SPRAY CALENDAR
WITH
SEED, SOIL AND DISINFECTION TREATMENT METHODS

OHIO
Agricultural Experiment Station

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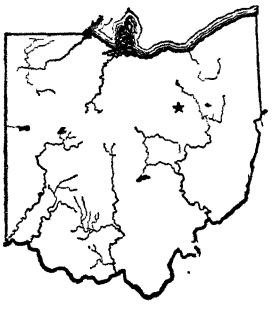

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BULLETIN

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Ohio Agricultural Experiment Station

NUMBER 309 JANUARY, 1917

CALENDAR FOR THE TREATMENT OF PLANT DISEASES AND INSECT PESTS

W. J. GREEN, A. D. SELBY AND H. A. GOSSARD

This calendar for the treatment of diseased conditions and insects on plants is designed to cover the needs of farmers and horticulturists. It was first prepared at the request of the Ohio State Horticultural Society. Fungicides and insecticides may often be combined in spraying, a practice that is recommended. Spraying young orchards with fungicides and insecticides from time of planting, and of stocks in nursery row, is strongly recommended to preserve healthy conditions.

REMEDIES

FUNGICIDES

1 BORDEAUX MIXTURE*

Copper sulphate (blue vitriol), 4 pounds
Quicklime (not air slaked), 4 pounds
(Air-slaked lime not good; hydrated lime one-fourth more)
Water to make 50 gallons

Dissolve the copper sulphate in about 2 gallons of hot water contained in a wooden vessel, by stirring, or even better suspending the sulphate contained in a cheese cloth sack in a large bucketful of cold water. With the cold water and cheese cloth bag a longer time is required. Pour the sulphate solution into the barrel or tank used for spraying, and fill one-third to one-half full of water. Slake the lime by addition of a small quantity of water, and when slaked cover freely with water and stir. Pour the milk of lime thus made into the copper sulphate, straining it through a brass wire strainer of about 30 meshes to the inch. Pour more water over the remaining lime, stir and pour into the other; repeat this operation until all the lime but stone lumps or sand is taken up in

*The strength of Bordeaux mixture best adapted to use upon apple trees varies with the spray appliances employed; with hand pumps and low pressure of the spray a 4-4-50 formula may be used with safety, while with high pressure and heavy applications of spray a 3-3-50 strength is safer even in earlier sprayings in foliage—for summer ones a greater strength than 2-2-50 is seldom desirable.

the milk of lime. Now add water to make 50 gallons in the tank. After thorough agitation the mixture is ready to apply. The mixture should be made fresh before using, and any left over for a time should be thrown out or fresh lime added. In most operations on a large scale, and for uniform results from arsenicals added to Bordeaux mixture, it is usually better to combine the diluted copper sulphate solution and the milk of lime diluted to volume in a mixing tank before putting into the spray tank.

When in a small way separate barrels are used, and both the lime and blue vitriol are made up to equal measured volume, insecticides may be added in the lime barrel and the equal volumes run together directly into the sprayer.

2 BORDEAUX MIXTURE II

Copper sulphate, 2 pounds
Quicklime, 2 pounds
(Air-slaked lime not good; hydrated lime one-fourth more)
Water to make 50 gallons

For use on such trees as have foliage injured by Bordeaux I

STOCK SOLUTION AND LIME PUTTY

A solution of copper sulphate containing 1 pound of sulphate to the gallon of water may be made and permitted to stand indefinitely in a covered barrel if no lime is added. Such a solution is known as a stock solution and 2 or 3 or 4 gallons of this stock solution, according to the strength desired, is taken for each 50 gallons of the mixture to be made. For extensive spraying, a long trough or box of uniform width may be used, in which to slake and keep the lime. The quicklime is weighed out according to the amount needed, immediately placed in the trough and slaked with a small quantity of water. The whole is evenly spread and covered as a putty with water to exclude the air. This putty may be removed in calculated portions, placed in a tub and treated like the freshly slaked lime. By means of stock solution of copper sulphate and the lime in putty state, much valuable time is saved in filling the barrels or tanks used in spraying. (See mixing-tank suggestions above.)

3 AMMONIACAL SOLUTION OF COPPER CARBONATE

Copper carbonate, 6 ounces
Ammonia, about 3 pints (*avoid excess*)
Water, 50 gallons

Dissolve the copper carbonate in the ammonia and add the water.

Caution.—Use no more ammonia than is required to dissolve the copper carbonate. Ammonia is variable in strength, and the amount required must be tested in practice.

To make copper carbonate.—Dissolve 10 pounds of copper sulphate (blue vitriol) in 10 gallons of water, also 12 pounds of carbonate of soda in same quantity of water. When cool, mix the two solution slowly, stirring well. Allow the mixture to stand 12 hours and settle, after which pour off the liquid. Add the same quantity of water as before, stir and allow to stand the same length of time. Repeat the operation, after which drain and dry the blue powder, which is copper carbonate.

4 SODA BORDEAUX MIXTURE

Copper sulphate, 4 pounds
Commercial caustic soda, soda lye (sodium hydroxide) slightly in excess so that mixture is alkaline—according to strength, 1 lb. 5 oz. to 1 lb. 8 oz. by testing
Water to make 50 gallons

For use instead of ammoniacal copper carbonate

Warning.—In each case of change of grade or brand of commercial caustic soda, it will be necessary to test the strength. Keep the mixture well agitated. In order to test the strength of caustic soda provide materials and appliances described in Bulletin 130, and test carefully the reaction with both red and blue litmus.

To keep caustic soda.—After opening a container and testing, weigh out the entire contents into portions such as are needed to make a single spray tank of mixture; put in Mason jars under shelter; cover with a pint or so of water. This portion is ready to be used as needed. Open packages of caustic soda will absorb water and increase in weight on standing; unopened packages will usually keep for a year or more.

5 COPPER SULPHATE SOLUTION

Copper sulphate, 4 pounds
Water to make 50 gallons

Dissolve the sulphate as directed in Bordeaux I.

Caution.—This solution will injure foliage. It can be used only before the buds open.

6 BORDEAUX MIXTURE AND IRON STICKER

Copper sulphate (blue vitriol), 2 pounds
Iron sulphate (copperas), 2 to 3 pounds
Quicklime, 4 to 5 pounds
(Air-slaked lime not good; hydrated lime one-fourth more)
Water to make 50 gallons

Recommended as a substitute for Bordeaux I upon most fruit trees in foliage and upon certain vegetables. It is used especially for apples and potatoes. The iron sulphate is precipitated by the lime as hydroxide and serves as a dilution sticker. The spray is rust colored because of this iron compound.

Note.—A stronger 4-4-8-50 formula may be used on apple, pear and plum trees before blossoms open.

Caution.—Do not leave a solution of iron sulphate standing beyond a second or third day. It is best to make it fresh for each day.

7 POTASSIUM SULPHIDE SOLUTION

Potassium sulphide (liver of sulphur), 1 ounce
Water, 3 to 4 gallons

This solution will not remain unchanged. The potassium sulphide must be kept in a well-stoppered bottle. This may be made by a similar process to that of No. 8.

8 SODIUM SULPHIDE SOLUTION

Commercial caustic soda, 2½ pounds
Flowers of sulphur, 5 pounds
Water to make 50 gallons

To make sodium sulphide at lowest cost.—Place the caustic soda in a metal vessel and add a little hot water. Then stir in sulphur gradually, adding meanwhile hot water or applying heat. The chemical reaction will generate heat. With its progress the color will change from yellow to nearly brick red. No heat is required after complete solution unless lime is added. Do not add excess of water until the solution is effected. It may be made in quantity with external heat and kept a day as stock solution. Excess of lime may be added with double and triple portions of sulphur to make the possible equivalent of lime-sulphur solution.

Caution.—This solution is prepared for application on dormant trees. Care must be observed. Upon foliage, as of peach, a strength greater than 1 pound of caustic soda to 2 pounds of sulphur is not to be recommended.

To make sodium sulphide for treating seed potatoes, use at the rate of 1 pound of caustic soda to 10 ounces of sulphur for 36 gallons of solution.

9 SELF-BOILED LIME-SULPHUR MIXTURE

Stone lime (only), 10 pounds
Flowers of sulphur, 10 pounds
Water to make 50 gallons

An 8-8-50 strength is also used.

It is best to prepare the mixture in large lots for at least 200 gallons of spray, using 40 pounds of lime and 40 pounds of sulphur, so as to get enough heat to produce a violent boiling for a few minutes. Place the lime in a barrel and pour on sufficient water (about 3 gallons to every 20 pounds) to start the slaking of the lime and to hold up the sulphur. Then add the sulphur after working through a sieve to break up the lumps, meanwhile stirring thoroughly; and finally add sufficient water to slake the lime into a paste. Considerable stirring is necessary to prevent caking on the bottom. If mixture tends to become sticky, a little more water may be added. After the violent boiling produced by the slaking of the lime is over, the mixture should be diluted ready for spraying, or at least sufficient cold water added to stop the cooking—5 to 15 minutes being required for this, according to whether the lime is quick acting or sluggish. The intense heat in boiling seems to produce the desired mechanical mixture of the lime and sulphur. If allowed to stand too long before dilution, the sulphur tends to unite with the lime, and at the end of 30 or 40 minutes sufficient reddish liquid is produced to burn peach foliage and even apple foliage in some cases. Strain through a sieve of about 20 meshes to the inch to remove coarse particles of lime, but all of the sulphur should be worked through the strainer. For the 10-10-50 strength, dilute to 200 gallons. For other strengths, use a different solution. The large disk nozzles are successfully used in the application of this spray.

Proposed by W. M. Scott, U. S. Department of Agriculture, as a fungicide for use on peach trees in foliage. Also available on American and Japanese plums and upon all varieties of cherries.

Caution.—While this may be used upon the peach in foliage and upon other fruits, care should be exercised in the preparation of the mixture to avoid the formation of soluble sulphides as by use of hot water or allowing to stand before dilution, since these result in foliage injury from the spray.

10 LIME-SULPHUR SOLUTIONS

Lime-sulphur solutions, either derived from commercial preparations or from home-boiled concentrates, are often useful fungicides. For dormant sprays these are the same as for San Jose scale treatment. For foliage applications, greater dilutions are required. Upon apple a dilution of 1 part of the concentrate of 32° Beaume is made with 40 parts of water.

These solutions are quite weak as fungicides, and as foliage sprays have not proved satisfactory where strong germicides are required. They have been thus far better adapted to use in apple orchards. See formulae 14 to 16.

10½ DUST PREPARATIONS (See also No. 16)

Dust preparations for treatment of apple orchards have been tested more or less in certain states, but are only in the experimental stage as yet. The tests made at the Cornell Experiment Station indicate fair promise for combination treatments especially. It has been found that finely ground sulphur is most promising as a fungicide. This is designated so fine that 95 percent passes a sieve having 200 meshes to the inch. Coarser sulphur is much less satisfactory. The most successful combination employed has been a mixture of 90 percent finely ground sulphur and 10 percent powdered arsenate of lead.

11 FORMALDEHYDE (FORMALIN) SOLUTIONS

For oat and wheat smuts, 1 pound or pint of 40 percent formaldehyde to 40 gallons of water
For potato scab, ½ pint of formaldehyde to 15 gallons of water
For cabbage black-leg, ¼ pound or pint of formaldehyde to 6 gallons of water
For onion smut, 1 pound of formaldehyde to 25 or 33½ gallons of water
For soil drench, 3 pounds or more of formaldehyde to 50 gallons of water
See table of Seed and Soil Treatment

11½ FORMALDEHYDE GAS

Commercial 40 percent formaldehyde, 3 pounds
Potassium permanganate crystals, 23 ounces
Sufficient for 1,000 cubic feet of space occupied by crates or trays [Maine formula]

Inclose open tiers or piles of slat crates filled with dry onions, potatoes, and so forth, in tight room or oiled tent of canvas buried in earth about the base. Generate the formaldehyde gas in a flat-bottomed dish or pan of adequate capacity by placing one of the materials, as the liquid formaldehyde, in the pan, and adding the other the last thing before retiring. Then close tight and allow to remain closed 24 to 48 hours.

Proportionate amounts may be taken for smaller or larger inclosed spaces. Applicable to fumigation of seed potatoes for rot troubles and to newly gathered, dry onions before storing for winter.

12 CORROSIVE SUBLIMATE (MERCURIC CHLORIDE)

Corrosive sublimate, 2 ounces
Water, 15½ gallons—equal to 1 to 1000 strength

Label POISON; use for potato scab and for disinfection.

To hasten solution, have druggist pulverize the mercuric chloride.

INSECTICIDES

13 KEROSENE EMULSION

Laundry soap (chipped), ½ pound
Kerosene (coal oil), 2 gallons
Water (preferably soft and free from dirt particles), 1 gallon

Dissolve the soap in the full amount of water, and when this solution is boiling hot remove from the fire and add the kerosene. Stir the mixture violently by driving it through a force pump back into the vessel until it becomes a creamy mass that will not separate. This requires usually from 5 to 15 minutes. For use, dilute one part of the emulsion with 8 or 10 parts of water for use on hard-bodied insects like the chinch bug. For soft-bodied insects, such as plant lice, lice on animals, and so forth, use one part emulsion to 15 or 20 parts of water. The stock emulsion will keep good for months if kept in air-tight vessels.

Kerosene emulsion kills by contact, and therefore, the application should be thorough. It may be used against a great many different pests, but is especially valuable for destroying those with sucking mouth parts, for they cannot be killed with arsenical poisons.

Caution.—Only the dilute emulsion, 1 part emulsion to 15 or 20 parts of water, should be used when the trees are in leaf, and in all cases it should be kept thoroughly stirred; otherwise the foliage or even the twigs will be injured. Applications of this insecticide are much safer if made only on dry, sunshiny days, not scorching hot, preferably with a light breeze blowing, so as to hasten evaporation, and thus minimize danger to the plants.

14 LIME-SULPHUR WASH

Stone lime, 12 to 15 pounds
(Hydrated lime one-fourth more)
Flowers of sulphur, 15 pounds
Water, 50 gallons

Slake the lime in a small quantity of hot water, gradually adding and stirring in the sulphur. Dilute mixture with 12 gallons of water and boil in an iron kettle or cook by steam in a covered tank or barrel for 1 hour or longer. Fill with water to the required 50 gallons. Strain the wash through a fine-mesh strainer and apply hot. In using an iron kettle, keep the mixture vigorously boiling and thoroughly stirred to prevent caking and burning of the materials. When the wash is cooked by steam, it is more easily prepared and better made.

Apply wash in spring before buds open or in fall after leaves drop. Cover all parts of the tree with a heavy coat of the wash. If a single application is made each year for scale insects, especially for San Jose scale, it is advised that the treatment be given in the early spring. Where infestation is excessive, one spraying should be given in the fall after the leaves drop, and a second the following spring before the leaves appear. Also in case of large orchards it may be necessary to commence work in the fall so as to insure its completion before vernation in spring. Cover every bit of bark on every tree to insure success.

This remedy is perfectly safe in anybody's hands, if used during the dormant period. It is also a fungicide and controls peach leaf curl as well as San Jose scale.

This is one of the early formulae for making lime-sulphur solution. The only objection to it is the great quantity of sediment which must be removed by straining. Even when carefully strained, it frequently clogs pumps and nozzles with accumulations of dirt. Notwithstanding this drawback, some of our best orchardists have returned to its use after a few years' trial of the commercial mixtures, being convinced that it is more effective for controlling scale insects.

For further details see Ohio Agricultural Experiment Station Bulletin 169.

15 COMMERCIAL LIME-SULPHUR SOLUTIONS

These are convenient to use, being free from sediment and requiring no preparation other than stirring into water. When properly made and properly diluted, these mixtures are thoroughly reliable. The most convenient method for diluting the mixtures is by the hydrometer test. The standard liquid should test 33° on the Beaume hydrometer (explained in Circular 143) and should contain 2.7 pounds of sulphur to a gallon of undiluted liquid. For use, such a liquid should be diluted at the rate of 1 gallon of lime-sulphur to 7 gallons of water.

TABLE OF DILUTIONS FOR DORMANT AND SUMMER SPRAYING WITH LIME-SULPHUR MIXTURES

Reading on hydrometer	Number of gallons of water to one gallon of lime-sulphur solution	
	For San Jose scale. Winter use	For summer spraying of apples
Degrees Beaume		
35	8.00	45.00
34	7.50	43.00
33	7.00	40.00
32	6.50	37.50
31	6.00	36.00
30	5.50	34.00
29	5.25	33.00
28	5.00	31.00
27	5.00	29.50
26	5.00	28.00
25	4.50	26.00
24	4.25	24.00
23	4.00	23.00
22	3.50	21.00
21	3.25	20.00
20	3.00	18.00
19	2.75	17.00
18	2.50	16.00
17	2.50	15.00
16	2.00	14.00
15	2.00	13.00
14	1.75	12.00

The foregoing table records the minimum strengths to be used for San Jose scale. The mixture can be used at twice the strength recommended in the table, or even stronger, and no ill effects will follow, but by so doing the expense is considerably increased and no practical advantage is gained. The summer strengths should in no case be increased beyond the figures given in the table.

16 POWDERED SULPHUR PREPARATIONS

These materials are comparatively recent developments in an attempt to secure a highly concentrated sulphur spray. Several brands are on the market at the present time. Tests by this Station are reported on three of them in Volume I, No. 1, Monthly Bulletin. Briefly stated, the results, while somewhat variable, were promising for scale control. Until more is known concerning them, they should not be used as summer foliage sprays. Use according to directions on the container.

17 SOAP SOLUTIONS

One pound of fish-oil soap or laundry soap in 4 to 7 gallons of water is a good spray against plant lice.

18 SOLUBLE OR MISCIBLE OIL

Some commercial houses make brands of oil that readily mix in cold water. They are used as dormant applications against San Jose scale, maple terrapin scale, magnolia scale, maple cottony scale and others which the lime-sulphur wash will not control. They are especially valuable for destroying scale on old, rough-barked apple and pear trees. The ordinary rate of dilution is 1 gallon to 15 gallons of water.

19 PARIS GREEN

In combination with Bordeaux mixture, Paris green may be used at the rate of 1 pound in from 50 to 150 gallons.

When Bordeaux mixture is unnecessary, the Paris green may be used at the same rate, but 2 or 3 pounds of freshly slaked lime must be added to prevent burning of the foliage. Keep the mixture well stirred so that the poison will be distributed evenly.

In cases where successive sprayings are necessary, it is important to consider the accumulation of the poison and consequent danger of injury to foliage from soluble arsenic. Arsenate of lead is safer for continuous use.

When diluted with 20 parts by volume of ground lime or cheap flour Paris green may be applied with a dusting machine or shaken from a cheese cloth bag on potato vines to kill the Colorado potato beetle.

20 COMMERCIAL ARSENATE OF LEAD

This poison is in many respects the most satisfactory for spraying purposes of any of the arsenicals. It is more adhesive than Paris green and if properly made of good materials will burn foliage but little, no matter what strength is used. The paste form is used at the rate of 2 to 5 pounds in 50 gallons of spray and the powdered product at from 1 to 3 pounds. For average use 3 pounds of the paste or 1½ pounds of the powder is the most frequent recommendation. The paste form should not be allowed to freeze or dry out. If either happens, the addition of soap at the rate of 2 pounds to 50 gallons of diluted spray assists materially in keeping the lead in suspension. Water, Bordeaux mixture, No. 6 or lime-sulphur solution may be used as the carrier. The powdered material may be applied in the dry form as a dust.

21 ARSENITE OF SODA

Dissolve 2 pounds of of commercial white arsenic and 4 pounds of carbonate of soda (washing soda) in 2 gallons of boiling water and use from 1 quart to 3 pints to a barrel of Bordeaux mixture (50 gallons).

Orchardists often use 1 pint of this poison with the addition of 1½ pounds of commercial arsenate of lead in 50 gallons of Bordeaux for spraying apples. Results seem nearly as good against codling worm as when full-strength arsenate of lead is used, but more burning of the leaves occurs.

The easiest way to make the solution is to put both the white arsenic and carbonate of soda in a gallon of boiling water and keep boiling about 15 minutes, or until a clear liquid is formed, and then dilute to 2 gallons for stock solution.

Caution.—This cannot be used alone safely, but must be applied in Bordeaux mixture. It is not safe in lime-sulphur.

22 ARSENITE OF LIME

White arsenic, 1 pound
Lime, 2 pounds
Water, 3 gallons

Boil together for fully 40 minutes after the boiling point is reached. As a precaution against danger of burning, slake 2 or 3 additional pounds of lime, put the milk in 3 or 4 gallons of water, and add to the boiled mixture. Strain and dilute to from 200 to 250 gallons for hardy vegetation such as potatoes. Do not use at all on stone fruits or on cucurbits. Dilute to 300 or 400 gallons for tender vegetation. It is safer when used in Bordeaux mixture.

23 WHITE HELLEBORE

Because it loses its poisonous properties quickly, hellebore may be employed to spray fruits a few days before harvest when arsenical sprays would be dangerous. Use 1 ounce to 3 gallons of water.

24 PYRETHRUM

Pyrethrum is usually applied as a powder with a bellows, but may be used as a spray at the rate of 1 ounce to 2 gallons of water. It is poisonous to insects but not to higher animals, and can be used on ripening fruits. By closing up rooms containing flies and mosquitoes, then filling the air full of the dust by means of a blow-gun, and keeping closed for several hours, preferably over night, most of the insects will be either killed or stupefied and will drop to the floor. They should then be swept up and destroyed.

25 NICOTINE SULPHATE. TOBACCO DECOCTION

Nicotine sulphate is a commercial preparation much used for the destruction of aphids and sucking insects. It is readily used in combination with Bordeaux mixture and arsenate of lead and somewhat less safely in combination with lime-sulphur solution and arsenate of lead. When used alone in water some soapsuds should be added to enhance its spreading qualities.

To make a decoction of tobacco, boil 1 pound of tobacco stems or tobacco dust in 1 gallon of water for about 1 hour. Strain to remove dirt that would clog nozzle, and add water to make 2 gallons of spray for each pound of tobacco used. Excellent for plant lice and does no injury to the most tender plants. Some of the commercial decoctions or preparations of nicotine are better than the homemade ones.

26 BISULPHIDE OF CARBON

This is a convenient fumigant for treating granaries, bins and closed compartments which contain stored grain, groceries and foodstuffs being injured by insects, provided the temperature is above 70° F. Make the compartment tight if possible by pasting paper strips over cracks and openings. When everything is made tight, pour the liquid on burlap sacks laid on top of the grain, using about 5 to 8 pounds or pints for every 1,000 cubic feet of space inclosed in the bin. A good way to distribute the liquid for rapid and effective action is to spray it over the grain through a small opening near the top of the bin, using a small spray pump. If the first method is used as soon as the

dosage has been completed, close the door and make it tight. Keep closed for 40 hours, then open and air thoroughly. Do not bring a lighted lantern or fire of any kind near the bin while fumigation is in progress as this gas is inflammable. Sometimes treatments at intervals of a few weeks apart are advisable in case the bins are not tight. Fumigation according to these directions will not injure grain for either feed or seed. This material can be used for fumigating woolens and furs infested with clothes moths. Place the article to be fumigated in a tight chest or trunk and saturate a sponge or mass of cotton with the carbon bisulphide at the proportions given above. Leave the chest closed for 48 hours or more, and if the goods are to be stored, place in tight chests or sew in paper bags. Carbon tetrachloride can be substituted for carbon bisulphide in clothes chests, but it should be used in approximately double the amounts. It has the advantage of being less offensive in odor, and not being inflammable is much safer for household use.

27 POISONED BAIT FOR CUTWORMS, GRASSHOPPERS, SLUGS, ETC.

Cutworms are quite readily destroyed by a poisoned bran bait made as follows: With 25 to 35 pounds of coarse wheat bran, thoroughly mix, while dry, one pound of Paris green or an equal weight of powdered white arsenic. Chop fine six lemons or six oranges and add juice, rinds and all to the ingredients. Dilute 1 quart of any cheap syrup with 2 or 3 gallons of water and mix with the bran and arsenic. Add sufficient water to wet all the bran, but do not have it sloppy when ladeled. This bait is scattered over infested lands in little heaps, which keep moist longer if covered with pieces of board; the cutworms are more likely to find the poison when thus hidden, since they retreat to such locations for hiding during the day. A teaspoonful of the mixture put at the base of each garden plant liable to attack will afford good protection. If the plants are in drilled rows, a line of the bait may be placed along each side of the row. It is always best when possible, to put the bait in gardens when freshly plowed, before the crops are planted; the worms finding nothing above ground to eat but the bait, feed on it greedily and are destroyed before the crop is planted.

If the bait is to be scattered for grasshoppers best results may be expected in Ohio when it is distributed early in the morning. It should be sown broadcast either on foot or from a light wagon or buggy. A broadcast grain seeder mounted on a wagon has been used successfully for this purpose in the western parts of the United States. From 1 to 5 days is required for the grasshoppers to die off in conspicuous numbers.

Another good bait for cutworms and grasshoppers is obtained by spraying a patch of clover or other succulent vegetation with Paris green, one-half pound to 50 gallons of water, or with arsenate of lead, 3 pounds to 50 gallons of water. A few hours after spraying, the poisoned grass is cut with a scythe or mowing machine and scattered in little heaps over the infested land. These piles should be made large enough to prevent rapid drying out of the under portions, or the grass may be placed under boards like the bran bait.

SPRAY CALENDAR*

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Alfalfa	Leaf spot	Possibly Bordeaux on seed crop	Bordeaux spraying at intervals of 2 or 3 weeks				Can be used only on seed crop
	Sclerotium wilt	Remove and burn infected stools	Remove roots and tops.				
Apple†	Bitter rot and black rot	Bordeaux II and ammoniacal cop. carbonate	With first appearance of rot about July 1 Bord. II or No. 6	2 weeks after first Bordeaux II	2 weeks later am. copper carb.	Not required if Bordeaux precedes	These follow spraying for scab; danger of russeting. Twigs killed by fire blight are attacked by black rot
	Blister canker. All cankers	Cut and burn diseased parts	Treat wounds with gas tar (coal tar)				Blister canker is a wound parasite. Dressings of gas tar required on all but smallest pruning wounds when active
	Blotch	Bordeaux II and ammoniacal cop. carbonate	June 15 Bordeaux II	July 1 Bordeaux II	2 to 3 weeks later am. cop. carbonate		These sprays follow spraying for scab. Very urgent
	Frog eye	Same as bitter rot	See bitter rot				
	Rust	Same as scab and bitter rot	Same as scab and bitter rot				Destroy cedar trees that infect apples
	Scab	Bordeaux I or 6 or lime-sulphur	Pre-blossom spray Bordeaux I	Calyx-cup spray, lime-sulphur	Same 7 to 10 days later	Rarely needed	The pre-blossom spray just before the blossoms open is very essential for scab. Stronger Bordeaux advised for first spraying on varieties susceptible to scab
	Sooty fungus	No. 6 or Bord. II	After blossoms drop (see scab)	As for scab	July 1 Bordeaux II. As for bitter rot, etc.	Bordeaux II or No. 6	Midsummer copper sprays effective (see blotch)

*For seed and soil treatment see page 509

†For apple and pear the application just before blossoms open is called "pre-blossom" spray; just after blossoms drop, "calyx-cup" spray. See Circular 149

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Apple continued	Twig blight...	Cut out and burn ...	Cut out and burn on appearance.....	.....	.....	.....	Bacterium lives over in blight cankers. Remove all in pruning
	Aphis	Nicotine sulphate or soluble oil.....	As buds are swelling..	Pre-blossom spray.....	Just after bloom if necessary.....	.....	Nicotine sulphate may be combined with lime-sulphur or Bord. mixture. Soluble oil should not be used after leaves appear
	Blister mite (see pear)						
	Bud moth	Arsenicals in Bord. or lime-sulphur solution.....	With opening of buds				
	Canker worm..	Arsenate of lead alone, 6 lb. to 50 gal.	With first young worms	2 or 3 days later if worms remain.....	Same as second.....	.....	20, 21 or 22 in Bordeaux are not quite as efficient as arsenate of lead alone
		Band with tree tanglefoot	... .	.....	.....	.....	Bands should be in place by Feb. 15
	Codling moth and curculio.	Arsenites or arsenates in Bord. I or 6 or lime-sulphur solution with arsenate of lead, 3 lb. to 50 gal.....	As soon as blossoms fall	7 to 10 days later.....	For southern Ohio, 2d week in July; central Ohio, 3d week in July; northern Ohio, 4th week in July or 1st week in August	.....	Third spraying, arsenate of lead alone on light-colored apples. Summer sprays may be combined with those for bitter rot and blotch
	San Jose scale.	Lime-sulphur or No. 18.....	Late in winter, early spring or late in fall.	.....	....	.....	In case of bad infestation spray in fall and repeat in spring
	Oyster shell scale and scurfy scale..	Lime-sulphur, kerosene emulsion or No. 18	Early spring with 14 ..	June 1 to 15 with lime-sulphur or 13 or 18...	For oyster shell scale Aug. 1 to 15 with 13 or 18.....	.....	See Mo. Bul. O. A. E. S., I (April, 1916) No. 4, p. 103
	Woolly aphis..	Nicotine sulphate...	When trees are in full leaf	In fall			
Ash.....	Canker of branches	Cut out and burn parts.....	.....	.....	.....	.....	Wound parasite to be avoided. This canker also attacks Box Elder, Horse Chestnut, Buckeye, Elm, Maple, Oak, etc. See O. A. E. S. Mo. Bul., I (Oct., 1916), No. 10
	Leaf spot.....	Gather and burn diseased leaves					

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Aster	Fusarium wilt.	See seed and soil treatment					
	Blister beetle	Whale oil soap, 1 lb. to 6 gal. water, or dilute chloro-naphtholeum	When beetles appear				
Asparagus	Asparagus beetle	Air-slaked lime or pyrethrum as a powder	When larvae appear	Same as first	Same as first	Same as first	Do not use arsenicals except in late summer; add soap
	Asparagus rust	Bordeaux I	After cutting crop	10 days later	10 days later	10 days later	Repeat 3 or 4 times. Burn rusted brush in fall
Barberry	Blight	Destroy diseased stools					
Bean	Anthracnose	Bordeaux I	Soak seed 1 to 2 hours in am. cop. carb. 5 times strength of 3	Bordeaux on 2 or 3 in. plants	Bordeaux 10 days later	After blossoms	Repeat if needed. Reject diseased seed
	Rust	Burn old plants	Destroy diseased pods.				Select resistant varieties
Beech	Mildews	Burn leaves in fall					
Beet	Leaf spot	Bordeaux I	When plants are 5 to 6 inches high	2 weeks after first	2 weeks later		
	Damping off	See soil treatment					
Birch	Anthracnose	Burn leaves in fall					Recommended sanitation measures for shrubs and trees very useful
	Canker	Destroy diseased parts					
Box Elder	Canker	Destroy diseased parts					See ash canker
Cabbage, Cauliflower, etc.	Black leg	See soil treatment					
	Cabbage worm	Pyrethrum	With first appearance of worms	Whenever worms are observed	Same as second	Same as second	1 oz. to 2 gal. water or dust 1 to 10 of flour by bulk
	Club root	See soil treatment					
	Yellows	See soil treatment					
	Maggot	See soil treatment					
	Downy mildew	Bordeaux mixture	With appearance of disease	Repeat 10 days later			

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Carnation....	Leaf or calyx mold.....	Bordeaux I or ½ of 5 ..	Upon appearance of fungus.....	2 weeks later	2 weeks later	Repeat if needed...	Begin early before the calyces are ruined
	Leaf spot.....	Bordeaux I or ½ of 5...	Upon appearance of fungus.....	2 weeks later	2 weeks later	.....	Cover foliage well
Catalpa.....	Leaf spot.....	Bordeaux I.....	Upon appearance of fungus.....	2 or 3 weeks later.....	Repeat if necessary....	.....	Cover foliage well
	Mildew and wilt.....	.....	.....	.....	.....	.....	Gather and burn leaves in fall to destroy leaf parasites
Celery.....	Leaf spot or leaf blight...	Bordeaux I.....	On young seedlings ...	Repeat on seedlings...	Before or after transplanting.....	2 weeks later.....	Keep leaves well covered in plant bed with mixture
	Root rot	Drain soil					
Chard.....	Leaf spot	See beet leaf spot					
Cherry stocks	Leaf spot.....	Bordeaux II or No. 9..	When leaves are half grown.....	2 weeks later	2 weeks later	About 2 weeks later	
Cherry.....	Leaf spot and mildew	Bordeaux II or No. 9...	When leaves are unfolding.....	2 weeks later	2 or 3 weeks after second.....	.....	First after blossoming. Often necessary to treat repeatedly after crop is gathered
	Rot	Bordeaux I and II.....	Before blossoming I....	After blossoms drop II on fruit.....	2 weeks later II on fruit.....	2 weeks later II, 3 or 4.....	Use 3 or 4 when fruit is large. No. 9 on sweet cherries.
	Aphis.....	Nicotine sulphate and soap suds	On first appearance of aphis.....	.....	.....	.....	Difficult to reach aphis. Use 1 lb. of soap to 50 gal. of solution
	Cherry slug...	Arsenate of lead in Bordeaux I or self-boiled lime-sulphur..	After fruit harvest when slugs appear..	Repeat if slugs remain	.....	.....	Air-slaked lime may be used when trees are carrying fruit

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Cherry	Curculio	Arsenate of lead in Bordeaux I and II or in self-boiled lime-sulphur with soap added	Before blossoming in I.	As blossoms dry up in II.	1 week later in II		Avoid strong solutions. Do not use other arsenicals than arsenate of lead
	San Jose scale.	14 or 18	Before buds open				
Chestnut	Bark disease	Cut out and burn diseased parts					Disease not yet general in Ohio. This is for earnest warning
	Anthracnose	Bordeaux I	When leaves are half grown				Seldom serious
	Weevil	Heat nuts in fall					Heat nuts in fall to 135° F. for 3 to 4 hours
Cineraria	Mildew	Bordeaux I or ½ of 5	When mildew appears in spring	2 weeks later	Repeat if necessary		
Chrysanthemum	Leaf spot	Bordeaux II or ½ of 5.	July 1	2 weeks later	Repeat if necessary		
Cucumber	Anthracnose	Bordeaux I	When plants begin to vine	2 weeks later	2 weeks later	2 weeks later	Repeat as necessary
	Downy mildew.	Bordeaux I	July 25 to August 1	8 to 10 days later	8 to 9 days later	8 days later	Repeat at weekly intervals
	Root rot	See soil treatment					
	Spot of fruit	Bordeaux I	After first blossoms	10 days later	2 weeks after second	2 weeks after third	Apply to fruit carefully
	Nematodes	See soil treatment					
	Wilt	See soil treatment	Pull out and burn infected plants				Rotate crops. See Rand* as to Bordeaux spray
	Cucumber beetle	Arsenate of lead in Bordeaux I. Or sprinkle and mulch freely with tobacco dust	Soon as plants appear.	Week later	Week after second	Week after third	Week after fourth
Currant	Leaf spot	Bordeaux I	As leaves are unfolding	2 weeks later	2 weeks later	2 or 3 weeks later	Fourth necessitates washing fruit
	Plant bug	Kerosene emulsion or nicotine sulphate	May	Early in June if necessary			

*Rand, F. W. and Enlows, Ella M. A., *Transmission and control of the bacterial wilt of cucurbits*, Jour. Agr. Research, U. S. Dept. Agr. 6, No. 11.

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Currant.....	Rust.....	Destroy plants	.....	.....	.....	.....	Rust on Ribes alternate stage of white pine blister rust
	San Jose scale.	Lime-sulphur or 18....	As with the apple.....	In spring as with apple			
	Worm	White hellebore or arsenate of lead.....	When worms first appear. Arsenate of lead when in bloom..	In 3 or 4 days repeat..	Repeat as second.....	.....	Look for worms on under side of lower leaves first
Egg plant...	Bacterial blight	Remove and burn					
Elm	Canker.....	Cut and burn.....	.....	.....	.....	.....	See ash canker
	Leaf spot and black spot...	Bordeaux I.....	When leaves are half grown	3 weeks later	.....	.....	These fungi mature spores on fallen leaves. Hence gather and burn diseased leaves in fall
	Powdery mildew	Lime-sulphur or Bordeaux	With first appearance of mildew in midsummer	3 weeks later			
	Flea beetle	See potato					
	Lecanium scale	As maple for terrapin scale					
	Leaf beetle	Arsenate of lead, 1 lb. to 10-15 gal., also bands of burlap and tanglefoot; band below	When larvae appear ..	.....	.....	.....	Repeat every 3 weeks until disappearance
Ginseng.....	Alternaria blight	Bordeaux I.....	As new stools appear..	2 to 3 weeks later.....	Repeat second.....	Repeat if necessary	
Gooseberry..	Leaf spot.....	Bordeaux I.....	As currants with leaf spot	As currants with leaf spot.....	As currants with leaf spot.....	As currants with leaf spot	
	Mildew	Bordeaux I or 7.....	Before leaves open I...	After blossoming I....	Potassium sulphide 2 weeks later.....	.....	Bordeaux coats fruits if used for third. Sodium sulphide may be substituted for 7
	Rust..... ...	See currant.....	Destroy diseased plants				
	Worm.....	White hellebore or arsenate of lead.....	As on currants				

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Grape.....	Anthracnose..	Bordeaux I.....	Just before buds open.	Just before blossoming	Just after fruit has set	10 days later, Bordeaux	
	Berry moth....	Arsenate of lead with Bordeaux II plus soap	4 to 7 days after bloom	10 days after fruit has set.....	Aug. 3 to 12	.....	Use 2 lb. soft soap to 50 gal.
	Downy and powdery mildew.....	Bordeaux I or 6.....	Just before blossoming	After fruit has set.....	10 to 15 days later		
	Necrosis.....	Bordeaux I...	In early spring coat vines and trunks well	Repeat with next rot spray			
	Rot.....	Bordeaux I or 6 and 3 or 4.....	Just before blossoming Bordeaux I or 6.....	Just after fruit has set I or 6	7 or 8 days later.....	7 or 8 days later, Bordeaux I or 6	Follow by two or three sprayings with am. cop. carbonate
	Leaf hopper...	Nicotine sulphate or 18	Before young can fly...	.....	.....	.....	Repeat treatments at short intervals until insects are exterminated
	Rose bug	Arsenate of lead, 6 lb. and glucose, 1½ gal. in water, 50 gal.....	Soon as bugs appear..	2 or 3 days later.....	1 week later	1 week later.....	Continue at intervals of 1 week or oftener as long as necessary
Hickory.....	Leaf spot.....	.....	Gather diseased leaves and burn in fall.....	.....	.....	.....	See under elm leaf spots
Horse Chestnut..	Leaf blotch....	Bordeaux I or dust spray.....	When leaves are half-grown.....	2 weeks later	2 weeks after second...	.....	Mixture of 90 parts fine sulphur and 10 parts powdered arsenate of lead successful dust
	Leaf hopper...	Tobacco decoction or dilute kerosene emulsion.....	As soon as noticed, before insect acquires wings.....	Repeat first 10 days later			
Japan Quince	San Jose scale.	Lime-sulphur or 18	As for apple				
Juniper or Cedar.....	Rust.....	Cut out cedar apples..	As soon as seen, better in fall.....	.....	.....	.....	Better destroy cedars near commercial apple orchards
Lettuce.....	Downy mildew	Keep houses cool and avoid water on leaves	.....	.....	.....	.....	Warmth and moisture about plants are dangerous. Subirrigation gives good conditions
	Rosette..... Rot or drop....	See soil treatment.....	Gather diseased leaves				

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Maple.....	Anthracnose..	Bordeaux I.....	When leaves are half-grown.....	.....	.....	.....	May usually control by gathering and burning leaves in fall.....
	Borers.....	Whitewash trunks	.....	.....	.....	.....	Keep trunks whitewashed from early summer till fall, 2 or 3 applications
	Caterpillars...	Arsenicals.....	When seen				
	Leaf scorch....	Protect from drying...	.....	.....	.....	.....	Mulching of great help to conserve water supply
	Tar spot	Burn diseased leaves					
	Terrapin scale	Kerosene emulsion, 1 part to 6 or 8 parts water or miscible oils, 1 part to 12 parts water.....	When buds are swelling				
Muskmelon..	Anthracnose..	Bordeaux I and II.....	In seed bed or when plants begin to vine Bordeaux II.....	2 weeks later Bord. I..	2 weeks later	2 weeks later	Repeat as necessary; use II very early
	Cucumber beetle.....	Same as for cucumbers					
	Downy mildew	Bordeaux I.....	July 25 to August 1...	8 to 10 days later.....	8 or 9 days later.....	8 days later	
	Leaf blight....	Bordeaux I.....	When plants begin to vine.....	3 weeks later	3 weeks after second...	2 weeks after third	Repeat same
	Wilts.....	See soil treatment.....	Pull out and burn wilted plants				
Oak.....	Anthracnose..	Bordeaux I or 14.....	Just as buds are opening I or 14	2 weeks later if necessary			
	Branch canker	Cut out and burn	.....	.....	.....	.....	Bordeaux spraying is aid to canker control; not complete remedy
	Powdery mildew	Bordeaux when leaves are half-grown.....	.....	.....	.....	.....	Destroy fallen leaves that have disease
	Caterpillars...	See maple					
Oats.....	Anthracnose..	See seed treatment					
	Blade blight...	Soap solution or kerosene emulsion.....	When green fly appears	2 weeks later			
	Smut.....	See seed treatment					

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Onion	Smut and storage rots	See seed treatment					
Pea	Blight and mildew	Bordeaux I	Just before bloom	2 weeks later	Repeat if needed		
Pine	Blister rust	Remove and burn					Remove and burn infected seedlings, etc.
	Damping off	See tree seedlings					
	Bark louse (woolly)	Kerosene emulsion, 1 to 8	On trunk and larger limbs				
	Leaf scale	Kerosene emulsion, 1 to 10 or 12	When young hatch in June				
Peach	Leaf curl	Bordeaux I, 5 or 14	In fall, or March, Bordeaux I, 5 or 14	As buds are opening, I, 5 or 14	Just after calyx drops, Bordeaux II	Not required (nor 3d) if others are well done	
	Little peach	Prune severely or dig out					
	Pustular spot	Bordeaux II or 9	Just after calyx drops	2 weeks after first	2 weeks later		Cover fruit well
	Rot	Bordeaux I, 14 and 9 or Bordeaux II.	As buds are swelling. 1 or 14	Just after calyx drops, 9 or Bordeaux II	3 or 4 weeks later, 9	As fruit begins to color, 9	Every 7 to 10 days repeat. Destroy all mummies. 3 may be used for fourth
	Scab	Bordeaux I, 5, 9 or 14	As buds are swelling, Bordeaux I, 5 or 14	Just after calyx drops, 9 or Bordeaux II	2 weeks later, 9 or Bordeaux II	Repeat third	9 is safest remedy on foliage
	Yellows	Cut out and burn					
	Bud moth	Arsenicals in Bord. I	With opening of buds				Use only half usual amount of poison
	Curculio	Arsenate of lead	Arsenate of lead 10 days after bloom falls	Arsenate of lead 10 days later			
	Terrapin scale	As on maple					
	San Jose scale	Lime-sulphur	In late fall or early spring				
Pear stocks	Leaf spot or blight	Bordeaux I	When leaves are half-grown	2 weeks later	2 weeks later	2 weeks later	5 to 7 sprayings are needed
Pear	Leaf blight and leaf spot	Bordeaux I or 6 and 3 or 4	Before blossoms open	2 weeks later, I or II	2 weeks after second, 3		Bordeaux may make russet fruit. Use 3 for 3d, not Bordeaux after 2d. Pear in foliage very badly injured by lime-sulphur solutions

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Pear	Scab	Bordeaux I	When leaves are half-grown	After blossoms drop			
	Blister mite	Kerosene emulsion, miscible oil or lime-sulphur	When buds begin to swell in spring	When leaves have fallen in autumn			
	Bud moth	Arsenites in Bord. I	With opening of buds				
	Canker worm	Arsenate of lead					See apple
	Codling moth	Arsenicals in Bord. I	As with the apple	Same as first			See apple
	San Jose scale	Lime-sulphur or 18	In winter or early spring				
	Slug	Arsenicals in Bord. I or dust with air-slaked lime	When slugs appear	Repeat if slugs remain			
Plum	Black knot	Cut out and burn, December to February					Formation of knots prevented when Bordeaux is used for sprays
	Pockets or bladders	Bordeaux I or lime-sulphur	In March, I or 14				Treat as for leaf curl of peach
	Rot	Bordeaux I, also 3; No. 9 on Am. and Jap. varieties	As buds are swelling, I or 14	Just after calyx drops, I or 6	3 or 4 weeks later, I or 6	As fruit begins to color use 3	Every 7 to 10 days repeat 4th; useless to spray for rot unless mummies are destroyed
	Shot-hole fungus	Bordeaux I or 6, also 9	When leaves are half-grown	3 weeks later	3 weeks later if needed.	No. 9 on Am. and Japanese varieties	Protect to end of season
	Curculio	Arsenate of lead in Bordeaux I or self-boiled lime-sulphur	With starting of buds.	Just after calyx drops.	5 days later		Destroy stung plums in addition
	Aphis	Nicotine and soap or soap, 1 lb. to 6 gal.	On appearance of aphis				
	San Jose scale	Lime-sulphur or 18	In late fall or early spring				
Poplar or Cottonwood	Cottonwood leaf beetle	Arsenate of lead, 1 lb. to 10 gal. water	Spray at intervals of 10 days until danger is checked				
	Leaf spot and rust	Gather and burn leaves					Control measures seldom needed
Potatoes	Black leg	See seed treatment					

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Potatoes	Early blight	Bordeaux I	When plants are 6 in. high	2 weeks later	2 weeks later	2 weeks later if needed	Seed selection desirable
	Fusarium blight	See seed treatment					
	Late blight	Bordeaux I or 6	July 15 to 20	2 weeks later	2 weeks later	2 weeks later	Repeat at 2-week intervals until crop is mature
	Rosette	See seed treatment					
	Blister beetle	Whale-oil soap or dilute chloro-naptholeum	When beetles appear	Repeat if necessary			Use 1 lb. soap to 6 gal. of water
	Colorado beetle	Arsenicals alone or in Bordeaux I	When beetles or young appear	As for first	As for first		Arsenate of lead, 5 lb. to 50 gal. of water
	Flea beetle	Bordeaux I or 6 combined with 20	When beetles appear	Repeat if necessary	As for first and second		
Quince stocks	Leaf spot	Bordeaux I	When leaves are half-grown	About 2 weeks later	2 weeks later	2 weeks later	Perhaps 5th spraying will be needed
Quince	Leaf spot	Bordeaux I and 6	When leaves are half-grown		2 weeks later, I or 6	2 weeks later	First should come before blossoms open
	Fruit and leaf spot	Bordeaux I	Just before blossoms open	After blossoms drop	2 weeks after second	2 weeks later	
	San Jose scale	Lime-sulphur or 18	In late fall or early spring				
Radish	Club root	See soil treatment					
	Maggot	See soil treatment					
Raspberry and Blackberry	Anthracnose	Bordeaux I and II	Before leaves open use I	II on canes 6 in. high	Repeat 2d 1 week later		Keep spray from leaves of bearing canes
	Cane blight	Bordeaux II	On young canes just before blooming of old	Immediately after fruit is gathered	3 weeks after 2d		Remove old canes at once after picking and spray new canes very thoroughly
	Leaf spot	Bordeaux I	When leaves are half-grown	2 weeks later	2 weeks later		
	Rust	Remove diseased stools and burn					Be prompt in destroying diseased stools
	Rasp. byturus	Arsenate of lead	Before beetles appear; about May 1	May 10 to 15			Cultivate thoroughly in fall to destroy and expose pupae
	Saw fly	Pyrethrum, hellebore or arsenate of lead	As for currant worm Arsenate of lead as soon as leaves are out	In 3 or 4 days repeat			

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Rose	Leaf spot	Bordeaux I or ½ of 5	With first appearance of fungus	2 or 3 weeks later	Repeat if necessary		Bordeaux shows on plants
	Mildew	Lime-sulphur as for apple or No. 9	With first appearance of mildew	2 or 3 weeks later	3 weeks later if needed.		When Bordeaux is used for leaf spot, other spray may not be needed
	Nematodes	See soil treatment					
	Slug	Arsenicals in Bord. II or hellebore	On appearance of slugs	Repeat if needed			
Rye	Anthracnose	See seed treatment					
	Ergot	Remove ergotized grain before seeding					
Salsify	Cystopus	Remove and burn diseased parts					
Squash	Cucumber beetle	Same as for cucumber					
	Squash bug	Hand picking					Pick bugs and egg-masses from leaves. Trap bugs by laying shingles beneath vines and collecting insects the following morning
Strawberry	Leaf spot	Bordeaux I, 6 or 9	On new growth after crop	2 or 3 weeks later			
Sugar beets	Damping off	See soil treatment					
	Leaf spot	Bordeaux I	With first appearance of spots	2 or 3 weeks later	2 or 3 weeks later	3 weeks later if needed	
	Blister beetle	Fish-oil soap or dilute chloro-naptholeum	When beetles appear				Use 1 lb. of fish-oil soap to 6 gal. of water
Sumac	Canker	Cut out and burn					
Sycamore	Anthracnose	As for oak					
	Powdery mildew	Lime-sulphur or No. 9	With first appearance, about July 15	3 weeks later on new growth	Repeat second		Gather and burn fallen leaves. Most troublesome on oriental variety

SPRAY CALENDAR—Continued

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Tobacco.....	Root rot and bed rot.....	See soil treatment					
	Mosaic disease	Handle separately from healthy plants.	.....	.....	.....	.....	Communicated by touching. See Bulletin 156
	Tobacco worm.	Paris green or arsenate of lead.....	When worms appear..	2 weeks later	2 or 3 weeks later if necessary.....	.....	Powdered arsenites applied with powder gun are most satisfactory
Tomato.....	Anthracnose..	Bordeaux I.....	Soon after fruit begins to set.....	3 weeks later	3 weeks later		
	Fusarium wilt.	See soil treatment. Rotate crop.....	.....	.....	.....	.....	Selection of resistant strains advised. See cabbage yellows
	Leaf blight....	Bordeaux I.....	3 weeks after transplanting.....	3 weeks after first.....	3 weeks later	3 weeks later	
	Mosaic disease (in greenhouse).....	Avoid too high temperatures at night..	Watch carefully and ventilate well.....	.....	.....	.....	Deficient ventilation makes this serious
	Point rot.....	See soil treatment					
	Sclerotium wilt	Remove and burn diseased plants.....	Watch carefully.....	.....	.....	.....	Danger in refuse from diseased houses
	Tomato worm.	Hand picking or clip in two with grass or sheep shears.					

SPRAY CALENDAR—Concluded

What to spray	For what to spray	With what to spray	When to spray				Remarks and cautions
			First Spraying	Second Spraying	Third Spraying	Fourth Spraying	
Tree seedlings (conifers)	Damping off	Slaked lime dust 10 parts, powdered copper sulphate 1 part, thoroughly mixed and screened	Dust freely on young seedlings in afternoon	Repeat first	Repeat first		Very strong Bordeaux mixture as 6-6-50 may be useful in bad, advanced cases
Turnip	Downy mildew	Spray with Bordeaux mixture	Upon appearance of disease	2 or 3 weeks later			
Watermelon	Anthracnose	Bordeaux II	When plants begin to vine	3 weeks after first	3 weeks later	3 weeks later	Bordeaux I, some danger
	Cucumber beetle	Same as for cucumber.					
	Downy mildew	Bordeaux II	July 25 to Aug. 1	8 to 10 days later	8 or 9 days later		
	Leaf blight	Bordeaux II	As disease appears on muskmelons	Repeat as on muskmelons	As on muskmelons	As for cucumbers	
Wheat	Anthracnose, scab, smut, etc.	See seed and soil treatment					
	Insects in stored grain	See seed treatment p. 509 and Mo. Bul. I, (March, 1916), No. 3, p. 86					

SEED AND SOIL TREATMENTS

Seed or plant	For what treated	Treatment	Method of treatment
Amaranthus	Fusarium wilt	Same as aster below	
Aster	Fusarium wilt	Sterilize soil with steam	Apply steam as under cucumber
Barley	Bacterial disease	Seed treatment	See Phytopathology, February, 1917
	Scab	Seed treatment	See wheat scab, also Bulletin 203
	Smuts (loose and covered)	Formaldehyde or modified hot water	For covered smut, sprinkling with stronger formaldehyde as for oats is successful. For loose smut, soak seed inclosed in sacks 4 hours in cold water, let stand to drain, dip 15 minutes in hot water at 124° to 125° F., or four degrees lower than for other hot water treatments
	Stripe disease	Soak in formaldehyde	Soak seed 3 hours at 68° F. in formaldehyde solution, 1 pint to 30 gallons of water
Bean	Anthracnose	See spray calendar	
	Rhizoctonia	Sterilize soil	Sterilize soil with steam as under cucumber, lettuce, etc., or drench with formaldehyde
	Sclerotinia	Sterilize soil	As for rhizoctonia with steam; formaldehyde of doubtful value
	Weevil	Bisulphide of carbon	Submit to fumes for 24 hours in air-tight vessel or chamber, or treat the same as for peas
Beets, sugarbeets	Black rot	Formaldehyde	Use ¼ pint formaldehyde in 6 gallons of water; soak seed 20 minutes; wash in pure water; dry or plant at once
	Damping off	As for lettuce rosette	
Begonia	Nematodes	Sterilize soil with steam	Disinfect soil to be used by heating with steam as described under cucumbers
Cabbage, cauliflower and kohl rabi	Black leg	Seed treatment	Treat seed with formaldehyde ¼ pint in 6 gallons water; soak 20 minutes; wash in pure water and dry or plant at once Change beds each year. Reject diseased plants. (See Bulletin 228)
	Black rot	Seed treatment	Treat as for black leg. Rotate beds and crops
	Club root	Quicklime on soil	Apply stone lime (quicklime) preferably ground lime, before planting, at rate of 80 bushels per acre and work into the soil with suitable tools
	Fusarium wilt or "yellows"	Place seed beds on new soil each year. Rotate crop. Resistant seed	"Yellows" is chiefly transmitted in the soil. Rotation of the crop is necessary. Resistant selections now available. See Ohio Agr. Exp. Sta. Bul. 228 and Mo. Bul. II (Feb. 1917), No. 2
	Maggot	Bisulphide of carbon, tobacco dust or carbolic emulsion or solution of hellebore	Make hole in soil near roots; pour in about a teaspoonful of bisulphide of carbon and fill holes with soil. Cover soil around stalks freely with tobacco dust once per week. Dilute one of the carbolic or coal tar sheep dips with 100 parts or more of water and pour ½ pint around the root after removing the earth from one side. Apply decoction of hellebore in same manner. Use non-infected soil for seed beds and cover with screens
	Nematodes in hothouse	Sterilize soil with steam	See cucumber
Corn	Dry rot and mold	Reject diseased seed ears	This fungus spreads badly in continuous corn growing. See Bulletin 214
	Ear rots	Reject diseased seed ears	Same as dry rot of corn

SEED AND SOIL TREATMENTS—Continued

Seed or plant	For what treated	Treatment	Method of treatment
Cucumber	Nematodes in hot-house	Sterilize soil with steam	Sterilize soil with steam by perforated pipes, high pressure 35 pounds 1 hour, 75 pounds ½ hour, or low pressure in subdrains 4 to 5 hours or inverted pan until soil is heated to 200° F. at depth of 12 inches. See Ohio Agr. Exp. Sta. Cir. 151
	Stink bug	Hand-picking eggs	Pick off patches of brownish eggs on leaves and burn. Go over the vines 2 or 3 times per week
	Root rot	Drench soil with formaldehyde	Drench soil with formaldehyde, 3 to 4 lb. to 50 gal. of water for preceding lettuce crop
	Wilts	Sterilize bed soil with steam	Method as for nematodes. See Ohio Agr. Exp. Sta. Cir. 151
Egg-plant	Wilts	Sterilize bed soil with steam	Method as for nematodes. See Ohio Agr. Exp. Sta. Cir. 151
Lettuce	Aphis	Tobacco smoke	Smudge for several hours by burning tobacco stems or leaves in closed greenhouse or use nicotine fumigant
	Rosette, root rot	Sterilize soil with steam or drench with formaldehyde	Steam as above or drench with formaldehyde 2 to 4 lb. where trouble follows with cucumbers 3 to 4 lb. to 50 gal. of water, 1 gal. solution to each sq. ft. of surface. Two weeks must elapse before setting plants. See Ohio Agr. Exp. Sta. Cir. 57 and Cir. 151
	Drop or rot	Steam soil	
	Slugs and snails	Toads, poisoned bait, lime, soot	Turn number of toads in greenhouse to devour slugs. Use poisoned bran bait recommended for cutworms. Mulch ground quite freely with ground lime or with soot
Muskmelon	Wilts	As for cucumber wilts	
Oats	Anthracnose	Formaldehyde	Treat seed as stated in next to kill adhering spores. This is only a partial remedy
	Loose smut	Sprinkle seed with formaldehyde or immerse seed in hot water. Soak seed in potassium sulphide	Preferably sprinkle a pile of seed with shoveling to saturate with formaldehyde solution, 1 pint to 40 gallons water, one gallon to a bushel, at 3 or 4 sprinklings; after 3 or 4 hours or over night in the pile, spread to dry. After treatment, handle the grain in disinfected bags, mills and drills. Immerse seed contained in open vessel for 10 minutes in hot water at 132-3 degrees Fahr., for 7 minutes at 136 degrees Fahr., or for 5 minutes at 140-2 degrees Fahr., spread at once to dry. Soak seek in ¾ percent solution potassium sulphide for 24 hours with stirring, then dry
	Insects in stored grain	(See wheat) bisulphide of carbon	Fumigate soon after storing in bins. See formula 27, and Ohio Agr. Exp. Sta. Mo. Bul. I (March, 1916), No. 3, p. 86
Onion	Smudge	Use formaldehyde as for onion smut	Sow seed with formaldehyde drip as for onion smut; rotate onions with other crops
	Smut	Use formaldehyde or ground quicklime. Plant other crop. Use sets or transplanted seedlings	Use formaldehyde solution 1 lb. to 30 gal. of water sprinkled on seed in contact with soil and cover at once, or better sow with drill and drip attachment, the solution falling with the seed. Or apply ground quicklime at the rate of 75 to 125 bushels per acre just previous to seeding on freshly plowed land, and stir into soil. (See Ohio Agr. Exp. Sta. Bul. 131)
	Storage rots	Disinfect with formaldehyde gas	Fumigate to disinfect the dry onions, with formaldehyde gas in inclosed piles of slat crates for 24 to 48 hours. (See description of method under No. 10 above)

SEED AND SOIL TREATMENTS—Continued

Seed or plant	For what treated	Treatment	Method of treatment
Pea	Anthracnose (blight)	Spray the growing crop with Bordeaux	Keep down infection of seed through spraying of plants. See Spray Calendar
	Weevil	Heat carefully in oven	Submit seed to heat of 125° F. for 1 hour, stirring to prevent uneven heating, at end of which time all weevil will be dead and germination will not be injured
Potato	Black leg	Reject tubers of diseased hills at harvest	Treat seed tubers with corrosive sublimate as for scab to kill adhering germs
	Fusarium wilt, dry rot	Cut away slight infection of seed tubers—then soak in corrosive sublimate. Rotation of crops	After rejecting badly diseased tubers, cut off slight infection and treat with corrosive sublimate as for scab. Rotate the potato crop. (See Ohio Agr. Exp. Sta. Bul. 229)
	Scab, powdery scab	Soak uncut seed in corrosive sublimate	Soak seed for 1 hour in corrosive sublimate; then dry and plant on scab-free soil; formaldehyde less effective
	Rosette (rhizoctonia)	Soak seed in corrosive sublimate as for scab	See Handbook of Plant Diseases. Also Ohio Agr. Exp. Sta. Mo. Bul. I (Jan., 1916), No. 1, p. 10
Radish	Club root	Quicklime on soil	As for cabbage
	Damping off	Drench beds with formaldehyde or sterilize with steam	See tobacco bed treatment
Rape—Rutabaga	Black rot	Formaldehyde	Treat seed with formaldehyde as for cabbage
Roses	Nematodes in hothouse	Sterilize soil with steam	Heat soil with steam as described above; thoroughly disintegrated soil from sod 1 year old or more is less dangerous. Limewater stimulates affected plants but is not a remedy
Rye	Anthracnose	Formaldehyde	Treat seed as for oats and wheat to kill spores. Remedy only partial
Sorghum	Kernel smut	Formaldehyde	Soak seed 1 hour with formaldehyde. Head smut not prevented
Sweet Potato	Black rot and stem rot	Formaldehyde	Soak or fumigate seed roots as for potato scab; discard old diseased hotbeds; drench slightly diseased beds with formaldehyde as for lettuce and tobacco. Then set plants on new soil
Tobacco	Root rot and bed rot	Drench beds with formaldehyde or sterilize with steam	Drench beds in fall or early spring with formaldehyde, 4 lb. to 50 gal. water, 1 gal. to each sq. ft. Do not seed until smell of formaldehyde has disappeared. Or sterilize with steam. See Ohio Agr. Exp. Sta. Cir. 151 and 156, also Mo. Bul. I (Feb., 1916), No. 2, p. 43
Tomato	Nematodes in hothouse	Sterilize soil with steam	As for roses and cucumbers above
	Point rot in hothouse	Mulch or subwater	An insufficient water supply seems favorable to development of point rot of green tomatoes
	Rhizoctonia	Same as for tobacco beds	
	Fusarium wilt	Sterilize bed soil with steam	Sterilize beds with steam as for cucumbers and tobacco. Transplant plants into new soil. Avoid succession of crops of tomatoes

SEED AND SOIL TREATMENTS—Concluded

Seed or plant	For what treated	Treatment	Method of treatment
Turnip	Black rot.....	Treat seed	Formaldehyde seed treatment as for cabbage
	Club root.....	Quicklime in soil	As for cabbage and cauliflower. Avoid succession of these crops
Violet.....	Nematodes in hot-house.....	Heat soil with steam.....	The time for prevention is by soil treatment beforehand as for cucumbers above
Wheat.....	Anthracnose.....	Formaldehyde.....	Sprinkling as for stinking smut may prove partial remedy. Avoid use of infected straw on wheat fields. See Ohio Exp. Sta. Bul. 203
	Loose smut.....	Modified hot water.....	Soak seed 4 hours in cold water, let stand 4 hours more in wet sacks, immerse 10 minutes in water at 129 to 130° F. and dry, or sprinkle with formaldehyde after soaking
	Scab.....	Reject scabbed grain.....	Separate shriveled grain with sieves and mill. Sow only heavy seed grain. Formaldehyde on seed as for stinking smut. See Ohio Exp. Sta. Bul. 203
	Stinking smut.	Formaldehyde, hot water or copper sulphate.....	Sprinkle grain in piles with formaldehyde as for oat smut, 1 gal. or less per bushel and dry in same manner
			Dip skimmed seed for 10 minutes in hot water at 129 to 130° F. and dry on disinfected surface or immerse 10 minutes in solution of blue vitriol (copper sulphate); dry with air-slaked lime by shoveling. Use 2 lb. of blue vitriol to 10 gal. water. Grain may be sprinkled in piles with copper sulphate or formaldehyde as for oats
☞	Insects in stored grain.....	Bisulphide of carbon.....	Use 5 to 8 pounds of bisulphide of carbon for each 1,000 cu. ft. of space in bins. The fumes will spread through the mass, killing the insect life. Use in tight bins or buildings and do not bring fire of any description near the bins while fumigating. See Ohio Agr. Exp. Sta. Mo. Bul. I (March, 1916), No. 3, p. 86

SPRAY MIXING AND FILLING OUTFITS

"Time saved is money earned," and in nothing is this more certain than in spraying. The old directions for making spray mixtures contemplate simply the minimum of labor or time-saving devices. With large orchards, time-saving devices become imperative. Of these, special arrangements to facilitate rapid filling of the spray tanks are helpful. Here are some essentials for Bordeaux mixture and conveniences for other sprays:

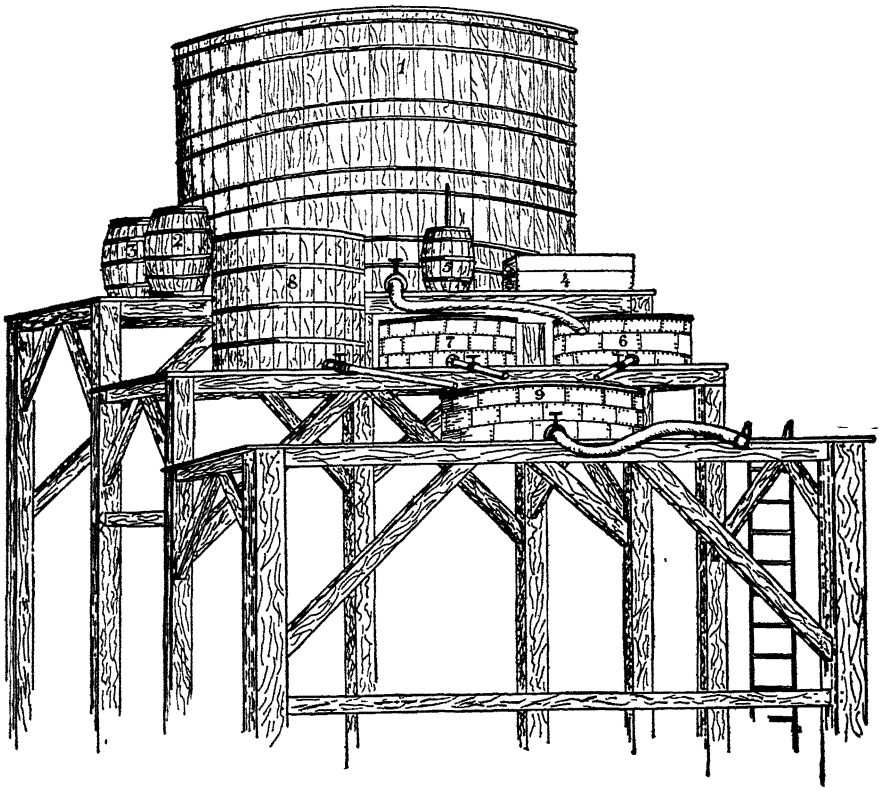

Fig. 1.—Adapted illustration of a complete spray mixing and filling outfit

(1) Large tank at elevation filled from eavestroughs of building or by pump, provided with outlet and valve with attached hose. (2) 50-gallon barrel for stock solution or copper sulphate. (3) Same for iron sulphate. (4) Lime box to contain lime in putty form. (5) Arsenate of lead mixer to prepare the paste by mixing with water before addition to lime tank. (6) Lime tank of 50 to 100 gallons capacity wherein the lime putty is diluted and made up to volume desired after counting volume of arsenicals added in it. (7) Tank of 50 to 100 gallons capacity for copper sulphate and iron sulphate. In this, the solutions are made up to half the capacity of sprayer or equal volume with milk lime and ready to be mixed with it. If of metal, this tank should be painted inside to reduce precipitation of copper on the metal. (8) Wooden tank for steam cooking of lime-sulphur by means of a boiler located nearby. (9) Mixing tank into which the copper sulphate, etc., and milk of lime are run in equal volumes for mixing. It also serves as a dilution tank for lime-sulphur prepared by steam cooking in (8).

Note: Tanks (6) and (7) should be of known volume, or say, half the capacity of the spray tank used. Tank (9) needs to be double the capacity of (6) and (7) or equal to the capacity of the spray tank.

(From Ohio Agr. Exp. Sta. Bul. 232 (1909), p. 49)

1. Adequate water supply in tank or reservoir above the level of the mixing platform—as by a tank filled from eavestroughs of high barn, or by lifting with pump.

2. Accessible supplies of spray material upon the same level as that on which the mixing is done—as covered storage for chemicals and barrels containing stock solutions of blue vitriol, iron sulphate, lime tank, etc.

3. A separate mixing tank, preferably of low, flat form above level of spray tank, in which the spray materials are thoroughly mixed before being run into the spray tank. This results in a terraced group of platforms at different levels, each carrying its proper tanks and barrels. (Fig. 1.)

4. For lime sulphur with arsenate of lead, a tank-filling pump or tank filler may be used successfully to fill the sprayer from a ditch or other reservoir. This may be of type operated by power on spray outfit.

Those who have used arsenate of lead have experienced the difficulty of getting the lead to mix after it has settled to the bottom of the package, or after it has partly dried out. Frequently the mixing of the lead requires as much time as any of the other processes in preparing a sprayer full of mixture. We have found that an old churn is efficient for the process, and if one is not available, a substitute may be made quite readily from a discarded 100-pound arsenate of lead keg or any keg of similar size. In making the churn, have the lid fit snugly, and it is preferable if the cross arms of the dasher are almost as long as the inside diameter of the bottom of the keg. (Fig. 3.)

In cooking lime-sulphur, either for the formula No. 14 or for the making of concentrates, the need for special devices is apparent. These have been well illustrated in Bulletins 169 and 144 of this Station. In Figure 1, the smaller wooden tank (8) is designed for cooking lime-sulphur by means of steam from a boiler; the larger mixing and dilution tank (9) is available for the dilution of the lime-sulphur.

In field work, especially in southern Ohio, where water supplies of adequate amount have not been generally developed, a portable mixing outfit will well serve as a substitute for the more highly developed, expensive, fixed ones. The illustration (Figure 3) shows one of these mounted upon wheels such as are used for binder trucks, and of the necessary elevation of frame to admit running from the barrels directly into sprayer. The tank-filling pump is useful in connection with this for lifting the water.

The larger illustration (Fig. 1) shows the details of a complete mixing plant adapted somewhat from that used at Orchard Farm, Mansfield, Ohio. It is presented to illustrate how the numerous materials, apparatus, etc., may be assembled and readily operated without relifting the water or the spray solutions. The prime need is a sufficient water supply in the tank, either by gathering from a building or by pumping into the tank. This once attained, the other details may be arranged at different levels, whereby the liquids are run from one or several sources into the lower receiving tank and thence into the sprayer.

Fig. 2.—Arsenate of lead mixer
A mixer for working up arsenate of lead paste. An old churn may be utilized; but if this is not available, a mixer may be made from a small keg. (From Ohio Agr. Exp. Sta. Bul. 232 (1909), p. 52)

In all these spray-mixing outfits, the first essential is that the one lifting of water or the reservoir supply of water shall place it at such height above the sprayer to be filled that no relifting and rehandling of the liquids are necessary. For the more expensive outfits this is done by the fixed water tank which is filled by power. For the inexpensive portable ones, the fundamental idea is to have a frame of sufficient height that when the liquid is lifted or pumped into the barrels supported by this frame, these supplies shall be at the necessary elevation for running directly into the sprayer itself. In portable outfits the spray materials must be carried about, and in proportion as the quantity is large, difficulties will appear.

For lime-sulphur concentrates to which arsenate of lead is added, the difficulty in this respect is slight, and by use of the arsenate of lead mixer (Fig. 2) the filling may be done directly with the tank-filling pump from any available water supply.

SPRAY OUTFITS

In selecting a spraying outfit, care should be taken to purchase only machines which have the qualities of durability, simplicity and sufficient capacity for the use of the average orchardist. The kind and quality of materials used in the construction, together with the sufficient strength of parts and the quality of the workmanship, largely determine the durability of the pump, if the design is good. Parts likely to give trouble should be readily accessible so that they

can be easily removed and repaired. Large bronze ball valves and fairly large air chambers are desirable features. Hose leads should be at least 35 feet long with extra long hose connections and two hose bands at each end. Extension rods should be preferably of bamboo, lined with brass or aluminum tubes, and about 10 feet in length. Cutoffs are needed at the bases of the rods. Disk nozzles are preferred to the other types, especially on power outfits.

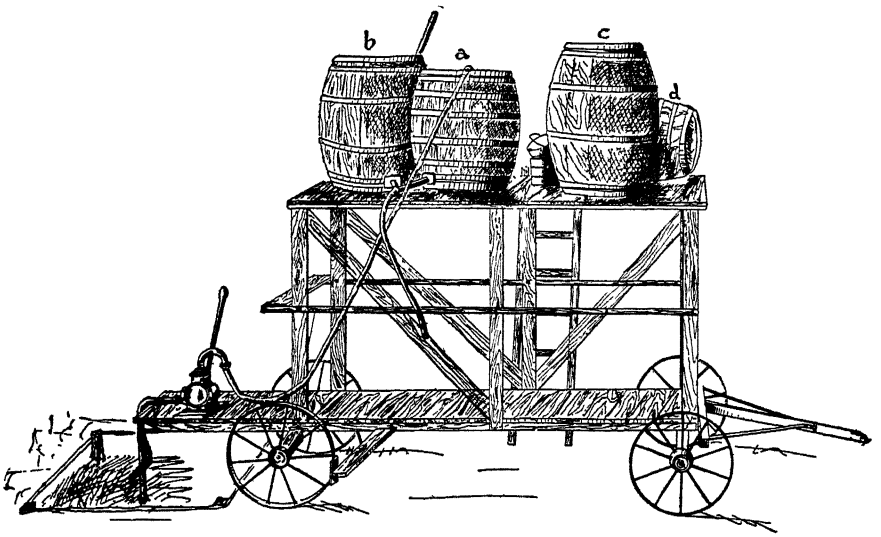

Fig. 3.—A portable mixing outfit
Barrels A and B are used for the dilute copper sulphate and lime-lead arsenate mixture, respectively. Barrel C is used for the concentrated copper sulphate stock solution and D may be used for iron sulphate or a water supply for rinsing, etc. The water is elevated from a spring by the use of the strong hand pump. (From Ohio Agr. Exp. Sta. Bul. 232 (1909), p. 51)

With hand pumps, as well as with power sprayers, it is desirable, in addition to an air chamber of at least 3 to 7 gallons capacity, to have a pressure gauge and to apply the spray under conditions of uniform pressure. A pressure of 100 pounds for hand outfits, and 200 to 300 pounds on power sprayers gives good results.

For further discussion of spraying machinery, see Bulletin 216 of this Station. Nozzles and spraying machinery accessories are covered in Bulletin 248.