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ORCHARD AND GARDEN SPRAYING.



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# Orchard and Garden Spraying.

BY A. G. RUGGLES AND E. C. STAKMAN.

## INTRODUCTION.

By the up-to-date orchardist, spraying is considered as essential as any of the other processes necessary to the production of good fruit. It is regarded in much the same light that insurance is by the householder. Without spraying, one runs the risk of considerable loss. To spray intelligently, one should know just what he is spraying for, and it is nearly always essential that he should know at least the main features of the life-history of the pest sprayed against, be it insect or disease. In the following pages we have endeavored to give brief life-histories, and thus show the reason for spraying with such and such a compound in each case. Very often we can advantageously use a fungicide at the same time we use an insecticide. It is advisable to do this wherever possible; in fact, when spraying against a known insect, it is always good policy to combine them even if not absolutely sure of the disease to be sprayed against. Sometimes, as with the lime-sulphur washes, a spray is both an insecticide and a fungicide. Arsenate of lead has a small fungicidal value, and when added to the lime-sulphur wash this fungicidal value is increased.

A few cautions are perhaps necessary, viz.:

1. Never spray when the trees are in bloom. A day's delay at this time will not materially affect the result of the spray. Bees and many other insects are very numerous at this time, fertilizing the flowers. A spraying compound thrown on them will lessen the amount of fruit set and destroy the honey-bees.

2. Sprays recommended for the dormant season should never be tried when the trees are in leaf.

Before taking up the insecticides and fungicides in detail, a general idea of the use of these killing compounds may be desirable. The "cide" of these words means "kill." An insecticide is something that will kill an insect; a fungicide is something that will kill a fungus. Different kinds of compounds are used for the different kinds of insects and diseases. There is no one spray that is the "cure-all" for everything. For instance, insects that bite, like caterpillars and beetles, take one kind of insecticide; insects that suck, like plant-lice and scales, require another kind of insecticide. One fungicide is good for one disease, but it may be worthless against another disease. The insecticides are usually separated into three groups:

1. Gaseous insecticides. These are used in an enclosed space, against either biting or sucking insects. Hydrocyanic acid gas, carbon bisulphide and tobacco smoke come in this group.

2. Contact insecticides. These are used against insects that suck their nourishment from plants through a proboscis-like beak, or against biting insects that cannot be induced to eat the parts of the plant covered with an internal insecticide. In this group are found the lime-sulphur washes, crude petroleum, kerosene, soaps, miscible oil, etc.

3. Stomach or internal insecticides. These are used against insects that eat the foliage. The most important of these, like arsenate of lead, Paris green and arsenite of lime, contain arsenic in some form, and are called arsenical insecticides. The killing ingredient in these insecticides is not soluble in water, but is in the small particles of matter that remain in suspension in the liquid.

The fungous diseases of plants are caused by minute parasitic plants known as fungi. Fungi, having no green coloring matter (chlorophyll), are reduced to the necessity of getting their food from other plants or animals, or from the dead remains of plants or animals. These fungi are composed of a great many threads, which gain entrance to the tissues of the host-plant, and absorb their nourishment from it. Minute reproductive bodies, known as spores, are produced. One fungus may produce more than one kind of spore; during the growing season it may produce one kind, which is especially well fitted to reproduce the plant very rapidly, while later in the season it may form another kind of spore, which will live during the winter and germinate the next spring.

The cold-resisting spores may live during the winter in the soil, on the seed, on leaves, rotted fruit, or in rubbish. Further, the threads of the fungus may themselves live during the winter; they may persist in the seeds, on mummied fruit, or, in the case of shrubs and trees, in the twigs. Each fungus has its own life-story: it gets into the habit of going through its life-cycle in a definite and fairly constant way. It may require, during the course of its complete development, two different kinds of plants. For instance, the rust of Wealthy apples is caused by a fungus which lives on red cedars in the winter and on apple trees in the summer. It is necessary, then, in order to effectually prevent fungous diseases, to know the life-habits of the fungi causing them.

Preventive and curative measures are various. Spraying is resorted to when it is possible, by covering parts of plant with some mixture, either to kill superficial fungi like powdery mildews, or to prevent the spores from germinating properly and thus infecting the plant. If

the fungus gets inside the twigs or branches, pruning must be resorted to; while if it lives on decayed or dried fruit, leaves or rubbish, these should be removed and burned. Seed disinfection is necessary in case the seeds are affected; such treatment is of value in preventing diseases like potato scab. Then, too, if the spores of the fungus persist in the soil, retaining their vitality for considerable periods, it is necessary to rotate crops or sterilize the soil. Again, it may be necessary, when a fungus requires two different plants for its complete development, to remove the so-called alternate host. Such a necessity often arises; in dealing with apple rust, the removal of red cedars from the vicinity of the apple orchard prevents the rust from living through the winter. Some fungi gain entrance to their hosts mainly through wounds; obviously, in such cases, great care should be exercised in avoiding injuries, and in disinfecting and covering all wounds. Some varieties of fruits are more resistant to a certain disease than others; these should naturally be selected. Weather and soil conditions often affect to a remarkable degree the prevalence and severity of a disease. It is not always possible to control these factors, but some precautions can always be taken both in the greenhouse and in the field; the proper kind of soil can usually be selected, good ventilation can be provided for, and excessive shade can be avoided.

Fungicides may be applied in different ways; they are usually used as steeps or sprays, sometimes as washes. The subject of sprays is still somewhat problematic. Bordeaux has been regarded as a panacea; but, under certain circumstances, it is objectionable. It stains the plant parts with which it comes in contact, so is unfitted for use on ornamental plants or ripening fruit. Further, the copper salts which are formed have an injurious effect on certain plants, among them the plum. In such cases, it is necessary to employ some other fungicide, or, at any rate, to use very weak Bordeaux. Nevertheless, Bordeaux, although being replaced to a certain extent by some newer fungicides—notably the self-boiled lime-sulphur mixture,—is probably better, for general purposes, than any other. The proper strength of Bordeaux is still somewhat uncertain; in fact it varies with conditions. The 5-5-50 formula has been regarded as standard, but excellent results have been obtained with weaker solutions, so it is probable that, for general work, a 4-4-50 mixture will be sufficiently strong.

The amount of spray to apply will vary with the size of the tree. A tree having a spread of twenty-five feet in full leaf will require at least four gallons. The person just learning to spray ordinarily does not put on a sufficient amount, but stops before even half of the required amount has been given. This is one of the main reasons why spraying is not as successful as it should be in the hands of the be-

ginning orchardist. A man must also learn to apply the spray evenly and thoroughly; and, with possibly one exception, not in the form of drops, but in a very fine mist.

In our discussion of plant pests there are perhaps many forms that we have not mentioned. It may be that they have never been reported to us as being found in this state, or perhaps are only of local importance. The Divisions of Entomology and Plant Pathology of the Experiment Station are always willing and anxious to find out the various pests present in the state, and will welcome correspondence and specimens of diseased plants, or, in the case of insects, the enemies themselves.

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## INSECTICIDES AND FUNGICIDES,

ALPHABETICALLY ARRANGED.

**Ammoniacal Copper Carbonate.**—This is not as good for general purposes as Bordeaux mixture. It is used instead of Bordeaux when it is desirable to avoid the spotting of leaves or ripening fruit. It is prepared as follows: Weigh out the proper amount (5 oz.) of copper carbonate, and use just enough ammonia to dissolve it. If the ammonia is strong it should first be diluted with water. Then add the proper amount of water (50 gal.).

**Arsenate of Lead.**—Arsenate of lead is one of the most valued of the arsenical insecticides. It has in many cases entirely displaced Paris green with orchardists, and there are at least three good reasons for it:

First—The arsenate of lead has great adhesive qualities. It will not wash off, even in heavy showers of rain. Some of our experiments here at the Station showed the presence of this arsenate on the leaf, in sufficient quantity to kill insects, ten weeks after spraying.

Second—It can be used in any strength without burning the foliage of the plant sprayed.

Third—It has some fungicidal properties that are increased when added to Lime Sulphur.

Arsenate of lead can be made at home or bought in paste form on the market. Ordinarily it will be easier to buy the prepared material.

The formula of the home-made preparation is as follows:

22 oz. acetate of lead (sugar of lead) dissolved in 2 gallons  
of warm water in a wooden pail.

8 oz. arsenate of soda dissolved in 1 gallon warm water in  
another wooden pail.

These two solutions, poured together, make a sufficient quantity of poison for 50 gallons of spray.

Three pounds of the commercial paste are recommended for 50 gallons of spray.

**Arsenite of Lime.**—This is essentially a home-made-preparation. If made properly, it is just as good as Paris green, and is much cheaper. The best method of preparation is as follows:

**Formula for Stock Solution:—**

White arsenic, 1 pound.  
Crystal sal soda, 4 pounds.  
Water, 1 gallon.

Boil these in an iron kettle for twenty minutes, or until thoroughly dissolved. *The kettle must be kept exclusively for this purpose.* The soluble material obtained is arsenite of soda, and can be stored away in jugs or bottles, labeled "poison," for future use. For 40 or 50 gallons of spray, take 1½ to 2 pints of this solution, and 4 pounds of freshly slaked lime. Dilute the lime and strain; then add the stock solution. Pour into the spray barrel and it is ready for use.

**Bordeaux Mixture.**—This is made of copper sulphate (bluestone), quicklime and water. It is used in various strengths, the 5-5-50 being probably that in most common use, although the 4-4-50 will probably give equally good results. 5-5-50 simply means that 5 pounds of copper sulphate, 5 pounds of lime and 50 gallons of water have been used in the preparation of the spray. In the same way 2-2-50 would mean that 2 pounds of copper sulphate, 2 pounds of lime and 50 gallons of water have been used. The number of pounds of copper sulphate is indicated by the first figure, the number of pounds of lime by the second, and the number of gallons of water by the third.

One of two methods may be used in making Bordeaux. Either it may be made directly, or stock solutions may be made and these stock solutions used whenever the fungicide is needed. In making the spray directly, take 5 pounds of copper sulphate, put it into a coarse gunny-sack, and hang it in a barrel containing 25 gallons of water. Being suspended, the copper sulphate will dissolve much more readily than if put into the bottom of the barrel. Now slake carefully 5 pounds of good quicklime, using just enough water to slake it slowly. Be sure that the lime is not at all air-slaked. When the lime is slaked, add enough water to make 25 gallons. Now stir it carefully and then pour together the copper sulphate solution and the milk of lime. It is desirable to have a slight excess of lime, since it prevents any injurious action of the copper salts. If there is an excess of copper, foliage injury is liable to result. Therefore two simple tests should be made to determine whether or not the mixture is safe to use. Take a piece of newly-filed iron or steel and put it into the mixture for about a minute. If it has a copper coating when it is taken out, there is an excess of

copper, and more lime should be added. To determine whether or not there is a sufficient amount of lime in the mixture, pour some of it into a flat dish and blow on it for a few moments. If a film forms on the surface, enough lime is present; if not, more should be added.

In making stock solutions, dissolve copper sulphate in water at the rate of 1 pound to 1 gallon of water. Slake the lime slowly in another receptacle; and, when slaked, add water until a thick lime milk, 1 pound to 1 gallon of water, is formed. When using the stock solution in making up the spray mixture, 1 gallon of copper sulphate solution represents 1 pound of copper sulphate, and 1 gallon of lime water represents a like amount—more or less, depending on the quantity of water used in making the stock solution. The proper amount of stock solutions should be diluted separately before they are poured together. The stock solution of lime should be first run through a fine-mesh sieve, to remove all lumps which might clog the nozzle of the sprayer.

**Carbon Bisulphid.**—This is a very inflammable liquid, that volatilizes readily when exposed to the air. It is one of the gaseous insecticides used against grain weevils etc.

**Copper Sulphate Wash.**—

Copper sulphate, 3 pounds.  
Water, 50 gallons.

This is used as a wash on dormant trees, for the prevention of such diseases as apple scab. It must never be used on trees after the buds have burst.

**Corrosive Sublimate.**—

Mercury bichloride (corrosive sublimate), 2 ounces.  
Water, 15 gallons.

This is an extremely poisonous mixture, and should be handled with great care. It is very effective against potato scab. It should not be made in tin vessels, as it corrodes them.

**Crude Petroleum.**—This is an oily, inflammable liquid, that, when refined, yields such products as paraffin, lubricating oil, kerosene, etc. A petroleum having a specific gravity of 43° (Baume scale), is an excellent insecticide for scale insects. In fact, it was used very successfully against the San Jose Scale until the lime-sulphur wash was found to be better.

**Formalin.**—

Formalin (40% formaldehyde),  $\frac{1}{2}$  pound.  
Water, 15 gallons.

This is used in treating seed for prevention of such diseases as potato scab.

**Hellebore.**—This is a stomach or internal insecticide. It is not poisonous to man, as are the arsenical insecticides, and therefore is used where there is danger of poison remaining on parts to be eaten.

It is often used on currants and gooseberry bushes when the berries are beginning to ripen. This material can be used in the dry form, or as a spray at the rate of 2 or 3 ounces to a gallon.

**Hydrocyanic Acid Gas.**—This gas is made by dropping potassium cyanide into sulphuric acid and water. The fumes are deadly to all kinds of animal life, and the gas is used only in special cases. As this gas is fatal to human life as well as to insect life, it should be used only by an expert.

**Iron Sulphide Mixture.**—This is a comparatively new, but—according to Circular No. 58 of the Bureau of Plant Industry, U. S. Department of Agriculture—very promising fungicide. It was tried on apples especially, and gave splendid results in preventing fungous diseases. It also proved non-injurious to the fruit. In preparing this fungicide, it is recommended that a self-boiled lime-sulphur mixture be prepared, as hereinafter described; except that 10 pounds of lime and 10 pounds of sulphur are used. The mixture is diluted to 40 gallons, and then 3 pounds of iron sulphate, (copperas) dissolved in about 8 gallons of water, is added.

**Kerosene.**—This is an excellent contact insecticide. The merest particle of it, coming in contact with any part of the anatomy of an insect, is fatal. Pure kerosene, however, will ordinarily burn the leaves of plants, consequently it is only recommended to be used in the pure form when trees are dormant, or against insects off of plants, for instance the killing of grasshoppers by hopperdozers, or household insects, etc.

**Kerosene Emulsion.**—This is probably the best form into which kerosene can be put for spraying growing plants. A stock emulsion is made as follows:

Hard laundry soap shaved fine, ½ pound.  
Water, 1 gallon.  
Kerosene, 2 gallons.

Dissolve the soap in boiling water, remove from the stove, and immediately add the kerosene; churn with a bucket pump until a soft, butter-like, clabbered mass is obtained. One part of this stock solution is added to ten or twelve of water for spraying. If the stock solution is properly made, this can be used on tender foliage of plants for such insects as plant-lice, etc. (Soft water must be used.)

**Lime-Sulphur.**—Within the last few years this wash has become very prominent. It is one of the best scale insecticides yet discovered, and will kill the eggs of plant lice. As an insecticide it has an accumulative action, being more active a few weeks after spraying than at the start. Since coming into prominence as a scale insecticide, it has been found that in its several forms it is also an excellent fungi-

cide, and will, in many cases, replace Bordeaux mixture. There are several formulæ for making this wash, three of which are appended.

**The Boiled Mixture (Home made):**

Best stone lime, 15 pounds (not over 5% impurities)  
Flowers of sulphur, 15 pounds.  
Water, 50 gallons.

Slake the lime in a small quantity of hot water, add the sulphur gradually and stir thoroughly. Dilute the mixture to 15 gallons with water, and boil in an iron kettle, or cook by steam in a barrel for forty-five minutes. Fill the vessel with water to the required 50 gallons; strain the wash through a fine-mesh strainer, and apply hot.

This wash should be applied in the fall after the leaves have dropped, or in the spring before the buds open. Spray thoroughly, covering all parts of the tree.

**Formula (Concentrated):**

80 pounds sulphur.  
40 pounds best stone lime (95% calcium oxide).  
50 gallons water.

The cost of making this material will depend on the amount that can be made at one time, and the cost of material and labor. The average cost is about \$2 per barrel of 50 gallons. Usually it is not practicable to make as much as 50 gallons at one time, consequently the following directions are for making only 25 gallons. Live steam run in a barrel, or fire under an iron kettle, may be used in boiling.

Place five gallons of water and forty pounds of the sulphur in the vessel, and apply heat until the sulphur becomes a smooth paste, stirring constantly. Now add ten gallons of water and twenty pounds of lime, and boil for forty-five minutes. Add water to make the twenty-five gallons. When cooled to 65° F., test with the Baume scale; the reading should be about 33°.

As a scalecide to use in the dormant season, this should be diluted 1-10 (i. e., one part of the above formula diluted with nine parts of water) and 6-10 pounds of stone lime added to every fifty gallons of the spray.

As a fungicide for summer use, dilute 1-30 (one part of stock formula diluted with 29 parts of water).

When stored away it is best to cover the solution with a layer of oil about an eighth of an inch thick. This will prevent evaporation and the forming of a crust on the material. The material should not be stored where the temperature may go very low.

In spraying with this mixture, definite dilution must be made, and to do this a Baume scale is required. The amount of dilution will vary from one part of this concentrate in nine or ten parts of water to one part concentrate in thirty or more parts of water. This con-

centrated material is now on the market in a commercial form, and is generally very reliable.

**Self-Boiled Lime Sulphur:**—

Lime, 8 pounds.  
Sulphur, 8 pounds.  
Water, 50 gallons.

This spray is especially valuable in cases where Bordeaux is injurious to foliage or fruit. The stone fruits, such as plums, are particularly susceptible to Bordeaux injury, while some varieties of apples are badly russeted by it. There is slight danger of injury by the self-boiled lime-sulphur preparation, and it is an efficient fungicide when properly made. It stains the fruit, as does Bordeaux. In making it, 8 pounds of lime of good quality should be placed in a barrel, and enough water to nearly cover it should be added. While the lime is slaking, add sulphur which has been run through a sieve to break up the lumps. The sulphur should be thoroughly stirred into the slaking lime, enough water being added to make a pasty mass. The barrel should now be covered, in order to retain the heat, and the contents should be occasionally stirred. The time required varies with the quality of the lime; if the lime acts quickly, five to ten minutes will be sufficient, while if it acts slowly, 15 minutes may be necessary. It should not be allowed to stand too long, because it may, in that case, be injurious to foliage. Now add a little water, stirring the mixture while it is being poured in. Then add enough water to bring the total up to 50 gallons. In applying the spray it is necessary to have a good agitator in the sprayer.

**Miscible Oils** (Oils that will mix with water).—There are several oils on the market that are miscible with water. These make a good winter spray for scales, and are also excellent summer sprays against the same insects. Great care, however, must be taken to obtain the right dilution, as per directions given on container, or burning of the leaves will result.

**Paris Green.**—This is the old stand-by, and is still used by many where an arsenical insecticide is necessary. Our experiments on orchard trees, and other reports, indicate that arsenate of lead is better in every respect; although our potato expert at the Experiment Station, Mr. Kohler, who has experimented with many of the stomach insecticides for potato beetles, finds Paris green the most satisfactory for these pests. It is generally used at the rate of 1 pound to 50 gallons of spray. In using, always first make a paste of the Paris green and water, and then add to the spray material. If water alone is used, 2 to 3 pounds of stone lime should be added. If Bordeaux mixture is used, the addition of lime is not necessary.

**Potassium Sulphide.** (Liver of Sulphur).—

3 to 5 ounces of potassium sulphide.  
10 gallons of water.

This is used in place of Bordeaux, to avoid spotting of foliage and fruit. It is considered to be especially effective against powdery mildews, such as the gooseberry mildew. It is also quite extensively used in greenhouses and on shrubbery.

**Pyrethrum or Insect Powder.** (Persian Insect Powder, Dalmatian Insect Powder or Buhach).—This is a powder from the ground-up flowers of the pyrethrum plant. It is a contact insecticide, and is used against fleas, cockroaches, etc. If the powder is burned in a room, the fumes will destroy mosquitoes and flies. Purchase only when warranted fresh, and then, when in sealed cans.

**The Resin-Lime Mixture.**—This is a mixture often used, in combination with a fungicide or an insecticide, to insure the sticking of the necessary poisonous material to smooth, glossy leaves.

**Formula:—**

Pulverized resin, 5 pounds.  
Concentrated lye, 1 pound.  
Fish or other animal oil, 1 pint.  
Water, 5 gallons.

Place the oil, the resin and 1 gallon of the water in an iron kettle, and heat until the resin softens; then add the lye and stir thoroughly. Add to this 4 gallons of hot water, and boil until a little mixed with cold water gives a clear, amber-colored liquid. Add water to make up to the 5 gallons.

This is our stock solution. In spraying with Paris green or Bordeaux mixture, take two gallons of this mixture, dilute it to ten gallons, and add to 40 gallons of spray.

**Soap.**—Ordinary soap is a valuable contact insecticide.

**Formula:—**

1 pound Ivory soap or other soap of known quality.  
14 gallons water.

Boil the soap in five or six gallons of water until dissolved; dilute with water to fourteen gallons and spray while still warm. It is recommended for plant-lice, red spiders, etc.

**Sulphur.**—Flowers of sulphur is often dusted on plants to prevent such diseases as the powdery mildews.

**Tangle-foot.**—Is a sticky material often used on trunks of trees, etc., to prevent caterpillars from crawling up to the leaves, or to prevent wingless females of some insects crawling up the trunk to lay their eggs.

**Tobacco.**—Tobacco is a very important contact insecticide. As a powder, it is one of the best remedies for root-lice on trees. It may also be used in the form of dry stems applied in the same way as the

dust. As a decoction of the stems (the liquid obtained from boiling in water), it may be used as a spray against plant-lice. This decoction is also good for lice on cattle. Tobacco-smoke, when generated in an enclosed space, kills numerous soft-bodied insects. There are several commercial forms of tobacco decoctions on the market, namely Nicotine, Black leaf and Nicofume. The latter is very highly recommended by green-house men for the green fly on lettuce. We have found it excellent for all kinds of plant-lice.

**Whale Oil Soap.** (Fish oil soap).—This is a commercial product, and is a good contact insecticide, particularly for soft-bodied insects like plant-lice and slugs.

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## APPLE INSECTS AND DISEASES.

**Codling Moth.** —The larvae of this moth are the ones to which we owe the most of our wormy apples. The larvae leave the apples in the fall and hibernate in cocoons, usually under loose bark on the trees. The adult lays eggs on the leaves or young fruit soon after the blossoms fall. Over ninety per cent of the larvae find their way into the calyx end of the fruit. Here they eat their first big meal. Consequently, if one can fill this calyx cup with a poison, practically all of the first generation of larvae will be killed, and the small number remaining will not seriously injure the fruit later. Any of the arsenical insecticides can be used.

**Curculio.**—In this state the curculio that works on the apple is the plum curculio. The adult curculio hibernates, and on the approach of warm weather in the spring is ready to take its first meal. At this time they will attack the swelling buds; consequently, if the buds are covered with an arsenical insecticide, many curculios will be killed. Later the female curculio lays the egg in the fruit, and then makes the familiar crescent-shaped mark. The egg hatches into a grub, making the fruit eventually drop. If the young fruit can be kept covered with an arsenical spray, fewer eggs will be laid, and many adult female curculios killed at this time.

**Scale Insects.**—The principal scale insects found in this state are the oyster-shell scale and the scurfy bark louse. The San Jose scale is probably present, as it has been found in the states surrounding Minnesota. These are sucking insects, consequently a contact or gaseous insecticide must be employed against them. The insects are covered with a scaly armor that ordinary insecticides will not penetrate. Fortunately the discovery of the lime-sulphur wash has very nearly solved the difficulty with these pests. The lime-sulphur attacks the scaly armor, and kills the insect or the eggs beneath. The diluted

lime-sulphur wash, or the self-boiled, is excellent to keep these insects in check during the growing season.

**Scab.**—This fungus attacks fruit, leaves and young twigs. On the fruit, small olive-brown patches are first formed. These later rupture the skin of the apple, and large scabby spots or cracks are formed. These permit the entrance of rots later. On the leaves and twigs, dark patches of velvety texture are formed, sometimes with an olivaceous tinge. The disease probably lives over on the fallen leaves, and possibly, to a certain extent, on twigs and fallen fruit. It is liable to be especially prevalent when the weather has been damp and cool.

If the disease has been very bad the previous year, a thorough spraying with copper sulphate, before the buds swell, may be advisable. Under ordinary circumstances a spraying with 4-4-50 Bordeaux before the flowers blossom, another after the petals have fallen, and a third about ten days or two weeks later, followed by a fourth, will probably be sufficient. Self-boiled lime-sulphur and iron sulphide mixtures have also been used with considerable success.

**Rust.**—This is usually found on the leaves, producing orange-colored spots. It may also be found on the fruit, and, less frequently, on the twigs. If examined closely, the orange spots are seen to consist of many cup-shaped bodies with fringed edges. It is especially bad on Wealthy apples, when it attacks the blossom-end of the fruit. The rust lives over the winter on the red cedar, where it produces the so-called cedar apples, from which infection of the apple again takes place in the spring, especially following moist weather.

Spraying for scab will keep rust in check to a certain extent, but not completely. Obviously, however, red cedars, whenever possible, should be removed from the vicinity of the orchard; or at least the cedar apples should be cut away early in the spring or late in the fall. If the latter is not effective, the cedar trees must be removed. Neighbors should cooperate.

**Bitter Rot—Ripe Rot.**—This rot is found on fruit and branches. On the fruit it appears first as small, brownish patches beneath the skin. These patches rapidly enlarge until they are of considerable size; they then form sunken, often wrinkled areas, which are often corky, and very bitter around the edges. The fruit is especially liable to attack while it is ripening, but may become infected earlier. Hot, damp weather is very favorable to the spread of the disease, which may cause great loss within a week or ten days from the time it first appears.

On the branches it forms cankers, which are usually round or somewhat elongated spots, sometimes several inches long. The bark becomes very dry, cracks, and causes a characteristic sunken, wrinkled

appearance. The disease probably persists largely in these cankers, but also on the "mummied" fruit.

All rotted apples should be destroyed, and the cankered twigs pruned out. If spraying to prevent this disease alone, it would probably be early enough to make the first application of Bordeaux or self-boiled lime-sulphur about a month after the petals have fallen, and to continue at intervals of about two weeks, until the fruit is nearly ripe. Pruning and destroying the diseased apples, together with the sprays used for scab, will keep the disease in check.

**Black Rot.**—This quite closely resembles the bitter rot. It forms brown, sunken areas on the fruit, which are often darker in color than those formed by bitter rot. The brown color changes to a darker color, until finally the apple dries out, leaving only a blackish, much shrunken remnant. Beneath the skin, numerous small black dots may be seen. The fungus gains entrance to trunks also, usually through wounds or sun-scald cracks in the spring, inflicting such damage that large limbs may be killed. A number of so-called leaf-spots are also probably due to this fungus.

Treatment is the same as that for the bitter rot.

**Fire Blight.**—This is a bacterial disease, which is no doubt spread very largely through the agency of insects. When they visit the flower, they may have some of the bacteria adhering to their mouth parts, thus permitting the organisms to get into the nectar, where they multiply with amazing rapidity, finally getting into the twig. Boring or biting insects may also cause the infection of older branches. Affected twigs first present a water-soaked appearance, but later the bark is ruptured and gummy exudations appear. The fruit may also be attacked. The leaves of affected branches yellow and dry, but remain on the twigs; usually they do not fall in the winter.

Pruning in the fall or winter should be resorted to, if the disease is prevalent. Precautions must be taken to disinfect pruning knives used, or the disease may be spread by means of them. The wounds should also be properly cared for. For disinfecting, use the corrosive sublimate preparation. Prune back 6 inches or more below the infection. Prune out all infected twigs. Neighbors must co-operate.

**Leaf Spots.**—There are various leaf-spots which are caused by different fungi. Almost all, if not all, can be controlled by the sprays which are applied to prevent the other diseases mentioned.

**Powdery Mildew.**—This mildew has the characteristics of mildews in general. It is usually most prevalent on nursery stock, where it may cause considerable damage. As the leaves begin to unfold, an application of ammoniacal copper carbonate should be made. This should be continued at two-week intervals.

## Spray Calendar.

Plant.	Pest.	Spray.	TIME TO SPRAY				Remarks.
			First.	Second.	Third.	Fourth.	
Apple.	Codling moth.	Arsenate of lead.	Just after blossoms fall.	10 days later.	Last of July.	10 days later.	The first spraying is the most important and should be a drenching spray, forcing the liquid into the calyx cups. Some orchardists rely entirely upon this first spraying.
	Curculio (Plum).	Arsenate of lead.	Just as buds are swelling.	When the fruit has set.	Ten days later.	One month before harvesting	
	Scab.	Lime Sulphur (Self-boiled).	Before blossom buds open.	After blossoms drop.	10 days later.		
	Scale Insects.	Lime Sulphur (boiled).	After the leaves are lost in fall.	Before leaf buds swell in spring.			All parts of the trees should be thoroughly and evenly covered.
	Bitter rot.	Bordeaux mixture.	When apples are two-thirds grown.	10 days later.			
Asparagus,	Beetles.	Arsenate of lead.	After cutting season is over.				If some shoots are left larger than others the beetles are attracted to them and there breed. Destroy these traps.
	Rust.	Resin Bordeaux mixture.	After cutting season is past.	2 weeks later.	2 weeks later.	2 weeks later.	Two or three sprayings usually are all that are necessary. The tops should be burned in the fall.
Cabbage and Cauliflower.	Cabbage worm.	Arsenate of lead plus resin lime mixture.	Whenever the worms appear.	Repeat before worms become abundant.			The resin-lime will make the arsenical stick to the smooth leaves. So also will soap if added to the spray. There is practically no danger in using Paris green or arsenate of lead on cabbage. With cauliflower greater care must be taken when the plant is heading.
Cucurbits.	Mildew.	Bordeaux mixture.	Middle of July.	Ten days later.	10 days later.	10 days later.	
	Cucumber beetle.	Arsenate of lead.	As soon as insects appear.	Repeat when necessary.			The larvae often work on roots of cucumber, when tobacco dust or its decoctions will hold in check.
Currant and Gooseberry.	Currant worm.	Arsenate of lead or Hellebore.	When insects appear.				When berries begin to turn it is better to use hellebore.
	Mildew.	Bordeaux mixture or Potassium sulphid (Liver of sulphur).	Before leaf buds open.	After blossoming.	10 days later.	10 days later.	In the first spraying use Bordeaux mixture. At the third spraying Liver of Sulphur is best.
Grape.	Mildew.	Bordeaux mixture.	Before blossoms open.	When fruit has set.	2 weeks later.		
	Leaf-hopper.	Kerosene emulsion or Some miscible oil.	As soon as they make their appearance.				
Plum.	Brown rot.	Bordeaux mixture or Lime Sulphur.	The Bordeaux mixture just before the buds break.	Lime sulphur, 2-3 weeks later when the leaves are grown.	Lime Sulphur, 2 weeks later.	Same, 2 weeks later.	Destroy all mummies.
	Curculio.	Arsenate of lead.	Same as for apple.				
	Plum pocket.	Copper Sulphate and Bordeaux mixture.	Copper sulphate, before any growth starts in spring.	Bordeaux mixture, after growth starts.			Prune six inches from the ends of all twigs in fall, and burn.
	Scale Insects.	Lime Sulphur (boiled).	Same as for apple.				
Potato.	Beetle.	Paris green (1-50), or Arsenate of lead (4-50).	As soon as beetle eggs hatch.	Repeat when necessary.			
	Blight.	Bordeaux mixture.	When plants are a few inches high.	2 weeks later.	2 weeks later.	2 weeks later.	Keep up every two weeks during the growing period.
Raspberry and Blackberry.	Anthracnose.	Bordeaux mixture.	Before leaves open.	On young canes a weak Bordeaux mixture (2-3-50) 2 weeks later.	Same, 2 weeks later.		Cutting out the diseased canes and burning is really the essential part.
Shrubbery.	Red spider.	Water or some tobacco decoction.	As soon as first noticed.	5 or 6 days later.	10 days later.		Water is as effective as any spraying compound.
	Powdery mildew.	Ammoniacal Copper Carbonate or Potassium Sulphid.	Spray as soon as leaves appear.	10 days later.	10 days later.	If necessary 10 days later.	
Strawberry.	Leaf roller.	Arsenate of lead.	Early in the growing season.	3 weeks later.			
	Leaf Spot.	Bordeaux mixture.	Before blossoms open.	10-14 days later.	10-14 days later.		
Sweet Peas.	Plant lice.	Soap solutions or Nicofume liquid.	As soon as noticed.	4-6 days later.			The spray should be very fine and put on forcibly. A spray of water alone is often very effective.
Tomato.	Worms.	Arsenate of lead.	Apply when worms appear.				Hand picking is ordinarily all that is necessary.

**A Combination Treatment.** for Insect and Fungous Pests.—In dormant season spray with lime-sulphur wash. As the buds are breaking spray with arsenate of lead and lime-sulphur (self-boiled) or with arsenate of lead and Bordeaux mixture. Repeat just after blossoms fall. Repeat in two weeks. Repeat at intervals of two or three weeks until the fruit begins to ripen, and then substitute ammoniacal copper carbonate for the Bordeaux mixture.

### ASPARAGUS.

**Rust.**—In its most conspicuous stages the rust appears in the form of brown eruptions, followed later in the season by black or brownish black patches of winter spores.

It has been observed that the disease is most prevalent on dry soils; so a good rich soil, very carefully cultivated and kept fairly moist, renders it less destructive. It is also favored by heavy dews and moist conditions; so there should be good aeration. In the fall all diseased stalks should be collected and burned. Spraying has been partially successful. Resin Bordeaux should be applied at intervals of about 10 days, beginning when the shoots are small. However, while the shoots are small and rapidly growing, it may be necessary to spray more frequently.

### BEAN.

**Bean and Pea Weevil.**—The beetles usually appear on the vines when the plants are in blossom, the eggs being deposited on the surface of the young pod. The hatched larva bores into the pod and enters the young seed, where it grows to maturity. In this state the pea weevil probably remains within the seed until planted the next spring. It does not breed in dry peas. The bean weevil, however, will breed in dry beans. For the pea weevil the best remedy is to hold over the seed a year before planting, keeping in a tight receptacle. Fumigating the infested seeds with carbon bisulphide is good. Heat also (130 to 140° F.) will kill the insects in stored material.

**Anthracnose.**—This produces the familiar reddish-brown or darker-colored sunken spots on pods, stems and leaves. The disease gets into the seed, and is carried over the winter in this way. No seed-treatment has been developed, so it is absolutely essential to get seed from healthy pods if the disease is to be avoided. It spreads only when the plants are wet, so no cultivation should be done when there is moisture on the vines. Spraying is of very doubtful value; the essential thing is to get seed from healthy pods. All plant-remains and rubbish should be destroyed in the fall. There is some question as to varietal resistance; wax varieties are said by some to be least resistant, while the limas are more resistant.

**Downy Mildew.**—The fungus attacks mostly the pods, but may also be found on the leaves, and in some cases on the stems. It produces white patches, which may become so numerous as to cause the pods to die. In some cases, when the disease is especially severe, it also gets into the seeds. It is pretty well established that insects aid very greatly in its spread.

Clean seed should be selected; all old vines should be destroyed in the fall; and, if the disease has been particularly bad, a rotation of crops may be necessary. Careful spraying with Bordeaux has been found to effectually prevent the occurrence of the disease.

**Blight.**—All above-ground parts may be affected by the disease. It is most noticeable on the leaves and pods, producing on the leaves large, irregular brownish patches, which later become dry and brittle. On the pods, watery brown spots, with no very definite boundaries, are produced.

The disease is of bacterial origin. The first infection is generally supposed to come from the seed in which the bacteria have lived over, and it is then quite largely spread by insects. Seed should be selected from fields in which there was no infection; all affected parts should be burned, and a crop rotation should be practiced.

**Rust.**—Small pustules, about 1/16 of an inch in diameter, are formed, usually on the lower surface of the leaf. Just opposite these pustules, on the upper surface, pale yellowish spots appear. Later, these pustules break open, liberating a mass of dull reddish-brown spores. The disease has not been reported as being very troublesome. Burning of dead parts in the fall, and clean culture methods, should help keep it in check.

**Powdery Mildew.**—Grayish patches, appearing as though dusted with a grayish powder, appear. Usually the disease is not very destructive. It can be controlled by means of dusting with sulphur or spraying with potassium sulphide.

## BEEF.

The principal insects of the beet are the leaf-eating forms, which can be controlled with any of the arsenical insecticides.

**Leaf Spot.**—Brown spots, with a purplish tinge around the edge and with a grayish center, appear. They may become dry and fall out, leaving many holes in the leaves. This occurs also on sugar beets.

Spraying with 5-5-50 Bordeaux, first when the plants are six weeks old, and then at 10 day intervals, gave a large increase in yield over unsprayed plots in the East.

**Scab.**—See Potato Scab.

## CABBAGE AND CAULIFLOWER.

The principal enemy is the so-called cabbage-worm, the larva of the common white cabbage-butterfly. The ordinary arsenical insecticides readily keep these in check.

**Black Rot.**—This is caused by bacteria. The first symptoms of the disease appear as a yellowing of the edges of the leaves. Later the leaf-veins become black, and the outer leaves may fall off, in bad cases leaving the stem with only a few leaves near the top. Moist conditions are especially favorable to the spread of the disease, since the bacteria enter through the water-pores at the edge of the leaf. All heads which show signs of infection should be rejected; since a soft rot, which may spread to the other heads, is likely to ensue. Such heads should not be fed to stock, the manure of which is to be used on land used for raising cabbage. Clean cultivation and rotation should be practiced, since the disease may live over in the soil. It may also be carried over in the seed; so only clean seed should be used. As an extra precaution, seed should be soaked 15 to 20 minutes in formalin, 1 pound to 30 gallons. The same disease occurs also on many other plants of the mustard family, both wild and cultivated, such as shepherd's purse, common wild mustard, kohlrabi, brussels sprouts, kale, rape, turnips, etc. This should be taken into account in attempting to control the pest.

**Club Root.**—Club root is caused by a slime mold, an animal fungus. It causes, on plants of the mustard family, large swellings or galls on the roots, which later decay. The above-ground parts are affected by the general decrease in vigor, so that in many cases they fail to head.

All refuse and diseased parts should be destroyed, and care should be taken not to use manure which may have come in contact with diseased parts. Since the soil, when once infected, may remain so for several years, a rotation should be practiced. An application of air-slaked stone-lime, at the rate of about 75 to 80 bushels per acre, has proven very beneficial. It should be applied a few weeks before planting, and should be very thoroughly worked into the soil.

**Downy Mildew.**—The downy mildew occurs usually in the seed bed—seldom in the field. It produces grayish-white patches on the under surfaces of the leaves. Opposite the spots, on the upper surface of the leaves, there are yellowish, somewhat shrunken spots. Spraying with Bordeaux will control the disease.

## CELERY.

**Leaf Spot—Early Blight.**—Yellowish, angular spots, with somewhat raised borders, appear on both sides of first the outer and then the inner leaves. As the disease progresses, the centers of the spots

become grayish in color; the leaves wilt and dry. Muggy weather is favorable to the spread of the disease.

In order to control it, spraying should be begun early—in the seed bed—and continued at intervals of ten days or two weeks. Either 5-5-50 Bordeaux or ammoniacal copper carbonate may be used.

**Late Blight.**—Leaf spots, similar in the early stages to those of the early blight, appear on the leaves. Later, numerous small black dots appear on the affected portions. The leaves may rot away entirely, either in the field or in storage. The trouble in storage is greatly increased if the celery is kept in moist, poorly ventilated places.

Control measures may be taken as indicated under early blight. It is especially important to begin spraying as soon as the plants come up. If the plants are at all affected, the leaves should be dipped in ammoniacal copper carbonate before being stored.

## CUCUMBER.

**Cucumber Beetle.**—In the adult condition, these striped beetles eat the leaves, and so can easily be combated with the arsenical insecticides. In the larval form they sometimes do great injury to the roots of cucumbers. We have had good success against this form by using tobacco-dust on the exposed roots of the plants.

**Downy Mildew.**—The downy mildew produces yellowish spots, irregular in outline, first upon the older and then upon the younger leaves. In warm weather the spots may spread rapidly, eventually covering the entire leaf, which then dries and may fall. Flowers are produced, but few fruits are matured, and those which come to maturity are usually small and misshapen.

Spraying to control the pest should begin as soon as the vines begin to run, and should be continued every ten days or two weeks. 4-4-50 Bordeaux may be used, although it is often recommended that the first spraying be made with 3-6-50 and the subsequent ones with a 4-4-50 mixture.

**Powdery Mildew.**—This produces the powdery patches characteristic of the powdery mildews. Usually it is not very destructive, and will yield to the treatment applied to control downy mildews.

**Sclerotinose or Sclerotium Disease.**—In the greenhouse this disease may do considerable damage, although out of doors it occurs but rarely. The stems become soft and yellowish, finally drying up. A white, fuzzy mass may also appear. Slender black storage-organs may appear. Affected vines should always be removed before these storage organs appear, and the place from which they were removed should be very thoroughly sprayed with Bordeaux or some other fungicide.

**Wilt.**—This disease is of bacterial origin. It has not been found on cucumbers in Minnesota, but was found on squash in 1910, so a description will be given, since it is probably present. It causes the vines to droop and finally to die. It is spread mainly by biting insects, and possibly, to some extent, lives over in the soil. Spraying to prevent other fungous diseases and insects will aid in preventing the spread of the wilt. Rotation of crops may also prove beneficial. Destruction of diseased vines is, of course, necessary.

**Tubercular or Wart Disease.**—The cucumbers are covered with knob-like protuberances, which later may cause the entire fruit to become misshapen. Although considerable work has been done at this Station in attempting to control the trouble, no effective remedy has yet been found.

## CURRENT.

**The Currant Worm.**—The currant-worm, the larva of a saw-fly, is the worst insect pest of this shrub. As the insect eats the leaves, however, it is easily combated with a stomach insecticide.

**Currant Aphid.**—This plant-louse works on the under side of the leaves, causing reddish, swollen discolorations. They are quite hard to combat, living, as they do, entirely on the under-side of the leaves. A contact insecticide must be used, the spray being thrown against the lower surface of the leaves.

**Leaf Spot.**—There are at least two distinct fungi causing leaf spots on currants. The spots are usually circular in outline, with a grayish-brown center. In serious cases, the leaves may finally fall, causing great damage.

To control the disease, spray with Bordeaux as soon as the leaves unfold, and continue at intervals of ten days or two weeks, until five applications have been made.

**Powdery Mildew.**—The fungus produces grayish, cobwebby patches at first. These later become brown and felt-like. Leaves, fruit and stem are attacked.

Potassium sulphide, used at the rate of 1 ounce to 4 gallons of water is the most efficient spray. Spraying should be begun just as soon as the leaves begin to appear, and should be continued at ten-day or two-week intervals, until at least five applications have been made. It may be necessary to add one or two more applications.

**Canker.**—The canker is produced as a reddish eruption on the stems; these eruptions may become dark later in the season. Twigs may be killed; and in any case vigor is greatly reduced. Pruning may be necessary. However, since the disease enters largely through

wounds, care in covering them, or spraying with Bordeaux, when such wounds occur, will be beneficial.

**Rust.**—Usually the rust is not very injurious. No extensive experiments in controlling the pest have been made, so that only the destruction of affected parts can be recommended.

### GINSENG.

**Blight.**—The leaves and stem are both attacked. Large, watery patches are produced on the leaves, and brown cankers are formed on the stem. The disease may spread rapidly and become very destructive. Infection in the spring seems to be caused by the spores which are on the ground. The plants are attacked as they come through the ground, the disease first appearing on the stems. In order to properly control the disease, it is necessary to spray the beds with copper sulphate, used at the rate of 1 pound to 10 gallons of water, before the plants come up. Then, as soon as they push above ground, they should be again sprayed with Bordeaux. This should be done every other day until the plants are fairly well along. Resin Bordeaux will adhere better than the ordinary mixture.

**Wilt.**—The leaves wilt, become yellowish, and finally die. The stems become black and defoliated. Great damage may be done within a week. It is said that the disease will not appear unless the plants are weakened by the attacks of other fungi. Spraying for the blight should also keep this disease in check.

### GOOSEBERRY.

See Currant.

### GRAPE.

**Leaf Hoppers.**—These are very active, insidious sucking insects, and consequently hard to combat. A contact insecticide, like kerosene emulsion or miscible oil, will keep the insects in check.

**Black Rot.**—The disease first appears on the leaves; it produces nearly round tan-colored or brown patches. Later it attacks the berries on which it appears first as small brown or purple spots. These spots enlarge very rapidly, until the entire fruit is covered. The skin does not usually rupture, but the berries shrink until they remain only as wrinkled, hard, dry mummies. Young shoots may also be attacked; in which case the spots are usually reddish and may cause a splitting of the shoot. The disease lives through the winter on affected parts; consequently all of these should be destroyed in the fall, and clean cultivation should be practiced. Just as the buds are beginning to swell in the spring, a very thorough spraying with Bordeaux should

be made. When the buds are unfolding, a second spraying should be given with 4-3-50 Bordeaux, and this should be repeated at ten-day or two-week intervals. The number of sprayings necessary depends upon weather conditions; in warm, moist weather the disease is most destructive. If it is necessary to continue spraying until late in the season, ammoniacal copper carbonate should be substituted for Bordeaux the last two times. This is done in order to avoid the spotting of the fruit.

**Downy Mildew.**—*Gray Rot.*—The symptoms are those usually appearing as a result of downy mildew. A grayish, felty mass of fungous threads appears on leaves and berries. The berries eventually shrivel, but do not become hard and dry, as in the black rot. If they are attacked after they are at least two-thirds grown, they become brown in color; and for this reason the name brown rot is sometimes applied.

The control measures indicated under black rot will suffice. It is especially important that spraying be begun early in the season.

**Leaf Spot.**—In moist seasons, irregular brown or black spots are produced on the leaves. They appear first on the under surface of the leaf. Use control measures indicated under black rot.

**Powdery Mildew.**—The powdery mildew appears as circular, flour-dusted spots on all above-ground parts of the plants. Under favorable weather conditions it may become serious, since the flowers may be attacked and then fail to set their fruit, while the berries themselves may be attacked and then cease growth, finally dropping from the vine. Lack of ventilation, excessive shade and damp situations are especially favorable for the spread of the disease.

Dusting with flowers of sulphur when the blossoms begin to open, and repeated dustings as occasion may demand, usually controls the pest effectively. The treatment suggested under black rot is also effective.

**Anthracnose.**—*Bird's Eye.*—This appears on the canes as small, dark spots, with sunken, ash-colored centers; it weakens the canes very greatly. The symptoms on the fruit are very much like those on the canes. The spots often have reddish edges. The diseased canes should be cut out as soon as they appear. In addition, spray as for black rot.

## LETTUCE.

**Gray Mold.**—The disease first becomes apparent by reason of the wilted edges of the leaves. Later, the affected leaves may droop and die, becoming covered with a dirty brownish-gray fuzz. Proper cultural methods and care of the greenhouse will generally prevent the

appearance of the disease. Good ventilation and a fairly constant temperature, which must not be too high, are essential.

**Wilt.**—Healthy lettuce in the greenhouse may succumb to this wilt in a single day. Affected leaves appear as though they had been suddenly plunged into boiling water and then taken out again. A dense, white growth of fungus threads appears on parts which have collapsed. The fungus produces storage organs which persist throughout the winter, causing infection the next year. All affected portions should be removed in order to prevent the formation of these organs. The same general sanitary precautions mentioned under gray mold should be taken. In case the soil becomes infected, it should be disinfected with formalin, used at the rate of 1 pound to 12½ gallons of water. It may be necessary to change the soil entirely.

## MELONS.

See Cucumber.

## ONION.

**Blight.**—*Downy Mildew.*—Warm, moist weather is especially favorable to the spread of the disease. The tips are first attacked, presenting a water-soaked appearance, which is followed by a fuzzy outgrowth. Later, the plants may collapse entirely, thus preventing the formation of normal bulbs.

Crop rotation, clean culture and spraying will prevent the disease. If it has never appeared before, it may not be necessary to spray before the disease appears, but upon the first indication of its appearance 5-5-50 Bordeaux should be applied. One spraying may or may not be sufficient, depending on weather conditions.

**Smut.**—The smut persists in the soil, so is particularly liable to attack seedlings, upon which it causes the formation of black, dusty patches of spores. Rotation is beneficial, as is soil treatment, with lime used at the rate of about 100 bushels per acre. Treating seed with formalin at the rate of 1 pound to 30 gallons of water is also beneficial.

## PEA.

See Bean.

## PLUM.

1. Plum Curculio. (See Plum Curculio, under *Apple*).
2. Scales. (Same as under Scale on *Apple*).

**Black Knot.**—This disease is prevalent on both wild and cultivated plums and cherries. The first indication of its presence is usually the development, on young twigs, of velvety, greenish or olive-colored swellings. These later in the season become black and brittle. Not

only young twigs, but also larger branches may become affected. The branches may be killed on account of the interference with the transportation of nourishment, or their vitality may be lessened. Infection probably takes place largely through wounds and abrasions; so all of these should be carefully avoided. Further, the disease spreads most rapidly while the knots are still young, so that careful pruning before they have had time to develop is necessary. If any have been missed, they should be removed later. Pruning alone, however, is not sufficient to control the disease, since it occurs also on wild plums and cherries. Spraying should also be practiced. The first application should be made in the late winter or early spring, while the trees are still dormant; another should be made when the buds begin to swell; while others may be made as necessity demands. For the first spraying a 6-6-50 Bordeaux mixture should be employed, but this would be almost sure to injure the foliage on the trees later in the season. A 3-4-50 mixture of Bordeaux is sometimes used without foliage injury resulting, but even this mixture may in some seasons be injurious. Even the weaker solutions proved injurious in experiments conducted by the Pathology Department in 1910. Although its worth on plums has not yet been absolutely demonstrated, self-boiled lime-sulphur has given much promise and should be tried.

**Brown Rot.**—Although brown rot is especially destructive on fruit, it occurs also on leaves and twigs, causing a blighted appearance and finally killing them. The fruit is more especially susceptible in the later stages of its development, moist weather being very favorable to the spread of the disease. Small brownish spots first appear; these enlarge rapidly, until the entire fruit may be covered. Upon the surface of the fruit brown patches of spores appear; and these spores may be blown long distances, thus spreading the disease. The diseased fruits finally shrivel and dry, often remaining on the tree indefinitely. Infection in the spring is caused largely by these mummied plums, which should, of course, be destroyed.

Spraying should be carried on as for black knot. The self-boiled lime-sulphur mixture has proven effective in controlling the same disease on peach, and will probably prove efficient when used on plums. Naturally, since plums are more liable to become infected after they are at least half grown, spraying should be continued until late in the season.

**Fire Blight.**—See Apple.

**Plum Pocket.**—The fungus attacks the fruit, destroying the pit and converting the entire fruit into a hollow, bladder-like sack, which later falls from the tree. Twigs may also be infected, and it is supposed that the disease hibernates mainly in this way. The disease ap-

parently does not spread very rapidly, so that pruning out and destroying affected parts, together with the spraying for brown rot and black knot, will help keep it in check.

**Powdery Mildew.**—See Apple.

**Scab.**—Dark brown, scabby spots appear on the surface of the fruit, especially in a rainy season. The disease will yield to the treatment given for brown rot.

**Shot Hole.**—Very numerous, rather small brown spots appear on the leaves. These later become dry, and the dried portions may fall out, leaving the leaves with the appearance of having been riddled with shot, whence the common name. The chief damage done is in the enormous decrease of leaf surface and the defoliation of the tree. It has been found that 2-4-50 Bordeaux or 8-8-50 self-boiled lime sulphur will effectively control the disease, if spraying is begun early and continued throughout the season at intervals of about two weeks.

**Combined Treatment for Insect and Fungous Pests.**—Lime-sulphur wash in the dormant season. Arsenate of lead and lime-sulphur (self-boiled) as the buds begin to swell. Repeat at intervals of two weeks until fruit is ready to harvest.

## POTATO.

**Colorado Beetle.**—This striped pest hibernates in the soil. As the potatoes show above ground, the beetles are on hand to lay the yellow patches of eggs on the under-side of the leaves. The greasy-looking grubs are the ones that do the damage. An arsenical insecticide will kill them easily, especially if the spray is applied while the larvae are still small.

**Early Blight.**—The disease is confined to the leaf, upon which grayish, dry spots are produced. Usually the spots are characterized by the presence of concentric circles. Although the tubers are not affected, the effect on the leaves may be so serious as to very greatly diminish the leaf-surface, thus making it impossible to form normal tubers. In dry seasons, considerable loss may result, if the vines are not properly sprayed. Control consists of proper spraying with Bordeaux. When the plants are young, a 4-4-50 mixture should be used; but, after the first two sprayings, a 6-6-50 mixture may be used. The idea is to keep the vines covered with Bordeaux, from the time they are about six inches high until the end of the season. It is uncertain at the present time, whether or not in Minnesota it would pay to spray to control this disease alone.

**Late Blight.**—Late blight has, fortunately, not yet become serious in this state, except when the weather in August is exceptionally wet. The leaves and tubers are both attacked. On the leaves the disease

appears first on the edges, blackening and drying them; while on the tubers dark, sunken spots are first developed, followed later by a dry rot or a soft, foul-smelling rot, which may continue after the tubers are stored. Only clean, healthy tubers should be selected for seed; and spraying should be conducted as for early blight, except that, when spraying for late blight alone, it may be begun later in the season.

**Scab.**—Affected potatoes show rough, corky patches which may, in severe cases, be cracked. The yield may be somewhat affected, but a greater loss is due to the decreased value of potatoes. It is necessary to remember that beets and turnips are susceptible to the same disease, and that the disease persists, not only on the tubers, but also in the soil. No susceptible crop should be planted on infected land for at least three years, and preferably longer. Seed-potatoes should be soaked for two hours in formalin, used at the rate of 1 pound to 30 gallons of water. The tubers may then be dried, cut and planted. They should not again be brought into contact with anything which contained them before they were treated. Thirty gallons will usually treat about 45 to 50 bushels of potatoes. Corrosive sublimate may also be used; but, on account of its poisonous nature, is not so desirable as formalin.

**Tip Burn.**—This is a disease which is not induced by any parasitic organism. The tips of the leaves dry and break off during hot, dry weather, especially if the crop is on light soil.

**Wilt—Internal Brown Rot.**—The disease is caused by a fungus which may live in the soil and gain entrance through the roots. The vines wilt; and, when pulled up, the roots usually break off very easily. The disease may be in the tubers at harvest-time, without showing conspicuous symptoms. However, when stored in warm places where considerable moisture is present, it may spread very rapidly, at first forming a yellowish or black ring near the stem-end; and later the entire interior may be converted to a dry, shrivelled mass. Bacteria also very often gain entrance and aid in the rotting process. Potatoes from wilted vines are very liable to be infected, so they should be examined, and, if they show a brown discoloration beneath the surface of the stem-end, they should be used at once, as at this stage they are not unfit for eating. In any case, tubers should be stored in a dry, cold place.

In controlling the disease, affected vines should be removed and destroyed; no affected tubers should be used for seed, and crop rotation should be practiced. It is not definitely known how long soil will remain infected, but it is probable, that several years will be neces-

sary to remove danger of infection from this source. It is important, in planting seed, to be careful to get clean seed.

**Wilt—Bacillose.**—The symptoms in the field are somewhat like those just given for internal brown rot. The leaves dry, and the stems and tubers become yellowish or black, exuding a soft, pus-like substance when broken. The disease is spread largely through the agency of insects; so it is especially important to guard against them. The same precautions regarding storage, soil and planting, which were mentioned under internal brown rot, apply here.

**Combined Treatment** for Insect and Fungous Pests.—Paris green and Bordeaux mixture when plants are six inches high. Repeat at intervals of two weeks during growing season.

## RADISH.

**Maggot.**—This is a very hard insect to combat. The adult insect looks very much like a house-fly. The eggs are laid on the soil near the base of the plant, or on the base itself. Early planting and excess of seed are the best preventives.

**Club Root.**—See Cabbage.

**White Rust.**—Upon radish leaves, especially in the greenhouse, smooth, white blisters may appear on the leaves. The flowers and pods may become swollen and otherwise misshapen. All refuse from diseased parts should be destroyed.

## RASPBERRY AND BLACKBERRY.

**Anthracnose.**—This fungus produces on the young canes the familiar purplish spots. Later in the season, the spots become grayish in the center, remaining purple around the border. As the spots increase in size, they may girdle the cane, eventually killing it on account of interference with the water supply. Leaf petioles, the veins of leaves and the leaf blades may also become infected. The berries produced by anthracnosed canes are usually small and dry, on account of their premature ripening.

Raspberries should not be grown on the same soil more than 3 years, if the disease is troublesome. The affected canes should be cut out and burned. Resin Bordeaux may be applied early in the season; but, alone, it will not prevent the disease.

**Crown Gall.**—Crown gall is a bacterial disease, producing on the roots of raspberries and other plants the well-known swellings or galls. From its very nature it would be extremely difficult to control when once established. All affected plants should be pulled up and burned. Only healthy nursery stock should be planted on land which has not recently grown raspberries or blackberries. From the most recent

researches on this disease it seems possible that raspberries may become infected from affected apple trees.

**Leaf Spot.**—Numerous small, light-colored spots, with darker borders, often appear. In the center of the spots, small black dots are often visible. Usually the disease is not serious, and the value of spraying is not known.

**Rust.**—The rust appears in its most conspicuous stage as bright red patches on the lower side of leaves, distorting and rendering them worthless. The fungus threads may live in the canes for a number of years, so that spraying is of value only in preventing spread to other plants. All affected parts should be removed and burned.

### SHRUBERRY.

**Plant Lice** often attack the leaves of shrubs, but any contact insecticide, like a soap solution or nicofume, will keep them in check.

**Red Spiders.**—These little pests are very bad in a dry season. Spraying with ordinary water will keep them in check.

### SQUASH.

See Cucumber.

### STRAWBERRY.

**Leaf Spot.**—The common large leaf-spot, with a purplish border and lighter colored center, is usually very prevalent. It may be controlled by spraying with Bordeaux, once before the blossoms open and once or twice after the fruit is picked. In the late fall or early spring, the leaves may be cut off and then burned.

### SWEET PEAS.

**Plant Lice.**—As in the case of shrubs, the lice on sweet peas can be kept in check by soap solutions, tobacco products or ordinary water.

### TOMATO.

**Worms.**—These are larvae of a large moth, often called the “humming-bird moth” because of its habit of hovering over flowers and sucking the nectar therefrom. It flies usually toward evening at dusk. Usually the larvae are not in sufficient numbers to warrant spraying. Hand-picking will keep the pests in check.

**Leaf Spots.**—A number of leaf-spots occur on tomato, but they have not been serious in this state. Spraying with Bordeaux will prevent them, if begun about 10 days after transplanting and continued at intervals of about two weeks.

**Point Rot.**—The point or blossom end-rot causes great damage in dry seasons. It appears on the blossom end of the fruit as sunken, brownish spots, which may increase rapidly in size, until the entire fruit is rotted. The cause of the disease has not been fully worked

out, but it is known to be most prevalent on light soils during hot, dry weather. Spraying is of little value; sub-irrigation gives some relief.

**Ripe Rot.**—This causes the black rot so common on the ripe fruit. Spraying for leaf-spots may prevent its appearance to a certain extent. The vines should be carefully trained so as to permit of sufficient aeration.

## TURNIP.

**Black Rot.**—See Cabbage.

**Club Rot.**—See Cabbage.

**Scab.**—See Potato.

## SPRAYING MACHINERY.

An individual may understand thoroughly all about insecticides and fungicides and their application; and yet, unless he is the right kind of man, or has the right kind of machinery to put the material on the plant in proper form, his knowledge avails him nothing. A spray-pump may be capable of applying the spray correctly and economically for a person in one orchard, and not be the right kind for another orchard. Again, one kind of pump may suit one orchardist, and good clean fruit be the result, though perhaps the pump is not as good as that of his neighbor, who sees no good in spraying because his fruit is spotted or worm-eaten. With the present-day advance in all kinds of machinery, it often pays a man to practically give away an old machine for a new one of more efficient pattern, which may be better suited for the work in hand. Spraying, therefore, is a question of individuality and spraying machinery.

For orchard work it is never advisable to purchase anything smaller than a barrel-pump. A good barrel-pump will last a life-time, and can be used for purposes other than spraying, such as white-washing, disinfecting, etc. When an orchardist has a sufficient number of trees to require five or six barrels of liquid for one spraying, it is advisable to purchase a large tank, holding 200 to 300 gallons, and a double-acting sprayer; or better, if he can afford it, a gasoline sprayer.

Always wash the spraying apparatus out with water after spraying or whitewashing, and oil and clean up all parts before putting away for winter.

Some essentials of a good spraying apparatus are:

1. The pump should be brass lined, to prevent corroding or rusting of the parts.
2. The pump must have a sufficiently large air-chamber, to keep the pressure uniform; one that will, with comparative ease, keep, with two leads of hose in operation, a pressure of at least 150 pounds.
3. As the principal ingredient in many of the insecticides and fungicides is the fine material held in suspension, there must be perfect agitators, that will keep the liquid in constant motion.
4. The nozzle must be the best that is suited to the occasion. The nozzles of the "Bordeaux" type are not very satisfactory in ordinary usage. The "Vermorel" gives an excellent fine spray, but often it is misty too soon after leaving the nozzle. The larger types of nozzles, like the "Mistry," are more satisfactory for much of the orchard spraying.

5. Another very important point in spraying is to have a good hose. Often a poor or worn-out hose causes more trouble than all the rest of the apparatus put together. Good hose bands, to hold the hose on the couplings, and long hose-couplings, are essential. A short hose-coupling is often more trouble than it is worth.
6. Bamboo extension rods, with cut-offs at the lower ends, are necessary in orchard spraying. The rod inside the bamboo is made either of iron, brass or aluminum. The latter are lighter to handle, and when properly made are excellent. Extension rods can be obtained from eight to fourteen feet long, but it is not often advisable, in this state, to purchase one over ten feet.
7. A necessity, when spraying compounds are used, is a good strainer. A fine-mesh brass screening, set at an angle in the frame of a box, is the simplest and best.

### COST OF SPRAYING.

The cost of spraying varies in different localities, depending upon wages, the topography of the land, the size of the spray-machine, the size of the trees, the distance from water used in the spraying material, etc. The cost will vary between the different kinds of large and small outfits, from five to fifteen cents per tree for each spraying.

### SPRAYING MACHINE MANUFACTURERS.

The following is a list of companies to whom the prospective purchaser may write for catalogues and prices.

American Sprayer Co., Minneapolis, Minn.	Goulds Mfg. Co., Seneca Falls, N. Y.
Barnes Mfg. Co., Mansfield, Ohio.	Hardie Mfg. Co., Hudson, Mich.
Bean Spray Pump Co., Cleveland, Ohio.	Hurst Mfg. Co., Canton, Ohio.
Binks Spraying Machine Co., Chicago, Ill.	International Harvester Co.
Brandt Manufacturing Co., Hastings, Minn.	Latham & Co., Sandusky, Ohio.
E. C. Brown Co., Rochester, N. Y.	Leggett & Brother, 301 Pearl St., New York City.
Cushman Sprayer Co., Lincoln, Nebr.	Morrill & Morley, Benton Harbor, Mich.
Dayton Supply Co., Dayton, Ohio.	F. E. Myers & Bro., Ashland, Ohio.
Deming Co., Salem, Ohio.	The New Way Motor Co., Lansing, Mich.
R. H. Deyo & Co., Binghampton, N. Y.	Niagara Sprayer Co., Middleport, N. Y.
W. & B. Douglas, Middleton, Pa.	Olds Gas Power Co., Lansing, Mich.
Fairbanks, Morse & Co., St. Paul, Minn.	Pierce Loop Co., Northeast, Pa.
Field Force Pump Co., Elmira, N. Y.	Splittstosen Mfg. Co., North Branch, Minn.
Friend Mfg. Co., Gasport, N. Y.	Spramotor Co., Buffalo, N. Y.
Gilson Mfg. Co., Port Washington, Wis.	Wm. Stahl Sprayer Co., Quincy, Ill.

### INSECTICIDE AND FUNGICIDE MANUFACTURERS.

Ansbacker & Co., 253 Broadway, New York City.	Merrimac Chemical Co., 33 Broad St., Boston, Mass.
Bowker Insecticide Co., 43 Chatham St., Boston, Mass.	Niagara Spraying Co., Middleport, N. Y.
Fergusson Bros., 109 Chestnut St., Philadelphia, Pa. (Copper Sulphate).	Sherwin-Williams Paint Co., Minneapolis, Minn.
Good, James, 934-941 N. Front St., Philadelphia, Pa. (Fish oil soap).	Talmadge, Geo. E., Inc., Madison, N. Y. (Aphine).
Grasselli Chemical Co., 172 E. 5th St., St. Paul, Minn.	Taylor, E. R., Penn Yan, N. Y. (Fuma Carbon bisulphid).
Hemingway's London Purple Co., 133 Front St., New York City.	Thomsen Chemical Co., Baltimore, Md.
Kentucky Tobacco Product Co., Louisville, Ky.	Thum, O. & W., Co., Grand Rapids, Mich.
Fred L. Lavanburg, 100 William St., New York City.	Vreeland Chemical Co., 50 Church St., New York City.