RECOMMENDATIONS FOR CODLING-MOTH CONTROL IN COLORADO FOR 1934

OFFICE OF THE STATE ENTOMOLOGIST
COLORADO AGRICULTURAL COLLEGE
FORT COLLINS, COLORADO

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A general statement in regard to the codling-moth control program seems advisable on account of:

1. The increasing intensity of the codling-moth problem in all apple and pear-growing sections of the state, as well as the entire country, that only properly planned work can check.

2. The uncertainty of the effects of certain spray programs and combinations of material on the ability to meet spray-residue tolerance requirements.

3. The confusion that comes from many new materials and combinations being talked and advertised.

This is not a detailed discussion for the complete guidance of inexperienced growers, but rather an outline to guide the commercial producers who are having difficulties in deciding on the best program for the year.

The program is based on the assumption that all fruits will be put thru the standard washing processes for spray-residue removal. Except in extremely limited areas having a low codling-moth infestation, no effective spray program can be recommended that does not involve the necessity for washing.

Locality.—Variations in the time of codling-moth activity and the intensity of moth population of the several apple-producing areas in Colorado call for a consideration of each district as a unit. The degree of infestation varies from season to season within each district and orchard. Every orchard is a separate problem; therefore, recommendations for control must be general enough in nature to be flexibly applied to the particular problem at hand.

These recommendations are based upon years of investigational work, supplemented by experimental trial upon a commercial basis, and upon information brought out by a recent national codling-moth conference, in which the problem was considered in the light of the residue problem, the efficiency of spray-residue removal, and experimental data presented from practically every important apple and pear-growing section of the country.
While many unsuccessful materials have been used in the experimental work, we shall consider here only those materials which can be recommended as having the greatest control values. Because of the ever-increasing codling-moth problem, it is inadvisable for any orchardist to experiment with unproved materials and spray schedules.

**Districts.**—For convenience in discussion, the various sections are placed in three groups as to degree of infestation: Heavy, moderate and light.

(Heavy).—The apple and pear-producing areas of Mesa County, known as the Grand Valley, have presented a most severe problem on account of the three broods of the moth, and very favorable conditions. This requires six to eight cover sprays, or in other words, a complete coverage throughout the growing season from the time moth activity begins. The overlapping of the broods in this district makes a continuous larval hatching period, extending almost to harvest time.

(Moderate).—In this group are considered the districts in which there are two complete broods and a partial third, requiring six cover sprays which may be applied as three cover sprays to each brood or as four to the first and two to the second brood. The latter is theoretically the better because of a more positive control of the first brood; however, there are times when two cover sprays will not be sufficient for second-brood control. The Austin-Cory district is considered in this recommendation.

(Light.)—Where the broods are distinctly separated, as in the Paonia, Cedaredge, Hotchkiss, Olathe and Montrose districts, and the apple-producing areas of Garfield, Montezuma, Fremont and Larimer Counties, the use of four cover sprays has been successful for a major portion of the time. This has become the standard spray schedule for these districts; however, it is suggested that one or two additional cover sprays would be worth while in case of severe infestation as experienced in the past three seasons. In some of the higher-altitude orchards around Cedaredge and Paonia, the use of three cover sprays has often given successful control, depending upon the degree of local infestation.

**Lead Arsenate.**—Lead arsenate has proved in all tests to be distinctly superior to any other material for codling-moth control and is therefore recommended, with the assumption that any objectionable residue will be removed by the recognized methods of washing.
While the use of spreaders has not materially improved the control in the experimental plots, a uniform coverage is to be preferred, particularly in the second-brood sprays, since it avoids spotted fruit and contributes to easy residue removal. Lead arsenate, used at the rate of from 2.5 to 3 pounds to the 100 gallons, has given protective coverage. Excessive amounts beyond this have not improved control, but have increased the residue problem.

Colloidal spreaders and neutral soaps should not be used in excess of one-third pound to the 100 gallons of water. Greater amounts are apt to cause an excessive run-off of the spray solution.

Other arsenuicals, such as calcium arsenate, zinc arsenate, magnesium arsenate, zinc arsenite, paris green, etc., have failed to give uniform control and have often resulted in a serious arsenuical burning.

**Mineral Oils.**—The use of mineral oils alone will not control the codling moth.

The mineral oils in combination with lead arsenate and certain fluorine compounds, have value as ovicides and spreaders. Their use is most effective at the time of egg deposition but should be applied only in the first-brood cover sprays. Later applications will complicate the residue removal.

The mineral oils in the form of summer oil emulsion should be used in not more than two cover sprays, and at the rate of 1 gallon in 100 gallons of spray solution.

Since oil sprays apparently interfere with the leaf function, their use is accompanied with a certain degree of danger, depending upon the vitality of the tree. It is suggested that oil sprays be used only in case of heavy and moderate infestations where codling-moth control shows a decided need of improvement.

Oil sprays cannot be used following delayed dormant or summer applications of lime-sulphur, because of serious foliage injury. Where oil sprays are to be used in summer applications for codling-moth control, the dormant sprays for blister mite, scale, etc., should consist of oil spray.

Oil sprays cannot be used in the spray schedule where powdery mildew must be controlled by the use of lime-sulphur in the delayed dormant, calyx and first cover sprays.
Oil in combination with lead arsenate may cause injury if allowed to stand in pipes or spray tanks; therefore, it should be sprayed out immediately.

Mineral oils for summer emulsion must be of the medium or “light medium” type (formerly termed from “65 to 75 viscosity”) having a sulfonation test of not less than 85.

Fish Oils.—Fish oil as a spreader and sticker has improved control when used in combination with lead arsenate and fluorine compounds to increase the poison deposit and spray coverage. For this purpose the fish oil should be used at the rate of 1 pint per 100 gallons of spray solution.

Fish oils carry the same danger of spray injury as the mineral oils when they follow closer than 30 days to a lime-sulphur spray.

Fish oils, such as the Pacific Coast Herring Oil and Dogfish Oil, which remain liquid at 65 degrees F., and are of a slow-drying quality, having an iodine number between 120 and 125, are to be preferred. The alkaline washes remove the residue from fish oil and lead arsenate combinations more readily than the acid wash.

Lead arsenate containing a deflocculating agent should not be used with fish oil. Fish oil and lead arsenate should be mixed together with a small amount of water to form a thick paste, and added to the tank as it is filled under agitation.

Fluorine Sprays.—Barium fluosilicate failed to give satisfactory protection.

Synthetic cryolite and the natural product (Kalo) in combination with fish oil show considerable promise as a substitute for lead arsenate. A synthetic product has shown more varying results than the Kalo.

Cryolite (sodium fluoaluminate) should be used at the rate of 3 pounds to the 100 gallons plus 1 pint of fish oil or 1 quart summer spray oil.

The fluorine sprays may be used to advantage in the late cover sprays in those cases where difficulty was experienced in removing the residue to below the tolerance for lead and arsenic.

Nicotine Sprays.—The combination of oil and nicotine has not proved effective for codling-moth control in Colorado.
Important Factors in Control

Moth Population.—As stated before, each and every orchard is an individual and separate problem to be solved upon its own requirements. The extent of moth population, the length of the season, and the size of the apple crop determine, to a large extent, the magnitude of the problem at hand.

Spray Schedules.—The calyx spray is a most important one and should be applied before the calyx lobes close.

Spray schedules should be worked out according to moth activity as determined by the use of moth traps. Every grower can well afford to give enough time to record the catch of at least six traps. With such a record the entomologist of the district can assist him in building a spray schedule to meet the particular problem. The traps should be placed in the upper third of the tree to be most efficient, and far enough away from packing houses to insure that the record is of actual field emergence.

The first cover spray should be complete in 10 to 12 days following active emergence. By active is meant the time at which moth flight shows a steady increase from day to day. First moths usually appear at the time of the calyx spray and the average time from the calyx spray to the completion date for the first cover spray averages 22 days with a minimum of 14 days. This period of time is longer for an early season with the minimum period of time occurring during late seasons.

The following cover sprays should be timed so as to maintain a protective coverage during the occurrence of the brood. The rate of growth of the apple, unusual weather conditions such as wind and rain, and the duration of the brood, are important local factors in determining the time and number of cover sprays required to maintain adequate coverage.

The first-brood moths which lay the second-brood eggs, reach active emergence in a shorter period of time than the spring-brood moths. Consequently the first cover spray for the control of second-brood larvae should be completed in 12 days following the first moth emergence.

Cover sprays for second-brood control will maintain a protective coverage for a longer period of time than during the first-brood because of the slower rate of growth of the fruit.

When an ovicide, such as mineral oil, is to be used it should be applied at the time the larger numbers of codling-moth eggs are in the field.
Spray Practice

A formula for successful control consists of a good insecticide plus a thorough application plus proper timing.

There are four aspects of a tree in spray application; namely, the inside, outside, top and bottom. In other words, every portion of the tree must be thoroughly drenched, giving special attention to the top and inside which are the most difficult to reach, and at the same time present the most important points of codling-moth attack.

The type of pruning and size of the tree will determine the amount of spray solution for thorough coverage. This will often average approximately 1 gallon of spray liquid per application per box of harvested fruit. It takes practically as much material to spray a light crop as a full crop. Hit-and-miss spraying for a scattering crop will never give successful control.

Modern spray equipment and the use of higher pressures are conveniences to be used when possible; however, the increase of pressure above 300 pounds is not essential to successful control providing the equipment at hand is used in a judicious manner. If the higher pressures are not available, adopt equipment and spray nozzles with smaller openings so as to meet the capacity of the sprayer. This will necessarily limit the amount of work to be done by some of the older spray machines. The equipment that will not apply the spray in a 3 to 4-day period is inadequate for successful control.

Supplemental Control Measures

Under conditions of high codling-moth infestation, no spray program in itself is fully effective for control. The use of insecticides should be looked upon as only one phase of the control program. The value of supplemental control measures and orchard sanitation have long been emphasized. They are especially important at this time in light of the residue problem and the increasing difficulty in codling-moth control.

The medicated band is a forward step in codling-moth control that assures the maximum of returns for the money and time expended. Trees should be properly prepared by the scraping and removal of all rough bark, which should be burned to destroy the over-wintering larvae. The bands should be in place on the tree, in approximately 30 days following the calyx spray.

Proper pruning will aid control and save spray material.
The thinning of fruit to break clusters and the removal of the wormy fruit, will facilitate control and aid in the sanitation program.

The destruction and removal of all over-wintering larvae, disposal of cull apples, screening of packing houses, cultivation, and any other practices that will destroy the over-wintering or transforming larvae, are important.

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