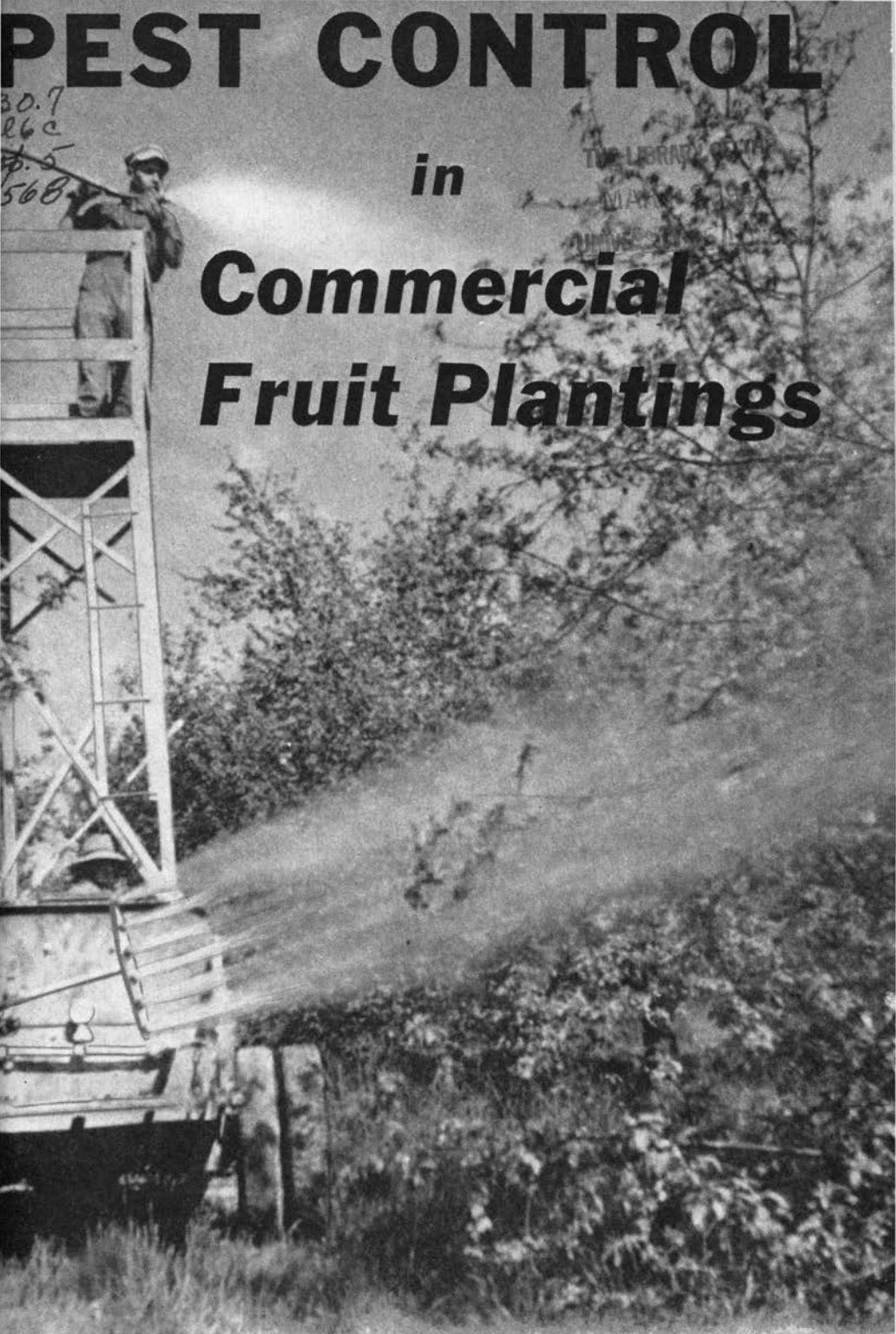
PEST CONTROL

in

Commercial Fruit Plantings



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TENSION SERVICE IN AGRICULTURE AND HOME ECONOMICS *in cooperation with*

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Urbana, Illinois February, 1944

Cooperative Extension Work in Agriculture and Home Economics: University of Illinois, College of Agriculture, and the United States Department of Agriculture cooperating. H. P. Rusk, *Director*. Acts approved by Congress May 8 and June 30, 1914.

PEST CONTROL

In Commercial Fruit Plantings[1]

PART I

INSECT AND DISEASE CONTROL

GOOD YIELDS of high-quality fruit are necessary to successful commercial fruit culture. In Illinois a vigorous program of pest control is essential to the attainment of this goal.

Recommendations in this circular are in accordance with the most recent investigations of the Illinois and Indiana Agricultural Experiment Stations; the Illinois State Natural History Survey; and the Bureau of Entomology and Plant Quarantine and the Bureau of Plant Industry, Soils, and Agricultural Engineering of the U. S. Department of Agriculture. Growers will need to make changes in these recommendations to adapt them to their own conditions, but they are urged not to experiment with untested materials and methods because this frequently results in disaster.

APPLES

Orchard Sanitation

Altho spraying is essential to the control of insects and diseases in the apple orchard, sanitation is just as important. To get full benefit from spraying, growers are urged to adopt the following sanitary practices:

Thin out branches and reduce height of tall trees (Fig. 1). Keep lower branches off the ground. Remove all dead twigs,

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For helpful criticisms and suggestions, the authors are indebted to H. W. ANDERSON, Professor and Chief of Pomological Pathology; M. D. FARRAR, Research Entomologist, Illinois State Natural History Survey; W. A. RUTH, Professor and Chief of Pomological Physiology; C. C. COMPTON, Associate Entomologist, Illinois State Natural History Survey.

limbs, split branches, punky wood, cankers, and old pruning stubs. Prune closely and smoothly. Wherever possible, make the cuts in such a way that the cut surfaces will shed water. Collect and burn all prunings.

Avoid coarse mulching materials. Clip sweet clover or other

Fig. 1.—Tops of high trees should be lowered for convenience in spraying and harvesting. Fruit trees should not be allowed to grow more than about 20 feet high. The cure for trees that have done so is to cut the leaders back to horizontal lateral branches, as indicated by the arrows. If the cutting is so heavy as to expose too much of the top to the sun, the branches may suffer sunscald. It is of course much better to prune lightly when the tree first begins to grow too high.

cover crops to prevent rank stem growth in which codling moth larvae might spin cocoons.

Collect and remove all dropped fruit.

Destroy all debris. Remove and burn broken crates, baskets, discarded sacks, and rotten wood.

Thin out all fruit showing disease or insect injury and all rotting fruit as soon as discovered.

Screen packing shed.

Grade or pack as far from the orchard as possible.

Scrape off loose bark. Scraping will reduce the number of overwintering codling moth larvae 80 percent. Do this during

winter and early spring on trunks and branches to a height of 10 feet from the ground. Collect and burn all scrapings.

Band trees. Banding will reduce the summer broods of codling moth larvae 50 percent. Apply chemically treated bands (Fig. 2) normally about June 10 to 30. The time for your section will be designated in radio broadcasts.

Fig. 2.—Chemically treated bands 2 to 4 inches wide are very effective in collecting and killing codling moth larvae on trees that have been carefully scraped and pruned.

Borer Control

There are two apple tree borers of importance in Illinois. Altho neither is always present in apple orchards, both may cause very serious injury on trees up to about 12 years of age.

The roundheaded apple tree borer is prevalent mostly in the northern two-thirds of Illinois. The burrows of this insect are usually made in the base of the trunk, from 1 to 2 inches below the surface of the ground to a foot or more above ground. Control may be obtained by pouring ½ pint of paradichlorobenzene-oil solution (see *lesser peach borer,* page 19) around the base of the tree, touching the bark. Mound 3 to 5 spadefuls of earth over the treatment. *For a full description of the roundheaded apple tree borer and its control, see Illinois State Natural History Circular 40.*

The flatheaded apple tree borer works higher up on the trunk than the roundheaded borer, and in some cases infests the branches. Infestations are nearly always on the sunny side, but may extend completely around the tree. Some degree of control can be obtained by shading, either by wrapping or by placing two boards, nailed together in the form of a trough, near the tree to shade the south and west sides. Weakened trees are especially susceptible. No satisfactory wash or paint is known for killing larvae in the tree or for repelling the adults.

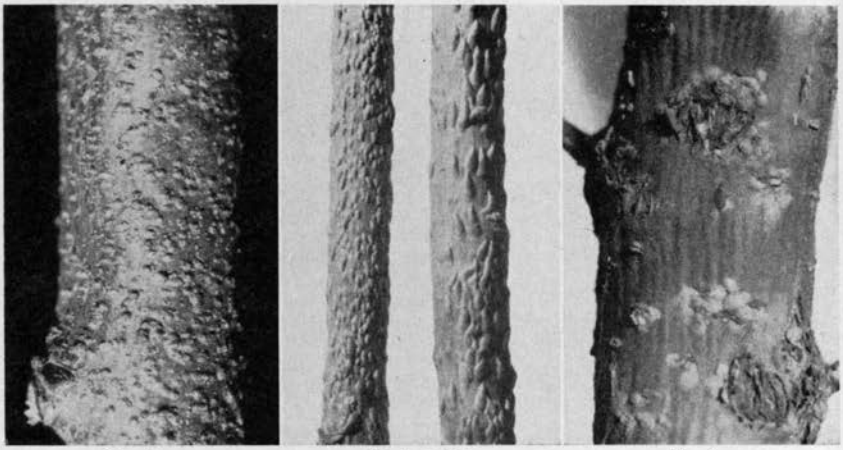
Spray Schedules for Fall and Winter Varieties

STANDARD SCHEDULE

• **Dormant.** Apply when the trees are dormant (Fig. 4, stage 1) and when the spray will dry before freezing. Early spring is the most desirable time from the standpoint of effectiveness and safety.

For San Jose scale (Fig. 3), in 100 gallons of water use:

Dormant oil, 2 to 3 gal. actual oil



San Jose Oyster-shell Scurfy

Fig. 3.—The three most important fruit-tree scales in Illinois. San Jose scale is the most destructive. Oyster-shell scale is of importance only in the northern half of the state. Scurfy scale causes little damage in well-sprayed orchards.

For oyster shell scale, scurfy scale (Fig. 3), green or rosy apple aphids, European red mite, in 100 gallons of water use:

Dormant oil, 3 gal. actual oil, *plus either*
"DN-Dry Mix No. 2," 2 lb.
—or "Elgetol," ¾ gal.

For fruit tree leaf roller, in 100 gallons of water use:

Dormant oil, quick-breaking type, 4 gal. actual oil

• **Prepink.** This spray is primarily for apple scab (Fig. 5), but may be used also for cankerworm. Apply before the flower buds

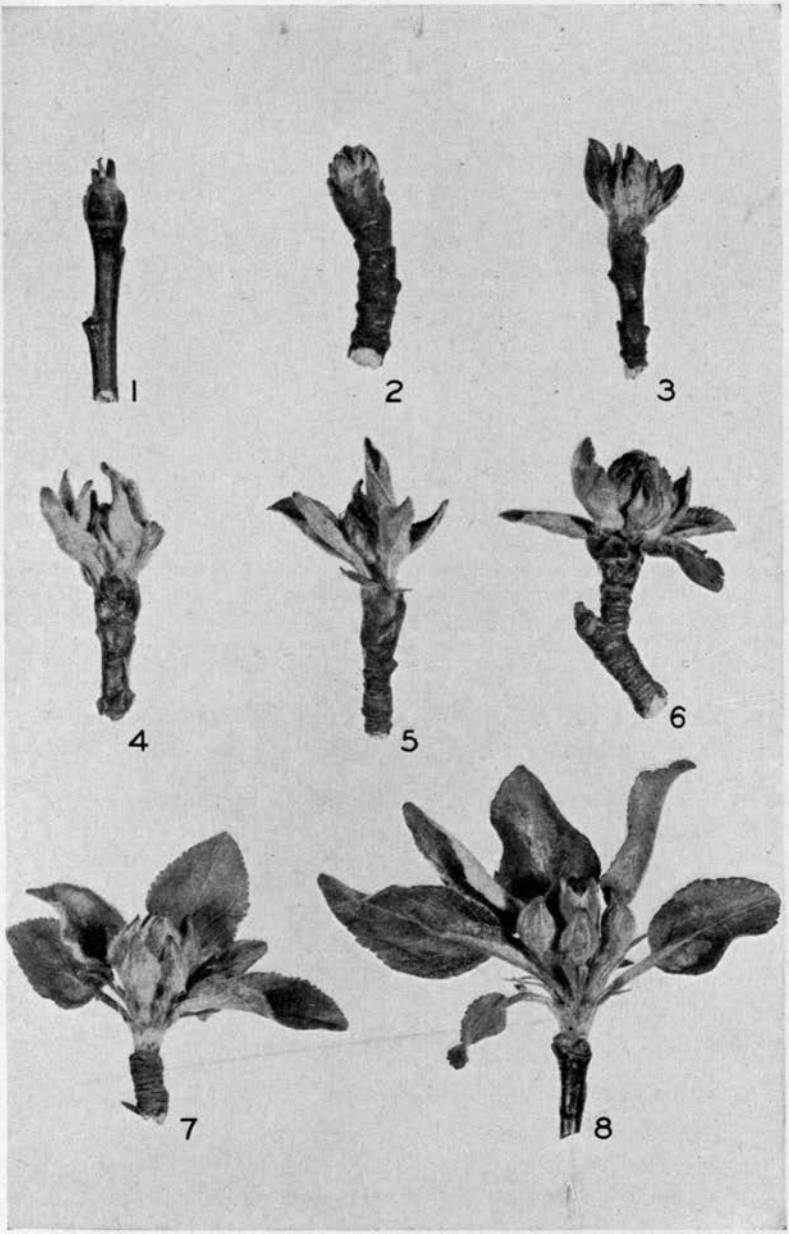


Fig. 4.—Stages in the development of apple fruit buds. The prepink spray should be applied between stages 3 and 6. The pink spray should be started at stage 7 and completed by the time the first flowers open. Aphid sprays should be applied in stages 1 and 2.

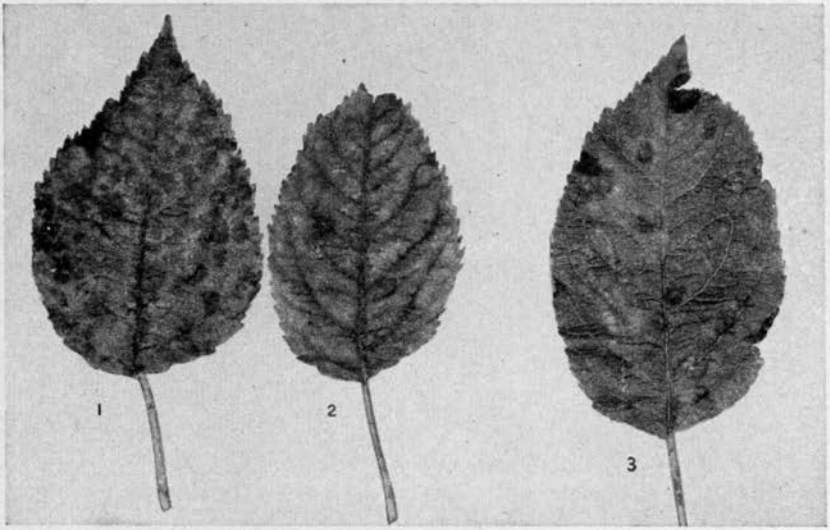


Fig. 5.—Three types of apple scab on leaves. (1) Diffused irregular spots. (2) Spots diffused but especially prominent along leaf veins. The most severe spray injury results when caustic sprays are applied to leaves showing this type of scab. (3) Well-defined spots; note also lesions on leaf stem.

show pink (Fig. 4, stage 3) and complete before the flowers separate in the cluster (Fig. 4, stage 6).

For apple scab only, in 100 gallons of water use:

Commercial liquid lime sulfur, 2 gal.
—or dry lime sulfur, 8 lb.

For cankerworm add 2 pounds of lead arsenate to the above.

• **Pink.** Apply as soon as most of the buds in the cluster have separated (Fig. 4, stage 8). This spray is primarily for apple scab but may also be used for cankerworm.

For apple scab, in 100 gallons of water use:

Same as prepink spray
—or flotation sulfur paste, 16 lb. (*see page 40*)
—or microfine wettable sulfur, 8 lb.

Do not use lime sulfur on Jonathan or Golden Delicious.

For cankerworm add 2 pounds of lead arsenate to the prepink spray. If flotation sulfur paste or microfine wettable sulfur is used for scab control, add 2 pounds of hydrated lime.

Rodent Baits and Poisons

District Agent, Div. of Predator and Rodent Control, U. S. Dept. of Interior, West Lafayette, Ind.

Santomerse

Monsanto Chemical Co., St. Louis, Mo.

Soybean Flour

Allied Mills, Inc., Chicago, Ill.
Archer-Daniels-Midland Co., Soybean Div., 927 Blackhawk St., Chicago, Ill.
The Glidden Co., 5165 W. Moffat St., Chicago, Ill.
Spencer Kellogg & Sons, Inc., Soybean Products Div., Decatur, Ill.
A. E. Staley Mfg. Co., Corn & Soybean Products, Decatur, Ill.
Stein Hall Mfg. Co., 2841 S. Ashland Ave., Chicago, Ill.
Swift & Co., Champaign, Ill.

Sulfur

Stauffer Chemical Co., Carbide & Carbon Bldg., 230 N. Michigan Ave., Chicago, Ill.
Camden Coke Plant, Camden, N. J.
Koppers Co., Tar and Chemical Div., Pittsburgh, Pa.
Douglass Sulphur Co., P. O. Box 231, Houston, Texas

Tobacco Products

Nicotine Production Corporation, Inc., Clarkesville, Tenn.
Tobacco By-Products & Chemical Corp., Louisville, Ky.

Treated Bands

M. A. Koeller, Barry, Ill.
Edwin C. Tyson, Flora Dale, Pa.

MANUFACTURERS OF SPRAY MACHINERY

Sprayers, Dusters and Accessories

John Bean Mfg. Co., Lansing, Mich. and San Jose, Calif.
The E. C. Brown Co., Rochester, N. Y.
Field Force Mfg. Co., Pottstown, Pa.
Friend Mfg. Co., Gasport, N. Y. (peach sizers, apple sizers, brush cleaners also)
Hardie Mfg. Co., Hudson, Mich.
H. D. Hudson Mfg. Co., 589 E. Ill. St., Chicago, Ill.
The F. E. Myers & Bro. Co., Ashland, O.
The Feeny Mfg. Co., Muncie, Ind.
Niagara Sprayer & Chemical Co., Inc., Middleport, N. Y.
The Root Mfg. Co., 1311 W. 80th St., Cleveland, O.

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

This list supplements Circular 568, "Pest Control in Commercial Fruit Plantings," issued by the University of Illinois, College of Agriculture, Extension Service in Agriculture and Home Economics

MANUFACTURERS OF SPRAY MATERIALS[1]

Bentonite (Mississippi)

American Colloid Co., 363 W. Superior St., Chicago, Ill. ("Panther Creek" brand) (Shipping point: Aberdeen, Miss.)
Filtrol Corp., 634 S. Spring St., Los Angeles, Calif. ("X110 Filtrol" brand) (Shipping point: Jackson, Miss.)

Beta Naphthol

American Cyanamid & Chem. Corp., Insecticide Div., 30 Rockefeller Plaza, New York, N. Y.

Corrugated Paper

Pomeroy Mfg. Co., Vincennes, Ind.

Dinitro Compounds

Dow Chemical Co., Midland, Mich.
Standard Agricultural Chemicals, Inc., Hoboken, N. J.

Fermate

E. I. duPont de Nemours & Co., Inc., Wilmington, Del.

General[2]

Ansbacher-Siegle Corp., 310 N. 7th St., Brooklyn, N. Y.
California Spray-Chemical Corp., Elizabeth, N. J.
Chipman Chemical Co., 6225 W. 66th Place, Chicago, Ill.
Dow Chemical Co., Midland, Mich.
E. I. duPont de Nemours & Co., Inc., Wilmington, Del.
General Chemical Co., 818 Olive St., St. Louis, Mo. (also tobacco products, oil sprays and soaps, sulfur, lime)
Grasselli Chemicals Dept., E. I. duPont de Nemours & Co., Inc., Wilmington, Del.
Latimer-Goodwin Chemical Co., 720 S. 7th St., Grand Junction, Colo.
J. A. McCarty Seed Co., 526 N. W. 4th St., Evansville, Ind.
McLaughlin Gormley King Co., 1715 Fifth St., S. E., Minneapolis, Minn.
Niagara Sprayer & Chemical Co., Inc., Middleport, N. Y.
Pittsburgh Plate Glass Co., Corona Chemical Div., Milwaukee, Wis.
G. S. Robins Co., 126 Chouteau Ave., St. Louis, Mo.
Röhm & Haas Co., Inc., 222 W. Washington Square, Philadelphia, Pa.
Standard Agricultural Chemicals, Inc., Hoboken, N. J.

Gypsum

U. S. Gypsum Co., 300 W. Adams St., Chicago, Ill. (lime also)

Lime

Marble Cliff Quarries Co., P. O. Box 1110 (20 N. 5th St.), Columbus, O.
Marblehead Lime Co., 160 N. LaSalle St., Chicago, Ill.
Mississippi Lime Co., Alton, Ill.

Oil Sprays and Soaps

Crystal Soap & Chemical Co., Inc., 6300 State Rd., Philadelphia, Pa.
National Oil Products Co., Inc., Harrison, N. J.
B. G. Pratt Co. (Western distributor—Wm. A. Weber Nursery, Kirkwood, Mo.)
Schaeffer Bros. & Powell Mfg. Co., 102 Barton St., St. Louis, Mo.
Standard Oil Co. of Indiana, 910 S. Michigan Ave., Chicago, Ill.

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[1]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.

[2]These firms handle most of the insecticides and fungicides, including miscible oils, soaps, casein-lime, paradichlorobenzene, wettable sulfurs, commercial copper sprays, dusts, materials for band treating, etc. Oils for making lubricating oil emulsion can be obtained from any of the larger oil companies; insist on oils of the proper specifications.

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For apple scab and for cedar rust on varieties susceptible to this disease where it is a problem, apply the following materials instead of the full-strength sulfur. In 100 gallons of water use:

"Fermate,"[1] ½ lb., *plus either*
Microfine wettable sulfur, 3 lb.
—or flotation sulfur paste, 6 lb.

• **Bloom.** *Do not use lead arsenate in this spray.*

For apple scab apply the following spray if cold damp weather prevails following the prebloom stages, thus prolonging the blooming period. In 100 gallons of water use:

Flotation sulfur paste, 10 lb.
—or microfine wettable sulfur, 5 lb.

For fire blight apply the following spray to susceptible varieties when 20 percent of the blossoms have opened. In 100 gallons of water use:

Copper sulfate, 2 lb.
Hydrated lime, 4 lb. (see page 37 for mixing)

For cedar rust and apple scab control on varieties susceptible to cedar rust, in 100 gallons of water use:

"Fermate," ½ lb., *plus either*
Microfine wettable sulfur, 3 lb.
—or flotation sulfur paste, 6 lb.

For cedar rust, apple scab, and fire blight on varieties susceptible to cedar rust and fire blight, in 100 gallons of water use:

Copper sulfate, 2 lb. "Fermate," ½ lb.
Hydrated lime, 4 lb.

• **Calyx.** Apply when ¾ of the petals have fallen (Fig. 6), and complete before the calyx lobes close on the most advanced fruit (Fig. 7).

For codling moth, apple scab, curculio, leaf roller, and green fruit worm, in 100 gallons of water use:

Lead arsenate, 3 lb.
Hydrated lime, 3 lb., *plus either*
Flotation sulfur paste, 12 lb.
—or microfine wettable sulfur, 6 lb.

[1]"Fermate" is an organic fungicide containing ferric dimethyldithiocarbamate.

Fig. 6.—Time to apply calyx spray for scab and codling moth. The petals have just fallen but the calyx lobes have not yet closed.

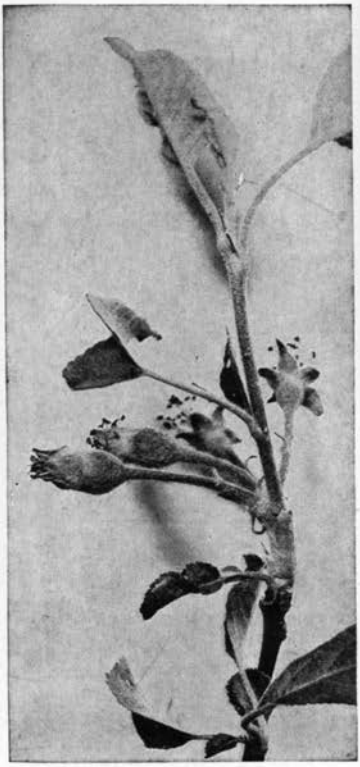

Fig. 7.—Too late for calyx spray. The calyx lobes have closed, making it impossible to drive the spray inside the calyx. The proper stage for applying the calyx spray is shown in Fig. 6.

For cedar rust and apple scab, substitute the following materials for the sulfur recommendation just given:

> **"Fermate," ½ lb., *plus either***
> **Microfine wettable sulfur, 3 lb.**
> **—or flotation sulfur paste, 6 lb.**

• **Calyx top-off.** Apply this to the top ⅓ of the tree immediately after the calyx spray. Use the same materials as recommended for the calyx spray.

• **First cover.** Apply 7 days after the calyx top-off spray.

For curculio, apple scab, codling moth and leaf roller, in 100 gallons of water use:

Lead arsenate, 4 lb.
Hydrated lime, 2 lb., *plus either*
Flotation sulfur paste, 12 lb.
—or microfine wettable sulfur, 6 lb.

For cedar rust control, substitute 1 pound of "Fermate" for the sulfur in this spray. Make the same substitution for apple scab control if summer oil is to be used in the second cover.

• **Second cover.**[1] Apply 7 days after the first cover.

For codling moth and curculio, in 100 gallons of water use:

Lead arsenate, 4 lb.
Soybean flour, ¼ lb., *plus either*
Hydrated lime, 4 lb.
—or copper sulfate, ½ lb., *plus*
Hydrated lime, 1 lb.

Bordeaux mixture (½ pound of copper sulfate and 1 pound of hydrated lime) is more efficient than hydrated lime alone in preventing lead arsenate injury to foliage and fruit and in increasing the sticking qualities of the spray. At this time, however, bordeaux mixture should not be used on Jonathan or Golden Delicious, as it causes russet.

For blotch, codling moth, and curculio on blotch-susceptible varieties, in 100 gallons of water use:

Lead arsenate, 4 lb.
Soybean flour, ¼ lb.
Copper sulfate, 4 lb.
Hydrated lime, 6 lb.

If leafhoppers are present, add 1 pint of nicotine sulfate (40-percent) to either of the above mixtures.

• **Third cover.** Apply 7 days after the second cover.

For codling moth, in 100 gallons of water use:

Lead arsenate, 4 lb.
Copper sulfate, ½ lb.
Hydrated lime, 1 lb.
Summer oil, 2 qt.

[1]Beginning with this spray northern Illinois growers follow the schedule on page 15.

For blotch and codling moth, on blotch-susceptible varieties, in 100 gallons of water use:

Lead arsenate, 4 lb. **Hydrated lime, 6 lb.**
Copper sulfate, 4 lb. **Summer oil, 3 qt.**

If leafhoppers are present, add 1 pint of nicotine sulfate (40-percent) to either of the above mixtures.

If lead arsenate sprays are added after the third cover, as recommended in this schedule, the apples at picking time may carry more lead and arsenic than the legal spray-residue tolerances (page 36).

• **Fourth cover.** For codling moth, apply 7 days after the third cover and use the same materials.

• **Fourth cover top-off.** For codling moth, apply 7 days after the fourth cover, using the same materials and spraying only the top ⅓ of the tree.

• **Special bitter rot sprays.** Where bitter rot is anticipated, start spraying 7 days after the fourth cover top-off spray and repeat at intervals of 10 days until at least four applications have been made. In 100 gallons of water use:

Copper sulfate, 4 lb.
Hydrated lime, 6 lb.

• **Second- and third-brood codling moth.** The *first spray* should be applied in accordance with the seasonal development of the codling moth. Notice of time of hatch will be sent out by the Illinois State Natural History Survey and the Illinois Agricultural Experiment Station by means of letters and by broadcasts over a number of radio stations. This information will be mailed to any grower upon request. For the first spray, in 100 gallons of water use:

Lead arsenate, 3 lb. **Hydrated lime, 1 lb.**
Copper sulfate, ½ lb.

If bitter rot control is required, increase the bordeaux mixture to:

Copper sulfate, 4 lb. **Hydrated lime, 6 lb.**

The *second spray* should be applied approximately 2 weeks following the first spray and the same materials should be used.

The *third spray* should be applied about August 15 or later, depending on codling moth development. Use the same material as for the first spray. This spray is primarily for late second- and third-brood codling moth. Additional sprays may be necessary in late August or September.

NICOTINE SCHEDULES FOR CODLING MOTH

(These schedules will not control bitter rot and late scab)

The following modifications in the standard schedule are designed for the grower who does not wash his fruit at harvest to meet the legal spray-residue tolerances. Two schedules are listed, a straight nicotine and a lead arsenate-nicotine "split" schedule. Either schedule may be used without leaving an objectionable residue on the fruit at harvest. Both schedules are considered effective and both are being used by growers. The same spray materials should be applied in the prepink, pink, calyx, and calyx top-off as in the standard schedule.

Straight Nicotine Schedule

• **First cover.** Apply 7 days after the calyx top-off spray. For insects and diseases controlled in this and the following sprays, see standard schedule. In 100 gallons of water use:

Lead arsenate, 4 lb. **"Fermate," 1 lb.**
Hydrated lime, 2 lb.

• **Second cover.** Apply 7 days after the first cover. In 100 gallons of water use:

Mississippi bentonite, 8 lb.
(see page 40 for directions for mixing tank-mix nicotine-bentonite)
Summer mineral oil, 2qt.
Nicotine sulfate (40-percent), 1 pt.
—or—
"Black leaf 155," 3 lb.
Summer mineral oil, 2 qt.

• **Third cover.** Apply 10 days after the second cover, using the same materials.

• **Fourth cover.** Apply 10 days after the third cover, using the same materials.

• **Fifth cover.** Apply 10 days after the fourth cover, using the same materials.

• **Second- and third-brood sprays.** Complete first application 2 weeks after fifth cover. Make two to four applications at 10- to 14-day intervals, depending on the abundance of codling moth. In 100 gallons of water use:

Mississippi bentonite, 5 lb.
Summer mineral oil, 2 qt.
Nicotine sulfate (40-percent), $^2/_3$ pt.
—or—
"Black leaf 155," 2½ lb.
Summer mineral oil, 2 qt.

Lead Arsenate-Nicotine "Split" Schedule

The same materials should be applied thru the second cover spray as in the standard schedule.

• **Third cover.** Apply 7 days after the second cover. In 100 gallons of water use:

Lead arsenate, 3 lb.
Summer oil, 2 qt.
"Black leaf 155," 1½ lb.

• **Fourth cover.** Apply 10 days after the third cover using the same materials.

• **Fifth cover.** Apply 10 days after the fourth cover. In 100 gallons of water use:

"Black leaf 155," 3 lb.
Summer oil, 2 qt.

• **Second- and third-brood sprays.** Complete first application 2 weeks after fifth cover. Make 2 to 4 applications at 10- to 14-day intervals, depending on the abundance of codling moth. In 100 gallons of water use:

"Black leaf 155," 2½ lb.
Summer oil, 2 qt.

NORTHERN ILLINOIS SPRAY SCHEDULE

In the northern third of the state apple scab is the most serious apple pest. It is therefore recommended that sulfur be included in more of the summer sprays, and that fewer summer and fall sprays be applied. In this part of the state *apple maggot*, an insect heretofore confined to the northern apple-growing regions, has become prevalent. Thus far well-cared-for orchards have not become infested; the pest is apparently controlled by the normal number of codling moth sprays.

The same materials should be applied thru the **dormant, pre-pink, pink, calyx, calyx top-off,** and **first cover** sprays as are listed in the preceding schedule.

• **Second cover.** Apply 10 days after the first cover.

For apple scab and codling moth, in 100 gallons of water use:

Lead arsenate, 3 lb.
Hydrated lime, 3 lb.
Soybean flour, ¼ lb., *plus either*
Flotation sulfur paste, 10 lb.
—or microfine wettable sulfur, 5 lb.

If leafhoppers are present, add 1 pint of nicotine sulfate (40-percent) to the above.

• **Third cover.** Apply 10 days after second cover.

For codling moth and apple scab, in 100 gallons of water use:

Lead arsenate, 3 lb.
Hydrated lime, 3 lb., *plus either*
Flotation sulfur paste, 4 lb.
—or microfine wettable sulfur, 2 lb.

If leafhoppers are present, add 1 pint of nicotine sulfate (40-percent) to the above.

• **Fourth cover.** Apply 10 days after the third cover, using the same materials.

• **Second-brood codling moth and apple maggot spray.** For

directions on time to apply, follow weekly broadcasts. In 100 gallons of water use:

Lead arsenate, 3 lb. Soybean flour, ¼ lb.
Hydrated lime, 3 lb.

Spray Schedule for Summer Varieties

For summer apples, the sprays applied up to and including the calyx spray are the same as for fall and winter varieties, except when the dormant blotch spray is used. Make a dormant blotch application as late in the delayed dormant period as possible (Fig. 4, stage 2). In 100 gallons of water use:

Copper sulfate, 12 lb. Miscible dormant oil, 2 gal.
Hydrated lime, 8 lb.

• **First cover.** Apply 7 days after the calyx spray.

For codling moth and curculio, in 100 gallons of water use:

Calcium arsenate, 3 lb. Hydrated lime, 3 lb.
—or lead arsenate, 3 lb.

• **Second cover.** Apply 10 days after the first cover on Duchess and other blotch-susceptible varieties. Both bearing and nonbearing trees should be sprayed.

For blotch and codling moth, in 100 gallons of water use:

Calcium arsenate, 2½ lb.
Copper sulfate, 4 lb.
Hydrated lime, 6 lb.
Summer oil, 3 qt.

For codling moth only, on varieties not susceptible to blotch, in 100 gallons of water use:

Nicotine sulfate (40-percent), 1 pt.
Summer oil, 3 qt.
—or—
"Black leaf 155," 3 lb.
Summer oil, 2 qt.
—or—
Calcium arsenate, 3 lb.
Hydrated lime, 3 lb.

• **Third cover.** Apply one week after the second cover, using the same materials for the same pests.

• **Fourth cover.** Apply for early second-brood codling moth. Use the same materials except omit the bordeaux mixture on blotch-susceptible varieties.

PEARS

SPRAY SCHEDULE FOR PEARS

Kind of spray and purpose	Time to apply	Materials in 100 gallons of water
1. **Dormant,** for pear psylla and scale	Before buds begin to open. Not needed every year	Dormant oil, 2 gal.
2. **Calyx,** for codling moth, curculio, leaf spot, and pear scab	As soon as petals have fallen	Lead arsenate, 3 lb. Liquid lime sulfur, 2 gal.
3. **First cover,** for codling moth, curculio, leaf spot, and pear scab	18 to 21 days after calyx spray	Same as for calyx
4. **Additional covers**		
—for codling moth.....	Same time as for 2d-brood codling moth sprays on apples	Lead arsenate, 3 lb. Hydrated lime, 3 lb.
—for leaf spot.....	If prevalent, apply at 14-day intervals until August 1	Copper sulfate, 6 lb. Hydrated lime, 8 lb.

PEACHES AND APRICOTS

Borer Control

Borers are serious pests in all parts of the state where peaches and apricots are grown. There are three borers to consider.

The *peach borer,* the most serious and the most common, works at the base of the tree. Excellent control is obtained by applying crystalline paradichlorobenzene (P.D.B.) to the ground in a ring around the tree just far enough from the trunk so that it does not touch the bark, and then mounding with 3 to 5

DUST AND SPRAY SCHEDULES FOR PEACHES AND APRICOTS

Time and purpose	Dust	Spray (materials in 100 gallons of water)
Dormant. Apply in spring before buds swell, for San Jose scale and leaf curl[a]	A satisfactory dormant dust is not known	Dormant oil, 2 to 3 gal. Copper sulfate, 4 lb. Hydrated lime, 3 lb. —or— If scale is not present, use liquid lime sulfur, 5 gal.
Bloom[b]	Sulfur, 60 lb. Talc, 35 lb.[c] Oil, 5 lb. (*see footnote on page 38*)	Wettable sulfur, 6 lb. (*Do not use lime sulfur in summer sprays*)
First cover. Apply when shucks are half-way off, for curculio. (If curculio is severe, make two applications: one just before the shuck stage indicated and one after it)	Sulfur, 30 lb. Lime, 25 lb. Talc, 30 lb. Lead arsenate, 10 lb. Oil, 5 lb.	Lead arsenate, 3 lb.[d] Zinc sulfate, 2 lb. Hydrated lime, 3 lb. (*See page 41 for directions on mixing zinc sulfate and lime*)
Second cover. Apply about 10 days after first cover for curculio and scab	Same as first cover	Same as first cover, except that on scab-susceptible varieties add wettable sulfur, 6 lb.[e]
Third cover. Apply about 2 to 3 weeks after second cover	Same as first cover, if jarring indicates heavy curculio infestation. If light, dust only scab-susceptible varieties, using: Sulfur, 60 lb. Talc, 35 lb. Oil, 5 lb.	Same as second cover if jarring indicates heavy curculio infestation. If light, spray only scab-susceptible varieties. Use wettable sulfur, 6 lb.
Special curculio application. Apply one month before harvest if curculio is severe	Same as first cover	Same as first cover
Fourth cover. Apply 20 days before harvest, for brown rot and oriental fruit moth	Sulfur, 60 lb. Talc, 35 lb. Oil, 5 lb.	Not usually necessary. If necessary, use same as indicated for fifth cover
Fifth cover. Apply 15 days before harvest, for brown rot and oriental fruit moth	Same as fourth cover	Wettable sulfur, 4 lb. "Black Leaf 155," 3 lb. (*Do not add lead or lime*)
Sixth cover. Apply 10 days before harvest, for brown rot and oriental fruit moth	Same as fourth cover	Same as fifth cover
Seventh cover. Apply 3 days before harvest, for brown rot and oriental fruit moth	Same as fourth cover	Same as fifth cover

(*For footnotes see opposite page*)

Fig. 8.—P.D.B. treatment for peach borers consists of a "death ring" of paradichlorobenzene crystals (*left*) placed close to the trunk of the tree *but not touching the bark*. The ring of crystals is covered with a mound of earth (*right*) to confine the gas.

spadefuls of earth (Fig. 8). Depending upon the circumference of the tree, use the following amounts of P.D.B. on:

Trees 1 year old, ¼ oz.	Trees 6 to 10 years old, 1 oz.
Trees 2 years old, ½ oz.	Trees older than 10 years,
Trees 3 to 5 years old, ¾ oz.	1 to 2 oz.

Fall treatments are more effective than spring treatments. The temperature of the soil should be 55° F. or over to volatilize the material. In general, the best dates for treatment are from September 25 to October 15, depending on the latitude and soil temperatures.

The *lesser peach borer* works farther up on the trunk or in the crotches and injured places over the tree. It can be controlled by painting the affected areas with P.D.B. in oil made up as follows: dissolve 2 pounds of P.D.B. in 1 gallon of "Dendrol," or similar dormant miscible spray oil, and make up to 2 gallons with water.

Bark beetles usually attack only weakened trees or branches, tho occasionally they are found on healthy trees. Usually they

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(*Notes for page 18*)

[a]Leaf-curl sprays are not needed on apricots.

[b]For large-flowered early varieties (Red Bird, for example) and where blossom blight has caused losses in previous seasons on standard varieties such as Elberta.

[c]A very light talc is necessary for making the best dust.

[d]If basic lead arsenate is used increase to 6 pounds.

[e]Peach varieties ripening later than Elberta are generally more susceptible to scab than those ripening with or earlier than Elberta. Elberta and similar varieties may be severely scabbed under climatic conditions favorable to the development of the disease. However, as a rule, lead arsenate with zinc sulfate and lime (or the sulfur-talc dust) will control the disease on these varieties.

may be controlled by increasing the vigor of the tree by means of fertilizers, proper drainage or scale control. Frequently a heavy application of nitrogenous fertilizer corrects the trouble because the grubs generally do not thrive on fast-growing wood.

The P.D.B.-oil treatment described for the lesser peach borer is also moderately effective in controlling bark beetles.

(For a full description of these borers and their control, together with a discussion of certain substitutes for P.D.B., see Illinois State Natural History Survey Circular 31.)

Catfacing

The injury to the surface of the peach and apricots known as catfacing is caused by the tarnished plant bug, various species of stink bugs, and by the plum curculio. Except for poisoning the curculios, as described in the dust and spray schedules for peaches and apricots, applications of insecticides have reduced catfacing only a little or not at all.

Legume cover crops tend to encourage catfacing more than nonlegumes. Legumes are, however, much to be preferred in the orchard soil-management program. Catfaced peaches, like other defective fruit, can be removed during thinning.

Virus Diseases of Peaches

Peach yellows, peach rosette, phony peach, and *yellow-red virosis* are virus diseases of peaches known to have been present in Illinois during the past ten years.

Peach yellows is often harbored in the plum, where the symptoms are inconspicuous. For this reason wild plums in the neighborhood of peach orchards should be eradicated. The yellow-red virosis is primarily a disease of chokecherry, but peach trees in the neighborhood of infected chokecherries may become infected. All chokecherries within half a mile of peach orchards should be destroyed. The common wild blackcherry does not carry this virus.

If virus diseases are suspected, the grower should request inspection by the STATE NURSERY INSPECTION SERVICE, Glen Ellyn, Illinois.

CHERRIES

SPRAY SCHEDULE FOR CHERRIES

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. **Dormant,** for San Jose and Forbes scale	Before buds begin to open	Dormant oil, 2 gal., or liquid lime sulfur, 11 gal.
2. **First cover,** for brown rot, leaf spot, curculio, and slug	Immediately after shucks have fallen	Lead arsenate, 3 lb. Copper sulfate, 4 lb. Hydrated lime, 6 lb.
3. **Second cover,** for same pests as first cover	10 days after first cover	Same as first cover
4. **Additional covers** —for leaf spot.....	Immediately after harvest	Copper sulfate, 4 lb. Hydrated lime, 6 lb.
—for cherry slugs.....	In August	Lead arsenate, 2 lb. Hydrated lime, 6 lb.

PLUMS

SPRAY SCHEDULE FOR PLUMS

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. **Dormant,** for scale insects	Before buds begin to open	Dormant oil, 2 gal.
2. **First cover,** for brown rot	Just before blossoms open	Commercial liquid lime sulfur, 2 gal.
3. **Second cover,** for brown rot, curculio, and leaf diseases	Immediately after shucks have fallen	Lead arsenate, 4 lb. Commercial liquid lime sulfur, 2 gal.
(On Japanese varieties, use microfine wettable sulfur, 8 lb., in place of the liquid lime sulfur, and add hydrated lime, 4 lb.)		
4. **Third cover,** for same pests as second cover	10 days after second cover	Same as for second cover
5. **Additional covers** —for brown rot.....	At weekly intervals starting 3 weeks before harvest	Microfine wettable sulfur, 8 lb.
—for aphids.....	Apply when needed	Soap flakes, 4 lb. Nicotine sulfate (40-percent), 1 pint

(For treatment of other diseases, see next page)

Plums are subject to only two virus diseases, *rosette* and *yellows*. The only method of control for these diseases is to remove all infected trees promptly.

Black knot, a fungus disease, may be controlled by removing and burning, for two successive years, all twigs showing knots during the winter months. On large limbs the knots may be cut out, thus saving the limbs. A dormant spray made up of 12½ gallons of commercial liquid lime sulfur for each 100 gallons of water has been found to aid in the control of black knot.

BRAMBLES

Sanitation

Certain diseases of brambles such as *crown gall, orange rust, mosaic, leaf curl,* and *bramble streak* cannot be controlled by spraying. The following practices are recommended to aid in preventing these diseases:

(**1**) Do not plant stock where diseased plants have been recently grown. (**2**) Select resistant varieties. (**3**) Order planting stock from a reliable nursery. (**4**) Have plantings of red and black raspberries as much as 300 feet apart. (**5**) As soon as

SPRAY SCHEDULE FOR BRAMBLES

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. Delayed dormant, for anthracnose, rose scale, and possibly red spider	In spring after beginning of growth but not after leaflets are ⅜ inch long	Copper sulfate, 8 lb. Hydrated lime, 8 lb. Dormant oil, 2 gal. —or— Commercial liquid lime sulfur, 2 gal.
2. Prebloom, for anthracnose	1 week before bloom	Copper sulfate, 8 lb. Hydrated lime, 8 lb. Summer oil, 1 gal.
3. Additional sprays —for sawflies	Within 1 week after full foliage	Lead arsenate, 2 lb.
—for red spider and other mites, leaf spots, and anthracnose	2 sprays at intervals of 2 to 3 weeks after harvest	Copper sulfate, 4 lb. Hydrated lime, 4 lb. Summer oil, 1 gal.

diseased plants are detected, dig them up with as many of their roots as possible, and burn at once. (**6**) At planting time cut off old stubs of 2-year-old nursery stock and "handles" of young purple and black raspberries. (**7**) Remove and burn old fruiting canes immediately after harvest.

(*For a full discussion of selection of varieties and cultural methods, see Illinois Circular 508, Bramble Fruits.*)

CURRANTS AND GOOSEBERRIES

SPRAY SCHEDULE FOR CURRANTS AND GOOSEBERRIES

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. **Dormant,** for scale insects	Before growth starts	Dormant oil, 2 gal.
2. **First cover,** for currant aphids and leaf spot	When leaves start to unfold	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Nicotine sulfate (40-percent), 1 pint
3. **Second cover,** for currant worm and leaf spot	When in full foliage; do not wait for worms to appear	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Lead arsenate, 2 lb.
4. **Additional covers** for leaf spot	2 sprays at 2-week intervals following 2d cover	Same as 2d cover except omit lead arsenate

STRAWBERRIES

Sanitation

Diseases and insects of strawberries can usually be controlled by cultural and sanitary methods. The following practices are recommended:

(**1**) To avoid white grubs, do not plant strawberries on sod-land until it has been under cultivation for at least two years. (**2**) To reduce crown borer injury, separate new beds at least 350 yards from old beds and plow up the patch after two picking seasons. (**3**) Choose varieties resistant to disease in so far as possible. For example, in areas where red stele root rot is common, plant varieties resistant to this disease. (**4**) Renovate beds immediately after each harvest.

(For a full discussion of cultural and sanitation methods for strawberries, see Illinois Circular 463, Strawberry Culture in Illinois.)

SPRAY SCHEDULE FOR STRAWBERRIES

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. **First cover,** for leaf spot and leaf roller	First appearance of blossoms	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Lead arsenate, 3 lb.
2. **Second cover,** for leaf spot and leaf roller	Immediately after blossoming	Same as for first cover

GRAPES

SPRAY SCHEDULE FOR GRAPES

Kind and purpose	Time to apply	Materials in 100 gallons of water
1. **Dormant,** for scale and anthracnose	Before buds open, (seldom needed)	Commercial liquid lime sulfur, 7 gal.
2. **Delayed dormant,** for grape flea beetle	When buds are swelling, (seldom needed)	Lead arsenate, 4 lb. Soybean flour, ¼ lb.
3. **First cover,** for grape berry moth, rose chafer, black rot, and anthracnose	Just before the bloom	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Lead arsenate, 3 lb.
4. **Second cover,** for grape berry moth, grape leaf folder, grape rootworm, rose chafer, black rot, anthracnose and downy mildew	Immediately after bloom	Same as for first cover
5. **Third cover,** for grape rootworm, grape leaf folder, leafhoppers, black rot, anthracnose, rose chafer, and mildews	10 days after the fall of bloom	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Calcium arsenate, 2 lb. Nicotine sulfate (40-percent), 1 pint[a]
6. **Fourth cover,** for leafhoppers, black rot, anthracnose, ripe rot, mildews	3 weeks after bloom.	Copper sulfate, 4 lb. Hydrated lime, 6 lb. Nicotine sulfate (40-percent), 1 pint[a]

[a] *Leafhoppers* are often a limiting factor in grape production. The best methods of control involve the use of nicotine. The time to spray is when most of the insects are in the wingless nymphal stage. Be sure to apply the mixture to the *undersides* of the leaves. The grape "boom" has been found to be highly successful in this respect.

PART II

RODENT CONTROL[1]

Rodents take a heavy toll in killed and damaged trees each year. Definite programs should be adopted for control of these pests as for insects and diseases.

MICE

Mice do most of their damage to orchards in the dormant season. Both *meadow mice* and *pine mice* are found in Illinois. *Meadow mice* are the more common. They have coarse, shaggy fur of slate-gray color. They feed and live largely above ground and have surface runways beneath the ground cover. In contrast, the *pine mouse* has compact, silky-fine, reddish-brown fur and lives and feeds largely below the surface of the ground.

A survey should be made each fall to determine whether mice are present. This can be done by walking up and down the tree rows, watching for mouse runways underneath the grass or mulch on top of the ground, and noting whether there are any small openings extending underneath the soil surface. If there is evidence of mice, prepare for baiting.

Two poisons have proved effective against rodents—zinc phosphide and strychnine. Zinc phosphide is considered very effective for both species of mice. Strychnine is not considered so effective on the pine mouse.

Zinc Phosphide Apple Bait

• **Preparation.** Select small ripe apples. Cut each apple in half and then slice each half into four equal pieces. Do not peel or core. Place 3 to 5 quarts of the cut bait in a clean, dry metal pail or can. Measure *one level teaspoonful* of the zinc phosphide *for each quart of cut bait.* Dust this over the sliced apples and stir until the bait is uniformly coated with the poison. It is then

[1]These recommendations are adapted for the most part from material furnished by G. C. Oderkirk, Division of Predator and Rodent Control, U. S. Department of the Interior, West Lafayette, Indiana.

ready to use. One quart of bait will treat ⅓ to 1 acre of orchard, depending on the degree of infestation. Prepare fresh bait daily.

• **Application.** Distribute bait systematically and thoroly. Use an ice pick or pointed stiff wire to locate the runways and place the bait. Mice require protective cover and seldom leave their trails under matted grass or other cover to venture into the open. For this reason bait containers of tile, glass, metal, or wood are no longer recommended.

Baits should be placed only in runways and holes. As a rule, make placements at about 10-foot intervals. Where runways are found beneath the drip area of the trees, 2 to 4 placements within the area should suffice. One apple slice at each baiting spot is enough. Place grass lightly over the bait. To avoid collapsing runways, bait them from the side rather than from the top.

If the trees are mulched, raise the mulch, place the bait in the runways beneath, and let the mulch down again.

• **Timing.** The best time to bait an orchard is after harvest, when cool weather has caused mice to complete their migration. This will vary from mid-October thru the first of November. Mice are most active from the late forenoon until midafternoon; hence baiting is best done in the forenoon. Avoid very windy days, rainy days, or very cold days.

• **Precautions.** Entrust preparation of bait only to reliable persons. Wash the hands and all utensils after mixing the bait, and at the end of the day wash all utensils in which bait was handled in the orchard. DO NOT HANDLE POISONED BAIT WITH BARE HANDS. Use only zinc phosphide taken from airtight containers, as it loses its potency when exposed to air.

Strychnine-Treated Grain Bait

Strychnine-treated grain bait may be purchased already mixed from reliable dealers. Place a heaping teaspoonful of it at each bait location in surface runways, holes, or mole runways. It is worth the added trouble to put out both grain and apple bait so that the mice will have a choice.

RABBITS

During the winter, especially when snow is on the ground and food is scarce, rabbits feed on the tender bark of many kinds of young fruit trees. Protection may be secured by using mechanical barriers, chemical repellents, or baits.

Mechanical Barriers

Mesh wire will keep rabbits from the trunks of young trees as long as necessary, or the trees may be wrapped each fall with paper of various kinds (Fig. 9). Veneer bands will also protect the trunks.

During deep snows the bases of the framework branches will need protection, since rabbits travel on top of the snow. Cottontail rabbits can reach about 2 feet.

Chemical Repellents

At the present time the use of chemical repellents is considered the least effective method for rabbit control. However,

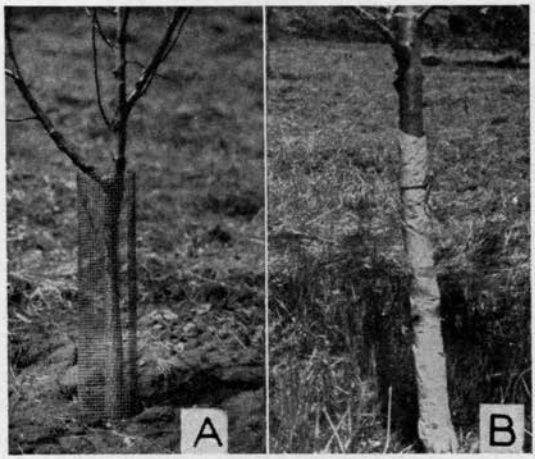

Fig. 9.—Failure to protect young trees from rodents and insects, even for one season, may result in their complete loss. Galvanized gravel screen, 4 meshes per inch, placed around the trunk (**A**) offers protection against rodents. Wrapping paper tied around the trunk with twine (**B**) protects against both rodents and wood-boring insects.

two formulas are given here. Since these have not been tried in Illinois, it is recommended that growers test them in an experimental way only.

FORMULA 1

This formula is a mixture of rosin and asphalt emulsion dissolved in ethylene dichloride, to which copper sulfate, copper carbonate, and dry lime sulfur are added. It may be purchased ready-mixed from the DISTRICT AGENT, DIVISION of PREDATOR and RODENT CONTROL, U. S. DEPARTMENT of INTERIOR, West Lafayette, Indiana.

Application may be made either as a paint or as a spray. As a paint, apply with a cheap paintbrush without dilution but after thoro stirring. As a spray, dilute each quart of the paint mixture with two quarts of ethylene dichloride.

FORMULA 2

This is a mixture of rosin and alcohol which the Michigan Agricultural Experiment Station has found effective.

• **Preparation.** Dissolve 7 pounds of rosin in 1 gallon of ethyl (grain) alcohol. The dark-colored cheaper grade of rosin and denatured commercial ethyl alcohol are satisfactory. Methyl (wood) alcohol is not recommended. A good method of mixing is to pulverize the rosin and add it to the alcohol in a container with a cover tight enough to allow shaking and prevent evaporation. Keeping the container in a warm room and shaking it occasionally helps to get the rosin into solution. NO HEAT SHOULD BE APPLIED. The rosin usually dissolves in 24 hours.

• **Application.** Apply the repellent with a cheap paintbrush in the fall and only when the bark is dry. One application will protect the trees all winter. Water causes a white precipitate to form in the solution. This changes its consistency and interferes with application. To avoid contaminating the solution with water, use a small container in the orchard and do not pour any of the solution from this can back into the reserve stock. Treated trees always turn white the first time it rains or snows, but this does not change the effectiveness of the repellent.

Since cottontail rabbits can reach about 2 feet above the surface of the snow, the trunks and the scaffold branches of low-headed trees should be painted 2 feet higher than the snow is expected to drift.[1] The amount of repellent required will, of course, depend upon the height of treatment and size of tree. One gallon will treat 150 to 200 two-year-old trees.

Baits

The use of poison bait for the control of rabbits is illegal in Illinois, unless permission has been secured from the STATE DEPARTMENT of CONSERVATION, Springfield, Illinois.

If the rabbit problem is severe enough, and permission to bait has been obtained, use strychnine-treated oats designed for mouse control or prepare the following bait:

Moisten with water 20 pounds of alfalfa leaves. Dust 1 ounce of powdered strychnine over the leaves and stir them well. Place the bait (either grain or alfalfa leaves) under boxes with openings at each end large enough for a rabbit to enter. Cover the boxes with brush or straw.

PART III

IMPORTANT SUPPLEMENTARY FACTS

In order to obtain satisfactory results in a pest-control program a grower should have a practical knowledge of the insects and diseases which affect his crops.

Two General Classes of Insects

Fruit insects may be divided into two general classes: sucking and chewing insects. Those with sucking mouthparts, such as the San Jose scale and aphids, extract plant sap as their food. They are controlled best by contact sprays which must strike the

[1]The rosin-alcohol repellent has not proved effective against the snowshoe hare and the meadow mouse.

insect's body to be effective. Oils, nicotine sulfate, and certain organic compounds are used as contact sprays.

Some of the chewing insects, including the codling moth, curculio, cankerworm, leaf roller and pistol casebearer, actually eat the fruit or foliage and may be combated by applying poisons to their food. Lead arsenate and fixed nicotine are two materials most commonly used for this purpose. Other chewing insects, such as the peach borer and the apple tree borers, are controlled by the use of fumigants or repellents. Still others, such as the white grub, can be controlled most effectively by cultural methods.

Certain pests, particularly the fruit tree leaf roller, aphids, and mites, are controlled most effectively by applying sprays known as ovicides to their eggs, which are laid on the twigs, branches, and trunks of trees.

Plant Diseases Are of Three Kinds

Fruit diseases may be caused by fungus, bacterial, or virus infections. *Fungi* are in reality microscopic plants living on the fruit, leaves, stems, or roots of other plants. Common fungus diseases are apple scab, blotch, and brown rot. Infection spreads by spores which, when wet for a sufficient time, germinate and enter the fruit, leaf, twig or other susceptible areas. The injuries or symptoms characteristic of the disease then appear.

In order to control most fruit diseases, sprays must cover the susceptible parts of the plant thruout the period of infection. These sprays are called protective or preventive sprays since they protect the plant by preventing infection. Usually after the spores of a fungus have germinated and the fungus has invaded the plant tissues, spraying will not control the disease. Bordeaux mixture and sulfur, in various forms, are the two most common fungicides used by fruit growers.

Bacteria, also, are really plants of the simplest form. Common bacterial diseases are fire blight and bacterial spot of peach. They are usually spread by insects, wind, and rain. Bacteria gain entrance to the plant tissues thru mechanical injuries and thru stomata, lenticels, and nectaries. Control may be obtained in some

cases by spraying. However, there are some bacterial diseases that cannot be controlled by any methods known at present.

Virus diseases infect only peaches, plums, and brambles to an extent that has any significance in commercial orchards. Little is known about the agent which causes these diseases. They may be transmitted by insects. Control of virus diseases is best obtained by cultural and sanitation methods.

Planning a Pest-Control Program

Several factors must be considered in planning an insect- and disease-control program. Selection of proper varieties is impor-

Northern One-Third

Scab serious. *Oyster shell* and *scurfy scales* prevalent. *San Jose scale* light. *Codling moth,* one full brood and a partial second brood. Occasional *blotch. Curculio* and *apple maggot* prevalent.

Central One-Third

Scab serious. *Codling moth,* two full broods over most of this area. *Curculio* and *San Jose scale* abundant. Occasional *blotch. Bitter rot* severe.

Southern One-Third

Codling moth, two full broods and a partial to a full third brood. *Scab, blotch* and *bitter rot* severe. *San Jose scale* serious. *Curculio* abundant.

Apple spray schedules must be modified for different sections of Illinois

tant for all fruits. Location of an apple orchard as to latitude determines the effort that will be necessary to control the various pests. Spray injury, spray-residue tolerances, and season are all to be reckoned with in fruit production. These more important items are discussed briefly in the following paragraphs.

APPLES: Varietal Resistance and Susceptibility to Scab, Blotch, Bitter Rot, and San Jose Scale

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

Variety	Scab	Blotch[1]	Bitter rot[1]	San Jose scale
Akin	R	R	R	—
Ben Davis	VS	S	VS	S
Benoni	R	VS	(2)	—
Collins (Champion)	R	R	R	—
Cortland	S	—	—	—
Delicious	VS	VR	—	S
Duchess (Oldenburg)	VR	VS	(2)	S
Early Harvest	VS	VS	—	R
Fameuse (Snow)	VS	—	—	S
Gano	VS	S	VS	S
Golden Delicious	S	R	S	S
Grimes	R[3]	R	VS	VS
Huntsman	R	VS	S	S
Jonathan	VR[4]	R	VS	R
King David	R	R	VS	—
Kinnaird	VS	VR	R	S
McIntosh	VS	VS	(5)	S
Maiden Blush	S	VS	R	S
Minkler	R	R	R	R
Missouri Pippin	R	VS	—	VS
Northwestern Greening	S	VS	(5)	VS
Red June	VS	R	(2)	S
Rome Beauty	VS	S	R	VR
Salome	R	S	—	—
Stark	—	VS	—	S
Stayman	R	VR	R	R
Turley	S	R	—	—
Wealthy	VR	VR	—	S
Willowtwig	S	S	VS	R
Winesap	S	VR	R	S
Yellow Transparent	R	R	(2)	S
York Imperial	R	R	R	S

[1]The degree of varietal resistance to *blotch* and *bitter rot* indicated in this table applies 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]Benoni, Duchess, Red June, and Yellow Transparent ripen early and thus ordinarily escape bitter-rot infection.

[3]Grimes is susceptible to late summer infection with scab.

[4]Jonathan leaves are susceptible to scab.

[5]McIntosh and Northwestern Greening are not grown in the bitter-rot area.

VARIETAL SUSCEPTIBILITY

Different varieties of a fruit exhibit definite degrees of susceptibility or resistance to certain insects and diseases. Because of this it is necessary for the grower to adapt his pest-control program to the variety or varieties grown.

The susceptibility or resistance of a plant to a pest is the result of a highly complex set of biological factors. Immunity to one fungus does not necessarily mean immunity to another. One variety may, for example, be resistant to apple scab but susceptible to blotch; whereas another may be resistant to blotch and susceptible to scab.

Varietal susceptibility is more pronounced for diseases than for insects. Damson plums are said to be more susceptible to *San Jose scale* than any other species of plums.

Varieties of the apple seem to vary more in susceptibility to diseases and insects than do other fruits. Information concerning the most important varieties grown in Illinois is given in the table on the opposite page.

All important varieties of peaches grown in Illinois are susceptible to *bacterial spot*. *Peach scab* may be more severe on some varieties than others: Elberta, Hale Haven, South Haven, and Gage are resistant; whereas Red Bird, Carmen, and Belle are susceptible.

Brambles exhibit varying degrees of resistance to diseases. The Eldorado blackberry is resistant to *orange rust*. Red raspberry varieties are resistant to *anthracnose*. Naples and Quillen black raspberries are resistant to *anthracnose*.

Among strawberry varieties, Aberdeen and Pathfinder are resistant to *red stele*.

SEASON AND ENVIRONMENT

Weather conditions are important factors in the intensity of disease and insect damage. Fire blight, for example, is most severe following a dry pollinating season. Apple scab and blotch infections are directly correlated with spring rainfall. Codling moth is more difficult to control during a dry season, but the

curculio population may decrease during dry seasons. Thus weather conditions that promote the development of certain pests hinder the development of others. Adjustments in the pest-control program will have to be made in accordance with the weather.

The environment or surroundings of an orchard or other fruit planting must always be considered. Neglected and poorly cared for orchards and woodlands are a source of disease inoculum and insect pests. For example, it is very difficult to control scale on fruit that is growing near scale-infested orchards, and the likelihood of injury from the curculio is increased when woodlands, neglected fence rows, and old apple orchards are close. Blotch is difficult to control on new plantings if older infected trees are nearby. Cedar rust is likely to be prevalent if red cedars are within a mile of the orchard site.

Each grower is confronted with special problems and must make adjustments suited to his conditions.

THORO SPRAYING IS ESSENTIAL

One good spraying is worth more than two poor ones

Unless spraying is done thoroly, good results will not be obtained even tho the right materials are used in the proper concentrations and applied at the right time. In the apple orchard the tree tops are easy to miss. Because of missing them, many growers have had severe second- and third-brood codling moth infestations in the upper area of the tree even tho the lower apples were entirely free of first-brood larvae.

Growers will find the following suggestions an aid in getting maximum efficiency from their sprays:

1. **Use adequate pressure.** Do not rely on measurements of pressure gages after 2 or more seasons of service. Have the gages checked.

2. **Select disks with correct apertures** for maximum pump discharge and replace worn disks. A 35 gallon per minute pump should be discharging at least 30 gallons per minute during full operation.

3. **Spray tops of trees with special care.** Equip the spray rig with a tower. Apply top-off sprays when recommended.

4. **Examine fruit and leaves frequently** for evidence of disease and insect injury and determine if spray coverage is complete, especially in the tops of the trees.

5. Apply enough spray per tree. Determine the amounts to apply to apple trees by this simple calculation: For the **prepink, pink, calyx,** and **succeeding sprays,** divide the age of the tree by ~~4, 3,~~ 2, and 1.5 respectively. A 10-year-old tree, for example, should receive the following amounts:

Dormant and prepink stages	2.5 gal.
Pink stage	3.3 gal.
Calyx stage	5.0 gal.
Each succeeding spray	6.7 gal.

REDUCING SPRAY INJURY

While the spray mixtures recommended in this circular are designed to give maximum protection with minimum injury, there is no assurance that they will be safe under all conditions. So many factors—climatic conditions, fruit varieties, tree vigor, time, method, and amounts applied—are involved in spray injury that it is impossible to give specific rules for avoiding it. The following general observations, however, may be of value.

• **Tree vigor.** Trees in a vigorous condition are less susceptible to spray injury than those lacking vigor.

• **Sulfur.** Lime sulfur has been found to cause injury when used after a heavy apple scab infection. In general, lime sulfur causes a stunting of leaves because of marginal injury, or it may cause yellowing and dropping of leaves in varieties such as Jonathan or Wealthy. It should *not* be applied when the temperature is 90° F. or above. Sulfur sprays should *not* be applied in combination with oil.

• **Oil sprays.** Sprays containing oil should not be applied until at least 10 days after the last sulfur spray. More than 10 days is required if dry weather prevails after the sulfur application. Dormant oils have proved safer when applied in early spring. Do not use dormant oil in summer sprays.

• **Bordeaux mixture.** Except during a dry period, use a bordeaux mixture only when apples are past the "fuzzy" stage, since it will cause russeting on the fruit. Bordeaux tends to increase plant transpiration, thus should not be applied if the soil is very low in water content.

• **Lead arsenate.** Lead arsenate will cause injury in most cases unless used with some safening agent (*see page 37*).

SPRAY-RESIDUE TOLERANCES

The federal government has established spray-residue tolerances of .025 grain of arsenic trioxide (As_2O_3), .05 grain of lead (Pb), .21 grain of copper (Cu), and .02 grain of fluorine (F) per pound of fruit. Fruit of any kind showing residues in excess of the above amounts is liable to seizure by federal authorities if the fruit is transported from one state to another or offered for foreign export. Certain states and municipalities have imposed tolerance regulations of their own. Illinois has adopted the federal tolerance. Growers should see that their fruit does not exceed the tolerances, which usually means having an analysis made.

Lead and arsenic residues on fall and winter varieties of apples will usually not be over the tolerances if the calyx and three additional cover sprays of lead arsenate are applied within one month of petal fall.

Directions for washing apples can be obtained by writing to the Department of Horticulture, Illinois Agricultural Experiment Station, Urbana, Illinois.

PART IV

PREPARING SPRAY MATERIALS

Materials for sprays and dusts should be chosen only after careful consideration of their merits as determined by reliable experiments. Home preparations are usually cheaper than commercial products, but standard commercially prepared materials are often more convenient to use.

Directions for preparing and mixing certain homemade standard sprays and dusts follow. Some types of commercially prepared materials which are in general use are described on pages 41 to 43.

Bordeaux Mixture

Bordeaux spray is composed of copper sulfate (blue vitriol or bluestone) and hydrated lime in water and is used mostly to control fungi.

The copper sulfate may be purchased in three forms—crystals, granules, and powder—all of which have the same composition. The powder is used almost exclusively by growers because of its convenience. Large crystals require several hours to dissolve before they can be used for spraying. In ordering, the form desired should be designated.

Lime for spraying is in the hydrated form and should be obtained when possible from firms manufacturing a special spray lime. This material should not be kept over from one season to another.

The proportions of copper sulfate and hydrated lime in bordeaux mixture vary, depending on the use for which the spray is intended. Such formulas as 4-6-100, ½-1-100, 2-4-100 and 4-3-100 are commonly recommended. In these formulas the copper sulfate dosage, in pounds, is given first, then the pounds of hydrated lime, and next the number of gallons of water. Thus a 4-6-100 bordeaux mixture indicates that there are 4 pounds of copper sulfate and 6 pounds of hydrated lime in 100 gallons of water.

The way ingredients are mixed is important in securing a good bordeaux mixture. Most growers use the instant bordeaux method. This entails slowly sifting in the required amount of copper sulfate as the tank is being filled with water and the agitators are operating. After ⅔ of the water and all of the copper sulfate have been added, the required amount of lime is sifted in as the rest of the water is added. The important point to remember is to add the copper sulfate first.

If it is desired to use lead arsenate in the same spray, add it as soon as the bordeaux is made and run the agitators.

Directions for mixing old process bordeaux will be sent on request.

Lead Arsenate

Lead arsenate is seldom used alone in sprays, as it may cause injury to fruit or foliage. It is important to select a safener in

accordance with the use for which the spray is intended. Various materials are recommended and should be used as follows: For each pound of lead arsenate use: 1 pound of hydrated lime, 2 quarts of liquid lime sulfur or 2 pounds of dry lime sulfur. Bordeaux mixture ½-1-100 or 2 pounds of zinc sulfate plus 3 pounds of hydrated lime will safen as much as 4 pounds of lead arsenate.

When mixing with safener in the spray tank, it is advisable to add the lead arsenate after the safener has become thoroly dispersed in the water.

Oil Dusts

Dusts are commonly used on peaches (*see schedules, page 18*). The ingredients must be mixed thoroly in a dust mixer. Simply stirring the materials together will not make a satisfactory oil dust.

Commercial mixes, if obtainable, are recommended.

Oil Emulsions[1]

BORDEAUX EMULSION

This emulsion should be used for dormant sprays only.

For a permanent-stock emulsion, mix 100 gallons of 8-8-100 bordeaux mixture and 100 gallons of oil. Emulsify by sending thru the pump at least twice. For 2-percent strength, use 4 gallons in 100 gallons of water.

Sometimes it is more desirable to use field-prepared bordeaux emulsions rather than make up large amounts of permanent stock. For this kind of an emulsion dissolve copper sulfate in one container 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 of spray, pour 4 gallons from each container simultaneously into the tank with the agitators operating. Add 1½ to 2 gallons of oil and operate the pump for a few minutes. While the tank is being filled with water, add 2 pounds of copper sulfate

[1]Best results have been obtained with oils meeting the following specifications:

Specific gravity at 20° C..... .87 to .93
Volatility at 110° C. for 4 hours.....not above 10 percent
Viscosity at 100° F.....90 to 250 seconds (Saybolt test)

that has been dissolved and 1 pound of hydrated lime. Apply the mixture at once, for the oil may separate on standing.

SOYBEAN-FLOUR EMULSION

Pump together for 10 minutes 100 gallons of oil, 100 pounds of soybean flour, and 100 gallons of water. After the emulsion is prepared, mix in it 3 pounds of copper sulfate, in solution, for preservation. The stock emulsion will run about 50 percent oil. When the injector is used for separate tanks or conveyors, 1 pound of soybean flour is added for each gallon of oil. When spraying for San Jose scale, use 4 gallons of this mixture to 100 gallons of spray.

Directions for the injection method of making cold-mix oil emulsions will be sent upon request.

Soybean Flour

Soybean flour can be used as a sticker and spreader in any spray. Many processors of soybeans sell a special grade of flour for sprays. This should be used in most waters at the rate of ¼ pound in 100 gallons of water. The proper amount added to spray mixtures will produce a film type of coverage. Too much will cause the spray to run off and therefore will do more harm than good.

Soybean flour will disperse easily in the spray tank. The best method of adding is to dilute the flour to a thin paste and then add to the spray tank. In sprays containing bordeaux mixture the soybean flour should be added after the bordeaux mixture is made.

Sulfurs

HOMEMADE WETTABLE SULFURS

Because of the large size of the particle and the poor sticking qualities, the homemade wettable sulfurs are inferior in fungicidal value to the commercial microfine wettable or paste sulfurs. Methods of making dusting sulfur wettable with two different wetting agents are described.

• **Soybean-flour wettable sulfur.** Mix 5 pounds of soybean flour with each 95 pounds of dusting sulfur. In preparing this for the spray tank, mix the required amount of flour and sulfur in a pail with just enough water to make a thick paste on stirring. After the paste is thoroly mixed, thin it out by adding more water and then pour it into the tank while it is being filled with water and the agitators are operating.

• **Santomerse field mix.** While the tank is filling and the agitators operating, first add 1 ounce of "Santomerse S" for each 100 gallons of water, then add 6 pounds of dusting sulfur. After the sulfur is thoroly dispersed in the water, add 1 pint of liquid lime sulfur.

FLOTATION SULFUR PASTE

This material is considered highly efficient as a sulfur fungicide. Because of its bulkiness, however, many growers have hesitated to use it. It is shipped in 500-pound barrels and contains from 40 to 50 percent of actual sulfur in water.

A convenient method of handling this paste is to mix it thoroly in the barrel by means of a single nozzle gun discharging water at about 500 pounds pressure. This produces a creamy paste which can be easily transferred to the spray tank in a bucket. Once mixed in this manner the sulfur will not settle out for some time. Ordinarily only one mixing is necessary for each barrel. Slight adjustments of amounts used will be necessary because of the water added while mixing.

Tank-Mix Nicotine-Bentonite

If the spray is to be effective, the nicotine and bentonite must be properly mixed in the tank.

Fill the tank ⅕ to ⅓ full of water. While the agitators are operating, add the nicotine sulfate, bentonite, and oil in the order named and then immediately fill the tank with water to the top. The following two points should be strictly observed: (1) add the nicotine *before* the bentonite; and (2) be careful not to add too much water at the beginning or the oil may not emulsify properly.

Zinc Sulfate-Lime

The formula now recommended for zinc sulfate and lime is:

Zinc sulfate, (55-percent), 2 lb.
Hydrated lime, 3 lb.
Water, 100 gal.

Commercial zinc sulfate may be used. Run a few gallons of water into the tank 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 ⅔ full.

Add thru the strainer the required amount of hydrated lime, which has been previously made into a thin paste in a separate container. Finish filling the tank and agitate it a few minutes before spraying.

PART V

COMMERCIAL SPRAY PREPARATIONS

Copper Sprays

A number of spray materials containing copper have been placed on the market as substitutes for bordeaux mixture. Also, some companies manufacture a dry bordeaux. None of these has fungicidal properties superior to bordeaux mixture made in the orchard, but some of them may cause less injury and are worthy of limited trial by growers who find bordeaux undesirable.

These new materials should be used at concentrations recommended by the manufacturers.

Nicotine

Nicotine is sold mainly in two forms: nicotine sulfate and so-called fixed nicotine.

Nicotine sulfate may be used in combination with many other sprays and is considered primarily a contact insecticide.

Fixed nicotines are combinations of nicotine and other materials such as bentonite and oil. These materials are designed

mostly for stomach poisons, as the nicotine does not volatilize from the spray residue for comparatively long periods. They should be used as recommended by the manufacturers.

Oil Sprays

Many types of oil sprays are available to fruit growers.

Summer oils are made from highly refined white oils and certain types of emulsifying agents. There are several reliable brands now on the market. These should be used according to the manufacturer's directions.

Miscible or soluble oils are commonly used in fruit sprays. Oils of this type are concentrated emulsions, containing little or no water, and they are therefore 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 which, in the undiluted form, looks like a clear oil. When they are added to water, typical white emulsions are formed.

Miscible oils must be applied according to the manufacturer's recommendations. The grower can prepare such oils, but the process requires special care, and in most cases it is not advisable for him to do so.

Sulfur Sprays

Sulfurs may be purchased in several forms, including liquid and dry lime sulfur, flotation sulfur pastes, specially prepared natural sulfurs known as microfine wettable sulfurs, ground wettable sulfurs, and fused and ground sulfur and bentonite.

The *lime sulfurs* are now standard commercial products and may be purchased from almost any insecticide or fungicide company. Dry lime sulfur, while more expensive than the liquid, is more convenient to handle. Both forms are very efficient but are more likely to cause injury than other sulfur fungicides.

Flotation sulfur pastes are derived from coal gasplant processes and have a particle-size range of $\frac{1}{25,000}$ to $\frac{1}{2,500}$ inch. Next to lime sulfur, flotation sulfur pastes are the most efficient sulfur fungicides now available. They are not so convenient to handle, but their mildness and efficiency counterbalance their bulkiness.

Microfine wettable sulfurs possess an average particle-size of $\frac{1}{2,500}$ inch. Altho flotation sulfur paste in reality belongs to this group, microfine commonly means dry sulfurs which have been especially treated to produce the small particle-size and to make them wettable in water. They are highly efficient fungicides and rank second to flotation sulfur paste in this respect. Because of the importance of fineness in the particle-size of sulfurs used for apple-disease control, growers are urged to select their brands of sulfur fungicides carefully.

Ground wettable and *fused sulfur bentonite* sulfurs are not considered practical for the control of apple diseases because of the large size of the particle and their poor sticking qualities. For other purposes, such as the control of peach scab or brown rot, they have proved satisfactory.

RADIO SERVICE

The following radio stations cooperated during 1943 in sending out information on the control of orchard insects and diseases. It is probable that most of these stations and some others will give this service in 1944. Consult your local station or get in touch with your farm adviser or the Illinois Agricultural Experiment Station, Urbana, Illinois, for the 1944 list:

WMRO	Aurora	WEBG	Harrisburg	WROK	Rockford
WKRO	Cairo	WJPF	Herrin	KFUO	St. Louis
WCRW	Chicago	WHOP	Hopkinsville	KMOX	St. Louis
WGN	Chicago	WBC	Indianapolis	KXOK	St. Louis
WLS	Chicago	WCLS	Joliet	WCBS	Springfield
WMAQ	Chicago	WASK	Lafayette	WDZ	Tuscola
WSOY	Decatur	WHAS	Louisville	WILL	Urbana-Champaign
WTMV	East St. Louis	WLBC	Muncie		
WGBF	Evansville	WGRC	New Albany	WAOV	Vincennes
WGL	Fort Wayne	WMBD	Peoria	WBAA	W. Lafayette
WOWO	Fort Wayne	WKBV	Richmond		

W-I-L-L, the University of Illinois radio station, will broadcast this information each Monday noon at 12:30 for the entire season. The weekly orchard insect and disease report is prepared cooperatively by the agricultural experiment stations of Indiana, Kentucky, and Illinois, the Kentucky State Horticultural Society, the Federal Deciduous Fruit Insect Laboratory at Vincennes, Indiana, and the Illinois State Natural History Survey.

12M—2-44—27355