

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE
AGRICULTURAL EXPERIMENT STATION

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Codling Moth Control

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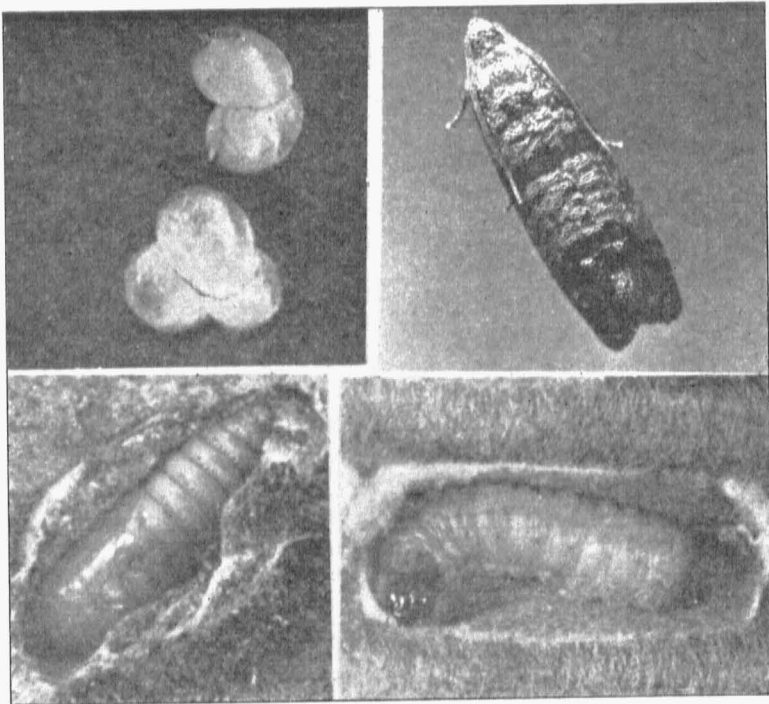


Figure 1—Life stages of the codling moth, showing the egg, larva, pupa, and adult. Eggs enlarged about 10 times, others about 4 times.

COLUMBIA, MISSOURI

Codling Moth Control*

The codling moth is an old pest of Missouri apple orchards. It was brought to the United States from Europe by the early settlers prior to 1750. By the time apple growing was well under way in this state, or as early as 1860, it had already arrived to establish permanent residence. However, for the first half century of apple growing in Missouri, with limited acreage, scattered orchards and good management, our growers were able to keep the pest under control. At the turn of the century the native plum curculio was considered a much more difficult apple pest to control. Not until the middle twenties had the codling moth built up its populations sufficiently to really threaten the state's apple growing industry. For the last fifteen years, however, it has been the outstanding fruit pest of Missouri as well as of most all other apple growing areas of the entire country.

A number of factors have assisted in bringing about the present epidemic of apple worms in most of the older bearing orchards. The shortage of rainfall, beginning in the late twenties, has favored the pest and reduced the effectiveness of spray control. The tendency toward more regular crops in most orchards in recent years has provided the pest with an unending food supply. In many orchards, inadequate spray equipment has reduced control efficiency. The newer larger types of sprayers have sped up coverage without always improving thoroughness of coverage. Prices, the depression, and other economic factors have reduced efficiency in many orchards. The residue problem and the necessity of washing have placed a damper on heavy spraying and effective spray control. The tendency, so common among insect pests, to develop periods of increased vigor and reproductive capacity, usually associated with a scarcity of natural enemies, is another factor responsible for much of the present abundance of codling moths. Some workers call this acquired resistance, but it is merely the natural upsurge of a creature surrounded by conditions which favor it. Be that as it may, this pest, for the last several years, has been more vigorous and more abundant than normal, and every effort by the grower to bring it under complete control has fallen short of desired results in most orchards.

*This report is based largely on the results of the codling moth investigations conducted by the following members of the Department of Entomology of the University of Missouri: Lee Jenkins, Harry E. Brown, Curtis W. Wingo, William Ward Smith, and Leonard Haseman.

This report includes a general summary of the results secured during the last ten years by the members of the entomology staff, who have been working on the codling moth and its control in Missouri. It includes recommendations based on these results and it is hoped that it may prove of some real help to growers in reducing future losses from this pest.

Life History

The codling moth has three broods a year in Missouri. Years ago, under normal conditions, it had only two full broods and a partial third. The winter is passed in the caterpillar stage in cocoons mostly under the loose bark on apple trees or prop poles, in bits of wood, or other objects on the ground, in used boxes and baskets, and in protected spots about the packing shed. A large percentage of these survive ordinary winter cold though experimental temperatures of 10 degrees below zero Fahrenheit will kill most of them.

In the spring, these caterpillars begin to pupate about apple-blooming time and moths usually begin to appear on wing close around May 1 and continue to emerge until early June. These lay their eggs mostly on the leaves near fruit clusters. The eggs hatch in about 10 days, and a certain number of the small caterpillars find and enter the developing apples. Some of them enter through the blossom end and some through the side of the fruit. After tunneling in the fruit for about three weeks and feeding on the pulp and seeds, the caterpillar becomes full-fed, eats its way out and finds a place to spin its cocoon, where it pupates and in about 15 to 20 days emerges as an adult.

These moths may begin emerging the latter part of June and continue to emerge throughout July, laying eggs which produce second brood worms to enter the developing fruits during July and early August. These become full-fed and produce moths, which usually begin emerging by the first of August and continue until the middle of September. In a summer and fall favorable to the pest this is usually the heaviest brood of moths. The eggs which they lay in August produce the destructive third brood of worms which enter the fruit ahead of picking time, and which proved so disastrous to the crop in many orchards in the fall of 1940 and 1941. The so-called pinworms at picking time are the late hatched third brood worms, though in a late fall we may have some fourth brood pinworms entering as winter apples are being picked.

The overwintering worms do not all emerge as moths at the same time in the spring though there is always a period of a few days when a majority of them emerge. This is what we call the peak of moth emergence. In about ten days there follows a period of heavy worm hatch or the peak of first brood hatch. The same thing is true of second and third brood worms. Growers should keep in mind, therefore, that while the broods do overlap, there are definite periods each year when heavy worm entrance occurs and the important so-called peak sprays should be applied just ahead of these periods. The weekly reports of moth emergence which are sent to all growers throughout the summer point out these periods of heavy moth emergence and worm entrance. With this information growers are able to time their spray applications more effectively. These peaks of moth emergence and worm entrance are influenced by the weather so they do not occur on the same dates each year and they may not be the same in all parts of the state. In order to determine these dates accurately for use in the weekly reports, daily breeding cage and bait trap records are taken each summer in all the principal orchard areas of the state.

Moth.—The codling moth is less than one-half inch long as it rests with its silvery-gray and brown-tipped wings folded over its back. (See Figure 1). It is not easy to find in the orchard, but can be reared in a fruit jar for study. The female moth lays, on the average, about one hundred eggs, mostly within the first week after emerging. Eggs are laid at night and during the day the moths rest among the leaves or in other shaded or dark places. They are somewhat attracted to bright lights and flock to bait traps at night containing a ferment, such as cider, brown sugar solution, or a malt solution. By recording the catch each night in the bait traps we are able to follow moth activity throughout the summer in any particular orchard or region. With this information the grower can better time his spray applications.

Egg.—The eggs of the codling moth are too small to be readily seen, though after hatching the small, circular, white egg shells are more easily seen. The eggs require about 10 days to hatch in the early part of the summer, but later they may hatch in 5 to 7 days. In hatching, the tiny worm uses its hard mandibles for cutting a circular hole through the shell large enough for it to crawl through.

Caterpillar.—Every grower is familiar with the pinkish-white apple worm found in the fruit or in cocoons under the bark on the

trunks of apple trees. The small worm, on hatching, starts out in search of food and a place to hide from the light, wind, and rain. After finding a satisfactory spot to enter the fruit the small worm first spins a tiny carpet of silk on which it rests while using its jaws to cut out bits of peel and pulp as it tunnels into the fruit. On the average, it takes about an hour for the worm to burrow beneath the surface of the fruit. The small worm's first aim in life is to burrow into the apple and get away from the elements and enemies. Many of the worms do not swallow any of the minute bits of peel and pulp which they cut out with their jaws until after they have completely buried themselves beneath the surface of the fruit. Even then the worm may continue to push out its cuttings at the

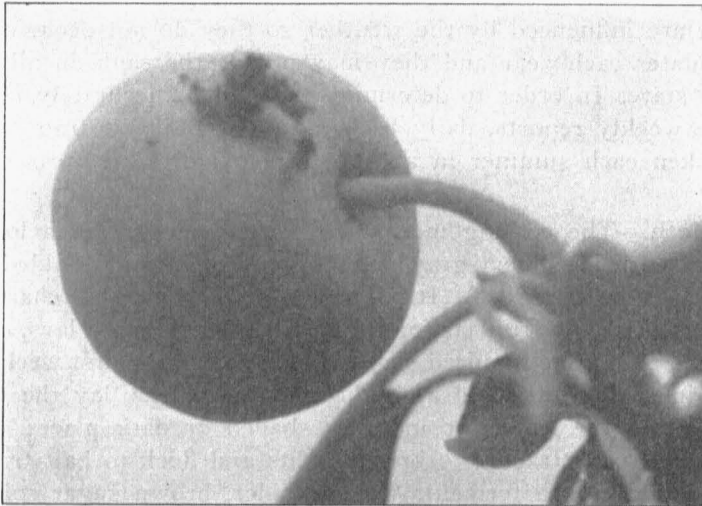


Figure 2—Apple showing typical injury, with frass protruding from worm entrance.

mouth of the tunnel. (See Figure 2) Because of this habit of discarding the cuttings which contain the poison spray, a certain per cent of young worms succeed in entering sprayed fruit even when they tunnel directly through a spot heavily covered with poison deposit. In fact, many of the worms which cause so-called stings and then die in the bottom of the shallow tunnels actually carry the poison into the tunnel on their feet, where they later eat some of it with the pulp. In some laboratory experiments, we have found as many as four out of ten young worms safely entering the sides of apples which were perfectly coated with lead arsen-

ate. Those worms especially of the first brood, which enter at the calyx end, are more apt to be poisoned where a calyx spray of lead arsenate has been applied since they begin to feed on the base of the stamens and the pistil almost as soon as they have become well concealed in the calyx end of the small apple. With many of the worms of each brood safely entering well-sprayed fruits, it is not difficult to understand why there is much wormy fruit in an orchard which is very heavily infested, no matter how well the grower sprays or how many applications he may make. One simply cannot hope to kill every worm that attempts to enter. However, by good spraying and with the help of supplementary controls, he can keep the total moth populations in the orchard sufficiently low that only a small part of his apple crop will be lost to worms.

Pupa.—The pupa or resting stage of the pest is a brown or black, oval-shaped object to which the caterpillar changes within the protecting cocoon. It is less than one-half inch long and as thick as a wheat straw. In the summertime it remains in this stage for about 12 days, but in cooler weather it may remain longer as a pupa before emerging as the moth.

Worm Prevention

There are a number of things which the grower can and should do in the orchard to help prevent the codling moth from becoming unduly abundant and destructive. Anything that will slow down codling moth increase and help to make spray control more effective should be done.

Planting the Young Orchard.—Looking to the future, it is well to keep in mind that the earlier summer varieties of apples are exposed to only the first brood of worms. Some of the mid-season varieties are exposed to the first and part of the second brood of worms. By planting these earlier varieties in blocks well separated from fall and winter varieties, of course providing for proper pollination, the grower can prevent summer moths, which mature on the early varieties, from flying to the late varieties and, in turn, he can prevent the moths emerging from overwintering worms on late varieties from flying back to reinfest the early varieties. The female codling moth normally will not lay eggs on trees which do not have apples, or on trees from which the apples have already been picked. Growers planting young orchards should keep this in mind, for it will help them later when the young orchard comes into full bearing.

It is well for growers also to keep in mind that in a young orchard the codling moth does not become a real problem until after the orchard is in bearing for a number of years. The young orchard should, therefore, be planted far enough from old infested orchards to prevent the young orchard becoming infested as soon as it comes into bearing. Also, replacing missing trees in an old orchard is not always a good plan. All such young trees are sure to be overrun with apple worms the first year they begin to bear.

Pruning.—All growers know the importance of proper pruning from the point of view of getting sunshine down into the tree. They also know that the tree properly opened up is easier to spray thoroughly. By keeping his orchard properly pruned the grower can reduce his spray cost and, at the same time, greatly improve his spray control of the codling moth and other fruit insects and diseases.

Packing Shed.—For the first few years after an orchard comes into bearing and the grower begins packing fruit in a shed in the orchard, he may see no real build-up of worms around the packing shed. After a few years, however, he may begin to find more worms developing near the packing shed. Literally thousands of overwintering worms spin up in used containers and in cracks about the shed and most of these escape the elements and natural enemies and emerge as moths in the spring to fly back into the orchard. In a commercial orchard a minimum of one codling moth may be expected to escape back into the orchard for every bushel of apples packed in the shed. In many cases, there may be five or ten for each bushel. These moths escaping from the packing shed will in a few years, step up worm populations to a distance of 25 to 35 tree rows from the shed. This menace to the orchard can be prevented by eliminating the packing shed from the orchard and by storing all used containers, such as hampers, baskets, and barrels somewhere at least one-fourth to one-half mile from the orchard. Also, all used prop poles should be removed from the orchard in the fall and kept away until they are needed again the following summer. These simple precautions will help immensely in preventing the pest from building up.

Orchard Sanitation.—Sanitation and good orchard management will help immensely in preventing the codling moth from becoming a serious problem in orchards which have recently come

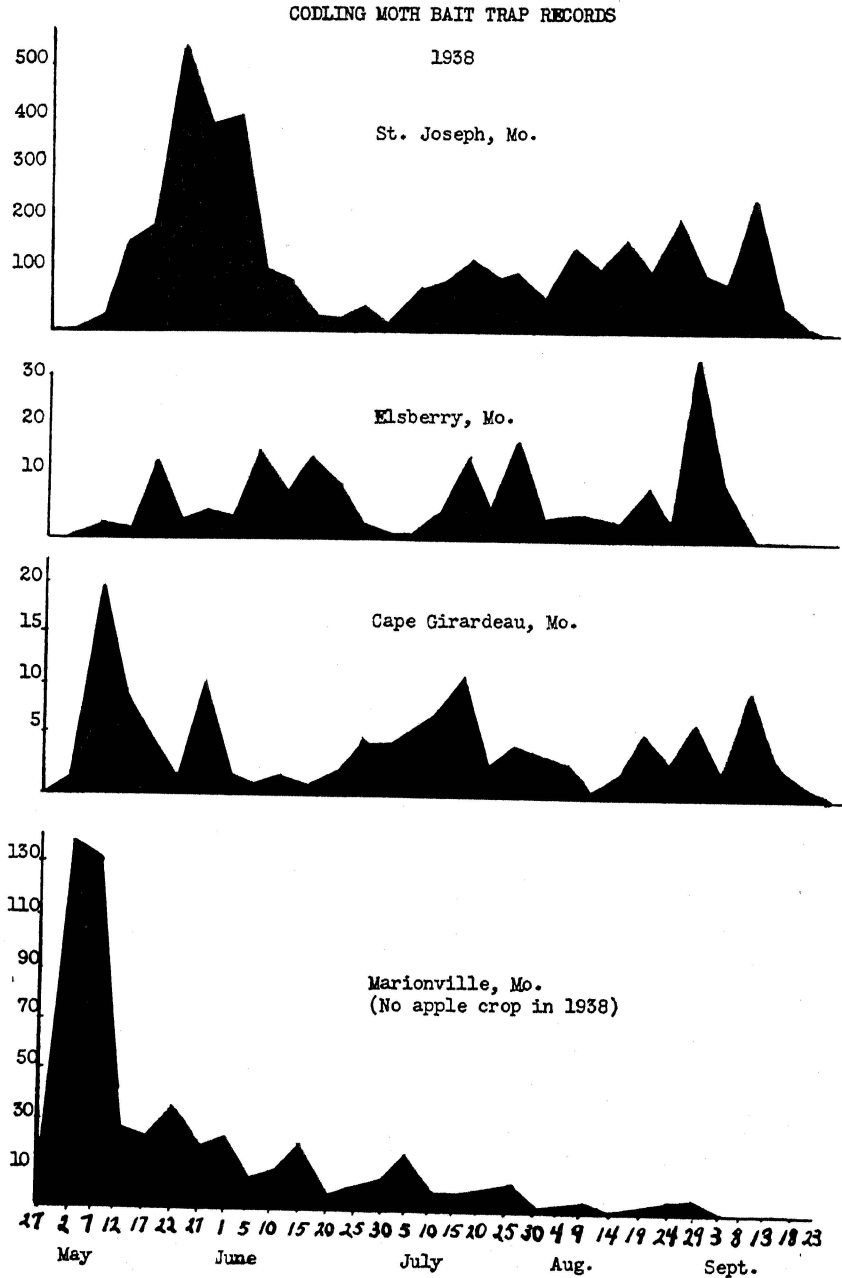


Figure 3—Graph showing daily catch of codling moths in bait traps in 1938, at St. Joseph, Elsberry, Cape Girardeau, and Marionville. Note reduction of codling moth abundance at Marionville, due to loss of crop by late freeze.

into bearing and it will go far to help cut down on undue increase of moths in older orchards where they have already become serious. Disposing of all prunings, pieces of broken baskets, paper, cobs, and other objects in which the worms can spin up will help to keep down moth populations. Also, the elimination of wormy drops and piles of culls will prevent many worms from maturing as moths. If the packing shed is in the orchard similar steps taken to keep it free of worthless wormy fruits and cocooning places will further cut down on next year's moths and worms.

Worm Control

The grower is confronted with the problem of protecting the fruit from worms by whatever means may prove effective and economical. First of all, he thinks of spray control, but it is only one of several means of killing worms and keeping the fruit clean. The control problem is never exactly the same in any two different orchards. What may give clean fruit in one orchard may not work satisfactorily in a second. Every grower, therefore, must give more thought to his particular orchard and worm problem and use different control plans in different parts of the orchard and on different varieties. While spraying is the most effective single control practice it certainly is not enough once the orchard has become very heavily infested. Supplementary control measures in such cases must also be used.

Effect of Heavy Carryover.—If it were not for the heavy carryover of worms under the bark, in litter on the ground, and in packing sheds in the orchard, it would not be difficult to protect the crop from worms. When an orchard shows 50 to 75 per cent of the fruit stung and wormy it is due either to a very heavy initial carryover or to faulty control during the spring and summer, or both. With three broods a year and each female normally laying 100 eggs, an average carryover of only one pair per tree would provide sufficient worms to do serious damage to the crop, if the control program proved ineffective, even assuming that weather and other natural forces eliminated half of the progeny. One pair to the tree, under these conditions, would provide thousands of worms per tree, which the grower's control program would be called on to destroy. In place of one pair per tree, frequently an orchard will have an average carryover of several hundred worms per tree. Under such conditions, only a most perfect control program can possibly give 80 or 90 per cent of clean apples. These heavy carryovers must be eliminated by orchard sanitation, scraping and banding, by encouraging

hairy and downy woodpeckers to harbor about the orchard, and by any other practical methods of destroying overwintering worms.

How Sprays Kill.—A large number of different kinds of chemicals have been tested by this Station. These have included mostly those which serve as stomach poisons when eaten by the caterpillar as it attempts to enter the fruit. The big drawback with these has been the difficulty of getting the worms to swallow the poison. Efforts have been made, with apparently some success, to mask the flavor of the poison or to pamper the worms' appetite with sweetenings. Besides poisons such as lead arsenate, calcium arsenate, paris green, fluorines, and fixed nictines, contact insecticides have been used. These included nicotine sulphate, pyrethrum, derris preparations, phenothiazine, summer oil, and certain synthetics, which may kill young worms and destroy some of the eggs.

Spray Control.—While spraying is the most important single control practice, no chemical or combination of chemicals has been found to give perfect protection to the fruit where worm populations are unusually high. In such cases, supplementary practices must be used along with a stepped-up spray schedule. Much of the grower's success with sprays may depend upon his equipment, his method of application, and the proper dosage and timing of the sprays. Since there are some worms hatching continuously throughout the summer and early fall, the grower must be sure to maintain good spray coverage on fruit and foliage, but there are certain periods in the summer when an extra heavy hatch of worms occurs and when added spray coverage must be given. Some prefer to apply the post-calyx cover sprays at 10-day intervals, which is satisfactory, though the better plan is to time the sprays to match the maximum hatch of worms, as determined by the bait trap catches reported to the growers on weekly cards by this Station.

The size of the spray outfit, the pressure it will maintain, and the gallons per minute output which it will deliver, do not determine the effectiveness of the spray program. Likewise, the number of gallons used or the concentration of the spray solution will never take the place of thoroughness of application. The grower must see to it that he has on plenty of spray deposits when the worms are entering the fruit since, at best, spray coverage will not reach and kill all worms.

After ten years of careful application of a great variety of different poisons and contact sprays for controlling apple worms, and after considering cost, availability and final results, no satisfactory

basic codling moth insecticide has been found to replace lead arsenate. Its effectiveness is stepped up by adding deposit builders or stickers, such as summer oil, and in case of severe infestations increased concentration and number of applications have greatly increased worm control. Under unfavorable weather conditions, or when used with sulfur fungicides, "safeners" should be used to keep down spray burn.

Where the grower is not prepared to remove spray residue he can use a combination of lead arsenate early, followed with sprays of fixed nicotine after the second or third cover spray of lead arsenate. Where worms are not too serious and where the grower uses supplementary controls he may secure satisfactory results with lead arsenate in the calyx and the first two cover sprays, followed with four or more cover sprays of fixed nicotine. The initial worm carryover and the nature of the weather as it influences worm increase will naturally determine the necessary number of late cover sprays and the final results as regards worm control.

Under prevailing conditions, no grower can hope to produce 100 per cent wormfree fruit. In fact, if it were humanly possible to step up control practices to that point it would not pay to do it. While each grower should try to produce as much clean fruit as possible, there is a limit to the number and the concentration of the sprays that can be safely and economically applied. Where worm populations are too high to be properly controlled with a reasonable spray program, the grower will usually find it better to increase his results by using supplementary controls rather than to depend entirely on an increased spray schedule.

Supplementary Controls.—In orchards where worm populations are high, growers should not attempt to keep them under control by spraying alone. In fact, growers should make greater use of practical supplementary measures even when worms are not so serious. In recent years, many growers have developed what might be called a spray complex and they are apt to neglect those little things about orcharding which, after all, mean so much in keeping the trees healthy and the crop of apples clean.

To supplement spraying for worm control, there are four important measures which any grower may use. Most valuable of these in actual worm destruction is scraping and banding, where the orchard is in full bearing. Second in importance is the moth-proofing of the packing shed, if it cannot be removed from the orchard. Third most helpful is the storing of prop poles and used apple containers somewhere remote from the orchard, or in case

the packing shed is moth-proof the containers may safely be stored there until they are needed later in the summer. A fourth important supplementary control includes the prompt destruction of worthless wormy culls and drops and the picking and destroying of wormy apples as they appear. Orchard sanitation, previously discussed as a method of helping to prevent a worm problem, should also be kept in mind in this connection.

Scraping and Banding.—In spite of the time required, scraping the rough bark from the trunk, crotches, and main limbs up as high as one can reach, followed by banding the trees about the first of June each year with a 2-inch corrugated paper band treated with oil and beta naphthol, will pay in any mature Missouri orchard where the grower has any real worm problem on his hands. Scraping and banding will dispose of about 90 per cent of those worms which escape the sprays and spin up on the trees. The scraping may be done at any spare time in the year, though most of it is done in the winter and it should be completed before the moths begin to emerge around the first of May. In scraping trees it is not necessary or desirable to remove everything down to the exposed live bark. Simply remove the loose, scaly bark and be careful with



Figure 4—Apple tree properly scraped for banding with scrapings collected on canvas.

crotches, cracks, and unhealed pruning scars. It requires more time, but it will generally pay to collect the scrapings on a canvas and burn them with the adhering worms. (See Figure 4) It is not necessary to spend thirty minutes to a tree, as some do. An active person can satisfactorily scrape 50 to 75 trees in a day. However, the grower should plan to lightly touch up the trees each winter.

Any blacksmith can prepare a handy steel scraper, made somewhat on the plan of a regular meat block scraper. A beehive scraper works very well, though it is a little narrow for speedy work. Always be careful not to injure the trees by too deep scraping, and scrape down to the ground line.

A 2-inch band placed around the trunk a foot from the ground is just as effective as a wider band. Some prefer to also apply bands higher up around each main limb, but if the trees are well scraped additional banding on the main limbs is less helpful. As a caution, remember that young, smooth-barked trees and limbs on older trees may be injured by the chemical in the band, and growers should not use the chemically-treated bands on young trees. If young trees are to be banded, use strips of heavy paper or burlap and during the summer remove them every ten days and kill the worms under them.

The chemically-treated bands found effective are prepared by soaking rolls of corrugated paper in a solution of engine oil and beta naphthol. Growers can prepare these at home, but most of them will find it preferable to purchase treated bands from a responsible firm experienced in preparing them. These bands will cost from three to five cents a tree for the band. No grower can afford to neglect to scrape and band his orchard if from 25 to 40 per cent of his crop is being injured by worms.

Moth-proof Packing Shed.—If the shed cannot be moved away from the orchard or the apples packed somewhere else, then it should be made moth-proof. Weather-stripping or heavy roofing paper may be used to close up cracks and openings in a frame building. Some packing sheds are well built and may require only packing about doors and windows. Naturally, an open shed is not easy to moth-proof. After making the shed moth-tight, arrange a trap light over a pan of water with a film of kerosene, into which the moths fall. Keep the trap running from May 1 until no more moths appear on wing in the packing shed. Keep doors and windows closed and do not open up the building until it is needed later in the summer. When the grower realizes that about one-half of

his overwintering worms are safely hiding in his packing shed and in his used equipment, he will understand why these worm harbors are a real menace to his apple crop.

Remove Used Containers and Prop Poles from Orchards.—If the packing shed is made moth-proof the used equipment may be stored in the shed, for as the moths emerge from it they will be trapped and killed inside the shed. On the other hand, if the shed is open, take the used equipment out of the orchard as soon as the crop has been picked and sold and store it until needed the following summer. In orchards where prop poles are used the poles will contain hundreds of overwintering worms, which, if left in the orchard, will give off swarms of moths at emerging time the following summer. These should be taken at least one-half mile from the orchard and stored until needed. Moving out infested containers and poles means work, but it also means the elimination from the orchard of many worms and moths.

Eliminate Wormy Fruits, Drops and Culls.—To systematically dispose of wormy fruits requires labor at a time when the grower and his help may be busy with other work, but a few men in a day or two can in this way remove from the orchards thousands of first and second brood worms, which means the saving of bushels of apples which would otherwise be destroyed later in the season by the progeny of these earlier worms. Some growers figure that a few days devoted to the picking of wormy apples early in the season is equal to one or two later sprays. The practice of leaving wormy drops and piles of worthless culls scattered about the orchard simply means more wormy drops and culls later in the summer and in following years. After the regular June drop and prior to the drop at ripening time, a large per cent of drops come down due to worm infestation and the systematic destruction of these worm-infested fruits should be a regular part of orchard management. All worthless culls and drops should be fed to hogs or dumped somewhere far from the orchard. As war necessities tighten up more on spray machinery and insecticides growers will find that in order to hold the worms in check more attention will have to be paid to orchard management and the use of those control practices which can be used effectively to supplement spray control.

Recommendations

After ten years of continuous study of the codling moth under varying seasonal conditions and in all parts of the state, some rather definite conclusions have been developed as to what steps growers

should take to control the pest and secure the greatest returns from the orchard. While each orchard has its own specific codling moth problem, all orchards may be grouped as (1) those in which worms are abundant and spray control alone is inadequate, and (2) those young orchards having recently come into bearing and older ones in which worm populations are still low and where a reasonably severe spray program will satisfactorily protect the crop. The recommendations which follow are based on these two types of orchards. Growers can either step down the heavy control program, or step up the light one to take care of their particular worm situation.

Severely Infested Mature Orchards.—In a mature bearing orchard where, in recent years, worms have stung or entered half of the crop, the following suggested control program, which if carefully followed out, should give a high per cent of clean, marketable fruit next year and still better results in succeeding years.

(1) Before May 1, scrape and collect on canvas and burn all loose, scaly bark from the trunks and as high as one can reach on the main limbs of every tree in the orchard, and then apply 2-inch treated corrugated paper bands June 1.

(2) This winter, moth-proof the packing shed and store all used containers in it, or move it from the orchard together with all used containers.

(3) Collect and burn all brush, ground litter, and other materials in which worms may be passing the winter, and stack prop poles at least one-half mile from the orchard before spring.

(4) Check up on sprayers and spray materials to be sure that they will be adequate for your needs. Allow preferably not more than five days of uninterrupted spraying to cover the orchard with any one application.

(5) Decide now on standard lead arsenate as your basic codling moth insecticide, with summer oil to be added to the peak applications, and, if not prepared to wash, the use of a type of fixed nicotine to replace lead arsenate in all summer cover sprays after the first brood peak spray.

(6) Apply the *regular pre-bloom* lime sulfur fungicide spray or sprays without the addition of lead arsenate, unless you have a leaf roller or cankerworm problem, in which case add 4 pounds of lead arsenate and lime to 100 gallons.

(7) In *calyx spray*, use 3 pounds lead arsenate to 100 gallons, with fungicide and lime.

(8) In *first cover spray*, use same dosage of lead arsenate as in

calyx spray with fungicide if scab is still serious, and apply about 10 days after calyx spray, if local moth emergence is normal.

(9) In *second cover spray*, which if moth emergence is normal will be an early first brood peak spray, use 3 pounds lead arsenate and $\frac{1}{2}$ gallon summer oil emulsion to 100 gallons with "safener,"* and apply about 7 to 10 days after first cover. Oil should not be used with sulfur and should not follow a sulfur spray sooner than 10 days.

(10) In *third cover spray* use same materials and dosage as in second cover and apply 10 days later as a second first brood peak spray, according to moth activity.

(11) In *fourth cover*, which is normally the last first brood spray applied 10 to 14 days later, use 3 pounds lead arsenate and "safener" to 100 gallons, if prepared to wash. If not prepared to wash, begin here with fixed nicotine and summer oil, using fixed nicotine as recommended by the manufacturer and $\frac{1}{2}$ gallon summer oil to 100 gallons.

(12) For control of second and third brood worms, if prepared to wash continue with the lead arsenate program, apply two second brood cover sprays of 3 pounds lead arsenate and "safener" to 100 gallons and for third brood worms apply one or, if late worms are serious, two additional sprays, using 2 pounds lead arsenate with "safener" to 100 gallons, timing all sprays by local moth emergence. If not prepared to wash, proceed with the fixed nicotine spray schedule, using preferably three second brood cover sprays and two third brood sprays timed by moth emergence. Fixed nicotine should not be used with a fungicide containing lime, as the lime will release the nicotine.

Lightly Infested Orchards.—In orchards, young or old, where growers have been controlling worms satisfactorily they may continue with their present program or use a modification of the following to meet their needs.

(1) For mature bearing orchards, scrape and band as recommended for heavily infested orchards. For young orchards just beginning to bear, scraping and banding is not needed.

(2) In all cases, follow out previous recommendations regarding packing shed, orchard clean-up, and check up on sprayers and spray materials.

(3) Follow previous recommendations on *pre-bloom* sprays.

*The Horticulture Department of this Station has found that a 1-1½-100 zinc bordeaux, or ½-1-100 copper bordeaux is a satisfactory "safener" to prevent arsenical injury.

(4) In *calyx spray*, use 2 pounds lead arsenate with fungicide and lime.

(5) For *first brood worms*, use three cover sprays timed by moth emergence, at about 14 day intervals the second one being the peak spray in which summer oil emulsion may be added. The dosage of lead arsenate to be 2 pounds to 100 gallons with a "safener" and a fungicide if needed in the first cover and in the second and third cover sprays use 2 or 3 pounds of lead arsenate with "safener."

(6) For second and third brood worms, where the grower is prepared to wash, proceed with the lead arsenate program, dropping to 2 pounds lead arsenate with "safener" if worms are not serious, and continuing with 3 pounds to 100 if worms continue serious. Apply two well-timed second brood sprays following moth emergence records and one third brood spray. If not prepared to wash, shift to the fixed nicotine schedule beginning with the last first brood cover spray as recommended for heavily infested orchard, using three applications for second and third brood worms timed by moth emergence.

Summary

The worm situation in most Missouri orchards continues serious. Where this is true, the grower should make every effort within reason to step up the use of sanitation and other supplementary controls and increase his spray schedule so as to lower worm populations and increase clean fruit. However, do not expect to get 100 per cent clean fruit under prevailing conditions. Growers find it more profitable to produce a high percentage of clean fruit with some culls than to attempt to produce all clean fruit. Where worms are not yet serious, by all means make every effort to prevent them from becoming worse. A little extra effort with supplementary controls and a reasonably heavy spray schedule to prevent worm build-up now will pay future dividends. Each grower must decide finally on the particular control program that best meets his needs.