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THE CONTROL OF THE TOMATO FRUITWORM, <sup>1</sup>/THE TOMATO PINWORM, THE TOMATO  
RUSSET MITE, AND HORNWORMS

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Introduction

Tomato plants and fruits are attacked commonly by several species of insects, and important among these are the tomato fruitworm, the tomato pinworm, hornworms, and a new pest of tomatoes in California known as the tomato russet mite. It is the purpose of this circular to set forth methods of controlling these pests which have developed during recent years.

The tomato fruitworm (Heliothis armigera (Hbn.)), also known as the corn earworm on corn and as the bollworm on cotton, is a pest of tomatoes, regularly or occasionally, in practically all sections of the United States where tomatoes are grown. Its principal damage to tomatoes is through the insects feeding on and in the tomato fruits, rendering them unmarketable.

The tomato pinworm (Keiferia lycopersicella (Busck)) is a pest of tomatoes in southern California. It is known to occur in Arizona, New Mexico, Missouri, Florida, Mississippi, Virginia, Delaware, and Pennsylvania. In addition to tomatoes, this insect also occasionally attacks potato and eggplant. In California, Arizona, New Mexico, and Florida the tomato pinworm has been primarily a pest of field-grown tomatoes, whereas thus far in Mississippi, Virginia, Delaware, Pennsylvania, and Missouri it has been present only as a pest of tomatoes grown in greenhouses and in tomato fields near the infested greenhouses.

The tomato russet mite (Phyllocoptes destructor Keifer) was first found in Modesto, Calif., in 1940. By 1941 it had spread over most of the San Joaquin and Sacramento valleys and in 1942 it was widespread in southern California. Besides tomato, other host plants recorded by the University of California are petunia, nightshade, Datura, potato, and morning-glory. This mite is minute in size, and its presence on the plant can be detected only by a microscopic examination. However, the injury caused by its feeding is readily recognizable. The plants are first attacked at the base and the leaves develop a bronze appearance before they die. During warm weather the mites increase very rapidly and can kill a vine or a whole field in a few weeks if control measures are not applied promptly.

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<sup>1</sup>/ This supersedes Circular E-489, Suggestions for the Control of the Tomato Fruitworm, which was issued in September 1939.

There are two species of hornworms that attack tomatoes--the tomato hornworm (Protoparce quinquemaculata (Haw.)) and the tobacco hornworm (P. sexta (Johan.)), which are widely distributed over this country. In certain sections they are, unless controlled, very destructive. They feed on the foliage of the plant, first attacking the leaves, oftentimes stripping the plants to the point where only the main stalk or stems remain.

#### Control

The problem of controlling these several pests when they occur in the same field is somewhat involved, as a remedy for one may not be suitable for the other. In California the tomato fields may be infested at some period during the same season with the tomato fruitworm, the tomato pinworm, hornworms, the tomato russet mite, cutworms, and the beet armyworm.

In consideration of these factors, the determination of the proper remedy or remedies will depend on the kind of insects present in the field. The discussion on the control of these several pests and their joint control follows.

#### Tomato Fruitworm Control

Cryolite and calcium arsenate dusts and a bait prepared by mixing corn meal with cryolite are all about equal in effectiveness for the control of the fruitworm. The choice between these materials is discussed in more detail in the following paragraphs.

Cryolite.--Extensive experiments have demonstrated that this insecticide is one of the best and safest materials to use on tomatoes for the control of the fruitworm, and is superior in the control of the pinworm. The active ingredient in cryolite is sodium fluoaluminate. Tests with the several brands and with different strengths of cryolite have not shown any great degree of difference in control when they were used at the same sodium fluoaluminate content and at the same rate per acre. For example, the same control can be expected from the use of a total of 180 pounds per acre of cryolite dust containing 35 percent of sodium fluoaluminate as can be expected from the use of a total of 90 pounds per acre of a cryolite dust containing 70 percent of sodium fluoaluminate. As it is cheaper to mix and apply 90 pounds of a dust containing 70 percent of sodium fluoaluminate per acre than it is to apply 180 pounds of the weaker dust, a 70-percent cryolite dust is recommended for general use.

Calcium arsenate.--Extensive experiments have demonstrated that calcium arsenate (undiluted) is as effective as a cryolite dust containing 70 percent of sodium fluoaluminate when both materials are used at the same rate per acre. Calcium arsenate also has the added advantage of being cheaper than cryolite and in being more effective than cryolite in the control of hornworms and the beet armyworm. Calcium arsenate has the disadvantage when compared with cryolite of not being so effective in the control of the pinworm, and in humid climates it may seriously burn the foliage and fruit. Calcium arsenate is preferred for use in localities where there is no chance of a pinworm infestation and in localities where it can be used without burning the plants and fruit.



Corn meal bait.--This bait is prepared by mixing 9 pounds of corn meal (as finely ground as for poultry feed) with 1 pound of cryolite containing 90 percent of sodium fluoaluminate. A total of 180 pounds per acre of this mixture has proved to be about as effective in the control of the fruitworm as a total of 90 pounds per acre of a cryolite dust containing 70 percent of sodium fluoaluminate, or as undiluted calcium arsenate. This corn meal bait mixture is cheaper than either of the dusts and is scattered over the leaves of the plants by hand, no special equipment being necessary, but it has the disadvantage when compared with the dusts of being ineffective against the pinworm, hornworm, beet armyworm, and russet mite.

When to treat.--The first application of either dust or bait for fruitworm control should be made as soon as the fruits of the main crop begin to set. At this time, depending on weather and other growing conditions, the plants may vary from 1 to 3 feet in diameter but there will be an average of about 7 tomatoes per vine, 5 of which should be 1/2 inch in diameter or less. The timing of the first application is very important, as under southern California conditions it has been demonstrated that a delay of 1 week in making the first application results in a marked increase in the number of fruits damaged by the fruitworm.

Number of applications.--Three applications of either the bait or the dusts are made at 2-week intervals.

Poundage of material per acre.--Experiments in southern California have shown that 90 pounds of the cryolite dust mixture containing 70 percent of sodium fluoaluminate, or of the undiluted calcium arsenate, is the most profitable quantity to use in this area. An application of a total of 150 pounds per acre for three applications proved superior to the 90-pound rate, but under the conditions of this experiment the added degree of control did not justify the expense of the additional material. Under war conditions the 150-pound rate is justified in many fields.

The experiments indicate that a cryolite dust mixture containing 70 percent of sodium fluoaluminate is preferable to one of lower strength. The three applications at 2-week intervals of 70-percent cryolite or undiluted calcium arsenate are made at 20, 30, and 40 pounds per acre, respectively, for a total of 90 pounds per acre, and at 25, 50, and 75 pounds per acre, respectively, for a total of 150 pounds per acre. If the cryolite is diluted to contain less than 70 percent of sodium fluoaluminate, the quantity of insecticide applied per acre should be increased accordingly. For example, when a cryolite dust mixture containing 50 percent of sodium fluoaluminate is used, it should be applied at a total rate of 125 pounds per acre to be equivalent to 90 pounds of a 70-percent cryolite. Likewise, if calcium arsenate is diluted with 25 percent of sulfur for tomato russet mite control, it will be necessary to use a total of 120 pounds per acre to get the equivalent of 90 pounds of undiluted calcium arsenate.

Three applications of corn meal bait should be made at 2-week intervals, using 40, 60, and 80 pounds per acre, respectively, making a total of 180 pounds for the season.

### Tomato Pinworm Control

Control of the tomato pinworm may be obtained by using a cryolite dust mixture containing 70 percent of sodium fluoaluminate, with talc as a diluent.

When to treat.--In the regular treatment schedule, the first application of cryolite dust mixture should be made when the first fruits on the tomato plant are approximately 1 inch in diameter. Under unusual conditions or in areas where the pinworm has been causing heavy losses, a careful watch should be made of the plant bed and of the newly set transplants, and if a noticeable infestation occurs, an application of cryolite should be made at once.

Number of applications.--Whether the plant bed or transplants have been treated or not, the regular treatment schedule, beginning as indicated, should consist of four applications at 10-day intervals. It is important, however, that the fourth application be made about the time of the first picking of tomato fruits for the cannery, or after the first picking for market, and therefore it may be necessary to allow 2 or 3 weeks between the third and fourth applications, depending upon weather conditions.

Poundage of material per acre.--On the basis of 1,000 tomato plants per acre, which is the prevailing planting rate in southern California, the most economical results have been obtained by using a range of from 20 to 25 pounds of the cryolite dust mixture per acre for each application, depending on the size of the plants, or a total of approximately 90 pounds for the four applications. In any event it is important that the plants be covered thoroughly by the insecticide at each application.

Although satisfactory control of the pinworm has been obtained by using a cryolite dust mixture containing 50 percent of sodium fluoaluminate, experiments indicate that better results can be obtained with the higher strength unless the quantity of the insecticide applied at the 50-percent strength is increased so that the same number of pounds of the active ingredient, sodium fluoaluminate, is applied per acre. If the 50-percent strength is used, it is suggested that the rate of application range from 25 to 35 pounds per acre per application, or a total of 125 pounds for the four applications.

### Tomato Russet Mite Control

Sulfur is used for the control of this mite. On canning tomatoes, not more than 25 percent of sulfur should be used when there is fruit on the vines, as excess amounts of sulfur might damage the canned product. Undiluted sulfur can be used on small plants before the fruit has set and on larger vines if the fruit is not to be canned.

When to treat.--When there is danger of early infestations (i.e., in later fields and in fields set out with plants grown in or near old vines or fields), applications of undiluted sulfur should be made at or about the third and sixth weeks after transplanting. During the fruiting period of the plants, applications of 25-percent sulfur dust are made at the same time that the fruitworm or pinworm applications are made. If the fruit is not to be used for canning and insecticides are not necessary for fruitworm or pinworm control, undiluted sulfur can be used for the later applications after the fruit sets.



Poundage of material per acre.--From 5 to 10 pounds of undiluted sulfur per acre per application should be used when the plants are small. From 20 to 50 pounds of 25-percent sulfur dust should be used per acre per application during the fruiting period of the plants when the regular fruitworm or pinworm applications are being made.

Number of applications.--In fields that are transplanted before June, 3 or 4 applications of 25-percent sulfur dust made at the time of the fruitworm or pinworm applications should be sufficient. In fields transplanted in June or later, it is desirable to make 2 additional applications of undiluted sulfur to the small plants at about the third and sixth weeks after transplanting.

Ordinarily it is not necessary to make special or extra applications of sulfur for mite control, as 25 percent of sulfur can be incorporated in the regular dust applications for fruitworm or pinworm control. Previous to these regular dust applications, cutworms, pinworms, flea beetles, or armyworms frequently attack the small plants. In case of such attacks, 25 or 50 percent of sulfur can be incorporated in either calcium arsenate or cryolite used for their control.

Joint Control of the Tomato Fruitworm, the Tomato Pinworm,  
and the Tomato Russet Mite

In the event that both the tomato fruitworm and the tomato pinworm are present in injurious numbers in the same field, which is likely to be the case in many fields, a cryolite dust mixture containing 70 percent of sodium fluoaluminum should be used to control these two species of insects. If the tomato russet mite is also present, sulfur should be used as the diluent for cryolite in these applications. Four dustings of this mixture should be applied. The first three applications should be made at 2-week intervals, beginning as soon as the fruits of the main crop begin to set, 20, 30, and 40 pounds being used per acre per application. The fourth application should be made shortly after the first picking of the fruits for canning, or ordinarily about a week or 10 days after the third application. Twenty-five pounds per acre of the cryolite dust mixture containing 70 percent of sodium fluoaluminum should be applied for this fourth application. The plants should be covered thoroughly by the insecticide at each application.

If the pinworm is not a problem and calcium arsenate can be used in your locality without danger of burning the plants, then a dust containing 75 percent of calcium arsenate and 25 percent of sulfur can be used. To obtain control of the fruitworm equivalent to the control obtainable with a cryolite dust containing 70 percent of sodium fluoaluminum, 30, 40, and 50 pounds per acre of the calcium arsenate mixture should be used for the three applications, respectively.

A bait prepared by mixing 9 pounds of corn meal with 1 pound of cryolite containing 90 percent of sodium fluoaluminum is effective in the control of the fruitworm and cutworms. This material is somewhat cheaper than dusting and would be the preferred treatment in localities where the fruitworm is the main pest to be controlled, and in localities where the margin of profit is small and the cost of treatment is a major consideration. (For rate of

application see page 3). This material is not effective against the pinworm, russet mite, hornworms, or the beet armyworm, and should not be used in localities where these pests usually cause damage.

Hornworms.--The regular applications of cryolite or calcium arsenate for fruitworm and pinworm control ordinarily give satisfactory control of these insects. In cases of severe infestation it may be necessary to make one or more supplementary applications of undiluted calcium arsenate for the control of these pests. Calcium arsenate has proved superior to cryolite for the control of these insects, and, if a regular cryolite schedule is being followed for pinworm control, calcium arsenate should be applied in the interval between the regular applications. If the pinworm is not a serious menace, then calcium arsenate can be used for one or more of the regular fruitworm applications.

#### Other Insects

Cutworms and the beet armyworm may also be present in the same field with the tomato fruitworm, pinworm, hornworms, and russet mite. Ordinarily the regular applications for the control of either the fruitworm or the pinworm will adequately control these insects, but in epidemic years, or in unusual infestations, special treatments may be necessary as outlined below.

Beet armyworm.--This insect usually attacks only tomatoes which mature in the fall, and in ordinary years the regular "worm" applications give satisfactory control of the beet armyworm. In epidemic years of this insect, it may be necessary to make extra applications of undiluted calcium arsenate to the plants when they are small and previous to the regular fruitworm or pinworm applications, and if cryolite is being used in the regular fruitworm or pinworm applications, calcium arsenate should be substituted for cryolite in one or more of these applications, or else an additional application of calcium arsenate for armyworm control should be made. In our experiments it has been demonstrated that calcium arsenate is superior to cryolite in the control of the beet armyworm.

Cutworms.--In southern California the regular dusting program for the tomato fruitworm has given excellent control of cutworms when they have attacked the plants during the fruiting period. But at times severe infestations will occur on young plants before the time for the regular fruitworm treatment schedule begins. Such infestations must be handled immediately, or many plants will be killed outright. Control can be accomplished by either dusting the plants with 70-percent cryolite or undiluted calcium arsenate, or by preparing a bait composed of 4 pounds of paris green, 100 pounds of wheat bran, and sufficient water to make a crumbly mash. Ten pounds of the dust or bran bait is sufficient to cover an acre. The dust should be applied primarily to the stem of the plant, and the bait should be scattered around the base of the plant, preferably in the evening. Sodium fluosilicate may be substituted for paris green in the bait mixture.

#### Warning

All the materials recommended in this circular are likely to leave insecticidal residues on the fruit if they are applied within 2 weeks of the time the fruits are harvested. In cases where excess residue is present, the

indications are that the washing process in the canneries and the process of wiping the fruit for market with a cloth will reduce the residue to a quantity well below the danger point. If any insecticidal materials are visible on the fruit when picked, such residue must be removed by wiping or washing before the fruit is offered for sale.

CAUTION.--In handling, mixing, and applying poisonous insecticides care should be taken not to inhale excessive quantities at any time. Well-designed respirators affording protection to the entire face are available and should be used when such danger exists. After working with insecticides the hands or any exposed parts of the body should be washed thoroughly.

#### Where to Obtain Insecticides

Information regarding the purchase of the insecticide materials mentioned in this circular may be obtained usually through local dealers in agricultural supplies, seedsmen, general stores, or through the county agricultural agent, State agricultural experiment station, State department of agriculture, or the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, United States Department of Agriculture.

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