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## INSTRUCTIONS for SPRAYING

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Reprint from the Annual Report of the Missouri State Board  
of Horticulture, 1908.



THE HUGH STEPHENS PRINTING COMPANY,  
JEFFERSON CITY, MO.





## INSTRUCTIONS FOR SPRAYING.

(By W. H. Chandler, Assistant Horticulturist, Missouri Agricultural Experiment Station,  
Columbia, Mo.)

If fruit is grown long in a country, insect enemies and fungous diseases generally become more numerous and it becomes necessary to combat them in some way, if orcharding is to be successful in that country.

The most successful method of combating the great majority of the orchard insects and diseases is by spraying.

In spraying for *insects that eat the surface of the leaves and fruit*, we generally use some form of arsenic as a poison. In spraying for the more common *diseases of the orchard*, we generally use copper sulphate with lime, making a mixture generally known as Bordeaux Mixture.

Spraying is an expensive process, but for successful orcharding in most sections it is absolutely essential. Professor Forbes of the Illinois Experiment Station has shown that spraying for one insect at a cost of seventeen cents per tree, will increase the profit from the orchard two and one-half times under their conditions. So while spraying is expensive it is nevertheless profitable where the insects and diseases are very prevalent. It may often make the difference between a good profit and no profit at all.

### SPRAYING APPLES.

In an apple orchard insects that can be sprayed against and the ones that give the most trouble are the Codling Moth and Curculio. In the case of the Codling Moth the egg of the first brood is laid in the blossom end of the fruit and that of later broods may be deposited most anywhere on the fruit and in either case the worm that hatches out must eat its way into the fruit, beginning at the surface and will thus be killed if we have a poison on the surface which will be the first thing it eats. In the case of the Curculio, the adult eats into the fruit both for feeding and for

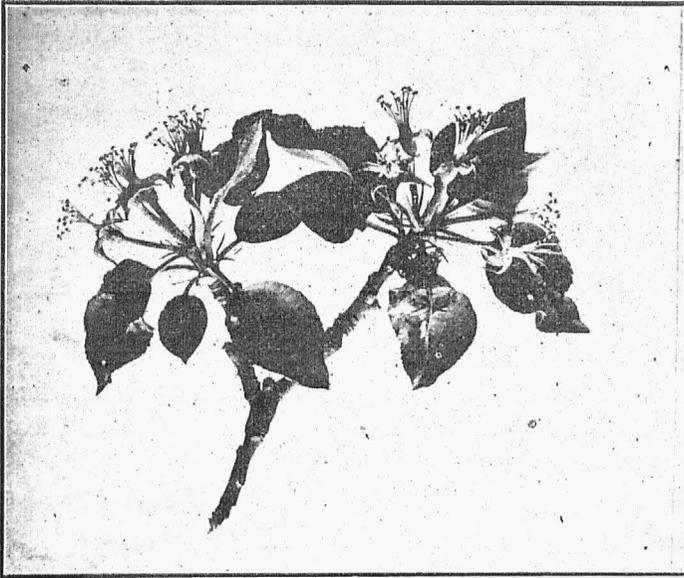


Figure 1. Apple blossoms at the proper stage for spraying for codling moth with arsenate of lead, using a Bordeaux nozzle which throws a strong coarse stream that will penetrate the cluster of stamens and fill up the calyx or flower cup.



Figure 2. Apple scab attacks the leaves. The diseased foliage may be spotted as shown on the twig at the left of the picture, or the leaves may turn black and drop off.

the purpose of depositing its eggs. The adult early in the season feeds on the young leaves so that if a poison is on the leaves early, the adult will eat it and be killed.

The fungus diseases that are most largely to be found in the apple orchard, are Apple Scab and Bitter Rot. The apple scab is found as a scabby appearance on the leaves and fruit early in the season and is favored by cool wet weather. The bitter rot appears later in the season, causing often a serious rotting of the apples. It is favored by hot wet weather.

It is plain that when we spray for both Curculio and Codling Moth, the Apple Scab and these insects and diseases are prevented at the same time. So in most cases the following spray would be the remedy for Apple Scab and these two insects.

#### THE FIRST SPRAYING.

Just before the blooms open, but after the buds have unfolded and the whorl of leaves that come out behind the blooms are out.

This is a most important spraying for apple scab and helps to control curculio and may be a benefit for other insects, such as canker worm.

Use copper sulphate, four or five pounds; lime, four or five pounds; lead arsenate paste, two pounds; and water fifty gallons.

If there is no apple scab in the orchard and the orchard has not been troubled with it for a year or so previous, the copper sulphate and the lime may be omitted and only the lead arsenate paste used at this time.

#### SECOND SPRAYING.

Just after the bloom falls.

This is the most important spraying for codling moth and should be very thorough and the nozzle should be so adjusted that the spray can be forced downward strong enough so that it will penetrate and fill the blossom end of the fruit.

Use arsenate of lead, two pounds; water fifty gallons, and if there is apple scab present, use in addition, two pounds of copper sulphate and three pounds of lime.

#### THIRD SPRAYING.

The next spraying should be given in about fifteen days to three weeks, using the same mixture.

Other sprayings should be given if bitter rot and fruit blotch

are present. In spraying for bitter rot use four pounds of copper sulphate and four pounds of lime to fifty gallons of water. It is also best to add two pounds of arsenate of lead for biting insects. The first spraying for bitter rot should be given about the middle of June, and if the orchard is badly infected, two other sprayings at intervals of about three weeks will be necessary.

#### SPRAY CALENDAR.

**APPLE.—*Scab.*** 1. Use strong Bordeaux mixture, containing five pounds of copper sulphate, five pounds of lime and fifty gallons of water, before the flower buds open. 2. Repeat just after the flowers fall. 3. If the orchard is badly infected, repeat at intervals of three weeks for two more sprayings.

*Bitter Rot.*—Use Bordeaux mixture, four pounds of copper sulphate and four pounds of lime in fifty gallons of water about the middle of June, or if it has not previously been serious, spray when the disease appears. Give two or three other sprayings at intervals of about three weeks.

*Canker Worm, Codling Moth, Curculio and Other Biting Insects.*—Use lead arsenate or other arsenical poison in the same kind of Bordeaux mixture recommended for the diseases.

*Canker, Blight.*—Cut out dead and diseased parts, apply sprays to large branches and trunks at each spraying.

*San Jose Scale.*—Use boiled lime-sulphur wash while the trees are dormant.

**GRAPES.—*Black Rot, Downy Mildew, Biting Insects.*** 1. Use Bordeaux mixture with arsenites before the flower buds open. 2. Repeat as soon as the flowers have fallen. 3. Repeat again at intervals of ten days or two weeks as may be needed.

**PEACH.—*Brown Rot, Scab.***—Use unboiled lime-sulphur solution about four weeks after blooming—about a month before the fruit is ripe, and midway between these two seasons.

*Leaf Curl.*—Use Bordeaux mixture or lime-sulphur when the trees are dormant.

*San Jose Scale.*—Use boiled lime-sulphur wash or some miscible oil such as Scalicide when the trees are dormant.

*Curculio.*—It is possible to use lead arsenate in a weak solution, such as one to one and one-fourth pounds in fifty gallons of water, but this will sometimes cause the leaves to fall badly. Probably the safest remedy that is reasonably effective against curculio, is to cultivate the orchard during July and possibly through

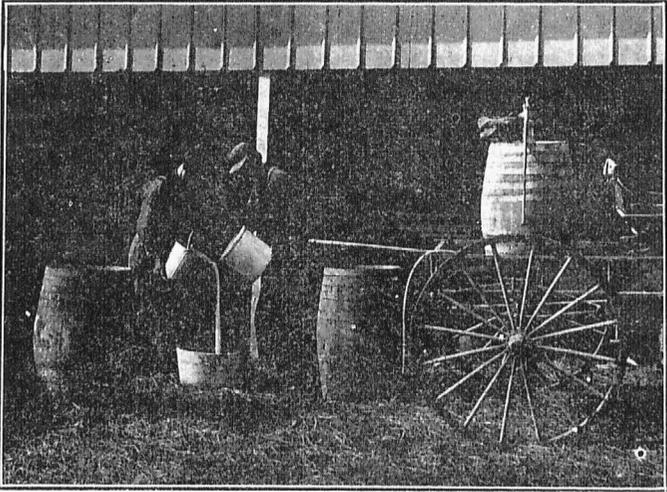


Figure 3. Small quantities of Bordeaux mixture may be made by pouring the two diluted materials together into a tub from buckets.

August. Of course the cultivation one year will help to keep the curculio in check the next year. This cultivation not only helps to keep the curculio in check, but by so doing also helps to keep down brown rot. A peach orchard in which curculio are bad should always be cultivated.

PEAR.—*Blight*.—Cut out all affected branches in the fall or winter, and repeat as often as necessary during the growing season. Cut several inches below the signs of the disease and burn all branches removed. Spraying will do no good whatever.

PEAR.—*Scab and Leaf Spot*.—See under Apple.

PLUM.—*Brown Rot*.—See under Peach.

PLUM.—*Black Knot*.—Cut out knots and burn. Spray as for brown rot.

PLUM.—*Curculio*.—Some success from spraying with arsenites before the buds open and twice afterwards. Jar the trees for a period of a month after the fruit has set, at intervals of one to three days, catching the insects on a cloth and killing them.

CHERRY.—*Leaf Spot*.—Self-boiled lime-sulphur about a month after blooming and just after fruit is picked.

RASPBERRY, BLACKBERRY AND DEWBERRY.—*Anthracnose*. 1. Cut out all affected canes in the spring and spray before the buds open with Bordeaux mixture. 2. Spray again at frequent intervals, using the same formula. As the fruit ripens use ammoniacal copper carbonate.

*Orange Rust*.—Prevent with Bordeaux mixture or some other fungicide. Plants attacked should be dug up and burned, as it is almost impossible to cure after once attacking a plant.

STRAWBERRY.—*Mildew*.—Dust with sulphur at the first sign of the disease. Bordeaux mixture is equally effective.

*Rust*.—1. Apply Bordeaux mixture before the flowers open. 2. Ammoniacal copper carbonate before the fruit ripens. 3. After fruiting, apply Bordeaux mixture again as may be needed.

POTATO.—*Blight, Rot and Beetle*.—Use Bordeaux mixture and lead arsenate when either appears and again at intervals of ten days as long as either is prevalent. The Bordeaux mixture is for the blight and rot and the lead arsenate is for the beetle, but generally both should be used.

TOMATO.—*Blight and Rot*.—Bordeaux mixture when first fruit is half grown; Bordeaux again in ten to fifteen days. Ammoniacal copper carbonate should be used when the fruit is ripening, if any spraying is necessary at that time.

## FUNGICIDES.

*Bordeaux Mixture.*

Copper sulphate (blue vitriol).....	4 pounds
Quick lime . . . . .	4 pounds
Water . . . . .	50 gallons

Dissolve the copper sulphate by hanging it in a sack in a wooden tub of water so that the bottom of the sack just dips into the surface of the water. Hot water will dissolve the copper sulphate more rapidly. Slake the lime slowly so as to get it into as fine a powder as possible. Add twenty-five gallons of water to the lime, dilute the copper sulphate to twenty-five gallons, then pour the two liquids at the same time into the spray barrel or tank. This is a very important step in making Bordeaux mixture and is the one most frequently neglected. The accompanying illustrations show how the mixing is done on both a large and a small scale. In making up this formula, if the two materials are mixed in a concentrated form the solid particles in the mixture will not stay in suspension well. This will result in an unequal distribution in spraying, the first of the mixture being stronger than the last.

In making up considerable quantities of Bordeaux mixture, it is convenient to have the mixing tank elevated so that the prepared mixtures may be drawn into the spray tank without the necessity of dipping or lifting. In Fig. 4 is shown such an arrangement. The barrels in the center contain the diluted copper sulphate and milk of lime, which may be run together and mixed as they flow through the pipe connecting them and into the tank. The barrels on either side of the center pair contain the stock solutions of copper sulphate and lime. The stock solution of copper sulphate is made by dissolving the crystals in water at the rate of one pound to the gallon, or fifty pounds in fifty gallons of water. It is best to suspend a sack of the crystals in the top of a barrel of water. To make up a tank of fifty gallons of Bordeaux mixture, four gallons of this stock solution would be used.

Slake a weighed quantity of fresh stone lime in the usual manner by sprinkling with just sufficient water so that it will crumble into a fine dust. The stock solution of lime is made up by adding enough water to the lime powder so that each gallon will contain one pound of lime. In making up the dilute solution for mixing



Figure 4. Convenient plan for mixing fairly large quantities of Bordeaux mixture. The middle two barrels are connected with pipes which come together, and thus the two mixtures are easily combined before passing into the spray tank.

in a 50-gallon spray tank, take four gallons of the stock solution of copper sulphate, four gallons of the *well-stirred* milk of lime, each being poured into its respective barrel. Twenty-one gallons of water are then added to the copper sulphate barrel; twenty-one gallons of water added to the lime barrel and each barrel then marked exactly and plainly the height of the solution in it. In mixing future amounts it is then necessary to measure only the stock solutions, and add water until the barrels are filled to the mark made in the first filling. Since Bordeaux mixture is not efficient for a great length of time after it is made, it is necessary to make up only the amount which is needed to fill the tank or which can be used that day. Arsenate of lead should be added for biting insects.

*Self-Boiled Lime-Sulphur Wash :*

Sulphur . . . . .	10 pounds.
Lime . . . . .	10 pounds.
Water . . . . .	50 gallons.

Place the lime in a barrel and pour on enough water to start it slaking and to keep the sulphur off the bottom of the barrel. Then add the sulphur, which should first be worked through a sieve to break up the lumps, and finally pour in enough water to slake the lime into a paste. Considerable stirring is necessary to prevent caking on the bottom. After the violent boiling which accompanies the slaking of the lime is over, the mixture should be diluted ready for spraying, or at least enough cold water added to stop the cooking. Five to fifteen minutes are required for the process, according to whether the lime is quick acting or sluggish. The intense heat seems to break up the particles of sulphur into about the physical condition of precipitated sulphur, and the violent boiling makes a good mechanical mixture of the lime and sulphur. Only a small percentage of the sulphur—enough to improve the adhesiveness of the mixture—goes into the solution, but if the hot mass is allowed to stand as a thick paste the sulphur continues to unite with the lime, and at the end of thirty or forty minutes enough of the reddish liquid is produced to burn peach foliage, and even apple foliage, in some cases. Hence the necessity for cooling the mixture as soon as the lime is well slaked.

The mixture should be strained through a sieve of 20 meshes to the inch in order to remove the coarse particles of lime, but all the sulphur should be worked through the strainer.

The directions for making this mixture were taken from Circular of Information No. 27, Bureau of Plant Industry, Department of Agriculture, Washington, D. C., by Professor W. M. Scott. It has been found by Professor Scott that this mixture will not injure the foliage of peaches, plums and cherries, and can be used to spray for peach scab and brown rot, and also for the leaf spot on cherries to good advantage.

*Ammoniacal Copper Carbonate:*

Copper carbonate . . . . . 6 ounces.  
 Strong ammonia (just enough to dissolve the  
 carbonate) about . . . . . 3 pints.  
 Water to make . . . . . 50 gallons.

Dissolve the copper carbonate in the ammonia, using no more of the ammonia than will barely dissolve the copper carbonate. When all is in solution, add fifty gallons of water and it is ready for use. This is for use only when the fruit is ripe, or nearly so, and we do not wish to discolor it with Bordeaux mixture.

FORMALIN SOLUTION.

*For Potato Scab:*

Formalin . . . . . 1 pint.  
 Water . . . . . 30 gallons

Soak the potatoes in this solution for about two hours before cutting into pieces for planting.

FOR GRAIN SMUT.

Mix one pint of commercial formalin (40 per cent strength) with fifty gallons of water in a large tub, or barrel. Pour the grain to be treated on a floor and sprinkle with the solution from a sprinkling can until the surface of every kernel is thoroughly moistened; allow to stand in the pile ten minutes, then spread out in a thin layer in an airy place to dry, shoveling over occasionally to hasten the drying process.

Another method of using this solution is to place the grain in gunny sacks and immerse in the liquid for ten minutes, taking care to see that the solution penetrates to the center of the mass. Hang up and allow to drain for five or ten minutes, then spread out and dry.

This method is entirely effective for smuts of both oats and wheat.

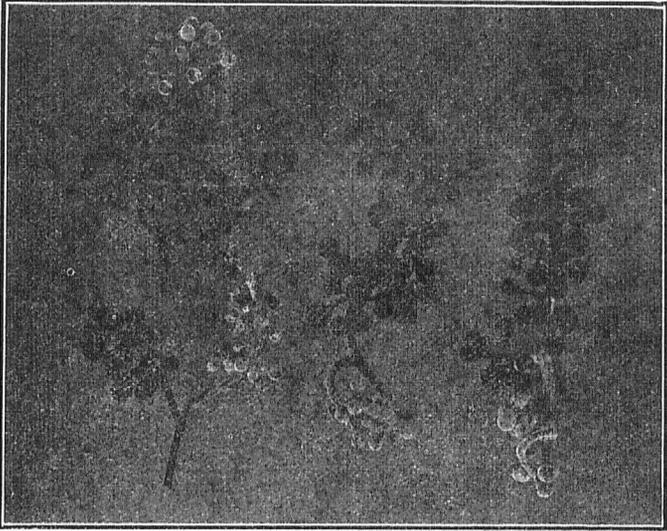


Figure 5. Clusters of young grapes affected by Downy Mildew.

## INSECTICIDES.

*Paris Green:*

Paris green .....	1 pound.
Quick lime .....	3 pounds.
Water . . . . .	100 to 175 gallons.

This insecticide is for *biting insects* only. It may be applied along with Bordeaux mixture, in which case the Bordeaux mixture is considered as so much water and the Paris green and lime added to it in the above proportions. The Paris green will mix with the water more readily if mixed with the lime after slaking and before putting into the spray tank. If added dry to the water, it is apt to float around on top of the liquid. It is thought to be the best insecticide to use with the lime sulphur wash.

*Arsenate of Lead:*

Lead acetate . . . . .	24 ounces.
Arsenate of soda .....	8 ounces
Water .....	100 gallons.

Use only the very best chemicals in making this preparation. Dissolve each of the materials in a separate bucket half full of water. After both are thoroughly dissolved, pour them together into another bucket and allow the mixture to stand for a few hours. A white precipitate or sediment is formed, which is the arsenate of lead. All of the bucketful should be added to a spray tank containing one hundred gallons of water, and it is then ready for use.

Arsenate of lead is one of the best insecticides to use for biting insects. It is less liable to injure the foliage than Paris green, sticks very well, and its white color shows very plainly where it has been applied.

Arsenate of lead is handled by dealers in spraying supplies as a commercial article, under the name of "Disparene." In large quantities it can be made more cheaply than bought in this form, but where only a small amount is needed Disparene is the cheaper. Two pounds of Disparene should be used in fifty gallons of water.

Besides Disparene (Bowker Chemical Co.), a number of companies have a good grade of arsenate of lead paste on the market, viz., the Swift's, Sherwin-Williams, Henry Heil, and others. Only high grades of lead arsenate should be used and each package should bear a statement and guarantee of the analysis.

*Hellebore:*

Fresh powdered white hellebore..... 1 ounce.  
 Water . . . . . 3 gallons.

Apply when thoroughly mixed. Hellebore is used when it is not advisable to use arsenates on account of the tender foliage or proximity to the ripening period.

*Kerosene Emulsion:*

Kerosene (coal oil) ..... 2 gallons.  
 Hard soap ..... 1½ pound.  
 Water (soft) ..... 1 gallon.

Dissolve the soap in boiling soft water, adding the kerosene as soon as all of the soap is dissolved. Mix by pumping back into the tub with the spray pump for fully ten minutes. A thick, creamy emulsion is formed from which the oil does not readily separate. For use mix this emulsion with nineteen gallons of water. If the stock emulsion has become cold it may be necessary to soften it up so as to mix more freely with the water by using some hot water. This is especially valuable in fighting plant lice and other soft-bodied insects which suck the juices of plants.

*Hydrocyanic Acid Gas:*

Fused cyanide of potassium (98 per cent  
 pure) ..... 1 ounce.  
 Sulphuric acid (concentrated) ..... 2 ounces.  
 Water . . . . . 4 ounces.

This is sufficient for one thousand cubic feet of space, and exposure to it should not be made for longer than one hour. Fumigating with this gas must be done in a tight box or room to secure efficiency against insects and to protect other plants, animals and men from injury. *This gas is very poisonous and must not be inhaled for even a moment.*

Empty the water into a glass vessel and pour the acid slowly into this. After weighing out the proper amount of potassium cyanide tie it up in a cloth sack just large enough to hold it. An old tobacco sack is just right. Place the jar of acid where it is wanted. Drop into it the sack of cyanide and quickly close the box or run out of the room, shutting the door tightly behind you. This gas is especially useful in greenhouse and nursery fumigation. No insect can withstand thorough fumigation with it.

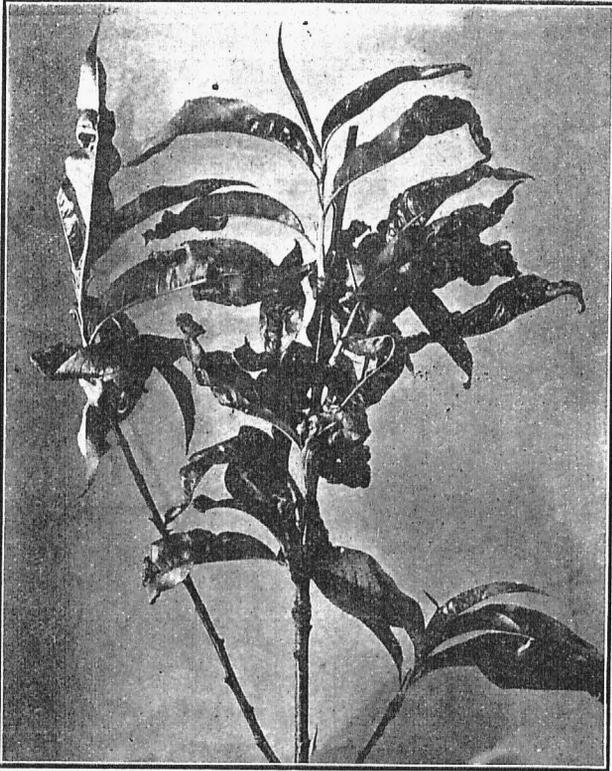


Figure 6. Peach leaves distorted by the Peach Leaf Curl.

*Tobacco Tea:*

Tobacco stems . . . . .	1 pound.
Water . . . . .	3 gallons.

Boil the stems for a few minutes and pour off the liquid. Add enough water to make up the three gallons. The value of this tea may be increased by adding one pound of whale-oil soap to each fifty gallons of the liquid. Valuable in controlling plant lice and woolly aphis.

*Lime-Sulphur, Boiled:*

Lime . . . . .	15 pounds.
Sulphur . . . . .	15 pounds.
Water . . . . .	50 gallons.

Slake the lime to a fine, thin paste, add water to the sulphur until it becomes a paste, mix well with the lime and stir the entire mass until all are well mixed. Add sufficient water to make up to a thin, white, wash. Bring the mass to the boiling point and allow it to boil vigorously for one hour. Add enough water to bring up to fifty gallons, strain as it is poured into the spray tank and apply while hot. The color will have changed in the boiling to a deep yellowish or brownish green. This artificially boiled mixture cannot be used when the foliage is on the trees.

*Pyrethrum:*

Fresh pyrethrum powder . . . . .	1 part.
Flour . . . . .	2 to 3 parts.

This is very poisonous to insects when perfectly fresh, and is very useful in combating lice on plants or poultry. It is not poisonous to man or animals.

*Carbon Bisulphide:*

Very effective against root infesting insects and those in stored grain. Inject a small quantity around the roots of the infested plants, or place a quantity on top of the seed. The fumes are heavier than the air and settle through the soil or bins of seed. It ignites very easily and must be protected from fire. Two pounds of bisulphide of carbon should be used for every one thousand cubic feet of bin space, regardless of the amount of seed in it.

## DUST SPRAYING.

Anyone interested in Dust Spraying should see Bulletin No. 19, Missouri State Fruit Experiment Station, Mountain Grove, Mo., by F. W. Faurot, and Bulletin No. 106, of the Illinois Experiment Station, Urbana, Illinois, by Charles S. Crandall. The results of both of these gentlemen's experiments indicate that Dust Spraying is so much less efficient in controlling insects and especially diseases of the orchard, that it is seldom, if ever, to be recommended.