Spraying Calendar
Michigan State University Extension Service
E.J. Rasmussen, Ray Hutson, Donald Cation
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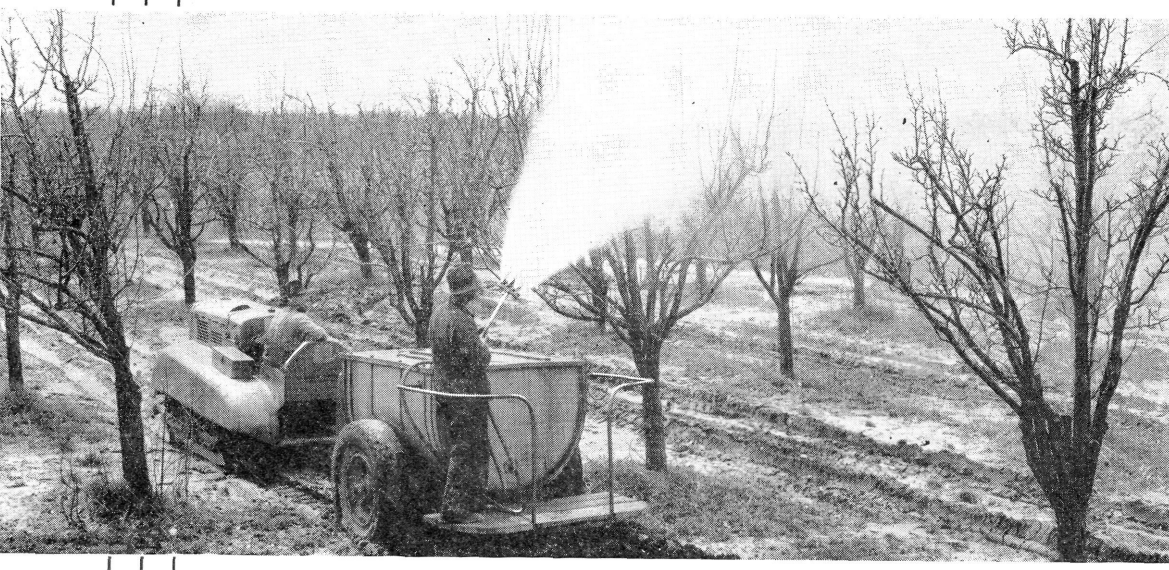

Adequate equipment insures timely and thorough coverage

SPRAYING CALENDAR

By E. J. RASMUSSEN, RAY HUTSON and DONALD CATION

MICHIGAN STATE COLLEGE
EXTENSION SERVICE
EAST LANSING

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Spraying Calendar

By E. J. Rasmussen, Ray Hutson, and Donald Cation

Fruit crops are considered one of the important products necessary to winning the war. Control of diseases and insects attacking fruits is the most important orchard operation prior to harvest. Effectiveness of this operation determines to a large extent the amount of marketable fruit harvested; consequently, in order to produce maximum yields, growers should make a real effort to control diseases and insects attacking their crops.

Recommendations in this publication are built around the important pests that usually attack apples, peaches, pears, cherries, and grapes in Michigan. The spray schedules were prepared to insure a commercial control of the various pests and good yields of good quality fruit if carefully followed.

There may be other pests of less importance than those mentioned which may cause damage in individual orchards and require control measures. For control measures of those pests, consult your county agricultural agent.

APPLE SCAB

Control of apple scab is largely dependent on keeping the foliage and fruit well covered with sulfur from the delayed dormant stage to about 2 weeks after the calyx application.

Apple scab spores develop in the old leaves on the ground during the winter. These spores are usually mature when the tips of the buds show green or in the delayed dormant stage. The spores may be discharged over a period of 5 to 6 weeks, depending on weather conditions. Rains are necessary for spore discharge and infection. Thorough coverage of the developing fruit and foliage with a sulfur material during this early spore discharge period is necessary for good control. When using wettable sulfurs, thorough application at 4- to 7-day intervals, depending on the rapidity of growth and frequency of rains, is required. Two or three extra applications early in the season will save the application of later sprays, avoid complicating the later codling moth control program, and result in less injury to fruit and foliage.

The past two years' experimental work with wettable sulfurs showed that they are a good substitute for lime-sulfur. Trees sprayed more frequently with wettable sulfur of fine-particle size (8 microns and smaller) produced larger yields of better quality fruit and as free from scab as did trees sprayed with lime-sulfur as outlined in the previous spraying calendar.

Use of wettable sulfurs requires more timely and thorough spraying. In the wettable sulfur program, sprays were applied at 4- to 7-day intervals during the period when spores were being discharged from the old leaves on the ground. Five pre-calyx, one calyx, and three cover sprays (a total of 9 sprays) were applied during the season.

Growers with adequate equipment to cover their orchard in 2 to 3 days can profitably use a wettable sulfur program on apples, while those unable to apply timely and thorough applications, either because of inadequate equipment or unavoidable delays, will obtain better control with lime-sulfur.

Thorough coverage of the tops of the trees is of prime importance. During prolonged rainy periods, or when extra sprays are needed during the early season, if wettable sulfurs are used, doubling the amount of material in the spray and spraying the upper half of the trees is a worthwhile practice.

CODLING MOTH

The fundamental principle of codling moth control is coverage. This involves coverage at the time of the calyx spray; coverage during the period of rapid growth immediately after calyx spray (the young apple increases its surface, very rapidly during the two weeks immediately after the petals fall), and coverage at the time of second and third cover sprays when moths are extremely active in egg laying. In brief, coverage should be complete during the entire period that first-brood worms are actively entering apples if the first-brood worms are to be prevented from maturing and breeding.

Furthermore, later spraying (mid-July and after) will control codling moth only if the number of larvae surviving the first brood sprays is kept to a low figure. "New materials and schedules" cannot substitute in July and August for arsenicals and nicotine in June.

A spraying schedule embodying the foregoing ideas in codling moth control consists of:

1. *Calyx*—2 pounds lead arsenate
2. *First cover, seven days after calyx*—3 pounds lead arsenate
3. *Second cover, 7-10 days after first cover*—4 pounds lead arsenate
4. *Third cover, 10 days after second cover*—3 pounds lead arsenate.

Note the intervals. Note also that ¾ pint of nicotine sulfate per 100 gallons or its equivalent in fixed nicotine included in the second and third cover sprays is one of the best known ways of obtaining better codling moth control without fear of residue. Additional cover sprays at two-week intervals will be needed until the time for the two or more second brood sprays is announced through county agents.

APPLE MAGGOT

By far the greatest number of fruit insect inquiries received during recent years by horticulturists, county agricultural agents, and entomologists have

been occasioned by apple maggot. This native insect is on its "home grounds" in the northern states and is rapidly becoming an important apple insect in Michigan. The adult fly may migrate approximately one-half mile from infested trees; therefore, all apple trees in the vicinity of an apple orchard should be protected against infestation. Elderly persons remember that before spraying became general in the 1880's, apple maggot, then called "railroad worm" because of its tunnels in the fruit, was the No. 1 orchard pest. Prior to the advent of arsenical spraying, the pasturing of livestock in orchards and the utilization of low-grade apples as "vinegar stock" retarded spread of the insect. The apple maggot began to return as a pest about the time growers became residue-conscious. At present it is probably more important than ever before.

The single generation of winged flies responsible for maggot-infested apples appear in greatest numbers shortly after July 4 and feed by scrubbing the surface of leaves and fruit with their mouthparts for about a week before laying eggs. Arsenicals on the fruit and foliage during the time the adult flies are feeding will kill them before they lay eggs. In the case of heavy infestations, several arsenical sprays will be needed. Obviously, no insecticide will reach the maggots after they are in the apples.

Since the maggots go from the infested apples into the soil where they over-winter; removal of fallen apples from beneath the trees before the maggots emerge, will destroy the chances of a buildup.

Drops and windfalls must be picked up in a heavily infested orchard. Systematic removal of drops and windfalls in all orchards will reduce the chances of their becoming heavily infested.

To be effective against apple maggot, pickup of drops and windfalls should be practiced after the third week in July. Summer varieties must be collected twice a week; fall varieties each week; and winter varieties every 2 weeks, since the maggots develop at different rates depending upon the condition of the apples. The best way to destroy unsalable apples is to pile them in some out-of-the-way corner and then, the following spring after they have rotted down, treat with 1 gallon of used crankcase oil for each 10 square feet of pile. Other methods of disposal will occur to orchardists but one should make sure that such methods are effective.

The exact date for the first spray against apple maggot is determined each year by the Entomology Department and the information is disseminated by the county agricultural agents, newspapers, and radio stations, but if you have had trouble with this pest be sure to plan to apply an arsenical just after July 4. Notice, also, that in the apple spraying program attention is called to an apple maggot spray.

RED MITE

Red mite eggs occur any place upon infested trees; smaller branches and rough places on the limbs are favorite sites. The young mites appear at the

time of the delayed dormant spray or soon after, and a new generation is produced in about 35 days. Since each female produces 25-35 eggs, the offspring of a single female mite may reach astronomical figures by midsummer when their damage is commonly seen.

Damage by red mites results from their feeding on the surfaces of the leaves. Bronzing of foliage is the first sign of damage, but severe infestations influence coloration and sizing of fruit by reducing food manufacture in the leaves, even to the extent of partial defoliation.

Dormant sprays of three per cent actual oil content have been used for many years with success against European Red Mite. However, in some years and on susceptible varieties such as Delicious and Baldwin even this gives insufficient control and further summer sprays may be necessary. Although two per cent oil applied with DN compounds has been used for San Jose scale and aphids, it has not satisfactorily controlled Red Mite. A three per cent oil and DN combination is dangerous from the injury standpoint, so that aphis control and red mite control should not be attempted in a single dormant application. Complete and thorough coverage with 3-percent oil in the dormant period is necessary for Red Mite control.

Experimental evidence shows that sprays of either 1-percent summer oil or the proper concentration of the dicyclohexylamine salt* of dinitro ortho cylohexylphenol (a DN compound different from the one used against aphids in the dormant spray) controls mites. However, oil is incompatible with sulfur. The DN compound is incompatible with oils and alkalis.

Consequently, the best way of handling the mite problem would seem to be to apply a 3-percent dormant oil spray to all the orchard for mites. Following this, additional foliage sprays could be planned for susceptible varieties. A good program might include the summer form of DN with a wettable sulfur, or the use of an arsenical schedule up to the third cover spray with a change to a nicotine oil program.

If the DN compound is used, it should be during the early part of the season (not later than second cover) and should not be followed by oil.

Scab control early in the season will clear the way to mite control if you plan to use summer oil.

PEAR SPRAYING

The three most important pests of the pear are pear psylla, scab, and codling moth.

Pear Psylla:

1. Use a dormant oil spray in March or early April *before* egg laying begins. This application is often applied too late.

2. A home-made bordeaux emulsion prepared from oil having a viscosity of 175 to 250 seconds (Saybolt at 100°) is preferred. Most commercially

*DND4, dust; and DN 111 for spraying; these are made by Dow Chemical Co., Midland, Mich.

prepared oils are of a lower viscosity and will not give as good control as the home-made emulsion. (See page 15 for instructions on making home-made emulsions.)

3. *Spray thoroughly*—It is imperative that all parts of the tree be covered.

4. If psylla is not entirely controlled by the application of dormant oil, spray later at its first appearance with ¾ pint of nicotine sulfate and 3 quarts of summer oil in 100 gallons of water, and repeat the application in 10 days if control is not obtained. *Thoroughness of application is essential to success in psylla control.*

Codling Moth:

1. The spray schedule as outlined for codling moth control is writtten for the grower who sells his fruit to a cannery. If the fruit is sold on the fresh fruit market, residue removal will be necessary. If no washing equipment is available, the nicotine sulfate-oil spray referred to above, or a fixed nicotine-oil spray, may be substituted for the lead arsenate. Nicotine oil sprays are effective for only 7 to 8 days. Six to eight applications beginning with the second cover spray may be necessary for control. The number of applications should be based on the prevalence of codling moth in the orchard. Apply only the number of sprays necessary for control. Too many sprays containing oil may cause injury.

2. Kieffer pears are not harvested until late in September or the first half of October, and nearly all of them are sold to commercial canners. *Codling moth emerging in September have so thoroughly infested Kieffer pears in some orchards as to cause the rejection of the entire crop. One or two applications of 3 pounds of lead arsenate in 100 gallons of water in September, will save much of the Kieffer crop going to canneries.* Contact your county agricultural agent or the Agricultural Experiment Station, East Lansing, if in doubt about the time of application.

Pear Scab:

1. Kieffer is quite resistant to scab. The schedule as outlined should give good control on this variety. Bartlett is somewhat more susceptible, and in years favorable for scab development an extra pre-bloom spray may be necessary.

2. Bordeaux is recommended as a fungicide on pears because it is less injurious to foliage than lime-sulfur, has some value in controlling fire-blight, and is compatible with oil.

Fire-blight Control:

1. Reduce the chances of infection by maintaining a moderate and uniform growth. Avoid excessive growth.

2. Remove sources of infection near the orchard, such as neglected pear and quince trees.

3. *It is very important to remove blighted branches and cut out blight cankers.*

Contact the Botany Department, Michigan State College, for detailed instructions.

PEACH LEAF CURL

The leaf curl fungus lives over harmlessly from year to year on the waxy coatings of peach twigs. It attacks leaves in the spring when protracted cold, wet periods occur. If the disease becomes established on the leaves, it is too late to spray. *(The fungus must be destroyed by a dormant spray before tree growth starts in the spring.)* The dormant spray is cheap insurance against possible loss of a crop from leaf curl infection. This spray should never be omitted.

The leaf curl spray may be applied either in the fall or in the spring. If the spray is applied in the fall, use bordeaux 8-8-100. If either red mite or San Jose scale is a problem, a spring dormant spray of bordeaux and home-made oil emulsion or compatible proprietary oil emulsions may be substituted. For leaf curl alone, if the spray is delayed until spring, lime-sulfur 5-100, applied before the buds swell, gives definite control of the leaf curl disease.

BROWN ROT OF STONE FRUITS

Brown rot is usually the most destructive disease of peaches, plums, and sweet cherries. The disease is most familiar as a fruit rot. The rather firm rot is first seen as a small brown spot but soon involves the entire fruit. Powdery, light brown or gray masses of spores may appear on the rotted areas. The rotted fruits frequently remain attached to the twigs, appearing as dried or mummied fruits. In reality, a mummy is largely composed of fungous tissue. This mummied mass of fungus lives overwinter, hanging on the trees and masquerading as a dried fruit. When wet with spring or summer rains at moderate temperatures the fungous tissue becomes active, producing millions of spores. These masses of dusty spores are readily disseminated by wind and air currents. Those mummies which fall to the ground and become partially buried produce mushroom-like fruiting bodies which ripen and give off additional clouds of spores at blossom time. In seasons when wet weather prevails during blossoming, the brown rot attacks and kills the blossoms. The blighted blossoms remain on the tree twigs, hanging limp and blasted. They become gummy and sticky in damp weather and are the source of additional masses of brown-rot spores.

Green fruit is rather resistant to infection although rot may occur following insect injury or bruises. Ripe fruit is very susceptible to attack.

Control:

The main reliance for control consists in spraying. Supplementary measures help and consist of knocking the mummied fruit from the trees

before blooming period, cultivation before blossom time, pruning trees to allow for circulation of air and thinning fruits so that no two will touch. Curculio must be controlled by adequate sprays and supplementary measures.

Spraying:

PEACHES: Where blossom blight has been prevalent, a pink spray is now advised. Lime-sulfur, 2 gallons in 100 gallons of spray, applied when blossom buds are pink and just before they open has materially reduced the amount of blossom blight. It has been superior to any other material used in comparison on peaches. *Do not use lime-sulfur on peaches after the blossoming period.*

A wettable sulfur spray is necessary in the second cover for peach scab and also helps to control brown rot. If blossom blight is present, additional sulfur sprays should also be included at petal fall and shuck fall.

The critical stage for fruit rot begins one month before ripening time. Spray often in this period if wet weather persists. Spray or dust with sulfur just before picking. If mechanical brushers (defuzzers) are used, they should be supplied with a sulfur-dusting attachment. An invisible coating of sulfur carried over from orchard sprays or applied as a dust at the grader should be present on the fruit to prevent rot during transit to the consumer.

PLUMS: Brown rot is difficult to control on many varieties of plums. Include sulfur in all the sprays according to the recommended schedule. Spray more frequently than indicated in the spray calendar if rainy weather persists and brown rot is present.

SOUR CHERRIES: Brown rot is not generally a problem on sour cherries and is controlled by sprays scheduled for leaf spot. A prebloom spray of liquid lime-sulfur 2-100 should be applied in orchards which showed blossom blight last season. This special spray may also aid in leaf-spot control.

SWEET CHERRIES: Spray just before blossoming with liquid lime-sulfur 2-100 if brown rot of fruit or blossoms has been troublesome. The other sprays indicated in the spraying calendar are effective in controlling brown rot as well as leaf-spot. A spray of wettable sulfur or a sulfur dust one week before harvest will permit a longer harvesting season and help the cherries to hold up in market.

PLUM CURCULIO ON STONE FRUITS

The plum curculio attacks peaches and other stone fruits just after they set, causing young fruits to drop as a result of injury either from larvae feeding or infection by brown rot carried by the adult beetle. From late July to harvest-time, adult curculios again cause injury by puncturing the fruit when feeding and by spreading brown rot.

There is one generation a year in Michigan, and the long life (10-15

months) of the adults is responsible for the extended period of attack. A curculio emerging in July feeds until cold weather, houses up for the winter in or near the orchard, and emerges the following spring to cause damage again. Since each female curculio may lay 300 eggs, the value of proper disposal of thinnings, destruction of overwintering places and good spray practices should be apparent.

Two or three sprays at the time the adults are beginning to feed are necessary. Happily, the proper time to spray for curculio coincides with the timing of the sulfur sprays usually applied just after bloom on stone fruits. Special attention and, perhaps, extra applications should be given to the first four rows of stone fruit trees near overgrown fence rows, gullies, sloughs, woodlands, buildings, or other suitable curculio over-wintering quarters. Heavy infestations (on the basis of past damage) should have three sprays: (1) at petal fall; (2) at shuck fall; and (3) two weeks after shuck fall.

Ordinary curculio infestations are controlled by two arsenical sprays—one at shuck fall and one 2 weeks later.

Basic lead arsenate, 3 pounds per 100 gallons of spray, has given excellent control of curculio. Acid lead arsenate (the standard or commonly used kind) used on peaches at the rate of 2 pounds per 100 gallons of spray, should never be applied to peaches unless zinc sulfate-lime is used with it as a corrective. (See page 17.)

Curculio control is included in the schedules for peaches, plums, and sweet cherries.

CHERRY LEAF-SPOT

Cherry leaf-spot can be controlled in most years with four applications of a copper material. (a) At petal-fall time; (b) 2 weeks after petal-fall; (c) 4 weeks after petal-fall; (d) immediately after harvest.

Thorough applications, especially to the tops of the trees, are necessary. At least 5 gallons of spray is required to cover an average-sized, bearing cherry tree.

The leaf-spot fungus lives over winter in the old leaves on the ground. The fungus develops during the winter, and spores are present in the old leaves for a period of 6 to 7 weeks and are discharged if rains occur. Keeping the foliage covered with a copper fungicide during this early spore-discharge period will prevent infections from which summer spores develop and aid greatly in keeping the foliage on the trees throughout the summer. Proprietary copper materials, plus an equal amount of lime, or a 2-3-100 bordeaux, are recommended. Six years' experimental spraying on leaf-spot control has shown that the copper materials are more effective than lime-sulfur. Some of the proprietary copper materials used in experimental work for leaf-spot control are: Basicop, Bordow, Cupro-K, Grasselli's Compound A, Oxobordeaux, Spray Cop, Tennessee 26, and Tennessee 34. None of these materials has fungicidal value equal to bordeaux, but some cause less

injury, and for that reason are more satisfactory in most years. They should be used according to manufacturer's recommendations.

Experimental results the past two years with a half-and-half mixture of proprietary copper and wettable sulfur plus lime (1½ to 2 pounds of proprietary copper, 2 to 3 pounds of wettable sulfur, 3-4 pounds of lime) showed this mixture to be satisfactory for leaf-spot control on both sweet and sour cherry. If copper materials should become scarce, wettable sulfur could be substituted for part of the copper without sacrificing any degree of disease control.

Always apply the after-harvest spray. This spray is important in preventing late leaf-spot infection and late summer defoliation. Primary leaf-spot spores develop in greater number in late infected leaves. The maintenance of good foliage throughout the season helps to keep the trees in a good vigorous condition so as to withstand winter injury.

There seems to be little excuse for heavy defoliation of cherry trees before harvest time if the trees are well sprayed. Cherry leaf-spot can be checked after infection has occurred. A thorough application of a copper spray to both the lower and upper surfaces of the leaves soon after the characteristic round purple-to-brown spots appear will check further development of the disease and prevent defoliation of many of the infected leaves.

Spray timing is especially important in leaf-spot control. The first spray should be applied immediately after most of the petals have fallen. The first cover spray should be applied within 14 days of the petal-fall spray and the second cover not more than 14 days after the first cover spray.

CHERRY APHIDS

Black cherry aphids are a serious pest of sweet cherries, and there is no better way of controlling them than a dormant application of DN compounds with or without oil. A water-soluble form of DN compound may be used in the northern sections of the state where San Jose scale is not a menace.

If aphids appear after the trees are foliated, 1 pint of nicotine in 100 gallons of spray with a spreader is the best control. There are various commercial spreaders on the market, and 4 pounds of soap (thoroughly dissolved) or 4 ounces of Dreft in 100 gallons of spray may be used. It has been noticed that if spraying control of aphids on sweet cherry foliage is attempted, brown rot becomes a serious problem unless sulfur is included in the spray. Some cherry growers have succeeded in controlling aphids on sweet cherry by dusting with 3-percent nicotine dust.

Thorough and complete application with a driving rather than a mist spray is necessary to control black cherry aphids.

CHERRY MAGGOT

Cherry maggot control on sour cherries must be accomplished. The state law on cherry maggot control is specific.

Fortunately, the flies responsible for maggot infestation of cherries are definite in habit and comparatively easy to control with arsenical sprays. The dates for spraying in the different districts are determined each year by a scouting system maintained by the State Department of Agriculture and the Department of Entomology.

Cherry maggot control depends upon the adult flies' habits of feeding for a period of at least a week before depositing eggs. If an arsenical is applied during the period the flies are feeding, control is secured. If a fungicide seems necessary at the time, it may be combined with the arsenical.

GRAPE BERRY MOTH AND GRAPE LEAFHOPPER

Use of properly designed covered booms will improve control of grape insects and diseases by insuring better coverage.

Grape berry moth and leafhopper are considered together because better control can be obtained in that way, insofar as spraying bears upon the subject.

Grape berry moth has three generations each year. The first brood appears about the time grapes bloom, and Michigan growers are familiar with their little webs in the bunches at that time. The second brood appears just as the berries are touching in the bunches. Grape leafhoppers move into the vineyards about a week before bloom. If they are not controlled soon after grapes set, it is virtually impossible to do so later.

A combined oil, arsenical, and nicotine program has given excellent control of grape berry moth and leafhopper chiefly because nicotine is an excellent material for use against leafhopper and also a good control for grape berry moth.

The first spray against grape berry moth, consisting of 3 pounds of an arsenical (lead or calcium arsenate) with 3 quarts of summer oil as a sticker, in 100 gallons of spray should be applied when the new shoots are 4 to 6 inches long. A second application of the same materials and dosage should be put on just as the grapes come into bloom. The third spray of summer oil 3 quarts, nicotine sulfate ¾ pint, and 3 pounds lead or calcium arsenate in 100 gallons should go on immediately after bloom. This spray is most important in control of grape berry moth; consequently a thorough application must be made.

In these applications of the pre-blossom period, no mention is made of the fungicide because the insecticides used are compatible with any fungicides used on grapes.

At least two more applications must go on after the post-bloom spray if control of berry moth and leafhopper is to be satisfactory. Such a program

necessitates that the grower decide what program to follow for the rest of the season. Sprays of oil, arsenical, and nicotine applied with bordeaux, may stain the fruit and result in grapes being unsalable on the fresh fruit market.

The grower may wish to change to a fixed nicotine-fish oil soap program; in that case, a proprietary copper fungicide must be used because fixed nicotine is incompatible with bordeaux. Grapes sprayed with this program may be sold for fresh fruit or juice.

In any case, nicotine added to the post-bloom sprays will control the leafhopper and improve the control of berry moth.

Working the soil toward the vines and leaving it undisturbed until after July 1 covers many berry moth pupae and thereby reduces the spraying problem.

BLACK ROT OF GRAPES

Black rot disease is rarely a problem in vineyards that are consistently and properly sprayed year after year. With proper spraying, the black rot fungus does not have a chance to build up a supply of overwintering spores and the disease is easily controlled even in years favorable for its development. Conversely, if the disease becomes established in the vineyard it is more difficult to control.

Black rot was present in many vineyards in 1943. Such vineyards should receive thorough and timely sprays this season to avoid large possible losses.

Home-made bordeaux sprays, consisting of copper sulfate and lime (8-8-100) especially in the early sprays, are necessary for success in controlling black rot under severe conditions. Home-made bordeaux sticks better and offers greater protection than any other copper spray.

The early sprays are very important because the disease is seldom sufficiently controlled after early infections are well established. Begin spraying when the new shoots are 4 to 5 inches long. Spray according to the directions in the regular schedule (page 25), which should give a new coverage, about every 10 days until the berries touch. If the disease is well controlled up to that time, the proprietary copper sprays may be substituted for bordeaux as they are compatible with the new nicotine schedule. Proper timing, thorough coverage, and the right materials will control black rot.

SPRAY INJURY

Plants, disease organisms, and insects are all living organisms. Any material applied to kill a disease spore or an insect will cause more-or-less injury to the plant. Wrong combinations of spray materials, improper methods of application, or applying spray under certain weather conditions may result in more serious injury and loss of fruit than that caused by pests on unsprayed trees. For example, acid lead arsenate applied to peach trees

without the addition of the zinc sulfate-lime corrective would be more serious than if no attempt were made to control curculio.

The following precautions will help to reduce spray injury to twigs, foliage and fruit:

Apply sulfurs and DN compounds only when temperatures are below 90° F. Injury from sulfur materials on apples can be nearly eliminated by controlling scab early and thereby avoid the use of sulfur late in summer when temperatures are high.

Allow a period of 7 to 10 days between applications of oil and sulfur sprays. Oils and sulfur are incompatible and should not be mixed when used during the growing period.

Always add the zinc sulfate-lime or the iron sulfate-lime mixture to acid lead arsenate-containing sprays applied to peach and European plum trees. (See page 17.)

Zinc sulfate-lime mixture added to lead arsenate sprays on apples in the second cover and later sprays will aid in reducing arsenical injury. One pound of zinc sulfate and 4 pounds of lime are recommended for each 3 pounds of lead arsenate.

Use lime-sulfur on apples for scab control only when sprays cannot be applied on time, when weather conditions are favorable for scab infection, or when thorough coverage is impossible. Wettable sulfurs, if properly applied, will give a commercial control of scab and larger yields.

Do not use lime-sulfur on apples at intervals of less than 7 days. Lime-sulfur when applied at too short intervals early in the season has a serious starvation effect on the tree which results in premature dropping of fruit.

When spraying cherries, never follow a copper spray with a lime-sulfur application. Serious defoliation will likely result. Wettable sulfurs, however, are compatible with copper materials.

DORMANT OILS

There are two sources of dormant oils available to the grower: proprietary oil emulsions or miscible oils prepared by various companies and sold under trade names, and cold-pumped or home-made emulsions. The oils used in cold-pumped emulsions are of the type called lubricating oils. Those used for control of red mite and scale insects should have a viscosity of at least 100 seconds (Saybolt at 100° F.) and those used for control of pear psylla should have a viscosity of 170 to 250 seconds viscosity.

For growers who wish to make their own oil emulsions, the cold-pumped emulsions are generally more satisfactory. Cold-pumped emulsions are recommended for the control of pear psylla and on peaches in combination with 8-8-100 bordeaux where one spray is applied for leaf curl and red mite. To make a 3-percent oil spray with fungicidal value first prepare a stock as emulsion as described on page 15. Next prepare an 8-8-100 bordeaux as described on page 16, and to this bordeaux add 4½ gallons of the cold-pumped

stock emulsion. Keep the agitator in operation continuously until the tank is empty.

Bordeaux Emulsions:

Bordeaux is a very satisfactory emulsifier. The formula and method of preparation follow:

Prepare the copper sulfate and lime as stock solutions. Convenient proportions for this purpose are 1 pound to 1 gallon of water for the copper sulfate and 1½ pounds to 1 gallon for the hydrated lime.

For each 100 gallons of a given concentration, proceed as follows. (Use stock solution of the strength indicated in the preceding paragraph.)

Materials	For each 100 gallons of spray with actual oil content of		
Place in sprayer in this order	3 percent	6 percent	8 percent
1. Water	¾ *gallon*	1½ *gallons*	2 *gallons*
2. Copper sulfate (stock solution)	3 *pints*	3 *quarts*	1 *gallon*
3. Hydrated lime (stock solution)	3 *pints*	3 *quarts*	1 *gallon*
4. Oil	3 *gallons*	6 *gallons*	8 *gallons*

If these quantities are insufficient to permit good agitation, add more water.

For a 200-gallon tank use twice the amounts indicated, for a 300-gallon tank use three times and for a 400-gallon tank use four times the indicated amounts. The procedure, step by step, follows:

1. Place the indicated amount of water in the empty sprayer tank. Have the agitator in operation.
2. Add the copper sulfate stock solution.
3. Add the hydrated lime stock solution (always stir before taking from the container).
4. Add the oil.
5. Emulsify by pumping at high pressure (at least 250 pounds) through spray gun or nozzle back into the tank. Continue until the emulsion is creamy in consistency and there is no evidence of free oil.
6. Add water to fill the tank and apply. Keep agitator in operation until tank is empty. MAKE CERTAIN THAT THE CONCENTRATED EMULSION IS ALL OUT OF THE HOSE BEFORE ANY SPRAY IS APPLIED TO TREES.

This emulsion must be continuously agitated. If through lack of agitation there is an appearance of free oil, discard the emulsion and start over.

If a large quantity is to be made up at a central mixing plant to supply several sprayers, the following formula for stock emulsion may be used:

Formula for Stock Emulsion of Bordeaux-oil-emulsion

Materials (Add to sprayer in this order)	Amount
	gallons
1. Water	7½
2. Copper sulfate (stock solution)	3¾
3. Hydrated lime (stock solution)	3¾
4. Oil	30

To dilute this stock emulsion, fill the sprayer about one-fourth full of water, and, with agitator in motion, add the stock emulsion. The amount to use can be determined by reference to the following section. When thoroughly mixed, fill the tank with water and apply, keeping agitator in motion until the tank is empty. It is not advisable to make up more stock emulsion than will be used the day it is made.

Diluting and Using Emulsions:

Emulsions prepared according to this formula contain approximately 66⅔ percent oil. Some commercial emulsions contain about the same amount. To dilute such emulsions, the general rule is that for each 100 gallons of spray the number of gallons of stock emulsion is one-half greater than the stated percentage of oil. A tabular statement of dilutions follows:

Table of Dilutions for Emulsions Containing Approximately 66⅔ Percent of Oil

Amount of dilute spray	Amount of stock emulsion to use to make actual oil content of				
	2 percent	3 percent	4 percent	6 percent	8 percent
	gallons	*gallons*	*gallons*	*gallons*	*gallons*
100 gallons	3	4½	6	9	12
200 gallons	6	9	12	18	24
300 gallons	9	13½	18	27	36
400 gallons	12	18	24	36	48

To make certain that the oil is properly emulsified, mix a pint of the finished emulsion in a bucket of water. If free oil appears on the top within 5 minutes, discard the entire mix.

Preparation of Bordeaux:

There are several methods for preparing bordeaux. The one in most common use today is the "instant bordeaux" method. It has replaced the old stock solution method because it is more convenient to make and the

mixture is entirely satisfactory. One precaution should always be remembered in making bordeaux. Never mix concentrated solutions of copper sulfate and lime. Such a mixture is coarse and does not adhere well to the fruit or foliage. The more dilute the solutions when mixed, the better the quality of bordeaux.

The "instant" method requires different forms of materials than the old stock solution method. The lime used should be a good grade of chemical hydrate or spray lime. The copper sulfate should be the powdered or snow form. These forms go into suspension or dissolve readily in water. To make "instant bordeaux," proceed as follows:

1. Fill the spray tank ¼ to ⅓ full with water.
2. With the agitator running, place hydrated lime on the tank strainer and wash through or mix with water in a pail and pour through the strainer.
3. *Fill tank nearly full with water.*
4. Dissolve the copper sulfate in a pail and pour slowly through the strainer while the water continues to flow into the tank.

Allow about 2 minutes for the two solutions to mix and react in the tank.

5. Add lead arsenate or nicotine sulfate at this time if either is to be used. Fill the tank with water and apply. Keep the agitator in operation continuously after copper sulfate has been added.

Ccorrectives

Iron Sulfate-lime Mixture:

For each 100 gallons of spray, use 4 pounds iron sulfate, 4 pounds hydrated lime, and 2 pounds acid lead arsenate; mix as follows:

1. Begin filling the sprayer with water with agitator running.
2. Sift or shake in gradually the "sugar" iron sulfate, which will dissolve in 1 or 2 minutes. If the crystalline form is used pour in the stock solution which has been prepared previously.
3. Continue to add water with agitation and add the hydrated lime in any convenient way.
4. Add the acid lead arsenate. Fill sprayer with water and apply. When wettable sulfur is used with this mixture add the sulfur after the acid lead arsenate. It is not known how bentonite sulfur will combine with this mixture. *The use of iron sulfate-lime mixture has proved satisfactory for peaches but not for apples because it interferes with color.*

Zinc Sulfate-lime Mixture:

A 1-4-100 zinc sulfate-lime mixture is recommended to prevent arsenical injury on apple; a 4-4-100 zinc sulfate-lime mixture to prevent arsenical injury on peach and plum; an 8-8-100 zinc sulfate-lime mixture for bacterial spot of peach.

It is a poor policy to use arsenicals indiscriminately just because the residue tolerance has been raised. If arsenicals are used on Jonathan, King,

Rhode Island Greening, Ben Davis, or other varieties susceptible to arsenical injury, the zinc sulfate-lime mixture added to the spray will reduce the amount of injury. This material should be used, beginning with the second cover application.

Zinc sulfate-lime mixture is prepared as follows:

1. Begin filling the spray tank with water.
2. With the agitator running, add the required amount of previously dissolved zinc sulfate to the water in the tank. Fill until two-thirds full.
3. Wash the required amount of lime through the strainer or make it into a thin paste and pour into the sprayer.
4. Finish filling the tank and agitate a few minutes before adding lead arsenate.
5. Add lead arsenate, then sulfur if required.

There are three forms or grades of zinc sulfate on the market. They vary in amount of zinc and water present. The first grade contains 22¼ percent zinc and is the crystal form; the second contains 25½ percent zinc and is the flake form; and the third contains 36 percent zinc and is the powdered form. The 25½-percent grade is the one used in Michigan State College experimental work and on which recommendations are based. If one of the other grades of zinc sulfate is used, the amount should be in proportion to the percentage of zinc present. For example, in the standard 4-4-100 mixture, 4 pounds of the 25½-percent zinc sulfate and 4 pounds of lime are recommended. If the 36-percent grade is used, then slightly less than 3 pounds of the zinc sulfate should be added to 4 pounds of lime. Zinc sulfate-lime mixture is an excellent corrective for use with all arsenates when applied to apples.

When lime-sulfur or wettable sulfurs are used with this mixture the sulfur should be added after the arsenate. Zinc sulfate should never be used without lime when applied to peach, apple, plum, or cherry trees. The zinc sulfate-lime mixture or the iron sulfate-lime mixture should always be used on peach and Japanese plums when acid lead arsenate is applied.

SPRAY SCHEDULE FOR APPLES

Stage of growth and application	Materials to make 100 gallons of spray		Pests controlled
DORMANT. Complete before buds show green	Lime-sulfur 12 gallons; or dormant oil, 3% actual oil; or DN		Red mite Scale *(1) Rosy aphids
DELAYED DORMANT. Apply in well developed green tip stage when leaf tips are ¼ to ½ inch long	Lime-sulfur 2 gallons or *(2) Wettable sulfur 5 to 8 pounds. Nicotine sulfate 1 pint	These applications are important in scab control	Scab Rosy aphids
PRE-PINK. Just as first leaves are unfolding around blossom buds. Complete as soon as possible	Lime-sulfur 2 gallons or *(2) Wettable sulfur 5 to 8 pounds. Lead arsenate 3 pounds		Scab Curculio Chewing insects
EARLY PINK. When the center bud shows pink	*(2) Wettable sulfur 5 to 8 pounds		*(3) Scab
PINK. Apply as soon as most of the blossom buds have separated, complete before blossoms open.	Lime-sulfur 2 gallons or *(2) Wettable sulfur 5 to 8 pounds		Scab
IN BLOOM. When trees are in full bloom	*(2) Wettable sulfur 5 to 8 pounds		*(4) Scab
CALYX. When most of petals have fallen and bees have quit working	Lime-sulfur 1½ gallons or *(2) Wettable sulfur 5 to 8 pounds. Lead arsenate 2 pounds		Scab Curculio Codling moth
FIRST COVER. 7 to 10 days after calyx	*(2) Wettable sulfur 4 to 6 pounds. Lead arsenate 3 pounds		Scab Codling moth Curculio
SECOND COVER. 7 to 10 days after first cover	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 4 pounds.*(2) Wettable sulfur 4 to 6 pounds	Codling moth control	Scab *(5) Codling moth Curculio
THIRD COVER. 10 to 14 days after second cover	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds		*(5) Codling moth Curculio Apple maggot
FOURTH COVER. 2 weeks after third cover	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds		*(5) Codling moth Curculio Apple maggot
SUMMER GENERATION. Exact time to be determined each year, usually Aug. 1	Zinc sulfate 1 pound. Lime 4 pounds. Lead arsenate 3 pounds.*(2) Wettable sulfur 4 to 6 pounds		*(5) Codling moth Curculio Apple maggot *(6) Scab
TWO WEEKS AFTER SUMMER GENERATION SPRAY. If necessary make one or two more applications at 2-week intervals	Lead arsenate 3 pounds. Zinc sulfate 1 pound. Lime 4 pounds		*(5) Codling moth Curculio

*See foot note next page

Thorough Coverage is Essential in All Applications

(1) This is the best time to control red mite which requires a 3-percent actual oil spray. On varieties susceptible to rosy aphids water soluble DN compound, or a 2-percent oil DN mixture may be used. The DN or DN oil mixture will not control red mite. Where both rosy aphids and red mite are a problem a 3-percent dormant oil is recommended for red mite control followed by nicotine sulfate in the delayed dormant for rosy aphids.

(2) Wettable sulfurs are obtainable in the dry-wettable and paste forms. The amounts suggested in the spray schedule are for the dry-wettable forms. If flotation pastes are used double the amounts of the material. The finer particle sized (8 microns and smaller) wettable sulfurs only are recommended for apple scab control.

(3) This spray may be omitted on scab-resistant varieties such as Jonathan, Rhode Island Greening and Wagener.

(4) Do not use lead arsenate in this spray because of danger of poisoning bees.

(5) If fruit is not to be washed, lead arsenate and the zinc sulfate-lime mixture should be substituted after the third cover spray with fixed nicotine, or fixed nicotine and oil.

(6) Sulfur in this application will aid in controlling late scab.

SPRAY SCHEDULE FOR PLUMS

Application	Materials to make 100 gallons of spray	To control
(1) DORMANT. Apply just before growth starts	Oil 3%	Scale insects and mites
(2) PRE-BLOSSOM. Just as leaf buds burst and before blossoms open	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds	Curculio
(3) PETAL-FALL. Just after the petals have fallen	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds. Wettable sulfur 4 to 6 pounds	Curculio, leaf spot and brown rot
(4) TWO-WEEKS. Ten days to two weeks after No. 3	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 3 pounds. Wettable sulfur 4 to 6 pounds	Curculio, leaf spot and brown rot
(5) LATE SUMMER. About one month before harvest	Wettable sulfur, 4 to 6 pounds	Brown rot and leaf spot
(6) SPECIAL. One week to ten days before harvest	Sulfur dust or wettable sulfur 4 to 5 pounds	Brown rot

PEACH SCHEDULE

Application	Spray materials to make 100 gallons of spray	Dusts substituted for sprays	Pests controlled
(1) DORMANT. Apply in early spring before growth starts	For leaf curl: Lime-sulfur 5 gallons. For scale and leaf curl: lime-sulfur 12½ gallons. For mites or scale: 3% oil. *For mites or scale and leaf curl: 8-8-100 bordeaux plus 3% oil. See page 15		Leaf curl Red mite Scale
(2) PINK. Apply just before blossoms open	Lime-sulfur 2 gallons	85-15 sulfur lime dust	Blossom blight Brown rot
(3) SHUCK FALL. After petals have dropped and most of the shucks have fallen	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 2 pounds.** Wettable sulfur 4 to 6 pounds	95-5 lime lead arsenate dust. or 80-5-15 sulfur-lead arsenate-lime dust	Curculio Brown rot
(4) Two weeks after No. 3	Zinc sulfate 4 pounds. Lime 4 pounds. Lead arsenate 2 pounds.* Wettable sulfur 4 to 6 pounds. Nicotine sulfate 1 pint. (See last column)	80-5-15 sulfur-lead arsenate-lime dust	Curculio, scab, brown-rot. Nicotine added for virus transmitting leaf hoppers
(5) 1 month before fruit ripens	Wettable sulfur 6 pounds	85-15 sulfur-lime dust	Brown rot and scab
(5a) 1 week after No. 5	Wettable sulfur 4 to 6 pounds	85-15 sulfur-lime dust	Brown rot
(5b) 1 week after No. 5a	Wettable sulfur 4 to 6 pounds	85-15 sulfur-lime dust	Brown rot
(6) 7 days before harvest	Wettable sulfur 4 to 6 pounds	85-15 sulfur-lime dust	Brown rot

*For combined bordeaux and oil spray, make the bordeaux in the usual way in the tank When the tank is nearly full, add the correct amount of home-made stock oil emulsion, or any proprietary dormant oil compatible with bordeaux.

**Basic lead arsenate may be substituted for the acid lead arsenate and the zinc sulfate-lime corrective. Basic lead arsenate should be applied at the rate of 3 pounds to 100 gallons of spray.

Iron sulfate may be substituted for zinc sulfate on peaches.

PEAR SPRAY SCHEDULE

Application	Materials to use	Pests controlled	Remarks
DORMANT. Apply with the first good spraying weather in March or early April	3% heavy oil emulsion	Psylla Red mite Scale insects	An oil spray prepared from oil having a viscosity of 175-250 (Saybolt) will give best results. *Apply early in spring before egg laying begins*
PRE-BLOSSOM. When the blossom buds begin to separate in the cluster	Bordeaux 3-8-100 Lead arsenate 3-100	Scab Leaf spot Curculio Bud moth	This spray should always be applied in districts where scab and leaf spot are prevalent. In years favorable for scab development an extra pre-blossom spray may be necessary
SPECIAL BLIGHT SPRAY. When ¾ of the blossoms are open	Bordeaux 2-6-100	Fire blight Scab	This spray is necessary only where fire blight is a problem
PETAL FALL or CALYX. When the last of the petals have fallen	Bordeaux 2-8-100 Lead arsenate 3-100	Scab, Curculio Leaf spot Codling moth, other chewing insects	
FIRST COVER. Two weeks after petal fall	Bordeaux 2-8-100 Lead arsenate 3-100	Codling moth Curculio	The bordeaux may be omitted if scab or leaf spot are not present
SECOND COVER. Four weeks after petal fall	Lead arsenate 3-100	Codling moth Curculio	If sold as fresh fruit, this schedule will make residue removal necessary. (See supplementary directions)
THIRD COVER. Six weeks after petal fall	Lead arsenate 3-100	Codling moth Curculio	
SECOND BROOD SPRAY. Time determined the same as for apples	Lead arsenate 3-100	Codling moth Curculio	*The late brood often is responsible for late codling moth injury, especially on Kieffer in September*

SOUR CHERRIES

Application	Materials to make 100 gallons of spray	To control
*PETAL-FALL. When most of the petals have dropped	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate 2 pounds	Leaf-spot Brown-rot Curculio and slugs
FIRST COVER. Should be completed within two weeks after petal-fall	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate 2 pounds	Leaf-spot Brown-rot Curculio and slugs
SECOND COVER. Should be completed within two weeks after Application 3	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate 2 pounds. Omit lead arsenate unless fruit is going to canning factory or can be washed	Leaf-spot Brown-rot Curculio and slugs
SPECIAL. For the control of cherry maggot	Information concerning the timing of this application for the control of cherry maggot is sent out by the Department of Entomology. Consult your County Agricultural Agent	
AFTER HARVEST. Immediately after the fruit is harvested	Approved proprietary copper compounds (Use according to manufacturer's recommendation); lead arsenate 2 pounds	Leaf-spot and slugs

SPECIAL. On young growing trees extra applications may be necessary until growth is completed.

RESIDUE REMOVAL. Instructions will be furnished on request to Department of Horticulture.

DO NOT follow a copper spray with lime-sulfur for summer applications during the same year.

Consult your county agent for information on special spray for cherry maggot. The exact dates are determined annually by the Department of Entomology.

*If brown-rot blossom blight has been prevalent, apply a pre-bloom spray of lime-sulfur—2½ gallons in 100.

SWEET CHERRIES

Application	Materials to make 100 gallons of spray	To control
1. DORMANT.	DN water soluble (Use according to manufacturer's recommendation)	Aphid†
*2. PETAL-FALL. Just after petals have fallen	Lead arsenate 2 pounds, 1½ pounds 25% proprietary copper compound or 2 pounds of 12½% proprietary copper compound plus 3 pounds of dry wettable sulfur plus 3 pounds lime	Leaf-spot Brown-rot Curculio and slugs
3. TWO-WEEKS. Two weeks after Application 2	Same as above	Leaf-spot Brown-rot Curculio and slugs
4. FOUR-WEEKS. Two weeks after Application 3	Same as above. Omit lead arsenate unless fruit is to go to canning factory or can be washed	Leaf-spot Brown-rot Curculio Slugs and maggots
4a. SPECIAL. For the control of cherry maggot	Information concerning the timing of this application for cherry maggot is sent out by the Department of Entomology. Consult your county agricultural agent	
5. BROWN-ROT. About one week before picking	Sulfur dust or spray of wettable sulfur 4 to 5 pounds or Fermate ½ pound	Brown-rot

RESIDUE REMOVAL. Instructions will be furnished on request to the Department of Horticulture.

†If black aphids are not controlled by the dormant application apply a special application as soon as the insect is observed. Use nicotine sulfate 1 pint and Dreft 4 ounces to 100 gallons: 4 pounds of cheap soap flakes may be substituted for the Dreft.

*If brown-rot blossom blight has been prevalent, apply a pre-bloom spray of lime-sulfur, 2½ gallons in 100.

GRAPES

Application	Materials to make 100 gallons of spray	To control	Explanations
1. When shoots are 4 to 5 inches long	Bordeaux, 8-8-100. Calcium arsenate, 3 pounds plus 3 quarts of summer oil in each 100 gallons of spray	Black-rot Downy mildew Berry moth and Dead arm	Applications 1 and 2 are usually very important for rot control in seasons when it develops in epidemic form. They should be made every year as insurance against rot
2. Just as the blossom buds are opening	Same as above	Black-rot Berry moth Downy mildew and Rose chafer	If rose chafer is present, use 5 pounds lead arsenate and perhaps a gallon of cheap molasses. This is a critical application for the control of berry moth
3. Immediately after fruit sets	Same as above plus 1 pint of nicotine sulphate	Black-rot Downy mildew Berry moth Rose chafer	This application is imperative for berry moth control
4. Two weeks after full bloom	Bordeaux, 8-8-100. Calcium arsenate, 3 pounds plus 3 quarts of summer oil plus 1 pint nicotine sulfate or 3 pounds fixed nicotine (14%) plus ½ pound rosin fish oil soap plus 3 pounds proprietary copper compound to each 100 gallons of spray	Black-rot Downy mildew Leaf hopper Berry moth and Rose chafer	If rose chafer is very bad or berry moth very plentiful, make this application four days earlier Better leaf hopper control follows inclusion of fixed nicotine in this spray
5. About the time the berries begin to touch	Fixed nicotine (14%) 3 pounds plus ½ pound rosin fish oil soap, 3 pounds proprietary copper compound to 100 gallons of spray	Black-rot Downy mildew Leaf hopper Berry moth	
6. Time determined by observations. Usually around August 15	Fixed nicotine (14%) 3 pounds plus ½ pound of rosin fish oil soap to 100 gallons of spray	Berry moth	Particularly valuable in heavily infested vineyards

SPRAY RECORD

SPRAY RECORD

Are You In Doubt—?

Regarding

- *Spray materials?*
- *The best combination of materials?*
- *Timing of applications?*
- *Methods of application?*

If so, consult your County Agricultural Agent.

He is a trained and experienced agriculturist. He knows your spraying problems and their relation to profitable fruit production. He is an authorized representative of Michigan State College and the U. S. Department of Agriculture in your county. He is in a position to supply you with the best available information—free from any possible bias—and his recommendations are for your best interest.

The recommendations in this calendar are derived from a careful analysis of research conducted by Michigan State College over many years, substantiated by growers' experiences under Michigan conditions.

New materials, although satisfactory in other states, should be used only in a limited way until their value has been established under Michigan conditions.

Feel free to call upon your County Agricultural Agent for counsel regarding your fruit production problems.

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