July 2017

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MACHINERY AND METHODS FOR SPRAYING.

HERBERT OSBORN.  L. H. PAMMEL.

The frequent requests for information as to methods of spraying, the apparatus to be used, and the formule for preparation of insecticides and fungicides is sufficient reason why we present here a condensed statement of directions for this work.

SPRAYING MACHINERY.

There are now on the market a number of excellent outfits for spraying adapted to all grades of work, and it would be out of the question to specify any particular one to the exclusion of others as meeting all requirements. We are not under any obligations to any firm for favors even to the extent of apparatus for experimental work, and hence can name different firms with impartiality. It will be best for each one intending to use such apparatus to get circulars from some of the firms named and select the apparatus that meets the requirements of their particular case as to capacity, cost, etc. The firms we name we believe to be entirely responsible and to manufacture apparatus of excellent quality. The Field Force Pump Co., of Lockport, N. Y., The Nixon Nozzle and Machine Co., Dayton, Ohio, The Gould Manufacturing Co., Seneca Falls, N. Y., all making apparatus of various sizes and furnishing nozzles. The Rumsey Manufacturing Co. make excellent pumps, but do not make nozzles or supply complete outfits to our knowledge. The Lewis and Cowles Co. manufacture apparatus convenient for light work, or where there is a small amount of spraying to be done. Wm. Stahl, Quincy, Ills., makes knapsack pumps and sprays. Thos. Woodason, 2900 D street, Philadelphia, Pa., makes a variety of spraying outfits and powder bellows.

For a large orchard the operator should have a good large force pump, capable of throwing a spray to the largest trees, and worked by hand or geared to the wheels of a wagon; the
former is in some respects preferable, as it is then possible to regulate the amount given each tree according to the size of the tree, density of foliage, or distance of trees apart. The nozzle should be capable of breaking the liquid into a fine mist not easily clogged and readily cleaned.

The outfits used in spraying for insects are similar to those used for fungi, and one outfit will in most cases answer for both. For many diseases the knapsack sprayer has advantages. An excellent type is that known as the Galloway Knapsack Sprayer. Various modifications are now made, many of these are excellent and answer the purpose for which they are intended. The reservoir is made of copper and holds from four to six gallons. It is not advisable to buy one of the larger kind, as four gallons with the weight of the sprayer is about all one man can carry conveniently. The pump works easily, and the only precautions to be taken in the use of the machine is to keep all grit and dirt out, as the nozzle is easily clogged when Bordeaux mixture is used.

With a good spraying outfit conveniently mounted in a wagon, or for garden or shrubbery in a wheelbarrow, the next consideration is the preparation to be used.

INSECTICIDES.

*London Purple.*—One pound of this substance to 200 gallons of water is the strength to use for general work. Some kinds of foliage will stand a somewhat stronger solution, but this is generally effective without injuring leaves.

The injury to foliage can be prevented even with much stronger solutions by adding lime water to the solution.

*Paris Green.*—This material can be used somewhat stronger than London Purple, about one pound to 160 gallons of water.

These poisons are effective against the codling moth affecting apples and can be used against leaf-eating insects generally. It is undesirable of course to spray fruit near the time when it is to go to market, though if no more than a week or ten days has elapsed between the spraying and the gathering of the fruit there is scarcely the possibility of poison remaining in quantities to endanger life or health.
There will however be very few cases where spraying at any time near the gathering of the fruit would be necessary.

For codling moth or plum curculio the spraying should be done after blossoms have fallen, both to secure most certain results as well as to avoid any possible injury to bees which collect honey from the blossoms. It may be said in passing that the evidence as to effect of the arsenites on bees is still conflicting, but as the best time to affect the insects we desire to kill is after the blossoms have fallen there is no occasion whatever to spray at a time when it will be possible to injure bees. For combination with fungicide see Bordeaux Mixture and London Purple.

**Kerosene Emulsion.**—To prepare this insecticide dissolve half a pound of hard soap in one gallon of water (preferably soft water) and while still boiling hot remove from fire and add two gallons of kerosene. Stir violently together by driving through a force pump back into the vessel containing the mixture, or by using an egg beater until it forms a creamy mass that will not separate. This requires usually from five to seven minutes.

This may be diluted at once with water kept for use, or kept indefinitely for use when wanted. The emulsion will thicken after a short time so as to form a jelly-like mass, but this will readily soften up and mix with additional water. In diluting use from nine to fifteen times as much water as of the emulsion, the former proportion for scale insects and the harder bodied insects, such as chinch bugs; the latter for plant lice and other soft bodied delicate or exposed insects.

This substance is applicable to a great number of insects that are exposed so that the substance will reach their bodies killing by contact or by entering the pores, but is especially useful for suctorial insects that cannot be destroyed by the arsenical preparations.

It is to be used directly on the insects at the time they are present and cannot be expected to affect any insects but those reached at time of application.

**Hellebore** is useful for currant worms, and in some instances where objections would arise to asenical substances. It may be dusted on the plants as a dry powder, or mixed in water at the rate of an ounce to twelve quarts of water.
Pyrethrum is very destructive to most insects while harmless to higher animals. It may be used as powder blown from bellows, as for flies in houses, or on cabbages to kill worms, or diluted in water and sprayed on plants. It is too expensive to replace London Purple or Paris Green, except for limited use in garden or greenhouses.

SUMMARY OF TIME TO TREAT INSECTS.

Insects generally must be treated as soon as their injuries appear, but a short summary may be of help.

In May or June, commencing as soon as blossoms fall, spray apples and plums for codling moth and plum curculio, also strawberry, if infested with strawberry slugs.

In June plant lice may be numerous on plums and cherries and should be sprayed with kerosene emulsion.

In July spray potatoes with London Purple or Paris Green, if infested with "potato bugs."

In August and September cabbage worms may begin to appear and can be treated by spraying with hot water or pyrethrum in water or as a powder.

Cherry slugs may be sprayed with London Purple, as also the leaf-eating caterpillars, etc., on plums or other orchard trees.

FUNGICIDES.

Bordeaux Mixture. Finely pulverize 2.5 or 6 pounds of copper sulphate. This is dissolved in two gallons of hot water. To this solution add fourteen (seven for smaller amount) gallons of water. Slake two or four pounds of fresh lime with six gallons of water; allow it to stand a while, stir and then pour it into a barrel containing 22 gallons of water or 45 gallons of water. The latter amount is used with the larger quantity of copper sulphate. Stretch a cheese cloth across the barrel to strain out all coarse particles. When the lime is poured into the copper sulphate solution, the mixture should be stirred. Bordeaux mixture deteriorates on long standing, so that it is better to make not more than is needed for one application.

Bordeaux Mixture and Paris Green or London Purple for Combined Insecticide and Fungicide.—Make a thin paste of
London Purple or Paris Green in water and add one-half pound to 45 gallons of the Bordeaux mixture.

This combination may be used after bloom of apple and plum to affect codling moth and curculio; at same time as preventative for leaf disease, and in July and August for potato bugs and potato leaf diseases, or in any case where it is desired to destroy a leaf eating insect and at same time protect against fungi, as strawberry slugs in early spring, prevent various leaf diseases, etc.

**Ammonical Carbonate of Copper—Galloway formula.** In an ordinary water pail mix five ounces of copper carbonate with enough water to make a thick paste. Dissolve this paste in three pints of aqua ammonia; then dilute with 45 gallons of water. If this does not dissolve all the carbonate of copper add enough to bring it in solution. Several houses now furnish carbonate of copper with amonia added. Powell's Copperdine, both solid and liquid, is one of these preparations. In using this, solid, weigh out two pounds and add 45 gallons of water.

**Modified Eau celeste.** Four pounds of pulverized copper sulphate are dissolved in two gallons of warm water; after solution add eight gallons of water, when cold add five pounds of washing or sal soda and stir, and then add three pints of strong ammonia, dilute with 45 gallons of water.

One great difficulty in the use of ammoniacal carbonate of copper, modified eau celeste and even Bordeaux mixture is that during rainy weather it is readily washed off—and then, too, the fungicide does not always spread uniformly over the leaf in Bordeaux mixture. To overcome these difficulties soap has been added. Beach¹ applied this latter mixture at the suggestion of D. G. Fairchild and found it highly efficient. Beach has made it in the following proportions: One pound of soap dissolved in hot water, to every eight gallons of the mixture. Giraud² has found that molasses, five pounds to 25 gallons of mixture makes it very retentive.

The above formula for eau celeste is essentially as given by Galloway. Sturgis, of the Conn. Station, uses sulphate of

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²Gardener's Chronicle, Mch. 12th, p. 339; July 16th, 1892, p. 71.
copper one pound, carbonate of copper 1/4 pound, strong ammonia one pint, water 25 gallons.

CALENDAR.

Sturgis in a recent bulletin has adopted the excellent plan of hints for various months. This, with some modifications, has been adopted to Iowa conditions.

April is the month to clean up all rubbish, cut out all black rust, plow the ground and remove all mummied plums, and bury the grapes that are affected with black rot.

May is the time of flowering of plums and apples. It is advisable for plum rot to apply once before the flowers are out; also for apple scab. Spray again after the petals have fallen. Examine plum trees for black knot, which are just bursting through the bark; cut out and burn.

June is the month to begin spraying for spot disease of the cherry and currant. Begin before the middle of the month. Continue the application for apple scab and rot of plum and cherry. Apply once every two weeks or oftener, if the weather is such that the mixture is washed off. Early potatoes should also be sprayed if there is any blight. June is also the month to begin the spraying of grape vines for downy and powdery mildew, grape rot. If pears are grown, especially seedlings, they are liable to be affected with leaf-blight. Spray as for spot disease of cherry. Strawberries—spray before berries are ripe in June.

July—Continue to spray the diseases commenced in June. If the weather is dry the applications will not need to be as frequent. In July and August spray late potatoes.

In the autumn months remove all diseased plants, fruits, and leaves and consign them to the fire.

Apple Scab, \textit{(Fusicladium dendriticum)}. Bordeaux mixture has been found most effective, and is most advantageous because the arsenic in London Purple and Paris Green is not dissolved. Before the leaves are out use a strong solution of sulphate of copper, one pound to five gallons of water to spray on the branches. Use Bordeaux mixture and Paris Green as soon as the apples are set. Avoid spraying when in flower. Make at least four applications, and, if the case demands, five.
Spot Disease of Cherry, \textit{(Cylindrosporium padi.)} The ground should be thoroughly cleaned in April. Remove all old leaves. In the nursery make the first application early in June, using Bordeaux mixture. Apply every two weeks, making five applications. The same treatment will also be effective for powdery mildew \textit{(Podosphaera oxyacanthea.)}

Grape Diseases. Black Rot \textit{(Laestadia bidwellii.)} It is not a serious disease in Iowa, although it occurs. Use Bordeaux mixture. Begin the application after the berries are formed, making at least four applications to prevent the spotting of the berries with copper sulphate, use for the last two sprayings ammonical carbonate of copper. Downy mildew \textit{(Plasmopara victicola)} and powdery mildew \textit{(Uncinula ampelopsidis)} will both respond to the treatment given for black rot.

Spot disease of Currants \textit{(Septoria ribis} and \textit{Cercospora anguita).}—Bordeaux mixture is most effective. Remove all old rubbish around bushes, especially leaves, in April. The branches may be sprayed with strong copper sulphate solution before the leaves appear—use the same formula as in apple scab. Early in June make one application with Bordeaux mixture. For the second application, 15th or 20th of June use ammoniacal carbonate of copper. The succeeding applications, two, three or more, may be made with Bordeaux mixture.

Strawberry Leaf-Blight \textit{(Sphaerella fragariae).}—Bordeaux mixture should be applied once before the flowers are out. After the berries are picked apply again; making two applications in July and one or two in August. If the disease is very bad it is much better to start a new bed. Growers of strawberries should always have new beds.

Potato Diseases.—There are at least two potato diseases amenable to treatment with Bordeaux Mixture, potato rot \textit{(Phytophthora infestans)} and leaf blight \textit{(Macrosporium sp.)} The former is not common in Iowa. The first application should be made when the foliage is well along. Make three or four applications at intervals of three weeks.