Directions for Spraying Fruits in Illinois

By Department of Horticulture and Natural History Survey

University of Illinois
College of Agriculture and Agricultural Experiment Station
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This circular is a revision of Circular 277 of this Station, which carried the same title.
Directions for Spraying Fruits in Illinois

Prepared by the Department of Horticulture and the Illinois Natural History Survey

Spraying is the most effective way of controlling insects and fungous diseases attacking fruits in Illinois. In order that spraying may be done intelligently and satisfactorily, the orchardist should have a practical knowledge of the insects and diseases which affect his crop.

Two Classes of Insect Pests. Fruit insects may be divided into two classes: sucking insects and chewing insects. The sucking insects, such as San Jose scale and aphids (commonly known as plant lice), extract their food from the sap of plants. These are combated by contact sprays which must strike the insects themselves. Lime sulfur, liquid or dry, oil emulsion, summer oils, and miscible oils are used against scale insects; nicotine sulfate, oil emulsion, and miscible oils are used against aphids. The chewing insects, such as the codling moth, plum curculio, and cankerworm, actually eat the fruit or foliage. These are destroyed by poisoning their food. Lead arsenate is the standard material used against chewing insects.

Certain pests, such as the leaf roller, European red mite and other mites, can best be controlled by sprays applied to their eggs, which are laid on the twigs, branches, and trunks. Some contact poisons are also effective against chewing insects.

Fungal Diseases. Examples of fungal diseases of Illinois fruits are brown rot of stone fruits, apple scab, apple blotch, and black rot of grapes. Fungi are in reality plants living on the fruit, leaves, stems, or roots. Infection spreads by means of spores, which, when wet for a sufficient length of time, germinate and enter the surface. The injuries characteristic of the disease are then produced. In order to control the disease, sprays must cover the susceptible parts of the plants throughout the period of infection. Usually after the spores have germinated and the fungus has invaded the tissues, spraying will not control the disease. A comprehensive description of the diseases of Illinois fruits is given in Circular 241 of this Station, “Diseases of Illinois Fruits,” which will be sent on request.

Lime sulfur and bordeaux are standard materials used to control fungal diseases in this state. Because of their convenience, dry-mix sulfur lime and the commercial wettable sulfurs have largely replaced self-boiled lime and sulfur. For spraying small orchards or fruit gardens commercial lime sulfur, either liquid or dry, is recommended rather than homemade lime sulfur because of time saved and convenience.
Thoro Spraying Highly Important. Thoroness in spraying is as important as is the use of the right materials at exactly the right time. It is of much more importance than any factor such as pressure or size of nozzle openings. No very definite estimate of the amount of spray necessary can be given, since it varies with many factors, including the kind, size, density, and variety of the tree or bush and the pests to be controlled. The efficiency of the apparatus in spraying without undue loss of material is also an important factor. The pump and nozzle should be large enough to avoid wasting the time of the operator and small enough to avoid wasting material. A beginner may roughly estimate the number of gallons required for one application to a mature apple tree by dividing the age of the tree in years by two.

The formulas in the following schedules are based on the preparation of 100 gallons of spray at one time. The proportions, of course, remain the same regardless of quantity.

PART I—SPRAY SCHEDULES

Associated with the climatic variations that occur in different sections of Illinois are found differences in the severity of certain fungous diseases and insect infestations. Certain insects or fungous diseases that may be absent in one section may be found in another. Climatic variations in different seasons also modify the severity of the attack and the ease of control of the various pests. All these factors affect the spraying program, especially that for apples.

CONSIDERATIONS IN PLANNING APPLE SCHEDULE

The spraying program for apples should be laid out with specific reference to the orchard to be protected, its locality, the varieties grown, the age and condition of the trees and their immediate surroundings. A spray that combines an insecticide with a fungicide can usually be applied, thus controlling insect pests and fungous diseases with the same application.

The insects upon the control of which an apple spray schedule is based are San Jose scale,1 scurfy scale, oyster shell scale, aphids, codling moth, and plum curculio; the fungi are apple scab, apple blotch, and bitter rot. Other insects, such as the canker worms and various leaf feeders, and other fungi, such as sooty blotch, are controlled incidentally.

Location of Orchard in State. The distribution of most apple insects and fungi and the severity of their attack vary primarily with the latitude (Fig. 1).

San Jose scale is relatively unimportant in the northern quarter of the state, where oyster shell scale is sometimes a limiting factor in apple production and where scurfy scale is often abundant. In the remainder of the state this condition is reversed, the oyster shell scale and scurfy scale doing little damage, while the San Jose scale is often very destructive in the southern half. The green aphis and the rosy aphis are distributed throughout the state,2 and the injury produced by the plum curculio is not greatly modified as yet by latitude.

2The severity of attacks by aphids varies greatly from season to season. See page 20 under heading "Nicotine Sulfate" for statement about control of these insects.
Northern

*Oyster shell* and *scurfy scales* prevalent. *San Jose scale* light. *Codling moth*, one brood and partial second.

North Central

*San Jose scale* moderately abundant. *Codling moth*, one brood and partial second. Occasional blotch infection. *Oriental fruit moth*.

South Central

*Bitter rot, blotch* moderating toward northern boundary. *San Jose scale* serious. *Codling moth*, heavy second and partial third brood. *Oriental fruit moth*.

Southern

*Blotch*, *bitter rot*, and *San Jose scale* serious. *Codling moth*, heavy second and third broods. *Oriental fruit moth*.

Entire State

*Scab, curculio, and green and rosy aphids* must be sprayed for in all sections of the state.

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**Fig. 1.**—General Distribution and Severity of Insects and Fungi Which Modify the Spray Schedule in Different Parts of Illinois

*Codling moth* is important throughout the state, but is especially troublesome in the southern section, owing to the greater number of broods that occur there. In the extreme northern part of Illinois there is one full brood, and a partial second brood. In southern Illinois there is one full brood, almost a full second, and a partial third brood. Thus late infestations are much more serious in southern Illinois than in northern.

The *Oriental fruit moth* was found in southern Illinois in 1927 and has now spread to all peach-growing sections of the state. It has been found attacking apples where interplanted with peaches or where located near peach orchards.
Among the fungi, *scab* is a serious disease over the entire state; *blotch* is confined, roughly, to the southern half; and *bitter rot*, roughly, to the southern third. Scab is to be considered, therefore, in planning a spray schedule for any part of the state; scab and blotch, in planning one for the southern half; and scab, blotch, and bitter rot in planning one for the southern third.

**Variety to Be Treated.** Varieties of apples differ greatly in their degree of susceptibility to fungi. Immunity to one fungus, however,

### Table 1.—Varietal Resistance and Susceptibility of Apples to Scab, Blotch, Bitter Rot, and San Jose Scale

(R = resistant; S = susceptible; V = very)

<table>
<thead>
<tr>
<th>Variety</th>
<th>Scab</th>
<th>Blotch</th>
<th>Bitter rot</th>
<th>San Jose scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akin</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>—</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>VS</td>
<td>S</td>
<td>VS</td>
<td>S</td>
</tr>
<tr>
<td>Benoni</td>
<td>R</td>
<td>VS</td>
<td>R</td>
<td>—</td>
</tr>
<tr>
<td>Collins (Champion)</td>
<td>VS</td>
<td>R</td>
<td>R</td>
<td>—</td>
</tr>
<tr>
<td>Delicious</td>
<td>VS</td>
<td>VR</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Duchess (Oldenburg)</td>
<td>VR</td>
<td>VS</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>Early Harvest</td>
<td>VS</td>
<td>VS</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>Fameuse (Snow)</td>
<td>VS</td>
<td>(2)</td>
<td>VS</td>
<td>S</td>
</tr>
<tr>
<td>Golden Delicious</td>
<td>S</td>
<td>—</td>
<td>—</td>
<td>S</td>
</tr>
<tr>
<td>Grimes</td>
<td>VR</td>
<td>VR</td>
<td>—</td>
<td>VS</td>
</tr>
<tr>
<td>Huntsman</td>
<td>R</td>
<td>VS</td>
<td>VS</td>
<td>S</td>
</tr>
<tr>
<td>Jonathan</td>
<td>VR</td>
<td>R</td>
<td>VS</td>
<td>R</td>
</tr>
<tr>
<td>King David</td>
<td>R</td>
<td>R</td>
<td>VS</td>
<td>—</td>
</tr>
<tr>
<td>Kinnaird</td>
<td>VS</td>
<td>VS</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>McIntosh</td>
<td>VS</td>
<td>VS</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>Maiden Blush</td>
<td>S</td>
<td>R</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>Minkler</td>
<td>R</td>
<td>VS</td>
<td>—</td>
<td>VS</td>
</tr>
<tr>
<td>Missouri Pippin</td>
<td>S</td>
<td>VS</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>Northwestern Greening</td>
<td>VS</td>
<td>VR</td>
<td>(1)</td>
<td>VS</td>
</tr>
<tr>
<td>Red June</td>
<td>VS</td>
<td>S</td>
<td>(1)</td>
<td>S</td>
</tr>
<tr>
<td>Rome Beauty</td>
<td>VS</td>
<td>S</td>
<td>R</td>
<td>VR</td>
</tr>
<tr>
<td>Salome</td>
<td>R</td>
<td>VS</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Stark</td>
<td>VR</td>
<td>VR</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Stayman</td>
<td>S</td>
<td>R</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Turley</td>
<td>VR</td>
<td>VS</td>
<td>VS</td>
<td>S</td>
</tr>
<tr>
<td>Wealthy</td>
<td>VR</td>
<td>S</td>
<td>R</td>
<td>—</td>
</tr>
<tr>
<td>Willowtig</td>
<td>S</td>
<td>VR</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Winesap</td>
<td>R</td>
<td>R</td>
<td>(4)</td>
<td>S</td>
</tr>
<tr>
<td>Yellow Transparent</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>S</td>
</tr>
<tr>
<td>York Imperial</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>S</td>
</tr>
</tbody>
</table>

1The data on varietal resistance to blotch and bitter rot, presented in this table, hold for the localities where these fungi are most prevalent. The varieties most susceptible to these fungi are subject to infection for some distance north of these regions. 2Not grown in blotch area. 3Not grown in bitter-rot area. 4Ripens early and thus ordinarily escapes infection.

does not imply immunity to another; one variety may be very resistant to scab and susceptible to blotch, and another may be resistant to blotch and susceptible to scab. The spraying program can often be adjusted to advantage to meet these differences. For example, Delicious, which is very susceptible to apple scab, should receive all sprays designated as important in the control of this fungus, but since Delicious is very resistant to blotch, the sprays designed primarily for blotch may be omitted.
While varieties differ somewhat in susceptibility to insect injury, these differences usually are not great enough to warrant changes in the spray schedule. However, those varieties listed in Table 1 as susceptible or very susceptible to San Jose scale should be given especial attention.

**Age and Condition of Trees and Immediate Surroundings.** Until they come into bearing, all apple trees in the southern and south-central sections of the state should receive yearly dormant spraying for San Jose scale.

In the southern and south-central sections all young trees of varieties susceptible to blotch should receive applications of bordeaux 2 and 4 weeks after petal fall to reduce twig infections. Arsenate of lead should be added (at the usual rate) to the bordeaux applied to control leaf-eating insects.

Fungus and insect control on trees of bearing age is facilitated by proper pruning. Altho this is a secondary object of pruning, it is often an important one. A tree should not be allowed to grow too high or become too dense.

Proximity to scale-infested orchards makes scale control very difficult; proximity to uncultivated fields and woodlands increases the likelihood of injury by curculio.

**Season.** Wet weather promotes fungous infection, and rain or humid weather during periods when infections are likely to occur increases the severity of fungous attacks. As a rule dry warm weather is favorable to insects.

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**APPLE SCHEDULE**

**Dormant spray.** This spray is used particularly for the control of *San Jose scale* and should be applied annually as a matter of precaution in all apple and peach orchards in the state. Apply any time during the dormant period of the tree when the temperature is high enough so the spray will dry before freezing.

Two groups of materials are recommended for the dormant, or scale, spray: certain lubricating oil emulsions and miscible oils, and strong lime-sulfur solutions. Oil sprays are more effective than lime sulfur in killing San Jose scale. *Each 100 gallons of dormant spray should contain—*

- 3 gallons lubricating oil emulsion (page 15)
- or 12 gallons commercial concentrated lime sulfur testing 33° Baumé (equivalent to a specific gravity of 1.2946)
- or the amount of homemade lime sulfur indicated in Table 2 (page 18) for dormant spraying
- or 30 to 56 pounds dry lime sulfur (30 pounds for points north of Hancock and Vermilion counties, 56 pounds for Hancock and Vermilion counties and points in same latitude or south
- or commercial miscible oils at concentrations recommended by manufacturers

If an orchard is infested with *green* or *rosy aphis*, the dormant spray may be delayed until the tips of the buds show green but not later; at which time some kinds of aphids will have hatched and clustered on the outside of the buds, where they can easily be hit by the spray. They can be killed by the addition of nicotine sulfate to the lime-sulfur sprays (1 pint of 40-percent nicotine sulfate in 100 gallons lime sulfur).

Most oil emulsions or miscible oils will kill the aphids hit by these sprays when used at the strength recommended above. Nicotine sulfate 1-2000 greatly increases the efficiency of these sprays.
FIG. 2.—PROPER CONDITION AND TIME FOR THE CALYX SPRAY OF THE APPLE

Note that the calyx lobes are still open and that the petals have fallen.

FIG. 3.—TOO LATE FOR CALYX SPRAY

The calyxes of the apples which have set are closed.
Orchards in western Illinois have been more or less injured by the apple leaf roller. Where this insect has caused damage, orchards should be sprayed thoroughly with an 8-percent lubricating oil emulsion or with miscible oil at the highest strength recommended by the manufacturers. Branches and trunks should be thoroughly covered with this spray.

**Cluster-bud spray.** This is primarily for the control of apple scab but is also used to control cankerworm, and bud moth. It should be begun when the flower buds first show pink and completed before any of them have opened. *Each 100 gallons of spray should contain—*

- 2 gallons commercial lime sulfur testing 33° Baumé
- or the amount of homemade lime sulfur indicated in Table 2 (page 18) for summer spraying
- or 6 pounds of dry lime sulfur

If cankerworm or bud moth is present, add 2 pounds powdered lead arsenate mixed to a cream with a small quantity of water at least an hour before using.

**Calyx spray.** This is the most important spray of the year in control of the codling moth and it is equally important as a spray for scab. It is also valuable as a spray against bud moth, green fruit worm, and plum curculio. Start applying when three-fourths of the petals have fallen, and complete before the calyx lobes close on the most advanced fruit, which usually will be within 5 days or less. Use same materials as for the cluster-bud spray but add 3 or preferably 4 pounds of lead and 8 pounds hydrated lime.

Varieties only moderately susceptible to scab may be sprayed with flotation sulfur (see page 22) in place of lime sulfur, using 8 pounds (dry-sulfur basis) to 100 gallons.

**One week after fall of petals.** An application should be made at this time for apple scab and curculio. It is sometimes made also for blotch. Use same materials in same proportions as for calyx spray.

**Two weeks after fall of petals.** Use this spray for varieties especially susceptible to blotch and omit for other varieties. Use same materials in same proportions as for the calyx spray, but arsenate of lead may be omitted.

**Three weeks after fall of petals.** Use this spray for blotch, scab, leaf spot, first-brood codling moth, and curculio. Use same materials in same proportions as for calyx spray. Flotation or wettable sulfurs are not recommended for blotch and should not be used on susceptible varieties where this disease is prevalent.

**Four weeks after fall of petals.** As this spray is for blotch and codling moth, it need be applied only where they are present. *On blotch-susceptible varieties* use borodeaux, standard strength (see page 16), unless the variety is known to be especially susceptible to bordeaux injury,¹ in which case lime sulfur should be used. *A special notice on orchard insect and disease conditions is sent out at this time to all those applying for this service.*

**Five weeks after fall of petals.** This spray is for blotch alone and need be applied only where blotch is prevalent. Use same materials in same proportions as for the spray 4 weeks after petals fall but omit the lead arsenate. If bordeaux is used for the 4-weeks spray, apply this spray 6 weeks instead of 5 weeks after fall of petals.

¹Among the varieties known to be especially susceptible to bordeaux injury are Ben Davis, Grimes, Jonathan, and Yellow Transparent.
Second-brood codling moth spray. Apply usually about nine weeks after petal fall. In each 100 gallons of solution use—

- 3 pounds powdered lead arsenate
- 4 pounds freshly slaked lump lime or 6 pounds hydrated lime—or bordeaux standard strength. This should be used in place of lime if bitter rot, blotch, or sooty blotch has caused injury in previous seasons.

During the past four years tests with oil emulsions made from highly refined oils have given nearly as good control of codling moth as has been obtained from arsenate of lead. Nicotine sulfate (1-1600) added to the oil emulsions, has given even better results. These emulsions have been used at 1½ to 2 percent strength, but, since they are commercial products, the recommendation of the manufacturer must be followed. The use of such sprays greatly lessens the danger of excessive spray residue on the fruit at time of marketing. There has been some spotting of fruit where oil sprays have been used.

If these oil sprays are used in place of the second- and third-brood lead sprays, they should be applied at intervals of about three weeks, starting with the first second-brood spray and making three applications in the southern half of the state and two in the northern half. The emulsions used should be made from saturated white oils having a loss to sulfuric acid of 1 percent or less.

Do not use dormant spray oils, oil emulsions, or miscible oils for summer spraying, as severe injury is likely to result. Write to the Natural History Survey, Urbana, for further information on summer sprays.

Note. The time of appearance of the second and third broods of codling moth varies with locality and season. The Experiment Station and the Natural History Survey make annual observations as to time to spray for each brood. Advice is mailed to about three thousand orchardists. This information will be sent any fruit grower on request. Timeliness is very important.

Additional codling moth and bitter rot spray. Use same materials as for second-brood codling moth spray but with only 2 pounds of lead arsenate. Spraying should generally be completed about 2 weeks after that application.

Third-brood codling moth spray. In the southern half of the state the third brood of the codling moth is frequently the most destructive. Use same spray as for second-brood codling moth. The application should be completed about August 15, or when the observations on emergence show that this spray would be most effective.

Additional late-brood codling moth spray. Use same spray as the preceding spray for codling moth. Complete by September 1.

Special bitter rot sprays. Where this disease is anticipated, start spraying the first week in July, and repeat at intervals of 10 days until four applications have been made. Bordeaux (standard strength) is the proper fungicide to use. If no preventive sprays have been applied and the disease appears unexpectedly, start spraying immediately.

SCHEDULE FOR PEARS

Dormant spray. On bearing Keiffer or Garber pears this spray is necessary only when the trees have actually become infested. Most other varieties of pears grown in the southern section will require annual spraying, the same as apples, as a precautionary measure.
A serious pest of pears known as the *pear psylla* appeared for the first time in Illinois in 1929. In areas where this insect is causing damage, pears should receive a thorough dormant spray with homemade oil emulsion, or one of the miscible oils, used at the highest strength recommended for the control of San Jose scale.

**Calyx spray.** This is for *codling moth*, *curculio*, *leaf spots*, and *pear scab*. Start applying as soon as most of the petals have fallen. Use same materials in same proportions as for calyx spray for the apple.

**Three weeks after fall of petals.** This is for *codling moth*, *curculio*, *leaf spots*, and *sooty blotch*. Use same materials in the same proportion as for calyx spray for apples.

**Additional sprays.** If leaf spot is prevalent, bordeaux (standard strength) should be applied at intervals of 2 weeks until about August 1.

### PEACHES

**Dormant spray.** This is used against *San Jose scale* and *leaf curl*. Apply in the fall after the leaves have dropped or in the spring before the buds swell. *In each 100 gallons of spray use—*

- 12 gallons commercial liquid lime sulfur
- or the amount of homemade lime sulfur indicated in Table 2 (page 18) for dormant spraying
- or not less than 30 pounds dry lime sulfur
- or cold mix oil emulsion plus bordeaux (see page 17)
- or 3 gallons boiled lubricating oil emulsion plus bordeaux (see page 16)
- or 4 gallons oil emulsion where scale is very abundant
- or commercial miscible oil with fungicide

When San Jose scale is very abundant, use oil emulsion at the rate of 3 gallons in 100 gallons of standard bordeaux mixture (see page 16), the bordeaux being used for the control of peach leaf curl.

**First summer spray.** This treatment, which is for *plum curculio*, should be begun about 10 days following bloom, when the shucks are half off the young fruit. *In each 100 gallons of spray use 3 pounds powdered lead arsenate, and zinc sulfate-lime* made according to formula on page 17.

Many commercial growers have found it an advantage to repeat this application as soon as the first spraying has been completed.

*Do not use dry lime sulfur or liquid lime sulfur as summer sprays for peaches.*

**Second summer spray.** About 10 days after the first summer spray, apply a spray for *plum curculio*, *bacterial spot*, and *scab*. Use same materials in same proportions as in first summer spray. On scab-susceptible varieties 6 pounds flotation sulfur or commercial wettable sulfur should be added.

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1 The most destructive insect attacking the peach is the peach borer. This insect cannot be controlled by spraying but is easily killed by the application of paradichlorobenzene about the base of the trunk from September 25 to November 1. This chemical should be used at the rate of 1/2 to 1 1/2 ounces per tree, depending upon the age of the tree. It should be applied at not more than 3 inches from the trunk, but care must be taken that none of it touches the bark. It should be covered with about 2 inches of soil. This material should not be applied during the season the trees are planted. For full directions for the control of the peach borer, see Illinois Natural History Survey, Entomology Circular 8, "The Peach Borer and Methods of Control." Address Natural History Survey, Urbana, Illinois.

2 The Oriental fruit moth, a serious pest of peaches and other fruits, is just becoming established in Illinois. No satisfactory spray has yet been found for the control of this insect. Supplementary directions for controlling this insect will be sent to anyone requesting them.

3 Zinc sulfate-lime (zinc bordeaux) has been found to reduce greatly lead arsenate injury and is recommended for this purpose irrespective of possible control of bacterial spot, for which it was originally intended.
Third summer spray. About 2 to 3 weeks later apply another spray, using same materials as used in second summer spray.

Additional zinc sulfate-lime sprays. If zinc sulfate-lime is used for bacterial spot, apply every two weeks until a month before harvest. No lead arsenate is needed in these sprays.

Fourth summer spray. Apply one month before harvest for control of late curculio and possibly bacterial spot. Use 2 pounds of lead arsenate and zinc sulfate-lime.

Fifth summer spray. Three weeks before harvest, sprays should be applied for brown rot. Use flotation or commercial wettable sulfurs, 6 pounds actual sulfur to 100 gallons of spray. Do not add lead or lime.

Sixth summer spray. One week before harvest apply another brown rot spray, using same materials in same proportion as in preceding spray.

Dusting. Dusting has given fairly satisfactory results. A mixture of 80 parts dusting sulfur, 10 parts hydrated lime, and 10 parts lead arsenate is usually used. Apply about every two weeks. In dusts applied less than three weeks before harvest, omit arsenate of lead.

Dusts containing 5 percent (by weight) of mineral oil have proved much more effective than dusts not containing oil. They have satisfactorily controlled insects and diseases without arsenical injury, which sometimes results from lead arsenate in sprays.

CHERRIES

The following schedule is recommended for sour cherry orchards in Illinois:

Dormant spray. Sour cherries are frequently infested with Forbes' scale and occasionally with San Jose scale. For these apply a dormant spray of lime sulfur or dormant oil the same as for the apple.

First summer spray. This is for brown rot, leaf spot, curculio, and slug. Spray immediately after the shucks have fallen. In 100 gallons of spray use—

- 2 gallons commercial lime sulfur
- or the amount of homemade lime sulfur indicated in Table 2 (page 18) for summer spraying
- or 10 pounds flotation sulfur (dry basis), 3 pounds powdered lead arsenate, and 6 pounds hydrated lime

Second summer spray. When damp weather follows the first summer spray, make another application 10 days later, using same materials as for preceding spray.

Additional sprays. If leaf spot (yellow leaf) is prevalent, apply a spray of lime sulfur 2-100 or flotation sulfur 10-100 immediately after harvest. If cherry slugs appear in abundance in August, apply a spray in each 100 gallons of which there are 2 pounds powdered lead arsenate and 6 pounds hydrated lime.

PLUMS

Dormant spray. Same as for apples.

First summer spray. Make this application, which is for the control of leaf diseases, brown rot, and plum curculio, just before the blossom buds open. Use lime sulfur lead arsenate as for first summer spray for cherries.

Second summer spray. This also is for leaf diseases, brown rot, and curculio. Apply immediately after the shucks fall. Use lime sulfur lead
arsenate as for the first summer spray. For Japanese varieties use flotation or commercial wettable sulfurs in place of lime sulfur.

**Third summer spray.** This again is for leaf diseases, brown rot, and plum curculio. About 10 days after the second summer application apply same materials as directed for previous sprays.

**Additional spray.** If the season is exceptionally wet, or if curculio is a serious pest, it will pay to spray at intervals of 2 weeks until 4 weeks before picking time, with same materials and at same strength as for the second summer spray.

*Apfids* occasionally become very abundant on plums. Spray with a 40-percent nicotine sulfate solution (1 pint to 100 gallons of water in which 4 pounds of soap have been dissolved).

**BRAMBLES**

A number of troublesome insects and diseases are commonly encountered in growing blackberries, dewberries, and raspberries. Certain diseases, such as crown gall, orange rust, mosaic, leaf curl, and bramble streak, cannot be controlled by spraying. Do not plant brambles on soil where diseased plants have recently grown. Inspect all nursery stock carefully for evidence of these diseases before planting. If trouble appears, dig up diseased plants with as many roots as possible and burn at once.

*Mild mosaic* of red raspberries, which is not serious on the reds, becomes virulent on blackcaps. Consequently red and black raspberries should not be planted within 300 feet of each other.

Blackberries growing wild often harbor orange rust and are a constant source of infection if near a cultivated patch. Varieties resistant to orange rust should therefore be planted when possible. Blackberries are frequently infested with rose scale. If the infestation is severe, spray in the dormant season with either oil emulsion or lime sulfur.

*Anthracnose*, most serious on the black raspberry, may be controlled in two ways: by the selection of a partially resistant variety, such as the Quillen, and by two seasonal applications of lime sulfur—a delayed dormant and a pre-bloom spray.

**Delayed dormant spray.** Apply in the spring after the beginning of growth, but not after leaflets have reached 3/4-inch in length. Use lime sulfur diluted 11 gallons of commercial material (testing 33° Baume) in 100 gallons of spray, or use homemade lime sulfur of equivalent strength (see dilution table, page 18).

**Pre-bloom spray.** This spray should be applied a week before bloom, but if unseasonably hot weather develops then, it is safer to use bordeaux than lime sulfur, on account of possible injury. Unless the plantation is severely infected, fairly satisfactory control is secured from the dormant application of lime sulfur. Use commercial liquid lime sulfur (testing 33° Baumé) at the rate of 2 gallons in 100 gallons of spray, or homemade lime sulfur of equivalent strength (see dilution table, page 18).

In spraying brambles every cane must be well covered. The addition of casein-lime, at the rate of about 1 pound to 100 gallons of solution, is suggested to facilitate covering. In setting out a bed of black raspberries, anthracnose will be controlled to a marked degree if all the old stubs are removed before the young plants are set.

The larvae of certain sawflies which work on blackberry and raspberry foliage are controlled by lead arsenate (2 pounds in 100 gallons of spray) applied within a week after the plants are in full foliage.
CURRANTS AND GOOSEBERRIES

Currants and gooseberries are largely subject to the same diseases and insect enemies, and hence demand much the same treatment.

San Jose scale may be controlled by a dormant spray of commercial liquid lime sulfur (12 gallons testing 33° Baumé to 100 gallons of solution, oil emulsion or homemade lime sulfur of equivalent strength, according to the dilution table on page 18, or with oil emulsions or miscible oils at the same dilution as for apple.)

The currant worm may be controlled by spraying with lead arsenate (2 pounds in 100 gallons of spray). Do not wait until the worms appear but spray early in the season just after the plants come into full foliage. If for any reason spraying is delayed, apply lead arsenate as soon as the worms are discovered.

Spraying for the currant aphis, which may be necessary only on the currant bushes, should begin when the leaves are one-fourth open, at which time the eggs are hatching. Apply nicotine sulfate, 2 pints, with 1 gallon of Penetrol, in 100 gallons of spray, to the undersides of the leaves. Make second application in 10 days.

Spraying for currant leaf spot should be begun when the leaves are unfolding and repeated at intervals of 2 weeks until four applications have been made. Use standard strength bordeaux (page 16).

Anthracnose, leaf spot, and mildew on gooseberries may be controlled by the use of lime sulfur. Make first application when the leaves are unfolding, using lime sulfur, dormant strength (as suggested above for San Jose scale). Make three additional applications at 2-week intervals, using commercial liquid lime sulfur diluted at the rate of 2 gallons testing 33° Baumé to 100 gallons of solution, or using homemade liquid lime sulfur of equivalent strength as determined from the dilution table on page 18.

GRAPES

Grapes need thorough and consistent spraying if they are to be grown profitably in this state.

Some varieties become heavily infested with scale. When this occurs, a dormant spray of lime sulfur should be applied as recommended for San Jose scale on currants and gooseberries. Anthracnose also may be controlled in part by this same dormant application. It should be applied if anthracnose has been prevalent in previous years. Lime sulfur will injure the plants if applied while they are in foliage.

The grape flea beetle, if troublesome, will appear as the buds are swelling. The opening buds should be protected with an application of 4 pounds of lead arsenate powder in 100 gallons of spray.

Common grape troubles can usually be held in check by the following spray schedule:

First application. For grape berry moth, rose chafer, black rot, and anthracnose, apply just before bloom a combination spray of bordeaux standard strength and arsenate of lead 3 pounds in 100 gallons of solution.

Second application. Use same mixture as for the first application. Apply immediately after the bloom has fallen. This is for control of grape berry moth, leaf folder, and occasionally grape root worm and rose chafer, as well as for black rot, anthracnose, and downy mildew.

Third application. This is made 10 days after fall of bloom, for the control of grape root worm, leaf folder, rose chafer, if present, black rot, anthracnose, downy mildew, and powdery mildew. Use combination spray of bordeaux with arsenate of lead 2 pounds in 100 gallons of spray.
Fourth application. Make 3 weeks after bloom has fallen, for the control of grape root worm, black rot, anthracnose, ripe rot, and the mildews. Use same spray mixture as for third application, except where leafhoppers are present, in which case add nicotine sulfate (1 pint in 100 gallons of solution). Apply spray thoroughly, especially to undersides of leaves. The insects should be hit by the spray.

**STRAWBERRIES**

Most insect pests and fungous diseases of strawberries can be controlled by proper cultural methods. An infestation of white grubs, the larvae of the May beetle, or “June bug,” may usually be avoided by not planting on sod land. A cultivated crop should be grown the year previous to setting plants.

Where leaf spot is troublesome, control by spraying with bordeaux. Make first application before blossoming, and second just after blossoming.

Where the leaf roller is destructive, lead arsenate (3 pounds in 100 gallons of spray) applied at the first appearance of blossoms, is effective. Spraying should be done before the worm has protected itself by folding up the leaf. A pressure of at least 100 pounds helps materially to drive the solution into the folds where insects may have begun their attack.

A combined spray of bordeaux and arsenate of lead applied before and after blossoming and again as soon as new foliage appears after the patch has been renovated in late summer, will aid in controlling leaf spot, leaf roller, and other insects such as the flea beetle.

Mowing and burning over the bed, followed by the narrowing down of the rows, an operation in the renovating process, also are a great help in holding strawberry pests in check.

**PART II—PREPARING AND MIXING SPRAY MATERIALS**

Materials for the preparation of sprays and dusts should be selected only after careful consideration of their merits, as determined by experimental evidence. Home preparations are usually cheaper than commercial products, but it is often more convenient to use standard commercially prepared materials. Directions are given below for the preparation and mixing of certain homemade standard sprays and dusts. This is followed by a description of some of the types of commercially prepared materials which are in general use.

**BOILED LUBRICATING OIL EMULSION**

To make the stock emulsion of boiled lubricating oil use:

- Light-grade lubricating oil\(^1\).........................1 gallon
- Water.................................................1 quart
- Potash fish-oil soap (40 percent soap)............1 to 2 pounds
  (Many waters require more than 1 pound of soap to stabilize the emulsion.)

Place water, soap, and oil in a kettle or tank heated by fire or steam. Boil for 5 minutes, being careful not to burn the mixture; remove from

\(^1\)Best results have been obtained with oils within the following specifications:

- Specific gravity at 20° C. ...........................................0.87 to 0.93
- Volatility at 110° C. for 4 hours. .......................not above 10 percent
- Viscosity at 100° F. ........................................90 to 250 seconds (Saybold test)
fire or turn off steam and pump thru a spray pump at 150 to 250 pounds pressure. At the higher pressure, one pumping is usually sufficient.

To make the stock emulsion on a large scale, use an all metal pump. The rotary type is very satisfactory. For small amounts a barrel pump may be used. The stock emulsion should not be made in a cooker previously used for cooking lime sulfur without a thoro cleaning, nor should it be stored in lime-sulfur barrels.

Use precaution to prevent the stock emulsion from freezing. If it does freeze, allow it to thaw out gradually and apparently no harm results. Do not heat or stir while thawing. A common method of testing doubtful stock emulsion is to put about a half pint into a bucket of water. If the diluted material has a milky appearance with no free oil on top, the emulsion has not broken down.

When stock emulsion has stood for some time, a part of the soap may settle to the bottom of the container in a dark brown layer. This does not injure the emulsion, but the material should be stirred well into the emulsion before diluting for spraying.

Directions for diluting the stock solution for spraying are given in the spray schedules for apples and peaches. In diluting, if the oil separates it is advisable to fill the tank with 1/2-1-100 bordeaux and then to add the required amount of stock emulsion.

Spray tanks which have been used for lime-sulfur solution must not be used for oil emulsion until they have been washed out with bordeaux mixture. To wash a tank with bordeaux, 8 pounds of hydrated lime or 6 pounds of freshly slaked lump lime should be mixed with about 100 gallons of water in the tank, and a solution containing 4 pounds of copper sulfate should be poured in while the agitator is running. When the inside of the tank has been thoroly splashed and soaked with the solution, a few gallons should be run thru the pump and hose and the tank drained.

Some cold mixed oil emulsions have given good results in scale control and are the cheapest sprays that can be used for this purpose (see directions for making cold mixed emulsions below).

**Boiled Lubricating Oil Emulsion Plus Bordeaux.** Make a 6-10-100 bordeaux mixture (see below) and add the required amount of boiled lubricating oil emulsion (see above) with agitator running.

**COLD-MIXED OIL EMULSIONS**

**Bordeaux Cold-Mixed.** Pump together equal parts of oil and 6-10-100 bordeaux mixture, sending the material at least twice thru the pump. For a 2-percent strength, dilute 4 gallons in 100.

**Calcium Caseinate Cold-Mixed.** Pump together 2 gallons of oil and 1 gallon of water in which is dissolved 4 ounces of calcium caseinate. For a 2-percent strength, use 3 gallons in 100. These emulsions should be used at once since they separate on standing.

**BORDEAUX**

When a small quantity of bordeaux is needed, a commercial preparation may be used. Dilute according to the directions of the manufacturer. For a considerable amount of spraying bordeaux is ordinarily prepared by the orchardist according to the following formula:

- 6 pounds copper sulfate (blue vitriol)
- 10 pounds hydrated lime.
- or 8 pounds lump (stone) lime
- 100 gallons water
Directions for Mixing. If stone lime is used, prepare two stock solutions, one of lime and one of copper sulfate, using these materials at the rate of 1 pound in a gallon of solution.

Carefully slake the lime with just enough water to prevent the formation of a dry powder. After the violent boiling is over, add a small amount of water. Work to a paste or cream and let cool; then dilute to contain 1 pound of lime to a gallon of solution.

If hydrated lime is used, the amount required for each sprayerful should be stirred into enough water to make a thin paste.

Place required amount of copper sulfate in a cloth bag and suspend in a wooden or stone vessel just at the surface of the water which has been measured into it. Do not stir until copper sulfate has dissolved.

The copper sulfate and lime are now ready for mixing. First, with the agitator going, partly fill the sprayer with water. Then add the lime thru a strainer—either 8 gallons of stock solution of stone lime or 10 pounds of hydrated lime in paste form for each 100 gallons of spray. Continue filling sprayer with water until it is about two-thirds full. With the agitator still going, add 6 gallons of copper sulfate stock solution for every 100 gallons of spray. Then add water to make up the final volume.

This method of mixing bordeaux can be used either with or without a tank filler.

Field Preparation of Cold-Mixed Oil Emulsion and Bordeaux. In one container (a barrel is convenient) dissolve copper sulfate at the rate of 1 pound to 2 gallons of water. In another container mix hydrated lime in the same proportions. To make 100 gallons pour 4 gallons from each container simultaneously into the tank with the agitator running. Add 1½ to 2 gallons of oil (for proper specifications see footnote on page 15), and run the pump so that the mixture is pumped back into the spray tank for a few minutes. This is the cold-mixed oil emulsion. While the tank is being filled with water, add 6 pounds of copper sulfate (previously dissolved) and 10 pounds of lime, as lime water, for each 100 gallons of complete spray. Use the mixture at once, for the oil may separate on standing.

ZINC SULFATE-LIME

The formula now recommended is as follows:

- 8 pounds zinc sulfate
- 8 pounds hydrated lime
- 100 gallons water

Directions for Mixing. Commercial zinc sulfate may be used. Run into the tank a few gallons of water and then add the required amount of zinc sulfate. Continue filling the tank. The zinc sulfate dissolves rapidly and will be in solution by the time the tank is 2/3 full. Add, thru the strainer, the required amount of lime, which has previously been made into a thin paste in a separate container. Finish filling the tank and agitate a few minutes before spraying.

HOMEMADE LIME SULFURS

For making the mixtures at home the following formula is in common use in Illinois:

50-gallon formula

- 100 pounds ground sulfur
- 50 pounds lump lime
- 50 gallons water

Lime sulfur is prepared by cooking the ingredients together until prac-
tically all the free sulfur has dissolved, a process which requires approximately 45 minutes. When the spray is made in large quantities, the cooking is usually done with live steam. With smaller quantities it is more often done in kettles over a fire.

**Cooking With Live Steam.** Provide two large tubs by cutting a large cask across the middle. Before cutting, draw two stout wires around the middle of the cask about 2 inches apart, and cut between them. Staple the wires in place to act as top hoops for the tubs. Bend a piece of 1-inch gas pipe into nearly circular form, so that it will lie on the bottom of the tub. Cap one end, drill \( \frac{1}{8} \)-inch holes at intervals of 4 inches to permit the escape of live steam, and attach the other end to a steam feed pipe leading from a steam boiler. Various systems of elevated platforms may facilitate the work, but whether or not their use is practical depends upon the arrangements in the individual cooking plants.

A mechanical agitator must be provided which will keep the solution stirred constantly from the beginning to the end of the cooking. A good form of agitator is made to work with sweeping arms, rotating on a shaft placed in the center of the tub. To aid in agitation, boards can be fastened to the tub, projecting toward the center. The agitator works on the bottom of the tub underneath the screen described later.

### Table 2.—Dilution Table for Lime Sulfur

<table>
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<tr>
<th>Degrees Baumé</th>
<th>Specific gravity</th>
<th>Amount of lime-sulfur solution to be used in making up 100 gallons of diluted spray</th>
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<tbody>
<tr>
<td></td>
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<td>Gallons</td>
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<tr>
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<td>18</td>
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<tr>
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</tr>
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<td>33(^2)</td>
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</tr>
<tr>
<td>35</td>
<td>1.3181</td>
<td>11</td>
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</table>

\(^1\)Approximate strength of lime sulfur made by the 50-gallon formula. 
\(^2\)Standard commercial.

**Note**—Since the strengths of the solutions made according to the 50-100-50 formula and also of the commercial lime sulfur are only approximately those indicated by the figures carrying notes 1 and 2 in column 1 above, it is suggested that the orchardist test his solution with a hydrometer, so that in making up 100 gallons of spray he can use exactly the number of gallons of lime-sulfur solution indicated in the table for a solution of that particular density.
A large-sized spigot, thru which to run the solution from the tubs after cooking, should be provided on one side near the bottom. Three inches from the bottom of the tub supported by wooden blocks at the outer edge and by the agitator bearing in the center, place a screen of ½-inch mesh of No. 9 wire cut to fit the tub snugly at the point where the screen rests.

Only a hydrometer made especially for testing lime sulfur should be purchased. These are about 10 inches in length. Both the hydrometer and the hydrometer jar can be obtained thru local druggists.

Depending on the size of the tub, quantities of 50 to 200 gallons may be made at one time. To make about 50 gallons by the above formula, place 50 pounds of fresh, unslaked lump lime on the screen near the bottom of the tub, and pour in enough water, preferably hot, to start the lime slaking. When slaking freely, pour in 100 pounds of sulfur, and add enough water, preferably hot, to bring the total volume up to 40 gallons. Turn on the steam and cook until the free sulfur has disappeared. The condensing steam will gradually increase the volume. The final volume will be influenced by the initial temperature of the water, the temperature of the steam turned in, and the thoroughness of the agitation. On this account the final product should be tested with a hydrometer. It should have approximately the density indicated for the 100-gallon formula in Table 2.
The clear lime-sulfur solution may be stored in large casks, barrels, or tanks, until needed.

**Making Over a Fire.** When lime sulfur is cooked over a fire, the following directions will be found practical.

Place in a large kettle over a low fire 15 gallons of water and 50 pounds of good lime free from air-slaked particles. When the lime is slaking vigorously, pour in 100 pounds of ground sulfur and mix thoroughly with the lime. Gradually add sufficient water to prevent the lime from drying out during the process of slaking. As soon as the lime is thoroughly slaked and the sulfur thoroughly mixed, add enough water to bring the total volume to 50 gallons. Boil for about 45 minutes, adding enough water from time to time to keep the volume at or above 50 gallons. For mixing in this way a 75-gallon feed cooker has proved convenient.

**Dilutions to Use.** Table 2 shows the dilutions to be used with different lime-sulfur concentrations. The first column gives the reading on the Baumé hydrometer usually used for indicating the strength of lime sulfur solutions. Hydrometers are sometimes graduated for specific gravity readings. The second column gives the specific gravity corresponding to the Baumé scale.

**OTHER HOME-MIXED SPRAYS**

**Dry-Mix Sulfur-Lime.** The formula for a dry-mix sulfur-lime is as follows, the percentages being based on weight:

- 64 percent superfine (dusting) sulfur
- 32 percent hydrated lime
- 4 percent casein-lime

To remove lumps, first work the sulfur thru a screen having 12 to 14 meshes to the inch. Then thoroughly mix all the ingredients. This product may be stored indefinitely in a dry place. For spraying, use 12½ pounds of dry-mix in 100 gallons of water. Add lead arsenate for the control of certain insects.

**Lead Arsenate.** Lead arsenate should always be made into a thin paste and allowed to stand before it is strained into the sprayer. If it is not used in combination with bordeaux, 1 pound of freshly slaked lump lime or 2 pounds hydrated lime should be used with each pound of arsenate of lead as there is always a small amount of soluble arsenic present, which may be injurious to the foliage unless neutralized by the lime.

**Bordeaux-Lead Arsenate.** It is usually advantageous to combat insects with the same application used against fungous diseases. If bordeaux is to be used, the required amount of lead arsenate can be mixed with the diluted lime just before the copper sulfate stock solution is added, or it can be added after the bordeaux is completed.

**Lime Sulfur Lead Arsenate.** When using lime sulfur and lead arsenate in combinations, first place the lime sulfur in the sprayer and fill to about two-thirds capacity with water. Then, with the agitator on the pump working, strain the lead arsenate into the sprayer and add enough water to complete the volume desired.

**Nicotine Sulfate.** This material may be purchased in concentrated form. One gallon will make 800 to 2,000 gallons of spray mixture. As the cost is very high, use this material only when sure that aphids are present in sufficient numbers to cause damage. If used alone, add enough fish oil soap or laundry soap to soften the water, i.e., to make it sudsy when stirred; this usually requires at least 2 pounds of soap to 50 gallons of water.
The most common brand of nicotine sulfate is "Blackleaf 40." The same manufacturer has another brand known as "Blackleaf 50." This is a form of free nicotine and does not require the addition of soap to the spray solution. It contains 10 percent more actual nicotine than "Blackleaf 40."

Nicotine sulfate may be used at 1-2000 with the better class of commercial miscible oil sprays, or with homemade lubricating oil emulsion. This makes a very effective combination against aphids.

**DUSTING MATERIALS**

Unless large quantities of dusts are used, it is best to purchase factory mixed dusts, since it is essential that an intimate mixture of the ingredients be obtained. In purchasing prepared dusts, the proportions of sulfur, lead arsenate, and lime should be specified, since these vary for different crops. An 80-10-10 dust means that 80 pounds of sulfur, 10 pounds of lime, and 10 pounds of lead arsenate are contained in each 100 pounds. An 85-15 dust means that 85 pounds of sulfur and 15 pounds of lead arsenate are contained in each 100 pounds.

If the dusts are to be mixed by the grower, a mixing machine especially designed for this purpose should be used or else the dusts should be mixed in power dusters with a special mixing attachment. Only "dusting" sulfur should be used, and the manufacturer should guarantee that 95 percent of the sulfur will go thru a 300-mesh screen. High-grade hydrated lime should be used. Any of the standard powdered arsenates of lead are satisfactory. When lead arsenate is not used, as in the later dusts on peaches, the pure dusting sulfur should be mixed with 10 to 20 pounds of hydrated lime.

Experiments have shown that the value of some dusts may be considerably increased by the addition of 5 percent mineral oils. This work is still in the experimental stage. Anyone wishing directions for making such dusts may obtain the same by writing to the Illinois Experiment Station for them.

**PART III—COMMERCIAL PREPARATIONS**

**Commercial Liquid Lime Sulfur.** Most growers now purchase liquid lime sulfur from reliable companies. This is prepared in large quantities and is standardized so that the quality is fairly uniform. The grower should consider mainly the price at the orchard and the service given by the company. While specific gravity or Baume reading is usually an indication of the concentration of fungicidal sulfur, this may vary. However, it is the only simple method of determining the fungicidal sulfur content of lime sulfur.

**Dry Lime Sulfur.** Lime sulfur can be dehydrated and prepared as a dry powder. While more expensive than liquid lime sulfur, it is much more convenient to handle, and the waste is not so great.

**Wettable Ground Sulfurs.** Pure sulfur, however finely ground, is not wettable; the addition of certain wetting agents is necessary before it can be used in liquid sprays. A number of commercial brands of wettable sulfurs are now on the market. They have the advantage over dry-mix sulfur-lime in that, due to the absence of lime, they do not mar the appearance of the fruit. In purchasing wettable sulfurs, the grower should consider five points (1) percentage of sulfur; (2) price; (3) fineness of particles; (4) rate of settling; (5) convenience of mixing.
A material having less total sulfur is not necessarily inferior provided the price is correspondingly low and the recommendations call for equivalent amounts of sulfur. The ground wettable sulfurs are not so toxic to fungi as is lime sulfur but they are safer to use on plants subject to lime-sulfur injury.

**Flotation Sulfur.** Sulfurs recovered from artificial gas plants by a process of precipitation and flotation are grouped under the general term of “flotation” sulfurs. They are sold in three forms: paste, dry wettable, and dust. The paste form contains about 40 percent of sulfur and this should be taken into consideration in mixing.

Owing to the method of production, the sulfur particles are extremely fine and consequently possess greater fungicidal power than the ground sulfurs. Like the ground wettable sulfurs, flotation sulfur is less injurious to plants than is lime sulfur.

**Summer Oil Emulsions.** Summer oil emulsions are made from highly refined white oils emulsified with certain types of emulsifying agents. No satisfactory method of home-mixing these emulsions has yet been devised. There are several reliable brands now on the market; these must be used according to the manufacturer's directions.

**Miscible (Soluble) Oils.** There are on the market oils known as miscible or soluble oils. Oils of this type are concentrated emulsions containing little water and they therefore are resistant to freezing. They consist of a mineral oil base combined with an emulsifier in such a way that the resulting mixture is a clear fluid, in the undiluted form possessing the appearance of a clear oil. When water is added to miscible oils, a typical white emulsion is formed.

The ingredients of various miscible oils vary greatly, and consequently the various products may differ widely in their ability to emulsify with water, in their stability, keeping quality, and in their insecticidal and other properties. Miscible oils must be applied according to the manufacturer's recommendations. The grower can mix these oils, but the process requires special care, and in most cases home-mixing is not advisable.
MANUFACTURERS OF INSECTICIDES AND FUNGICIDES

Genera

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<th>Company</th>
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<tbody>
<tr>
<td>Ansbacher-Siegel Corp.</td>
<td>50 Union Square, New York, N.Y.</td>
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<tr>
<td>Bowker Insecticide Co.</td>
<td>43 Chatham St., Boston, Mass.</td>
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<tr>
<td>Corona Chemical Co.</td>
<td>Union Square National Stock Yards, New York, N.Y., East St. Louis, Ill.</td>
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<td>Dow Chemical Co.</td>
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<td>General Chemical Co.</td>
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<td>Grasselli Chemical Co.</td>
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<td>310 S. Commercial St., St. Louis, Mo.</td>
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Miscible Oils and Soaps

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Sulfur

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</tr>
</thead>
<tbody>
<tr>
<td>Koppers Company</td>
<td>Koppers Building, Pittsburgh, Pa.</td>
</tr>
</tbody>
</table>

This list does not pretend to be complete, for there are many other firms handling this class of materials. Products are in no way guaranteed by the inclusion of the name of the manufacturer in this list.

*These firms handle most of the insecticides and fungicides, including miscible oils, soaps, casein-lime, parachlorobenzene, wettable sulfurs, dusts, etc. Oils for making lubricating oil emulsion can be obtained from any of the larger oil companies; insist on oils of the proper specifications.

6000—1:32—1842-S
<table>
<thead>
<tr>
<th>Lime</th>
<th>Casein-Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lehigh Lime Co.</td>
<td>Golden State Sales Corp.</td>
</tr>
<tr>
<td>111 W. Washington St.</td>
<td>189 W. Madison St.</td>
</tr>
<tr>
<td>Chicago, Ill.</td>
<td>Chicago, Ill.</td>
</tr>
<tr>
<td>11th and Locust Sts.</td>
<td>205 E. 42d St.</td>
</tr>
<tr>
<td>St. Louis, Mo.</td>
<td>New York, N. Y.</td>
</tr>
</tbody>
</table>

**MANUFACTURERS OF SPRAYING AND DUSTING MACHINERY**

**Sprayers and Accessories**

- John Bean Mfg. Co.
  - Lansing, Mich.
- The Deming Co.
  - Salem, Ohio
- Field Force Pump Co.
  - Elmira, N. Y.
- Fitzhenry-Guptill Co.
  - Cambridge, Mass.
- Friend Manufacturing Co.
  - Gasport, N. Y.
- Hardie Manufacturing Co.
- Hayes Pump & Planter Co.
  - Galva, Ill.
- F. E. Meyers & Bros.
  - 1305 Orange St.
  - Ashland, Ohio
- Bateman Manufacturing Co.
  - Greenlock, N. J.

**Dusting Machinery**

- John Bean Mfg. Co.
  - Lansing, Mich.
- Feeny Mfg. Co.
  - Muncie, Ind.
- Messinger Mfg. Co.
  - Tatamy, Pa.
- Niagara Sprayer Co.
  - Middleport, N. Y.
- Peerless Dust Gun Co.
  - 1600 E. 24th St.
  - Cleveland, Ohio

There are many reliable local dealers in spray materials from whom standard insecticides and fungicides may be obtained.

This list supplements Circular No. 388, Illinois Agricultural Experiment Station, "Directions for Spraying Fruits in Illinois."