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SPRAYING CALENDAR

By W. C. Dutton, R. H. Pettit, and C. W. Bennett



AGRICULTURAL EXPERIMENT STATION MICHIGAN STATE COLLEGE Of Agriculture and Applied Science

Horticultural, Entomological, and Botanical Sections East Lansing, Michigan

by

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The directions given in this publication are intended for dealing 1. with moderately severe cases of disease or insect infestation; --- in other words, they are intended for average conditions. In the schedules which appear on following pages the applications that are usually sufficient to meet these average conditions are printed in *bold* faced type. If no part is shown in **bold-faced** type, the grower must determine what treatment is necessary for his conditions. In special cases more drastic measures may be necessary. In the case of relatively light infestations or of relatively resistant varieties, the number of applications may sometimes be reduced, the strength of the materials lowered, or some change in materials may even be made. However, it is suggested that any changes from these schedules be made only after careful study of local conditions clearly indicates their advisability. Such modification or adjustment of the spray schedules to meet particular conditions is necessarily something that must be left to the individual grower.

To obtain special information concerning spraying or the identification and control of pests address the Michigan State College, East Lansing, Michigan. Give a full statement of conditions and previous treatment and, if possible, send specimens.

2. Spray Residues:—The importance of avoiding spray residues and stains, due to the recently inaugurated activity in fruit inspection, accentuates the importance of concentrating efforts on the earlier sprays of tree-fruits. It is imperative that late sprays capable of leaving injurious residues, be reduced to the lowest point practicable, and this of necessity will require an increase in the care and thoroughness with which early spray applications are made, especially with arsenate of lead.

Spraying Materials

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

4. Dry Lime-Sulphur:—Dry lime-sulphur is, essentially, liquid limesulphur 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 that go to make up lime-sulphur solution. Dry lime-sulphur varies, somewhat, from the liquid in its exact composition, 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. This recommendation is based on experience with apple scab only and may not be found to hold for all diseases and insects. Furthermore, there is undoubtedly considerable variation between different brands of dry limesulphur 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.

5. *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. Before putting lead arsenate, either paste or powder, in the sprayer it should first be reduced with water to a thin paste or "milk."

6. 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 provided they contain 40 per cent of nicotine.

In times past home-made nicotine sprays have been recommended but their use has never become general. The 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.

7. Derrisol:—Derrisol is a comparatively new spraying material in America. It seems to act much like nicotine though it lacks the disagreeable odor of that material. Limited field trials indicate that it possesses considerable merit—enough to induce some growers to use it, either alone with water or combined with other sprays as a substitute for nicotine. It is believed to be non-poisonous to warm-blooded animals.

8. Mixing Combined Sprays of Lime-Sulphur, Lead Arsenate and Nicotine Sulphate:—The method of mixing these materials may have more or less effect on results. Proceed as follows: (1) Pour the required amount of lime-sulphur solution into the tank as it is being filled. (2) Mix the lead arsenate to a smooth thin paste with water, add more water to make milky in consistency, and pour into tank with agitator running and (3), if nicotine sulphate is to be used, add last. Keep the agitator running to prevent the lead arsenate from settling. Never use a mixture of lime-sulphur and lead arsenate that has stood for any considerable length of time. Serious foliage injury usually follows if this is done.

9. Bordeaux:—Bordeaux is made from copper sulphate (blue stone, blue vitriol), lime and water. Wherever bordeaux is recommended in this

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bulletin will be found a formula, as 4-8-100. The first figure always indicates the amount of copper sulphate in pounds, the second figure the amount of lime in pounds and the third figure the amount of water in gallons. A 4-8-100 bordeaux will require then:

- 4 pounds copper sulphate.
- 8 pounds quick or lump lime.

100 gallons water.

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

Lime comes in two forms: (1) hydrated lime, which is a powder and is packed in paper bags, and (2) quick or lump lime. All formulae fors bordeaux in this bulletin are based on quick or lump lime. A good grade of lime containing a high percentage of calcium is very desirable. Much of the quicklime sold in barrels has a high percentage of magnesium and other impurities which make slacking and straining difficult. High grade lump lime packed in air-tight metal drums is available and will probably be most satisfactory and economical in the end, although the initial cost may be slightly higher.

If a good grade of quick lime is not available use hydrated lime. It is very essential that it be fresh as it soon becomes carbonated and is unfit for making bordeaux. Hydrated lime is not as strong as lump lime, so always use one-half more by weight than the amount specified in the formula for lump-lime.

solutions" of copper sulphate and 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 barrel (preferably 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. Then 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. Lime may be slaked to a paste and covered with water in barrels or in troughs made for this purpose and kept indefinitely if covered with water. It is essential to know how many pounds of lime are in each gallon of the paste. When hydrated lime is used it is desirable to mix it with water a little in advance of the time it is to be used. Soaking over night is best, but an hour or two will help.

Mixing:—There are several good ways of mixing 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 which is nearly full of water. Dilute the required amount of lime stock solution so that it will pour and strain easily and, with agitator running, strain it into the sprayer tank. Finally, fill the tank to capacity with water. If lead arsenate is to be used, add at this time after mixing with water into a thin paste. Nicotine sulphate, when used with bordeaux, should be added last.

10. Dry-Mix Sulphur-Lime Spray:—Probably the most satisfactory spraying material for summer applications on peaches and Japanese

plums is a mixture of sulphur, hydrated lime and casein spreader. The sulphur should be of a high grade, preferably a very fine dusting sulphur. Fresh hydrated lime which is free from grit and lumps should be used. The best grades of "finish lime" will generally be most satisfactory. Casein spreader is made from casein, a milk product, and lime.

Formula

For each 100 gallons of spray mixture use:

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Sulphur	16 pound	S
• Hydrated lime	8 pound	S
Casein spreader	1 pound	

Sift the sulphur through a screen (12 to 14 meshes to the inch will be satisfactory) to break up all lumps. Mix the sulphur, lime, and casein spreader in the dry form until of uniform color throughout. For small quantities this may be done in any convenient container but for large quantities a mechanical mixer of some sort is very desirable.

This mixture may be made up in advance if desired. Twenty-five pounds of the stock preparation should be used for each 100 gallons of spray. When lead arsenate is used with dry-mix on peaches always add 8 pounds more of hydrated lime to each 100 gallons of spray.

Dilution and mixing may be accomplished in any one of several ways:

1. Place the proper amount of stock mixture in a barrel or other tight container. Add water slowly, stirring thoroughly until the mixture is wet and in the form of a thin paste which will pass readily through the sprayer strainer. The mixing may be done with a paddle or hoe or a very easy way is to use a spray gun, turning the water from the sprayer into the mixture. This adds the necessary water and mixes at the same time. Strain into sprayer tank, which should be nearly full of water and with the agitator running to insure thorough mixing and to prevent settling.

2. Pour the proper amount of dry-mix into the spray tank, which is nearly full of water, and with the agitator running. Turn the nozzle or spray gun directly into the mixture as it falls on the water in the tank.

Thorough agitation is very necessary and the agitator should be kept running from the time the mixture is added to the tank until it is all sprayed out. Lead arsenate may be added to this if desired.

Dry-mix is also made up by several manufacturers and dealers in spraying materials. These mixtures should be satisfactory, if they contain the proper ingredients in the correct proportions.

11. Wettable Sulphur:—For certain applications on peaches and plums where lead arsenate is not used, hydrated lime is undesirable, because of staining the fruit. This may be eliminated and a mixture of sulphur and casein spreader used. For each 100 gallons of dilute spray use:

Fine sulphur	16	pounds
Casein spreader	1	pound

Mix in the dry form and dilute exactly as instructed for the dry-mix sulphur-lime spray. The same precautions as to agitation should be observed.

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

Oil Sprays

12. Much interest has been shown recently in the use of oil sprays of various kinds. There are two general classes of oil sprays: -(1)miscible oils and (2) oil emulsions. In general, the miscible oils are factory-made products; the emulsions are usually home-made, although several commercially-made emulsions are available. An oil emulsion consists of oil that has been mixed with water and some emulsifying agent and then treated mechanically so as 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 and are still in emulsion condition. The emulsions are usually creamy in consistency.

A miscible oil is generally a mineral oil combined with an emulsifying agent and so prepared that the product appears much like oil alone. It usually contains very little 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.

Miscible Oils:—The miscible oils are mostly comparatively permanent, that is, they can be kept for reasonably long periods 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 compatable with lime-sulphur and with these serious difficulties will follow if any lime-sulphur is present in the sprayer or on the tree. The manufacturer's instructions should always be carefully followed, especially with 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 oils. The danger of injury to the plants is generally considered to be greater than with the emulsions and their cost is usually considerably higher. The final cost is determined by the price per gallon and the dilution used.

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 making the emulsions will be found in Secs. 13 and 14. The properties of these two classes of emulsions vary considerably.

The boiled soap emulsion, if well made, remains stable for several months while the cold pumped emulsion should be used the same day it is made and preferably at once. The soap emulsion is broken down by freezing which occurs at about 15 degrees F. Freezing is not a factor with cold pumped emulsions as storing them is not advised. Lime-

sulphur will break down the soap emulsion but does not seen thave so much effect on an emulsion made with casein spreader. There is also evidence that the use of some of the oil emulsions, soon after or just before an application of lime-sulphur, may cause injury. This is especially true with the soap emulsion. Hard water does not break down the cold pumped emulsion but the water may have to be treated if the 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 emulsions, in general, with the miscible oils: the emulsions are much cheaper, they are effective and are generally considered to be less likely to cause injury. They are less convenient to use and store and greater care is necessary when diluting them to avoid breaking down or the release of free oil. It may be necessary to clean the sprayer tank at intervals to remove any accumulation of oily sludge. The choice between miscible oils and emulsions is largely a question of balancing cost against convenience with the factor of safety somewhat on the side of properly made and used emulsions. It is, of course, necessary to determine first if oils in general, or some oil in particular, is effective against the insects to be controlled.

Precautions in the Use of Oil Sprays:—Applications of oil sprays have been made safely under many conditions but at other times with conditions apparently very similar, serious injury has followed. In order to avoid possible 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 applications of some miscible oils have caused injury to peach trees, therefore should be avoided.

c. Do not apply oil when rain or snow is likely to follow quickly or when the temperature is below 40 degrees F. and is likely to drop to the freezing point before the spray has thoroughly dried.

d. Follow carefully the instructions of the manufacturers with regard to the use of miscible oils in combination with lime-sulphur or other sulphur sprays and where the use of lime-sulphur precedes or follows an application of a miscible oil. An application of soap emulsion should not follow one of lime-sulphur closer than two weeks or be followed by lime-sulphur or other sulphur sprays in less than ten days;. The cold pumped emulsions are probably safer in this respect but it is not definitely established that injury never follows. Injury resulting from the close application of lime-sulphur and oil usually does not occur but has been known to be severe under some conditions.

e. The regular strength of the miscible oils are apparently safe in the dormant and early delayed-dormant period (the green-tip stage) and have often been used in the late delayed-dormant, or even later stages, without trouble, but in some years injury has followed the use of such oils in the late delayed-dormant stage. The application of miscible oils,

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then, should be completed by the early delayed-dormant period. The emulsions apparently are less likely to cause injury at the late delayeddormant period.

f. Clean the sprayer tank and pump thoroughly before using oils, being especially careful to remove all lime-sulphur residue and other sludge or scale.

g. Observe carefully the instructions furnished by the manufacturers of miscible oils and factory-made emulsions for testing and diluting them. It is advisable, with some of them at least, to test a small quantity in a glass of water to see if any free oil comes to the surface. Such materials should not be used.

h. The best procedure in diluting oil sprays is to run a small amount of water into the sprayer tank, 10 to 20 gallons in a 200 gallon tank, start the pump and agitator and pour in the proper amount of miscible oil or stock emulsion. When complete mixture has taken place, fill the tank with water and apply. An excellent precaution, especially in cold weather, is to place the measured oil in an open container, preferably on top of the sprayer, and turn into it the stream from the spray gun or nozzle so that it becomes thoroughly agitated by and mixed with the added water. Proceed then as already described, pouring this mixture into the small amount of water in the tank, with agitation, then fill the tank with water.

i. Inspect every tankful of oil spray during and after mixing to determine if proper mixing has taken place. If free oil comes to the surface, separation has occurred and the entire mixture should be discarded.

Formulae and Methods for Making Emulsions

13. Boiled Soap Emulsion:—This emulsion may be made up in small or large quantities according to the following formula:

	For Small Quantity	For Large Quantity
Oil	1 gal.	30 gals.
Soap	1 lb.	30 Ibs.
Water, with soap to	make $\frac{1}{2}$ gal.	15 gals.

The soap that seems best adapted for this use is potash fish-oil soap containing 60 to 70 per cent of water.

For small quantities, the soap and water are mixed, the oil added and the whole mixture boiled for a few minutes or until the brown scum which forms has disappeared. Remove from the fire and while still hot, pump twice under at least 60 pounds pressure. When pumped under this low pressure the emulsion should be used soon after making.

For large scale operations, the proportions are the same as for small quantities, but the equipment needed is much greater. Two or three 50 gallon barrels for mixing and emulsifying, a storage tank, engine and large all-metal pump that will carry at least 250 pounds pressure, boiler, connections, etc., are needed. Emulsions made under high pressure and pumped four times will hold up for several months. Operations on this scale are possible only for large growers or groups of growers, working co-operatively. This stock emulsion is broken down by hard freezing (15 degrees F.)

14. Cold Pumped Emulsions:—In some districts the cold pumped emulsions are preferred, especially where very hard water must be used. The proportions for this method where casein spreader or calcium caseinate is used follows:

	For small quantities	For large quantities
Oil	1 gal.	30 gals.
Casein spreader	2 oz.	4 lbs.
Water, with spreader to	o make $\frac{1}{2}$ gal.	15 gals.

The equipment necessary is two 50-gallon barrels, a high pressure duplex or triplex pump and a 3 or 4 H. P. engine and pump (the ordinary sprayer pump and engine unit with suction hose will work very satisfactorily.)

To prepare the emulsion, the casein spreader is stirred very rapidly and thoroughly into a small part of the water, then diluted with water to the full amount. The oil is then added with constant stirring. Place the suction hose in the mixture and pump with at least 250 pounds pressure into another container. Repeat until the emulsion has been pumped three times. It is not best to make up more than can be used during the same day as the cold pumped emulsions are not permanent and have to be re-emulsified if allowed to stand very long. If a large quantity is emulsified it is a good practice to place it in small containers, each with enough for one sprayer tank. In case a sprayer without the overhead removable suction is used for making the stock emulsion the mixture can be placed in the sprayer tank and pumped back on itself until thoroughly emulsified. If this method is used, extreme caution should be exercised to be sure that emulsification is complete and that no globules of free oil remain.

Diluting and Using Emulsions:—Home-made emulsions made according to these formulae, and commercial emulsions similarly prepared, contain approximately 66% per cent oil; hence, if a 3 per cent spray is to be used, $4\frac{1}{2}$ gallons of the stock emulsion are required for each 100 gallons of dilute spray. The general rule is that for each 100 gallons of spray the amount of stock emulsion required is always one-half greater than the stated percentage of oil. If an emulsion containing some other percentage of oil is used, dilution should be made accordingly.

The cold pumped emulsions can be used in hard water without breaking down but under such conditions it may be necessary with the soap emulsions to use one pound of caustic soda or lye to each 100 gallons of dilute spray. Another commonly used method is to make a weak bordeaux $(\frac{1}{2}-\frac{1}{2}-100)$ and then add the oil. If the properties of the water are not known, a test should be made with a small quantity to determine if free oil separates out and comes to the top. This indicates a breaking down of the emulsion and the water should be treated.

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

Dusting

15. The substitution of dusting for spraying has taken place, to a certain extent, during the last few years. The future trend in the use

of dusts will probably depend, in a general way, on the improvements in materials and equipment. The gradual accumulation of information concerning the use of dusting materials of all kinds should also make it possible to obtain better results in some instances and to open up new fields where dusting is not now successfully employed.

The dusting method has many distinct advantages over spraying. The original investment for dusting equipment is much less and depreciation and maintenance costs are lower. It is sometimes possible to use 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 and this is a marked advantage, especially with large acreages. Many growers, who do not dust exclusively, employ it 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 and with peaches, the addition 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 all dormant applications and the cost of materials is almost always greater than for spraying. It is frequently more difficult to find conditions favorable for dusting than for spraying. Wind is the most frequent interfering factor, but temperature and humidity are sometimes important. The difficulty of finding favorable conditions is probably compensated for, in part at least, by the greater speed of application.

Many insects and diseases, such as the majority affecting the peach in Michigan during the summer period, may be satisfactorily controlled by dusting. For certain kinds of aphids, leaf-hoppers, etc., nicotine dust may be used to advantage, but there are other pests for which the dusting method 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 and codling moth on apples and pears. In many instances excellent results in the control of these troubles has followed the use of dust but the results have not always been satisfactory. The failures have usually occurred in seasons in which some disease in question has been present in epidemic form, or, in districts where some insects 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 spraving 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

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of codling moth, dust has usually 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.

To repeat-dusting has some marked advantages over spraying, but it also has some obvious shortcomings. Whether or not any particular grower should dust or spray should be determined largely by a balancing of the advantages against the shortcomings 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, water supply, etc. In some instances dusting may be the best procedure for the growing season applications or the grower may prefer to take some chance with regard to control in order to get the benefit of the advantages of the dusting method. In others, dust can be used to advantage for part of the applications or as a supplement to the available spraving equipment. 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.

ESTIMATED COSTS OF SPRAYING APPLES

An idea of the approximate expense of spraying fully grown apple trees is afforded by the accompanying tables. Average retail prices for materials, average labor and machine upkeep costs, average efficiency in spraying and dosage of 10 gallons per tree are assumed.

Material	Dilution	Cost per Gallon	Application Cost per Gallon
Lime-sulfur Lime-sulfur Arsenate of lead Nicotine sulfate	$^{1-8}_{1-40}$ $^{1-50}_{1-800}$	$0212\frac{1}{2}$.0042 $\frac{1}{2}$.0034 .0162	Labor\$.0088 Machine wear

Table I—Cost of spraying per gallon as applied in the orchard.

Table II—Cost of spraying per tree and per acre, assuming 10 gallons per tree per application and 30 trees per acre.

	Application	Material	Dilution	Cost per Tree	Cost per Acre
1.	Dormant	Lime sulfur	1-8	\$0.365	\$10.96
2.	Pre-pink	Lime sulfur and	1-40	.358	10.75
3.	Pink	Lime sulfur and Lead arsenate	1-300 1-40 1-50	.230	6.91
4.	Calyx	Lead arsenate	1 - 50	.230	6.91
5.	2-week	Lead arsenate	1 - 50	. 230	6.91
5.a	21 Day	Lead arsenate	1 - 50	. 230	6.91
6.	Second brood	Lead arsenate	1-50	.230	6.91

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If seven applications are made the total cost will be about \$1.87 per tree or from \$50 to \$60 per acre. Reduced to a bushel basis this means a total spraying cost of approximately 29 cents per bushel of treerun product (this figure being based on the assumption of an average tree yield of 6.5 bushels, the actual average for a large number of fully bearing apple trees in commercial orchards over a period of years). In comparatively few orchards, however, is the 21-day application (No. 5a in the table) necessary and the same statement may be made regarding the dormant application. When those two applications are omitted the cost per tree is reduced to \$1.28, the cost per acre to \$38.39 and the cost per bushel to about 20 cents. This is a considerable saving and may be made with comparatively little risk if the orchard is not infested with scale, leaf roller and red mite. Some growers are inclined to take a chance on omitting the nicotine sulfate from the pre-pink spray, thereby effecting some saving in cost of material. As a matter of fact such an omission will result in a saving of only about 16 cents per tree, or \$4.90 per acre. Reduced to a bushel basis this means about a $2\frac{1}{2}$ cent difference in cost of production in the tree-run product of the average orchard. It is a saving (?) that the grower is hardly warranted in making, in view of the fact that this application properly made practically guarantees commercial control of the rosy apple aphis that dwarfs the fruit.

Twenty cents for every bushel of tree-run fruit is a comparatively high price to pay for comparative freedom from injurious insects and fungi, when the records show that over a period of years and for the general run of varieties 63 cents per bushel is the average value of that quantity of fruit just as it is harvested from the tree. Is there not some practical way of reducing it? The answer is that it can be materially reduced, even cut in two, by speeding up production. If twice the assumed yields are obtained (a figure well within what is actually found in some of the best orchards), spraying costs per bushel are correspondingly reduced, even though on an acre basis they remain the same. This is a reduction that is well worth while and the method of procedure is within the reach of nearly every grower. Furthermore, it is a method of procedure that will effect a corresponding reduction in nearly every one of the other items that enter into cost of production. It is by far the most practicable way of reducing spraying costs.

STAGE OF GROWTH	APPLICATION	MATERIALS	TO CONTROL
	1. DORMANT. Apply before growth begins in spring.	Lime-sulphur, 12½ gallons, water to make 100 gallons: or an oil spray. (See Sec. 12 for "Oil Sprays").	Scale insects, mites and leaf- roller.
	OR A. DELAYED DOBMANT. Apply in the period beginning when the buds show silvery and complete by the time the leaves on blossom buds are ¼ inch long.	Lime-sulphur, 12½ gallons, nico- tine sulphate, 1 pt. water to make 100 gals. or an oil spray. (See Sec. 12 for "Oil Sprays.")	Scale insects, mites, leaf
	2. PREPINK. Begin soon after the delayed dormant stage and finish as soon as possible.	Lime-sulphur, 2½ gallons, and water to make 100 gallons. Add I pint nicotine sulphate if aphid treatment has not been made in the delayed dormant and 3 lbs. lead arsenate if bud moth is present.	Apple scab, aphids and buc moth.
	3. PINK (CLUSTER STAGE). Begin to apply as soon as most buds have separated in the cluster and complete before blossoms open.	Lime-sulphur, 2½ gallons, lead arsenate, 3 lbs. and water to make 100 gallons.	Apple scab, cankerworm green fruit worm, leaf-roller and red-bug.
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SUPPLEMENTARY DIRECTIONS FOR APPLES

16. Leaf-roller:—The leaf-roller is an active, naked caterpillar which rolls the leaves of apple and other fruits, and lives in their shelter, feeding on the leaves and fruits. The winter is passed in the egg stage on the bark, and these eggs may be killed by a spray of a miscible oil or an oil emulsion applied just as the leaf-buds begin to show green. The very latest information available concerning strength to be used will be furnished on request. The later arsenical sprays will aid in killing such individuals as escape the oil spray. Refer to Sec. 12 for general instructions for the use of oil sprays.

17. Aphids:—Three common aphids (aside from the woolly-aphis) work in the tops of apple trees; all winter as eggs on the trees. The budaphid hatches out first but most of the eggs of all three are hatched by the time the trees reach the late dormant condition. It would appear to be well established that early applications for apple applies should be made at the delayed dormant period, or at the most, not later than the pre-pink. The first choice of spraying material would seem to be a delayed dormant spray of lime-sulphur, $12\frac{1}{2}$ gallons in 100 with one pint of 40% nicotine sulphate, when both scale and plant-lice are present. For aphids alone one obtains nearly as good results, at either the delayed dormant period or the pre-pink, from 21/2 gallons of lime-sulphur and one pint of the nicotine. The latter dilute formula serves as well for a summer spray. Derrisol used in place of nicotine in identical proportion is favored by some growers because of its less offensive nature. Delived dormant applications of miscible oils and home-made emulsions are now on trial. Tests seem to show that the former used at strengths recommended by the makers and the latter, so prepared that the spring as applied, contains two gallons of cylinder oil to each 100 gallons of the are effective enough to lead some growers to select them. Several precautions must be observed in order to avoid spray injury when fising oil sprays. These will be noted under the caption of oil sprays. (See Sec. 12.)

In case aphids are troublesome during the summer, spraywhen n with nicotine added to one of the regular summer spraywor with one pint of 40% nicotine sulphate in 100 gallons of water to which has added four pounds of hydrated lime, or four pounds of cheap so por 2½ gallons of lime-sulphur with or without one pounder, casein one spreader. If preferred, spray with Derrisol, one pint to 100 gallons of water, or else dust with freshly made 2% nicotine dust. If factory mixed is used, 3% of nicotine is desirable.

The green apple aphis often returns to the trees during (e stati and its presence does not necessarily mean that one has relled in g the early applications.

18. *Fire-blight:*—Special instructions for the contract of ght will be sent on request.

19. Climbing Cutworms:—Special instructions in Section In wing the grape schedule.

20. Fruit Mites and Clover Mites:—Three species of mites, and perhaps more, affect apples in Michigan,—the clover mite which has a been with us,—the common red spider,—and the European red mit Fortunately, the treatment for all of these is identical and therefore is

is not imperative that the grower distinguish between them too critically, further than to remember that the new European red mite seems to be the one most capable of damaging the trees, and that the clover mite is ordinarily rated as of least importance. 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 applied during the dormant period and consisting of one of the prepared miscible oils or of homemade lubricating oil emulsions. Use these home-made emulsions with 2% of oil. (Secs. 12, 13 and 14). If a prepared miscible 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. (Sec. 12). The "dormant" spray is intended as a destroyer of the eggs. Summer applications of nicotine and dilute limesulphur are not so satisfactory and therefore the principal effort should be expended in making an effective dormant spray.

21. *Red-bug:*—Two species of red-bug infest apples in Michigan, both passing through the winter buried in the bark in the egg stage. Nicotine applied just after the eggs hatch, or possibly derrisol, serves best to control both species. For the dark, apple red-bug, the best time to spray is at the late "pink" stage, while for the light species, a calyx spray is better, since the latter species hatches out later than the dark species. If one finds difficulty in getting control with either spray, it will be well to try the other one, or to add nicotine at both periods, as a test. Nevertheless, where both species are present, as is usually the case, the calyx spray seems to be the more effective of the two.

22. Apple-maggot:—The apple-maggot or rail-road worm is the larva of a true fly which lays its eggs in slits cut in the flesh of the fruit. The winter is passed underground and the adults fly from mid June until mid August. They continue to lay eggs until frost. The maggots refuse to leave the fruit until it falls to the ground, but leave the apples and burrow into the ground very soon afterward. Remove apples daily, within a few hours after they fall, and bury deeply (two feet deep or more) and apply extra arsenical sprays, with or without lime-sulphur, to keep fruit covered up until the time of last codling-moth application. The inmediate destruction of fallen fruit, by hand or by farm animals, is of utmost importance.

17

PEARS

STAGE OF GROWTH	APPLICATION	MATERIALS	TO CONTROL
A CONTRACT OF THE OWNER	1. DORMANT. Time to be determined by insects to be controlled.	Oil-emulsion (3 per cent heavy oil) or a miscible oil, or lime- sulphur, 12½ gallons and water to make 100 gallons.	Psylla, scale insects an blister mite.
	2. DELAYED DORMANT OR PREPINK. When in the condition shown at left.	Bordeaux, 4-8-100 (See Sec. 9 for instructions for making bor- deaux).	Pear scab.
A BBB	3. PINK OR CLUSTER. Apply when the buds have separated in the cluster but before the blossoms have opened.	Bordeaux; 4-8-100 (See Sec. 9 for instructions for making bor- deaux).	Pear scab.
138	4. PETAL-FALL (CALYX). Just as the petals are falling and complete at once.	Bordeaux, 3-8-100 with 3 lbs. lead arsenate to each 100 gallons of spray.	Pear scab and codling mo
	6. SECOND BROOD. Time determined the same as for apples.	Lead arsenate, 2 lbs. in 100 gallons of water.	Codling moth.

SUPPLEMENTARY DIRECTIONS FOR PEARS

23. *Pear Psylla Control:*—Spray from the ground. Spray very thoroughly. Use driving spray with high pressure. Pear psylla cannot be controlled by ordinary spraying. All applications for psylla should be made from the ground to insure covering of the under sides of spurs, branches, leaves and stems.

For psylla the most satisfactory treatment now seems to be the use of a 3% home-made oil emulsion applied as a dormant spray, or one of the miscible oils diluted according to the directions supplied by the makers, applied just after the insects come out from their hiding places and before many eggs are laid. In using home-made emulsions (See directions in Secs. 13 and 14) add $4\frac{1}{2}$ gallons of the stock emulsion containing three gallons of either Enarco spray oil or Atlantic Red Engine oil, or some similar heavy oil, to $95\frac{1}{2}$ gallons of soft water. Also observe precautions against spraying during freezing weather, or of preceding or following oil sprays too closely with lime-sulphur. As a summer followup spray, one can use one pint of nicotine-sulphate in 100 gallons of water adding from 30 to 40 pounds of hydrated lime. This works well with bordeaux.

24. Climbing Cutworms:—Special instructions in Sec. 37 following the grape schedule.

25. *Fire-blight*:—Special instructions for the control of fire-blight will be sent on request.

CHERRIES*

	APPLICATION	MATERIALS	TO CONTROL	
1.	DORMANT. Apply just before growth starts.	Lime-sulphur, 12½ gallons with water to make 100 gallons.	Scale insects. For aphid control, refer to Sec. 26.	Sour cherries the sweet v scale only wh
2.	PETAL-FALL. Just after the petals have fallen.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 2 lbs. and water to make 100 gallons.	Leaf-spot, brown-rot, curculio and slugs.	This applicati "shucks" are
3.	TWO-WEEKS. Should be com- pleted within two weeks after petal-fall.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 2 lbs. and water to make 100 gallons.	Leaf-spot, brown-rot, curculio, slugs.	
4.	FOUR-WEEKS. Should be com- pleted within four weeks after petal- fall.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 2 lbs. and water to make 100 gallons.	Leaf-spot, brown-rot, curculio, slugs and maggots.	Lead arsenate harvest) exce factory and
4a.	SPECIAL. For the control of cherry maggots.	Refer to Sec. 27 for information concerning	a special application for the control of	cherry maggots
5.	AFTER HARVEST. Just after the fruit is harvested.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 1 lb. and water to make 100 gallons.	Leaf-spots and slugs.	This is desi leaf-spot and

*Sweet Cherries. All cherries should be sprayed according to this schedule, but for summer application on sweet cherries the lime-sulphur in 100. Avoid heavy spraying.



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

27. Black Cherry-louse:—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% nicotine sulphate, just as the leaf-growth is nicely started (before blossoming) before leaves curl, using one pint to 100 gallons of strong soap-suds (2 to 3 pounds of soap) or $2\frac{1}{2}$ gallons of lime-sulphur and drench every leaf, twig, spur and water sprout or sucker.

28. Fruit-flies:—There are two species of fruit-flies, one of which is common in Michigan. These fruit-flies produce maggots which feed in the fruit. These larvae are footless and headless, about one-fourth inch long. 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 June. For canning cherries which are to be thoroughly washed, put on an application of arsenate of lead, using 2 pounds to 100 gallons of water, during early and mid-June to kill the flies before they lay their eggs.

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 dates so determined.

29. Climbing Cutworms:—Special instructions in Sec. 37 following grape schedule.

PEACHES (Apricots and Nectarines)

	APPLICATION	MATERIALS	TO CONTROL	
1.	DORMANT. Apply in early spring before growth starts.	Lime-sulphur, 12½ gallons and water to make 100 gallons.	Leaf-curl and scale insects.	To iasure contr made before g an oil spray is special instruct
2.	After the blossoms have dropped and most of the "shucks" are off.	Dust with lead arsenate-lime mixture con- taining 5 per cent lead arsenate, or spray with lead arsenate, 2 lbs., lime 8 to 10 lbs. and water to make 100 gallons.	Curculio.	If the lead arse 80-5-15 sulphur although the u essential. When do not use more
3.	About two weeks after No. 2.	80-5-15, sulphur-lead arsenate-lime dust, or spray with dry-mix sulphur-lime, 25 lbs. (See Sec. 10), lead arsenate 2 lbs., fresh hydrated lime, 8 lbs. and water to make 100 gallons.	Curculio, brown-rot and scab.	This is importa peach scab and on the early th
4.	About one month before the fruit ripens.	80-5-15, sulphur-lead arsenate-lime dust or spray with dry-mix, lead arsenate and lime as in No. 3.	Brown-rot, scab, and curculio.	If curculio is a fluffer) or spr arsenate or exc
5.	One week to ten days before the fruit ripens.	Sulphur dust (with fluffer) or a wettable sulphur. (See Sec. 11)	Brown-rot.	On many varie to retard rot d

SUPPLEMENTARY DIRECTIONS FOR PEACHES

30. *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 recommended method of control. It is applied as follows:

Prepare the tree by removing weeds, grass and debris from near the crown. 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 half an ounce to a well grown tree. Use less on a tree under six years old and half an 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. It does not work well when the temperature of soil at four inches depth falls below 58 or 60 degrees F.

In case one does not wish to use paradichlorobenzene, dig out the larvae in spring or fall and either mound or ditch, to facilitate the process. The knife or other instrument used for digging out the borers should be sterilized with lysol to prevent the carrying of crown-gall infection from tree to tree.

31. 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. "Dead spots" appear in the orchard. Remove trees from such areas and put the land in clover for several years before resetting to peaches.

32. Climbing Cutworms:—Special instructions in Sec. 37 following the grape schedule.

PLUMS

	APPLICATION	MATERIALS	TO CONTROL	
1.	DORMANT. Apply just before growth starts.	Lime-sulphur, $12\frac{1}{2}$ gallons and water to make 100 gallons.	Scale insects.	Whether or not depend on the p
2.	SPECIAL. Just as leaf-buds burst and before blossoms open.	Lead arsenate, 2 pounds and water to make 100 gallons.	Curculio.	Beetles feed on th from hibernation. as additional in infestation has be
3.	PETAL-FALL. Just after the petals have fallen.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 2 to 3 pounds and water to make 100 gallons.	Curculio, leaf-spot and brown-rot.	If curculio has b the poison may va of water. Japan with lime-sulphu and use not more 100 gallons of wa
4.	TWO-WEEKS. Ten days to two weeks after No. 3.	Lime-sulphur, $2\frac{1}{2}$ gallons, lead arsenate, 2 to 3 lbs. and water to make 100 gallons.	Curculio, leaf-spot and brown-rot.	The number of e will depend on curculio. Leaf-s districts.
б.	LATE SUMMER. About one month before harvest.	Lime-sulphur, 2½ gallons, and water to make 100 gallons.	Brown-rot, leaf-spot and curculio.	This is an impo brown-rot. If cu arsenate to each
6.	SPECIAL. One week to ten days before harvest.	Sulphur dust (with small percentage of a fluffer) or a non-staining spray. (Sec. 11)	Brown-rot.	This application the development transit.

SUPPLEMENTARY DIRECTIONS FOR PLUMS

33. 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. They are sources of re-infection.

34. Black Knot:—Plum or cherry orchards, in which this disease is present, should be inspected in the late fall or early spring, before infection takes place, and all knots removed and destroyed. 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 out of diseased parts may be necessary.

35. Climbing Cutworms:—Special instructions in Sec. 37 following the grape schedule.

GRAPES

	APPLICATION	MATERIALS	TO CONTROL	
1.	When shoots are 8 to 10 inches long.	Bordeaux, 8-8-100 (See Sec. 9 for instructions for making bordeaux).	Black-rot and downy mildew.	If black-rot application sh This is a critic rot develops i
2.	Just before the blooming period.	Bordeaux, 8-8-100 and lead arsenate, 3 lbs. in each 100 gallons of spray. (Refer to Sec. 9 for instructions for making bordeaux).	Black-rot, berry-moth, downy mildew and rose chafer.	If rose-chafe perhaps a gal
3.	Just as the blossoms are falling.	Bordeaux, 8-8-100 and lead arsenate, 3 lbs. in each 100 gallons of spray.	Black-rot, berry-moth, downy mildew and rose-chafer.	Very importan
4.	Ten days to two weeks after_the blossoming period.	Bordeaux, 8-8-100 and lead arsenate, 3 lbs. in each 100 gallons of spray.	Black-rot, downy-mildew and berry- moth.	The importan whether wea development poison should berry-moth.
5.	Just as the berries began to touch in the clusters.	Bordeaux, 4-4-100 and lead arsenate, $2\frac{1}{2}$ lbs. and resin fish-oil soap, 2 lbs. and nicotine sulphate 1 pt. in each 100 gallons of spray.	Black-rot, downy-mildew, berry-moth and leaf-hopper.	This applicat serious attac application for this time. (S if hoppers are

SUPPLEMENTARY DIRECTIONS FOR GRAPES

16. Grape Berry-Moth:—Application No. 5 should be made with trailing hose, short rods and angle nozzles. Spray upward so as to get under the foliage and fill the bunches with spraying material. Use large amounts of material.

37. Grape Leafhopper:—Spray in exactly the same manner as outlined above for the control of berry-moth. It is very necessary to hit the under sides of the leaves. Use nicotine sulphate (40%) one pint to 100 gallons of water with soap, three to four pounds, or add the nicotine sulphate to the berry-moth application, or dust with 2% nicotine and hydrated lime. Apply dust at night while the air is not stirring. Use freshly mixed hot dust. If cold dust is used, use a higher per cent of nicotine. Apply just as the very first nymphs of the leafhopper acquire wings.

, 38. 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 the worst following a cold, wet spring. The attack comes early in the season. The "worms" ascend trees and feed on buds, young leaves and 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. In the case of grapes, the arms and wires should be tanglefooted but in the case of newly set orchards the tanglefoot should be applied to a strip of paper wrapped around the tree and the ordinary poisoned bran-bait should be scattered on the ground at the bases of the trees to supplement the bands in order to prevent the "worms" from gnawing the bark just below the band.

Formula for bran-bait:

- 20 pounds wheat bran
- 1 pound white arsenic
- 1/2 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 $8\frac{1}{2}$ gallons of water and then stirring in and dissolving 100 pounds of white arsenic. This makes a stock solution of arsenate of soda containing 8 pounds of arsenic to the gallon. In preparing bait add one quart of the stock solution to ten gallons of water, two gallons cheap molasses, and use this to moisten 100 pounds of bran, then stir in three ounces of banana oil. Made by this formula, no great amount of stirring is required. For preliminary statement containing more detailed directions, see Michigan State Quarterly Bulletin, Vol. 9, No. 4.

39. *Flea-beetle:*—The grape flea-beetle used to be a serious pest in this state but the regular routine sprays usually applied in Michigan vine-yards, have proven very effective in keeping them down.

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

CURRANTS AND GOOSEBERRIES

	APPLICATION	MATERIALS	TO CONTROL	
1.	DORMANT. Apply just before growth starts.	Lime-sulphur, $12\frac{1}{2}$ gallons, and water to make 100 gallons.	Scale insects.	Scale is seldom present on cu when necessary
2.	When terminal leaves are one-half to one inch in diameter.	Bordeaux, 8-8-100. (See Sec. 9), 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 cri thorough work upward from b
3.	Soon after the blooming period.	Bordeaux, 8-8-100. (See Sec. 9), and lead arsenate, 2 lbs. in each 100 gallons of spray.	Leaf-spot and leaf-eating insects.	The number governed by tl susceptibility persist, add thoroughly.
-	the state of the s			
4.	Ten days or two weeks after No. 3.	Bordeaux, 8-8-100 (See Sec. 9), lead arsenate, 2 lbs. in each 100 gallons of spray.	Leaf-spot and leaf-eating insects.	
5.	Just after the fruit is harvested.	Bordeaux. 8-8-100, (See Sec. 9 for instruc- tions for making bordeaux).	Leaf-spot.	This is desirabl controlled in ea

SUPPLEMENTARY DIRECTIONS FOR CURRANTS AND GOOSEBERRIES

40. *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.

41. Witches-brooms:—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 over-winters on the gooseberry in the egg stage. The eggs hatch in April and May and a spray of nicotine at that time applied in the ordinary way is more effective than at any other for, while the brushy-heads or witches-brooms appear and continue to develop later in the season, the lice themselves are more plentiful just after the eggs hatch.

42. Currant-borer:—The currant-borer is the larva of a moth, which larva burrows in the smaller canes of the currant, eating out the pith and leaving a blackened burrow which causes the death of the cane. The parent moths fly in June, depositing 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 as shown by the sickly foliage, being sure to cut below the bottom of the burrow, and burn all pruned out canes.

43. 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, $2\frac{1}{2}$ 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.

Potassium sulphide (liver-of-sulphur) may be used in place of limesulphur. As a late spray it has the advantage of not spotting the fruit. It should be used at a strength of 3 pounds to 100 gallons of water.

DISEASE CONTROL FOR RASPBERRIES, DEWBERRIES AND BLACKBERRIES

44. Use vigorous disease free plants:—Every new planting should be started with vigorous plants which have come from plantings having 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.

45. Remove the old canes from black raspberry and dewberry tips before planting:—Anthracnose is carried to the new field on the so-called "tails." Removing these and covering all parts of the tips with soil greatly reduces anthracnose in the new planting.

46. Rogue first year plantings of raspberries several times for curl, mosaic, streak, and orange rust:—This is one of the most important measures for raspberry disease control. The diseases named above can be practically eliminated the first year, making subsequent control relatively simple and inexpensive. Blackberry plantings should be rogued for orange rust.

47. Rogue older raspberry plantings if the percentage of disease is not too high:—Fields more than a year old and having more than ten per cent curl, mosaic, streak and orange rust rarely pay for rogueing. If the percentage is lower careful rogueing may be of value. No field which is well rogued the first year should show more than one per cent of the plants diseased the second year. Usually, old fields having less than 2 per cent of these diseases can be successfully rogued.

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

1. When the buds show green. Use 5 to 10 gallons of liquid lime sulphur and add enough water to make 100 gallons.

2. About one week before the blossoms open. Use bordeaux mixture 4-8-100 (See Sec. 9 for instructions for making bordeaux.) Two gallons of liquid lime sulphur, to which enough water is added to make 100 gallons of the mixture, applied at this time will also control anthracnose but there is more danger of burning the leaves than with bordeaux.

After-blossom sprays are likely to cause leaf injury. Usually red raspberries and blackberries are not sprayed. Purple raspberries may be sprayed if anthracnose becomes severe.

SPRAYING YOUNG NON-BEARING ORCHARDS

49. 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 they be found, the dormant spray, as recommended for bearing trees, should be applied. If aphids have been prevalent make the delayed dormant application instead, using lime-sulphur and nicotine sulphate as recommended in the apple schedule. (Application la). Aphids may cause serious injury to young apple trees by attacking the new growth and by spreading fire-blight. 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 soon after growth is well started with nicotine sulphate (40%), one pint in 100 gallons, to which has been added two or three pounds of soap. 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. Failure to control borers may seriously impair the vigor of the trees.

Pearst. Young pear orchards should be examined every year for the presence of scale. If present, make the dormant application. Psylla seldom attacks young, open plantings of pears seriously 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 important 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 berry-moth or leaf-hopper.