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FIELD EXPERIMENTS IN SPRAYING APPLE ORCHARDS IN 1916

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FIELD EXPERIMENTS IN SPRAYING APPLE ORCHARDS IN 1916

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INTRODUCTION

The chief investigations in the spraying experiments in apple orchards carried on by the Department of Horticulture in 1916 were with regard to: (1) the relative values of Bordeaux and lime sulfur in the control of blotch; (2) the relative merits of dust and liquid spraying in the control of insects and fungi; and (3) the value of the cluster-bud spray in the control of scab. Observations were also made with regard to the value of certain new and proprietary sprays. This circular summarizes the results of these experiments; a more detailed account will appear in a later publication.

The experiments on the control of blotch were conducted at Flora, Clay county, by A. J. Gunderson; those on the value of dust spraying and of the prebloom spray were conducted by W. S. Brock at Neoga, Cumberland county.

RELATIVE VALUES OF BORDEAUX AND LIME SULFUR AS SPRAYS FOR BLOTCH

A number of southern Illinois apple growers claimed to have controlled blotch very satisfactorily during 1915 with lime sulfur, and intimated that it was as effective as Bordeaux when applied more frequently. Experimental evidence on this point, however, indicates that Bordeaux is superior, in a greater or less degree, to lime sulfur as a spray against blotch. The present experiment was designed as a further test of these two sprays in this respect.

CONDITIONS OF THE EXPERIMENT

The experimental orchard chosen for this work is the property of Mr. V. O. Suggett, of Louisville, Illinois, and is located one and one-half miles southeast of Flora. At the time of the experiment, the average vigor of the trees was impaired somewhat by general neglect, and particularly because of the unchecked development of blotch (Phylosticta solitaria E. & E.), which had formed cankers on spurs, twigs, and small limbs. Bitter-rot (Glomerella rufomaculans) and

black-rot (*Sphaeropsis malorum*) cankers were present to some extent. The serious blotch infection offered unusual opportunities for carrying on the work. Approximately two acres of sixteen-year-old Ben Davis trees were chosen from a block of thirty-eight acres.

The weather at Flora during the spring was extremely cool and wet, and the summer was unusually hot and dry. Cool and rainy weather prevailed during full bloom, which occurred April 25.

In all cases where Bordeaux was used, it was made according to the formula: 6 pounds of copper sulfate and 8 pounds of lime in 100 gallons of water. Thomsen lime sulfur was used at the rate of 2\(\frac{1}{2}\) gallons in 100 gallons of water. Dow paste arsenate of lead was used at the rate of 4 pounds in each 100 gallons of spray.

All sprays were applied with a Hardie No. 32 hand outfit, at about 125 pounds pressure. Friend disc nozzles were used.

**Effect of Bordeaux and Lime Sulfur**

In the Flora experiments where Bordeaux was applied three, five, seven, and ten weeks after the fall of the petals, the fruit showed 12.73 percent blotch, whereas that sprayed with lime sulfur at these periods showed 42.12 percent blotch. These results further demonstrated the superiority of Bordeaux over lime sulfur as a spray for blotch in an orchard where the infection was at its worst.

**Effect of Different Applications of Bordeaux and Lime Sulfur**

Scott and Rorer found from investigations carried on in Arkansas during 1907, that the principal blotch infection on apples occurred from four to six weeks after the fall of the petals, and that scattering infections continued to take place throughout the season.\(^1\) In view of these facts the writers recommended applying four sprays of Bordeaux: the first, three to four weeks after the fall of the petals; a second, about four weeks later; and a third and fourth at three-week intervals thereafter, the purpose being to keep the fruit well coated until picking time. The number of applications would, however, depend upon the season, a wet one requiring more sprays than a dry one. Lewis reported that in Kansas the greatest blotch infection occurred from four to six weeks after the fall of the petals, and continued during the remainder of the growing season, or at least until the last of August.\(^2\) Lewis recommended Bordeaux during dry weather and lime sulfur in a wet season, to be applied three, five to seven, and ten weeks after the fall of the petals.

The results of experiments conducted at Flora on this point showed that lime sulfur applied ten days after the fall of the petals

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exerted practically no control over blotch, and that neither Bordeaux nor lime sulfur applied ten weeks after the fall of the petals were of much value as sprays for blotch.

The fruit from the unsprayed trees showed 93.24 percent blotch. Fruit sprayed with lime sulfur three weeks after the fall of the petals showed 73.12 percent blotch; the same spray applied both three and five weeks after the fall of the petals reduced the infection to 59.78 percent, and when applied three, five, and seven weeks after the fall of the petals, to 47.84 percent. Bordeaux applied three weeks after the fall of the petals reduced blotch infection to 51.97 percent; the same spray applied both three and five weeks after the fall of the petals reduced this infection to 16.06 percent, and when applied three, five, and seven weeks after the fall of the petals, to 12.73 percent. With both lime sulfur and Bordeaux the sprays applied three and five weeks after the fall of the petals were the most important in the control of blotch. Under the conditions of this experiment an application of Bordeaux applied seven weeks after the fall of the petals was scarcely necessary, in view of the fact that two sprays applied three and five weeks after the fall of the petals gave practically equal control of blotch. This was probably due to the great adhesiveness and lasting effectiveness of Bordeaux; the superiority of Bordeaux over lime sulfur in the control of blotch was undoubtedly due to these qualities.

Effect of Interchanging Applications of Bordeaux and Lime Sulfur

During the wet season of 1915 certain southern Illinois growers reported serious russetting of fruit following the use of Bordeaux three weeks after the fall of the petals, and even later. Such an occurrence is rare, altho in 1912 experiments conducted at this station showed that Bordeaux applied three weeks after the fall of the petals caused 33.1 percent slight russet.¹ Investigations on the control of blotch have shown that the first and most important spray is the one applied three or four weeks after the fall of the petals. Since russetting of the fruit may follow such an application and those applied still later, it was thought that lime sulfur, which does not cause russet, might be substituted for Bordeaux, with the additional hope that it would control blotch.

This experiment showed that where Bordeaux was applied three, five, seven, and ten weeks after the fall of the petals, the fruit showed 12.73 percent blotch and 13.28 percent serious and 22 percent slight russet. Where lime sulfur was substituted for Bordeaux in the spray three weeks after the fall of the petals, there was 49.49 percent blotch,

but no russetting of the fruit. Where lime sulfur was substituted for Bordeaux in the applications made three and five weeks after the fall of the petals, the fruit showed 36.86 percent blotch and no russet. These results show that lime sulfur did not control blotch as well when substituted for Bordeaux either three or five weeks after the fall of the petals. Such a substitution eliminated the russet factor but did not satisfactorily reduce blotch infection. The amount of russet caused by Bordeaux applied three weeks after the fall of the petals was more desirable than the increased amount of blotch resulting from the substitution of lime sulfur for Bordeaux at that time.

THE VALUE OF THE DUST SPRAY

The dust method for the control of orchard pests was reported unfavorably in Illinois in 1906.1 The very favorable results secured in New York during 1913 and 1914,2 and the widespread publicity given the new method by certain companies manufacturing spray materials and apparatus, led the Station to take up the problem again in 1915. The results3 were quite satisfactory, and it was deemed advisable to continue the work during 1916 in an effort to determine conclusively whether the claims for the dust method in other states could be applied to Illinois conditions.

CONDITIONS OF THE EXPERIMENT

Two orchards at Neoga, Cumberland county, were chosen in which to conduct this experiment. The H. A. Aldrich orchard, one-half mile west of Neoga, containing 120 acres of 14-, 15-, and 16-year-old trees, was selected as being a type representing the highest degree of commercial orchard management; the Morris orchard, about one mile northwest of Neoga, containing twelve acres of 20-year-old trees, presented the opposite extreme. In the Aldrich orchard, 16-year-old trees of the Ben Davis variety were selected as best suited for experimentation. The Morris orchard consisted of Ben Davis for the most part, with a few Willows and scattered varieties, the principal records being made on Ben Davis.

The season was unusual both in temperature and in precipitation. During April and May the weather was cool, and in May there was an unusual precipitation, 4.18 inches, which resulted in a heavy infection of apple scab (Venturia inaequalis). June, with a half inch greater rainfall, was unusually cool, consequently much late scab infection was encountered. These conditions retarded the development

of codling moth, a very significant factor in the control of this serious pest. Beginning with the last few days of June the weather became hot and dry, continuing until about August 11. In spite of this, the later generations of codling moth were negligible, because of light infestation during the preceding season and the retarding influence of the cold, wet weather during the spring.

The materials used in the dust sprays were finely ground sulfur, commonly known as superfine sulfur, to distinguish it from the ordinary commercial sulfur, and powdered arsenate of lead. The sulfur was prepared by the Union Sulfur Company, and the arsenate of lead by the Corona Chemical Company. The two materials were mixed by the latter company and donated to the Station for experimental purposes. In addition to the above preparations a similar mixture, prepared by the Niagara Sprayer Company, was used. In the Morris orchard the following combinations were tried for the dust spray:

1. Sulfur, 80 percent; arsenate of lead, 20 percent
2. Sulfur, 85 percent; arsenate of lead, 15 percent
3. Sulfur, 90 percent; arsenate of lead, 10 percent
4. Sulfur, 50 percent; arsenate of lead, 15 percent; terra alba, 35 percent

Two plats were sprayed with liquid consisting of lime sulfur, testing 33° Baume, 1 to 40 with 2 pounds to 50 of paste arsenate of lead for all sprays except the July application, which consisted of 3-3-50 Bordeaux with 2 pounds to 50 of paste arsenate of lead, since this orchard had been infected with apple blotch (*Phyllosticta solitaria*) in previous years. Two plats were unsprayed.

The experiment in the Aldrich orchard was a duplication of the Morris experiment, except that the plats were smaller and the arrangement was slightly different. Each plat was separated from its neighbor by two buffer rows which were sprayed with standard liquid to prevent the dust materials from one plat falling on another and so confusing results.

The dust was applied with a machine manufactured by the Kansas City Dust Sprayer Manufacturing Company, driven by a 2½-horsepower engine. The liquid sprays were applied with a Friend powerspray outfit at a minimum pressure of 200 pounds.

**Results in Morris Orchard**

In this experiment none of the dust mixtures compared favorably with the liquid sprays as to fungicidal value. The scab infection on check trees was 95.2 percent, which was reduced to 1 percent by the liquid sprays. The best control exerted by the dust mixtures was that on the plats receiving 80 percent sulfur and 20 percent arsenate of lead, where scab was reduced to 23.4 percent. The poorest control was exerted by the Niagara mixture, where 73.7 percent of the fruit
was infected with scab. The 35-15-50 and the 90-10 formulas resulted in 61.5 percent and 62 percent scab infection, respectively.

The insecticidal value of the dust mixtures was quite noticeable. Check trees showed 20.4 percent infestation of codling moth, and the lowest control exerted by any of the dust mixtures was 3.9 percent. The control of curculio was not as conclusive, since only 12 percent of the apples on check trees were injured by this insect. On all but one of the plots receiving the dust treatment, however, the number of blemished apples from this source was below that on plots treated with the standard liquid sprays.

The general appearance of the fruit on all dusted plots, notwithstanding the infection of scab, was better than that of the liquid-sprayed fruit. The finish and color of the fruit on the dusted plots was noticeably better at picking time, partly because of some Bordeaux russet on the liquid-sprayed fruit. No marked effects on the color or the vigor of the foliage were noted.

RESULTS IN ALDRICH ORCHARD

Altho less efficient in the control of scab than the liquid sprays, the dust mixtures gave fairly satisfactory results in the Aldrich orchard. One or more spots of scab appeared on 52.7 percent of the unsprayed fruit. The 90-10 and 80-20 mixtures reduced scab to 6.3 percent and 7.8 percent, respectively; in both cases the infection was slight. The standard liquid sprays gave almost perfect control of scab, only .2 percent of the fruit so treated being infected. As in the Morris orchard, the old formula containing 35 percent of an inert substance was less satisfactory than either of the other two mixtures above mentioned, the fruit sprayed with this material showing 12 percent scab. The poorest control was exerted by the Niagara 85-15 mixture, which reduced scab to 22.2 percent. No satisfactory data were secured on the control of codling moth in this experiment, since only 10.6 percent of the fruit on check trees was infested. The dusted fruit was more highly colored and of a finer finish than the liquid-sprayed, the latter, in common with most sprayed fruit, having a dull appearance in comparison, and the skin was not as smooth and waxy. The effect on the foliage, while not as striking, was noticeably in favor of the dust with regard to color and luxuriance.

RELATIVE COST

About 2 pounds of dust material was used in these experiments to dust one tree, which at 5 cents per pound (the approximate cost of an 85-15 mixture) makes the cost per tree rather expensive for materials. The labor required is almost negligible. Forty acres of trees can easily be dusted in one day by two men with one team, making
the cost of labor less than half a cent per tree. Commercial growers estimate the expense for spraying a 20-year-old tree at from 5 to 7 cents per tree, so that the expense incurred by the dust at most is from one-half to three-quarters greater, depending upon the individual.

VALUE OF THE CLUSTER-BUD SPRAY IN CONTROLLING SCAB

Recently the value of the cluster-bud, or prebloom, spray in the control of scab has been questioned. It has been stated that in orchards in southern Illinois which had been free from scab the preceding season, the prebloom spray could be omitted as far as the control of scab was concerned. This was borne out by experimental data gathered in the Aldrich orchard at Neoga, which had been free from scab for several years. No greater scab infection was encountered where the prebloom spray was omitted.

The same series of experiments demonstrated also the possibilities of a flexible spray schedule. One plat was designed to receive but one fixed spray, the calyx spray, all others to be applied as needed, omitting the prebloom spray for reasons given above. Because of the cold, wet weather an application for scab was made ten days after the bloom. Three weeks later a second spray would normally be applied, but as codling moth were so late developing, this spray was omitted. The spray for second-brood codling moth was also omitted, since the infestation by the first generation had been so light. Thus the plat received but two applications, and the fruit was the equal of any fruit in the orchard. The observation necessary to such a program can be made by any well-informed grower, supplemented by advice from the Experiment Station.

VALUE OF CERTAIN NEW AND PROPRIETARY SPRAYS

Two new sprays, when tried out in the experiments at Neoga gave considerable promise as fungicides. Sherwin-Williams dry lime sulfur applied before the bloom, at the fall of the bloom, ten days later, and three weeks later, with an application of arsenate of lead with lime ten weeks after the bloom, gave very clean fruit which was attractive in appearance. No injury resulted to either fruit or foliage. Ordinary bleaching powder, when used at the rate of 1 pound to 50 gallons in combination with arsenate of lead, reduced scab from 52 percent to 11 percent when applied five times. More extended trial will be given in order to determine, if possible, a more effective dilution.

Ansbacher Adheso and Thomsen B.T.S. proved unsatisfactory as sprays for blotch in the experiments at Flora. Ansbacher Adheso,
Modoc Spra Sulfur, Sherwin-Williams Fungi Bordo, Thomsen atomic sulfur, and Thomsen B.T.S., all satisfactorily controlled scab in the experiments at Neoga, but they injured fruit and foliage so severely that their use cannot be recommended.

**SUMMARY OF RESULTS**

**FLORA EXPERIMENTS**

1. Bordeaux proved superior to lime sulfur as a spray for blotch.
2. The most important sprays for blotch were those applied three and five weeks after the fall of the petals; those applied either seven or ten weeks after the fall of the petals were of less value. Bordeaux applied three and five weeks after the fall of the petals gave practically as good blotch control as the same spray applied three, five, seven, and ten weeks after the fall of the petals.
3. The greater efficiency of Bordeaux in comparison to lime sulfur as a spray for blotch was probably due to its greater adhesiveness or to its being effective over a longer period of time than lime sulfur.
4. Bordeaux applied three weeks after the fall of the petals caused some russeting of the fruit, but this russeting was less objectionable than the increased amount of blotch which resulted where lime sulfur was substituted for Bordeaux at that time.
5. A small amount of foliage injury resulted from the use of Bordeaux.
6. Ansbacher Adheso and Thomsen B.T.S. proved unsatisfactory as sprays for blotch.

**INCIDENTAL OBSERVATIONS**

1. Blotch appeared on the fruit about June 15, six weeks after the fall of the petals. Later in the season it was detected on the foliage both of sprayed and of unsprayed trees, particularly on the interiors.
2. Black rot (Sphæropsis malorum) was present on the foliage of all sprayed trees and in abundance on the unsprayed trees.
3. At picking time the greatest blotch infection on the sprayed trees appeared on the fruit located on the interior parts of the trees, where the foliage was very dense. The sprays would doubtless have been more effective if the trees had been pruned. Thoroness of application on the interior of the tree is essential; the spray should cover not only the fruit and foliage, but also the twigs, to prevent infection of the small branches. Thinning out the tree will facilitate spraying; all water sprouts should be removed, since they serve as sources of canker infection. In spraying for blotch, the man on the ground should direct the spray as far up on the inner branches as possible.
4. Some spray injury was observed on the foliage of the Bordeaux-sprayed trees.

5. Lime sulfur arsenate of lead applied during the hot weather of mid-July caused a negligible amount of burn; that the injury was not greater may have been due to the fact that the trees were not drenched.

NEOGA EXPERIMENTS

1. The dust mixtures were less efficient than the liquid sprays in the control of fungi.
2. The dust mixtures controlled codling moth and curculio equally as well as the liquid sprays.
3. The Niagara dust mixture was less efficient in the control of fungi than the others.
4. Superfine sulfur did not prove to be a perfect fungicide, even when thoroughness of application was assured.
5. The fruit on dusted trees was more attractive in appearance than the liquid-sprayed fruit.
6. The prebloom, or cluster-bud spray, was valueless in the control of scab where the infection was not present the preceding season.
7. Thoroness of application proved to be the most important single factor for the success of the liquid sprays.
8. These experiments showed that certain sprays may be omitted if careful observations are kept on orchard and weather conditions.

INCIDENTAL OBSERVATIONS

1. Bordeaux applied just before the bloom was no more efficient than lime sulfur arsenate of lead in the control of apple scab.
2. On one plat where arsenate of lead was used alone throughout the season, scab infection was reduced materially.
3. Commercial concentrated lime sulfur 1 to 5, applied just as green aphids were hatching, apparently failed to kill aphids eggs or immature insects.
4. Some Bordeaux russet occurred when 3-3-50 Bordeaux was applied ten weeks after the bloom.
5. Serious burning of the fruit was caused by lime sulfur (1 to 40) with arsenate of lead applied ten weeks after the bloom.

SPRAY SCHEDULES

Since climatic conditions vary so greatly with different localities, a spray schedule which will be effective in northern Illinois would be almost valueless in southern sections. Separate schedules are, therefore, given for the southern horticultural division, comprising those counties south of Mattoon, and for the central and northern divisions.
RECOMMENDATIONS FOR SOUTHERN DIVISION

Dormant-tree Spray.—This spray is used particularly for the control of San Jose scale. It is applied in the fall after the leaves drop or in the spring before the buds open. This spray is advised as a matter of precaution in all orchards throughout the state.

For the dormant-tree spray either commercial or homemade lime sulfur should be used. The commercial lime sulfur testing 33° Baume should be used at the rate of 11 gallons in 100 gallons of spray, or 11 gallons to 89 gallons of water. This is equivalent to 1 gallon of commercial lime sulfur to 8 gallons of water. The homemade lime sulfur, made according to the Illinois formula (100 pounds sulfur, 50 pounds lime, 66 gallons water), is used at the rate of 20 gallons in 100 gallons of spray or 20 gallons to 80 gallons of water.

Cluster-bud Spray.—This spray is primarily for the control of apple scab, but is also used to kill such leaf-eating insects as cankerworm and bud moth. It should be applied when the flower buds are showing pink, but before any have opened.

Lime sulfur arsenate of lead should be used at this time; 2½ gallons of commercial lime sulfur, or 5 gallons of homemade lime sulfur (Illinois formula), and 4 pounds of paste or 2 pounds of powdered arsenate of lead should be contained in each 100 gallons of spray.

In cared-for orchards which have been free from scab the preceding season, this spray may be omitted except where it is necessary to apply a spray for the control of spring cankerworm.

Calyx Spray.—This is the principal spray for first-brood codling moth, and is equally important as a spray for scab. It is also valuable as a spray against leaf-eating insects such as cankerworm, bud moth, green fruit worm, and also plum curculio. This spray should begin when most of the petals have fallen, to insure its completion before the calyxes have closed.

For this application the same strength of lime sulfur arsenate of lead should be used as for the cluster-bud spray.

Three Weeks after Bloom.—This spray is the principal one for blotch, but it is also effective against first-brood codling moth and curculio. To some extent it is effective against certain fungi which appear later in the season, such as sooty blotch, flyspeck, and leaf spot (Sphaeropsis maliorum).

Lime sulfur arsenate of lead as directed for the cluster-bud spray should be used for this application. Notwithstanding the fact that Bordeaux applied at this time is likely to russet the fruit, its use is recommended in orchards known to be subject to serious blotch infection. In such cases the 6-8-100 formula should be used, plus the usual amount of paste or dry arsenate of lead.

Five Weeks after Bloom.—This spray is primarily for the control of apple blotch. Bordeaux, 6-8-100, should be used at this time. The arsenate of lead may be omitted.
Ten Weeks after Bloom.—This spray is primarily for the control of second-brood codling moth and incidentally for the control of currucio, blotch, sooty blotch, flyspeck, and leaf spot (Sphaeropsis malorum). It should be applied approximately ten weeks after the fall of the petals.

Bordeaux arsenate of lead should be used, as recommended for the spray five weeks after the bloom, in orchards seriously infected with apple blotch. Others may be sprayed with arsenate of lead and lime; 4 pounds of the paste or 2 pounds of the powdered form should be used in each 100 gallons of spray, to which should be added 4 pounds of freshly slaked lime.

Additional Sprays.—Additional sprays are chiefly used as precautions against bitter rot. Where this disease is anticipated, spraying should begin the first week in July, and should be followed at intervals of ten days until four applications have been made. Bordeaux, 8-8-100, is the proper fungicide to use for this disease. If no preventive sprays have been applied, and the disease appears suddenly and unexpectedly, spraying should be commenced without a moment’s delay as soon as the presence of the disease is discovered.

Recommendations for Central and Northern Divisions

Dormant-tree Spray.—This spray should be applied at the same time and the same materials should be used as recommended for the southern division (page 12).

Cluster-bud Spray.—This spray is used particularly for the control of apple scab. As a secondary object, however, it is used to kill the various leaf-eating insects which appear early in the season, including bud moth, tent caterpillar, and eankercrm. It should be applied when the flower buds are showing pink, but before any have opened.

Lime sulfur arsenate of lead, at the rate of 2½ gallons of commercial concentrated lime sulfur, or 5 gallons of homemade lime sulfur (Illinois formula), in each 100 gallons of spray, or Bordeaux, 8-8-100, may be used for this spray. In either case 4 pounds of paste or 2 pounds of powdered arsenate of lead should be used in each 100 gallons of spray.

Calyx Spray.—This spray is used both for the control of codling moth and as a preventive of apple scab. Spraying should begin when most of the petals have fallen, to insure its completion while the lobes of the calyxes are still distended.

For this spray the same strength of lime sulfur arsenate of lead should be used as for the cluster-bud spray.

Ten Days after Bloom.—This spray is used as an additional precaution against apple scab; it is also a safeguard against codling
moth and leaf-eating insects, and to some extent **against** certain fungous diseases which appear later in the season, including sooty blotch and leaf spot (*Sphaeropsis malorum*). This spray should be made about ten days after the calyx spray, which means that in large commercial orchards the second spray will probably not be completed until the third must be commenced. It is recommended that this application be made to all apple orchards in the northern third of the state, but that in central Illinois it be applied only in seasons when cool, wet weather, favorable for scab development, follows the bloom.

Lime sulfur arsenate of lead as recommended for the cluster-bud spray should be used.

*Three Weeks after Bloom.*—This spray is a safeguard against codling moth, and, in the central part of the state, against apple blotch. Lime sulfur arsenate of lead as directed for the cluster-bud spray should be used.

*Ten Weeks after Bloom.*—This spray is applied particularly for the control of second-brood codling moth, and incidentally for the prevention of curculio injury.

For this spray arsenate of lead, 4 pounds of paste or 2 pounds of powder, to which has been added 4 pounds of freshly slaked lime in each 100 gallons of spray, should be used.

**RECOMMENDATIONS FOR THE USE OF DUST MATERIALS**

The sulfur lead dust mixtures may be used for those sprays where an insecticide is the primary object. For the southern division this would mean the cluster-bud or prebloom spray, and, under certain conditions, the calyx spray. For the central and northern divisions the dust may be used for the applications three and ten weeks after the fall of the bloom.

In any part of the state the dust method is essentially a problem for the large commercial grower, and is not advised for those whose orchards are less than 40 acres in extent.

**STANDARD SPRAYS: FORMULAS AND PREPARATION**

*Bordeaux.*—Eight pounds copper sulfate, 8 pounds freshly-slaked lump lime, 100 gallons water. The mixture is prepared by dissolving the copper sulfate in half the total quantity of water used, and mixing the slaked lime with the other half. The diluted solution of copper sulfate and the diluted mixture of lime are then poured together simultaneously thru a sieve, either into the mixing tank or directly into the spray tank.

*Lime Sulfur, Commercial, for Summer Sprays.*—Eight pounds sulfur in 100 gallons spray (3 gallons commercial concentrated lime
sulfur to 97 gallons water, or 3 gallons commercial concentrated lime sulfur in 100 gallons of the dilute summer spray).

**Lime Sulfur, Commercial, for Dormant Spray.**—Twenty-nine to 30 pounds of sulfur in 100 gallons spray (11 gallons commercial concentrated lime sulfur to 89 gallons water, or 11 gallons commercial concentrated lime sulfur in 100 gallons of spray).

**Lime Sulfur, Commercial, for Summer Sprays.**—Eight pounds sulfur in 100 gallons spray (5½ gallons stock solution homemade lime sulfur to 94½ gallons water, or 5½ gallons stock solution homemade lime sulfur in 100 gallons spray).

**Lime Sulfur, Homemade, for Summer Sprays.**—Eight pounds sulfur in 100 gallons spray (5½ gallons stock solution homemade lime sulfur to 94½ gallons water, or 5½ gallons stock solution homemade lime sulfur in 100 gallons spray).

**Lime Sulfur, Homemade, for Dormant Spray.**—Twenty-nine pounds sulfur in 100 gallons spray (20 gallons stock solution homemade lime sulfur to 80 gallons water, or 20 gallons stock solution homemade lime sulfur in 100 gallons spray).

**Stock Solution, Homemade Lime Sulfur.**—One hundred pounds sulfur, 50 pounds lime, water to make 66 gallons. Homemade lime sulfur is prepared by placing in a large kettle 15 gallons water and 50 pounds good lime, free from air-slaked particles. When the lime is slaking vigorously, 100 pounds of powdered sulfur are poured in, and mixed thoroly with the lime. Sufficient water is added gradually 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, enough water is added to bring the total volume to 66 gallons or a little more. Boiling is continued for 30 to 45 minutes, water being added from time to time to keep the volume at 66 gallons. By following this method it is found possible to get the maximum amount of sulfur into solution. In most of the experimental work, the boiling has been done in large iron kettles heated over simple outdoor fireplaces constructed for the purpose.

**Arsenate of Lead.**—Four pounds arsenate of lead paste, or 2 pounds of arsenate of lead powder, in 100 gallons water, Bordeaux, or lime sulfur. The paste arsenate of lead is worked up with a small quantity of water into a mixture that will pour readily and mix evenly with the water or the fungicide when subjected to the action of the agitator in the spray tank. The powdered arsenate of lead may be mixed most easily with water by shaking in a closed receptacle. It may, however, be placed on the strainer and worked thru it by the water used in filling the tank.