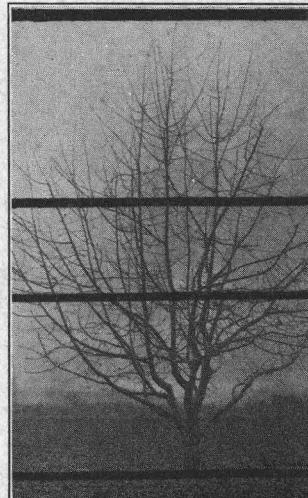


Oregon APPLE AND PEAR Spray Program

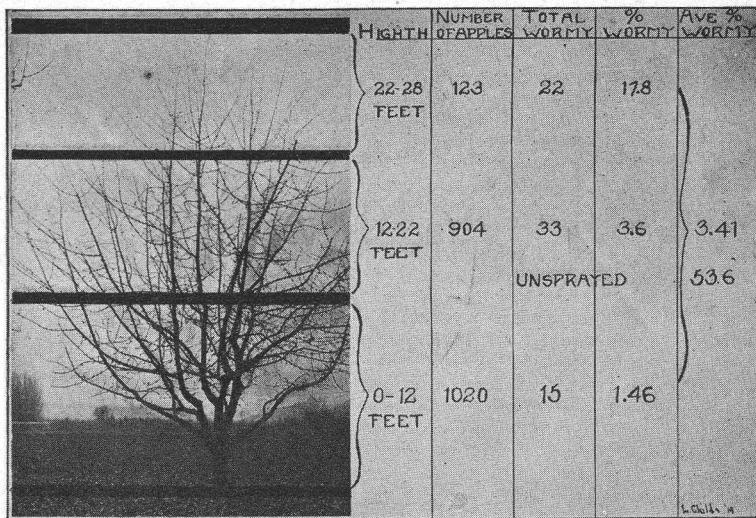


HIGHT FT.	TOT APPLES	TOT SCAB	% SCAB	TOT-AVE SCAB
15-26 FT.	2279 25.13 %	1042	45.72	
10-15 FT.	3587 39.56 %	800	22.31	22.52%
0-10 FT.	3201 35.29%	209	6.52	

Spray the top well for scab!

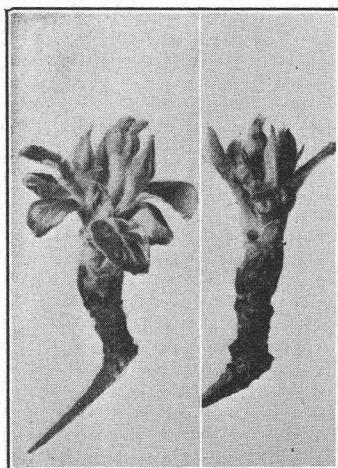
Distribution of scabby apples on an average sprayed tree. Note that the percentage of scab rapidly increases toward the top of the tree. Better scab control will be obtained if more attention is paid to spraying the top ten feet of the tree.

Oregon State System of Higher Education
Federal Cooperative Extension Service
Oregon State College
Corvallis

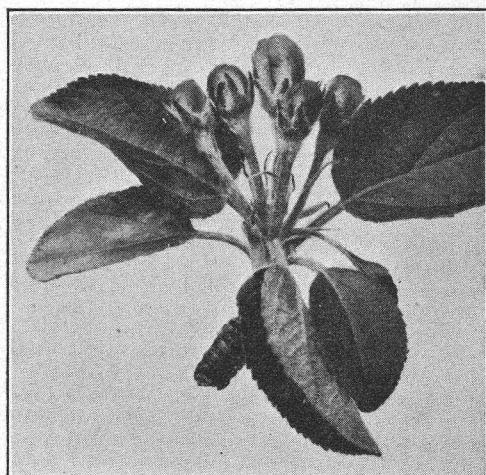


Spray the top well for worms!

Distribution of wormy apples in an experimental block sprayed with guns on a 3½-h.p. sprayer. Good control was obtained up to a height of 22 feet. Above this point worminess rapidly increases. The average worm control was good, but poor in the tops of the trees. A gun on a low-capacity outfit tends to slight the top of the tree.



"Prepink" stage. Winter buds just opening.



The "Pink" stage. Blossom buds just ready to open.

Clean fruit can be obtained only by thorough spraying at the right time.

APPLE AND PEAR Spray Program

The following staff members of the Experiment Station and Extension Service cooperated in formulating the recommendations given in this bulletin: W. S. Brown, Horticulturist; Leroy Childs, Superintendent of the Hood River Branch Experiment Station; H. F. Cline, Assistant County Agent, Umatilla County; C. B. Cordy, Assistant County Agent, Jackson County; L. G. Gentner, Associate Entomologist, Southern Oregon Branch Experiment Station; S. C. Jones, Assistant Entomologist; O. T. McWhorter, Extension Horticulturist; Don C. Mote, Entomologist in Charge; C. E. Owens, Plant Pathologist; R. H. Robinson, Chemist; B. G. Thompson, Associate Entomologist; S. M. Zeller, Plant Pathologist.

This bulletin deals with the control of insect pests and plant diseases that infest apples and pears grown in Oregon. It includes a description of each pest and suggests the spray material that will give best results under local conditions.

Infestations may vary in intensity each season depending on climatic conditions, degree of infestation the previous year, length of growing season, and other factors. Some districts and even orchards in the same district have heavier infestations than others. It is important therefore that the orchardist plan carefully the entire season's spray program, considering all pests that must receive spray treatment for economic control.

In recent years many new spray materials, spreaders, and deposit-forming stickers and spreaders have been developed. Most of them have been tested out in orchard experiments, but comparatively few have shown merit. The orchardist is warned against the use of these materials unless especially recommended for the locality.

Where an abnormally heavy infestation appears in an orchard, which may require a modified spray program different from the schedule outlined in this bulletin, it is suggested that the grower consult his county agent or local authority on procedure to follow. During recent years much fruit has been seriously damaged and the storage season shortened, because of the use of ill-advised spray programs that have made necessary the use of high temperatures in the washing solutions in order to accomplish proper residue removal. Many growers do not realize the seriousness of this problem because often they never see their fruit after it leaves the packing house.

For effective control it is important to observe the following precautions:

1. Spray thoroughly giving special attention to the top and interior of the trees, and wetting all portions.
2. Apply the different sprays at the proper time. For each codling moth spray, notifications are usually made in local newspapers. If not, consult your county agent.
3. Use adequate spray equipment and maintain a pressure to deliver preferably about 350 pounds at the nozzle.
4. Use the spray materials recommended and prepare carefully according to directions.

Insect Pests of Apple and Pear

Codling moth. This is the common pinkish-white worm found in apple and pear fruits. The spray program for codling moth is found on pages 15 and 16 of this bulletin. The following supplementary control measures are of value:

CHEMICALLY TREATED BANDS. The use of chemically treated bands placed around the tree trunks about June 1 is recommended where codling-moth control is a serious problem. To be effective, the loose bark should be scraped

from the larger branches and trunks to a distance of one or two inches below the ground line before placing the bands. If this is done during the winter or early spring, and the loose bark burned, many worms will be destroyed.

ORCHARD AND PACKING-SHED SANITATION. Coarse trash, such as boards, broken boxes, pruning wood, etc., on the ground in and near the orchard and around packing sheds should be removed and destroyed. Wherever possible, fruit containers should be placed in packing sheds and the packing sheds should be tightly closed during the spring and summer in order to prevent the many moths that emerge from reaching the orchard. The careful collection and destruction of wormy fruit at thinning time, the prompt destruction of windfalls during the summer and of all culls after harvest, and thorough steaming of orchard boxes will aid in reducing infestation and the carry-over for the following season. More attention should be given to the control of codling moth in abandoned orchards where it is a menace.

San Jose scale manifests itself as small, ash-gray or blackish pimple-like scales clustered on the bark. The bark usually shows a purple stain for a short distance around each scale especially on young trees and new growth. The trees become bark-bound and devitalized. Infested fruit shows bright-red spots. The pest seldom becomes serious in well-sprayed commercial orchards. Where present, the dormant spray of lime sulphur or oil is advisable.

Spider-mites. Several species of these mites, the European and red spider-mite, brown orchard mite, the common or two-spotted spider-mite, and Willamette mite attack Oregon orchards. The first two species overwinter in the egg stage on the tree. Lime sulphur 12 to 100, applied just before the buds open, is recommended for the control of these forms. A dormant spray of petroleum oil emulsion has given partial control of these two species. The common spider-mite, however, cannot be controlled by a dormant or delayed dormant spray since it migrates to the orchard from adjacent weeds and other plants later in the season. Summer sprays of oil emulsion or lime sulphur are recommended for the common spider-mite. A "summer" oil emulsion, 1 to 2 gallons to 100 gallons of water, is of value when used as a summer spray for spider-mite control. See page 12 for discussion of oil sprays. Dusting with sulphur is sometimes effective.

Pear slug occurs as a greenish-brown, slimy, slug-like larva, which skeletonizes the foliage of pear and cherry. Spray with lead arsenate, 2 pounds to 100 gallons, when insect appears.

Bud moth. This is a chocolate-brown worm $\frac{1}{8}$ inch long found inside a mass of webbed leaves at the tip of the twig. Attacks all fruit trees, but owing to arsenate sprays for other pests it is rarely serious.

Pear thrips. These tiny insects, about 1/20 inch long, come from the ground in the early spring (about March 15 to 20) as the buds are swelling and opening. These insects work into the buds before they open and in parts of western Oregon have caused serious bud injury. One pint nicotine sulphate plus $\frac{1}{2}$ pound of casein spreader to 100 gallons, added to the prepink and pink lime-sulphur sprays for scab, has given encouraging results.

Apple aphids. The degree of success obtained in apple-aphis control with the standard aphid spray of lime sulphur and nicotine in the prepink has not been in all cases satisfactory. Seasonal climatic conditions have a material

influence on the development and control of apple aphids. Under Hood River conditions the best time for application is from the "green tip" to the "early delayed dormant" stage of development of the tree. In the Willamette Valley best results are obtained usually when the spray is applied a few days previous to the "prepink" stage. An oil emulsion spray applied as indicated in Application No. 1 just as the eggs are hatching, which usually occurs just as the buds begin to show green, has proved effective.

Leaf rollers are small green caterpillars, which occur as a major pest only in our more northern and eastern fruit districts. Irregular cavities are chewed in the side of the young fruit. Oil emulsion in the early prepink (delayed dormant) is the standard control spray. Combining the oil with bordeaux 3-4-50 reduces danger of oil injury and aids in control of scab and anthracnose. Rain within four days to a week subsequent to the application may materially decrease the efficiency of the oil spray. Where conditions develop that prevent complete control being obtained from the oil application, and for very light infestations of leaf roller, use lead arsenate (4 to 100) in the pink and calyx sprays.

Pear and apple fruit worms. Two or more species of small green caterpillars attack the fruit from the time the fruit sets until it is the size of a walnut. Many injured fruits drop, but others mature as scarred and malformed fruit, typical examples of fruit-worm injury. These worms appear very early and feed promiscuously over the foliage before the fruit sets. Lead arsenate in the pink spray affords excellent control. The calyx application alone is not equally successful as it is too late for best results in control.

Pear- and apple-leaf blister mite. These microscopic mites produce small, bright-colored, slightly raised blisters on the leaves and young fruit. The blisters on the leaves turn brown to black with age. All indications show that the growers generally are not achieving the thoroughness of application essential to successful blister-mite control. Every bud in the tree must be covered with the spray for in these buds the mites overwinter. Wind renders effective spraying impossible. Lime sulphur, 12 to 100, applied any time in the spring before the buds begin to open, is the ideal application. The increasing abundance of blister mite on apples in some districts is serious. Although spring applications are very effective, fall applications of lime sulphur, 12 to 100, appear to give good results in blister-mite control on apples. Apply any time during winter after the majority of leaves fall.

Apple and Pear Diseases

Apple scab produces blackish spots on the fruit, turning brown and scabby with age, and on the leaves appears as blackish spots or dusky areas often brown in age. This is the most serious disease of fruits of the apple in Oregon. It is carried over on the old leaves of the season before. Therefore these leaves ought, if possible, to be plowed under before the buds burst. Winter or dormant sprays are of little advantage for this trouble. The early spring sprays are of utmost importance and a clean crop of fruit in western Oregon is practically impossible unless the "prepink," "pink," "calyx," and "first cover" sprays are given at the proper times. With highly susceptible varieties like Newtown the "second cover" spray can rarely be omitted with safety in the moister sections of the state. The leaves as well as the fruit must be covered.

Pear scab is very similar in appearance to apple scab. The disease overwinters, however, in lesions on new-twigs growth. Recent investigations conducted at Hood River indicate that these twig infections are the major source of carry-over from one season to the next, as well as a source of seasonal infection. Unlike apple scab, a late dormant application of lime sulphur has been found materially to reduce spore development and thus to assist in the reduction of infection. Only after several seasons of careful spraying can the full measure of scab control be attained on very susceptible varieties where infection has become severe. Noncaustic-sulphur sprays must be used in place of ordinary lime sulphur on tender-skinned sorts, like Anjou and Comice. These sprays are not as active as lime sulphur and a complete coverage must be maintained as long as rains continue in the spring. In badly infected orchards at least four or five sprays will be found necessary. It is desirable to apply the dormant spray for scab control as late as possible to reduce spore development, which takes place on carry-over cankers on the shoot growth produced last year. It must be remembered that russetting will result if this late dormant spray is applied after the bud scales have loosened to the extent that the young pears are exposed to the spray.

Powdery mildew appears as a powdery white coating on shoots and leaves. This is serious on certain varieties of apples like the Jonathan, Grimes, and Rome and causes much russetting of Anjou and some other varieties of pears. The disease winters over in the buds. All mildewed twigs that can be discovered should be pruned out during the dormant season. The most troublesome effects on the fruit arise from the attacks that come early in the season as the fruit buds are developing and opening. The most effective applications are, therefore, the "prepink" and the "pink." Later sprays will keep the foliage clean, and when these are combined with systematic pruning of the white mildewed shoots that appear, there will be a noticeable reduction in the mildew infection the following season. Dusting sulphur properly applied in warm weather gives excellent results against mildew.

Fire blight has not been successfully controlled except by surgical methods. Send for Circular of Information 112.

Anthracnose canker and fruit rot. This causes elliptical dead spots on bark and circular slow-growing rot spots on fruit after fall rains and in storage. It may be prevented successfully by a single thorough summer application of bordeaux mixture 3-3-50, except in areas of heavy rainfall where 4-4-50 should be used. It is best combined with the last arsenate spray for worms in August. A thorough application should be made. In seasons of early fall rains the presence of spray on light-colored varieties may cause some reddish spotting around the lenticels. Such fruit should be picked as early as possible. In orchards that are badly infected the anthracnose fruit rot as well as the canker will be materially decreased by the late bordeaux spray. The residue is readily removed by the acid washing process.

To avoid the presence of bordeaux on the fruit, some growers do not give the summer application. They are using instead a bordeaux application for both scab and anthracnose in the "prepink" spray, or where oil is used against leaf roller, in the leaf-roller spray. With the addition of bordeaux both miscible and quick-breaking oils can be used with much less injury to buds and advanced foliage. This spring application of bordeaux must be put on before the fruit buds are much exposed or the fruit may be russeted. The spray must be carefully made and thoroughly applied as it must stay on the trees until

fall at which time it becomes effective in controlling anthracnose. Since the spring spray at best will not protect either fruit or new shoot growth it is not recommended in place of the summer spray unless the disease is already well under control. (See Circular 73, Oregon Agricultural Experiment Station.)

Perennial canker and fruit rot. This serious wound disease of apples occurs in the Hood River Valley and in localities east of the Cascades. It causes dying back of bark around pruning cuts and other wounds made while the trees are dormant and especially around calluses previously attacked by woolly aphid. The killing back of tissue is most extensive in years when extreme low temperatures come early in the winter and is insignificant in years when winters are mild. Successive advances about original infection centers give the impression that this disease is perennial, which is not strictly true. These infections result, however, in large open wounds showing a series of concentric dead calluses. Following fall rains, the fungus associated with the disease also causes serious rot infection of fruit which shows up in storage.

It has been demonstrated that attacks on the trunk and main framework can be economically controlled by suitable surgery, wound protection, and prevention of woolly aphid infestation, while fruitfulness can be maintained indefinitely by a careful plan of top renewal. The use of fungicides has proved entirely unsuccessful except in the case of fruit rot, which can be largely prevented by spraying the fruit with bordeaux in late summer. The control program worked out by Leroy Childs, Superintendent of the Hood River Branch Experiment Station, is as follows:

1. Trim back to sound tissue all cankered bark on trunk and framework of tree to a height of six or eight feet. Do this in early summer, preferably June.
2. Allow wounds to heal for 10 to 14 days to prevent paint damage and apply with brush, or better with paint gun, the following mixture: 10 parts fish oil, 1 part nicotine sulphate. Stir frequently while applying in order to keep the nicotine well mixed. Repaint wounds annually with same material in June (or early July). This prevents woolly aphid infestation through the rest of the season.
3. Delay all pruning until after February 15. Avoid heading-back or making numerous small pruning cuts which are subject to later infection. Thin out trees by removing larger branches, protecting the cuts as directed above.
4. Renew tops of trees by saving one or two upright shoots on each scaffold branch at height of five to eight feet to be used as needed, removing older wood around them from time to time as they develop.
5. After the cankers have been cleaned out and painted in early summer, it is often advisable to spray in midsummer and again in late summer or whenever woolly aphids begin to show up. This spray should consist of $\frac{1}{2}$ pint nicotine sulphate, 1 pound calcium caseinate, 100 gallons water. Three or 4 gallons should be used on each tree directed at the lower inside area to kill woolly aphids and to prevent infestation of water sprouts.
6. In badly infected orchards, apply bordeaux 3-3-50 in the late August codling-moth spray to prevent fruit rot in storage. Yellow fruit like Newtown or Ortley should be picked as early as possible where bordeaux has been used, in order to avoid red spotting that appears on such sprayed fruit when prolonged rains occur before picking or when picking is delayed. See page 14 regarding spray residue removal.

For perennial canker control every essential step must be followed out each season. Send for Experiment Station Bulletin 243.

European canker. This disease starts around leaf scars, in winter-injured crotches or pruning cuts. It is especially destructive to pear bark and is occasionally found on apple bark. The bark of newly formed cankers is often soft and oozy in wet weather. Old dead canker bark is rough and cracked. It may fall away and show concentric rings of callous wood beneath. On such pear varieties as Anjou and Bartlett the fungous infection reaches the cambium the first year, while on Surprise, Bosc, and Howell varieties, the infection may be merely superficial the first year, striking in to the cambium during its second year's growth. On apple the cankers reach the wood. Cutting out of cankers is necessary and spraying with bordeaux 3-3-50 before fall rains set in will materially reduce the number of new infections. In areas of heavy rainfall this should be increased to 4-4-50.

Superficial cankers should be shaved off with a sharp instrument, like a farrier's knife. This cutting away of the surface should extend well beyond the visible limits of the canker so as to uncover all dark streaks in the pulpy portion of the bark. From deep cankers clean away all diseased bark and any of the surrounding bark which covers discolored cambium. All exposed wood and bark should be covered at once with an antiseptic coating. Bordeaux paint has given excellent results. This must be made the day it is used, slowly stirring raw linseed oil into a quantity of commercially prepared bordeaux powder until a very thick paint is formed. Winter-injured bark is extremely susceptible to infection unless coated with fungicide (see Station Circular 73).

Important Points About Spray Materials

Effective results in spraying depend to a large extent upon the use of proper methods of preparing, diluting, and combining sprays. It should again be emphasized that, after the spray material has been selected, timing of application and complete coverage are essential for good results. General information on the preparation of sprays and precautions to observe in their use may be obtained from Oregon Agricultural Experiment Station Bulletin 336.

Combination sprays. It is common orchard practice to combine two or more different spray materials by mixing them in the spray tank and applying them as a unit. In order to retain the active principle of each insecticide or fungicide unchanged as much as possible, combinations should be prepared by following a definite procedure. In Station Bulletin 336 are outlined recommended combinations of different sprays and the preferable order of mixing in the tank.

Spreaders. Materials used in sprays to increase the spreading and adhesive properties are sometimes of advantage, but frequently do not increase the fungicidal or insecticidal value. In some sprays, and especially certain combinations of sprays, it is very necessary to use spreaders. These recommendations are given specifically and in more detail wherever they may be used advantageously. Station Bulletin 336 outlines how various spray materials may be mixed in the spray tank and suggests spreader treatment.

Many different commercial spreaders are on the market, each of which is suitable only for certain purposes. When improperly used they may be detrimental by causing excessive run-off of spray, or fruit and foliage injury. For codling moth control, benefits have been derived from the use of casein spreaders, certain special neutral soaps, new "deposit building" spreaders, and a wide

range of liquid spreaders, commonly referred to as "semi-dynamite" spreaders. Except as specially recommended in some fruit districts, a casein spreader, $\frac{1}{2}$ lb. to 100 gallons of lead arsenate spray, is suggested. The special neutral soaps have shown promise both as spreaders and as agents to increase deposits when needed. One-fourth pound of these soaps to 100 gallons of spray is recommended. If larger amounts are used, or if ordinary soap, high in free alkali, is added to the lead arsenate spray, too much soluble arsenic may form and cause burning of foliage. The dry "deposit building spreaders" are used with a little oil and increase the amount and uniformity of the arsenical material. The "semi-dynamite" liquid spreaders are variable in composition, depending on the manufacturer. Usually they have a petroleum-oil or fish-oil base or mixtures of the two oils, together with a soluble emulsifier, and often contain some oleic acid. Especial care should be taken when using these "semi-dynamite" liquid spreaders or difficulty will be experienced. When properly used they produce a mixture with lead arsenate that is very effective in depositing a heavy coat of the arsenical on the surface sprayed. If, however, hard water only is available for spraying purposes, the orchardist is warned against the use of these materials until he learns that they are compatible with his spray water.

Fruit sprayed with the "semi-dynamite" liquid spreaders in combination with lead arsenate and small amounts of petroleum oil can be cleaned only with the greatest difficulty and by efficient double-process machines. Growers are warned against using these mixtures in second-brood sprays.

Calyx injury. Some varieties of apples, especially the Newtown, are susceptible to calyx injury from soluble arsenic. In order to prevent this injury as much as possible, it is recommended that one-fourth pound of zinc sulphate and an equal amount of hydrated lime be added to each 100 gallons of arsenical spray. The zinc sulphate should first be dissolved in a little water and added to the spray tank, followed by the lead or calcium arsenate and then the lime.

Arsenicals. In spite of its limitations, arsenate of lead still is the most satisfactory insecticide for use in codling-moth control. In the Willamette Valley, however, calcium arsenate may be substituted for lead.

SULPHUR SPRAYS

Liquid Lime Sulphur. The proportions of lime sulphur recommended for sprays in this bulletin are based on the use of the standard concentrated liquid lime-sulphur, testing about 32° by Baumé hydrometer test. Thus, for example, where the recommendation "lime sulphur 12 to 100" appears in the calendar, use 12 gallons of the standard concentrated liquid lime-sulphur and add water to make 100 gallons of dilute spray. Where the stock lime-sulphur is different from standard strength, dilute according to accompanying Liquid Lime-Sulphur Dilution Table, given on page 10.

Dry Lime Sulphur. When dry lime sulphur is used for dormant spraying, it will take about 5 pounds of the dry powder to be equivalent chemically to one gallon of the concentrated liquid lime sulphur, 32° Baumé. For example where this bulletin recommends "lime sulphur 12-100" the grower employing the dry form should use 60 pounds of powder to each 100 gallons of water, in order to obtain a spray of equivalent strength.

For summer spraying, where the free sulphur present in the dry product is also active, about 3 pounds of the dry lime sulphur is equivalent to one gallon of the liquid lime sulphur. The grower, therefore, should use 6 pounds of dry lime sulphur to 100 gallons, where 2 gallons to 100 liquid lime sulphur is recommended for late spring spraying.

LIQUID LIME-SULPHUR DILUTION TABLE

For use when stock solution is different from standard strength (32°) when tested by hydrometer.

Strength of stock solution		To make 100 gallons of dilute spray use the number of gallons of concentrated stock lime sulphur indicated in the columns below and add water to make 100 gallons				
Degrees Baumé	Specific gravity	1 Dormant strength for scale clean-up (12-100)	2 Dormant strength for blister mite and twig miner (8-100)	3 Early spring spray (3½-100)	4 Mid-spring spray (2½-100)	5 Late spring spray (2-100)
34°	1.304	Gal. 11+	Gal. 7½	Gal. 3+	Gal. 2½+	Gal. 1¾+
32°	1.282	12	8	3½	2½	2
30°	1.260	12½+	8½	3½	2½+	2+
28°	1.239	14—	9½	3¾	2¾+	2¼+
26°	1.218	15	10	4	3	2½
24°	1.198	16½—	11	4½—	3½+	2¾
22°	1.179	18½+	12½	4¾+	3¾	3¼
20°	1.160	20½+	13¾	5½—	4½—	3½

Note: Where the + sign is used, employ a little more than the number of gallons indicated. Where the — sign appears use scant measure.

Sulphur shock. Under certain climatic conditions if lime sulphur has not been used on apple trees in the earlier prepink or pink applications, a very severe injury, with foliage and fruit drop, may result when lime sulphur is applied later on. This is known as "sulphur shock" and occurs without regard to strength of spray. *Immunity against this danger can be obtained only by application of the preblossom sprays as scheduled.* Trees in a run-down condition due to poor care or to the effects of previous drought or poor soil conditions and culture are much more susceptible to spray injury than are healthy trees in fertile, well-cared-for soils.

Wettable types of sulphur sprays. Within recent years substitutes for ordinary liquid lime sulphur and dry lime sulphur have been devised which do not have the caustic or burning action of lime sulphur and hence are safer to use on tender skinned varieties of pears and apples and on stone fruits. Most of these sprays are not so active as fungicides or insecticides when the weather is cool and rainy and hence cannot always be relied upon for effective action in the early spring. They are, however, active in warm weather such as may usually be expected from the time the pear and apple blossoms have fallen. They are safe and effective in warm weather for the control of scab, mildew, leaf spot, and brown rot. It is usually advisable to employ a spreader with them unless a spreader is used in the manufacture. These spray materials are preferable to the old self-boiled lime sulphur and are recommended wherever the latter has been advised in the past.

Among the noncaustic types of sulphur sprays are: (1) Those powders or pastes that consist of finely-ground sulphur (95 per cent of which should pass a 325 mesh screen), and 5 to 10 per cent of some material, such as blood albumen and clay, skim-milk powder, wetting agents, etc. These latter ma-

terials when mixed with the sulphur make it possible to mix the combinations with water. (2) Certain commercial products in which the sulphur is present in a somewhat colloidal form, as in the different types of "flootation" sulphurs that are now available on the market.

In preparing these materials for entering into the spray tank, it is preferable to make them first into a thin paste before passing through the strainer into the tank. When the wettable sulphurs contain 90 to 95 per cent sulphur, they should be used at the rate of 6 pounds to 100 gallons. When the sulphur content is below 90 per cent, the amount should be in accordance with the directions given on label of the commercial product.

During very warm weather the wettable sulphurs may cause foliage burn to sensitive plants. Hydrated lime used at the rate of 2 pounds to 100 gallons will reduce the danger of sulphur burn. For most purposes, however, and under Oregon climatic conditions, the use of lime is not necessary. Lime tends to reduce the fungicidal activity of sulphur and should be used only when necessary.

Dusting. Dusting with finely divided sulphur prepared for orchard use has given good results where properly applied in warm weather for the control of such troubles as brown rot and powdery mildew. The dust should be fine enough so that 95 per cent will pass through a 325-mesh screen. To prevent the particles from lumping, some other material such as magnesium carbonate or bentonite clay should be present in small amount, otherwise the covering power and spread are not satisfactory. In cool, moist, spring weather dusting has not proved as effective as the usual liquid sprays for such a trouble as apple scab. No practicable dusting method for the control of such diseases as apple-tree anthracnose or peach blight has been demonstrated thus far in Oregon.

For spider-mites sulphur dusts have not proved as effective as have the standard liquid sprays. Dormant dusting for scale insects, peach twig miner, and blister-mite control is yet to be demonstrated as effective. In cool, moist spring and early summer weather nicotine dust has not proved as effective as the liquid spray for aphid control. Later in the season, when summer temperatures are high, nicotine dusting may well be used.

Effective dusting is impossible unless the air is perfectly quiet as in the early morning.

BORDEAUX

Bordeaux mixture of the highest quality can be made by the grower if the standard methods are followed (see Oregon Agricultural Experiment Station Bulletin 336), but slipshod methods give poor results. No commercial powdered bordeaux has been found superior to the best home-made material although satisfactory commercial products are now manufactured. Various commercial brands, however, differ in quality and there is evidence that deterioration may sometimes take place in storage. In general they cost more than the home-made spray. Where commercial powdered bordeaux is used, $\frac{1}{4}$ pound of casein spreader should be added to 100 gallons if a spreading agent is not already contained in the product. Home-made bordeaux must be used promptly unless a stabilizer is added as otherwise it soon starts to deteriorate. An ounce of sugar to 100 gallons of prepared bordeaux will prevent deterioration for a few weeks.

OIL SPRAYS

Great care should be exercised in the selection of the correct oil spray for the specific purpose needed. *There are two contrasting types of oil sprays:* those used for dormant sprays and those classified as summer oil sprays. The oils used in the preparation of the dormant oil sprays are of comparatively low purification and should not be used for summer spraying. On the other hand, the summer oil sprays are of higher purity and therefore more costly.

Summer oil sprays. Summer oil sprays combined with lead arsenate have proved of value for codling moth control. When used in the early cover sprays, they are especially effective as an ovicide at the height of the egg-laying period. Oil sprays, however, often interfere with the use of established spray programs that have been developed in Oregon as the result of many years of experimental investigations and growers' experiences. In sections where fungous diseases, such as scab or mildew, are major problems, oil sprays improperly used may cause severe fruit and leaf injury. For example, oil sprays must not be applied immediately following sulphur-containing sprays since they may cause serious leaf and fruit drop. At least six weeks should intervene between the application of the sulphur spray and the oil spray. Oil sprays also complicate the removal of spray residues, especially when applied in late sprays. Where severe codling moth infestations prevail, the use of a quart or more of oil emulsion, together with some of the "semi-dynamite" liquid spreaders, have given good results. Especial care must be exercised in the use of these materials and only on the advice of your local authorities. These mixtures should never be used in second-brood sprays.

Summer oil specifications. It is important that the proper grade and purity of oil be selected for the purpose. The purity of an oil is indicated by the "sulphonation" test. For all practical purposes the following specifications will indicate the different grades of oil available for summer spray use:

1. Medium oils: Viscosity between 65 and 75 seconds Saybolt. Sulphonation test, not less than 85.
2. Light medium oils: Viscosity, 56 to 65 seconds Saybolt. Sulphonation test, not less than 85.
3. Light oils: Viscosity, 50 to 56 seconds Saybolt. Sulphonation test, not less than 85.

The Newtown and other susceptible varieties of apples have developed severe injury around the calyx when the "medium" or "light medium" grade of oil was used. Hence, a "light" oil is necessary on these varieties.

Summer oil dosage. Combined with lead arsenate for codling moth control, petroleum oils may be used as an ovicide at the rate of $\frac{1}{2}$ gallon of the emulsion to 100 gallons of spray. The "medium" oil, having a viscosity of about 70 seconds Saybolt, should be used. If a lighter oil is used the dosage should be increased to 1 gallon to 100 gallons of spray. The lead arsenate in this combination should be used at the rate of 2 to 3 pounds to 100 gallons, depending on infestation. Without oil, 3 pounds lead arsenate per 100 gallons should be used.

For spider-mites the best results are obtained when $1\frac{1}{2}$ gallons of "medium" or "light-medium" oil emulsion and $\frac{1}{4}$ pound of casein spreader are used to 100 gallons of spray. When necessary to use the "light" oil, $1\frac{1}{2}$ gallons of the emulsion should be used to 100 gallons of spray.

Zinc sulphate $\frac{1}{4}$ pound and hydrated lime $\frac{1}{4}$ pound to 100 gallons should be used in the calyx and first two cover sprays, to reduce calyx injury as much as possible.

Number of oil applications. If oils in combination with lead arsenate are used for codling-moth control, the number of applications in which oil is used should not exceed *two* because of possible injury and spray residue difficulties.

Time of oil application. Oils in combination with lead arsenate should be applied during the height of the egg-laying period of the spring brood of codling moth, usually in the second and third cover sprays. It must be remembered, however, that if sulphur sprays are applied *after* the dormant period, no oil can be used safely in codling-moth control. This will prevent the use of any summer oil sprays for codling-moth control where scab is a serious problem.

The time for applying oils for spider-mite control will vary according to local conditions. Consult your County Agent.

Latest date for oil sprays. Because of difficulty in removing spray residue, especially the lead residue, the oil and lead arsenate combination should be used on apples in the first brood applications only. On late varieties of pears, oil emulsions may be used for spider-mite control as late as July 25.

Dormant oil sprays may be home-prepared as outlined in Station Bulletin 336. A comparatively low-grade oil, which has a viscosity between 100 and 120 seconds Saybolt, and a purity sulphonation test of 50 to 70, may be used for this purpose.

Commercial dormant oil emulsions are available in several forms: (1) the old type miscible oil which is an oil emulsified by means of soap and cresylic acid; (2) the so-called quick-breaking type oil emulsions which are primarily casein-ammonia emulsified oils; (3) various soluble oils which may also be classified as miscible oils and are mixtures of the proper grade of petroleum oil with a soluble emulsifier. Any of these oils, properly used, will be effective as dormant sprays.

To avoid injury, dormant oil sprays should be applied in the spring before the bud scales separate and before the buds show green. Injury may result if dormant oil sprays (4 gallons or more to 100 gallons of water) are applied during the critical period (delayed dormant) of bud development. This period occurs during the time the buds first show green and the cluster-bud stage (prepink). Injury is increased by continuous cool, cloudy weather during which time the trees are making little or no growth. In the Hood River Valley, however, miscible oils prepared from cresylic acid and soap, when used for the control of leaf-roller, ordinarily have not caused injury during this critical period when combined with bordeaux mixture.

Home-prepared oil emulsions may be made by the orchardist for either dormant or summer application. Directions for preparing these emulsions may be obtained in Station Bulletin 336 or Circular 107. More than ordinary care must be taken by the orchardist when preparing these emulsions, in order to obtain a product that will not injure the tree.

Summer and dormant oil spray dilutions. Commercial oil emulsions vary greatly in the amount of oil which they contain. The effectiveness of the diluted spray depends primarily upon its actual oil content and the type of emulsion. Hence all of the recommendations in this bulletin give the per-

centage of actual oil to be used. The proportion of oil in any commercial emulsion is or should be marked on the container. In order that the grower may know how much of the emulsion to use for every one hundred gallons of spray, the accompanying table is given, which specifies the amounts in gallons and quarts required for commercial emulsions containing different percentages of oil. The figures give the amount to the nearest fraction of a quart, which is sufficiently close for all practical purposes. For emulsions carrying percentages of oil different from those listed, the grower should use correspondingly a little more or a little less than the nearest figures given.

OIL-SPRAY DILUTION TABLE

Amount of Oil Emulsion to Use in 100 Gallons of Spray

Percentage of oil in concentrated emulsion—→	70%	75%	80%	85%	98%
Recommended proportion of oil in dilute spray	Gal. & Qt.	Gal. & Qt.	Gal. & Qt.	Gal. & Qt.	Gal.
1 per cent	1 & 2	1 & $1\frac{1}{2}$	1 & 1	1 & $\frac{3}{4}$	1
2 per cent	2 & $3\frac{1}{2}$	2 & $2\frac{3}{4}$	2 & 2	2 & $1\frac{1}{2}$	2
3 per cent	4 & $1\frac{1}{2}$	4 & —	3 & 3	3 & 2	3
4 per cent	5 & $3\frac{1}{2}$	5 & $1\frac{1}{2}$	5 & —	4 & $2\frac{3}{4}$	4
5 per cent	7 & $1\frac{1}{2}$	6 & $2\frac{3}{4}$	6 & 1	5 & $3\frac{1}{2}$	5
6 per cent	8 & $2\frac{1}{2}$	8 & —	7 & 2	7 & —	6

SPRAY-RESIDUE REMOVAL

Promulgation by the government of minimum residue tolerances during the last few years, has required intensive investigations and careful planning of the spray program in order that the fruit may be cleaned effectively by washing treatments. Each orchardist in the state should learn the spray program that may be followed in his district for effective control of the codling moth and easy removal of the residue by the washing process. General information regarding spray-residue removal may be obtained from Oregon Experiment Station Bulletins 317 and 341.

Lead residues have been found much more difficult to remove than arsenic from apples and pears, and consequently special solvents may be necessary in order to clean the fruit effectively. At present hydrochloric acid and sodium silicate fortified with soap, wetting agents, or light oil are the solvents recommended for general use. For pears, hydrochloric acid alone should be used. In order to clean apples effectively, it may be necessary to use a double process whereby the fruit is first put through a unit containing the sodium silicate, followed by an acid wash, supplemented with light oil or kerosene.

All orchardists should harvest their fruit at the proper time. Allowing the fruit to remain on the trees until excessive amounts of wax form may prevent the satisfactory removal of the residue. Improper use of the "dynamite" type and certain other spray combinations may also require such harsh washing treatment that injury to the fruit may result. The fruit should be washed immediately after picking.

Spray Program for Apples and Pears

This schedule is prepared to meet maximum spraying requirements. It does not follow that this outline is needed in all orchards, or in fact in any single orchard. It may be used as a basis for pest control work in all apple

and pear orchards in Oregon. Consult county agent and experiment station investigators for satisfactory modifications to meet your needs. See page 8 for spreader information.

Time of application	Pest or disease	Spray material and strength
Dormant spray. As winter buds swell just before opening.	San Jose scale, blister mite and spider-mite, except common red spider-mite, and for aphis if applied as delayed dormant (see pages 4 and 5).	Lime sulphur 12 to 100, or quick-breaking emulsion (80 per cent actual oil) 4 to 100 gallons
	Apple leaf-roller	Use emulsion as above or bordeaux-oil ¹
	Apple scab Pear scab (see page 6)	Plow under old leaves
	Scab and powdery mildew	Lime sulphur 3½ to 100 ³
Prepink or green bud spray. Little leaves separating just enough to expose blossom bud cluster.	Pear thrips	1 pint nicotine sulphate to 100 gallons of spray ²
	Aphids on apples	Add nicotine sulphate $\frac{3}{4}$ pint to 100 gallons of spray ²
	Scab and mildew	Lime sulphur 2½ to 100 ³
	Pear thrips	1 pint nicotine sulphate to 100 gallons of spray ²
Pink or preblossom spray. Just before blossoms open.	Fruit worms and bud moth	Lead arsenate 4 pounds to 100 gallons of spray. With lime sulphur add hydrated lime 1 pound to 100 gallons
	Scab and mildew.	Lime sulphur 2½ to 100 ³
	Codling moth	Lead arsenate 3 pounds to 100 gallons ⁴
	Leaf roller where infestation is moderate	Lead arsenate 4 pounds to 100 gallons ⁴
Calyx spray. When $\frac{2}{3}$ petals have fallen. Before apple calyx closes on central fruit in cluster. Spray pears as soon as petals fall.	Fruit worms	Lead arsenate 4 pounds to 100 gallons if omitted in pink spray ⁴

Time of application	Pest or disease	Spray material and strength
First cover spray. About fifteen days after petals fall. ⁶	Scab and mildew	Lime sulphur 2 to 100 ^{3, 8}
	Codling moth and pear slug	Lead arsenate 3 pounds to 100 gallons ^{4, 7}
Second cover spray. Approximately 10 to 15 days later. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons ^{4, 7}
	Scab and mildew	Wettable sulphur spray, 6 to 10 pounds to 100 gallons
Third cover spray. Approximately 10 to 15 days later. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons ⁷
Fourth cover spray. Second brood spray middle-late July. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons.
Fifth cover spray. Mid-August. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons.
	Apple rots and anthracnose	Bordeaux 3-3-50. (Extra lime not needed) ⁵
Sixth cover spray. Necessary only in certain sections. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons

¹If bordeaux is combined with oil, use 5 gallons of oil to 100 gallons spray.

²Add $\frac{1}{2}$ pound casein spreader to each 100 gallons of spray before putting in nicotine.

³Lime-sulphur solution cannot be safely used on Anjou, Howell, and Comice after the blossom buds become exposed. Ordinary lime sulphur is likely to russet the skin of these varieties of pears. Under such circumstances, substitute any reliable noncaustic or "wettable" sulphur spray, used at the rate of 6 to 10 pounds per 100 gallons.

⁴Three pounds recommended when codling moth is controlled with difficulty. When lead is combined with lime sulphur, either use hydrated lime, 1 pound to 100 gallons, or a casein spreader containing lime. Where calyx injury may occur, see page 9 on calyx injury. Arsenate-lime-sulphur combination is a very dangerous mixture on pears and should be avoided. Where necessary to use this mixture, it should be applied immediately after mixing.

⁵In areas of heavy rainfall, increase dosage to 4-4-50.

⁶Consult local county agent or Experiment Station for timing the sprays.

⁷With oil, use 2 or 3 pounds, depending upon infestation; without oil, use 3 pounds. Use of spreader is optional. With the oil and lead combination, add spreader containing lime, $\frac{1}{2}$ pound to each 100 gallons.

⁸Lime sulphur may cause burning of apples when hot weather comes on. Under such circumstances, substitute any reliable "wettable" sulphur spray, used at the rate of 6 to 10 pounds per 100 gallons.