made carefully and thoroughly so as to insure complete coverage but no more material than is necessary should be used.

5. Spraying should be done very carefully as over-spraying is likely to lead to arsenical injury. Use a fine, mist-like spray. Cover completely but never drench a peach tree with an arsenical spray.

55. *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 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 to a well grown tree. Use less on a tree under six years old and a half-ounce on smaller stock. Cover lightly with soil, being careful not to disturb the ring of crystals. Apply late in August or about the first of September. Paradichlorobenzene does not work well when the temperature of the soil at four inches depth falls below 58 or 60 degrees Fahrenheit.

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, dig out the larvae in spring or fall. The knife or other instrument used for digging out the borers should be disinfected with lysol to prevent the carrying of crown-gall infection from tree to tree.

56. *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 cotton seed oil during the dormant period will control these pests. 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%. This mixture consists of one pound of paradichlorobenzene dissolved in two quarts of raw cotton seed oil. This material is not effective at temperatures below 50 degrees F. Hence, in order to have this application effective in the dormant period, it is necessary to watch the temperature closely and act decisively.

57. *Bacterial Spot.* This is a bacterial disease in which grayish angular spots, later becoming watersoaked and changing through purple red to dark brown are formed on the twigs, leaves and fruit. Special instructions for the control of this disease will be sent upon request. This disease is easily confused with arsenical injury and Coryneum blight.

58. *Coryneum Blight.* Coryneum blight is a relatively new fungus disease in Michigan in which dark red, circular spots with lighter centers are formed on the leaves, fruit and branches. Infection is common at the bases of the buds. Special instructions for the control of this disease will be sent upon request. This disease may be easily confused with bacterial spot and arsenical injury.

59. *Black Peach-Aphis.* 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 these areas and seed the land to clover for several years before resetting to peaches.

60. *Climbing Cutworms.* Refer to special instructions in Section 69.

60a. *Curculio.* In peach plantings where curculio is of importance as a pest, clean-up measures will aid materially in its control, since the use of heavy arsenical applications on peach trees causes burning. Clean-up measures which can be applied in the peach orchard are the same as those described in Section 39 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. The heat of the sun will destroy most of the curculios which would otherwise develop to adults in the peaches on the ground.

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 scale or mite eggs.
2. PRE-BLOSSOM. Just as leaf buds burst and before blossoms open.	Lead arsenate, 3 lbs., and water to make 100 gallons.	Curculio.	Beetles coming out from hibernation feed on the opening buds. This application is important.
3. PETAL-FALL. Just after the petals have fallen.	Lime-sulpher, 2 ½ gallons, lead arsenate, 3 lbs., and water to make 100 gallons.	Curculio, leaf-spot and brown-rot.	Japanese varieties should not be sprayed with lime-sulphur, substitute dry mix (See Sections 14 to 16) and use not more than 2 lbs. of arsenate of lead in 100 gallons of spray.
4. TWO-WEEKS. Ten days to two weeks after No. 3.	Lime-sulphur, 2½ gallons, lead arsenate, 3 lbs., and water to make 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.	Lime-sulphur, 2½ gallons, and water to make 100 gallons.	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 fluffer,) or a non-staining spray. (See Section 15.)	Brown-rot.	This application is very important to prevent the development of rot as the fruit ripens and during transit.

See page 38 for SUPPLEMENTARY INSTRUCTIONS FOR PLUMS.

Supplementary Instructions for Plums

61. *Red-Mite.* Plums are frequently infested with red mites. The treatment is the same as recommended for the apple. Refer to Section 31.

62. *Sanitary Measures for Rot Control.* Brown-rot 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 from one plum to another if they touch. **All "mummied" fruits from the previous season should be removed from the tree and raked up from the ground and destroyed, by being buried under two feet of compacted soil.** They are sources of reinfection.

63. *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 should be 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.

64 *Climbing Cutworms.* Refer to special instructions in Section 69.

65. *Bacterial Spot.* Refer to Section 57.

65a. *Curculio.* See Section 60a.

GRAPES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. When shoots are 8 to 10 inches long.	Bordeaux, 8-12-100. See Sections 12 and 13 for instructions for making bordeaux.	Black-rot and downy mildew.	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 66 for further discussion of black-rot.
2. Just as the blossom buds are opening.	Bordeaux, 8-12-100, and lead arsenate, 3 lbs. in each 100 gallons of spray. (Refer to Sections 12 and 13 for instructions for making bordeaux.)	Black-rot, berry-moth, downy mildew and rose-chafer.	If rose chafer is present, use 5 lbs. lead arsenate and perhaps a gallon of cheap molasses. This is a critical application for the control of berry moth.
3. Ten days after Application 2.	Bordeaux, 8-12-100, and lead arsenate, 3 lbs. in each 100 gallons of spray.	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 Application 3.	Bordeaux, 8-12-100, lead arsenate, 3 lbs., and resin-fish-oil soap 2 lbs. in each 100 gallons of spray.	Black-rot, downy mildew and berry-moth (See Section 67.)	This application is imperative for berry moth control, as the use of lead arsenate 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 as first leaf-hoppers acquire wings.	Bordeaux 4-6-100, and nicotine sulphate, 1 pint in each 100 gallons of spray.	Black-rot, downy mildew, and leaf-hopper.	This application should be made if black-rot and mildew threaten. Usually the first application for leaf-hopper control may be made at this time. (See Section 68.) Omit the nicotine sulphate if hoppers are not present in injurious numbers.

TO PREVENT FOAMING. One-half pint of kerosene may be added to each tank of spray to prevent foaming from fish-oil soap.
See page 40 for SUPPLEMENTARY INSTRUCTIONS FOR GRAPES.

Supplementary Directions for Grapes

66. *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 to become slack 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 predict whether or not 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.

67. *Grape Berry-Moth.* Application 4 should be made with trailing hose, short rods and angle nozzles. Spray upward so as to get under the foliage and fill the fruit bunches with spraying material. Use large amounts of material. The possibility of residue on grapes heavily-sprayed for grape berry-moth makes it necessary to pay particular attention to the early applications of poison. Strict attention to clean-up measures will also aid materially in cutting down infestations of berry-moth, especially in the vicinity of woodland and on land containing gullies, low places, and hollows.

68. *Grape Leaf-Hopper.* Spray in exactly the same manner as outlined above for the control of berry-moths. It is necessary to hit the undersides of the leaves. Use nicotine sulphate with bordeaux as indicated in Application 5; or, make a separate application of nicotine sulphate, 1 pint, in 100 gallons of water with 3 or 4 pounds of potash fish-oil soap. 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 when the very first nymphs acquire wings.

69. *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 after a cold, wet spring. The attack comes early in the season. The worms ascend trees 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 the 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 orchards, the tanglefoot should be applied to a strip of paper, which is wrapped around the tree. Ordinary poison bran-bait should be scattered on the ground at the bases of the trees to supplement the bands and to prevent the worms from gnawing the bark just below the bands.

FORMULA FOR BRAN-BAIT

20 pounds wheat bran
1 pound white arsenic
½ gallon molasses
2 ounces of amyl acetate of good grade (banana oil)
Water to moisten.

Add molasses and poison to the water and stir all ingredients together. 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 8½ gallons of water and then stirring in and dissolving 100 pounds of white arsenic. This makes a stock solution of arsenite of soda containing eight pounds of arsenic to the gallon. In preparing bait, add two quarts of the stock solution to ten gallons of water and two gallons of cheap molasses, use this mixture to moisten 100 pounds of bran, and then stir in three ounces of banana oil. Made by this formula, no great amount of stirring is required. For more detailed directions, see Michigan State College Quarterly Bulletin, Vol 9, No. 4.

70. *Flea-Beetle.* The grape flea-beetle used to be a serious pest in this state but the regular routine sprays which are usually applied in Michigan vineyards have proved very effective in keeping it down.

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 four pounds of lead arsenate in 100 gallons of water or bordeaux just as the leaf-buds are bursting.

71. *The Grape-Root Worm.* The adult of the grape-root worm is a reddish brown beetle, covered with short grey 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, using three pounds of arsenate of lead to 100 gallons of spray in each case, are usually not attacked. If chain-like punctures appear on the leaves make a special arsenical application spraying from above downward, since root injury is severe if adults escape poisoning.

CURRANTS AND GOOSEBERRIES

APPLICATION	MATERIALS	TO CONTROL	EXPLANATIONS
1. DORMANT. Apply just before growth starts.	Lime-sulphur, 12½ gallons, and water to make 100 gallons.	Scale insects.	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 12 and 13), lead arsenate, 2 lbs. and nicotine sulphate, 1 pt. 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 upward from beneath.
3. Soon after the blooming period.	Bordeaux, 8-12-100, (see Sec. 12 and 13) and lead arsenate, 2 lbs. in each 100 gallons of spray.	Leaf-spot and leaf-eating insects.	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, 8-12-100, (see Sec. 12 and 13)	Leaf-spot and leaf-eating insects.	If currant worms appear add 2 ounces of hellebore to each gallon of spray; or dust with 20% of hellebore in hydrated lime.
5. Just after the fruit is harvested.	Bordeaux, 8-12-100. See Sections 12 and 13 for instructions for making bordeaux.	Leaf-spot.	This is desirable when leaf-spot has not been well controlled in early summer.

Supplementary Directions for Currants and Gooseberries

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

73. *Witches'-Broom.* One species known as the Houghton Gooseberry aphis 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 applied at that time, is more effective than at any other, for, while the witches'-brooms appear and develop later in the season, the lice themselves are more plentiful on the currants just after the eggs hatch.

74. *Currant-Borer.* The currant-borer is a moth larvae which burrows in the smaller canes of the currants, eats out the pith, and leaves a blackened burrow 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 are able to start growth in the spring; at least they usually put out leaves, which never develop very far. **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 pruned out pieces of canes.

75. *Powdery Mildew.* This disease is sometimes very destructive on Houghton and English varieties of gooseberries and on some varieties of currants. Susceptible varieties should be sprayed with liquid lime-sulphur, 2½ gallons in 100. Put on the first spray when the buds open and continue at intervals of two weeks until four or five sprays have been applied.

Raspberries, Dewberries, and Blackberries

76. 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, orange rust, and streak. The best plants are usually secured from young fields. Where possible, the plants should be taken directly from the mother plants to the new field.

77. Remove the old canes 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.

78. 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 but which cause severe stunting of blacks. Wild red raspberries in the immediate vicinity of black 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.

79. 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 two per cent of these diseases can be successfully rogued.

80. Spray black raspberries and dewberries for anthracnose. Applications should be as follows:

1. When the buds show green. Use 5 gallons of liquid lime-sulphur and water to make 50 gallons.

2. About one week before the blossoms open. Use bordeaux 2-4-50. (See Sections 12 and 13 for instructions for making bordeaux.) One gallon of liquid lime-sulphur, to which water is added to make 50 gallons of mixture, applied at this time will also control anthracnose but there is more danger of burning the leaves than with bordeaux.

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.

81. *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.

82. *The American Raspberry Beetle.* The small grubs, or worms, occuring in raspberries are the larvae of a brown beetle, about an eighth of an 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 plant subsequently kept covered by dusting at intervals until blossoms appear. The inclusion of three pounds of lead arsenate in the early fungicidal sprays is also an effective treatment.

83. *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 been set cannot be treated in this way, because of the danger of residue. Such infestations can be controlled by the use of Derrisol, one pint in 100 gallons of water, together with two pounds of ivory or some similar soap. Derris preparations are slow-acting poisons, and a good, thorough application is required. Repeat in a week if all the larvae are not killed the first time.

Strawberries

84. 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.

85. *Strawberry Leaf-Roller.* This is a small grayish caterpillar with a brown head. It draws the leaflet together with a 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 surface 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 larvæ 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 as well as leaf-spots. Old beds that are to be abandoned should be plowed under immediately after the last picking.

86. *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 4-6-50 bordeaux (refer to Sections 12 and 13 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 old 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

87. Young orchards, in general, do not require as much spraying as bearing trees, but a certain amount of attention is necessary to insure proper protection from insects and diseases. Treatment should depend largely upon the prevalence of insects and the susceptibility of the foliage to injury by fungi. A general statement of the requirements for several fruits follows. Use the materials as recommended in the special schedule for the fruit in question.

APPLES. Young apple trees should be kept free from scale insects. Should scale be found, the dormant spray, as recommended for bearing trees, should be applied. If aphids have been prevalent, make the delayed dormant application (Application 2) instead, using lime-sulphur and nicotine sulphate as recommended in the apple schedule. Aphids may cause serious injury to young apple trees by attacking the new growth and by spreading fireblight. Summer applications are desirable to keep the foliage free from scab and to kill leaf-eating insects. Two applications of lime sulphur and lead arsenate, one soon after the leaves are well started and another two or three weeks later, are usually sufficient. Bordeaux can be used in place of lime-sulphur on non-bearing trees.

CHERRIES. Young cherry trees should be sprayed regularly for the control of leaf-spot and slugs. Heavy defoliation of young trees by

leaf-spot may stunt the trees seriously so that they will be short-lived and unproductive. Follow the same schedule as recommended for bearing cherry orchards. If aphids have been prevalent, the trees should be sprayed just before the buds burst, using nicotine sulphate 40 per cent, one pint in 100 gallons, to which has been added 2½ gallons lime-sulphur. Summer infestations should be treated as indicated in Section 49. This is more often necessary with sweet than with sour cherries.

PEACHES. Young peach trees should receive the dormant application as recommended in the peach schedule. Close attention should also be given to peach borers and mites. Failure to control borers, mites and curl will seriously impair the vigor of the trees.

PEARS. Young pear orchards should be examined every year for the presence of scale. If present, make the dormant application. Psylla seldom attack seriously, young, open plantings of pears, but, if they should appear, spray as directed for bearing orchards. If slugs appear in the summer, they may be easily controlled by an application of lead arsenate.

PLUMS. Young plum orchards should receive the dormant application if they become infested with scale. Summer applications are usually not necessary unless leaf-spot is prevalent. Spray as directed in the plum schedule if necessary to control this disease. Keep on the alert during the summer for leaf-eating insects.

CURRANTS AND GOOSEBERRIES. Young plantings of these fruits will require about the same attention as bearing plants. Requirements will vary somewhat according to variety and conditions.

GRAPES. Non-bearing grapes will usually require little or no spraying further than to make sure that they do not serve as breeding places for the leaf-hopper or rootworm.