Proper condition and time for the calyx spray of the apple. Note that the calyx cups are still open.
## CONTENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insect Pests</td>
<td>3</td>
</tr>
<tr>
<td>Fungal Diseases</td>
<td>3</td>
</tr>
<tr>
<td>Amount of Spray</td>
<td>4</td>
</tr>
<tr>
<td>Spray Schedule for Apples</td>
<td>4</td>
</tr>
<tr>
<td>For Pears</td>
<td>11</td>
</tr>
<tr>
<td>For Peaches</td>
<td>11</td>
</tr>
<tr>
<td>For Cherries</td>
<td>12</td>
</tr>
<tr>
<td>For Plums</td>
<td>13</td>
</tr>
<tr>
<td>For Brambles</td>
<td>14</td>
</tr>
<tr>
<td>For Currants and Gooseberries</td>
<td>14</td>
</tr>
<tr>
<td>For Grapes</td>
<td>15</td>
</tr>
<tr>
<td>For Strawberries</td>
<td>16</td>
</tr>
<tr>
<td>Directions for Making and Mixing the Standard Sprays</td>
<td>17</td>
</tr>
<tr>
<td>Bordeaux</td>
<td>17</td>
</tr>
<tr>
<td>Commercial Lime Sulfur</td>
<td>17</td>
</tr>
<tr>
<td>Homemade Lime Sulfur</td>
<td>18</td>
</tr>
<tr>
<td>Self-Boiled Lime and Sulfur</td>
<td>20</td>
</tr>
<tr>
<td>Dry-Mix Sulfur Lime</td>
<td>21</td>
</tr>
<tr>
<td>Lead Arsenate</td>
<td>21</td>
</tr>
<tr>
<td>Bordeaux Lead Arsenate</td>
<td>22</td>
</tr>
<tr>
<td>Lime Sulfur Lead Arsenate</td>
<td>22</td>
</tr>
<tr>
<td>Self-Boiled Lime and Sulfur with Lead Arsenate</td>
<td>22</td>
</tr>
<tr>
<td>Nicotine Sulfate</td>
<td>22</td>
</tr>
<tr>
<td>Boiled Lubricating Oil Emulsion</td>
<td>22</td>
</tr>
<tr>
<td>Equipment for Making Boiled Lubricating Oil Emulsion</td>
<td>23</td>
</tr>
</tbody>
</table>
DIRECTIONS FOR SPRAYING FRUITS IN ILLINOIS

By the Department of Horticulture and the 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.

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, and miscible oils are used against scale insects; nicotine sulfate, a commercial tobacco preparation, and oil emulsions 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.

FUNGOUS DISEASES

Examples of fungous 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 fungus, sprays must cover the susceptible parts of the plants throughout the period of infection. After the spores have germinated and the fungus has invaded the tissues, spraying will not eradicate the disease.

Lime sulfur, self-boiled lime and sulfur, and Bordeaux are standard materials used to control fungous diseases in this state. On account of its easier preparation, the new dry-mix sulfur lime is likely

This circular is an extensive revision of Circular 266 of the same title.

to replace 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 for the sake of both time and convenience.

With the climatic variations occurring in the different sections of Illinois are found differences in the severity of certain fungous diseases and insect infestations. Certain insects or fungous diseases which may be absent in one section may be found in another. Such varying conditions call for variations in spray schedules, especially in the case of apples.

Since the information contained in this circular is particularly designed to meet the needs of the growers of small plantations, the formulas in the following schedules are based on the preparation of 50 gallons of spray at one time; that is, one barrelful. The proportions, of course, remain the same regardless of quantity.

AMOUNT OF SPRAY

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 selected, on the one hand to avoid waste of time because of being too small, and on the other hand, to avoid waste of material because of being too large. A beginner in spraying 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.

SPRAY SCHEDULE FOR APPLES

The spraying program or schedule should be laid out with specific reference to the orchard to be protected. Importance should be attached to its locality and to the varieties of apples grown, as well as to the age and condition of the trees and their immediate surroundings. 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.

The insects upon the control of which the spray schedule is based are San Jose scale,1 scurfy scale, oyster shell scale, aphids, codling

---

1 The orchardist is referred to Ill. Agri. Exp. Sta. Circ. 180, Observations and Experiments on the San Jose Scale. 1915.
moth, and plum curculio; the fungi are apple scab, apple blotch, and bitter rot. Other insects, such as the canker worms, and other fungi, such as sooty blotch, are controlled incidentally.

**Locality.**—The distribution of most of the insects and fungi and the severity of their attack vary primarily with the latitude.

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 aphid and the rosy aphid are distributed throughout the state, and the injury produced by the plum curculio is also not modified as yet by latitude in Illinois. Codling moth is an important insect throughout the entire state, but owing to the fact that a greater number of broods occur in the southern part, it is of more importance in that section. In extreme northern Illinois there is one full 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 than in northern Illinois.

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 of the state. Scab is to be considered, therefore, in planning a spray schedule for an orchard in 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. These fungi must be controlled in addition to the insects in each locality. In most cases a spray made by combining an insecticide with a fungicide can be applied, thus controlling both sorts of pests with the same application.

In Fig. 1 are shown the prevalence and severity in Illinois, according to latitude, of the attacks of apple blotch, bitter rot, and San Jose scale, and the number of broods of codling moth which generally occur. It will be noted that scab and curculio are prevalent over the entire state. From this map it is evident that in planning a spray schedule for a given orchard, the first consideration must be the location of the orchard within the state.1

**Variety.**—Varieties of apples differ greatly in their degree of susceptibility to fungi. Immunity to one fungus, however, does not imply immunity to another. For example, 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

---

1 The severity of attacks by aphids varies greatly from season to season. See statement on page 22 under the heading "Nicotine Sulfate" in regard to the 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.

SOUTH CENTRAL
Blotch moderating toward northern boundary. San Jose scale serious. Codling moth; heavy second and partial third brood.

SOUTHERN
Blotch, bitter rot, and San Jose scale serious. Codling moth; heavy second and third broods.

ENTIRE STATE
Scab and curculio present; also green and rosy aphids.

FIG. 1.—GENERAL DISTRIBUTION AND SEVERITY OF INSECTS AND FUNGI WHICH MODIFY THE SPRAY SCHEDULE

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 some varieties vary in susceptibility to insect injury, these differences are not great enough to warrant changes in the spray schedule.
Data on varietal resistance and susceptibility to the three most important fungi from the standpoint of the spray schedule are presented in Table 1.

### Table 1.—VARIETAL RESISTANCE AND SUSCEPTIBILITY TO SCAB, BLOTCH, AND BITTER ROT

<table>
<thead>
<tr>
<th>Variety</th>
<th>Scab</th>
<th>Blotch 1</th>
<th>Bitter rot 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akin</td>
<td>Resistant</td>
<td>Resistant</td>
<td>Resistant</td>
</tr>
<tr>
<td>Ben Davis</td>
<td>Very susceptible</td>
<td>Susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Benoni</td>
<td>Resistant</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Delicious</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Early Harvest</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Grimes</td>
<td>Very resistant</td>
<td>Very resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Huntsman</td>
<td>Resistant</td>
<td>Resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Jonathan</td>
<td>Very resistant</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>King David</td>
<td>Resistant</td>
<td>Resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Kinnaird</td>
<td>Very susceptible</td>
<td>Very resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>McIntosh</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Maiden Blush</td>
<td>Very resistant</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Minkler</td>
<td>Resistant</td>
<td>Resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Missouri Pippin</td>
<td>Resistant</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Northwestern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greening</td>
<td>Susceptible</td>
<td>Very susceptible</td>
<td></td>
</tr>
<tr>
<td>Oldenburg (Duchess)</td>
<td>Very resistant</td>
<td>Very susceptible</td>
<td></td>
</tr>
<tr>
<td>Red June</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
<td></td>
</tr>
<tr>
<td>Rome Beauty</td>
<td>Very susceptible</td>
<td>Resistant</td>
<td></td>
</tr>
<tr>
<td>Salome</td>
<td>Resistant</td>
<td>Resistant</td>
<td></td>
</tr>
<tr>
<td>Snow (Fameuse)</td>
<td>Very susceptible</td>
<td>Very susceptible</td>
<td></td>
</tr>
<tr>
<td>Stark</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stayman</td>
<td>Very resistant</td>
<td>Very resistant</td>
<td>Resistant</td>
</tr>
<tr>
<td>Wealthy</td>
<td>Very resistant</td>
<td>Very resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Willow Twig</td>
<td>Susceptible</td>
<td>Very resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Winesap</td>
<td>Susceptible</td>
<td>Resistant</td>
<td>Very susceptible</td>
</tr>
<tr>
<td>Yellow Transparent</td>
<td>Resistant</td>
<td>Resistant</td>
<td></td>
</tr>
<tr>
<td>York Imperial</td>
<td>Resistant</td>
<td>Resistant</td>
<td></td>
</tr>
</tbody>
</table>

(1) The 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.

(2) Not grown in blotch area.

(3) Not grown in bitter-rot area.

(4) Ripens early and thus ordinarily escapes infection.

**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 two and four 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. The 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.

**Dormant Spray.**—This spray is used particularly for the control of scale and should be applied annually as a matter of precaution in all apple and peach orchards in the state. It is applied at any time during the dormant period of the tree and while the temperature is above 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 in killing San Jose scale than lime sulfur and may be made at home more cheaply. Whether oil sprays can be applied year after year without ultimate injury to the trees has not been determined, but they can be used safely with sufficient frequency to bring San Jose scale under control in severely infested orchards.

Each 50 gallons of dormant spray should contain—

1. 1 3/4 gallons lubricating oil emulsion (page 22)
2. or 5 1/2 gallons commercial concentrated lime sulfur testing 33° Baumé (equivalent to a specific gravity of 1.2946)
3. or the amount of homemade lime sulfur indicated in Table 2 (page 20) for dormant spraying
4. or 15 1/2 to 28 1/2 pounds of dry lime sulfur
5. or commercial miscible oils at the concentrations recommended by the manufacturers

If an orchard is infested with green or rosy aphids, the dormant spray may be delayed until the tips of the buds show green, at which time the 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 (1/2 pint of 40-percent nicotine

---

1 Recommendation for points north of Hancock and Vermilion counties.
2 Recommendation for Hancock and Vermilion counties and points in the same latitude or south.
sulfate in 50 gallons lime sulfur). Oil emulsions or miscible oils will kill the aphids hit by these sprays when used at the strength recommended above.

Orchards in western Illinois have been more or less injured by the apple leaf roller. Where this insect has caused damage, the orchards should be thoroughly sprayed with a 4-percent lubricating oil emulsion or miscible oil at the highest strength recommended by the manufacturers. The large branches and trunks should be thoroughly covered with this spray.

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

Lime sulfur in combination with lead arsenate should be used at this time. In each 50 gallons of spray there should be—

1 gallon commercial lime sulfur testing 33° Baume
—or the amount of homemade lime sulfur indicated in Table 2 (page 20) for summer spraying
—or 4 pounds dry lime sulfur
and 1 pound powdered lead arsenate
—or 2 pounds paste lead arsenate

**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. The application of this spray should be started when three-fourths of the petals have fallen, and completed before the calyxes, or blossom ends, have closed, which as a rule will be one week after all the petals have fallen.

The same materials should be used, and in the same proportions, as for the cluster-bud spray.

**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 the control of blotch. The same materials should be used, in the same proportions, as for the cluster-bud spray.

**Two Weeks after Fall of Petals.**—This spray is for blotch, scab, first-brood codling moth, curculio, and leaf spot. The same materials should be used, in the same proportions, as for the cluster-bud spray.

**Three Weeks after Fall of Petals.**—This spray is for blotch, sooty blotch, leaf spot, first-brood codling moth, and curculio. The same materials should be used, in the same proportions, as for the cluster-bud spray.

**Four Weeks after Fall of Petals.**—As this spray is for blotch alone it need be applied only where blotch is prevalent.

---

1 Lead arsenate should be mixed to a cream with a small quantity of water at least an hour before using. This applies to both powder and paste.
On blotch-susceptible varieties use—

Bordeaux, standard strength (see page 17), unless the variety is known to be especially susceptible to Bordeaux injury,¹ in which case lime sulfur should be used, diluted as directed immediately below.

On less susceptible varieties, in each 50 gallons of spray use—

1 gallon commercial lime sulfur testing 33° Baumé
—or the amount of homemade lime sulfur indicated in Table 2 (page 20) for summer spraying
—or 4 pounds dry lime sulfur

**Five Weeks after Fall of Petals.**—This spray also is for blotch alone and need be applied only where blotch is prevalent. The same materials should be used, in the same proportions, as for the spray made four weeks after the fall of the petals. If Bordeaux was used for the four-weeks spray, this spray should be applied six weeks, instead of five weeks, after the fall of the petals.

**Second-Brood Codling Moth Spray.**—This spray should generally be applied nine weeks after the fall of the petals. In each 50 gallons of solution there should be—

1 pound powdered lead arsenate
—or 2 pounds paste lead arsenate

and 2 pounds freshly slaked lump lime
—or Bordeaux, standard strength. This should be used in place of lime in the bitter-rot area and where sooty blotch has caused injury in previous seasons.

**Note:** The time of appearance of the second and third broods of codling moth varies in different seasons and localities. The Experiment Station and the Natural History Survey make annual observations as to the time to spray for each brood. Advice is now mailed to about three thousand orchardists. This information will be furnished to any fruit grower upon request.

**Additional Codling Moth and Bitter Rot Spray.**—The same materials should be used, in the same proportions, as for second-brood codling moth spray. The spraying should generally be completed about two 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. The same spray should be used as that applied for second-brood codling moth. An approximate date for completion of application is August 15.

¹ Among the varieties known to be especially susceptible to Bordeaux injury are Ben Davis, Grimes, Jonathan, and Yellow Transparent.
Additional Late-Brood Codling Moth Spray.—The same spray should be used as for the preceding spray applied for codling moth. The application should be completed by September 1.

Special Bitter Rot Sprays.—Where this disease is anticipated, spraying should be started the first week in July, and should be repeated at intervals of ten days until four applications have been made. Bordeaux (standard strength) is the proper fungicide to use for this disease. If no preventive sprays have been applied and the disease appears unexpectedly, spraying should be begun without delay.

SPRAY SCHEDULE FOR PEARS

Dormant Spray.—On bearing Keiffer or Garber pears this spray is necessary only in case the trees have actually become infested. Most of the other varieties of pears grown in the southern section will require annual spraying, the same as apples, as a precautionary measure.

Cluster-Bud Spray.—This spray is primarily for the control of pear scab and currucio. It should be applied when the individual flower buds in the cluster begin to separate but before they open. The same materials should be used, in the same proportions, as for the cluster-bud spray for the apple.

Calyx Spray.—This spray is for codling moth, currucio, and pear scab. Applications should be begun as soon as most of the petals have fallen. The same materials should be used, in the same proportions, as for the cluster-bud spray for the apple.

Three Weeks after Fall of Petals.—This spray is for codling moth, currucio, and sooty blotch. The same materials should be used, in the same proportions, as for the cluster-bud spray for the apple.

SPRAY SCHEDULE FOR PEACHES

Dormant Spray.—This spray is used against San Jose scale and leaf curl. It may be applied in the fall after the leaves have dropped, or in the spring before the buds swell. In each 50 gallons of spray there should be—

\[
\frac{5}{2} \text{ gallons commercial liquid lime sulfur} \]

—or the amount of homemade lime sulfur indicated in Table 2 (page 20) for dormant spraying

—or not less than 15 pounds dry lime sulfur

1 The most destructive insect attacking the peach is the peach tree borer. This insect cannot be controlled by spraying, but is easily killed by the application of para-dichlorobenzene about the base of the trunk from September 25 to November 1. This chemical should be used at the rate of \( \frac{1}{2} \) to \( 1\frac{1}{2} \) ounces per tree, depending upon the age of the tree. It should be applied at not more than three inches from the trunk, but care must be taken that none of it touches the bark. It should be covered with about two inches of soil. This material should not be
When San Jose scale is very abundant, oil emulsion should be used at the rate of 1½ gallons in 50 gallons of water in preference to any of the above sprays. Oil emulsion does not control peach leaf curl, and if this disease is present, an application of lime sulfur will be necessary also.

First Summer Spray.—This treatment, which is for the control of plum curculio, should be begun about ten days following the bloom, when the shucks are being pushed off by the young fruit. Each 50 gallons of spray should contain—

1½ pounds powdered lead arsenate
—or 3 pounds paste lead arsenate
and from 2 to 3 pounds freshly slaked lump lime

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

Second Summer Spray.—About four weeks after the fall of the bloom a spray should be applied for the control of scab, brown rot, and plum curculio. This application should consist of—

8-8-50 self-boiled lime sulfur
—or 12½ pounds of dry-mix sulfur lime
and 1½ pounds powdered lead arsenate
—or 3 pounds paste lead arsenate

These two summer applications will be sufficient for such early varieties as Red Bird and Carman.

Third Summer Spray.—For protection against brown rot another application should be made on mid-season varieties such as Elberta, J. H. Hale, Ede, Belle of Georgia, Early Crawford, and Late Crawford, and on such late varieties as Salway, Heath, and Krummel. This spray should be the same as that used for the second summer application and should be applied about a month before the fruit is ripe.

Additional Spray.—If the weather is damp and warm as the fruit approaches ripening, it will be necessary to keep the fruit well coated by an additional spray of self-boiled lime and sulfur or of dry-mix sulfur lime, to be completed not later than two weeks before picking.

SPRAY SCHEDULE FOR CHERRIES

The following spray schedule is recommended for sour cherry orchards in this state:

Dormant Spray.—Sour cherries occasionally are infested with San Jose scale. In case they are, a dormant application of lime sulfur should be made the same as for the apple.

applied during the season the trees are planted. For full directions for the control of the peach tree borer, see Illinois Natural History Survey, Entomology Circular 8, The Peach Borer and Methods of Control. Address, Natural History Survey, Urbana, Ill.
First Summer Spray.—For the prevention of brown rot, and plum curculio, an application of lime sulfur lead arsenate should be made just before the blossom buds open. In 50 gallons of spray there should be—

1 gallon commercial lime sulfur

—or the amount of homemade lime sulfur indicated in Table 2 (page 20) for summer spraying.

and 1½ pounds powdered lead arsenate

—or 3 pounds paste lead arsenate

Second Summer Spray.—This application is against brown rot, leaf spot, curculio, and slug. Spraying should be done immediately after the blossoms have fallen, using lime sulfur lead arsenate as for the first summer spray.

Third Summer Spray.—In case damp weather follows the second summer spray, it will be necessary to make another application ten days later. Lime sulfur lead arsenate should be used as for the two preceding sprays.

Additional Spray.—If cherry slug appears in abundance in August, application should be made of a spray in each 50 gallons of which there are—

1 pound powdered lead arsenate

3 pounds freshly slaked lump lime

SPRAY SCHEDULE FOR PLUMS

Dormant Spray.—The trees should be sprayed for San Jose scale with lime sulfur, in the same proportions as for the apple.

First Summer Spray.—This application, which is for the control of leaf diseases, brown rot, and plum curculio, should be made just before the blossom buds open. Lime sulfur lead arsenate should be used as for the first summer spray for cherries.

Second Summer Spray.—This spray is also for the control of leaf diseases, brown rot, and curculio. It should be applied immediately after the blossoms fall. Lime sulfur lead arsenate should be used, as for the first summer spray.

Third Summer Spray.—This spray is also for the control of leaf diseases, brown rot, and plum curculio. About ten days after the second summer application, lime sulfur lead arsenate should be applied as directed for the two previous sprays.

Additional Spray.—If the season proves to be exceptionally wet, or if curculio is a serious pest, it will pay to spray at intervals of two weeks until a month before picking time, with lime sulfur lead arsenate at the same strength as recommended for the other summer sprays.

Aphids occasionally become very abundant on plums. They may be sprayed with a 40-percent nicotine sulfate (½ pint to 50 gallons of water in which 2 pounds of soap have been dissolved).
SPRAY SCHEDULE FOR BRAMBLES

A number of troublesome insects and diseases are commonly encountered in the growing of blackberries, dewberries, and raspberries. Certain diseases, such as crown gall, orange rust, mosaic, leaf curl, and eastern blue-stem cannot be controlled by spraying. Brambles should not be planted on soil where diseased plants have recently been grown. All nursery stock should be carefully inspected for evidence of these diseases before planting. If trouble appears, diseased plants should be dug up with as many roots as possible and burned at once. Blackberries growing wild often harbor orange rust and are a constant source of infection if near a cultivated patch. Blackberries resistant to orange rust should be planted when possible.

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.

The delayed dormant spray may be applied in the spring after the beginning of growth, but not after the leaflets have reached three-eighths of an inch in length. Lime sulfur diluted at the rate of 5 1/2 gallons of the commercial material (testing 33° Baumé) in 50 gallons of spray, or homemade lime sulfur of the equivalent strength (as determined from the dilution table on page 20), should be used.

The pre-bloom spray should be applied a week before the bloom. Commercial liquid lime sulfur (testing 33° Baumé) at the rate of 1 gallon in 50 gallons of spray, or homemade lime sulfur of the equivalent strength (as determined from the dilution table on page 20), should be used. Every cane must be well covered by the spray. The addition of Kayso,1 at the rate of 1/2 pound to 50 gallons of solution, is suggested for a more efficient control of anthracnose.

In setting out a bed of black raspberries, anthracnose will be controlled to a marked degree if all the old stubs are removed before setting the young plants.

The larvae of certain saw flies which work on blackberry and raspberry foliage are controlled by an application of lead arsenate (1 pound of powder in 50 gallons of spray) made within a week after the plants are in full foliage.

SPRAY SCHEDULE FOR CURRANTS AND GOOSEBERRIES

Since currants and gooseberries are largely subject to the same diseases and insect enemies, both demand much the same spray treatment.

---

1This is a commercial mixture of finely ground casein and hydrated lime. Several other brands are advertised. It is possible for the orchardist to do his own mixing, but the commercial caseins have not been tested sufficiently to justify definite recommendations as to their selection and mixing.
San Jose scale may be controlled by a dormant spray of commercial liquid lime sulfur (5½ gallons testing 33° Baumé, or homemade lime sulfur of equivalent strength, according to the dilution table on page 20, to 50 gallons of solution).

The currant worm may be controlled by spraying with lead arsenate (1 pound of powder or 2 of paste in 50 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, an application of lead arsenate should be made as soon as the presence of the worms is 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. Nicotine sulfate (½ pint in 50 gallons of spray) should be applied thoroughly, especially to the undersides of the leaves. A second application should be made in ten days.

Spraying for currant leaf spot should be begun when the leaves are unfolding and repeated at intervals of two weeks until four applications have been made. Bordeaux should be used.

Anthracnose, leaf spot, and mildew on gooseberries may be controlled by the use of lime sulfur. The first application should be made as the leaves are unfolding, using lime sulfur, dormant strength (as suggested above for San Jose scale). Three additional applications at two-week intervals should be made, using commercial liquid lime sulfur diluted at the rate of 1 gallon testing 33° Baumé to 50 gallons of solution, or homemade liquid lime sulfur of the equivalent strength as determined from the dilution table on page 20.

**SPRAY SCHEDULE FOR 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 2 pounds of lead arsenate powder or 4 pounds of the paste in 50 gallons of spray.

The common grape troubles can usually be held in check by the following spray schedule:
First Application.—This application should be made just before the bloom appears for control of grape berry moth, rose chafer, black rot, and anthracnose. A combination spray of Bordeaux and arsenate of lead (1 pound of powder or 2 pounds of paste in 50 gallons of solution) may be used.

Second Application.—The same spray mixture as that used for the first application should be made immediately after the fall of the bloom. This is for the control of grape berry moth, and occasionally grape root worm and rose chafer, as well as for black rot, anthracnose, and downy mildew.

Third Application.—This application is made ten days after the fall of the bloom for the control of grape root worm, rose chafer, if present, black rot, anthracnose, downy mildew, and powdery mildew. A combination spray of Bordeaux with double-strength lead arsenate (2 pounds of powder or 4 pounds of paste in 50 gallons of spray) should be used.

Fourth Application.—This application is made three weeks after the fall of the bloom for the control of grape root worm, black rot, anthracnose, ripe rot, and the mildews. The same spray mixture as recommended for the third application should be used except where leaf hoppers are present. In that case, nicotine sulfate (½ pint in 50 gallons of solution) should be added. The spray should be applied thoroughly, especially to the undersides of the leaves. The insects should be hit by the spray.

SPRAY SCHEDULE FOR STRAWBERRIES

Most of the 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, it may be controlled by spraying with Bordeaux. The first application should be made in spring, before blossoming, and the second, just after blossoming.

In sections where the leaf roller is destructive, the application of lead arsenate (1½ pounds of powder or 3 pounds of paste in 50 gallons of spray) at the first appearance of the worms in spring, 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, operations in the renovating process, also are a great help in holding strawberry pests in check.
DIRECTIONS FOR MAKING AND MIXING THE STANDARD SPRAYS

Bordeaux

When a very small quantity of Bordeaux is required, a commercial preparation may be used. This should be diluted according to the directions of the manufacturer. When any considerable amount of spraying is to be done, however, Bordeaux is ordinarily prepared by the orchardist according to the following formula:

3 pounds copper sulfate (blue vitriol)
4 pounds lump (stone) lime
—or 6 pounds hydrated lime
50 gallons water

Directions for Mixing.—If stone lime is used, two stock solutions must be prepared, one of lime and one of copper sulfate. Each should be made up at the rate of 1 pound in a gallon of solution.

The required amount of copper sulfate is placed in a burlap bag and suspended in a wooden or stone vessel just at the surface of the water which has been measured into it. No stirring should be done until the copper sulfate has dissolved.

The lime required should be carefully slaked with just enough water to prevent the formation of a dry powder. After the violent boiling is over, a small amount of water should be added and the whole worked up to a paste or cream and allowed to cool. It should then be diluted to contain 1 pound of lime per 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.

The copper sulfate and lime are now ready for mixing. First partly fill the sprayer with water and then add the lime thru a strainer, either 4 gallons of the stock solution of stone lime or 6 pounds of hydrated lime in paste form for each 50 gallons of spray. Continue filling the sprayer with water until it is about two-thirds full. With the agitator going, add 3 gallons of copper sulfate stock solution for every 50 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.

Commercial Lime Sulfurs

It is generally more convenient, and where only a small acreage is to be sprayed it is sometimes cheaper, to purchase lime sulfur ready-made than it is to attempt to prepare it at home. It is cheaper when purchased in 50-gallon lots than by the gallon. It comes in two forms,
liquid and dry. Dry lime sulfur is somewhat more expensive than liquid lime sulfur but it is more convenient to obtain and use.

Homemade Lime Sulfurs

The following formulas are in common use in Illinois:

<table>
<thead>
<tr>
<th>The 50-gallon Formula</th>
<th>The 66-gallon Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 pounds ground sulfur</td>
<td>100 pounds ground sulfur</td>
</tr>
<tr>
<td>50 pounds lump lime</td>
<td>50 pounds lump lime</td>
</tr>
<tr>
<td>50 gallons water</td>
<td>66 gallons water</td>
</tr>
</tbody>
</table>

The 50-gallon formula is more generally used. The 66-gallon formula, however, is somewhat more economical of sulfur.

Lime sulfur is prepared by cooking the ingredients together until practically 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.

Directions When Cooking Is Done 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 two inches apart, and cut between them. Staple the wires in place to act as top hoops for the tubs. Bend a piece of one-inch gas pipe into nearly circular form, so that it will lie on the bottom of the tub. Cap one end, drill one-eighth inch holes at intervals of four 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 the use of these 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, which is described later.

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 half-inch mesh of No. 9 wire cut to fit the tub snugly at the point where the screen rests.

Depending on the size of the tub, quantities of from 50 to 200 gallons may be made at one time. Either the 50-gallon or the 66-gallon
formula may be used; the former is customary. To make a lot of about 50 gallons by this formula, place 50 pounds of fresh, unslaked lump lime on the screen near the bottom of the tub, and pour in sufficient water, preferably hot, to start the lime slaking. When it is 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 50-gallon formula in Table 2. The clear lime-sulfur solution may be stored in large casks, barrels, or tanks, until needed.

Directions for Making Over a Fire.—When lime sulfur is cooked over a fire, the following directions will be found practical. Either the 50-gallon formula or the 66-gallon may be used. 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 thoroly 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 thoroly slaked and the sulfur thoroly mixed, add enough water to bring the total volume to either 50 gallons or 66 gallons, depending on which formula is being used. Boil for about 45 minutes, adding enough water from time to time to keep the volume at or above 50 or 66 gallons, depending on the formula. For mixing in this way a 75-gallon feed cooker has proved convenient.

Dilutions Used.—Table 2 shows the dilutions to be used with different lime-sulfur concentrations.
TABLE 2.—DILUTION TABLE FOR LIME SULFUR

<table>
<thead>
<tr>
<th>Degrees Baumé</th>
<th>Specific gravity</th>
<th>Amount of lime-sulfur solution to be used in making up 50 gallons of diluted spray</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>For dormant spraying</td>
</tr>
<tr>
<td></td>
<td></td>
<td>gallons</td>
</tr>
<tr>
<td>20</td>
<td>1.1600</td>
<td>11</td>
</tr>
<tr>
<td>21</td>
<td>1.1693</td>
<td>11</td>
</tr>
<tr>
<td>22</td>
<td>1.1788</td>
<td>10</td>
</tr>
<tr>
<td>23</td>
<td>1.1885</td>
<td>10</td>
</tr>
<tr>
<td>24</td>
<td>1.1983</td>
<td>9</td>
</tr>
<tr>
<td>25</td>
<td>1.2083</td>
<td>8</td>
</tr>
<tr>
<td>26</td>
<td>1.2184</td>
<td>8</td>
</tr>
<tr>
<td>27</td>
<td>1.2288</td>
<td>7</td>
</tr>
<tr>
<td>28</td>
<td>1.2393</td>
<td>7</td>
</tr>
<tr>
<td>29</td>
<td>1.2500</td>
<td>6</td>
</tr>
<tr>
<td>30</td>
<td>1.2608</td>
<td>6</td>
</tr>
<tr>
<td>31</td>
<td>1.2719</td>
<td>6</td>
</tr>
<tr>
<td>32</td>
<td>1.2831</td>
<td>5</td>
</tr>
<tr>
<td>33</td>
<td>1.2946</td>
<td>5</td>
</tr>
<tr>
<td>34</td>
<td>1.3063</td>
<td>5</td>
</tr>
<tr>
<td>35</td>
<td>1.3181</td>
<td>5</td>
</tr>
</tbody>
</table>

1 Approximate strength of lime sulfur made by the 66-gallon formula.
2 Approximate strength of lime sulfur made by the 50-gallon formula.
3 Standard commercial.

Note.—Since the strengths of the solutions made according to the 50-100-50 and the 50-100-66 formulas, and also of the commercial lime sulfur, are only approximately those indicated by notes 1, 2, and 3 in column 1, it is suggested that the orchardist test his solution with a hydrometer, so that in making up 50 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 hydrometer is a weighted glass bulb with a long stem on which densities are indicated in specific gravity or degrees Baumé or in both. The test is made by floating the hydrometer in the solution. See Fig. 2.)

Self-Boiled Lime and Sulfur

Self-boiled lime and sulfur is a special spray for peaches and should not be confused with the cooked solutions just described. The only heat employed in this preparation is that furnished by the slaking lime.

Formula: The mixture is made according to the following formula:

8 pounds lump lime
8 pounds ground sulfur
50 gallons water

Lime free from all air-slaked particles should be used. Ground sulfur which contains no hard lumps is satisfactory. Extreme care must be exercised in the preparation of this mixture and the following directions carefully adhered to.


Equipment.—The equipment needed for making self-boiled lime and sulfur consists of a barrel or tub, a hoe, paddle, buckets, and a scale.

Preparation.—If 50 gallons of the mixture are to be made, place 8 pounds of lime in the barrel or tub with 1 or 2 gallons of water. As soon as the lime is slaking vigorously, add 8 pounds of sulfur. The mixture should be stirred constantly, and more water should be added as needed to form at first a thick paste, and finally a thin paste.

As soon as the boiling has stopped, add several gallons of cold water to cool the mixture. It must not be allowed to stand in the form of a paste. Strain into the spray tank, using the paddle to work thru everything that will pass thru the strainer, and dilute to 50 gallons. The mixture is now ready for application. As it settles very rapidly, the agitator should be allowed to run a few minutes before starting to spray, and should be kept going as long as any spraying is being done.

Dry-Mix Sulfur Lime

Dry-mix sulfur lime was originated at the New Jersey Agricultural Experiment Station and is recommended to replace self-boiled lime and sulfur. The formula by weight is as follows:

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

To remove lumps, the sulfur should first be worked thru a screen having 12 to 14 meshes to the inch. All the materials should then be thoroly mixed together. The product thus formed may be stored indefinitely if kept in a dry place. For spraying, use 12 1/2 pounds of dry-mix in 50 gallons of water. For the second summer spray 1 1/2 pounds of lead arsenate should be added to each 50 gallons of spray.

Lead Arsenate

Lead arsenate comes in both powdered (dry) and paste forms. The paste form contains about 50 percent water. This difference explains why twice as much paste lead arsenate as powdered should be used in each 50 gallons of spray. The dry form keeps better and is more easily handled. 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 lime sulfur or Bordeaux, 2 pounds of freshly slaked lump lime or 3 pounds of hydrated lime should be mixed with each 50 gallons of solution, as there is
always a small amount of soluble arsenic present, which would be injurious to the foliage unless neutralized by the lime.

**Bordeaux Lead Arsenate**

Generally it is found advantageous to combat insects with the same application that is 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 combination, 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.

**Self-Boiled Lime and Sulfur with Lead Arsenate**

It is often desirable to apply lead arsenate with self-boiled lime and sulfur. After the self-boiled lime and sulfur is in the spray tank and diluted to nearly 50 gallons, start the agitator and strain into the sprayer the required amount of lead arsenate.

**Nicotine Sulfate**

This material may be purchased in concentrated form. One gallon will make 800 to 1,000 gallons of spray mixture. The cost is very high and consequently this material should be used only when the orchardist is sure that aphids are actually present in sufficient numbers to cause damage. If used alone, enough fish oil or laundry soap should be added to soften the water, i.e., to make the water sudsy when stirred. This usually requires at least 2 pounds of soap to 50 gallons of water.

**Boiled Lubricating Oil Emulsion**

The following formula should be used in making the stock emulsion:

Diamond Paraffin Oil or other oil of similar grade... 1 gallon
Water .................................................. ¼ gallon
Potash Fish Oil Soap.............................1 to 2 pounds

(Many waters require more than one pound of soap to stabilize the emulsion.)

Place the water, soap, and oil in a kettle or tank heated by fire or steam. Boil for five minutes, being careful not to burn the mixture; remove from the fire or turn off the steam and pump twice
thru a spray pump at a pressure of 75 to 150 pounds. Make sure that all the mixture passes thru the pump twice. Do not allow it to cool before pumping.

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

Precaution should be taken to prevent the stock emulsion from freezing. If it does freeze, it should be allowed to thaw out gradually, under which circumstances apparently no harm results to the emulsion. Do not heat or stir while the emulsion is thawing out.

Directions for diluting the stock solution for spraying are given in the spray schedules for apples and peaches. In diluting, it is advisable, in order to prevent separation of the oil, to fill the tank with $\frac{1}{4}$–$\frac{1}{2}$–50 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.

**Equipment for Making Boiled Lubricating Oil Emulsion**

A cooker similar to that described for making large quantities of lime sulfur may be used for boiling the oil emulsion, or a metal cooking tank may be substituted for the wooden cask. Steam may be used in the same way, but no agitator is needed.

A second tank with a capacity equal to that of the cooker should be provided and the pump and connections so arranged that the stock emulsion after cooking may be pumped from the cooker to the second tank and pumped from this into barrels or other containers used for storage.

Lime-sulfur cookers cannot be used for this work without a thoro cleaning; and a wooden cooker that has been used for making lime sulfur for several seasons is very difficult to clean.
FIG. 3.—Too Late for Calyx Spray. These Apple Calyces Have Closed

See illustration on the front cover showing calyces as they should be for the calyx spray.