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Tobacco Insects of Tennessee and Tobacco Culture in Montgomery County

University of Tennessee Agricultural Experiment Station

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L.R. Neel

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TOBACCO CULTURE IN MONTGOMERY COUNTY

BY

L. R. NEEL

KNOXVILLE, TENNESSEE

Agricultural Experiment Station

OF THE UNIVERSITY OF TENNESSEE

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Bulletins of this Station will be sent, upon application, free of charge to any farmer in the State.

TOBACCO INSECTS OF TENNESSEE

BY

A. C. MORGAN

INTRODUCTORY NOTE BY H. A. MORGAN

In the last biennial report of the co-operative experiment work a preliminary statement on tobacco insects was given, being an account of the operations of the U. S. Department of Agriculture, Bureau of Entomology, in co-operation with the Experiment Station of the University of Tennessee. Investigations were continued during 1909 and 1910, and through the helpful courtesy of Dr. L. O. Howard, Chief of the Bureau of Entomology, Mr. A. C. Morgan, who has been in immediate charge for the Bureau, has prepared for this biennial period an extended report on tobacco insects of Tennessee. These results have been procured at the Bureau's station, in Montgomery County, and in the fields of Montgomery and adjoining counties. Mr. Morgan, the Federal agent, was assisted by Mr. D. C. Parman, the Station's representative. The report follows:

LOSS DUE TO TOBACCO INSECTS

The loss due to tobacco insects, of which there are over 100 species in the United States, is rarely less than $5,000,000 yearly, if we consider, in addition to the actual loss in pounds of tobacco, the lowering of the grade and consequent lowering in price of injured tobacco, the poor quality of the late tobacco which has been reset after insect attack, and cost of combating the different species. Most of the loss in Tennessee is due to a few species of insects. Of these, the most notable are the tobacco flea-beetle, various species of cutworms, and the tobacco horn-worms. The unprecedented outbreak of the flea-beetle in 1907, reduced the acreage of tobacco in Tennessee at least 10 per cent, causing a loss of approximately $400,000. Cutworms occasion serious damage locally almost every year, but the pests that cause the worst yearly damage are the tobacco horn-worms. Their injury varies from 2 or 3 per cent, in years of scarcity, to 10 per cent or more when they are numerous. To this shortening of and injury to the crop we must add the cost of fighting the tobacco worms, which varies from $2.00 or $3.00 per acre, when insecticides are used, to $8.00 or $10.00 per arce, when hand picking is relied upon.

Brief discussions of the methods of combating these insects follow under the proper headings.

THE TOBACCO FLEA-BEETLE (*Epitrix parvula* Fabr.)

The tobacco flea-beetle (Fig. 1) begins to emerge rrom hibernation and to attack the tobacco as soon as the young plants appear

in the beds and may be found in the tobacco fields in more or less injurious numbers from setting time until frost. In addition to the unprecedented damage to plant beds in 1907, which has already been mentioned, these pests frequently injure newly set plants so severely that a considerable percentage of them have to be reset.

About thirty years ago farmers in Tennessee began to cover the seed beds with canvas to protect the plants against sudden changes in temperature. It was found that this also excluded the flea-beetle. Unfortunately, in practice the canvas was not renewed as frequently as it should have been. In a given locality it is always possible to find plant beds covered with canvas in various stages of decay. When the flea-beetles are not numerous, not very serious damage results, but when they are very numerous, as they were in 1907, the torn canvas offers practically no obstacle to their entrance to the bed, and total devastation is likely to take place. This is what happened in 1907. In many instances the second and third resowings were destroyed, but those plant beds that were canvased properly with whole canvas did not suffer from flea-beetle attack. Even after the flea-beetles did appear in injurious numbers and begin their ravages, prompt applications of an insecticide would have reduced the damage to a negligible quantity.

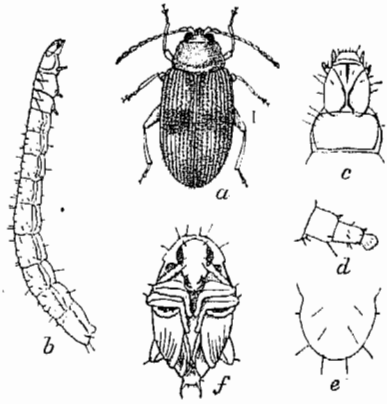

FIG. 1.—The tobacco flea-beetle (*Epitrix parvula*) : *a*, Adult beetle; *b*, larva, side view; *c*, head of larva; *d*, hind leg of same; *e*, anal segment of same; *f*, pupa. *a*, *b*, *f*, Enlarged about 15 times; *c*, *d*, *e*, more enlarged. (From Chittenden.)

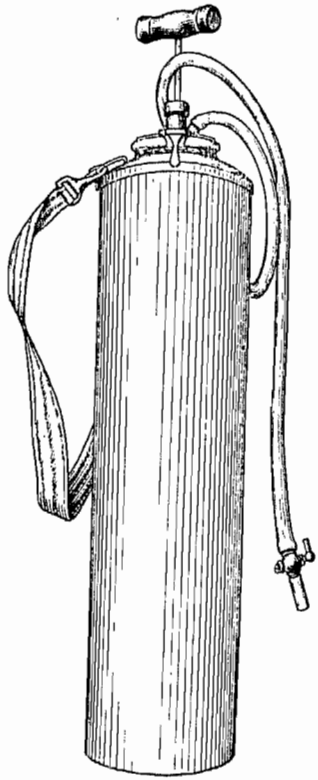

FIG. 2.—Compressed-air spray pump.

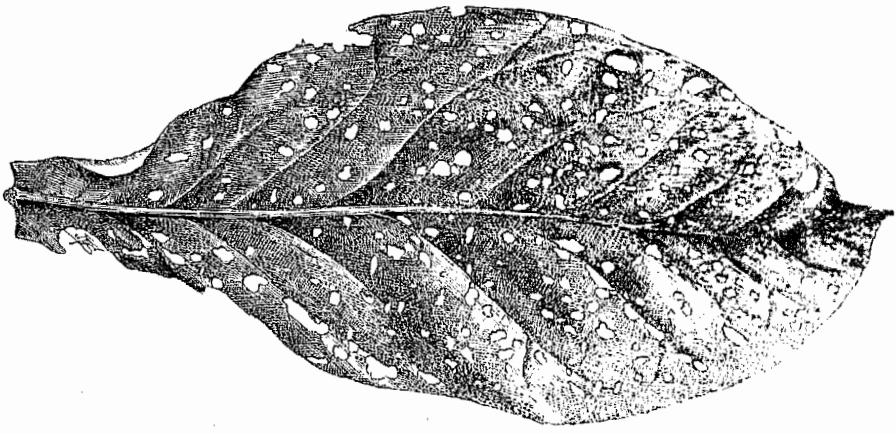

FIG. 3.—Leaf of young tobacco plant, showing work of the tobacco flea-beetle. (Original.)

REMEDIAL MEASURES

The writer has found the following insecticide very efficient in killing the flea-beetles, both upon plant beds and upon tobacco in the field, and not at all injurious to the plants:

Arsenate of lead (in paste form, or ½ lb. powdered form) 1 lb.
Water .....12 to 16 gals.

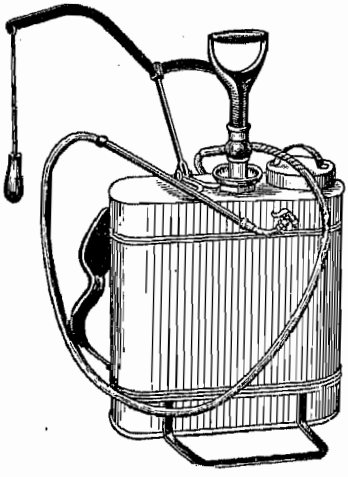

FIG. 4.—Knapsack spray pump.

Mix the arsenate of lead thoroughly in a small quantity of water and pour into the tank of the spray pump (Fig. 2). Add sufficient water to make the desired quantity, then apply to the plant bed or to tobacco in the field until every leaf is thoroughly dampened. If a heavy rain falls soon after the application is made, it may be necessary to make a second application. It must be remembered that arsenate of lead will stick to the foliage much longer than Paris green, and will not be greatly dissipated by a light shower. After the plants have grown considerably, it will, of course, be necessary to spray the bed again if the flea-beetles are still numerous.

If flea-beetles are very numerous at the time of setting tobacco, dip the *tops* of the plants, just before setting, in arsenate of lead, made according to the formula recommended above. If the flea-beetles continue to be exceptionally numerous in the field, the tobacco

may be sprayed with the same insecticide with the knapsack sprayer shown in Fig. 4. One man can spray from five to six acres of young tobacco in a day, at a cost of from 25 to 35 cents per acre for arsenate of lead.

The ounce of prevention is, in this case, worth more than the pound of cure. Tobacco growers, as a rule, pay too little attention to protecting their plant beds from insect attack. The result is that more of the crop has to be set late than would be the case if plant beds were properly protected. Late tobacco, as nearly every tobacco grower knows, produces a less number of pounds and cures a poorer grade than early-set tobacco. Another distinct advantage of early tobacco over late tobacco is the fact that very frequently the early-set tobacco will mature in time to be housed before the heavy August infestation of tobacco worms.

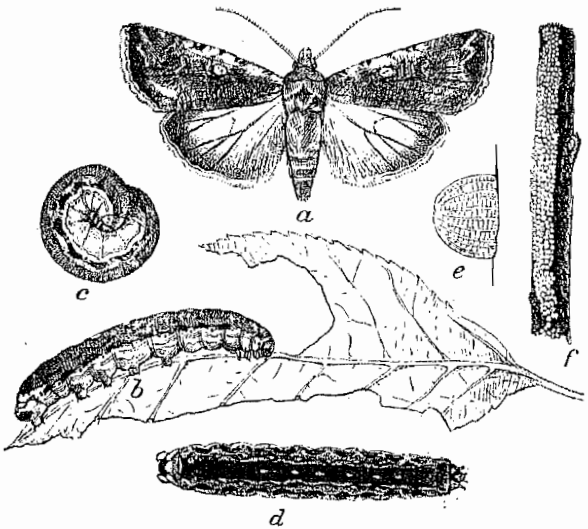

FIG. 5.—A tobacco cutworm (*Peridroma margaritosa*): *a*, Moth; *b*, normal form of larva, side view; *c*, same, in curved position; *d*, dark form of larva, from above; *e*, egg, from side; *f*, egg mass on twig. All natural size except *e*, which is greatly enlarged. (From Howard.)

CUTWORMS—Fig. 5

Various species of cutworms frequently injure tobacco seriously. It is the common experience of all farmers that cutworms are most abundant and injurious on land that has been left uncultivated for some time previous to being planted in tobacco. Where tobacco follows clover, serious injury from these pests is likely to result. On the other hand, if winter grain precedes the tobacco crop, very little injury is likely to result. However, if tobacco must follow sod, it is a simple matter to rid the soil of cutworms. Plow in the fall or early winter, and by disking or harrowing keep down the vegetation until time to set the tobacco. In this way the cutworms, when they become active in the early spring, will find no food and will be

TABLE I.—*Life-history of the Southern Tobacco Moth* (*Phlegethontius sexta* Joh.)

First Generation						Second Generation				
Moth emerges from hibernation	Begins to deposit eggs	Eggs hatch	Worm becomes full-grown	Enters ground to pupate	Pupal stage ends	Moth emerges	Deposits eggs	Eggs hatch	Worm becomes full-grown	Moth emegres
June 1	June 5	June 9	June 29	June 29	July 20	July 20	July 24	July 28	August 17	
15				July 14	August 4	August 4	August 8	August 12	September 1	Next year
30				29	19	19	23	27	16	
July 10				August 9	Nearly all emerge next year					
15				14	All of these emerge next year					

starved to death. When sod land is plowed only a short time before setting, cutworms are likely to be very numerous in the field and very injurious to the newly set tobacco. In this case a trap bait may be used. In Farmers' Bulletin No. 120, Dr. L. O. Howard recommends thoroughly spraying a patch of weeds or clover with Paris green, then cutting it and dropping it in little bunches here and there throughout the field a few days before setting time. Another bait that meets with wide favor is also mentioned by Doctor Howard. It consists of 1 pound of Paris green mixed with 50 to 75 pounds of bran, sweetened with molasses and moistened with water to make a mash. This should be dropped about the field three or four days before setting tobacco. However, if the presence of the cutworms is not detected until after the tobacco is set, these trap baits may be used to good advantage even then. Drop a little of the clover or a small handfull of the mash at each hill. It is believed that cutworms prefer the sweetened mash to the young tobacco and that they will cause very little injury to the plants after this bait is applied.

TOBACCO HORNWORMS

There are two species of tobacco hornworms found in Tennessee, namely, the Northern tobacco worm and the Southern tobacco worm. However, since the life-histories and seasonal histories of the two species are so nearly alike; since the remedial measures that are effective against one are equally effective against the other; and since about 90 per cent of the hornworms belong to the Southern species, the data given here on the life-history and the seasonal history are from notes and observations upon the Southern tobacco worm.

LIFE-HISTORY AND SEASONAL HISTORY OF THE SOUTHERN TOBACCO WORM (*Phlegethintius sexta* JOH.)—FIG. 6

Tobacco moths begin to emerge from hibernation about June first, and the emergence continues until late in August. Within a few days after emergence the female moth will begin to deposit eggs, which will hatch, in about four days, into the hornworm of tobacco. By reference to Table I we see that in about three weeks this worm will become full-grown and will enter the ground to pupate. For pupal form, and also for position of pupa in the cell, see Fig. 7. In midsummer the pupa spends only about three weeks in the cell in the soil, at the end of which time it emerges as a moth of the second generation and begins to deposit eggs.

By referring again to Table I we see that all moths that emerge from hibernation as late as from July 10 to 15 may produce a second generation during that year, and that moths emerging from hibernation after July 10 to 15 will not produce a second generation, but that the hornworms produced by these moths will begin to enter hibernation about the 10th to 15th of August.

It has been and is the commonly accepted belief that the heavy

"shower" of worms in late July and August is due to a second generation of tobacco worms. Such, however, is not the case. By reference

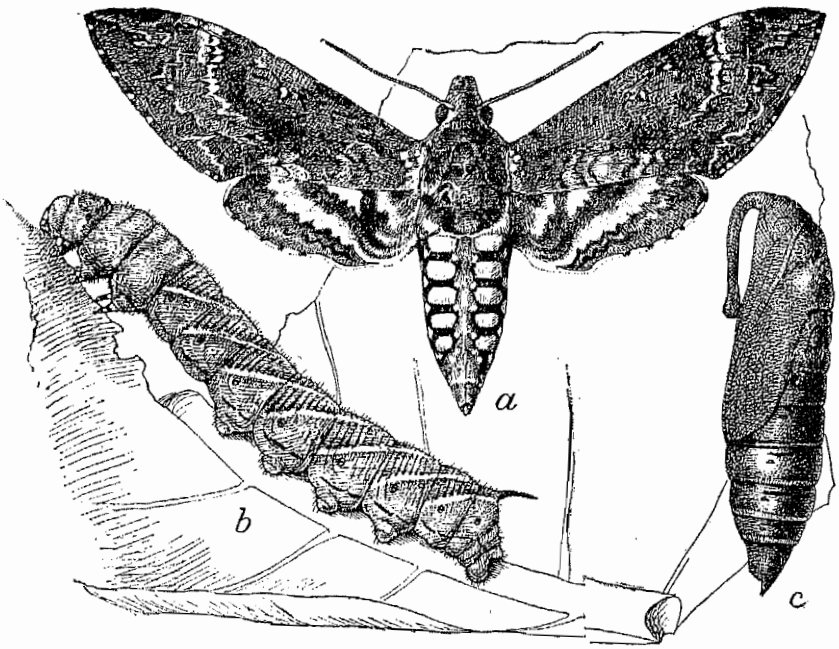

FIG. 6.—The Southern tobacco hornworm (*Phlegethontius sexta*): *a*, Adult; *b*, larva; *c*, pupa. (From Howard.)

to Table II we see that in the year 1909, by July 10, only 11 per cent of the total emergence had taken place and that in 1910 only 3 per cent had emerged by July 10. We also observe that 50 per cent of the emergence in 1909 took place between the dates of July 29 and August 9, and that 52 per cent of the total emergence in 1910 occurred between the dates of July 30 and August 12.

MORTALITY DURING HIBERNATION

Fig. 7 shows the pupa, or hibernating form, of the tobacco worm in its cell about four inches below the surface of the ground. This period of the seasonal history of the tobacco moth is the most critical one. Experiments carried on at Clarksville, Tenn., for two seasons showed that of the 5,000 tobacco worms placed in hibernation under natural conditions, in 1908, only 32.4 per cent emerged the following season. In the hibernation experiments in 1909, over 3,000 larvae were used. Of these only 16.4 per cent emerged in 1910. The smaller percentage of emergence in 1910 is undoubtedly due to the exceptionally severe winter of 1909-10.

Since the mortality of the hibernating pupa is so large under

TABLE II.—*Emergence of Phlegethontius sexta* JOH. *from hibernation—comparison of the percentages that emerged by a given date for the years* 1909 *and* 1910.

1909		1910	
Date	Per cent emerged	Date	Per cent emerged
June 1-June 30	3.0	June 12*-June 30	1.
June 1-July 10	11.0	June 12 -July 10	3.
June 1-July 15	17.5	June 12 -July 15	6.
July 16-Aug. 22	82.5	July 16 -Sept. 1	94.
July 29-Aug. 9	50.0	July 30 -Aug. 12	52.

*The emergence at Clarksville began several days later in 1910 than in 1909.

normal conditions, it would naturally be supposed that any disturbance of natural conditions would produce an increase in their mortality. In Fig. 7 we see that the cell containing the pupa of the tobacco moth is considerably larger than the space occupied by the pupa. The interior of the cell is considerably more firm than the surrounding ground, so that the ordinary packing of the soil will not destroy its shape. We find that if this cell is broken up and the soil comes into close contact with the pupa, death is almost certain to result. Even in the summer months, when the pupa normally stays in its cell for only three weeks, if the cell be broken and the soil is thoroughly wet so that it adheres to the pupa, death always results. If death takes place in the summer months from such treatment, at a time when not so much of the vitality of the pupa is consumed as is consumed in passing the long hibernation period of 8 to 10 months, death will be more sure to result from such treatment during the long hibernation period.

PLOWING VERSUS DISKING TO KILL PUPA IN HIBERNATION

In 1908, an experiment to determine the effect of plowing the soil upon the survival of the hibernating pupa was performed. A cage into which a known number of larvae of the tobacco moth were placed late in September was plowed in November. Three check cages were placed beside the treated cage. The average emergence from the check cages was 22 per cent. The emergence in the plowed cage was only 1.4 per cent. We see, therefore, that under normal conditions 78 per cent died during hibernation, but that in the treated cage 98.6 per cent died, showing that plowing had increased the mortality over the normal by 93.6 per cent.

Unfortunately, many farmers follow the practice of disking the land that was in tobacco in preparation for the winter crop and many of them believe that the wheat, which is the crop usually following tobacco, produces a better yield when the land is disked than when it is plowed. It is unfortunate that this rotation should be continued. Some crop other than wheat should follow the tobacco, so that the land might be plowed in preparation. In order to test the

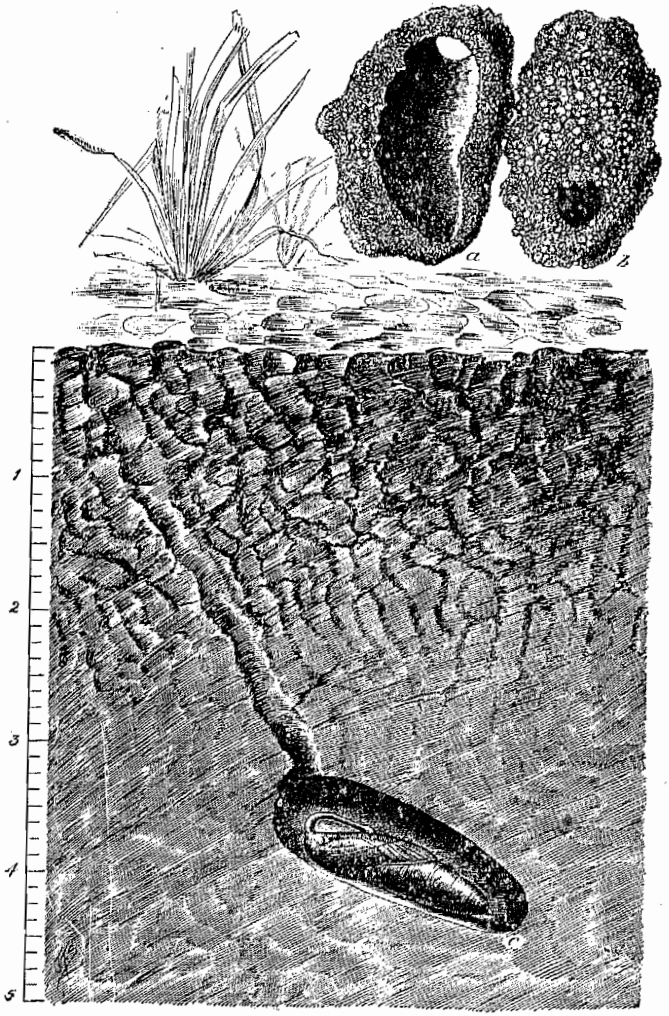

FIG. 7.—Hibernation of Southern tobacco hornworm: *c*, Pupa in hibernating cell in soil, at the depth at which pupation usually takes place in the stiffer soils; *a*, cross section of pupal cell viewed from below; *b*, pupal cell showing entrance hole of larva or "worm." Two-thirds natural size. (Original.)

effect of disking upon the larvae in hibernation, in the fall of 1909, five cages of tobacco worms were placed in hibernation. One cage was disked, one was plowed, and three were left as checks. Owing to the severe winter, a smaller percentage survived in the check cages than survived in the check cages of the experiments of the

previous year, in 1910. The average survival of the check cages w only 16 per cent. The survival from the disked cage was 9.3 per ce or, in other words, disking increased the normal mortality by 42 p cent. None emerged from the plowed cage. Thus we see that diskin does not increase the mortality of the hibernating form to anythin like the extent that plowing does, for plowing in 1908 increased th normal mortality by 93.6 per cent, while in 1910 the mortality in th plowed cage reached 100 per cent. It is evident, therefore, that a tobacco land should be plowed in preparation for the winter crop i stead of being disked. Prof. H. A. Morgan, Director of the Tennesse Agricultural Experiment Station, recommends the following rotation for tobacco districts:

1st year—Tobacco; wheat or rye sown at last cultivation.
2nd year—Soy beans, for hay.
3rd. year—Winter wheat.
4th year—Red clover.

1st year—Tobacco.
2nd year—Wheat.
3rd year—Clover.
4th year—Pasture, to be fall-plowed.

We have already shown, in Table II, in the last line of table, that by far the larger percentage of the emergence of tobacco moths takes place during the 12 to 15 days following July 29 or 30. Field observations show that it is at this period also that the heavy July and August "shower" of worms appears. We have just shown, by records of experiments, the large percentage of the hibernating form that can be killed by the plowing of the land and breaking up the hibernating cell. We can now see what a direct influence such treatment would have upon the destructive July and August "shower" of tobacco worms. This is another opportunity for applying the ounce of prevention.

USE OF INSECTICIDES AGAINST TOBACCO WORMS

It has been the custom for several years in the dark tobacco belt of Tennessee to apply Paris green to tobacco by means of a dust gun when the tobacco worms become numerous and destructive. Very few growers now attempt to keep the tobacco clean of worms by hand-picking after they appear in any great numbers. When the worms were numerous it would frequently require an expenditure of from $6.00 to $10.00 per acre, or more, to keep the tobacco clean for the remainder of its period of growth. Even if the labor could be secured this method is unsatisfactory for the reason that at the time of the appearance of the destructive wave of tobacco worms the temperature is very high and during the hottest parts of the day the worms crawl down to the bases of the leaves and secrete themselves in the "ruffles" to avoid the hot sun, and are therefore very difficult to find, so that many of them are overlooked. With two or three

applications of Paris green practically all the hand-picking can be dispensed with and at a cost not greater than $1.00 to $1.50 per acre. It is the custom to use from 1 to 2 pounds of Paris green per acre at each dusting. If there are many half-grown worms upon the tobacco not less than 1½ pound should be used, although if the first application is made (as it should be) when the eggs are beginning to hatch and when the worms are small 1 pound per acre will be sufficient. If the weather is dry this application when thoroughly made will last for five or six days. The next application should be somewhat heavier—about 1½ pound per acre—in order to kill the large worms (Fig. 8), a few of which will have escaped the first application. If

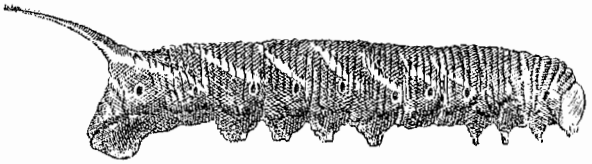

FIG. 8.—The Southern tobacco hornworm: Larva, fourth instar. Natural size. (Original.)

the tobacco has been set early, it will be well matured and ready to cut by the time the worms appear in large numbers, and a third application will not be necessary. Late tobacco, however, will require more applications.

DANGERS IN THE USE OF PARIS GREEN

If the operator is careful no danger to himself need be feared while applying Paris green. Paris green should be dusted on tobacco when there is no breeze; or if there is a breeze the operator should wear a veil or a sponge over the nose, go quartering the breeze, and always upon the windward side of the row. Protection for the face in the latter case will not be necessary. Always bathe the entire body thoroughly immediately after finishing the dusting to prevent the irritation that is likely to occur where the Paris green has sifted through the clothing and has come into contact with the tender parts of the body.

INJURY TO TOBACCO BY THE USE OF PARIS GREEN

Although Paris green is in common use in the dark tobacco district of Tennessee, there is frequent complaint of damage to tobacco. In rainy weather the Paris green is frequently washed down into the axils of the leaves and into the wounds made by the breaking out of the suckers, or is collected along the midribs of the leaves, and frequently causes very severe burning. Burning does not occur every year, nor with every grower, but during rainy weather, when worms are numerous and frequent applications of Paris green are required, serious injury often results. Frequently entire leaves drop from the

plants as a result of the caustic effect of this insecticide which has been washed into the sucker wounds.

Because of this danger from the use of Paris green the writer and his associates determined to find, if possible, some poison that could be used in place of Paris green and would not burn the tobacco plant. As a result of three years' work along this line, it has been found that powdered arsenate of lead, *when specially prepared for use upon tobacco*, can be used in place of the Paris green and with absolutely no injury to the plant.

PARIS GREEN VERSUS ARSENATE OF LEAD

Experiments performed by the writer in 1910, with arsenate of lead showed that 4 or 5 pounds per acre must be applied to give as good insecticidal results as could be obtained by an application of 1½ pound per acre of Paris green. Paris green at the rate mentioned was applied alongside a plot to which arsenate of lead was applied at the rate of 5 pounds per acre. At the expiration of three days practically all worms were dead on the Paris green plot and at the expiration of four days the arsenate of lead had produced the same results. Paris green had burned the tobacco somewhat, but there was no injury upon the arsenate of lead plot. We see by this experiment that arsenate of lead is somewhat slower than Paris green, but that there is no danger of burning the tobacco. We have even applied the arsenate of lead in quantities as high as 10 pounds per acre without burning the tobacco.

DIRECTIONS FOR APPLYING INSECTICIDES TO TOBACCO

Paris green may be applied to tobacco in the dust form without a carrier. The writer has found that Paris green cannot be applied any more evenly or thoroughly when mixed with a carrier; in fact, not so thoroughly and evenly as when no carrier is used. In every case the best results were obtained when the Paris green was used alone. On the other hand, it is absolutely necessary to mix the arsenate of lead with a carrier. Finely sifted, air-slaked lime was first used. The application was apparently fairly even, although the mixture did not blow from the dust gun as evenly as could be wished. Freshly burned, finely sifted wood ashes were used next as a carrier for the arsenate of lead, and in this case it was found that the application was perfect and the dust from the gun was absolutely even and well distributed. There was no lumping of the mixture, and it was found that where five pounds of the arsenate of lead, with ashes as a carrier, was applied per acre, at the expriation of four days not more than one or two per cent of the worms were alive. The writer therefore advises that only freshly burned (and therefore very dry), finely sifted wood ashes be used as a carrier for the arsenate of lead. Disappointment will be sure to result from the use of air-slaked lime. *An absolutely even and thorough application must be made to insure success*, and such an *application can not be made with lime*

as a carrier. Use the most powerful dust gun that can be obtained. Apply to only one row at a time, while the dew is on the plants, and while there is no breeze.

COMPARATIVE COST OF PARIS GREEN AND ARSENATE OF LEAD

As has already been stated, Paris green at the rate of 1½ pound per acre will cost from 40 to 45 cents per application. Five pounds of arsenate of lead per acre will cost, if the lead has been purchased in quantities of 100 pounds or more, 18 to 20 cents per pound, which would make the cost per acre from 90 cents to $1.00. The 5-pound application will be necessary if there are many half-grown worms upon the tobacco. However, if all the worms are small, that is, less than half-grown, 3½ to 4 pounds will be found sufficient, in which case the cost per acre would be reduced to 70 or 80 cents. In no case should less than 3½ pounds of arsenate of lead be used per acre when the tobacco is well matured. In preparing the arsenate of lead for use, mix it very thoroughly with an equal bulk of the dry, finely sifted wood ashes as recommended above.

The question of the advisability of using arsenate of lead in place of Paris green is one which each grower must answer for himself. The cost is greater, and the labor somewhat greater, but there is no danger of burning the tobacco and not so much danger to the operator. There are also two other advantages to be derived from the use of arsenate of lead. First, it is not so easily washed from the plant as Paris green, and in rainy weather would be but very little more costly than the Paris green. Second, if the tobacco is well advanced in growth and nearly mature, that is, has reached the "graining" stage, and half-grown and full-grown tobacco worms are numerous, an application of 1½ pound of Paris green is almost sure to cause serious burning. A smaller application would not kill a sufficient number of the large worms to make the application advisable. On the other hand, arsenate of lead can be applied to the tobacco at this stage of growth in a strength sufficient to kill the half-grown tobacco worms.

REPORT ON TOBACCO CULTURE IN MONTGOMERY COUNTY

BY

L. R. NEEL

Montgomery is a typical tobacco county in the dark tobacco district, so that methods that bring results there should bring good results on similar land in other counties of the State. There are progressive tobacco growers in the county, who started with a yield of only 600 or 700 pounds per acre but now often produce 1,200 to 1,500 pounds. There are others who are down where these successful men started; they too can double their yields and improve the quality if they will adopt the principles that have made the former successful.

ROTATION

The successful tobacco farmer follows very strictly a crop rotation. A good crop of tobacco does not tempt him to try to get another one on the same land the following year. He may give the field a year's rest and then put it into tobacco the second year, but tobacco after tobacco is not at all in favor unless the soil is virgin.

The rotation followed by the majority of successful tobacco farmers is clover, tobacco and wheat. Each crop occupies the land a year, although some farmers allow the clover to stand two years and pasture it the second year. Tobacco and corn occupy the same place in the rotation; part of the clover land being devoted to tobacco and part to corn. This is a good rotation for tobacco theoretically and practically. The nitrogen stored in the soil by the clover helps to a great extent to meet the heavy demands of tobacco for this element. The roots of the clover loosen the soil and increase its water-holding capacity. Then, the crop of clover hay is needed on the farm and the manure made from feeding it goes to enrich the tobacco land. Wheat does excellently after tobacco. The intensive tillage and the earliness at which the tobacco crop comes off help to produce a good crop of wheat.

A superior rotation recommended for trial is as follows:

1st year—Wheat.

2nd and 3rd years—Clover and grass.

4th year—Tobacco or corn.

5th year—Rye cover crop, sown in tobacco or corn; soy beans.

Where conditions are favorable crimson clover may be sown with the rye. When once established this is an easy rotation to follow and may be used to advantage in the building up of the soil to greater productiveness:

MANURE

Most of the successful tobacco growers value stable manure very highly. The poor spots are "touched up" with it to make them nearly as productive as the better parts of the field. It gives good results alone or in combination with commercial fertilizer. Experimental tests have shown that on some lands six tons of stable manure, alone or with a liberal application of commercial fertilizer, will produce nearly $50 worth of tobacco. In one trial manure alone or commercial fertilizer alone increased the yield nearly 500 pounds, but when the two were brought together there was nearly 500 pounds more of increase.

The majority, if not all, of tobacco farmers need more stable manure. With it they could very considerably raise the yield and could make their fields more uniform. More intensive farming would give larger crops, which would make it possible to keep more stock, and this would result in more manure. By improved methods better results are undoubtedly possible. The average farmer has not learned to get the use of the valuable hog manure. The hogs are usually fed in a pen either in a barn or woods lot. This very rich manure does not help the tobacco crop any. Other leaks of fertility around the feed lots and farms should be corrected.

FERTILIZERS

At least a large part of the tobacco farmers use some commercial fertilizers. But the amount is usually small. The average application is not far from 100 pounds per acre. This is placed in the hill and is usually a 3-8-6 or a 2-7-4. The first figure refers to the per cent of nitrogen, the second to the per cent of phosphoric acid, and the last to the per cent of potash. Some tobacco farmers apply 200 or 300 pounds of the same fertilizer broadcast on the poorer parts of the field.

Such fertilization without doubt pays well under the system of farming that has been described, but heavier applications would undoubtedly pay far better in many instances. If legumes were grown and manure applied to the extent that the soil would be well supplied with nitrogen, and if the soil were naturally well supplied with potash in an available form, the usual fertilization would be nearly adequate. That is, it would replace the phosphoric acid removed by a 1,000-pound crop, but supplies only about one-tenth of the nitrogen and potash removed. On well-farmed land the potash supply of the soil and the nitrogen accumulated by leguminous crops may, as a matter of fact, be largely depended on to furnish these elements of plant food. So that on such lands the common application may not be far wrong for the tobacco crop. But on land lower in vegetable matter larger applications of 500 or more pounds per acre of commercial fertilizer will be very profitable. And the application may well be made with a view to soil building for all the crops of the farm.

PREPARATION AND CULTIVATION OF THE LAND

The more successful tobacco growers plow the land in the fall or winter. Some prefer to plow before Christmas so that the clover seed will be prevented from sprouting and will help to make a stand of clover when the land is sown to wheat again. The plowing is deep and is limited by the strength of the team—three mules—and not by the wish of the farmer. Some plow eight or nine inches deep. This depth has been reached gradually as the vegetable matter of the farms has been built up with clover and manure. After disking and smooth-harrowing the land some farmers re-plow in the spring, letting the plow run a little deeper than it did in the winter.

A good seed bed is made with the disk, a drag harrow, and a roller or plank drag. The land is marked off with a small turning plow or a shovel. The width of rows (the plants are set in squares) varies from 3½ feet to 3 feet and 10 inches. Some of the best growers prefer the wider rows.

There is a great variety of opinions about cultivating the crop, but on essential points most successful cultivators are agreed. The cultivation should be intensive and should not be deep toward the close, especially near the plants. For the first two cultivations, once in each direction, a five-point cultivator and a fourteen-tooth harrow are used by many. These cultivations are soon after the plants are set. Many farmers make the next two cultivations rather deep, using the double-shovel or turning plow. After this stage, shallow cultivation is coming more and more into favor. However, some of the most successful farmers use a turning plow for late cultivating, but it is run shallow. The number of cultivations will amount to eight or ten. The hoe is used to some extent to loosen the soil around the plants early and to take out weeds later.

It would seem that the system of cultivation that is giving best results consists of what is equal to a harrowing very soon after the plants are set, a deep cultivation before the plant roots are in the way, and comparatively shallow cultivation thereafter. The crust should be broken as soon as possible after a rain as long as the crop can be cultivated.

SEED SELECTION

Attention is being paid to seed selection. Some farmers merely allow well-formed plants to make seed and save this for planting. Others allow good plants in groups to form seed and give each plant and the seed that come from it a number so that only the seeds from plants making leaves of good texture will be planted. Another method that would make for greater uniformity of the crop and would improve it generally would be to select seed plants and to place a paper bag over the flowers before they have opened. Any flowers that had opened before the sack was placed over them or that opened after it was removed should be cut off. This plan is worthy of a trial by every thoughtful tobacco grower.