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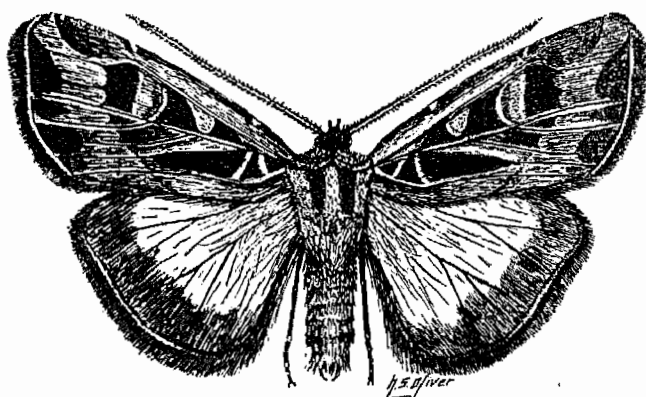
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STUDIES OF THE ECOLOGY AND
CONTROL OF CUTWORMS
IN TENNESSEE

By

W. W. STANLEY



Adult cutworm moth (*Feltia ducens* Walk.)

About twice natural size

KNOXVILLE, TENNESSEE

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STUDIES OF THE ECOLOGY AND CONTROL OF CUTWORMS IN TENNESSEE

By

W. W. STANLEY¹

INTRODUCTION

Studies by Cook², in Montana, and Seamans³, in Canada, have shown that fluctuations in the cutworm population are governed principally by temperature, moisture, and parasites. Aside from the observations of these two workers, very little is known about the ecology of cutworms, particularly in the southern part of the United States. This bulletin is the result of a study of underlying factors governing the abundance of cutworms, in which an attempt was made to discover facts that would aid in predicting their arrival. The data presented deal with constant-temperature studies on all stages of several species of noctuid moths, and an attempt to correlate the prevalence of moths with climatic factors. Poison-bait experiments on larvae were also carried out. Particular attention was paid to the dingy cutworm, *Feltia ducens* Wlk. and *F. subgothica* Haw. These are two important economic species in Tennessee.

LIFE-HISTORY AND HABITS OF CUTWORMS

Cutworms represent the larval stage of an insect that is commonly known as the candle fly, or moth. The mature form of a cutworm is a moth, which lays many hundreds of eggs (Fig. 1). In due time these eggs hatch out into very small worms (about 1/25 inch in length) that are seldom observed. The worms periodically shed their skin, and when full-grown are nearly 2 inches long (Fig. 2). They then dig tunnels in the soil about 4 inches deep, where they construct oval-shaped cavities, or cells. Within the cell the cutworm changes into a pupa (Fig. 3), corresponding to the cocoon stage of a butterfly. The moth emerges from the pupa and crawls out of the ground through the tunnel made by the larva.

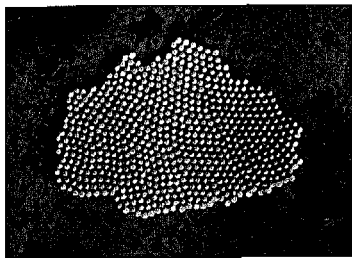


Fig. 1.—Egg mass of the cutworm
Lycophotia margaritosa

These 650 eggs show the high productive capacity of cutworm moths. Several such egg masses are usually laid by each female.

¹Many helpful suggestions received from Dr. Marcovitch during this study are gratefully acknowledged.

²Cook, W. C. Studies in the physical ecology of the Noctuidae. Minn. Agr. Exp. Sta., Tech. Bul. 12. 1923.

³Seamans, H. L. Forecasting outbreaks of the pale western cutworm in Alberta. Can. Ent. Vol. 55. 1923.

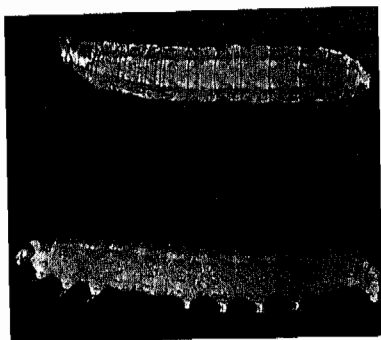


Fig. 2.—Larvae of the cutworm
Feltia ducens

There are many different species of cutworms, and they all have the same cycle, but the time required to complete their transformation varies. For instance, the dingy cutworm requires one year to pass through the various stages, while the variegated cutworm, *Lycophotia margaritosa* Haw., has three or four broods each year.

As a general rule cutworms are most common in the spring. This is due to the fact that the most

abundant species, the dingy, go through the winter as larvae and are present in most fields at planting time. The variegated cutworm winters as a pupa and requires more time to reach the injurious stage. If spring weather comes early the variegated species will appear early. Cutworms feed in the cooler parts of the day, beginning about dusk. If food is scarce and many worms are present, they may be found feeding in the daytime.

Moths also are active in the evening and at night, when they come out to feed on flowers and to lay eggs. Most of the eggs are laid on plants in sod land or weedy fields. When such a field is cultivated in spring and the plants upon which the cutworms have fed are destroyed, they turn to the newly set plants, such as cabbage and tomatoes, which are choice morsels for the voracious worms.

Usually a stem will be cut off just above the ground (Fig. 4) or just below the surface. Often a plant is only partially cut and will remain alive for several days. Some species of cutworms climb the plants and devour the leaves, but seldom consume an entire plant.

Cutworms may occur in such large numbers that they quickly consume their immediate food supply. They start out then in search of other food, all moving in the same general direction. They are so voracious that no succulent plant escapes. When such an "army" invades a corn or grain field, it does great damage unless it is stopped at once.



Fig. 3.—Pupa of the cutworm
Prodenia ornithogalli

LIGHT-TRAP STUDIES ON CUTWORM MOTHS

Light traps afford a simple method of studying cutworm moths, since light has a strong attraction for the moths. These studies have

revealed the time of year that the moths are flying, as well as the time that they are laying eggs. In addition, the records obtained over a period of years may be correlated with climatic conditions to determine the factors that favor and those that retard the increase of the various species. All the data obtained were secured in the vicinity of Knoxville, Tennessee.

Each trap used consisted of a light placed over a 5-gallon bucket fitted with a funnel. The moths when flying around the light would fall down through the funnel and succumb to poison gas within the bucket.

Over a period of 7 years, these traps have caught moths of more than 275 species, approximately 10 per cent of which were injurious. Nearly 100 species of other moths have been recorded from light-trap catches.

Cutworm moths have been caught from April 5 to December 24. Records show that few moths are out in the early spring and late fall. The last week of August and first week of September are the periods of maximum flight for a majority of them. Catches containing 202 specimens, representing 58 species, have been recorded for one night during this period.

The location of a trap affects the number of moths caught. A trap on top of a 5-story building caught several times as many as one on the ground. One on top of an 18-story building caught a smaller aggregate number than the one on the 5-story building, but larger numbers of 5 species.

The number of moths of a given species varies from year to year, as shown by records of *F. ducens* and *F. subgothica*. The same is true of other species. The climatic factors that favor *F. ducens* do not necessarily favor other species.

A study of the number of moths caught during a 7-year period reveals the fact that the total number was highest when the annual rainfall was about normal. Precipitation above or below the average tended to decrease the number caught. These variations, however, favored some and were unfavorable to others.

In 1935, a study was made of the moths caught in two types of environment. The data obtained from traps operated simultaneously in a tomato patch and a small corn patch showed that 17 species were caught in equal numbers in the two locations; that 14 species preferred corn, as the majority of them were caught in the corn; and that 14 other species had a preference for tomato. Late in August the cornfield was plowed and left unplanted. For the remainder of the season a trap was operated in the same field on the bare ground, and the one in the tomato patch was continued. The records show that 20 species were caught in equal numbers in the two traps, that 22 species preferred tomatoes, and 18 preferred the bare ground.

CLIMATIC FACTORS AFFECTING ABUNDANCE OF *F. DUCENS* AND *F. SUBGOTHICA*

Records obtained over a period of 7 years indicate that moth population of *F. ducens* and *F. subgothica* varied from year to year. It was found that rainfall, temperature, and relative humidity are factors affecting the abundance of moths. Temperature, however, seems to have a minor influence.

For *F. ducens* a dry fall was most favorable. Rainfall throughout the remainder of the year was found not to affect the abundance to a great extent, although the evidence obtained indicates that dry years were more favorable. The conditions favoring increase were light rainfall during September, October, and November, and low relative humidity in October. The precipitation of October is probably the most important factor. When October is dry the moths fly practically every night, and consequently many eggs are laid. If rain occurs frequently during the moth flight, conditions will be unfavorable for egg-laying. A dry November seems to favor growth of the young larvae. Above-normal temperatures from January to April appear favorable for survival.

F. subgothica increases in numbers when the fall is wet, especially if the remainder of the season is dry. High temperature in August favors moth abundance. Relative humidity in September must be low for this species, as the moths fly during that month.

TEMPERATURE STUDIES

Eight economic species of cutworms were used in temperature studies: the dingy cutworm (*Feltia ducens* Wlk., *F. subgothica* Haw., *F. herilis* Grt.); the granulated cutworm (*F. annexa* Treit.); the clover cutworm (*Caenurgia erechtea* Cram.); the fall army worm (*Laphygma frugiperda* A. and S.); the bristly cutworm (*Polia renigera* Steph.); and the cotton cutworm (*Prodenia ornithogalli* Gn.).

METHODS OF STUDY

Eggs and larvae were kept at different temperatures and the various stages of development observed. All stages were reared in 1- and 2-ounce tin salve boxes, with towel-paper discs in the bottom.

The method used to obtain eggs was to capture moths at flowers or in bait traps and place them in 2-ounce boxes. Eggs were laid either on towel-paper discs or on the sides of the boxes. Food for moths in the form of a 10 per cent honey solution was placed in drops on the side of the box. Larvae were fed leaves of a variety of plants, as each species required certain types of food.

NUMBER OF EGGS LAID AND LENGTH OF LIFE OF MOTHS

Female moths of *F. ducens*, *F. subgothica*, and *F. herilis* were captured at flowers and placed at 15° C., 20° C., 25° C., and 30° C., and observed several days until all died. The maximum number of eggs, 253, was laid by *F. subgothica*. The optimum temperature for moths seemed to be 20° C. The data obtained are shown in table 1.

TABLE 1—Effect of constant temperature on length of life and on number of eggs laid by moths of *F. ducens*, *F. subgothica*, and *F. herilis*, caught on flowers.

Species	Temperature °C.	No. of females	No. of laying females	Maximum days lived	Average	
					Length of life in days	No. of eggs laid per female
<i>F. ducens</i>	15	15	8	15		
<i>F. subgothica</i>	15	8	5	13	9.4	41.6
<i>F. herilis</i>	15	9	8	15	9.5	113.7
					11.5	89.5
<i>F. ducens</i>	20	11	11	10	6.9	54.4
<i>F. subgothica</i>	20	6	6	9	7.6	146.2
<i>F. herilis</i>	20	9	9	16	10.3	113.4
<i>F. ducens</i>	25	9	5	10	5.4	76.2
<i>F. subgothica</i>	25	5	4	10	6.2	98.5
<i>F. herilis</i>	25	7	7	9	7.5	96.8
<i>F. ducens</i>	30	9	6	10	7.0	48.7
<i>F. subgothica</i>	30	4	3	6	5.0	40.3
<i>F. herilis</i>	30	7	6	9	6.8	38.2

INCUBATION

Incubation for the different species ranged from 2 to 14.1 days, at temperatures from 30° C. to 15° C. Increase in temperature shortened the time spent in the egg stage. Data on length of incubation for the various species are shown in table 2, which also shows the rate of growth for all the immature stages at constant temperatures.

LARVAL STAGE

For all species the larval stage decreased in length as the temperature increased. Larvae of *F. ducens* required 150.2 days at 15° C. and *P. ornithogalli* required 14.8 days at 30° C. These two periods represent the longest and the shortest time observed for the various species. *F. subgothica* could not be grown at 15° C. The larvae lived about 150 days. *P. renigera* was the only species that could not be reared at 30° C.; the larvae lived about 10 days. *F. annexa* was the only species that could be reared at 35° C.

PREPUPAL STAGE

The prepupal stage (from the time the larvae stop feeding until they pupate) was very short for the multiple-brooded species, but for single-brooded species (*F. ducens* and *F. subgothica*) this stage lasted much longer and increased in length with increase in temperature. *P. renigera* showed practically no variation in length of the prepupal stage.

PUPAL STAGE

The pupal stage for all species reacted similarly to the larval stage, becoming shorter as the temperature increased. The maximum time observed was 51.2 days for pupae of *F. ducens* at 15° C., and the minimum time was 6.9 days for *L. frugiperda* at 30° C.

TABLE 2—Data showing the average number of days required for growth at various constant temperatures for *F. ducens*, *F. subgothica*, *C. erechthea*, *F. annexa*, *P. ornithogalli*, *P. renigera*, and *L. frugiperda*.

Stage	Temperature °C.	Average number of days of growth						
		<i>F. ducens</i>	<i>F. subgothica</i>	<i>F. annexa</i>	<i>C. erechthea</i>	<i>P. ornithogalli</i>	<i>P. renigera</i>	<i>L. frugiperda</i>
Egg	15	13.9	14.1	12.5	14.0	5.0	9.6	11.0
	20	7.1	7.7	6.5	7.0	6.0	8.0	4.2
	25	6.1	6.6	4.0	4.0	3.3	3.0	3.0
	30	4.3	5.5	3.0		4.0	6.0	2.0
	35			3.5	4.0			
Larval	15	150.2		98.6	40.5	57.8	145.1	32.6
	20	137.0	129.3	68.0	44.6	32.1	107.6	25.5
	25	92.2	101.5	29.2	23.7	19.2	85.5	16.5
	30	72.1	79.2	28.7		14.8		14.4
	35			28.7	20.5			
Prepupal	15	121.2		11.5	3.0	2.9	4.3	3.3
	20	7.0	26.6	2.4	4.3	3.7	4.3	2.4
	25	51.6	31.9	2.0	2.2	1.6	4.1	1.6
	30	55.5	41.2	2.4	1.0	1.4		1.1
	35			2.0				
Pupal	15	51.2		27.7	20.0	31.5	23.2	22.8
	20	23.0	24.8	22.6	15.2	16.0	21.0	19.8
	25	19.0	18.1	13.2	9.0	11.3	16.0	10.1
	30	16.6	18.7	10.7		8.4		6.9
	35			10.3	8.0			
Total for all stages	15	336.5		150.3	77.5	97.2	182.2	69.7
	20	174.1	188.4	99.5	71.1	57.8	140.9	51.9
	25	168.9	158.1	48.8	38.9	35.4	111.6	31.2
	30	148.5	144.6	44.8		28.6		24.4
	35			44.5	33.5			

DISCUSSION OF TEMPERATURE STUDIES

Three closely related species of cutworms (*F. ducens*, *F. subgothica*, and *F. annexa*) were studied. The greatest difference was found in the length of the prepupal stage, which *F. annexa* passed through in about two days, while the others required a much longer time, the period increasing in length as the temperature increased. *F. subgothica* could not be reared at 15° C. It is not found as far north as *F. ducens*. Low temperature appears to be the limiting factor in its northern distribution.

P. renigera is slow-growing. The larval stage shows the effect of various temperatures to a greater extent than the other stages. In Tennessee, *P. renigera* has two broods, but in Canada only one brood occurs.

The remaining species all grow rapidly and are dangerous pests, for with favorable conditions a large number of cutworms can be produced in a very short time.

EFFECT OF TEMPERATURE ON THE DISTRIBUTION OF *F. DUCENS*

The rate of growth of egg, larval, and pupal stages of *F. ducens* increased with rise in temperature, while the growth of the prepupal stage was retarded. This peculiar reaction is common with a group of cutworms that are single-brooded throughout their northern and southern distribution. *F. ducens* is naturally a single-brooded species. Some workers believe that only one brood occurs, because its food plants are available only at certain periods of the year. Experiments have shown that this insect can be reared at temperatures as high as 30° C. In Tennessee there is a large variety of flowers for the moths and of food for the larvae. Since this species is single-brooded, the prepupal stage at high temperatures is prolonged in order that a year may be consumed in development. The retarded growth compensates for the increase in rate of the other stages¹.

That the prepupal stage of *F. ducens* is shorter at higher latitudes, where lower temperatures occur, is shown in table 3.

TABLE 3—Dates (approximate) of beginning of prepupal stage and maximum moth flight for *Feltia ducens* from Tennessee north to Canada.

Location	Beginning of prepupal stage	Maximum flight of moths
Tennessee	May 7	September 20
Illinois	June 1	August 25
Montana	June 7	August 12
Canada	June 15	July 27

In Tennessee the larvae of *F. ducens* are the first to enter the prepupal stage and the moths are the last to fly in the fall, while in Canada the prepupal stage is very short and not often observed.

F. ducens occurs over a wide range of climatic conditions, as shown by climographs in Fig. 6. The points of the climographs were

¹Crumb, S. E. The bronzed cutworm (*Nephelodes emmedonia* Cram.) Proc. Ent. Soc. Wash., Vol. 28. 1926.

obtained by plotting the means of the monthly temperature and precipitation. In Canada, *F. ducens* is reported as causing some damage, while in Tennessee it is a serious pest. The climographs for Canada and Tennessee illustrate the extremes of climatic conditions at which this species can exist. The records for Alabama show unfavorable conditions.

EXPERIMENTS WITH POISON BAITS

The economic control of cutworms can be improved upon from several different angles, such as more effective poisons, attractants, and carriers for poison bait. This study presents the results of experiments to test the toxicity and repellent effects of certain chemicals on cutworms.

The chemicals tested were sodium fluosilicate, paris green, sodium arsenite, and white arsenic. Tests were also made with different brands of these materials. In order that the toxicities of the different poisons might be carefully determined, tests were carried out under laboratory conditions. This was accomplished by rearing larvae from eggs and obtaining them from the field, and offering them small quantities of wheat bran containing known amounts of poison. While experiments were in progress the larvae were kept at a constant temperature. Those that lived more than 3 days after receiving poison were not used in the calculations. In the preliminary experiments, larvae were placed singly in 1-ounce boxes with a small amount of poison bran. After 24 hours the poison was removed and green leaves were placed in the boxes for food. Ten larvae were tried with each poison.

Coarse wheat bran was used as a carrier for the poison. A small amount of bran was weighed out on an accurate balance and the poison added either as a powder or in solution. In the "dry-mix" method the poison and bran were thoroughly mixed before water was added. In the wet method the poison was placed in solution or suspension before being added to the bran. The results show no difference in toxicity from the two methods of mixing the bait.

As the experiments progressed, the effects of feeding larvae on the poison baits appeared to be uncertain. A particular bait would show a good kill in one case and decidedly different results in another case. This irregularity was thought to be due to the fact that some larvae were not hungry when the experiment was begun. The plan was therefore adopted of starving the cutworms about a day before starting experiments.

After the first tests it was evident that sodium fluosilicate would kill equally as well as sodium arsenite. Then experiments were conducted in which the larvae were given their choice of food or poison bait. This was done by placing 20 cutworms in a galvanized pan with steep sides. The bottom of each pan was covered with an inch of moist dirt, which served as a hiding place for larvae when

not feeding. The poison bait and food were scattered on top of the dirt. In these experiments sodium fluosilicate gave a higher percentage of kill than the arsenical poisons.

The amount of poison required to give the best kill was 1-50 (one part of poison to 50 parts, by weight, of bran). Paris green 1-25 and 1-50 showed approximately the same degree of control, but the stronger bait gave a better kill during the first 24 hours. Sodium fluosilicate gave the best kill at 1-50. At 1-25 the concentration of poison may have been repulsive to the larvae—and 1-100 was too weak. Sodium fluosilicate proved to be superior to paris green at comparable strengths of 1-25 and 1-50.

TABLE 4—*Summary of all poison-bait experiments with cutworms.*

Material	Strength of bait	No. of larvae used	Per cent killed
Paris green	1-25	40	61
" "	1-50	120	61
Sodium arsenite	1-50	46	59
White arsenic	1-50	10	40
Sodium fluosilicate	1-25	40	67.5
" "	1-50	222	80.6
" "	1-100	40	55

In experiments testing various brands, and different strengths of the same brands, it was found that all brands of any one poison were about equally toxic per unit. The results of these experiments are summarized in table 4.

Ripley¹ found that sodium fluoride in cutworm baits gave better results than the arsenites, owing to the fact that it was less repellent. The experiments tend to show that the arsenicals are either less toxic or more repellent than the fluorine compounds. This was especially apparent in experiments where the cutworms had a choice of food or poison bait. To test the comparative attractiveness of sodium arsenite and sodium fluosilicate, poison baits of these materials were mixed and placed in small piles in galvanized pans. These piles were placed alternately with piles of moist bran, which was used as a check. Thus, in each pan there were 2 piles of bait poisoned with each material and 4 check piles. A large pile of sawdust in the middle of each pan served as a place of concealment for the larvae when they were not searching for food. When the experiment was started, 3 pans, containing 13 cutworms each, were placed on the sawdust. The larvae had been starved for 3 days. The experiment was run for 80 minutes, during which time the number of cutworms feeding at each bait was recorded every 5 minutes. The total number of larvae feeding at each bait in the 3 pans were as follows: Sodium fluosilicate, 33; sodium arsenite, 13; check, 38. It was observed that larvae feeding on sodium arsenite bait fed intermittently—they seemed to take a few "bites," then move about in

¹Ripley, L. B. Experiments with cutworm baits: Success with sodium fluoride. Memoir, Univ. of S. Africa, Dept. of Agr., 3, 1925.

search of other food—while larvae feeding on the sodium fluosilicate bait fed continuously, without showing signs of being repelled.

In Tennessee, several field tests with sodium fluosilicate in poison bait have given excellent results. Workers in Indiana have reported favorable results with sodium fluosilicate; while Lyle¹, in Mississippi, reports that paris green is more toxic to *L. frugiperda*, *P. ornithogalli*, and *A. ypsilon*. Likewise, unfavorable results were reported from Connecticut on the use of sodium fluosilicate in poison bait for cutworms.

Sodium fluosilicate is very toxic to insects and can be used in poison baits for various pests. Grasshoppers can be successfully controlled by the use of sodium fluosilicate in poison bait, as shown by Marcovitch². Severin³ recommends this material in poison bait for control of the common black field cricket.

HOW TO CONTROL CUTWORMS

The most economical method of killing cutworms is to apply a poison bait containing only wheat bran and sodium fluosilicate or paris green. The formula for poison bait is as follows:

Dry wheat bran (free of shorts).....	25 pounds
Sodium fluosilicate or paris green.....	½ pound
Water	2½ gallons

The various steps in preparing the bait are as follows: (1) Mix the bran and poison in a bucket or tub, so that each flake will be thoroughly coated with poison; (2) add water, and stir until every flake is moist. At first it will appear that more water will have to be added, but when the mixing is complete the bran will be moist but not sticky. A cheap grade of molasses may make the bait more attractive and prevent rapid drying, but cutworms will readily eat poisoned bait without it. When using molasses, first dissolve it in water, then add the water to the bran.

After the bait has been distributed, the containers should be thoroughly cleaned. Otherwise, if they are used for feeding, the small amount of poison sticking to the sides and bottoms might be enough to kill livestock.

The wheat bran used for poison bait should be coarse, with very little shorts. If it contains too much shorts it will have many small lumps, which will not break up when distributed. These lumps may be picked up weeks or months later by livestock with serious results. Poison bait that is properly made and applied can be safely used in places frequented by livestock.

¹Lyle, C. Cutworm bait studies. Miss. Pl. Bd., Quart. Bul. Vol. 7, 1927.

²Marcovitch, S. Studies on the toxicity of fluorine compounds. Tenn. Agr. Exp. Sta., Bul. 189, 1928.

³Severin, H. C. The common black cricket a serious pest in South Dakota. South Dakota Agr. Exp. Sta., Bul. 295, 1935.

WHEN AND HOW TO APPLY POISON BAIT

Poison bait should be applied just before dusk. Cutworms begin to come out of their hiding places in late afternoon and are hungry, as they have not eaten for several hours. Another reason for making the application at this time is that bait is more attractive when fresh. When dried out it will seldom be eaten by cutworms.

Poison bait is best applied broadcast by hand. If a small area is to be treated the bait may be placed in a bucket or sack and carried about. In a large field it is a good plan to start with the bait in the forward end of a light wagon. Shovel about 25 pounds into a box resting waist-high at the rear end. While the team is driven over the infested area a person standing in front of the box facing back can broadcast the poison, using both hands. In this way a wide strip of ground can be poisoned with minimum effort and maximum speed.

WHERE TO APPLY POISON BAIT

Ordinarily, poison bait is applied where the cutworms are found. However, in the case of army worms (cutworms in large numbers, which generally move in one direction), when they enter one side of a field the poison should be applied to the infested area and to a strip about 15 feet wide ahead of it. When worms start "marching," plow a deep furrow just in front of the army, throwing the dirt toward the worms. Make a clean cut so as to leave a perpendicular bank. This will slow up the "army," as they will have trouble climbing out of the furrow. Scatter poison bait in and on both sides of the furrow. The cutworms will come into contact with the poison, and a good kill should be obtained. If necessary another application of poison bait should be made a day or two later.

Before setting out plants such as tobacco or cabbage, it is a good plan to examine the field, and, if cutworms are present, apply poison bait two or three days before transplanting. If plants are destroyed after being set in field, control may be obtained by a very small amount of poison bait scattered around each plant.

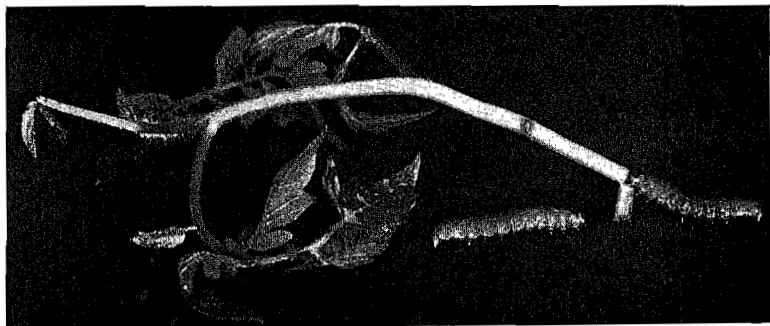


Fig. 4.—Cutworms at work on tomato

CUTWORMS IN PLANT-BEDS

Occasionally cutworms enter plant-beds and cause injury to the small plants. They may be controlled by dusting with lead arsenate or with poison bait.

COST OF POISON BAIT

The cost of poison bait will depend upon the amount used per acre. For a heavy application, 25 pounds of dry bran will make enough bait to cover about one and a half acres. With bran costing $1\frac{1}{2}$ cents per pound and poison 38 cents, the cost per acre will be about 38 cents. The cost could be considerably reduced by large-scale treatments.

CULTURAL METHODS OF CONTROL

Fall and winter plowing will not help in the control of cutworms unless the plowing is done before October 1 and the fields are kept free of all vegetation. Late plowing will kill many overwintering pupae, but not all, and usually overwintering cutworms will find enough food to keep them alive until planting time.

FIRES OR LIGHTS INEFFECTIVE

There is a general idea that cutworm moths can be killed by the use of fires and lights at night. This is not the case. Although killing the moths will prevent egg-laying, only a small number are controlled in this way. For several years a light trap has been operated at the Experiment Station farm especially to catch cutworm moths. A large majority of the moths caught are males, and most of the females caught have already laid their eggs. It is evident, therefore, that control by attractants is not practicable.

SUMMARY

Data obtained on the rate of growth of the immature stages of 7 species of cutworms at constant temperatures showed that higher temperatures accelerated development of all stages except the prepupal stage of the dingy cutworms (*Feltia ducens* and *F. subgothica*). The increase in length of the prepupal stage for the dingy cutworms at the higher temperatures is a natural reaction, which allows these species to exist over a wide range of temperature conditions. The other species studied are multiple-brooded, and they completed their growth in a relatively short time as compared with the dingy cutworms. *L. frugiperda* showed a more rapid rate of growth by completing its cycle in 24.4 days from egg to adult, at 30° C. Moths of dingy cutworms confined at constant temperature showed that 28° C. was about the optimum for egg-laying.

A study of the climatic factors indicates that a dry fall (Sept., Oct., Nov.) and a warm winter are the conditions that favor moth abundance for *F. ducens*. A rather wet fall, with the remainder of the year dry, favored adult abundance of *F. subgothica*.

Location of light traps affected the catch of moths. A trap on top of a 5-story building caught more moths than a similar trap operated on the ground or on an 18-story building.

Moths have been caught from April 5 to December 23. More moths are caught during the last week of August and first week of September than at any other time.

Near-normal rainfall is favorable for large moth catches. A variation from normal tends to decrease the moth catch.

Data obtained from light traps operated in various environments, such as patches of tomatoes and corn, indicate that some species are attracted, others are repelled, and still others are not affected, by environment.

Numerous tests with dingy cutworms showed that one-half pound of sodium fluosilicate mixed with 25 pounds of wheat bran is more toxic to cutworms than paris green or other arsenicals used at the same strength.

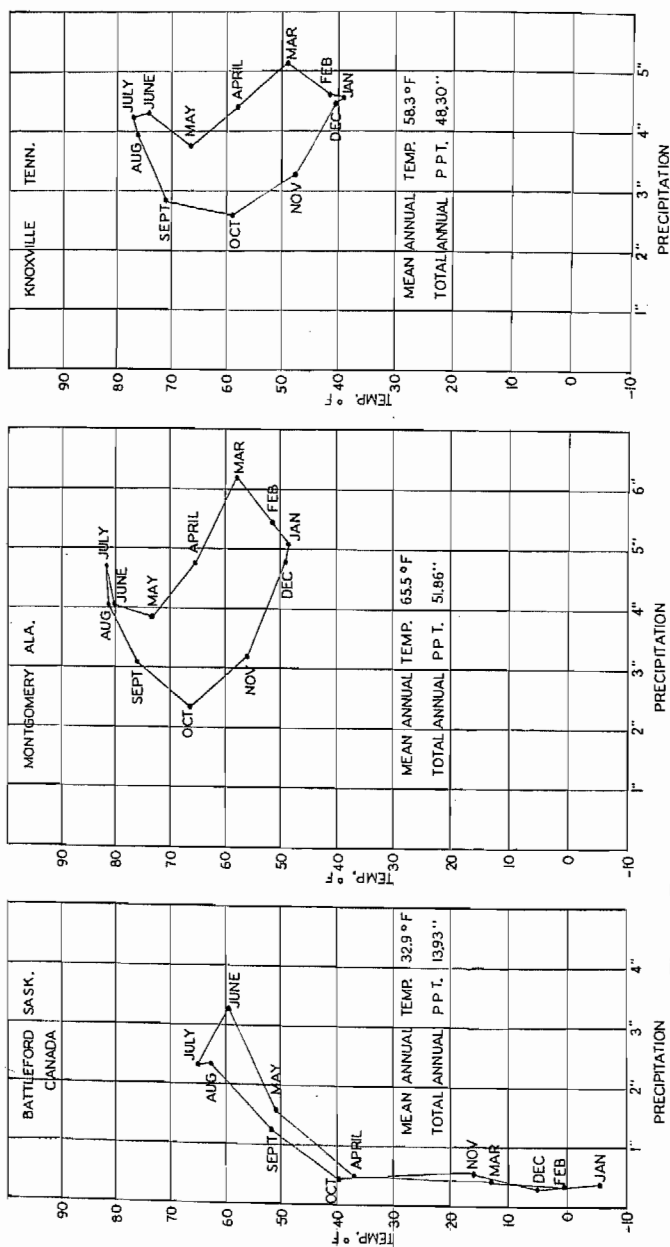


Fig. 5.—Temperature and rainfall averages for three widely separated points. The climographs for Battleford, Canada, and Knoxville, Tenn., represent the extremes at which *F. duarum* can exist. Conditions at Montgomery, Ala., are unfavorable.