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OREGON AGRICULTURAL COLLEGE
EXTENSION SERVICE
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Orchard Spraying in Oregon 1916

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Spraying Machinery

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The Extension Service of the Oregon Agricultural College embraces all instructional work done by the College staff outside the institution. This includes institute, lecture, and fair work in all its varied phases, supervision of the county demonstration and farm work provided for by state legislation; correspondence courses; preparation of educative exhibits; publication of bulletins and distribution of news matter; cooperative work with granges, farmers' unions, schools, churches, commercial clubs, and other progressive organizations in the promotion of industrial and social enterprises. The Extension Service, in short, consists of carrying out to the people of Oregon practical and usable information on all subjects taught at the College.

Applications for assistance along any of the lines indicated, together with all particulars relating thereto, should be sent to the Director of Extension as far in advance as possible. It is the desire of the College to help all who apply, but its staff, facilities, and funds are limited; consequently, short-notice requests may not find the department in position to render the best service.

Particular attention is called to the fact that counties desiring to organize for agricultural field and demonstration work, under the provisions of Chapter 110, Laws of 1913, must make an initial appropriation in order to secure the State aid. Those interested in promoting this work should communicate with the Director of Extension, or the State Leader, at the Agricultural College, with reference to the best methods of procedure.

ORCHARD SPRAYING IN OREGON---1916.

H. P. BARSS, Botanist and Plant Pathologist
and
A. L. LOVETT, Acting Entomologist

Spraying has become a necessary practice in every orchard. Clean, high quality fruit, the only sort of fruit crop that pays, cannot be expected year in and year out if the orchard is not sprayed regularly and thoroughly at the proper times. The object of spraying is never to cure a tree from the effects of a disease or pest by which it has already been attacked. Spraying is intended either to kill the pest or parasite by hitting it with the proper solution at a stage when it is found unprotected, or to coat all the susceptible parts of the trees or fruit with a fungicide or insecticide at such a time that the fungus or insect can make its attack at no spot that is not already protected with a layer of fatally poisonous material. It is evident that spraying cannot be effective unless adapted to the life-habits of the parasite and the condition of the tree and fruit. Yet many growers apply sprays uselessly at times when the parasite cannot be destroyed or when protection is of no value, while at the critical periods of active infection or attack spraying is omitted. Other growers, while spraying at the right times, fail to do the work thoroughly enough to reach all the insects or to coat all susceptible parts of the tree. Still others use the wrong materials. Failure is the natural consequence of careless methods in spraying. A reasonable knowledge of our more common sprays and their proper application is therefore an essential part of the education of the successful grower.

Not all orchard troubles are amenable to sprays. There are plant diseases and insect pests which must be combated in other ways than by sprays, and there are orchard troubles for which no definite control is yet known.

There are a great variety of commercial spray materials on the market, some of them for general use, many of them for special purposes. Most of these materials are very good when properly used; some are of questionable value when price and purpose are considered, and a few are really dangerous. It is not the purpose of this bulletin to discuss these various commercial preparations. A limited number of spray materials are considered. Their use, in most cases, has passed beyond the experimental stage; they are regarded as standard sprays for general use. There is no intent to imply that other materials, which are of proved value, are not thoroughly efficacious.

As a rule the commercial preparations of the various spray materials recommended are standardized, are more convenient to use, and, everything considered, are usually as cheap as the home-mixed spray. It is important that the material, if a commercial product, be pure and fresh. It should be in the original unopened container and should not have been allowed to dry out or to freeze.

The object of this bulletin is to give to the fruit grower, in a condensed form, such information as will assist him to combat the pests

and diseases in his orchard with the right materials, at the right time, and in the right way. The recommendations are based upon the most recent available results of experiments and studies carried out in Oregon or of those conducted by reliable workers elsewhere and adapted to Oregon conditions.

APPLES.

The Young Orchard, if clean of disease and insects when planted, seldom requires any regular schedule of sprays. Thorough inspection should be made in the early spring, in early summer, and in the fall, for possible troubles. Inspect the trees carefully for apple mildew, apple-tree anthracnose, San Jose and oyster-shell scale; examine for woolly aphis and borers and look frequently during the growing season for bud weevils, aphis, tent caterpillars, etc. San Jose scale and woolly aphis particularly should not be neglected. When any of the troubles are present, follow out the spray schedule as outlined below to cover the particular case.

The Bearing Orchard. With few exceptions a regular spraying program should be adopted. The two worst fruit pests, apple scab and codling-moth, are present in practically every well-established orchard district in the state. Frequent inspection should be made for other insects and plant diseases, which, if allowed to go unchecked, are liable to establish themselves and cause considerable loss in the orchard.

Winter Treatment. For powdery mildew, prune out as many of the mildewed twigs of the previous season as possible. For apple and pear scab, plow the fallen leaves under before the winter buds open, at any time consistent with soil conditions and the general orchard practice being followed. This will greatly reduce the primary scab infections.

For fire blight (see under pear) go over the orchard and remove and sterilize all hold-over cankers. If hold-over cankers are thoroughly eradicated from an orchard, the grower can hold the disease in check to an extent otherwise impossible. Look for collar and root rot due to blight and cut out and sterilize. If fire blight is present in the orchard, it is necessary to sterilize the pruning instruments used in the regular pruning, since wide dissemination of blight can take place in an orchard through failure to sterilize the pruning instruments after they have been used on infected fruit trees.

Pruning should be done in such a way as to let light and air into the interior of the tree as far as is consistent with horticultural practice. This helps to some extent to prevent conditions favorable to fungous infections. While pruning also inspect the trees for San Jose scale and woolly aphis.

1. **Dormant Spray.** To be applied while the winter buds are swelling just before they open.

For scale insects and red spider mites.

Use lime-sulfur, 1 to 8 (1 gallon lime-sulfur to 8 gallons water) or Miscible Oil Emulsion, 1 to 17.

Primarily for San Jose and other scale insects but will also control red spider mites. (Helps to kill moss and lichens on trees, although these disappear wherever the regular spraying program is adopted for insects and fungus diseases.)

This is the ideal time to spray for the control of the San Jose scale. Begin at outer tips of twigs and spray down the limbs to the trunk, driving the spray under the buds. Many scales are concealed here.

Leaf Rollers. Where the leaf-roller or green fruit-worm is present it is advisable to use the miscible-oil emulsion. Spray in the spring at the time indicated above. This oil spray will control scale, red spider, and aphis.

2. **Delayed Dormant Spray.** To be applied a short time after the winter buds have burst. In the case of apples, when the leaves are about half an inch long.

For plant lice (Aphids), red spider mite, and bud moth.

Use lime-sulfur 1 to 18 or 20, plus nicotine sulfate 40%, 1 to 1200 (1 pint to 150 gallons) plus arsenate of lead 4 to 100 (4 lbs. to 100 gals. of dilute spray solution.)

The first spray for apple scab and often very important. Probably helpful in mildew control.

This is usually the first general spray, where scale and leaf roller are not present, and is aimed to protect the unfolding parts from the first infestions of fungi and insects.

If plant lice and red spider are absent, omit the nicotine.

If bud moth is not serious, omit the arsenate of lead.

Injury. When used in the strength indicated, lime-sulfur is likely to burn the tips of the young leaves, etc., but experience has shown that this generally results in no particular harm. This application is usually very necessary.

3. **"Pink" Spray.** To be applied just before the petals open.

For scab, the second spray; also for bud moth, leaf-roller, leaf-eating caterpillars.

Use lime-sulfur 1 to 25 or 30, plus arsenate of lead 4 to 100.

This application will protect blossom parts, the young fruit stems and the developing leaves from the scab infections which will otherwise be very abundant if weather conditions are favorable. Cover all parts thoroughly, but aim not to drench.

Where the insects mentioned above are not serious, omit the arsenate.

4. **"Calyx" Spray.** To be applied just as the last petals are falling and before the calyx lobes close.

First codling-moth and third scab spray.

Use Lime-sulfur 1 to 35 or 40, plus arsenate of lead 4 to 100.

Where lime-sulfur injury is likely to occur in later sprays, add four pounds of Atomic Sulfur to each 100 gallons of lime-sulfur spray at this time to prepare the trees for the use of Atomic Sulfur alone later on.

5. **"Ten Day" Spray.** To be applied ten days or two weeks after the preceding.

For apple scab.

Use lime-sulfur 1 to 40 (or Atomic Sulfur 12 to 100).

It is not safe to omit this application, as new foliage and fruit surface is rapidly developing.

Injury. Under certain conditions lime-sulfur injury is likely to occur. If indications point to very warm weather Atomic Sulfur 12 lbs. to 100 gals. might be used as a substitute.

Use only a fine mist spray at this time and cover all surfaces evenly. Where leaf-eating insects are present, add lead arsenate as above.

6. **The "4 to 5 Weeks" Spray.** To be applied 4 to 5 weeks after the calyx spray.

The second and most important spray for the first generation of the codling-moth, and the last spring spray for scab.

Use lime-sulfur 1 to 40, or Bordeaux 4-4-50, or Atomic Sulfur 12 to 100, plus arsenate of lead 4 to 100.

When moist weather occurs late in the spring this spray is required for the control of apple scab. Where lime-sulfur at this time is likely to cause injury, a substitute is desirable. Atomic Sulfur may be used provided some of this material has been used on the trees earlier. Otherwise, it is likely to cause defoliation. If the down or fuzz has disappeared from the fruit, Bordeaux at this time is not likely to injure.

The exact date for the application of this spray will vary with the season and with the locality. Approximate dates are the best we can submit. The date should correspond with the first deposition of eggs by the codling-moth. Procure a standard thermometer, and take daily readings at 8 p. m. When the evening temperature registers 60 degrees or above it is time to apply this spray. As a general rule this date will follow the calyx spray by about 3½ to 4½ weeks in Eastern and Southern Oregon; 4 to 5 weeks in the Hood River Valley, and 5 to 6 weeks in the Willamette Valley. In a bearing orchard, it is never advisable to omit this application for the moth.

7. **The July Spray.** To be applied July 10 to 25.

For the second generation of the codling-moth. It is this brood of worms which produces the costly "September Sting."

Use lead arsenate 4 to 100.

In the summer codling-moth applications pay particular attention to the fruit. Use a fine misty spray and cover thoroughly the surface of every apple.

8. **The August Spray.** To be applied August 5 to 20.

For the second generation of the codling-moth (also of some value for apple scab and apple-tree anthracnose.)

Use arsenate of lead 4 to 100 (plus Bordeaux mixture 4-4-50 if desired).

As a general rule except in districts where the codling-moth has been particularly bad the past season, one summer application is usually sufficient to control the second generation. The time of application where a single spray is given will come approximately half way between those recommended above. Where possible, if in doubt, consult the Fruit Inspector, County Agent, or some official who is in a position to know as to the time to apply this summer spray. The time will necessarily vary with the season, locality, and local conditions.

It is believed that if Bordeaux mixture is used at this time and the branches and fruit thoroughly coated, some protection will be afforded against the early fall infections of apple scab on the fruit and of apple-

tree anthracnose on both the fruit and branches. It would be preferable, however, to spray a few weeks later for these diseases.

9. **Early Fall Spray.** To be applied in early September, before the fall rains.

For apple-tree anthracnose and apple scab.

Use Bordeaux mixture 4-4-50 (or Burgundy mixture.)

This is the most effective time for the first spray to control apple-tree anthracnose rot and canker, and fall fruit infections of scab, and should always be given where these pests are abundant, unless a fungicide was added to the August insect spray.

10. **Late Fall Spray.** To be applied soon after picking, late October or the first week in November.

For apple-tree anthracnose (and scale, if lime-sulfur is used.)

Use Bordeaux 4-4-50 or lime-sulfur 1 to 8.

This is put on to control the late fall infections of anthracnose and will kill a good deal of the scale if lime-sulfur is used. The twigs, limbs, and trunk should be given a complete and thorough coating.

The Woolly Apple Aphis is a serious orchard pest of both apple and pear. It attacks the tree both above and below ground and where once thoroughly established is a very difficult insect to eradicate. In blight-infested districts it is undoubtedly an active agent in the dissemination of this disease, often carrying the infestation to the roots and crown of the tree. Every woolly-aphis-infested tree should be marked and given individual attention. Use kerosene emulsion 15 percent solution (see directions for dilutions page 22), applying it freely to the infestation above ground and to the trunk of the tree. Remove the soil exposing the surface rootlets and saturate with this solution, then recover.

Borers seldom attack thrifty vigorous trees. Keep the trees in good condition by care and cultivation. Cut out borers where found and protect the wound with grafting wax or pruning compound. Use repellant wash No. 1 on young trees.

Powdery Mildew of the Apple. This disease is becoming quite serious in some sections of the state. Experiments for its control will be commenced in Oregon during the coming season. Definite recommendations cannot be made at this time, but it is believed that the application of lime-sulfur through the spring or of lime-sulfur first and Atomic sulfur later, as suggested above for scab control, will result in material decrease if not complete control of the disease. In California "iron sulfide mixture" is used in the control of mildew alone, with apparently good results.

Fire Blight. This is Oregon's most serious orchard disease. It should be watched for constantly and upon being discovered steps should at once be taken to eradicate it from the neighborhood as well

as from the orchard where found. Notify the fruit inspector and get his assistance. For a discussion of the disease see under Pear.

PEARS

In general, the same recommendations for the application of sprays as given for the apple will apply for the pear.

Blister Mite. On pear varieties which permit the practice, use lime-sulfur 1 to 12 as the tips of the leaves are emerging. For varieties where the fruit buds open with or before the leaf buds, apply the solution shortly before the blossoms open, and dilute the lime-sulfur 1 to 15.

Codling-Moth. The calyx application of arsenate of lead is not necessary for the codling-moth.

Pear Slug. In the "10-day" spray (No. 5 under Apple) add lead arsenate 4 to 100 for the first brood. The regular summer application (late July or early August) for the control of codling-moth will usually control the second brood of slug.

Pear Scab. Control as for Apple scab. Give the first application in the "Delayed-Dormant" condition before the cluster of blossom buds has pushed out to any considerable extent. In this application use lime-sulfur 1 to 15, where blister mite is present. In later applications use a little weaker solution than recommended for apples.

Fire Blight (Pear Blight.) Watch for Fire Blight. There are few parts of Oregon that have not been invaded by this disease. If not detected in its first attacks in an orchard and promptly eradicated, the disease increases rapidly and it becomes a matter of great expense and difficulty to overcome it. Wherever it is discovered, the fight against it should become a community matter, since its presence in one orchard is a menace to all the orchards of the community. In those sections of Oregon where the disease is being successfully held in check, the fight has been made a distinctly community fight and funds have been provided for the careful and thorough inspection of the orchards throughout the district and for the enforcement of the eradication measures necessary for the control of the disease. Where this has not been done, the disease has swept in, resulting in tremendous damage to both pear and apple orchards.

If any grower discovers a diseased condition that he suspects may be fire blight, he should send a fresh specimen at once to the Agricultural College or to his local fruit inspector for identification. In this way steps may at once be taken, if it prove to be fire blight, to locate the source from which it entered the orchard, and by the adoption of proper methods, to eradicate the disease from the grower's own place and from the entire neighborhood. No one should try to eradicate the disease himself until he finds out from a reliable source just how to do it. Because of the extremely contagious nature of the disease, ignorant efforts can easily result in spreading it instead of checking it.

Fire blight is caused by bacteria of a particular kind. It may be recognized in general by the wilting and dying of blossoms, spurs, twigs, and branches. The dead foliage clings to the twigs, turning black in the case of the pear, brownish in the apple. The bark invaded by the bacteria also turns dark colored. When the disease is very active, bacteria ooze out of the affected parts in pearly drops that contain millions of individuals. This ooze is attractive to insects, which become contaminated with the germs and easily spread disease. The exudiation also may be washed by rains or spattered onto foliage and green shoots and start new infections in this way.

The disease is carried over the winter in the margins of dead areas known as hold-over cankers. In the early spring the bacteria become active in these cankers. From these sources fireblight is carried by insects, birds, etc., to the blossoms or other healthy parts, thus producing new infections that develop rapidly. The disease is often spread by unsterilized pruning tools. Any part of the tree may be attacked. It usually begins in the spring as a blossom blight. Later twig blight and blight cankers make their appearance. Water sprouts are very susceptible and the blight makes its way rapidly down such shoots to the trunk or roots where body blight, collar rot, and root blight may develop with the most serious consequences.

The season of the most rapid development of fireblight corresponds with the season of most active growth of the tree, and warm, moist conditions which accelerate tree growth also favor the increase of the disease. In general, the healthiest and most vigorous trees suffer the most severe effects. In addition to the apple and pear, quinces are very susceptible. Native pomaceous trees such as wild crab, hawthorne and service berry are also attacked.

Control. The only successful method of fighting fire blight, whether in a single orchard or in an entire community, is by removing the diseased parts or tissues from affected trees as rapidly as infections are discovered, and by cutting out all hold-over cankers. In the fall and winter the trees should be gone over and inspected, branch by branch and limb by limb and all dead parts cut out and the wounds sterilized. This eradication of hold-overs is of tremendous importance and where thoroughly done is of immense benefit. Later, as the disease makes its appearance during the growing season, active efforts should be taken to detect and eradicate every new case. In cutting during the most active period, the bark should be removed or the branch cut back from one to two feet below the point of lowest evident discoloration. If the outbreak is serious, such methods should be adopted in the orchard as will check the growth of the trees and thus tend to check the rapidity of the advance of the disease.

All wounds should be sterilized with a 1 to 1000 solution of corrosive sublimate (bichloride of mercury.) This material can be secured at any drug store with directions for preparing the proper strength. It will attack metals and therefore should be kept in clean wooden or glass containers only. The material is a deadly poison and should be so labelled. Keep a sponge or cloth soaked in the solution and wash the surface of every wound. The cutting and pruning instruments ought to be disinfected after each cut. Do not use the solution after it has become dirty, and keep the sponge freshly wet while it is being used. Brush and bark removed from trees should be burned at once and not left on the ground to attract insects.

Growers who are expecting to plant pears in the future will do well to secure information in regard to the fire-blight resistant pear stocks which have been under investigation by Prof. F. C. Reimer of the Southern Oregon Experiment Station, at Talent, Oregon. Professor

Reimer has made some very important and very encouraging discoveries in this connection which will be of immense value to the future pear industry. Inquiries may be addressed to Professor Reimer himself or to the Oregon Agricultural College at Corvallis.

PEACHES

1. **The Dormant Spray.** To be applied at least one or two weeks before the buds begin to open. (February for most parts of Oregon).

For peach leaf curl and San Jose scale.

Use Lime-sulfur 1 to 8. If no scale is present Bordeaux 6-6-50 will be effective.

Infections of peach leaf curl take place just as the leaves are emerging. A single spray will control the disease if applied before the buds begin to come out. To be effective the fungicide must cover every bud.

2. **Late Dormant Spray.** To be applied just as the first buds begin to open in the spring.

For Peach-twig miner, aphis, red spider mite.

Use Lime-sulfur 1 to 12, plus nicotine sulfate (40%) 1 to 1200, (one pint to 150 gallons). Add arsenate of lead 3 to 100, (3 pounds paste to 100 gallons of dilute solution) if Bud Moth is present.

If aphis and red spider are not present omit the nicotine sulfate. This spray will probably be of some value for the control of powdery mildew and to some extent possibly for brown rot, but will usually be too late for peach-leaf curl.

3. **To Be Applied When the "Shucks" or Flower Parts Fall Off.** For peach blight, fruit spot and shot hole, for powdery mildew and brown rot.

Use self-boiled lime-sulfur 8-8-50.

Failure to control spring infections of peach blight is due largely to beginning too late. This is a very important application.

4. **To Be Applied Two Weeks Later.**

For peach blight fruit spot and leaf shot hole, brown rot, and mildew.

Use self-boiled lime-sulfur 8-8-50.

To protect the newly developing surfaces of the fruits, foliage and shoots against infection. Spray thoroughly. If season is rainy another application 2 or 3 weeks later would be beneficial.

5. **To Be Applied 1 Month Before Picking Fruit.**

For peach brown rot, mildew, bud moth and peach twig miner.

Use self-boiled lime-sulfur 8-8-50, plus lead arsenate 3 to 100.

As the fruit matures the danger of brown rot increases. This application is aimed to cover, thoroughly, all parts of the fruit for the last time before picking. This will also help to control peach blight in late varieties.

In Eastern Oregon the peach twig miner frequently attacks the nearly mature fruit causing it to bleed or gum profusely. This summer fruit injury appears to be confined to the eastern section of the state. The arsenate may therefore be omitted in Western Oregon unless the bud moth is serious.

6. **To Be Applied As Soon As the Fruit Is Picked.**

For peach blight.

Use Bordeaux mixture 4-4-50.

This spray is designed to protect the branches and buds from the first infections of the peach blight that occur as soon as the fall rains start. Cover all branches and buds thoroughly.

7. **To Be Applied About November First.**

For peach blight.

Use Bordeaux mixture 6-6-50.

This spray is given to insure adequate protection against the blight fungus through the late fall and early winter rains. It is the opinion of the Plant Pathologist that if the two fall sprayings were thoroughly applied in the manner recommended above, there would be little need for spring spraying for fruit spot and shot hole.

Peach Root Borers. On young trees, use repellant wash No. 1, (see p. 17). For older trees cut out borers and use paving asphaltum, grades "C" or "D." Write to the Experiment Station, Corvallis, Oregon, for directions.

PRUNES AND PLUMS

1. **Winter Treatment.** To be applied just as the winter buds are opening.

For San Jose Scale, red spider mite, twig miner, and aphis (for brown rot see below).

Use lime-sulfur 1 to 8, plus nicotine sulfate (40%) 1 to 1200 (one pint to 150 gallons).

If aphis and red spider are not present, omit nicotine.

This application will not be effective for the control of brown rot. During the late winter, however, all dead twigs and branches and all mummied fruits should be removed from the trees and burned to prevent infection from these sources when the buds come out. In the regular pruning work aim to let in plenty of light and air to the interior of the trees.

2. **To Be Applied Just Before the Blossoms Open.**

For brown rot, blossom and twig blight, and bud moth.

Use Bordeaux mixture 4-4-50 or lime-sulfur 1 to 30, plus arsenate of lead 3 to 100.

3. **To Be Applied 10 Days or Two Weeks After the Petals Fall.**

For brown rot and Coccomyces (Cylindrosporium) leaf spot or shot hole.

Use Bordeaux 4-4-50 or lime-sulfur 1 to 50.

A previous application for brown rot just after the petals drop would be of benefit, but for the sake of economy is not insisted upon. The use of a sticker with the Bordeaux would be desirable.

4. **To Be Applied Two or Three Weeks After the Preceding.**

For leaf spot and brown rot.

Use Bordeaux 4-4-50, or lime-sulfur 1 to 50 or self boiled lime-sulfur 8-8-50.

Drenching should be avoided but all parts, upper and lower, of foliage and fruit should be covered with a fine mist. Use a sticker with Bordeaux.

5. **To Be Applied One Month Before Picking.**

For brown rot (bud moth).

Use Bordeaux 4-4-50 with sticker.

(Omit sticker and add arsenate of lead 3 to 100 if bud moth is serious).

This is the most important application of all for the control of the brown rot as it is designed to protect the fruit against the infections that usually occur in their most serious abundance as the fall rains come on and the fruit ripens. If any sprays have to be omitted do not omit this one. Use a fine mist with high pressure, and get a coating on all sides of the fruit. (To secure thorough protection against brown rot the trees ought to be sprayed about once a month through the summer, but it is not believed that the value of these extra summer applications has been sufficiently demonstrated under average Oregon conditions to warrant their general adoption at this time).

Brown Rot. Since the rotted prunes are a source of infection, some means for destroying them as rapidly as they fall should be employed. Not only do the infected prunes immediately produce a crop of spores able to infect still healthy fruit, but if not destroyed they will be able to discharge a new crop of spores from the buried or half buried mummies the second spring following. To allow them to stay on the ground is to make satisfactory arrangements for a future abundant infection. The only practical method that has been adopted in Oregon is that of allowing the hogs to run in the orchard and clean up the rotting fruit. A half dozen animals in a large orchard, however, will soon become glutted with the fruits and will not devour the flesh, which is the part that carries the fungus. Enough hogs must be provided to clean up flesh and all.

Bud Weevil. Often attack young trees, particularly when near uncleared areas. They sometimes do serious injury to grafts that are just starting well. Jar insects from tree and apply belt of tanglefoot around trunk about 15 inches above surface of soil.

Root Borer. See under Peach.

Internal Browning. In many prune-growing sections of Oregon in certain seasons there occurs a great deal of injury to the fruit from the softening and browning of the flesh commencing around the pit and often accompanied by more or less shrinking of the prune. This condition is not caused by the presence of any parasite, is not infectious, and cannot be prevented or controlled by spraying. It is an effect due probably to unfavorable climatic and soil relations as well as to the condition of the trees during the ripening period. No satisfactory control method has been worked out. During the season of 1915 this trouble was exceedingly common and serious and was wrongly called "brown rot" by many growers and shippers, a fact which resulted in confusing this with the fungus disease correctly known as brown rot.

CHERRIES

1. **The Dormant Spray.** To be applied just as the winter buds are opening.

For San Jose scale, aphis, and red spider.

Use lime-sulfur, 1 to 8, plus nicotine sulfate (40%) 1 to 1200 (1 pint to 150 gallons); plus lead arsenate 3 to 100. (3 pounds of paste to 100 gallons of dilute spray solution).

Apply tanglefoot in a band around the trunk to prevent ants from carrying the aphis up the tree.

2. **To Be Applied Just Before the Blossoms Open.**

For brown rot, Bud Moth and Fruit-tree leaf Syneta.

Use Bordeaux 4-4-50 or lime-sulfur 1 to 30 plus arsenate of lead 3 to 100. Nicotine sulfate (40%) should be added if aphids are bad.

3. **To Be Applied About 10 Days or 2 Weeks After the Petals Fall.**

For brown rot, Coccomyces (Cylindrosporium) leaf spot and cherry slug.

Use Bordeaux 4-4-50 or lime-sulfur 1 to 50, plus lead arsenate 3 to 100.

Where brown rot is bad an additional previous spraying just after the petals fall would doubtless be beneficial.

4. **To Be Applied About 2 or 3 Weeks After the Preceding.**

For brown rot and leaf spot.

Use Bordeaux 4-4-50 or lime-sulfur 1 to 50.

5. **August Spray.** To be applied about August 1 to 10.

For bud moth and slug where these pests are serious.

Use lead arsenate 3 to 100.

Bacterial Gummosis of Cherry. This disease is common in the Western Oregon cherry growing sections and seriously affects young plantings particularly from their third to sixth or seventh years, but does not often produce serious results on older trees. All the common commercial varieties of sweet cherries are affected to a greater or less extent. The sour cherries and the Duke cherries, however, are affected very little or not at all.

The disease is caused by bacteria. The infections are believed to take place in the late fall and early winter through the agency of sucking insects. The bacteria spread gradually through the tissues during the winter but their effect is usually not noticeable until spring. The disease results in a blighting of buds and spurs and in the formation of dead spots on the branches and trunks of large or small size. Where the trunk or limbs are completely girdled by the bacteria the parts above the girdled point die. This dying may take place during the winter, the buds barely opening in the early spring then withering, or it may not make its appearance until late in the spring. Where young trees are completely girdled, there is, as a rule, little gum exuded. Where the cankers do not girdle, a copious exudation of gum usually takes place

during the spring at the margins of the dead area. Gum also exudes from the blighted spurs and buds. The advance of the bacteria in the tissues ceases as soon as the tree resumes active growth again in the spring, and a callus begins to form around the margins of the dead spots. Gumming starts. The dead bark then flattens down and the canker appears as a sunken area. The loss from this disease is serious and growers should adopt the necessary means for keeping it under control.

Control. After an orchard is already set out there is nothing that can be done to check the disease except the careful and complete removal of the diseased bark as soon as cankers are discovered. The same methods should be adopted as recommended for fire blight control. The hold-over cankers, however, should all be removed before autumn, if possible in the spring, as there is then a greater chance of rapid healing. The wounds after sterilization should be coated with a good paint to prevent heart rot, and these areas should be re-painted as often as necessary to keep a complete protection over the wood.

Prevention. It has been found that practically all so-called Mazzard seedlings are resistant to this disease and it has been proved that to set out Mazzard seedlings, or similar, vigorous, resistant, sweet cherry seedlings, and after two or more years to graft or bud the desired commercial variety onto the limbs is a successful method of avoiding serious consequences from the disease. The danger of girdling trunks and limbs is eliminated and the amount of bacterial gummosis appearing in the tops is much reduced. Among the commercial varieties commonly grown in Oregon, the Lambert is more resistant than the Royal Ann or Bing but is by no means free from the disease.

Shot Hole Borer. This small borer attacks practically all of our fruit trees. It is particularly serious on the cherry, prune, and peach. The pest never attacks healthy, vigorous trees. Keep trees in vigorous growing condition by proper cultivation and drainage. Where the pest occurs, cut out seriously affected limbs or trees and burn. Paint slightly infested portions with Deterrent Wash No. 2. Apply in late March and repeat at 3 week intervals until the pest is checked.

INSECTICIDES.

Materials which kill insects or which deter the insect from attacking plants are termed insecticides. There are two general types of insecticides:

1. **Arsenical Poisons,** to be applied to the foliage and fruit. Poisons are for insects which devour foliage or chew their food. Example—caterpillars.

2. **Contact Insecticides** for soft-bodied insects which suck their food through a beak. Insects of this type generally insert the beak inside the tissue of the plant and suck out the juice from within. No poison applied to the exterior of the plant would materially affect them. Contact insecticides, to be effective, must actually wet the insect. Example—plant lice.

ARSENICAL POISONS

Arsenate of lead is the standard arsenical poison spray for the control of insect pests. The majority of the commercial arsenates of lead are good; they conform to the standard as required by law; have a low percentage of water soluble arsenic; and are very satisfactory for all general spray work.

From a chemical standpoint, two forms or types of lead arsenate are recognized. These are known respectively as the basic lead arsenate, (neutral arsenate), or triplumbic and the lead hydrogen arsenate, (acid arsenate), or diplumbic. Careful studies of these materials in a chemically pure state reveal certain properties which are worthy of brief mention. The triplumbic arsenate is of a very granular consistency, does not stay in suspension well and kills comparatively slowly. It is more stable and probably safer to use in combination and there is less likelihood of burn to tender foliage from its use. The diplumbic arsenate is of a fluffy consistency, stays in suspension well and kills much more quickly than does the triplumbic. Theoretically there is an element of danger with it when used in combination, and probably it is not so safe to use on tender foliage.

Due to rather haphazard methods of manufacture, the average commercial lead arsenate is probably never wholly one form or the other, but a combination of the two. Probably no two commercial brands run exactly alike nor will various samples of a particular brand run precisely uniform at all times. This variation, however, is not generally sufficient to be of especial moment. Some commercial brands are particularly high in diplumbic lead arsenate and ordinarily prove very satisfactory. Basic or neutral brands are high in triplumbic lead arsenate and are undoubtedly the safer to use where there is strong tendency to spray burn. It has been our experience and observation, however, that in spite of the seeming differences, under average orchard conditions almost any standard commercial arsenate of lead, either alone or in combination, will prove entirely efficient and satisfactory.

Arsenate of lead is prepared in both the paste form and as a powder. Both are equally effective in the control of insect pests. The proportions recommended in this bulletin are figured on the basis of the paste form. In case the powdered arsenate of lead is employed use only one-half as much as recommended.

Use. Arsenate of lead may be used alone for the control of leaf-eating insects, codling-moth, etc. It may be combined with the following materials and used with reasonable safety on apple foliage; lime-sulfur, Bordeaux or iron sulfide, where it is desirable to combat both a fungous trouble and insects. It may be combined with nicotine sulfate solutions or with kerosene emulsion when it is desired to treat both sucking insects and chewing insects. Combinations of lead arsenate, lime-sulfur or Bordeaux and a nicotine sulfate solution, may be used where desirable.

The combination of lead arsenate and soap; lead arsenate, Bordeaux, and resin sticker; lead arsenate, soap, and lime-sulfur; or lead arsenate, kerosene emulsion, and lime-sulfur, are not advisable on apple foliage, owing to the likelihood of severe foliage injury.

In preparing the arsenate of lead either powder or paste for the spray tank, first make up as a thin paste and add to partly filled tank or place in bowl of strainer and wash into tank with hose, having agitator in motion. The arsenate should never be placed in the spray tank first nor added in the undiluted bulk form.

CONTACT INSECTICIDES.

Lime-sulfur is the standard spray for the control of San Jose and oyster-shell scale. It also has insecticidal properties when used against the peach-twig miner, the red spider, or spider mites, and probably to a lesser extent against other scale insects and hatching plant lice. For a general discussion of this spray see page 20.

Commercial Nicotine Sulfate sprays have the advantage of being easily prepared and do not burn foliage. They generally run about 40% nicotine, a concentration which permits of high dilutions. They are very effective against plant lice, etc., at dilutions ranging from 1 to 1000 to 1 to 2000. They may be used with fish-oil soap or whale-oil soap and water or with dilute spray solutions of lime-sulfur or Bordeaux. For use with lead arsenate see above.

Miscible Oil Emulsions are commercial preparations in which the emulsifier is incorporated in the oil during the manufacture. They represent our highest type of oil-emulsion spray. They have a remarkable power of penetration, tend to spread out evenly over a sprayed surface, and give effective control where an oil spray is desired.

Kerosene Emulsion is usually prepared as a stock solution and then diluted, as used, to the desired strength for spraying.

Whale-oil soap	½ pound
Water	1 gallon
Kerosene	2 gallons

Dissolve the soap in the boiling water. Remove from the fire and add the kerosene, stirring vigorously. The solution must now be agitated until it assumes a thick, creamy, consistency that does not separate on cooling. This condition is most readily brought about by the use of a small bucket pump, forcing the solution through the hose and back into the container.

About a 7 percent solution will serve for most ordinary soft-bodied insects. In some cases a heavier dosage is necessary and in a few cases a weaker dilution is advisable. The following dilutions will probably serve all ordinary purposes. The figures are given on the basis of 1 gallon of the stock solution.

To obtain 4 percent solution, add 15⅔ gallons of water.

To obtain 7 percent solution, add 8½ gallons of water.

To obtain 12 percent solution, add 4½ gallons of water.

To obtain 15 percent solution, add 3½ gallons of water.

Kerosene emulsion is particularly effective against the aerial form of the woolly aphis and when properly prepared is a very effective contact insecticide.

Summer applications of oil sprays are best applied on bright sunny days when there is a slight breeze blowing.

For combinations see under lead arsenate above.

Crude-Oil Emulsions and Distillate-Oil Emulsions may be prepared at home. They are used in much the same way as the emulsions discussed above. They are probably a little more difficult to prepare and the possibility of foliage injury may be slightly greater. Write the Oregon Experiment Station, Corvallis, Oregon, for directions on preparation.

White Hellebore, Pyrethum, or Buhach are insect powders usually carried in stock by druggists. They may be used either in the powdered form or combined with water to control insects on foliage where, because of nearly mature fruit, the use of a poison is undesirable. When used as a spray employ one ounce in 3 to 5 gallons of water. Effective against the pear and cherry slug and against the native green currant or gooseberry worm, which defoliates the bushes.

Deterrent Washes:

No. 1. For Borers.

Soft soda soap	10 gallons
Crude Carbolic acid	1 pint

The soft soap is thinned to the consistency of thick paint by the addition of a strong solution of washing soda. This combination constitutes the soft-soda soap used with the crude carbolic acid.

No. 2. For Shot-hole Borer.

Water	3 gallons
Soft soap	1 gallon
Crude carbolic acid	½ pint

Mix and paint over infested portions of the tree with a brush.

FUNGICIDES.

Fungicides are in reality preventives. They cannot cure an injury that is already produced, nor stop the progress on an infection after the fungus has entered the tissues of the plant. Fungicides must be so applied that the tree and its foliage and fruit are protected at the time when infections would naturally take place, and every bit of exposed surface must be covered if perfect protection is to be secured.

BORDEAUX MIXTURE.

This fungicide has been for a long time the most widely used material for controlling fungous diseases of plants. It is now being supplanted to a considerable extent by lime-sulfur and other materials,

although for certain diseases Bordeaux is still the most efficient and safest preventive known.

Bordeaux Mixture is a combination of copper sulfate (bluestone) and lime. For winter use it is generally made up in what is known as the

6-6-50 Formula

6 lbs. bluestone (copper sulfate)
6 lbs. stone lime (best grade)
50 gals. water

For trees in leaf it is often made up in the

4-4-50 Formula

4 lbs. blue stone (copper sulfate)
4 lbs. stone lime (best grade)
50 gallons water.

Other proportions are also frequently used.

Manufacture. It is of great importance that Bordeaux mixture be properly prepared. It must be made up fresh each time it is to be used. Stock solutions of bluestone alone or of lime alone may kept almost indefinitely, but the mixed lime and bluestone solutions rapidly deteriorate on standing. The barrels or tanks in which Bordeaux mixture is made up and the container for the stock solution of copper sulfate should always be of wood, since the copper will attack and destroy iron. On this account it is well to have wooden hoops on the barrels. The stone lime used should be of the best quality.

Stock Solutions. .If large quantities are used, it is best to prepare stock solutions which contain one or two pounds of the bluestone or lime respectively for each gallon of water. For example, take a 50-gallon barrel of water and suspend near the top a coarse sack containing 50 pounds of bluestone. After a few hours it will have dissolved. Take also 50 pounds of quick lime and slake carefully with constant stirring and the addition of water as needed to prevent it from becoming dry and "burning." When thoroughly slaked, add water to make up to 50 gallons. These stock solutions then contain each 1 pound of the original material to 1 gallon of water. If kept for a long time the stock solutions may lose volume by evaporation. This should be made up with water before using.

Methods. The Bordeaux mixture may be made in a satisfactory manner by several different methods, but the two concentrated solutions should never on any account be mixed together without dilution. The following method will be found to give good results, using the "1 pound to the gallon" stock solutions mentioned above. The quantities given here will make 50 gallons of the common 4-4-50 formula. If a stronger or weaker solution is desired, the quantities of the stock solutions should be increased or decreased to correspond. Larger or smaller amounts may be made up, of course, using the same proportions.

1. Take four gallons of the stock copper-sulfate solution and add 21 gallons of water.

2. Stir up the stock solution of milk of lime thoroughly, take four gallons of this and add 21 gallons of water.

3. Pour the two together slowly through strainer into tank or barrel stirring thoroughly or pour one into the other stirring thoroughly.

It is often convenient to prepare the two solutions on an elevated platform and to run them simultaneously from the dilution tanks directly into the spray tank.

Cautions. The spray tank or barrel should be rinsed free from all dirt and foreign particles before putting in the spray material; and the spray mixture before going into the spray tank must be strained through a strainer of copper wire, 20 meshes to the inch. This is very important. Always use brass or bronze spray rods or connections, since Bordeaux will attack iron. Always rinse out spray tank, hose, and rod with clean water after using. Before using, test the Bordeaux with red litmus paper secured from the druggist. If the solution is correct, it will have an excess of lime and the litmus paper will turn blue. If it does not turn blue, add more milk of lime to the solution till it gives the right color. The formulae given in this bulletin call for an excess of lime so that there is little danger of excess of copper unless the lime is of very poor quality. Where the lime is insufficient, the uncombined bluestone is injurious to fruit and leaves.

Bordeaux Injury. This material often causes severe russetting of apple fruit, if applied while the fruit is young, particularly when the application is followed by rainy spells. When the fruit and foliage are more mature, it can be safely used in late sprayings. In the early part of the season, however, lime-sulfur will control fungi with much less danger of injury. Bordeaux is generally considered throughout the country to be very dangerous for stone-fruit foliage. Oregon growers, however, have sometimes used it on peach and prune foliage with no apparent ill effect.

Combinations. Bordeaux may be combined without detriment with arsenate of lead and with nicotine sulfate preparations. The spreading and adhesive qualities of the fungicide may be increased by adding some form of soap "sticker", but no soap of any sort can safely be added to a solution containing arsenate of lead.

Resin Fish-Oil Sticker. In spraying fruits and foliage with a very smooth or waxy skin, it is often of great advantage to add some material which will increase the spreading and adhesive qualities of the spray. The following formula will give good results.

Resin Fish-Oil Sticker

Resin	5 pounds
Potash lye	1 pound
Fish Oil	1 pint
Water	5 gallons

Place the oil and resin in a large iron kettle and heat until the resin is dissolved. Remove from fire and cool somewhat to prevent sputtering and boiling over when the lye is added. The lye should be dissolved in a little water and the solution added slowly with stirring to the resin-oil mixture. Place again over the fire, add the required amount of water and boil for an hour or more until the sticker will mix perfectly with cold water forming an amber-colored solution.

Use two pounds with fifty gallons of dilute spray. This sticker cannot be used with ordinary lime-sulfur because of the chemical reaction which takes place. It is used with excellent effect with Bordeaux mixture and would probably be of value when added to self-boiled lime-sulfur or Atomic Sulfur.

The Jas. Goode Company of Philadelphia place on the market a resin-fish-oil soap which has given excellent results.

BURGUNDY MIXTURE.

This material is sometimes used in place of Bordeaux in sprays given shortly before picking, because it does not leave the objectionable deposit on the fruit which comes from applying Bordeaux at such a time. The effective principle is copper as in the Bordeaux. It has not been tried out extensively in Oregon, but has been used on apples just before picking without any apparent injury and has been successfully employed on loganberries for the control of cane fruit anthracnose.

Preparation. It is prepared in much the same manner as Bordeaux by dissolving the two chemicals separately and then combining the dilute solutions. The following formula is commonly used:

Burgundy Mixture.

2 lbs. blue stone (copper sulfate)
3 lbs. sal soda (sodium carbonate)
100 gals. water.

LIME-SULFUR.

This material has in recent years come to take the place of Bordeaux mixture and other fungicides for the control of many plant diseases. Its effectiveness as an insecticide against San Jose scale gives it an added advantage. It is a combination of lime and sulfur, manufactured in concentrated form, and diluted with water to various strengths for various purposes. Like Bordeaux, this material under certain conditions, has drawbacks which must be taken into consideration.

Commercial Concentrated Lime-Sulfur. This material is now made and sold in large quantities by many reliable firms in this state and elsewhere. The commercial solutions are usually fully equal to, if not superior to, the average homemade lime-sulfur.

Unless a grower has a large acreage or unless several growers can combine and make lime-sulfur for all at one plant, it is usually more economical to purchase the commercial article. Taking into considera-

tion the cost of materials, equipment, time, and labor, it may be said that the cost of making lime-sulfur in small quantities on the farm will generally be considerably greater than the cost of the commercial article at prevailing prices.

How to Make Lime-Sulfur. Lime-sulfur may be prepared by boiling the materials over an open fire, but this method is less satisfactory and uniform in its results than that in which live steam under pressure is used in the boiling process.

Chemist H. V. Tartar, of the Oregon Agricultural Experiment Station, after testing various ways of making this material, recommends the following method as one which if carefully followed will give a practically uniform product of high quality, testing just about 30° Baume. "Take 110 lbs. of good quality stone lime and slake it. Then take 220 lbs. of finely ground sulfur, sifted to remove lumps, and mix carefully with a little water until a rather thick, but smooth, paste is secured. Add the sulfur paste to the slaked lime in the vat or cooker. Then add water to make the volume of the mixture 108 gallons. Turn in the steam. Sufficient steam pressure should be provided to bring the material to a boil in about 20 minutes. If much longer is required the condensing steam will dilute the solution too much. To insure complete combination of the sulfur and lime the material should be thoroughly agitated through the whole of the cooking. After it has reached an active boil, allow the mixture to continue boiling vigorously for 30 or 35 minutes. Never boil more than 35 or 40 minutes, as changes begin to occur that will reduce the test of the solution. The solution should be allowed to cool as rapidly as possible. After the sediment is allowed to settle, the supernatant liquid is drawn off. This should give about 85 gallons of concentrated lime-sulfur solution testing about 30° Baume. The cooking vat should never be filled more than two-thirds full, since the mixture will seethe up a great deal while the chemical action is going on. In making up lime-sulfur in larger or smaller quantities, the same proportions of lime and sulfur and water should, of course, be used."

Where the cooking is done in a fifty-gallon barrel or kettle the formula given below gives about the quantities desirable:

Lime-Sulfur

30 lbs. good quality stone lime
60 lbs. finely ground sulfur
Water sufficient to make 30 gallons.

If prepared in kettle with fire beneath, the volume should be increased to about 35 gallons at the start to allow for evaporation.

Dilution. The grower who makes his own lime-sulfur should always secure from the druggist a Baume acid scale hydrometer to test his stock solutions. Otherwise he will have no idea as to the correct amount of water to use in diluting for use in spraying. The commercial solutions have the strength marked on the barrel. The following table shows the

number of gallons of water to use for the usual winter or dormant strength and for the average summer or foliage strength with each gallon of concentrated lime-sulfur ranging in test from 25° to 35° Baume. Peaches should not be sprayed with lime-sulfur of any strength when leaves are out.

LIME-SULFUR DILUTION TABLE.

Hydrometer test of Concentrated Solution	The Number of **Gals. of Water** to **One Gal.** of Concentrated Solution	
	Winter Strength	Summer Strength
35	9	45
34	8 ¾	43
33	8 ¼	41
32	8	40
31	7 ½	38
30	7 ¼	36
29	7	35
28	6 ½	33
27	6 ¼	32
26	6	30
25	5 ½	29

The different proportions of lime-sulfur recommended in this bulletin for the various spray dilutions, are based on the use of a concentrated solution testing approximately 32° Baume. If the stock solution tests weaker or stronger than this, the amount of water used to dilute should vary accordingly.

Injury. Lime-sulfur even in very dilute form is liable to injure peach foliage severely. Under certain conditions prune fruit and foliage have also been injured by it. Even apple fruit and foliage often suffer, particularly in the late spring when very hot weather occurs. The reasons for the injury are not clear, but the use of lime-sulfur should, if possible, be avoided for the late apple-scab sprays, especially in sections where spells of extremely hot weather are likely to occur. If the fruit is sufficiently developed, Bordeaux may be substituted and such materials as Atomic Sulfur may prove to be satisfactory if certain precautions are observed. Self-boiled lime-sulfur also ought to be harmless and of some value as a substitute.

Combinations. Lime-sulfur may be combined without detriment with nicotine-sulfate preparations to control plant lice and with arsenate of lead for codling-moth and foliage-eating insects, or with both nicotine and arsenate together. It cannot be used safely with a soap or resin sticker.

SELF-BOILED LIME-SULFUR.

This material was devised as a substitute for the ordinary fungicides, which, if used on peaches and other stone fruits in foliage, are likely to cause serious injury. It has been used successfully for the control of brown rot and other diseases of stone fruits without injury. It is a mix-

ture of sulfur and lime with but very little chemical action occurring during its preparation. The formula most commonly recommended is the

8-8-50 Formula.

8 lbs. stone lime(best quality)
8 lbs. sulfur (finely ground)
50 gallons water.

Manufacture. It is most satisfactory to make up three or four times the formula at one time. Actively slaking quick lime should be used if possible.

1. Place the lime in a barrel and add enough water to start active slaking.

2. As soon as this begins, add the required amount of sulfur, after sifting it to break up lumps, or make a smooth paste of the sulfur and add to the lime.

3. Stir the mixture constantly and add water from time to time to prevent burning and to bring to the consistency of a thin paste. The slaking of the lime should boil the mixture actively for several minutes. As soon as the slaking is completed, which should not occupy more than 15 minutes, fill the barrel with cold water to prevent further boiling.

4. Strain through a sieve (20 meshes to the inch) into the spray tank, adding whatever water is necessary to bring up to the required volume. An efficient agitator must be used while spraying, because of the heavy sediment.

Combinations. Self-boiled lime-sulfur may be combined with arsenate of lead, and nicotine sulfate preparations.

ATOMIC SULFUR

This is a commercial preparation consisting of very finely divided sulfur mixed with organic materials and put on the market in the form of a paste. It is diluted before using. This material has not been fully tested under Oregon conditions, but experiments indicate that during the early part of the spring, when cool, cloudy weather is likely to prevail, it is not so effective as later on during warmer weather. It is intended to be used as a convenient substitute for self-boiled lime-sulfur or sulfur dust in controlling such diseases as brown rot and mildew on peaches and other stone fruits and mildew and scab on apples when the ordinary lime-sulfur is likely to cause injury.

Injury. Atomic sulfur seems generally to cause very little spray burn. It has been found, however, to bring about serious dropping of foliage at times when applied late in the spring on apple trees that had not received any application of this material previously. The late spring application, however, caused no defoliation on trees sprayed earlier in the season with this material. It must be stated that the use of Atomic sulfur in Oregon is still in the experimental stage.

Combinations. Safe with arsenate of lead and nicotine sulfate.

"IRON SULFIDE MIXTURE."

"Iron sulfide mixture" made according to Ballard's formula (U. S. Department of Agriculture, Bulletin No. 120) has been found very successful for the control of mildew alone on apples in California. A simplification of this method is suggested for Oregon growers who may wish to experiment with this material.

4 lbs. Iron sulfate (copperas).
1 gal. Lime-sulfur (33° Baume).
200 gal. water.

Dissolve the iron sulfate in a few gallons of water. Fill the spray tank with water, add the lime-sulfur and start the agitator. Add slowly the dissolved iron sulfate. A black precipitate will be formed. Enough lime-sulfur should be used to combine with all the iron sulfate.

DUST SPRAYING.

This method of controlling orchard diseases has not been tested out in Oregon up to the season of 1916. While there appear to be some possible advantages in this method, yet there are certain possible drawbacks to be reckoned with. Since this method of dealing with orchard pests has not been given sufficient practical demonstration in the United States, growers are urged to be cautious about substituting the dust method for the tested and tried methods of spraying until the fungicidal efficiency of the new method shall have been demonstrated beyond question by thorough tests under Oregon conditions, which, by the way, are distinctly unlike the conditions in any of the Eastern states.

SPRAYING MACHINERY.

By V. R. Gardner, Pomologist

The object of orchard spraying is to enable the fruit grower to obtain large quantities of high-grade fruit through the control of injurious insects and diseases. It constitutes one of the more important items of expense in cost of production; furthermore, it is one of the items of expense that cannot be eliminated or even very materially reduced, if the grower finds himself forced to economize. However, by being thoroughly acquainted with his particular conditions—with the prevalence of different insects and diseases in his orchard, with the susceptibility or resistance of his varieties to these insects and diseases—and by knowing what to apply and when to apply it for their control, he can often quite successfully handle the insect and disease problem with a smaller number of applications and with less waste of material than would otherwise be the case. By the use of spray machinery and spray machinery accessories of the type best adapted to his particular conditions, moreover, he may be able to reduce materially the cost of application. It is to some of the general principles pertaining to the adaptation of spray machinery of different types to particular orchard conditions that attention is here called.

Types of Outfits for Different-Sized Orchards.

Hand Outfits.

One of the questions most frequently asked regarding spray machinery is concerning the type of outfit most practicable for an orchard of a certain size.

Knapsack Outfits. There are many different kinds of knapsack outfits upon the market. Roughly, they may be divided into two main groups: (1) Outfits in which the spray material passes through the pump itself, as in the case of larger spraying outfits; (2) outfits in which no spray material passes through the pump, but the pump puts the spray material in the tank under air pressure. It cannot be said that all of the outfits of one type are superior or inferior to all the outfits of the other type; it may be stated, however, that in general the outfits of the second type are more satisfactory than those of the first type, and that they are coming into more general use. They are usually easier to operate and less apt to get out of repair. Knapsack spraying outfits are of greater value in the greenhouse, the vegetable garden, and the small-fruit plantation than in the orchard. For the first one or two years after the trees are set, however, a good knapsack outfit may be found the most economical type to use. Generally such young trees require little spraying. An occasional tree that may be troubled with caterpillars, mildew, or aphids may be easily sprayed by means of a knapsack outfit whose cost is less than the interest and depreciation on a power outfit that otherwise might be required.

Single-Action Barrel Pumps. There are a great many kinds of single-action barrel outfits on the market. These usually consist of a single-action pump mounted in a 50-gal. barrel. The pump cylinders vary from an inch and three-quarters to two and one-half inches in diameter. The plunger stroke varies from 3 to 5 inches in length. Most barrel outfits have some kind of an agitator, usually of the "paddle" type. The pump supplies one or two lines of hose and is equipped with a corresponding number of extension rods, cutoffs and nozzles. Outfits of this general type vary in price from twelve or fifteen dollars to twenty-five or thirty dollars complete. With the larger and stronger of these outfits it is possible to maintain a pressure of 80 to 100 pounds supplying two lines of hose and each line of hose discharging approximately a gallon of spray material a minute. With only one line of hose it is possible to maintain a pressure of 100 to 115 or 125 pounds, discharging approximately a gallon and a quarter a minute. The lighter and cheaper outfits of this general type are correspondingly less efficient. The larger and more powerful outfits are much to be preferred in practically all cases; for it is impossible to do very satisfactory work where a pressure of 80 or 90 pounds cannot be maintained. With a pressure of 80 or 90 to 110 or 120 pounds, however, efficient work can be done. This is far from stating that such pressures are as satisfactory as the higher pressures that can be maintained by power outfits. With a good barrel outfit it is possible to apply from 300 to 500 gallons of spray a day, assuming that only a reasonable amount of time is required to refill the barrel. This is sufficient for approximately 100 good-sized orchard trees that are in leaf, or for half again as many in the dormant state. Naturally the cost of application per gallon of spray is higher with an outfit of this type than with one of the larger power outfits, but it is the type of outfit that probably will be found most practicable for small home orchards and for commercial apple and pear orchards of from three to five acres. The orchard unit of some of our fruits, like prunes, cherries, and peaches, that may be economically sprayed with an outfit of this type is considerably larger—8 to 12 acres—because in general practice these fruits are sprayed less frequently than apples and pears.

Double-Acting Horizontal or Vertical Pumps. There outfits usually consist in a double-action horizontal or vertical pump with accessories. They are generally sold unmounted. The grower furnishes his own tank. The pump, together with hose, cut-offs, extension rods, and nozzles costs from $25 to $50. Generally, such pumps are capable of of hose that are each discharging approximately a gallon-and-a-quarter maintaining a pressure of 100 to 125 pounds when supplying two lines that are each discharging approximately a gallon-and-a-quarter to a gallon-and-a-half of spray a minute. Outfits of this type may be used with tanks of 100 to 200 gallon capacity. This affords them a distinct advantage over the barrel outfits. On the other hand, atten-

tion should be called to the fact that agitators are seldom provided with outfits of this type. This makes their use rather unsatisfactory with certain spray materials, like the self-boiled lime-sulfur, that are prone to settle out rapidly. Outfits of this type are practicable in apple and pear orchards of from six to eight acres in size, and for stone-fruit orchards of 10 to 20 acres.

POWER OUTFITS

For apple or pear orchards of 10 acres or more in size and for prune or peach orchards of 15 or 20 acres or more in size it is necessary, or at least desirable, to have some kind of power outfit. Though power outfits are considerably more costly than the hand-power outfits, they are much cheaper in operation. Power outfits may be grouped into three classes: those in which power is furnished by a gasoline engine, those in which it is furnished by compressed gas, and those in which the pump is geared to the wheel of the truck. Only the gasoline power outfit will be discussed in this article. The following points in connection with such outfits are worthy of separate consideration.

Tank Capacity. Power spraying outfits are usually provided with tanks holding from 100 to 200 gallons. Other conditions being favorable, the larger the tank the more satisfactory it will be. A considerable portion of the time spent with the spraying outfit is in going back and forth between the orchard and the filling station. Naturally the greater the tank capacity, the fewer such trips will have to be made. This saving in time means that the outfit will cover a larger orchard area within a given period, or that the grower is enabled to put an application upon a larger portion of his trees at the critical time, thereby more nearly realizing all the benefits that may be obtained from spraying. On very soft or very hilly land it is impracticable, of course, to use the larger-sized spray tanks. Perhaps in such cases 100- to 150-gallon capacity is most satisfactory.

The Pump. The pump of the power spraying machine should have ample capacity. For average orchard conditions it should be capable of delivering (depending upon whether one or two lines of hose are to be supplied) from three or four to five or seven gallons of spray material a minute at 175 to 225 pounds pressure, and it should be able to do this without being over-speeded. Attention is here called to the fact that the pumps of many spraying outfits are built to deliver from 12 to 15 gallons a minute at the pressure indicated, or at even a higher pressure. It is only under very exceptional conditions that anything like this latter capacity is required in orchard spraying work. This means that the grower who purchases very large pumps pays for a mechine that he seldom, if ever, uses to full, or even approximately full, capacity. Such an outfit requires more power to operate. This in turn means a larger, heavier, and more expensive engine, and a higher operating cost. This statement is far from recommending a pump of

very much upon his particular conditions; for instance, if his water supply is a pond or stream running through or close by his orchard and to which he must drive for filling, a tank filler is an almost indispensable part of his equipment. On the other hand, if the grower obtains his water supply from hydrants of a municipal or private water system the tank filler would be of very little use.

General Accessories. Hose. For each extension rod there should be a 25- to 35-foot run of hose. This enables the men who are doing the actual spraying work to move around the trees with the least possible trouble. Freedom of movement and efficiency is interfered with if the hose is too short. On the other hand, too much hose gives an added weight to drag about, is inclined to kink, and is in the way of the operator. With the high-working pressures now employed, it is necessary to have a high-grade hose. Only Regular 6- to 8-ply spray hose should be used with power outfits.

Extension Rods. The extension rod should be of bamboo with either aluminum or brass lining. The aluminum lined extension rod is lighter but it should be provided with brass couplings on each end with which to make connections with the cut-off at the base and the nozzle. The upper end of the extension rod should be provided with a drip guard to prevent any spray material from running down the extension rod and interfering with the work of the operator.

Cut-Offs. Each line of hose should be provided with a cut-off at the point where the hose is connected with the spraying outfit and at the other end where it is connected with the extension rod. In most cases the cut-off at the point where the hose is connected with the spraying outfit proper is a part of the equipment regularly supplied by the manufacturer of the spray outfit. Of no less importance however, is a cut-off at the base of the extension rod. This enables the operator to stop the flow of spray as he goes from tree to tree, and thus saves material.

Nozzles. The ideal nozzle throws a fine, mist-like, but at the same time, driving spray. When operating at 175 to 225 pounds pressure it delivers about a gallon and a quarter to a gallon and a half a minute. A nozzle of very much smaller capacity is apt to waste the time of the operator, as he must spend unnecessary time at one particular point in order thoroughly to cover the surface. A nozzle of very much larger capacity wastes material, for the average operator will not distribute more than a gallon and a half of spray material a minute and spread it on the trees evenly, so that there will be little or no drip. There are a number of different nozzles which meet, fairly satisfactorily, these requirements. Among these may be mentioned the Bordeaux nozzle, which throws a flat fan-shaped spray that may be fine or coarse, according as the nozzle is adjusted. Under ordinary conditions it should be adjusted so as throw about a gallon and a quarter to a gallon and a half a minute. There are also a number of the larger eddy-chamber

disc nozzles of the "Friend" type that are very satisfactory. There is no one best nozzle. Some kinds are best adapted for one purpose, other kinds for other purposes. In general, it may be said that the lower pressures maintained by the hand-power outfits, nozzles of ¾ gallon to 1¼ gallon a minute capacity are better than those of 1¼ to 1½ gallon capacity. If the nozzle is set at an angle of about 45° to the extension rods, more efficient work can be done and it will lighten the work of the operator.

GENERAL HINTS ON SPRAYING

Overhaul the Spray Pump and accessories and have them in first class shape before the spray season starts. Then at the end of each day's work clean out the pump and hose by pumping pure water through them. The insides will keep in better condition by adding a quart of machine oil to the water following the last day's spraying.

Have the Spray Materials on hand before the date for the spraying operations to commence.

The Angle Nozzle is a great aid in successful spraying. By this device the spray may be applied from all angles by simply tilting the spray rod, and all surfaces of leaves and fruit may be reached with much greater ease than where a straight nozzle is used.

Spray Thoroughly. Any part of fruit or foliage not covered by spray will be unprotected from attack. Reach the under sides of leaves. Do not drench, do not skimp. Use a good pressure and a nozzle that delivers a fine mist.

Hot, Bright Weather should be avoided for applying combined lime-sulfur and lead arsenate because of the burning that usually results under such conditions.

Spraying Adds to the Cost of production. It must pay for itself in an increased yield of high quality fruit. To accomplish this economically the grower must take the time and care necessary to acquaint himself with the nature of the troubles he will have to combat and with the most efficient methods for controlling them.

Economy in Spraying. It is not economy to devote time, money and attention to the production of a fine bearing orchard of choice varieties and then to lose a part or all of the profit on a crop through the omission of a necessary spraying. The most economical spraying program in the long run is the one that will result in the highest percentage of perfect fruit.

A Reduced Number of Applications cannot safely be given except when the peculiar climatic conditions of a district shorten the period of susceptibility to certain pests or diseases or when the fruit varieties grown are distinctly resistant to a particular trouble.

The General Recommendations appearing in this bulletin are adapted as far as possible to the conditions present in the principal fruit-growing sections of the state, but each grower must study the conditions in his own orchard, the diseases and pests which are prevalent there, and the influence of the climatic and weather conditions of his own locality upon them, in order to construct a spraying program to meet most perfectly his own particular needs. This will be especially true for the orchardists east of the Cascades, where climatic conditions are so entirely unlike those of Western Oregon fruit sections. In cases of doubt do not hesitate to consult the local fruit inspector or the county agriculturist or to write to the Agricultural College.

Information About Plant Diseases and Insect Pests, and their control will be gladly given by the College at all times. Specimens should accompany the inquiry whenever possible. In the case of insects, send specimens of both the injury and the insect. Wrap the material in a container which will not be crushed in the mails. Put your name and address somewhere on the package. In the accompanying letter tell us all you have noticed of the trouble, its first appearance, rapidity of spread and increase, extent of injury, etc. Address all communications to the Oregon Experiment Station, Corvallis, Oregon.