

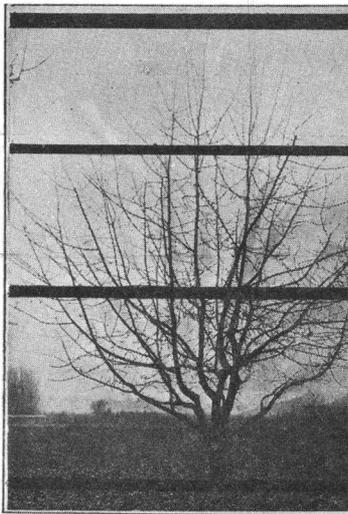
Oregon State Agricultural College Extension Service

Corvallis, Oregon

Oregon Apple and Pear Spray Program

Prepared by

Representatives of the Oregon Agricultural Experiment Station
and issued by the Extension Service



HIGHTH	NUMBER OF APPLES	TOTAL WORMY	% WORMY	Ave % WORMY
22-28 FEET	123	22	17.8	3.41
12-22 FEET	904	33	3.6	
0-12 FEET	1020	15	1.46	
UNSPRAYED				53.6

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.

Cooperative Extension Work in Agriculture and Home Economics

Wm. A. Schoenfeld, Director

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Apple and Pear Spray Program

Oil sprays often interfere with the use of established spray programs that have been developed in Oregon as a result of many years of experimental investigation and growers' experiences. In sections where fungous diseases, such as scab or mildew, are major problems, it is questionable whether oils should be used in connection with codling-moth control. Growers should consider carefully these problems in their individual orchards before starting the season's spraying activities.

It has long been known that oil usage cannot follow earlier sulfur-containing applications without the danger of causing serious leaf and fruit drop. This applies especially to the Hood River Valley and sections west of the Cascades (except the Rogue River Valley) where fungous disease control is often as important as insect control.

Furthermore, oil seriously complicates the subsequent removal of the lead arsenate combination because, at present, none of the known solvents that can be used in washing the fruit will remove lead effectively when oil is present.

Therefore it is suggested that the grower, before applying his spray program for the season, carefully consider the information given in the following paragraphs.

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.

Arsenate of lead. 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.

Use lime to prevent calyx injury. Fresh hydrated lime, $\frac{1}{2}$ pound to 100 gallons, should be used in calyx and last cover sprays. Bordeaux mixture 3-3-50 in the last cover spray serves the same purpose. Where a spreader is used, $\frac{1}{4}$ pound of spreader should be supplemented with $\frac{1}{2}$ pound of hydrated lime.

Summer oils. Petroleum oil sprays combined with lead arsenate have proved of value for codling-moth control, but they complicate the removal of spray residue. These summer oils, when used, should be employed only in the early cover sprays, being especially effective as an ovicide at the height of the egg-laying period. In this combination "medium" or "light-medium" oils having a sulfonation test of not less than 85 have proved generally satisfactory.

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

Summer oil specifications. Oils are sold commercially under the designations "medium," "light-medium," and "light" and should meet the following specifications:

1. MEDIUM

40 to 49 per cent of the oil should distill at 636° F.; not more than 10 per cent should distill at 540° F.; not less than 80 per cent should distill at 725° F.
Viscosity: 65 to 75 Saybolt.
Sulfonation test: Not less than 85.

2. LIGHT-MEDIUM

50 to 64 per cent of the oil should distill at 636° F.; not more than 10 per cent should distill at 530° F.; not less than 80 per cent should distill at 715° F.
Viscosity: 60 to 66 Saybolt.
Sulfonation test: Not less than 85.

3. LIGHT

65 to 100 per cent of the oil should distill at 636° F.; not more than 10 per cent should distill at 520° F.; and not less than 80 per cent should distill at 665° F.
Viscosity: 50 to 55 Saybolt.
Sulfonation test: Not less than 85.

Oils which do not meet the aforementioned specifications are likely to cause injury or to complicate the spray residue removal.

Dosage. For codling moth, petroleum oils may be used at the rate of one gallon of emulsion to 100 gallons of water, though there is evidence that $\frac{3}{4}$ gallon of medium oil to 100 gallons of spray is enough. The lead arsenate in this combination should be used at the rate of 2 pounds to 100 gallons. Without oil, use 3 pounds lead arsenate per 100 gallons.

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

Fresh hydrated lime $\frac{1}{2}$ pound to 100 gallons should be used in the calyx and last cover sprays. Where a spreader is used, $\frac{3}{4}$ pound of this material should be supplemented with $\frac{1}{2}$ pound of hydrated lime.

Bordeaux mixture 3-3-50 in the last cover serves the same purpose.

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 sulfur 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.

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 agents and experiment station investigators for satisfactory modifications to meet your needs.

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 aphid if applied as delayed dormant (see pages 7 and 8)	Lime sulfur 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 9)	Plow under old leaves
Pre-pink or green bud stage spray. Little leaves separating just enough to expose blossom bud cluster.	Scab and powdery mildew	Lime sulfur 3 $\frac{1}{2}$ to 100 ³
	Pear thrips	1 pint nicotine sulfate to 100 gallons of spray ²
	Aphids on apples	Add nicotine sulfate $\frac{1}{2}$ pint to 100 gallons of spray ²
Pink or pre-blossom spray. Just before blossoms open.	Scab and mildew	Lime sulfur 2 $\frac{1}{2}$ to 100 ³
	Pear thrips	1 pint nicotine sulfate to 100 gallons of spray ²
	Fruit worms and bud moth	Lead arsenate 4 pounds to 100 gallons of spray. With lime sulfur add hydrated lime 1 pound to 100 gallons
Calyx spray. After $\frac{3}{4}$ petals have fallen. Before apple calyx closes on central fruit in cluster. Spray pears before calyx closes.	Scab and mildew.	Lime sulfur 2 $\frac{1}{2}$ to 100 ³
	Codling moth (on apple only)	Lead arsenate 2 or 3 pounds to 100 gallons ^{4,5}
	Leaf roller where infestation is moderate	Lead arsenate 4 pounds to 100 gallons ⁵
	Fruit worms	Lead arsenate 3 or 4 pounds to 100 gallons if omitted in pink spray ⁵

Time of application	Pest or disease	Spray material and strength
First cover spray. About fifteen days after petals fall. ⁶	Scab and mildew	Lime sulfur 2 to 100 ⁸
	Codling moth and pear slug	Lead arsenate 3 pounds to 100 gallons ⁵
Second cover spray. Approximately 10 to 15 days later. ⁶	Codling moth	Lead arsenate 2 or 3 pounds to 100 gallons ⁷
	Scab and mildew	Wettable sulfur spray, 6 to 10 pounds to 100 gallons
Third cover spray. Approximately 10 to 15 days later. ⁶	Codling moth	Lead arsenate 2 or 3 pounds to 100 gallons ⁷
Fourth cover spray. Second brood spray middle-late July. ⁶	Codling moth	Lead arsenate 2 or 3 pounds to 100 gallons. In this or the next spray use hydrated lime, ½ pound to 100 gallons to prevent calyx end rot
Fifth cover spray. Mid-August. ⁶	Codling moth (usually may be omitted on pear)	Lead arsenate 2 or 3 pounds to 100 gallons. Use hydrated lime un- less used in previous ap- plication.
	Anthracnose canker, ap- ple rots, and European canker of pears.	Bordeaux 3-3-50. (Extra lime not needed) ⁹
Sixth cover spray. Necessary only in cer- tain sections. ⁶	Codling moth	Lead arsenate 3 pounds to 100 gallons

¹If bordeaux is combined with oil, increase actual oil 1 per cent (5 to 7 gallons emulsion to 100 gallons spray).

²Add ½ pound casein spreader to each 100 gallons of spray before putting in nicotine.

³Lime-sulfur solution cannot be safely used on Anjou, Howell, and Comice after the blossom buds become exposed. Ordinary lime sulfur is likely to russet the skin of these varieties of pears. Under such circumstances, substitute any reliable non-caustic or "wetttable" sulfur 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 sulfur, either use hydrated lime, 1 pound to 100 gallons, or a spreader containing lime. Where calyx injury may occur, add 1 pound hydrated lime with the arsenical to each 100 gallons of spray. Arsenate-lime-sulfur 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.

⁵With lime sulfur, add hydrated lime 1 pound.

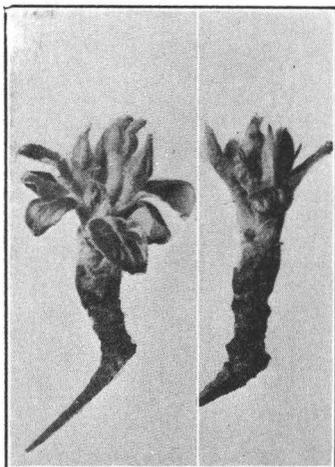
⁶Consult local county agent or Experiment Station for timing the sprays.

⁷With oil, use 2 pounds; without oil, use 3 pounds where codling moth is controlled with difficulty. Use of spreader is optional. With the oil and lead combination, add hydrated lime or spreader containing lime, ½ pound to each 100 gallons. Air-slaked lime is ineffective.

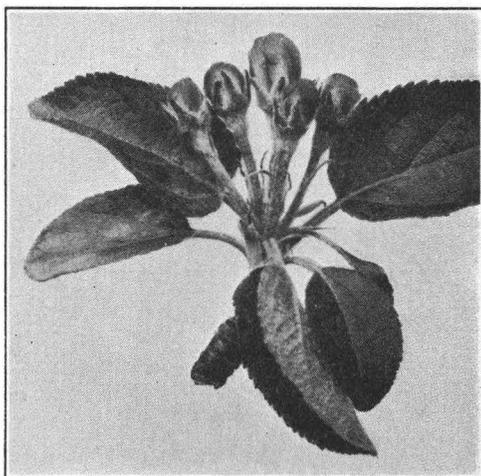
⁸Lime sulfur may cause burning of apples when hot weather comes on. Under such circumstance, substitute any reliable "wetttable" sulfur spray, used at the rate of 6 to 10 pounds per 100 gallons.

⁹In areas of heavy rainfall, increase dosage to 4-4-50.

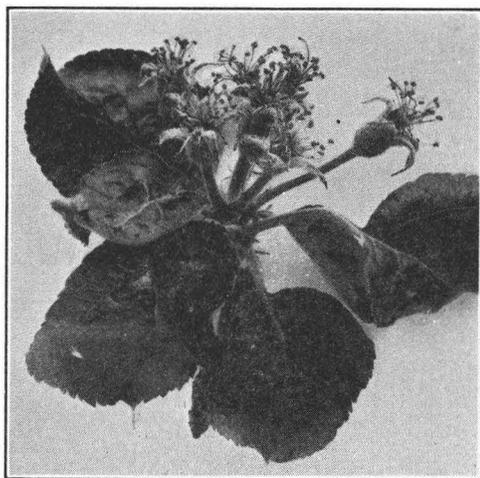
Spray Thoroughly and at Right Time



"Pre-pink" stage. Winter buds just opening.



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



The "Calyx" stage. Petals off, calyx lobes open.

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

Apple and Pear Pests and Diseases

Codling moth. This is the common pinkish-white worm found in apple and pear fruits. The spray recommendations for codling moth are found on pages 2 and 3 and the spray program on pages 4 and 5 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 which 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.

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 sulfur or oil is advisable.

Red spider-mites. Three species of these mites, the European red spider-mite, brown orchard mite, and the common or two-spotted spider-mite, attack Oregon orchards. Mites are more frequently serious on prune and cherry where no spray program is regularly applied, and of late years on pears where ordinary lime sulfur russets the tender-skinned varieties. The first two species overwinter in the egg stage on the tree. Lime sulfur 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 sulfur 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 14 for discussion of oil sprays. Dusting with sulfur 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 $\frac{1}{2}$ 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 on apple and pear, bud moth 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 sulfate plus 1/2 pound casein spreader to 100 gallons, added to the pre-pink and pink lime-sulfur sprays for scab, has given encouraging results.

Apple aphids. The degree of success obtained in apple aphid control with the standard aphid spray of lime sulfur and nicotine in the pre-pink 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 "pre-pink" 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 pre-pink (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 which prevent complete control being obtained from the oil application and for very light infestations of leaf roller, use double strength 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 sulfur, 12 to 100, applied any time in the spring before 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 sulfur, 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-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 "pre-pink," "pink," "calyx," and "15-day" sprays are given at the proper time. With highly susceptible varieties like Newtown the next 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. Very similar in appearance to apple scab. The disease overwinters, however, in lesions on new-twig 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 sulfur 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. Non-caustic-sulfur sprays must be used in place of ordinary lime sulfur on tender-skinned sorts, like Anjou and Comice. These sprays are not as active as lime sulfur 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 "pre-pink" 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 sulfur 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 number 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 which 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 "pre-pink" 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 aphis. 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 the 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 aphis 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 sulfate. 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 $\frac{3}{4}$ pint nicotine sulfate, 1 pound calcium caseinate, 100 gallons water. Three or 4 gallons should be used on each tree directed at the lower inside areas 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 16 regarding spray removal.

For perennial canker control every essential step must be followed out each season. Send for 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 callus 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 a fungicide (see Station Circular 73).

Important Points About Spray Materials

Effective results in spraying depend to a large extent on the use of proper methods in preparing, diluting, and combining sprays. Send for Oregon Agricultural Experiment Station Bulletin 336 on the Preparation of Spray Materials.

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

LIQUID LIME-SULFUR 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 sulfur 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)
		Gal.	Gal.	Gal.	Gal.	Gal.
34°	1.304	11+	7½	3+	2½+	1¾+
32°	1.282	12	8	3½	2½	2
30°	1.260	12¾+	8½	3½	2½+	2+
28°	1.239	14-	9¾	3¾	2¾+	2¾+
26°	1.218	15	10	4	3	2½
24°	1.198	16½-	11	4½-	3½+	2¾
22°	1.179	18¾+	12½	4¾+	3¾	3+
20°	1.160	20¾+	13¾	5½-	4½-	3¾

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

Dry Lime Sulfur. When dry lime sulfur is used for dormant spraying, it will take about 5 pounds of the dry powder to be equivalent to one gallon of the concentrated liquid lime sulfur, 32° Baumé. For example, where this bulletin recommends "lime sulfur 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 sulfur present in the dry product is also active, about 3 pounds of the dry lime sulfur is equivalent to one gallon of the liquid lime sulfur. The grower, therefore, should use 6 pounds of dry lime sulfur to 100 gallons, where 2 gallons to 100 of liquid lime sulfur is recommended for late spring spraying.

The powdered form of lead arsenate is the basis of the formulas for this poison recommended in this bulletin. Where arsenate in paste form is used the grower should employ double the number of pounds indicated in the bulletin.

Spreaders. Materials used with a fungicide or an insecticide spray 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. Oregon Agricultural Experiment Station Bulletin 336 outlines how various spray materials may be mixed in the spray tank and suggests spreader treatment.

Neutral soaps have recently shown promise as a spreader and as agents to increase deposits when used with lead arsenate and certain other arsenicals. It is important, however, that the special soap prepared for the purpose be used. About $\frac{1}{4}$ pound to 100 gallons is recommended. If larger amounts are used or if ordinary soap is added to the lead-arsenate spray, too much soluble arsenic may form and cause burning of foliage.

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 slip-shod methods give poor results. No commercial powdered bordeaux has thus far been found superior to the best home-made material although satisfactory commercial products are now manufactured. Different 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 spreader should be added to 100 gallons if a spreading agent is not already contained in the commercial 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.

Wettable types of sulfur sprays. Within recent years substitutes for ordinary liquid lime sulfur and dry lime sulfur have been devised which do not have the caustic or burning action of lime sulfur 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 sulfur and are recommended wherever the latter has been advised in the past.

Among the non-caustic types of sulfur sprays are: (1) Those powders or pastes that consist of finely-ground sulfur (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, degumming agent, etc. These latter materials when mixed with the sulfur make it possible to mix the combinations with water. (2) Certain commercial products in which the sulfur is present in a somewhat colloidal form, as in the different types of "flotation" sulfurs 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 sulfurs contain 90 to 95 per cent sulfur, they should be used at the rate of 6 pounds to 100 gallons. When the sulfur content is below 90 per cent, the amount to use should be in accordance with the directions given on the label of the commercial product.

During very warm weather the wettable sulfurs may cause foliage burn to sensitive plants. Hydrated lime used at the rate of 2 pounds to 100 gallons will reduce the danger of sulfur 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 sulfur and should be used only when necessary.

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.

Dormant oil sprays are available in two forms: the old type *miscible oil* containing cresylic acid and the newer so-called *quick-breaking* type oil emulsion. By overspraying, the latter type may deposit excessive amounts of oil on the tree surface, while the miscible oil drains off. 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 spray (4 gallons or more to the 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 (pre-pink). 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.

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 percentage 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 amount 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%
Recommended proportion of oil in dilute spray	Gal. & Qt.	Gal. & Qt.	Gal. & Qt.	Gal. & Qt.
1 per cent	1 & 2	1 & 1½	1 & 1	1 & ¾
2 per cent	2 & ¾	2 & 2¾	2 & 2	2 & 1½
3 per cent	4 & 1½	4 & -	3 & 3	3 & 2
4 per cent	5 & ¾	5 & 1½	5 & -	4 & 2¾
5 per cent	7 & 1½	6 & 2¾	6 & 1	5 & ¾
6 per cent	8 & 2¼	8 & -	7 & 2	7 & -

Sulfur shock. Under certain climatic conditions if lime sulfur has not been used on apple trees in the earlier pre-pink or pink applications, a very severe injury, with foliage and fruit drop, may result when lime sulfur is applied later on. This is known as sulfur shock and occurs without regard to strength of spray. Immunity against this danger can be obtained only by application of the pre-blossom 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.

Dusting. Dusting with finely divided sulfur 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 sulfur dusts have not proved as effective as have the standard liquid sprays. Dusting with lead arsenate for codling-moth control has given good results in certain districts when properly applied. 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 be used with good results.

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

Spray residue removal. The establishment of a lead tolerance in addition to the arsenic tolerance during the last few years, has required intensive investigations and careful planning of the spray program in order that the fruit may be cleaned below the required tolerances. Each orchardist in the state should learn the spray program that may be followed 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 new solvents may be necessary in order to clean the fruit effectively. At present hydrochloric acid and sodium silicate fortified with soap are the only solvents recommended for general use. For pears, hydrochloric acid 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.

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 removal of the residue. The fruit should be washed immediately after picking.

HEIGHT	TOT. APPLES	TOT. SCAB	% SCAB	TOT. AVE. SCAB
15-25 Ft.	2279 OR 25.13 %	1042	45.72	22.52%
10-15 Ft.	3567 OR 39.56 %	800	22.31	
0-10 Ft.	3201 OR 35.29 %	209	6.52	

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 increased. 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.

ORCHARD PEST CONTROL COMMITTEE:

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