

# MINNESOTA COMMERCIAL ORCHARD SPRAY PROGRAM



## DISEASE AND INSECT CONTROL

Remove Dead Trees

Plant Recommended  
Varieties

Clean Up Fallen Fruit

Spray at the Proper Time

Use the Right Materials

Apply Thoroughly



by *E.G. Sharvelle  
& A.C. Hodson*

UNIVERSITY OF MINNESOTA  
*Agricultural Extension Service*  
U. S. DEPARTMENT OF AGRICULTURE

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# Orchard Spray Program

E. G. Sharvelle and A. C. Hodson

**A**PPLES, like most other crops, are subject to attack by various insect pests and diseases which sometimes destroy most of the crop. Outbreaks of insect pests and plant diseases, in addition to destroying the current season's crop, may also serve as a starting point for similar troubles in succeeding crops unless control measures are practiced. Use of correct control measures every year will prevent the development of outbreaks which usually cannot be brought under control in one or two seasons.

Disease and insect control is an essential part of orchard management, one which cannot be achieved without adequate equipment and planning. Clean fruit cannot be grown in neglected orchards. *There is no easy way out.*

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### GENERAL SANITATION



Most insect pests and plant disease organisms live through the winter on decaying refuse, dead branches, and old leaves. Clean up or destroy all weedy fence rows, neglected plum thickets, woodlot margins, and brush piles every year because they serve as winter quarters for such insects as the plum curculio. The removal and destruction of such refuse usually will greatly reduce the danger of losses in the current season.

When pruning, cut off limbs close to the main trunk or branch to promote rapid healing of the wounds. Long pruning stubs and unprotected wounds permit the entrance of wood-rotting fungi that can destroy a mature tree in a few years. Poorly healed wounds and rough bark also provide places where the codling moth worms can

spin their cocoons. Large pruning wounds and those caused by cultivating machinery should be protected with a recommended wound dressing. Shellac or commercial asphalt tree paint is satisfactory for this purpose.

Remove all dead and worthless trees and replace them with recommended varieties. Old trees that have passed their prime are not only unsightly and unprofitable but are a source of infection for healthy trees.

In orchards where apple maggot has been a problem, all dropped fruit should be picked up once a week, starting the first week in August and continuing through harvest. These drops should either be buried two feet deep, fed to stock, or piled at the edge of the orchard to be treated in the spring with old crankcase oil. Apply the oil at the rate of one gallon to every square foot of the ground surface on which the fruit is piled. The addition of 3 ounces of naphthalene flakes to each gallon of oil increases its effectiveness.

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## SPRAY MATERIALS



Spraying with the chemicals recommended in the complete spray schedule will protect the trees against diseases and insect pests if they are applied BEFORE the appearance of these troubles, and will be of little value if applied too late. To be effective spraying must be THOROUGH and must be CONTINUED THROUGHOUT THE SEASON according to a recommended schedule. One or two sprays even though applied at the correct time will be of little value in most seasons if the other sprays are omitted.

None of the spray materials will withstand heavy rains. Should heavy rains occur for several days following the application of any cover or maggot spray it should be applied again for its protective value against diseases and insects depends upon having the foliage and fruit adequately covered with the spray chemicals at all times. The use of high-pressure spray machinery is desirable but low pressure machinery such as a barrel pump sprayer can be used if all parts of the tree are thoroughly covered.

The effectiveness of spraying for the control of diseases and insects depends upon the materials used, and more especially on the accurate timing of the spray applications, the complete coverage of the foliage and fruit and persistence in following a complete spray program.

The spray program outlined in this bulletin has been tailored to fit Minnesota conditions and is based on experimental work done in orchards in various parts of the state. The chemicals recommended are included for specific purposes. Arsenate of lead is used for the control of certain insects which are not controlled by the use of sulfur materials. Diseases such as apple scab cannot be controlled by lead arsenate

and for this reason lime-sulfur and the wettable sulfurs are recommended. These materials—lead arsenate, lime sulfur, and the wettable sulfurs—are applied as combination sprays to save time and cost in applying.

### Preparation of Sprays

The methods used in mixing the various spray chemicals may affect the effectiveness of the spray and a definite routine should be followed.

**The delayed dormant spray** should be prepared as follows. First fill the spray tank half full with water, add the necessary amount of liquid lime sulfur with the agitator in the sprayer running and then fill the sprayer up to the "full" mark. This procedure insures proper distribution of liquid lime-sulfur to avoid tree injury and insure good results.

**The pink and petal fall sprays** should be prepared as follows. Fill the sprayer half full with water, add the required amount of liquid lime sulfur, mix thoroughly, then fill the spray tank two-thirds full by adding water. Add the required amount of lead arsenate to the sprayer by washing through a fine screen with a stream of water. Then fill the sprayer up to the "full" mark. Always mix the spray thoroughly by running the mechanical agitator for several minutes. Lead arsenate should be added when the tank is nearly full and just before spraying to avoid chemical changes which cause burning of leaves and fruit.

**The curculio and cover sprays** should be prepared as follows. Fill the sprayer half full with water. Place the required amount of spray lime on the screen and wash through with a stream of water. Paste the necessary amount of wettable sulfur in a pail with a small amount of water and add to the sprayer by washing through the screen with a stream of water. Fill the sprayer to the

"two-thirds" mark by adding water. Next, wash the required amount of lead arsenate through the screen and fill the spray tank to the "full" mark. Always add lead arsenate to the spray tank last, just before the spray is applied. When nicotine sulfate is used, always add it to the spray tank first. If nicotine sulfate is added to ready-mixed spray it will not remain in solution and its effectiveness will be lost. The use of a suitable screen is essential in making up these later sprays as it will prevent loss of time from clogging of the spray nozzles.

### Stickers

The use of stickers is recommended, as they will always increase the effectiveness of the materials under Minnesota conditions. Always add the sticker to the spray tank last. If a commercial sticker is used, add the required amount to the sprayer and thoroughly mix the spray before applying. If soybean flour is used, paste one pound of the material with water in a coffee can and add to the spray just before the complete spray is applied to the trees. Casco glue has been used in experimental and some commercial orchards in Minnesota with good results. If Casco glue is used as a sticker, it should be mixed as follows: Place 3 ounces of the glue in a small tin can. Add enough water to make a thick cream. Allow to stand 15 minutes, add an equal amount of water, and pour into the sprayer.

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## EXPLANATION OF SPRAY SCHEDULE



The practical success of any spray schedule depends to a considerable extent upon the accurate timing of each

spray to meet seasonal needs. CALENDAR DATES CANNOT BE RELIED UPON as a guide in timing sprays because of seasonal variations in the development of fruits, insects, and diseases.

Every spray in the accompanying schedule (page 5) has a definite purpose, and the sprays are timed on the basis of past records of the appearance of diseases and insects as related to foliage and fruit development. The following explanation of the spray schedule gives the reasons for using the chemicals recommended at the times indicated.

**Ground Spray**—This is designed to clean up severe infections of apple scab and is not necessary every year. It destroys the overwintering scab fungus found on fallen apple leaves and thereby reduces the chances of heavy scab infection in the spring.

**Dormant Spray**—Liquid lime-sulfur, when used at the dormant strength, is recommended for the control of oyster shell scale. The control of this insect is made easier by removing the rough bark from the trunk and main limbs of the tree. A 4 per cent oil emulsion or one of the DN-oils is also effective against oyster shell scale and must be used to destroy the overwintering eggs of aphids (plant lice) and apple leaf roller. This spray may be omitted if the insects mentioned above have not been troublesome in past years.

**Delayed Dormant Spray**—This spray prevents early apple scab infections. It is important in wet seasons.




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FIG. 1. When tips of buds show green apply delayed dormant spray

## COMPLETE SPRAY SCHEDULE

The spray applications which are printed in bold type (Nos. 3 to 8) are necessary in all seasons. The other sprays are recommended for special purposes outlined in the explanation of the spray program.

Spray No.	Time of application	Materials	Special purpose
1	<b>GROUND Spray:</b> Apply in spring after ground dries and before buds burst.	Elgetol $\frac{1}{2}$ gal., water to make 100 gals.	For varieties with severe scab in previous years. Apply to ground under trees, 500 gals. per acre.
2	<b>DORMANT Spray:</b> Apply just before buds burst.	Liquid lime-sulfur 1-8 (12 $\frac{1}{2}$ gals. in 100 gals. water) or 4% oil emulsion.	For scale, aphids, leaf-roller eggs. Of no value for scab.
3	<b>DELAYED DORMANT Spray:</b> Apply when tips of buds show green, before leaves are out $\frac{1}{2}$ inch (see figure 1).	Liquid lime-sulfur 3 gals., water to make 100 gals.	Chiefly for apple scab.
4	<b>PINK Spray:</b> Start spraying when fruit buds show pink at tips, complete before center buds open (see figure 2).	Liquid lime-sulfur 2 gals., lead arsenate 2 lbs., water to make 100 gals.	For scab, cankerworm, leaf-eating insects. If aphids severe in past years on young trees add 1 pint nicotine sulfate.
5	<b>PETAL-FALL (Calyx) Spray:</b> Apply after three fourths of petals have fallen (see figure 3).	Liquid lime-sulfur 2 gals., lead arsenate 3 lbs., water to make 100 gals.	Very important for scab, codling moth, curculio.
6	<b>CURCULIO (First Cover) Spray:</b> Apply about 7 days after petal-fall or when apples are no more than $\frac{1}{4}$ inch diameter (see figure 4).	Wettable sulfur 5 lbs. (for sulfur pastes follow manufacturer's recommendation), lead arsenate 3 lbs., spray lime 3 lbs., water to make 100 gals.	For scab, codling moth, curculio, leaf-eating insects. If more than 50 leafhoppers per 100 leaves add 1 pint nicotine sulfate.
7	<b>SECOND COVER Spray:</b> Apply about 10 days after curculio spray when fruit is about $\frac{1}{2}$ inch diameter.	Same as No. 6	Important for first-generation codling moth, scab, curculio.
8	<b>THIRD COVER Spray:</b> Apply 10-14 days after second cover spray when fruit is about 1 inch diameter.	Same as No. 6	Chiefly for codling moth and in wet seasons for scab.
9	<b>FIRST MAGGOT Spray:</b> Apply 1 week after first flies appear.	Same as No. 6 (Omit sticker on early varieties)	For apple maggot and second-generation codling moth. Use if maggot injury present in previous year.
10	<b>SECOND MAGGOT Spray</b>	Same as No. 6 (Omit sticker)	A cleanup measure when many maggot flies are present. Also prevents codling moth side injury, fall scab infection.

Lime-sulfur-lead-arsenate sprays should not be applied on very humid days. The later cover sprays should not be applied when the temperature is over 85° F. in the shade.



FIG. 2. When fruit buds show pink at tips apply pink spray



FIG. 3. When three fourths of petals have fallen apply petal-fall spray

**Pink Spray**—This is particularly important in preventing scab infection on the expanding leaves. If permitted to remain, such infection will serve as a source of spread for apple scab throughout the season. Arsenate of lead is necessary to control the canker worms and other leaf-eating insects. Young trees commonly become infested with aphids at this time of year. The use of nicotine sulfate will prevent their increase and will eliminate the damage which they often cause on young trees.

**Petal-fall (Calyx) Spray**—The application of this spray coincides with the appearance of the plum curculio and general apple scab infection. Furthermore, this spray is very essential for codling moth control because a high percentage of the first generation worms enter through the calyx end of the apple. For this reason the spray material should be driven into the open calyx as much as possible. This spray and the one which follows are the two sprays which **MUST BE TIMED EXACTLY AND APPLIED THOROUGHLY.**

**Curculio Spray**—This is the most important spray for the control of the plum curculio. It is also of value in preventing further establishment of apple scab and is important for the killing of apple leafhoppers while they are young. By the time apple leafhoppers mature they will already have done considerable damage and are much more difficult to kill. If there are several successive days with a top temperature of 75° F. or higher soon after the petal-fall, this spray should not be delayed longer than one week after the petal-fall spray. In cool weather it may safely be delayed 10 to 14 days.

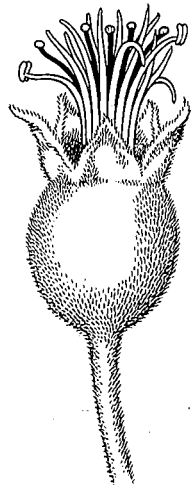


FIG. 4. When apples are about one-fourth inch in diameter apply curculio spray

**Cover Sprays**—The two cover sprays should be timed to protect the developing fruit during the period when continuous coverage is necessary for good control of first-generation codling moth. It is important that the entire surface be covered with spray material.

**Maggot Sprays**—The first maggot spray must be timed by the first emergence of maggot flies in the orchard. Bait traps and ground cages should be used rather than relying upon casual observation (see Extension Folder 122 on Apple Maggot). In some years, a spray for second-generation codling moth may be needed during the last week in July if an inspection of the orchard shows the early signs of codling moth side injury. This usually coincides with the first maggot spray. The second maggot spray is recommended primarily in orchards badly infested with the apple maggot.

In most seasons all sprays from the third through the eighth (the delayed dormant up to and including the third cover spray) should be applied even though there is no threat of a serious outbreak of insects and diseases. It is easy to keep ahead of diseases and insects but very difficult to clean up neglected orchards.

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## HOW TO SPRAY



The success of a recommended spray schedule is determined largely by the method of application as well as upon the use of the proper materials and equipment. No single spraying method is suitable for all orchards because of differences in topography, tree size, type of equipment, and weather conditions. However, there are certain definite practices which must be followed while spraying to get complete coverage of leaves and fruit on all parts of the tree. The ideal spray is a driving

Always wash out the spray tank and flush out the pump, hose, and spray gun with clean water after the day's work; otherwise the spray chemicals will corrode the metal parts of the sprayer.

Spray mixtures of liquid lime-sulfur and lead arsenate should be applied within an hour after mixing. If such mixtures are allowed to stand longer, their protective value is decreased and serious injury to the leaves and fruit may result from arsenical and lime-sulfur burning.

Use measured quantities of materials always. It is never safe to guess.

mist that can be "fogged" through the tree without mechanical injury to the foliage.

First of all, the best results can be obtained only by using good spraying equipment in good working condition. In general, orchards of an acre or more in size should be sprayed with a power sprayer because the ideal "mist" type of spray can only be obtained in commercial orchards by means of spray pumps capable of maintaining adequate pressure. The amount of pressure required will depend upon the number of nozzles in use. A large 300-gallon sprayer carrying two lines of hose should maintain a pressure of 350 to 500 pounds, depending upon the number of nozzles used. Smaller machines of 100 gallons capacity should maintain a pressure of 200 to 300 pounds. The number of nozzles and the size of disks used should be adjusted to stay within the capacity of the machine as specified by the manufacturer. Since

the size of the hole in the disk determines the amount of spray delivered, disks should be examined regularly and replaced as soon as they show signs of wear.

The object of spraying is to cover thoroughly all leaves and fruits without wasting material. Soaking a tree until it drips is not economical, and the spray job will not be satisfactory. For young trees from 5 to 15 feet high, the best results are obtained by spraying from the ground with a 3- or 4-nozzle broom. The tree should be sprayed from both sides, making certain that the tops are thoroughly covered.

For spraying larger trees, most spray rigs should be equipped with a tower from which the tops can be covered with a single-nozzle gun. In addition,

large trees should be sprayed from both sides from the ground by another operator. The ground man, using a 3- or 4-nozzle broom, should not only spray the outside of the tree but also cover the under side of the foliage. This can be done only by directing the spray from beneath the tree upward and toward the opposite side. This practice is particularly important for the control of insects such as leaf-hopper and leaf roller.

Most of the failures in orchard spraying can be traced directly to faulty methods of application. Poor results often come from failure to cover the top third of the tree where most of the fruit is produced. Each tree should be sprayed as an individual and enough time should be taken to do a thorough job.

### *No Mystery About Success*

There should be no mystery involved in the successful control of those apple insects and diseases for which spraying is effective if a careful consideration is given to the explanations outlined in this bulletin and the recommendations followed step by step.

For special suggestions on control of the apple maggot and for information on other orchard pests, the following Minnesota agricultural extension publications will be useful:

Folder 122—Apple Maggot Control

Folder 71—Fire Blight of Apples

Folder 110—Apple Cedar Rust

Folder 121—Plum Curculio, Plum Gouger, and Apple Curculio