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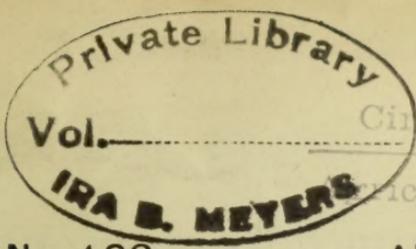
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BULLETIN No. 123.

APRIL, 1908.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT
STATION.

FUNGICIDES, INSECTICIDES,

AND

SPRAYING DIRECTIONS.

BY

GEORGE E. STONE AND HENRY T. FERNALD.

This bulletin gives formulas for the preparation of fungicides and insecticides, with directions for preventing and controlling fungous diseases and insects.

Requests for bulletins should be addressed to the
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AMHERST, MASS.

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Fungicides, Insecticides and Spraying Directions

BY GEORGE E. STONE AND HENRY T. FERNALD.

The time has come when insects and fungi are so abundant that no crops can be neglected if profitable returns are to be expected. More care in cultivation and the production of healthy, vigorous plants is necessary, accompanied by spraying or special treatments for special cases, and it is the purpose of this bulletin to offer suggestions along these lines.

It is now recognized that if plants are healthy, vigorous and in good condition, they can better resist the attacks of injurious insects and fungi than if in poor condition. Every effort should accordingly be made to get the soil into good condition; to have it supplied with the proper fertilizers for the crop; to cultivate well and to use every means for the production of strong plants, which can resist attack and bring better results to the owner.

This plan alone will do much good, but if supplemented by spraying or other treatments, made in the right way and at the right times, the results will become far more satisfactory, and any farmer who now neglects such an important part of his business as properly caring for his crops has only himself to blame for poor results.

The more important fungi and insects on the different crops are listed below, with the treatment for each, and these treatments will also protect from the less important foes. The number of applications suggested is given for cases where the enemies are abundant, and where these are present only in small numbers the later treatments may frequently be omitted. In any case prevention is better and cheaper than cure.

See that all spraying apparatus is in shape for immediate use before the season opens. Have connections tight, the hose in good condition, the packing in the pumps perfect, and everything ready. The insects and diseases are ready; the farmer must also be ready if he is to keep them under control.

Learn to know the insects and diseases by their appearance and their work, so as to apply the right treatment, for treatments differ for different foes and there is no one material which is effective for all insects and diseases any more than there is any one medicine good for every kind of illness with man.

“There is no one best pump or nozzle.” Almost any spray pump now on the market will do at least fair work. For Bordeaux mixture use a Bordeaux nozzle. For most insects use a Vermorel nozzle. There are many varieties of this, but in all the spray enters the chamber behind the outlet hole from one side and whirls around the chamber before escaping, and a nozzle made on this plan, whatever its name, should do the work. The smaller the outlet hole the better, unless it clogs, in which case use a cap with a slightly larger hole. The spray should be a fine mist or fog.

One THOROUGH spraying at the right time is worth ten careless treatments. Most people who have given up spraying have done so either because they were not thorough enough and were disappointed in the results, or because they were lazy, and this country will soon have no place for the lazy farmer who thinks that planting, cultivating and harvesting are the only things necessary to obtain a crop.

This bulletin contains a compilation of formulas for fungicides and insecticides taken from various sources, and the usual spraying directions. The treatments recommended are similar to those given in other Station bulletins of the same nature, but are based upon the personal observations of the authors covering a period of years. Many of these mixtures can be bought already prepared from reliable dealers, which saves much time and trouble in mixing them. The following precautions should be taken into consideration:

1. Care should be taken to keep all substances employed in spraying where they cannot be used by mistake. All substances should be correctly labeled.
2. Solutions and mixtures containing copper sulfate, corrosive sublimate, and arsenate of lead, should be made in wood, glass or earthen vessels.
3. Arsenical sprays should not be applied to fruits, etc., within two weeks of the time they are to be used as food.
4. Trees should not be sprayed when they are in blossom unless one wishes to reduce the crop.

Directions for making and applying the different treatments follow.

FUNGICIDES.

1

BORDEAUX MIXTURE.

- Copper sulfate, (blue vitriol), 4 pounds.
- Lime, (unslaked), 4 pounds.
- Water, 25 to 50 gallons.

Dissolve the copper in hot or cold water, using a wood or earthen vessel. Slake the lime in a tub, adding the water cautiously and only in sufficient amount to insure thorough slaking. After thoroughly slaking, more water can be added and stirred in until it has the consistency of thick cream. When both are cold, dilute each to the required strength and pour both together in a separate receptacle and thoroughly mix. Before using, strain through a fine mesh sieve or a gunny cloth.

The mixture is then ready for use. Considerable trouble has frequently been experienced in preparing the Bordeaux mixture. Care should be taken that the lime is of good quality and well burned and has not been air slaked. Lumps are far superior to the fine lime and are selected by masons for preparing finishing coats. Where small amounts of lime are slaked it is advisable to use hot water. The lime should not be allowed to become dry in slaking, neither should it become entirely submerged in water. Lime slakes best when supplied with just enough water to develop a large amount of heat, which renders the process active. If the amount of lime in the Bordeaux mixture is insufficient, there is danger of burning tender foliage. In order to obviate this the mixture can be tested with a knife blade or with ferro-cyanide of potassium (1 oz. to 5 or 6 oz. of water). If the amount of lime is insufficient, copper will be deposited on the knife blade, while a deep brownish-red color will be imparted to the mixture when ferro-cyanide of potassium is added. Lime should be added until neither reaction occurs. A slight excess of lime, however, is desirable, and it is seldom one has to apply these tests.

The standard mixtures are :

- (a). 25 gallons (full strength mixture, or 4-4-25 formula), that is, 4 lbs. copper sulfate, 4 lbs. lime and 25 gallons water.
- (b). 50 gallons (half strength mixture, or 4-4-50 formula).
- (c). 6-4-50 formula.
- (d). 3-6-50 formula.
- (e). 2-2-50 formula.
- (f). 3-9-50 formula.

d, e and f are suitable for peach and plum foliage, which are susceptible to burn when full strength mixtures are used.

2 SODA BORDEAUX MIXTURE.

Copper sulfate, 4 pounds.

Water, 50 gallons.

Add enough soda lye to make the mixture alkaline to test paper.

3 AMMONIACAL COPPER CARBONATE.

Copper carbonate, 5 ounces.

Ammonia (26° Beaumé.), 3 pints.

Water, 50 gallons.

Dissolve the copper carbonate in ammonia. This may be kept any length of time in a glass stoppered bottle, and can be diluted to the required strength. The solution loses strength on standing.

4 COPPER SULFATE SOLUTION.

(Strong Solution.)

Copper sulfate, 1 pound.

Water, 25 gallons.

Applied only on trees without foliage.

5 COPPER SULFATE SOLUTION.

(Weak Solution.)

Copper sulfate, 2 to 4 ounces.

Water, 50 gallons.

For trees in foliage.

6 POTASSIUM SULFID.

Potassium sulfid, 3 ounces.

Water, 10 gallons.

Valuable for gooseberry mildews, etc.

7 CORROSIVE SUBLIMATE.

(*For Potato Scab.*)

Corrosive sublimate, 2 ounces.

Water, 15 gallons.

Dissolve the corrosive sublimate in 2 gallons of hot water, then dilute to 15 gallons, allowing the same to stand 5 or 6 hours, during which time thoroughly agitate the solution several times. Place the seed potatoes in a sack and immerse in the solution for 1½ hours. Dry before planting.

Corrosive sublimate is very poisonous, consequently care should be taken in handling it, and the treated potatoes should not be kept within reach of stock. The solution should not be made in metallic vessels.

8 FORMALIN.

(*For Potato Scab.*)

Formalin (40 per cent solution), 8 ounces.

Water, 15 gallons.

Used for the same purpose as corrosive sublimate, but not poisonous. Immerse the seed potatoes for 2 hours and spread out to dry before planting.

INSECTICIDES.**STOMACH POISONS.****9 PARIS GREEN.—DRY.**

Paris green, 1 pound.

Flour, 20 to 50 pounds.

Mix thoroughly and apply evenly; preferably when dew is on the plants.

10

PARIS GREEN.—WET.

Paris green, 1 pound.
 Quicklime, 1 to 2 pounds.
 Water, 200 gallons.

Slake the lime in part of the water, sprinkling in the Paris green gradually, then add the rest of the water. For the peach and other tender leaved plants use 300 gallons of water. Keep well stirred while spraying.

11

ARSENITE OF LIME.

White arsenic, 2 pounds.
 Sal-soda, 8 pounds.
 Water, 2 gallons.

Boil till the arsenic all dissolves,—about 45 minutes. Make up the water lost by boiling and place in an earthen dish. For use take one pint of this stock, 2 pounds freshly slaked lime and 45 gallons water, and spray.

12

ARSENATE OF LEAD.

Arsenate of soda (50% strength), 4 ounces.
 Acetate of lead, 11 ounces.
 Water, 100 gallons.

Put the arsenate of soda in 2 quarts of water in a wooden pail, and the acetate of lead in four quarts of water in another wooden pail. When both are dissolved, mix with the rest of the water. Warm water in the pails will hasten the process. For the elm-leaf beetle use 10 instead of 100 gallons of water.

A number of ready-made arsenates of lead are now on the market, and except when very large amounts are needed it will probably prove cheaper to buy the prepared material than to make it. With this ready-made material take 3 pounds to 50 gallons of water for codling moth, and 5 pounds to 50 gallons for the elm-leaf beetle and on potatoes.

CONTACT POISONS.**13 a** **WHALE OIL SOAP.**

Potash whale oil soap, 2 pounds.

Hot water, 1 gallon.

For winter use only.

13 b

Potash whale oil soap, 1 pound.

Hot water, 6 gallons.

For summer use.

14 **KEROSENE EMULSION.**

Hard soap, shaved fine, $\frac{1}{2}$ pound.

Water, 1 gallon.

Kerosene, 2 gallons.

Dissolve the soap in the water, which should be boiling; remove from the fire and pour it into the kerosene while hot. Churn this with a spray pump till it changes to a creamy, then to a soft butter-like mass. Keep this as a stock, using one part in nine of water for soft bodied insects such as plant lice, or stronger in certain cases.

15 **RESIN-LIME MIXTURE.**

Pulverized resin, 5 pounds.

Concentrated lye, 1 pound.

Fish or other animal oil, 1 pint.

Water, 5 gallons.

Place the oil, resin and 1 gallon of hot water in an iron kettle and heat till the resin softens; then add the lye and stir thoroughly; now add 4 gallons of hot water and boil till a little will mix with cold water and give a clear, amber colored liquid; add water to make up 5 gallons. Keep this as a stock solution. For use, take

Stock solution, 1 gallon.

Water, 16 gallons.

Milk of lime, 3 gallons.

Paris green, $\frac{1}{4}$ pound.

The object of this preparation is to obtain an adhesive material which will cause the poison to adhere to smooth leaves. It has been highly recommended by the New York State (Geneva) Experiment Station.

The stock solution No. 15 can also be used in making the resin-Bordeaux mixture by taking two gallons and adding it to 10 gallons of water. This is mixed with 40 gallons of Bordeaux.

16 LIME-SULFUR WASH.

Fresh stone lime, 20 to 22 pounds.

Flowers of sulfur or sulfur flour, 18 to 20 pounds.

Water, 45 to 50 gallons.

Slake the lime with some of the water in a large iron kettle, sprinkling in the sulfur gradually. Start a fire under the kettle to continue the heat begun by the slaking lime, and boil till the mixture becomes dark orange in color, adding water till 35 or 40 gallons are in the kettle. Boiling should probably take from 40 minutes to an hour. Stir frequently and a successfully prepared lot should have little sediment on the bottom when the boiling is finished. Strain through a fine meshed strainer into the spray pump, adding the rest of the water, and spray while warm. It is generally better to use only the freshly prepared wash, though good results have sometimes been obtained with it when it has stood over night. This should not be applied to trees after the leaves have opened.

17 CARBOLIC ACID EMULSION.

Hard soap shaved fine, 1 pound.

Water, 1 gallon.

Crude carbolic acid, 1 pint.

Dissolve the soap in boiling water; add the carbolic acid and churn as for kerosene emulsion. Use one part of this with 30 parts of water.

18 HELLEBORE.

Hellebore, 1 ounce.

Water, 1 to 2 gallons.

Steep the hellebore in a pint of water and gradually add the rest of the water. Hellebore may also be dusted over the plants, either pure or mixed with flour or plaster.

19 INSECT POWDER. PYRETHRUM.

Mix with half its bulk of flour and keep in a tight can for 24 hours ; then dust over the plants. Or,

Insect powder, 100 grains.

Water, 2 gallons.

Mix together and spray.

COMBINED FUNGICIDES AND INSECTICIDES.

20 BORDEAUX MIXTURE AND PARIS GREEN.

Paris green if pure, 6 ounces ; more if necessary.

Bordeaux mixture, 50 gallons.

21 BORDEAUX MIXTURE AND ARSENATE OF LEAD.

Prepare the arsenate of lead as directed above, but instead of adding the arsenate of soda and acetate of lead to the water when dissolved, mix them together and then add to 50 gallons of Bordeaux mixture. On potatoes, use 20 ounces of arsenate of soda and 55 ounces of acetate of lead to 50 gallons of Bordeaux mixture. With ready prepared arsenate of lead use 5 pounds to 50 gallons of Bordeaux.

22 BORDEAUX MIXTURE AND ARSENITE OF LIME.

Arsenite of lime (made by formula No. 11), 1½ quarts.

Bordeaux mixture, 50 gallons.

23 IVORY SOAP.

Ivory soap (10 cent size), 1 bar.

Water, 15 gallons.

Apply warm as it thickens on cooling.

Recommended for rose mildew, plant lice, etc.

FUMIGANTS.

24 CARBON BISULFID.

Evaporate one pound of carbon bisulfid to every thousand cubic feet of space. This is done by pouring the bisulfid into shallow dishes placed in the upper part of the place to be fumigated, and closing everything tightly and leaving 24 hours. Then open, air for ten minutes before entering or using anything which has been fumigated. This treatment is effective for infested grain, weevily seed, clothes moths, carpet beetles, etc., in closets, trunks, tight boxes or wherever these substances are kept or in which they may be placed for treatment. **Caution: Do not use carbon bisulfid near a fire, or where there is much heat, as it takes fire easily, even from a lighted pipe or cigar.**

25 HYDROCYANIC ACID.

For Nursery Stock.

Potassic cyanid (98 or 99%).

Sulfuric acid (1.83 sp. gr. commercial).

Water.

Multiply the number of cubic feet to be fumigated, by .2 or .25, giving the number of grams of cyanid needed for the house or box; divide the answer by 28.35, giving the weight of the cyanid in ounces. Take twice as many fluid ounces of acid and four times as many fluid ounces of water as was taken in ounces by weight of the cyanid. Mix the water and acid in an earthen or granite-ware jar, then by loose bag and string drop in the cyanid after tightly closing the place to be fumigated. Leave closed 40 minutes, then open from the outside and air for at least ten minutes before entering.

26 HYDROCYANIC ACID.

For Empty Houses.

Potassic cyanid (98 or 99%) 1 oz. per 100 cu. ft.

Sulfuric acid (1.83 sp. gr. commercial), 2 fluid oz.
per 100 cu. ft.

Water, 4 fluid oz. per 100 cu. ft.

Mix as directed under Number 25.

27

SULFUR.

For Empty Houses.

Close the house tightly and burn 200 grams (about 6 oz.) to 1000 cu. ft. of space. Keep the house closed at least twelve hours.

28

SULFUR.

For Houses with Growing Plants.

Evaporate a small quantity in a kettle over a kerosene stove, taking care that it does not catch fire. Or, better, paint some of the heating pipes occasionally with a mixture of sulfur and oil.

TREATMENT OF GREENHOUSE PLANTS.

On general principles the practice of spraying greenhouse plants cannot be recommended, since the control of their diseases is possible to a large extent by maintaining favorable or hygienic conditions. This requires skill obtained from long experience in greenhouse management. When greenhouses are about to be emptied or before replanting, fumigation can be practised to advantage with Nos. 26 and 27.

Red Spiders and Mites.

Drench the plants with 2 ounces of common salt in a pailful of water. No really satisfactory treatment for these pests has yet been found.

Plant Lice : Aphids.

Burn tobacco stems ; when the house is empty, fumigate by any fumigant, such as Nos. 26 or 27.

Thrips.

Nikoteen 4 cc. ($\frac{1}{7}$ oz.)	} Per 1000 cubic feet.
Water 150 cc. (5 fl. oz.)	

Mix and vaporize in the house at night ; will kill most of the thrips.

White Fly.

Fumigate as for Nursery Stock above, No. 25, except that instead of using .2 or .25 gram of cyanid per cubic foot, use .007 to .01

gram according to how tight the house is. Use the corresponding proportions of sulfuric acid and water, fumigate at night for three hours, and then ventilate. Repeat the fumigation two weeks later and a third time two weeks later. This treatment must be used with caution, as tender plants may under exceptional conditions be somewhat injured.

Eel Worms.

For eel worms on cucumbers, melons, violets, tomatoes, roses, etc. change the soil, or freeze or sterilize it. Excess of water in soil or drenching it for a few days has a marked repressive effect on eel-worms. Avoid manure containing greenhouse refuse or that contaminated with eel worms.

Mildews and Leaf Spots.

Mildews and leaf spots can be controlled by paying careful attention to details of heat, light, ventilation and moisture. Powdery mildew of cucumbers is brought on by lack of light and too much moisture in the atmosphere during the short days in winter. Downy mildew of cucumbers is a summer trouble and does not survive the winter in the greenhouse. It affects both out-door and indoor crops about the middle of August in this State. In order to avoid downy mildew in the greenhouse, crops should not be planted until September or October, and what holds true of downy mildew on cucumbers is also applicable to outbreaks of bacterial wilt on greenhouse cucumbers. Anthracnose occurs usually about the middle of March on greenhouse cucumbers and is induced by too much moisture in the atmosphere and lack of light and ventilation. If cucumbers are affected with anthracnose, apply sulfur and oil to the pipes.

Leaf blight of tomatoes (scab) is caused by a too moist atmosphere and lack of light. The leaf spot of the tomato (*Cylindrosporium*) results from crowding and shading. To prevent the leaf blight, avoid excessive moisture, and give sufficient light and ventilation. If present, paint the pipes with sulfur. For the leaf spot, (*Cylindrosporium*), prevent crowding of the plants and allow access of air and sunshine. For chrysanthemum leaf spots, (*Cylindrosporium*), give the same treatment as for tomato leaf spot. For rose mildew evaporate sulfur or paint the pipes occasionally with a mixture of sulfur and oil.

Rots.

For blossom end rot of tomatoes (bacterial, *Fusarium*, etc.), give the plants plenty of water when the fruit is forming. Keep the atmosphere of the house fairly moist, although not enough so to induce scab. In general a house should not be kept too moist during the night, as infection is likely to result. The foliage of greenhouse plants should be watered only on bright, sunshiny mornings, when it will dry off quickly. For chrysanthemum stem rot prevent overcrowding and give sufficient light and air. For carnation dry rot (*Fusarium*), select healthy cuttings and avoid planting in infected soil, extreme forcing and adverse conditions in general. Outdoor culture seems to be more favorable for dry rot than greenhouse culture. For lettuce rot (*Sclerotinia*) and *Rhizoctonia* of lettuce, radishes, and carnations (wet rot), and timber rot of tomatoes and cucumbers (*Sclerotinia*) sterilize the soil.

Rusts.

For chrysanthemum rust select healthy stock and pick off all rusted leaves. In outdoor culture avoid exposure to dews and excessive moisture on the foliage. Carnation rust is best avoided by selecting rust-free stock and avoiding excessive moisture on the foliage during periods when there is no sunshine. The application of lime to the foliage and sub-irrigation have proved successful in checking the rust.

Burns, Wilts, Etc.

For lettuce top-burn maintain low temperatures on cloudy and succeeding days. The principal feature in lettuce growing is maintaining low night temperatures, when the plants are making their most rapid growth, and avoiding too high day temperatures. The night temperature for lettuce may range from 35° to 45° , depending upon conditions. On cloudy days it should not exceed 65° , but during periods of bright sunshine, the temperature may run higher in the daytime.

Extreme cases of cucumber wilt are caused by insufficient light, too high temperatures and lack of air. Leaf burns are often brought about by an excess of certain chemical constituents in the soil. To prevent leaf curl, stem curl, contorted leaves and various other malformations occasionally seen in greenhouses, avoid too concentrated

manure. Unless one has an extended knowledge of soil fertility, it is best to avoid the use of all commercial fertilizers in greenhouse culture. Greenhouse soils are as a rule provided with so much plant food that the addition of fertilizers is not absolutely necessary, and the formulas given for out door crops cannot be followed. If it is desired to use fertilizers on greenhouse crops, consult station authorities familiar with the subject of soil fertility.

TREATMENT OF OUTDOOR PLANTS.

APPLE.

Leaf Spots, Sooty Mold, Scab.

These can be controlled by spraying with Bordeaux mixture.

Canker.

Remove diseased twigs. Early spraying before the leaves appear with lime and sulfur wash or strong copper sulfate solution (No. 4) is most effective for this trouble. Allow no rotten fruit to remain on the ground. (See apple maggot.)

Crown-Gall.

This is becoming more common. Buy nursery stock free from the disease, and if the young stock is affected, destroy it.

Apple Maggot or Railroad Worm.

Gather and destroy all fallen fruit once every day, or let fowls or hogs run under the trees. They eat the maggots both in the fruit and on the ground.

Bud Moth.

Spray with a stomach poison (No. 10, 11 or 12) when the buds first open. Repeat just after the blossoms fall.

Canker Worms.

Band the trunks with tree tanglefoot: Oct. 1st for the fall canker worm; band on the first warm day in March for the spring canker worm; or, spray as soon as the leaves open with a stomach poison (No. 10 or 12).

Codling Moth (Apple Worm.)

Spray with a stomach poison (No. 12) just before the blossoms open. Repeat as soon as they fall. Repeat in two weeks.

Oyster-Shell Scale.

Spray trunk, branches and twigs thoroughly about June 5 in average seasons with No. 13a or 14, varying the date according to the season. Repeat two weeks later. Old scales may remain all summer after successful treatment.

Plum Curculio.

Eats leaves in early spring and punctures small apples, causing hard spots with woody places inside them. Spray with a stomach poison (No. 12) just before the blossoms open. Beginning about ten days after the blossoms fall, jar the trees about sunset and early in the morning, spreading a white cloth beneath and killing the insects which fall.

Round-Headed Borer.

Look for "sawdust" at the base of the trunk in October and from this find and cut out the borers. Make a cone of wire mosquito netting, fitting the trunk about two feet from the ground and setting the other end in the ground, keeping the borers off. This will also protect from mice in winter.

San Jose Scale.

Spray during the winter with lime-sulfur wash (No. 16) covering every part of the tree thoroughly. If this treatment is impossible for lack of facilities for making, or the number of trees to treat is very small, use "Scalecide" 1 part, water 14 parts. In either case use a nozzle giving a very fine, misty spray and apply very thoroughly. The lime-sulfur wash has given better results than "Scalecide" at this Station. Home-made "soluble oils" are still in an experimental stage, in the opinion of the writer, and are not recommended for that reason.

Woolly Aphis.

White, woolly places on limbs in fall with lice beneath: they may also be present on the roots. Remove the soil to the top roots two

feet each way from the trunk, and if lice are present, apply 15% kerosene emulsion liberally, then replace the earth. For those on the limbs spray with the emulsion.

The apple is comparatively free from diseases in Massachusetts and in well-kept and thoroughly cultivated orchards one spraying in the spring with the lime-sulfur wash for the scale before the leaves appear, followed by one or two sprayings for codling moth, is usually sufficient. If sooty mold or scab is troublesome, midsummer spraying with Bordeaux is advisable. The lime-sulfur treatment has proved the most successful of any for fungous diseases of the apple.

ASPARAGUS.

Rust, summer stage.

Avoid planting new beds on too dry soil, and in preparing a bed incorporate considerable organic matter, occasionally applying stable manure. Maintain the highest degree of fertility possible and during dry seasons cultivate thoroughly.

Asparagus Beetle.

Keep cutting beds closely cropped, leaving a few stalks for the beetles to lay their eggs on. Destroy these once a week and take others for the purpose. Spray the fruit stems thoroughly with arsenate of lead about once a month during the summer. Let fowls run in the beds.

Asparagus Miner.

A maggot mining in and often girdling the stems near or below the surface of the ground. Leave a few plants in spring for the fly to lay eggs on, destroying these by pulling up and burning about the end of June.

BEAN.

Anthracnose.

Select clean seed. Spray with Bordeaux mixture when the leaves first expand, and repeat two or three times if occasion demands. Some varieties are more susceptible to anthracnose than others.

Weevils in Seed.

Place the seed in a tight box on gathering, and add a teaspoonful of carbon bisulfid for every cubic foot of space in the box. Keep closed 24 hours; then store for the winter. **During treatment keep the box away from any fire.**

BEET.

Leaf Spot.

This is not as a rule troublesome in Massachusetts, but if so, apply Bordeaux mixture when four or five leaves are formed, and repeat, if necessary, at intervals of 10 to 14 days.

Flea Beetle.

Spray with Bordeaux mixture as needed.

BLACKBERRY AND RASPBERRY.

Anthracnose.

Cut out badly infested canes. The Bordeaux spray may be used at intervals after growth has commenced.

Rust.

In bad cases of rust remove and destroy infected plants. Both anthracnose and rust are difficult to control by spraying. The intelligent application of fertilizers and frequent cultivation are the best treatment for raspberries and blackberries.

Rose Scale. See Rose.

CABBAGE AND CAULIFLOWER.

Clubfoot.

Start seedlings in uninfected soil, and for planting select land free from clubfoot if possible. If the soil is infected, use lime, 50 to 75 bushels per acre.

Black Rot.

Treat seeds with formalin, one pound to 20 gallons of water for 15 minutes. Avoid infected soil.

Cutworms.

If noticed while preparing the ground for the crop, finish preparation, then cut some clover and sprinkle it heavily with a stomach poison (No. 10), and scatter the clover over the ground for the cutworms to feed on. If they appear after the cabbages are set, make a mash of 60 pounds of bran or middlings, 1 pound of Paris green, water to make a dough and molasses enough to sweeten. Place a little of this at the base of each plant, and keep fowls away. The cutworms will eat the sweet, poisoned mash in preference to the plants.

Root Maggot.

Apply disks of tarred paper to the stems of the plants when setting them. Powdered hellebore placed at the base of each plant about once a week is often a successful treatment.

Cabbage Worm.

Spray with a stomach poison (No. 10 or 12) till the heads form, then dust with hellebore as needed.

CELERY.

Blights.

Start seedlings in soil free from infection. If spraying is necessary, use Bordeaux mixture on young plants and continue its use at intervals throughout the season.

CHERRY.

Brown Rot, Etc. See Plum and Peach.

Curculio. See Apple.

Plant Lice.

Spray with kerosene emulsion (No. 14) when the lice first appear, before the leaves curl. Repeat as needed.

Slug.

Spray with a stomach poison (No. 10 or 12) when the slugs appear.

CORN.

Wireworms.

Fall plowing and thorough pulverizing of the soil for several years. Rotation of crops. Trapping in early summer with freshly cut clover dipped in Paris green water and placed under boards in the field. This is a very difficult pest to control.

CRANBERRY.

Rots, etc.

Consult Bulletin 110, Bureau of Plant Industry, Washington, D. C.

Cranberry Insects.

Send for Bulletin No. 115, Massachusetts Agricultural Experiment Station.

CURRANT AND GOOSEBERRY.

Leaf Blights.

Spray with Bordeaux before the leaves start, and continue to spray if the disease is troublesome after the leaves have formed.

Currant Worm.

Apply a stomach poison (No. 10) either wet or dry, or hellebore, FREQUENTLY, as new lots of the worms may appear shortly after a treatment.

Imported Currant Borer.

Works along the centers of the stems. Cut off and burn all injured stems.

San Jose Scale. See Apple.

CUCUMBER, MELON, SQUASH.

Bacterial Wilt.

Occasionally present in Massachusetts. Destroy cucumber beetle, which is largely responsible for the distribution of the disease.

Downy Mildew.

Appears about August 15th. It is controlled by spraying with Bordeaux mixture every ten days or two weeks, commencing about August 10th.

Alternaria.

Occasionally more or less troublesome. Partly controlled by spraying.

Anthracnose.

Spraying is practically useless.

For further advice in reference to these diseases, write this Experiment Station.

Striped Cucumber Beetle.

Keep under netting till well started. Apply a stomach poison (No. 10 or 12), wood ashes or air-slaked lime thoroughly and frequently. Burn plants as soon as crop is gathered.

Squash Bugs.

Keep under netting till well started. Pick and destroy bugs and eggs. Burn plants as soon as crop is gathered.

Squash-vine Borer.

Plant summer squash early to attract this insect. Keep main crop under netting till well started. Cover stems with earth at the joints to start roots at these places. Cut out borers, splitting the stem lengthwise. Harrow lightly in fall and plow at least six inches deep the following spring.

GRAPE.

Anthracnose, Black Rot, Downy Mildew and Powdery Mildew.

Spraying with Bordeaux is successful in the treatment of these diseases.

Flea Beetle.

Spray with a stomach poison and repeat if necessary.

Rose Bug or Rose Chafer.

Hand picking; spray with arsenate of lead 5 lbs., water 50 gallons. A very difficult pest to control.

For the control of fungus and insect pests of the grape, the following treatment is recommended: Before the buds unfold in the spring, spray with copper sulfate (No. 4). After the leaves have

expanded, spray with Bordeaux (No. 1 b). When the fruit has set, spray with Bordeaux (No. 1 b) and repeat this once or twice until the fruit is mature. If insects are troublesome, use a combined fungicide and insecticide (No. 21).

MELON. See CUCUMBER.

ONION.

Smut.

Infects young seedlings but not transplanted onions, or sets. 100 pounds sulfur thoroughly mixed with 50 pounds lime per acre, applied with a seeder in drills, has proved beneficial; also ground lime drilled in with a fertilizer drill at the rate of 75 to 125 bushels per acre, is helpful. The best results have been obtained with the use of formalin, 1 pound (pint) to 30 gallons of water (1-240) or 1 ounce to 1 gallon of water (1-128), thoroughly sprinkled over the seeds before covering them. A drip attachment on the seeder, treating two rows at once, is a cheap and efficient method of applying formalin. One gallon of formalin solution will treat about 400 feet of drill.

Maggot.

Apply carbolic acid emulsion around the base of the plants, when these first appear, using enough to wet the ground well on all sides of the stems; repeat three or four times at weekly intervals.

Thrips. (Blight)

Spray very thoroughly with kerosene emulsion when the insects first appear; repeat as needed.

OATS.

Smut.

Place the seed in a sack and immerse in formalin, 1 pound (1 pt.) to 36 gallons of water, for ten minutes, after which spread out and dry for two or three days. This has proved very successful in preventing oat smut.

PEA.

Pea Weevil. See Bean Weevil.

PEACH.

Peach Leaf Curl, Twig Blight, (Cladosporium and Monilia.)

If the lime-sulfur wash for the San Jose scale has not been applied, spray in March or April before the buds swell with strong Bordeaux (No. 1a), or the copper sulfate solution (No. 4.)

Shot-Hole Fungus.

Thorough spraying in the spring with the lime-sulfur wash is very beneficial. If Bordeaux mixture is used when the tree is in foliage, use formula (No. 1d, e or f.)

Brown Rot.

In this region brown rot is seldom troublesome in well-kept peach orchards except when the fruit is ripening. Allow no over-mature fruit to remain on the trees. If the season is muggy and damp, spray with ammoniacal copper carbonate before the fruit is mature and repeat if necessary. The lime-sulfur wash applied in the early spring has proved the best remedy for all fungus troubles of the peach.

Peach Yellows and Rosette.

Remove all diseased trees.

Plant Lice. See Cherry.**Peach Borer.**

Cut out borers in the tree as early in the spring as they can be found. Mound up earth about 18 inches high around the trunks the last of June and leave till in September.

Plum Curculio. See Apple.**San Jose Scale.** See Apple.

The use of the lime-sulfur wash on peach trees has proved of the greatest value. It is remarkable for its control of peach leaf curl and twig blights caused by *Monilia* and *Cladosporium*, which are very common on peaches. In well-kept orchards no other spray is as a rule necessary except occasional treatment for brown rot.

PEAR.

Blight.

Remove all affected branches. Early spring spraying before the buds swell with the lime-sulfur wash, copper sulfate (No. 4), or Bordeaux is beneficial.

Leaf Blights and Fruit Spots.

Spray with Bordeaux at intervals.

Sooty Mold of Twigs.

When the pear psylla is abundant, sooty mold is often very troublesome. For prevention see pear psylla.

Pear Psylla.

Spray with kerosene emulsion as soon as the blossoms have fallen. Repeat twice more at intervals of a week. Winter treatment with the lime sulfur wash, or whale oil soap, 1 pound; water, 1 gallon, is helpful.

Pear Slug. See Cherry.

San Jose Scale, Scurfy Scale, Codling Moth. See Apple.

The pear in general can be treated like the apple.

PLUM.

Brown Rot, Leaf Curl, and Shot-Hole Fungus. See Peach.

Black-Knot.

Early spring spraying with copper sulfate (No. 4) or the lime-sulfur wash has proved beneficial in holding the knot in check. When knots are present they should be removed. In the young stage they may be dug out and painted, which will check their development.

Curculio, San Jose Scale. See Apple.

Peach Borer. See Peach.

For general treatment of the plum see peach.

POTATO.

Early Blight.

Spray with Bordeaux mixture when the potatoes are five or six inches high, about June 20th, or preferably with Bordeaux and Paris green or arsenate of lead, (Nos. 20 or 21). Repeat application every two weeks.

Late Blight.

A continuation of the treatment recommended for early blight answers for this blight. To prevent the rotting of tubers, avoid poorly drained soil.

Scab.

To destroy germs on seed potatoes soak one and one-half hours in corrosive sublimate, (No. 7) or two hours in formalin (No. 8.). Dry the potatoes after soaking in formalin or corrosive sublimate. Avoid fertilizers containing stable manure, and as scab develops freely in alkaline soils do not use fertilizers containing free lime. The tendency to produce scabby potatoes may be lessened by the use of such fertilizers as acid phosphate and sulfate of ammonia.

Cf. Wheeler et al. in R. I. Bulletins Nos. 26, 33 and 40.

Potato Beetle.

Spray with a strong stomach poison (Nos. 9, 10, 11 or 12); repeat as needed.

Flea Beetle.

Spray with Bordeaux mixture and Paris green or arsenate of lead.

For the control of blights and insects on potatoes it is best to use a combined fungicide and insecticide, (either No. 20 or 21) as potato beetles are usually troublesome. Paris green acts more quickly on the potato beetle than arsenate of lead, but the latter is more adhesive than Paris green, and many growers are using formula No 21 in preference to No. 20.

QUINCE.

Leaf Blight.

Spray with Bordeaux when the blossom buds appear, and repeat at intervals, if necessary.

Rust.

Remove all affected fruit, etc., from the tree.

Borer, San Jose Scale. See Apple.

ROSE.

Leaf Hoppers, Plant Lice.

Kerosene emulsion, whale oil soap or tobacco water applied thoroughly and frequently.

Red Spider.

See under Treatment of Greenhouse Plants.

Rose Scale.

Cut out badly infested stems, spray with whale oil soap 1 pound, water 1 gallon late in the fall or during the winter; also spray the following April with whale oil soap 1 pound, water two gallons. During the summer whale oil soap 1 pound, water five gallons about every three weeks may be used.

SQUASH.

See Cucumber.

STRAWBERRIES.

Leaf Blight.

Attention to cultivation and fertility is much more important than spraying for the development of healthy plants. Mulch thoroughly to prevent winter killing.

White Grub.

Rotation of crops or destruction by hand. Salty fertilizers may be of some value.

TOMATOES.

Leaf Blight and Fruit Rots.

Leaf blights and fruit rots are only partially controlled by spraying. The blossom end rot is more common upon dry soil and during dry seasons than wet, and some varieties are more susceptible than others. Irrigation has proved successful during the time of fruit ripening.

Flea Beetle. See Potato.

Cutworms. See Cabbage.

TOBACCO.

Root Rot.

Plant seeds in beds sterilized with steam or treated with formalin, one pound to 12 or 15 gallons of water, using about a gallon for each square foot of surface treated. Cover the soil for 24 hours to hold the formalin vapors, then remove cover and allow to air afterwards.

Cut Worms. See Cabbage.

Tobacco Worm.

Hand picking, or spraying with a stomach poison (No. 12.)

SHADE TREES.

Shade trees have to contend with various difficulties,* many of which can be prevented if proper treatment can be given in time.

Elm-Leaf Beetle.

Spray about the middle of June with arsenate of lead 5 pounds, water 50 gallons.

Leaf Eating Insects, Caterpillars, etc.

Spray as necessary with a stomach poison.

*There are many substances applied to shade trees which have proved very injurious, much injury having been caused by the use of banding substances,—gas oil, kerosene and water, etc. Only those substances which have been thoroughly tested and proved to be reliable should be used.

Gypsy and Brown-tail Moths.

For advice in regard to these pests address the Superintendent of the Gypsy Moth Commission, 6 Beacon Street, Boston, Mass.

Spruce Gall Louse.

Swellings at the bases of the smaller twigs, fresh and soft in May. Pick off and burn. Spray thoroughly with kerosene emulsion in April.

Woolly Aphis on Maple.

Spray with kerosene emulsion.

Leaf Spots.

There are many leaf spots more or less common to shade trees, viz: the linden leaf spot (*Cercospora*), the sycamore blight (*Gloeosporium*), oak blight (*Gloeosporium*), horse chestnut blight (*Phyllosticta*) and the English hawthorne leaf spot (*Entomosporium*), which can undoubtedly be controlled to a large extent by spraying with any good fungicide, but the question of treatment depends upon whether the tree is valuable enough to warrant it.

Sun Scorch.

Some shade trees are subject annually to sunscorch and wilts which are the result of strong, warm winds when the soil moisture supply is low. Trees growing on lawns in rich soil seldom suffer from these troubles, as the conditions are unfavorable for their development. When soil is very dry water may be applied by means of a sub-irrigation system installed near the feeding roots.

Wounds.

By far the greatest amount of injury to trees from fungi is due to lack of antiseptic treatment of wounds caused by poor pruning and mechanical injuries. When large pieces of bark are removed from the trunk of the tree an old European method of treatment is sometimes used, consisting of carefully scraping the wound and covering it with a mixture of one part lime, two parts cow-manure and 2 parts clay, which is securely bandaged with burlap. Whatever other virtue it has, this mixture probably assists in keeping the parts moist, which would help in the process of healing.

Pruning.

Attention should be given to the removal of all dead limbs on shade trees and all wounds should be antiseptically treated with a thick coat of paint or coal tar.

Cavities.

If there are cavities formed by decay in a tree which is of value they should be carefully dug out, scraped and treated first with creosote, and then with tar. If it is necessary to fill the cavity, Portland cement should be used, for the rough work employing grouting, —one part cement to five of sand and gravel,—and for the surface one part cement to two of sand. It is essential that the cavity should be thoroughly treated and filled and all moisture prevented from entering. If it is not desired to fill the cavity, it can remain open or be closed over with tin. In no case of filling should the cement extend beyond the wood.

Chaining and Bolting.

When trees show a tendency to split, they may be strengthened by bolts and chains, but whichever are used, care should be taken to have the work done thoroughly to prevent infection from fungi. When bolts are put through the tree, they may be treated with tar and the washers and nuts imbedded in tar and elastic cement, flush with the wood. An extension bit is valuable for this purpose.

Wires.

To prevent injuries from electric wires, wooden or porcelain insulators should be used to protect the trees. Wires should not be allowed around trees in any form which would cause girdling.

TREATMENT OF WEEDS.

Lawns.

Plants like chickweed, moneywort and other running weeds can be largely eradicated from lawns by treatment with nitrate of soda, which should be used strong enough to kill the weeds. This may also kill the grass, but a good growth of grass will come in again to the exclusion of the weeds.

Dandelions on lawns can be sprayed with iron sulphate at the rate of $1\frac{1}{2}$ to 2 pounds to 1 gallon of water. Mechanical devices are also used for injecting acids and chemicals into the crowns of plants like the dandelion and plantain. The midsummer application of lawn fertilizers is beneficial in maintaining a strong growth of grass and keeping certain fall weeds out.

Mowings and Cultivated Fields.

Golden hawkweed in mowings has been more or less successfully treated by the application of 3,000 pounds of salt per acre. For wild mustard, smartweed, pigweed, cocklebur and ragweed in oat fields or mowings, spray with sulphate of iron at the rate of 100 pounds to 52 gallons of water. The sulphate of iron application is said to cost 20 or 25 cents per acre, 52 gallons being sufficient for 1 acre. Special spraying appliances are used for this work. Lime and wood ashes are valuable for sorrel, mosses, ferns, etc. which grow in acid soil.

Tennis Courts, Walks, Etc.

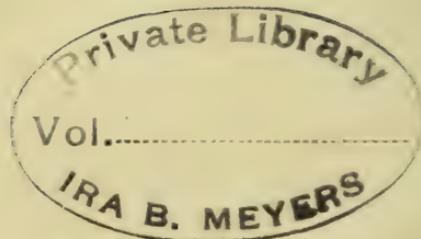
The weeds on tennis courts, gravel walks, drives, etc. can be successfully removed by treatment with arsenate of soda at the rate of 2 pounds to 10 gallons of water. This amount will cover about one square rod and can be applied with a watering can or spraying machine. On tennis courts in use it is generally sufficient to treat only 6 or 8 feet of the edges. It can also be applied to railroad beds where grass and troublesome weeds interfere with traffic. By treating a strip of grass 4 to 6 inches wide close to the foundation of buildings with arsenate of soda much hand trimming may be obviated. Arsenate of soda is poisonous and care should be used in handling it. It should not be applied too freely near valuable trees.

There are many proprietary compounds on the market known as "Herbicide", "Weedicide," etc. which are effectual weed killers.

Poison Ivy, Etc.

Arsenate of soda can be used very successfully in killing ivy on large trees, stone-walls, buildings, etc. Two or three applications of the strength already given are generally sufficient. In treating trees it is sometimes advisable to remove the sod for a distance of 1 foot around the base and apply the solution in this space. It is not advisable to apply this treatment to small trees under 6 to 10 inches in diameter.

Arsenate of soda may also be used for killing trees, and for this purpose holes should be bored in the trunk of the tree with an auger, arsenate of soda put in and the holes plugged up with corks. In some cases the spring of the year is the best time to apply this substance. The practical advantage of this method of treatment if it is successfully applied, is that sprouting from the stump may be effectually prevented, which obviates the necessity of digging out the stump.



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