THE BIOLOGY AND CONTROL OF THE LESSER CORNSTALK BORER, *ELASMOPALPUS LIGNOSELLUS* ZELLER

A Dissertation

By

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INTRODUCTION

About one fifth of the nation's peanut crop is produced in the states of Arkansas, Alabama, Louisiana, New Mexico, Oklahoma and Texas. More than ninety-five per cent of this production is in Texas and Oklahoma. The Southwest's first modern peanut-shelling plant was established at Terrell, Texas, in 1907. By 1950, thirty-one shelling plants were reported in operation in the southwestern states.

Peanut production in Texas first came into prominence during and immediately after World War I. Another peak was attained during World War II and for two years thereafter with a decline beginning after this period. Through these rises and declines there has been a general upward trent of acreage and production.

The United States Department of Agriculture first reported a peanut census for the state of Texas in 1909. The total harvested acreage for that year was 48, 000 acres, producing 26, 400, 000 pounds of peanut with a cash value of $1, 003, 000. By 1954 a total of 281, 000 acres was harvested and 108, 185, 000 pounds of peanuts were produced with a cash value of $12, 658, 000. The year 1954 was one of the driest in the history of Texas agriculture. Because of the drouth that prevailed over most of Texas during the census interval, 1949-1954, the data of the 1954 census probably do not reveal the progress that would have been shown in a normal year.

According to the Texas Almanac, the Texas commercial peanut production comes largely from: (1) the Comanche-Eastland-Erath County area, (2) the Wilson-Karnes-Atascosa-Frio-Bexar County area, (3) a wide area in East Texas and in the sandy land extending along the Red River north of the blacklands, and (4) the Waller-Harris-Fort Bend County area. A large peanut-crushing business in cottonseed oil mills has been equipped for this process. The heaviest marketing center shifts from year to year with weather conditions, but De Leon in Comanche County is probably the greatest primary market.

For a long time, peanut growers and researchers considered the peanut crop practically immune to the attacks of insect pests. This belief was based on the fact that the entire crop is not destroyed by such attacks when no control measures are used, as is often the case with other crops. Only recently have studies been conducted to identify pest species and to develop control measures for them.

Various insects are known to attack peanuts, among which are the corn earworm, *Heliothis zea*; thrips, *Frankliniella* spp.; leafhopper, *Empoasca fabae* (Harr.); the fall armyworm, *Laphygma frugiperda* (A. & S.); the red-necked peanut worm *Stegasta basquella* (Chamb.) and the lesser cornstalk borer, *Elasmopalpus lignosellus* Zeller.

The infestations and magnitude of damage vary from year to year. In some cases the damage caused by the insect to the peanut plant is ignored by the grower. For example, in the vicinity of Downing, Texas, the corn earworm Heliothis zea feeds considerably on the foliage of the peanut plants during the early season. This situation is generally disregarded by the grower because he has observed that the plant will produce new growth and yield a normal crop.

This research was limited to the lesser cornstalk borer because at the time of this study this insect was the major economic pest of peanuts in the peanut-growing area of Texas.

REVIEW OF LITERATURE

The lesser cornstalk borer Elasmopalpus lignosellus Zeller has been known as a plant pest for some time. However, not until the past twenty or thirty years did this insect become recognized as an economic pest, particularly in the Southern states on crops grown in nutritionally poor soils or in sandy soils.

C. V. Riley (1882a, 1882b) in his report of the Entomologist to the Federal Government gives a small résumé of the insect with some observations on its behavior. He also noted that this insect overwinters as an adult, pupa or larva.

Luginbill and Ainslie (1917) studied the life history of this insect in South Carolina. Corn, sorghum, beans, cowpeas and peanuts were listed as some of its plant hosts. Luginbill and Ainslie found in their study that Neopristomerus sp. and Ongilus sp., both hymenopterous insects were natural enemies of the borer, but the life cycle of the borer is such that the borer suffers very little from predatory or parasitic insects. Luginbill and Ainslie recommended for control a very late fall or early winter plow-up of plant remnants to break up the winter quarters of the pupae. These two workers also suggested a thorough application of fertilizer to make the sandy fields as fertile as possible to stimulate plant growth, and thus make the plants more resistant to the attacks of this insect.

Lyle in the Mississippi State Plant Board Quarterly Bulletin for 1927 reported that damage by this insect occurred every third year. He listed corn, beans, cowpeas, sorghum, sugar cane, and peanuts as the economic hosts for the borer. His report includes a short note on the feeding habits, paralleling the findings of Luginbill and Ainslie (1917). Lyle further stated that this insect overwinters in the pupal stage.

Watson (1931) recommended crop rotation for partial control of the lesser cornstalk borer.

Isely and Miner (1944), in studying the life history of the lesser cornstalk borer in Arkansas, noted that the survival of newly hatched larvae was higher in corn than in beans. Isely and Miner also reported that the time required for completion of larval development on corn was 3/4 as long as that on beans, and that corn was preferred by the larvae. These workers also observed that larvae migrated from plant to plant above ground even during the heat of the day. Cryolite, barium fluosilicate, and calcium arsenate were used as dusts on plants to control the insect, with unsatisfactory results.

Vorhies and Wohrle (1946) reported corn, beans, cowpeas, sorghum, Johnson grass, peanuts, and turnips as host plants in Arizona. For control they recommended burning all infested crop remnants, including weeds and grass, followed by plowing in the late fall or early winter.

Bissell and Dupree (1947) reported that damage by the lesser cornstalk borer on beans and cowpeas could be reduced by forcing growth of the plants with fertilizer.

Cowan and Dempsey (1949) reported that the lesser cornstalk borer attacked newly set pepper plants in a field which had a winter cover crop of rye.

Kelsheimer and Hayslip (1950) observed that their data on the larval feeding habits parallel the results obtained by other researchers. The larvae tunnel into the main stem of the plant just below the surface of the soil and feed within the stem. A thin silken tube covered with sand and excrement, originating from the point of entry in the stem, extends perpendicularly to the main stem, just below the soil surface. The larvae, however, do not remain in their tunnels, except for feeding, but are usually found inside the silken tubes. Kelsheimer and Hayslip also reported that early dust or spray treatments with DDT and chlordane on the bases of the plants reduced damage.

Arthur and Arant (1951) reported that four applications of 10% DDT applied to the foliage of peanuts at weekly intervals during July and August reduced the infestation of lesser cornstalk borer and more than doubled the yield of peanuts over that of the untreated checks.

SYSTEMATIC HISTORY AND SYNONOMY

P. C. Zeller first described the lesser cornstalk borer in 1848 from specimens collected in the South American countries of Brazil, Uruguay and Colombia. For his description he also used a female moth collected from "Carolina" in this country. In Zeller's original description the lesser cornstalk borer was given the name Pempelia lignosella. Blanchard in 1852 established the genus Elasmopalpus and redescribed the species under the name Elasmopalpus angustellus. This genus has been accepted as the proper genus for this species.

No other reference to this species is made in the literature until 1872 when Zeller recorded that it occurred in Texas, where two adults were collected on July 15, no sex denoted, and two females on August 15, 1872. Two varieties, incautella and tartarella, are described in this paper, the descriptions being based on color variations. In 1874, Zeller also described a new variety from Valparaiso, Chile, designating it simply as variety "B".

C. Berg, in 1875, added details to Blanchard's description, using South American specimens collected from Buenos Aires, Cordova and Carmen de Patagones. Two years later Berg placed Blanchard's angustellus as a synonym of lignosella and thus made Pempelia and Elasmopalpus synonyms, since both of these species were genotypes.

In 1881 Zeller published another paper dealing with the synonomy of this insect. He determined at this time that incautella was a synonym of lignosella though he considered tartarella as a valid variety; thus, the specific names were Pempelia lignosella and P. lignosella tartarella.

In 1888 G. D. Hulst named the lesser cornstalk borer as Dasypyga carbonella and described it as a new species from material that had been collected in Texas. In 1890, he realized his error and made the proper correction in his monograph of the Phycitidae and placed his species carbonella synonymous with Zeller's variety tartarellus. In this publication, Hulst also redescribed the species lignosellus and placed it under the genus Elasmopalpus for the first time while also recognizing Zeller's two varieties incautellus and tartarellus.

The synonomy for the lesser cornstalk borer is as follows:

Pempelia lignosella Zeller

Elasmopalpus angustellus Blanchard

Pempelia lignosella tartarella Zeller

Pempelia lignosella incautella Zeller

Dasypyga carbonella Hulst

Elasmopalpus lignosellus (Zeller) Hulst

Elasmopalpus lignosellus incautellus (Zeller) Hulst

Elasmopalpus lignosellus tartarellus (Zeller) Hulst

THE EGG STAGE

The egg of the lesser cornstalk borer is ovate in shape, ranging from .35 mm. to .43 mm. in width, and averaging .39 mm. Its length ranges from .51 mm. to .67 mm., averaging .58 mm. (Table 1). The exochorion is sculptured with shallow pits which are pentagonal or polygonal in outline. When first deposited, the egg is greenish-white but it turns pink in 8 to 24 hours. As it nears hatching, the egg turns a deeper red until, just prior to hatching, it is strongly iridescent crimson.

Attempts were made to determine the oviposition site by caging field-collected females on peanut plants grown in six-inch pots. One plant was grown per pot. The five cages used for this study were cylindrical in shape, one foot in length, and were made from 16-mesh screen wire with a muslin top. The wire cages were constructed to fit inside the pot and to extend one inch below the soil level. When the peanut plant attained a height of six inches, five females were placed inside each of the five cages. The majority of the female moths collected in the field had already mated and oviposited readily under laboratory conditions. The soil around the plant was loosened to prevent packing and provide soil conditions similar to those in the field.

The females were allowed to remain inside the cages for five days. At the end of this period, the upper one inch of soil was examined with a binocular microscope for the presence of eggs.

The enclosed females apparently deposited more eggs on the screen cage walls than on the plants or in the soil. No more than four or five eggs were found on the plants at any one time. They were deposited on the lower leaves and stems.

Plants growing in the field where heavy borer infestations were prevalent were examined for the presence of eggs as well as for the presence of young larvae feeding on the aerial portions of the plants, but negative results were obtained. At no time were eggs found under field conditions.

Studies to determine the duration of the egg stage were made under laboratory conditions. Field-collected females, presumably already mated, were placed in small glass jars, the mouths of which were covered with a piece of muslin held by a rubber band. A small wad of cotton previously immersed in sugar solution was placed at the bottom of the jar, providing food for the adult females. The moths oviposited on the underside of the muslin cover. The cover containing the eggs was replaced daily. The muslin cloth on which the eggs were deposited was kept at room temperature (70°F. to 100°F.) and examined every day until hatching, and the date of hatching recorded. Incubation records of 477 eggs disclosed that hatching occurred in 2 to 3.5 days, averaging 2.8 days (Table 2).

TABLE 1.--Length and width measurements of eggs of *Elasmopalpus lignosellus.* Stephenville, Texas. 1956.

Width	Length
.39	.55
.39	.59
.39	.55
.39	.55
.39	.59
.39	.55
.43	.59
.39	.55
.35	.51
.39	.55
.39	.63
.39	.63
.34	.67
.35	.59
.39	.59
.39	.55
.39	.51
.43	.55
.35	.63
.39	.59
Average .39	Average .58

TABLE 2. -- Incubation records of eggs deposited by field-collected female moths of the lesser cornstalk borer, _Elasmopalpus lignosellus_ Zeller. Stephenville, Texas. 1956.

Deposited		Hatching		Incubation
Date	No. of Eggs	Date	No. of Eggs	Days
Aug. 3	88	Aug. 6	4	3
9	77	12	7	3
10	12	12	63	2
10	47	13	47	3
11	12	--	--	--
11	8	--	--	--
12	65	15	65	3
13	15	16	15	3
13	25	16	18	3
16	36	19	36	3
17	115	19	20	2
17	37	20	58	3
18	14	21	37	3.5
20	58	--	--	--
22	42	24	42	2
29	22	Sept. 1	22	3
Sept.12	29	15	29	3
13	48	--	--	--
			Average	2.8

THE LARVAL STAGE

Host Plants. The larva of this species has a wide range of host plants, which are generally restricted to legumes and grasses. The extent of host plants and distribution of the insect is best illustrated by the 1953 Cooperative Economic Insect Report. During the year the lesser cornstalk borer was reported to have caused economic damage to beans, corn and black-eyed peas in California. Damage also was reported in Arizona on beans and hegari. Agricultural workers from Texas, Louisiana, Mississippi, Virginia, Alabama, Georgia, Tennessee, Oklahoma, South Carolina, North Carolina, Florida and Missouri reported this insect to have caused economic damage on one or more of their local agricultural crops.

The 1953, 1954 and 1955 Cooperative Economic Insect Reports list the following species as the host plants of the lesser cornstalk borer:

Alfalfa, Medicago sativa
Beans, Phaseolus vulgaris
Cantaloupes, Cucumis melo
Chufa, Cyperus esculentus
Colorado grass, Panicum texanum
Corn, Zea mays
Cowpea, Vigna sinensis
Crabgrass, Digitaria sp.
Hegari, Sorghum vulgare
Johnson grass, Sorghum halepense
Lima beans, Phaseolus limensis
Lupines, Lupinus sp.
Milo maize, Sorghum vulgare
Oats, Avena sativa
Peanuts, Arachis hypogea
Peas, Pisum sativa
Snap beans, Phaseolus vulgaris
Sorghum, Sorghum vulgare
Sugar Cane, Saccharum officinarum
Turnip, Brassica rapa
Wheat, Triticum vulgare

As may be seen from the above list the known host plants include economic crops as well as plants regarded as noxious weeds.

In the vicinity of Stephenville, Texas, the author found the lesser cornstalk borer attacking field peas, black-eyed peas, corn, sorghum, hegari, Colorado and Johnson grass, peanuts, oats, crab grass and cantaloupes.

Feeding Habits. In the two seasons during which this work was conducted, attempts were made to determine when the larvae first appeared in the field, since there were no larvae found in the winter. The first larvae of the lesser cornstalk borer were found in the latter part of June feeding on volunteer peas; the second year the borer was not found until the middle of July, although the host plant range was better known and a more thorough survey was done than the first year.

Once the larvae were found, careful observations were made to determine the mode of feeding on the various plants attacked. The larvae characteristically feeds by boring into the root or stem of the plant immediately below the soil surface and tunnelling upward into the main stem for a distance of one or two and sometimes three inches.

The larvae usually were not found in the tunnels of these stems, but were located in constructed tubes radiating horizontally from the attacked stalk, immediately below the soil surface. These tubes varied in length depending on the age of the larvae, but usually they were about two or three inches long. The tubes were constructed from dried particles of sand that the larvae had spun together along with dried excrement.

The tubes were very delicate and were readily broken when the plant was pulled up. Close examination disclosed that the mouth of the tube was attached to the area where the borer tunneled into the stem. More often than not, when a plant was pulled out of the ground, the roots and stems were devoid of borers although feeding signs were present. In such cases it was necessary to locate the tubes in which the larvae were located. Although several larvae often attacked a plant, there was only one borer per tube.

The feeding habits of the lesser cornstalk borer varied, depending upon whether the host plant had a taproot as in peanuts or adventitious roots as in plants belonging to the grass family.

The peanut plant has a fleshy taproot and stem from the outset of the plant's development. This characteristic provides the feeding borer an opportunity to tunnel into the taproot and up into the stem. However, in the grasses, such as Colorado grass, the larva attaches the tube to the crown of the plant and feeds on the roots alone, making no attempt to tunnel into the stems until the plant has grown and the stems are sufficiently large to support the borer.

The feeding is not confined to tunneling in the stems. The damage may be restricted to the root system which may be girdled. The stems may also be girdled by the feeding of the borer. When this takes place, the plants are weakened and very little pressure is required to break them off. When attempts are made to pull the plants up, they readily break at this girdled point.

In peanuts, all plant portions below the ground level are attacked. Taproots, secondary roots, pegs, and nuts are fed on indiscriminately. It is not unusual to find the larva boring into the developing peanut shell and feeding on the immature seed. (Figure 1).

In young peanut plants not more than two or three larvae were found feeding on one plant, each within a separate tube; in more mature plants, as many as ten larvae were found damaging the plant (Figure 2).

Number of Instars. This study began in late June as soon as moths became available. Forty specimens were reared for each instar. This number of larvae was considered adequate to determine the number of instars.

The date of hatching was recorded for each egg hatch. The larvae were placed singly in glass jars and observed daily. By maintaining the larvae singly, the change from one instar to another was readily noted by the presence of the exuviae on the bottom of the glass jar.

The head capsules of the 40 larvae in each instar were measured at their widest point, by means of an ocular micrometer, and the readings were converted to millimeters. Body length measurements also were taken.

The first instar larvae were allowed to feed for 24 hours before they were killed in KAAD, and head and body measurements were taken. KAAD is a larval preservative made up of the following ingredients:

Kerosene	1 part
Ethyl alcohol	7-10 parts
Acetic acid	2 parts
Dioxane	1 part

The acetic acid serves as a color preservative, although the larvae will discolor after a period of time, but not as rapidly as when the larvae are immersed in 70% alcohol alone. The dioxane is included in this formulation to emulsify the alcohol and kerosene since they tend to separate.

For the succeeding instars, the larvae were fed daily on fresh peanut roots and killed and measured at regular intervals.

The measurement of the last larval instar was obtained after the larvae had attained the prepupal stage.

Six larval instars were passed through by the lesser cornstalk borer in the vicinity of Stephenville, Texas, under laboratory conditions. (Tables 3, 4, 5, 6, 7 and 8) Although the number of instars probably varies according to climatic variations and food availability, no such variation was noted.

The results of this study are in accord with the results obtained by Luginbill and Ainslie. The body length and width measurements of head capsule obtained correlate very closely with the measurements of the six larval instars they described.

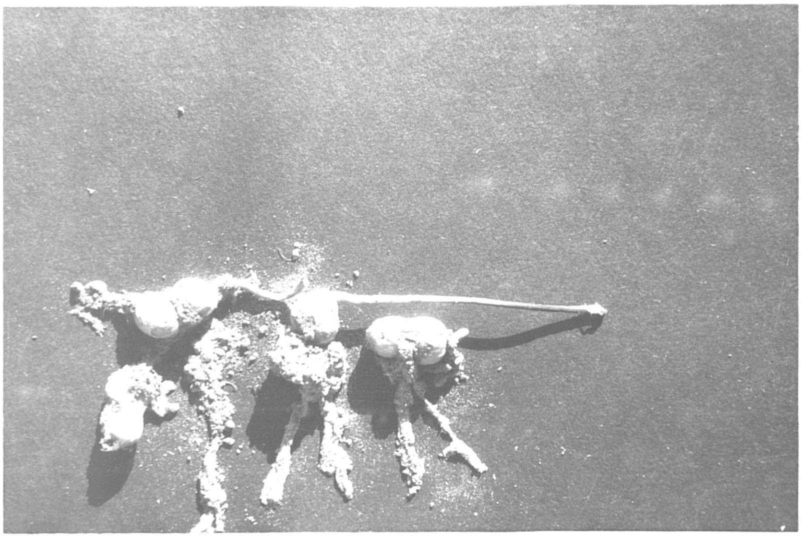

Figure 1. Peanuts with tunnels radiating from entry holes made by the lesser cornstalk borer.

Figure 2. Peanut vine with tunnels surrounding the peanuts.

TABLE 3. -- Body length and width of head capsule in millimeters for first instar larvae of Elasmopalpus lignosellus. Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	1.6	.23
2	1.5	.23
3	1.8	.23
4	1.6	.23
5	2.0	.23
6	1.4	.23
7	1.6	.23
8	1.7	.23
9	1.4	.23
10	1.9	.23
11	1.6	.23
12	1.5	.23
13	1.3	.23
14	1.6	.23
15	1.7	.23
16	1.5	.23
17	1.5	.23
18	1.5	.23
19	1.5	.23
20	1.6	.23
21	1.6	.23
22	1.6	.23
23	1.6	.23
24	1.4	.23
25	1.6	.23
26	1.6	.23
27	1.5	.23
28	1.3	.23
29	1.3	.23
30	1.4	.16
31	1.5	.23
32	1.6	.23
33	1.5	.20
34	1.9	.23
35	1.7	.23
36	1.3	.23
37	1.6	.23
38	1.4	.23
39	1.3	.23
40	1.6	.23
Average	1.6	.22

TABLE 4. -- Body length and width of head capsule in millimeters for second instar larvae of Elasmopalpus lignosellus. Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	3.9	.31
2	4.0	.31
3	4.1	.31
4	3.9	.31
5	3.8	.31
6	4.2	.31
7	3.9	.31
8	3.9	.31
9	4.6	.31
10	4.2	.31
11	4.4	.31
12	3.9	.31
13	3.7	.31
14	2.0	.31
15	3.6	.21
16	3.4	.31
17	3.3	.31
18	3.3	.31
19	3.8	.31
20	3.9	.31
21	3.7	.31
22	3.9	.31
23	4.4	.31
24	4.0	.31
25	3.7	.31
26	2.0	.31
27	4.0	.31
28	3.9	.31
29	4.2	.31
30	2.0	.31
31	3.9	.31
32	2.7	.31
33	3.4	.31
34	3.3	.31
35	3.7	.31
36	3.3	.31
37	3.8	.31
38	3.1	.31
39	4.0	.31
40	3.6	.31
Average	3.6	.31

TABLE 5. -- Body length and width of head capsule in millimeters for third instar larvae of *Elasmopalpus lignosellus.* Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	5.3	.38
2	5.3	.44
3	5.2	.44
4	5.4	.44
5	4.2	.44
6	5.7	.44
7	3.0	.38
8	5.4	.44
9	4.0	.44
10	4.6	.38
11	5.7	.50
12	7.6	.50
13	7.6	.50
14	6.3	.50
15	6.3	.50
16	7.5	.50
17	6.7	.50
18	4.6	.44
19	6.3	.50
20	6.3	.50
21	6.3	.44
22	6.2	.44
23	5.1	.44
24	4.6	.44
25	6.3	.50
26	5.7	.50
27	6.6	.44
28	6.7	.50
29	5.0	.44
30	4.5	.44
31	3.6	.38
32	4.4	.38
33	7.5	.50
34	6.6	.44
35	5.4	.44
36	4.8	.38
37	3.9	.50
38	4.9	.44
39	5.0	.38
40	2.0	.38
Average	5.6	.45

TABLE 6. -- Body length and head capsule measurements in millimeters for fourth instar larvae of *Elasmopalpus lignosellus*. Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	7.2	.57
2	10.6	.63
3	8.2	.63
4	5.7	.57
5	9.9	.63
6	9.2	.63
7	7.6	.57
8	7.6	.63
9	5.9	.63
10	6.0	.57
11	5.8	.57
12	7.8	.57
13	7.6	.63
14	8.4	.63
15	9.3	.60
16	10.7	.70
17	11.4	.70
18	9.5	.70
19	10.4	.70
20	9.2	.70
21	7.6	.60
22	6.8	.60
23	9.1	.60
24	8.8	.60
25	6.7	.60
26	7.6	.70
27	5.3	.60
28	7.6	.70
29	5.3	.60
30	8.7	.70
31	9.1	.70
32	10.7	.70
33	7.6	.70
34	8.6	.70
35	5.7	.60
36	5.1	.70
37	5.4	.60
38	8.1	.70
39	7.6	.60
40	8.3	.60
Average	7.9	.64

TABLE 7. -- Body length and head capsule measurements in millimeters for fifth instar larvae of Elasmopalpus lignosellus. Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	9.9	.76
2	8.9	.76
3	10.7	.76
4	9.5	.76
5	9.6	.76
6	8.4	.76
7	8.9	.82
8	8.2	.90
9	13.8	.90
10	11.4	.80
11	7.6	.90
12	8.2	.90
13	13.3	.90
14	7.6	.90
15	10.3	.90
16	11.4	.90
17	11.4	.90
18	11.4	.90
19	9.2	.90
20	11.4	1.00
21	9.7	.90
22	11.4	.90
23	13.0	1.00
24	8.6	.90
25	12.4	.90
26	13.5	1.00
27	8.5	.90
28	11.4	.90
29	7.6	.80
30	11.0	.90
31	11.4	.90
32	9.5	.90
33	8.3	.90
34	12.1	1.00
35	10.1	1.00
36	11.0	.80
37	12.5	.90
38	13.3	1.00
39	11.4	.86
40	10.2	.90
Average	10.4	.88

TABLE 8. -- Body length and head capsule measurements in millimeters for the sixth instar larvae of Elasmopalpus lignosellus. Stephenville, Texas. 1956.

Larva Number	Body Length	Head Capsule
1	15.3	1.26
2	16.6	1.26
3	17.6	1.26
4	17.7	1.26
5	18.9	1.26
6	16.4	1.26
7	18.6	1.26
8	15.2	1.26
9	16.4	1.26
10	16.4	1.26
11	16.8	1.26
12	18.7	1.26
13	19.4	1.26
14	15.2	1.26
15	15.2	1.26
16	17.2	1.26
17	18.0	1.26
18	17.3	1.26
19	18.1	1.26
20	16.0	1.26
21	18.9	1.20
22	17.8	1.10
23	17.3	1.20
24	20.8	1.20
25	18.9	1.20
26	15.2	1.20
27	17.9	1.20
28	11.0	1.10
29	13.8	1.10
30	13.3	1.10
31	14.1	1.20
32	11.4	1.10
33	15.1	1.10
34	15.8	1.10
35	13.9	1.10
36	11.0	1.10
37	11.4	1.10
38	13.5	1.10
39	14.4	1.20
40	16.4	1.10
Average	16.1	1.20

Duration of the Larval Stage. Eggs collected from laboratory-reared females were retained until they hatched, and the larvae were placed in small glass jars. It was possible to keep three or four larvae in one jar while they were young. Although no cannibalism was noted, the larvae were raised separately after reaching the second or third instar, and thus the competition for food was eliminated.

A thermograph was operated in the laboratory during the tenure of this study, which began in late June and ended in September. The average daily maximum and minimum temperatures for these months were as follows: June, 92.3°F. and 77°F.; July, 93°F. and 79.5°F; August, 94.5°F. and 79.5°F.; September, 89°F. and 74°F.

Tables 9, 10 and 11 show that the duration of the larval stage in the latter part of June and early July averaged fourteen days with a range of twelve to eighteen days. During the month of August the length of the larval stage averaged seventeen days with a range of fourteen to twenty-one days. During the month of September the length of the larval stage averaged thirty days with a range of twenty-six to thirty-nine days. This increase in the duration of the larval stage probably was due to variations in temperatures during September. Although the average daily temperatures did not differ greatly from the August temperatures, the September lows were commonly around 65°F. to 70°F. and the high temperatures were usually 90°F. During August, however, the majority of the low temperatures were approximately 80°F. and the high temperatures on on many days were 100°F. or slightly over.

TABLE 9. -- Duration of the larval stage of Elasmopalpus lignosellus during June and July. Stephenville, Texas. 1956.

Hatching Date	Pupation Date	Days in Larval Stage
6/25	7/9	14
6/25	7/10	15
6/26	7/14	18
6/26	7/13	17
6/28	7/12	14
6/29	7/13	14
7/2	7/17	15
7/4	7/17	13
7/4	7/14	12
7/5	7/20	15
7/11	7/28	17
7/12	7/24	12
7/15	7/17	12
7/15	7/29	14
7/17	7/30	13

TABLE 10. -- Duration of the larval stage of Elasmopalpus lignosellus during August. Stephenville, Texas. 1956.

Hatching Date	Pupation Date	Days in Larval Stage
8/12	8/30	18
8/13	8/30	17
8/13	9/1	19
8/15	8/29	14
8/15	8/30	15
8/15	8/30	15
8/15	9/1	16
8/15	8/30	15
8/16	9/2	17
8/16	9/2	17
8/19	9/2	14
8/20	9/10	21
8/24	9/13	20
8/24	9/12	19

TABLE 11. -- Duration of the larval stage of *Elasmopalpus lignosellus* during September. Stephenville, Texas. 1956.

Hatching Date	Pupation Date	Days in Larval Stage
9/1	9/29	28
9/1	9/29	28
9/1	10/1	30
9/1	10/2	31
9/1	9/29	28
9/3	9/29	26
9/3	10/3	30
9/3	10/2	29
9/3	10/3	30
9/3	9/28	25
9/10	10/11	31
9/10	10/19	34
9/10	10/15	35
9/10	10/16	36
9/10	10/10	30

<u>Description.</u> The following descriptions of the six larval instars are in agreement with those of Luginbill (1914). The measurements of the various larval instars were determined by the author from specimens reared in the laboratory at Stephenville, Texas.

First Instar. Length 1.3 mm. to 2.0 mm., average 1.6 mm. Head slightly bilobed, flattened, highly polished dark brown, width .23 mm., about as high as wide; clypeus triangular, .11 mm. high. Paraclypeal pieces not perceptible, labrum pale, tips of mandibles reddish brown, not projecting; antennae pale, moderate. Cervical shield almost straight in front, much rounded behind, not quite as wide as the head. Prespiracular tubercle bears 2 setae, the upper of the two being shorter; subventral tubercle also bears 2 setae, the cephalad one being the shorter. Anal plate somewhat triangular, dusky. Body pale yellowish to yellowish green; posterior portion of each segment bright red to reddish brown on dorsum; whole dorsum of joint 5 of this color, giving the larva a longitudinally striped as well as transversely banded appearance. Segments slightly swollen, except last. Tubercles small; "iv-v" coalescent on joints 5-13, inclusive, below spiracle on joint 5, laterad and slightly cephalad of spiracle on joints 6-12, inclusive, directly laterad of "iii" in joint 13. Setae "iib" of joints 3 and "iii" of joint 12 .25 mm. long, about twice as long as others. Abdominal segments except terminal crossed transversely through the middle by shallow grooves on dorsum. Thoracic feet pale, though somewhat dusky; abdominal prolegs all whitish.

Second Instar. Length 2.0 mm. to 4.4 mm., average 3.6 mm. Head slightly bilobed, flattened, highly polished, blackish brown, width .31 mm. Cervical shield concolorous with head, .26 mm. in width. Anal plate dusky. Body pale yellowish; transverse bands and stripes adjoining as in the first instar. Tubercles "iib" of joints 3 and "iii" of joint 12 large, each supplied with a long setae as before; sub-primaries present. Thoracic feet pale to dusky; abdominal prolegs same as venter of body, pale yellowish.

Third Instar. Length 2.0 mm. to 7.6 mm., average 5.6 mm. Head as in second instar except paler, width from .38 mm. to .50 mm., average .45 mm., a little wider than high; clypeus .20 mm. high, labrum pale amber, mandibles dark amber, almost black at tips; antennae pale amber at tips, otherwise pale whitish. Cervical shield large, darker than head, the anterior border extending somewhat over the head lobes, wider than head, width .54 mm., length .30 mm., corneous, polished. Body pale greenish white to pale yellowish green; transverse bands and connecting stripes reddish brown to brown, body sometimes only greenish white between the stripes, tapering posteriorly. Thoracic legs dusky; abdominal prolegs pale yellowish green, same as venter.

Fourth Instar. Length 5.1 mm. to 11.4 mm., average 7.9 mm. Head slightly bilobed, polished dark brown, .57 mm. to .70 mm. average .64 mm., about two- thirds as high as wide; clypeus .25 mm. high; around base of spines pale. Cervical shield concolorous with head, width .89 mm., length .45 mm. Prespiracular tubercle large, somewhat corneous, dusky, subventrical tubercle also dusky, normal. Greenish white color of body more conspicuous and breaking into the transverse bands, very deeply in some segments; stripes joining transverse bands wider than before. Thoracic legs and abdominal prolegs as before.

Fifth Instar. Length 7.6 mm. to 13.5 mm., average 10.4 mm. Head bilobed and polished as before, shaded dark brown to black, width .76 mm. to 1.00 mm., average .88 mm., clypeus .32 mm. high, the paraclypeal pieces distinct, the sutures almost touching the beginning of the intersection point of the lobes on the vertex, whitish; labrum pale amber, mandibles amber, very dark at tips. Cervical shield darker than head, 1.02 mm. wide, .62 mm. long; on the meson is a pale stripe extending longitudinally from the posterior border to a point almost across the shield. Body as in preceding stage except that transverse bands are now at point of being broken up, giving away to pale yellowish white color of the dorsum, the dark color confined chiefly to the longitudinal stripes, almost continuous over the body but very irregular; in some specimens there is a whitish patch, ellipsoidal in outline, on the dorsum of joints 3 and 4 venter tinged with pale reddish. Thoracic legs and abdominal prolegs as in preceding stage.

Sixth Instar. Length 11.0 mm. to 20.8 mm., average 16.1 mm. Head slightly bilobed, somewhat flattened, dark brownish black, highly polished, width 1,10 mm. to 1.26 mm., average 1.20 mm. Clypeus triangular pale in the upper angle, extending over two-thirds of height of head, .43 mm. Paraclypeal pieces prominent, sutures converging at the beginning of intersection point of head lobes on vertex; setae pale, stiff, pale around base; proximal parts of antennae pale whitish, distal amber; labrum pale amber, width .32 mm.; mandibles dark red, black at tips. Cervical shield dark brown, width 1.49 mm., length .93 mm.; pale line on meson extending across the shield, coming to a point before; extending over head to intersection of lobes. Body green, prevailing color on the dorsum greenish white, which almost breaks up completely the dark brown transverse bands; longitudinal stripes conspicuous, dark brown somewhat broken. Tubercles "ia" and "ib" of joint 3 small, setae short, "iia" and "iib" small, seta long; "ia" and "ib" of joint 4 small, seta short, "iia" and "iib" small, seta long, caudad of latter dusky patch, somewhat polished, on joints 3 and 4; "iii" caudo-laterad of "iib" distant, "iv" cephalad and slightly laterad of "iii", distant, "v" cephalolaterad of "iv", well separated; "iv-v" is coalescent on joints 5-13, inclusive, arrangement as before; on joint 13 "vi" is near "v"; on joints 12 and 13 "ii" arranged in form of square. All segments slightly swollen except last two; transverse grooves prominent; thoracic legs dusky; abdominal prolegs pale.

<u>Effects of Temperature on Larval Activity.</u> Several larvae in the fourth to sixth instar were field collected and placed in pint ice cream cartons which contained about one inch of soil. Fresh peanut roots were provided for food every other day. The ice cream cartons were placed in two walk-in refrigeration units set at 65°F. and 35°F. respectively.

Larvae collected on September 6 were refrigerated at 65°F. After being exposed to this temperature for twenty-four hours, the younger larvae were found to be inactive, whereas the older larvae, or those in the late fifth instar and sixth instar, had formed a cocoon. The larvae were then removed and placed at room temperature (91°F.). The younger larvae became active again, but no change was noticed in those larvae that had formed a cocoon.

Another series of larvae in the same stages of development was collected on the same day, refrigerated at 65°F. for twenty-four hours, then transferred to the 35°F. room where they remained until October 3. These larvae were taken out of the 35°F. room, removed from the containers and placed in the laboratory at room temperature (78°F.) to allow them to thaw out. After being exposed to these two temperatures, none of the larvae survived.

Another series of larvae, varying in stages of development, was placed directly in the 35°F. temperature room. They were in ice cream cartons with the necessary soil and food provided. These larvae remained in this room until October 3, when they were taken out and placed in the laboratory at room temperature (89°F.). Following this exposure the larvae failed to survive.

The larvae did not remain active when environmental temperatures attained 65°F. The late instar larvae upon reaching 65°F. started to construct a cocoon for hibernation, an indication that the overwintering may be accomplished in the pupal stage.

THE PUPAL STAGE

Description. The typically obtected pupa when newly formed is pale green in color, with yellowish abdominal segments. As the pupa matures it becomes brown and turns a uniform shiny black prior to adult emergence. The pupa ranges in length from 7.6 mm. to 9.6 mm., averaging 8.4 mm. Its width ranges from 1.8 mm. to 2.5 mm., averaging 2.1 mm. (Table 12).

Pupation Site. Pupae were found readily in fields examined in Erath, Mason and Llano Counties during the summers of 1955 and 1956. The pupae generally were found near the crown of the peanut plant below the soil surface, either in a loose cocoon or in a cocoon formed as part of the exit tube attached to the underground portions of the plant. An exposed pupa not protected by a cocoon was never found in the field (Figure 3). Larvae reared in the laboratory, without access to sand or dirt, also spun cocoons.

Luginbill and Ainslie (1917) and Lyle (1927) stated that the larvae pupate within the stalks of corn plants. This method of pupation was not discovered in peanuts, where all the pupae observed were in the soil.

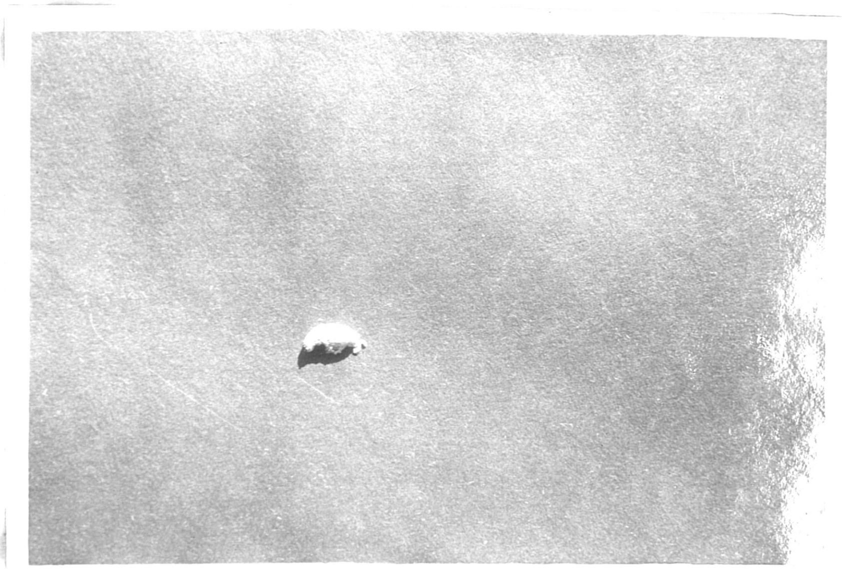

Figure 3. Cocoon of the lesser cornstalk borer containing the pupa.

TABLE 12. -- Measurements in millimeters of the pupa of *Elasmopalpus lignosellus* Zell. Stephenville, Texas. 1956.

	Length	Width
	8.2	2.2
	8.9	2.2
	8.9	1.9
	8.9	2.2
	8.4	2.0
	8.9	2.0
	8.1	1.8
	8.5	2.2
	8.4	2.2
	8.4	2.2
	9.2	2.3
	7.6	1.9
	8.9	2.2
	9.6	2.5
	7.7	1.9
	7.6	1.8
	7.6	1.8
	8.4	1.9
	9.2	2.2
	7.7	1.9
Average	8.4	2.1

Duration of Pupal Stage. Table 13 shows the duration of the pupal stage during the months of July, August and September under laboratory conditions. The temperatures in the laboratory for these months were the following: Maximum temperatures for July were 100°F., with 76°F. the lowest recorded. During the month of August a high of 102°F. was recorded inside the laboratory, the low being 66°F. The high for September was 98°F.; the low, 64°F.

The duration of the pupal stage for the month of July ranged from six to ten days, with an average of seven and one-half days. From the middle to the end of August the pupal stage was lengthened, ranging from eight to twelve days with an average of nine and one-fourth days. However, during the month of September, the pupal longevity was from ten to seventeen days and averaged thirteen and one-half days.

Effects of Temperature on the Pupa. Maintaining pupae at constant temperatures in the walk-in refrigerators had some interesting effects on the longevity of the pupal stage.

Newly formed pupae, during the month of July, were refrigerated at a constant temperature of 65°F. for twenty-four to forty-eight hours. Following this exposure period they were taken out of the refrigerator and maintained in the laboratory at room temperature. The pupae required from fifteen to twenty-five days for emergence, whereas the normal pupal period for July averaged seven and one-half days. Pupae maintained in the 35°F. room for twenty-four and forty-eight hours failed to survive.

Pupae subjected to a constant temperature of 65°F. or 35°F. for two months failed to emerge.

TABLE 13. -- Duration of pupal stage of Elasmopalpus lignosellus for the months of July, August and September. Stephenville, Texas. 1956

Number of Individuals	Date Pupation	Date Emergence	Days in Pupal Stage
1	7/20	7/30	10
1	7/21	7/30	9
1	7/22	7/31	9
1	7/23	7/30	7
1	7/23	7/30	7
1	7/24	8/1	8
1	7/24	7/30	6
1	7/24	7/31	7
1	7/24	7/31	7
1	7/24	8/1	8
1	7/25	8/1	7
1	7/27	8/2	6
1	7/27	8/2	6
			Average 7.50
1	8/15	8/24	9
1	8/15	8/24	9
1	8/17	8/27	10
1	8/17	8/25	8
1	8/18	8/28	10
1	8/18	8/26	8
1	8/20	8/29	9
1	8/20	8/30	10
1	8/21	8/29	8
1	8/22	8/30	8
1	8/24	9/2	10
1	8/27	9/8	12
			Average 9.25
1	9/22	10/2	10
1	9/22	10/3	11
1	9/22	10/6	14
1	9/24	10/4	10
1	9/26	10/7	11
1	9/26	10/10	14
1	9/26	10/12	16
1	9/27	10/14	17
1	9/28	10/14	16
1	9/28	10/14	16
35			Average 13.50

THE ADULT STAGE

Description.[1] Head blackish. Labial palpi erect not recurved, heavily scaled, lying close together on the shining crest which is hollowed out for them, and member very short. Maxillary palpi pencil tufted. Proboscis long, strong and scaled. Ocelli present. Antennae brownish in color, filiform, bent above base, with a heavy tuft of scales in the bend in the male; in female antennae more slender, tuft wanting.

Thorax brown to black. Legs brown tinged with gray. Tarsal segments yellow. Fore wings narrow, 8-9 mm. long, outer margin oblique, inner margin waved. In male, fore wing brown to black on posterior margin from base out, with a poorly defined median stripe of ochre-brown reaching to almost distal margin. Blackish color present all around the edge of the wing from a narrow edging to a complete covering; disk is yellow to reddish. Dense brown dot located on subdorsal vein; diagonally outwards above it upon median vein is a smaller dot and distad a more prominent one on the cross vein, both lying close to brown shading on anterior margin. Distal margin marked by row of confluent dots within which is distinct grayish stripe; within this in the dark color of surface appears beginning of second cross line very close to distal margin and

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[1] G. D. Hulst's original description of the adult is used here, as well as Ainslie's compilation of Zeller's and Hulst's description of the species.

most apparent on anterior margin; fringes brownish gray. In the female, markings are the same but darker; sometimes wing is entirely black. Hind wings in both sexes transparent fuscous white, darker on veins and edges. Venation: fore wings 11 veins, 4 and 5 separate, 10 separate; hind wings 2 more or less distant from angle, 4 and 5 stemmed, 6, 7, and 8 stemmed, cell rather short.

Abdomen fuscous to yellowish, darker in female; terminal tuft yellow, darker in the male. Genitalia of male; Uncus longer and slenderer than in related genera, bifid at base, these parts arched, spine long; harpes broad, with long hairs along upper edge forming an anal tuft; a strong bent spine at base; lower plate conical, within entrance of long, slender, bent spine.

Time of Activity. The moths were active after sundown and in the early part of the night. In the daytime they rested under the peanut plants taking short flights when disturbed. On cool, cloudy mornings, the moths were active but would come to rest with the rise in morning temperatures and increase in light.

Collection of Moths. Two different means were used in attempts to collect moths. One was the standard light trap. The second method consisted of placing coffee cans containing a bait in various locations. The bait was composed of 1 part sugar, 9 parts water, 0.5 parts terpineal and 3 parts "Tween 20" per gallon of bait.

The light trap and bait cans were checked daily for the presence of lesser cornstalk borer moths. No moths were collected in the bait traps during the summers in which they were operated.

Temperature Effects on Adult Activity. Adults were collected from the field and brought in to the laboratory for this phase of the study.

The moths were found resting on 16-mesh screen cages in the field throughout the day.

Adults maintained in the 65°F. walk-in refrigerator remained active and continued feeding and ovipositing. Moths of both sexes refrigerated at 35°F. for a week remained inactive when they were placed at room temperature, but began activity within a few minutes. Exposures to temperature of 35°F. for periods longer than seven days killed the moths.

Longevity. Records obtained from moths in the laboratory showed that they lived longer during the month of July. The life cycle was shortened during the late summer and early fall. These results are summarized in Table 14.

TABLE 14. -- Duration of the moth stage as shown by laboratory-reared moths at room temperature. Stephenville, Texas. 1956.

Emerged	Died	Sex	Adult Longevity in Days
July 14	July 24	M	10
July 14	July 30	F	16
July 17	July 28	M	11
July 18	July 30	M	12
Aug. 2	Aug. 9	M	6
Aug. 12	Aug. 23	M	11
Aug. 13	Aug. 18	M	5
Aug. 16	Aug. 23	M	7
Aug. 18	Aug. 25	F	7
Aug. 18	Aug. 23	F	5
Aug. 19	Aug. 25	F	6
Aug. 20	Aug. 25	M	5
Aug. 24	Aug. 29	M	5
Aug. 26	Sept. 2	M	7
Aug. 26	Sept. 3	F	8
Sept. 9	Sept. 14	M	5
Sept. 11	Sept. 15	F	4
Sept. 11	Sept. 15	M	4
Sept. 11	Sept. 15	F	4
		Average	7.26

OVERWINTERING

The stage of development in which the lesser cornstalk borer overwinters has been a question never satisfactorily answered by the few workers that have studied this insect. Apparently the overwintering stage varies from one area to another, depending on the severity of the winters. Lyle (1927) reports that in Mississippi, this insect species passes the winter in the pupal stage, Vorhies and Wehrle (1946) in Arizona report that it overwinters in the soil in the larval stage.

The lesser cornstalk borer probably overwinters in the Stephenville area in the late larval or the pupal stage in soil or plant debris. Inspection of various fields that had been in peanuts the previous growing season failed to reveal any quiescent larvae or pupae. It is doubtful whether the larvae feed during the winter in this area because of the cold temperatures and lack of available host plants.

MOISTURE EFFECTS ON LARVAL ACTIVITY AND DEVELOPMENT

Because the author had observed that lesser cornstalk borers appeared to be less numerous in certain irrigated fields in Erath County, an experiment was designed to determine the effects of moisture on larval activity by controlling the amount of water available to the test plants.

A shed (Figures 4 & 5) was constructed of lumber and translucent polyethylene material to house the potted peanut plants during this study. The roof and the wall frames were made of 2" x 4" lumber covered with the polyethylene material to admit sunshine but keep rain out. The walls of the shed consisted of removable panels which were removed during the daytime if the weather was clear, but were put on at night to keep out the rain.

Three peanut seeds were planted in each of eighty 12-inch pots. After germination the seedlings were thinned out to one plant. The pots were taken inside the shed and set on wooden blocks (Fig. 6) to prevent the roots from growing into the soil and obtaining additional water.

The eighty pots were divided into four groups of twenty each to correspond with the four watering levels used. The watering levels were equivalent to trace amounts 1-1/2, 3 and 4-1/2 inches of rainfall a month; the trace level consisted of watering the plants as needed to keep them alive.

Before planting, the soil in the pots was soaked to assure germination.

Once the plants sprouted and were thinned the watering schedule was followed. The watering levels for the various amounts of simulated rainfall were as follows: Enough water was provided to keep the plant alive in the trace level. Ninety-three, 185 ml. and 278 ml., respectively, were the daily requirements for the 1-1/2, 3 and 4-1/2 inches of simulated rainfall.

Watering was initiated on July 13, and the proposed schedule was followed for one month. However, as the plants grew and the heat increased, it became evident that the water provided was not enough to keep the plants alive. From the middle of August to the end of the experiment in October, the schedule was changed so that the four series of pots were watered with the following amounts: The trace level remained the same. The 1-1/2 inch level was varied from 400-700 ml. per day depending on the condition of the plant. The 3 and 4-1/2 inch levels were altered to be two and three times, respectively, the amount given the plants receiving the second level.

Each of the sixty pots was infested on July 27 with five third instar larvae of the lesser cornstalk borer, and reinfested on August 23 with one three-day old larva. The remaining twenty pots were kept borer-free.

Table 15 shows the results obtained from infested and non-infested pots. Records were obtained of green and dry weights of the plants and the weight of the peanuts off the plants. There was little or no difference between the infested and non-infested pots in the green and dry weights or the weight of the peanuts. Two explanations for the insignificant results are offered. The first one is the possibility that the borer infestation was not large enough to cause extensive injury. Unless mortality was severe, five larvae would have caused severe damage to these plants. The second, and more probable, explanation is that the larval were unable to become established.

TABLE 15. -- Average weight in grams of peanut plants and peanuts in the moisture experiment showing effects of feeding by the lesser cornstalk borer under various watering levels.

Water Amts.[1]	Green Weights[2]		Dry Weights[2]		Peanuts[2]	
A	13	18	5	6	2	2
B	17	17	6	7	2	3
C	23	27	9	10	4	4
D	34	32	11	12	5	6

1/ Treatments: A, trace; B, 400-700 ml. of water per day; C twice B; D, three times B.

2/ Left column indicates average of sixty infested pots; right column indicates average of twenty borer-free pots.

Figure 4. Shed shown with wall panels removed.

Figure 5. Shed shown with wall panels in place.

Figure 6. Arrangement of pots to prevent roots from growing into the soil.

STUDIES ON THE RELATIONSHIP BETWEEN THE INCIDENCE OF SOUTHERN BLIGHT, SCLEROTIUM ROLFSII SACC., AND THE PRESENCE OF THE LESSER CORNSTALK BORER

The presence of southern blight *Sclerotium rolfsii* Sacc. in the peanut-growing area in the vicinity of Stephenville, Texas, is of economic significance. An experiment was designed to determine the relationship between the incidence of southern blight and the presence of the lesser cornstalk borer.

Two benches, 16 feet long, 2-1/2 feet wide and 10 inches deep were used in this work. The benches remained outdoors throughout the experiment. Each was planted with Spanish peanuts. Upon germination, the plants were thinned to fifty per bench.

The soil of both benches was inoculated with fresh oat cultures of *Sclerotium rolfsii*. The inoculum was in the mycelial stage of development. This inoculation was done in such a manner as to surround the plant with the pathogen.

One bench, considered the check, was not infested with borers, whereas the second bench was infested with two larvae per plant at the outset of the experiment. It was necessary to reinfest the plants periodically, as the borer population diminished.

It was also necessary to make a second attempt to inoculate the peanut plants with the disease. When the first soil inoculation failed to cause any disease symptoms on the plants, a second soil inoculation, with a fresh culture of the pathogen, was made approximately a month after the first one.

The duration of the experiment was from June 25 to October 15. During this period, none of the peanut plants developed disease symptoms. The plants were examined for borer feeding damage at the conclusion of the test, and a number of the plants exhibited extensive damage.

The results indicate that factors other than borer damage are instrumental in making the plant susceptible to the southern blight pathogen. The peanut plants that were damaged by the feeding of the borers, as well as the check plants, failed to become infected with the disease organism, although the soil where these two series of plants were grown was heavily infected with phytopathogenic organisms.

CONTROL EXPERIMENTS

Use of Trap Crops. In the summer of 1955 the lesser cornstalk borer was discovered in volunteer and cultivated black-eyed peas before it was found on peanuts. Hence an experiment was designed to determine whether the borer preferred peas to peanuts, or whether it appeared in the peas because they were in the field earlier than the peanuts.

Three blocks, each consisting of eighteen rows eighty-five feet long, were planted in the following manner: Block I: two rows of peas, twelve rows of peanuts, four rows of peas. Block II: four rows of peas, eight rows of peanuts, six rows of peas. Block III: two rows of peas, four rows of peanuts, two rows of peas, four rows of peanuts, two rows of peas and four rows of peanuts.

Initial infestations records were obtained on July 2, when the peanut plants were blooming and were from four to eight inches in height. A few small pegs were appearing. The pea plants were not blooming and ranged from six to fourteen inches in height. To calculate the size of the borer infestation, five plants per row in each block were pulled up and a percentage of damaged plants on specified dates was determined. The number of borers present was not recorded since many were not found on the roots after pulling the plant out. The low percentages obtained on July 31 were attributed to difficulty in making counts due to soil adherence to the roots following a heavy rain.

It is apparent from the results summarized in Table 16 that the lesser cornstalk borer does not exhibit a preference for black-eyed peas over peanuts. By July 20 the infestation was well distributed among the various blocks and rows within these blocks.

TABLE 16. -- Percentage of infested black-eyed peas and peanut plants on specified dates. Stephenville, Texas.

Date	Block I a[1]	Block I b[2]	Block II a[1]	Block II b2	Block III a[1]	Block III b[2]
July 2	2.33	10.00	20.00	0.00	8.33	0.00
5	10.00	0.00	27.50	0.00	20.00	0.00
9	5.00	0.00	12.50	4.00	10.00	10.00
13	5.00	10.00	5.00	0.00	3.33	6.67
20	41.67	23.33	27.50	12.00	23.33	16.67
31*	5.00	13.33	22.50	16.00	11.67	20.00
Aug.11	48.33	30.00	57.50	40.00	57.67	26.67
17	66.67	46.67	70.00	48.00	81.67	50.00
24	80.00	66.67	85.00	62.00	85.00	53.33
30	88.33	70.00	75.00	76.00	78.33	76.67
Sept. 6	90.00	76.67	85.00	90.00	83.33	83.33
18	95.00	93.33	95.00	96.00	90.00	93.33
26	96.67	100.00	100.00	98.00	95.00	96.67
Oct. 3	96.67	100.00	97.50	98.00	96.67	96.67

* Soil muddy following 1-1/2" rain.
1/ Peanut plants.
2/ Black-eyed pea plants.

Use of Commercial Insecticides. Test 1. An insecticide spray experiment for the control of the lesser cornstalk borer on dry land peanuts was initiated on August 16, 1955, at the Stephenville station. Three treatments were applied by means of a conventional six-row cotton sprayer. A randonized block design with four replications was used. Each plot was 100 feet long and six rows wide. The materials and dosages applied per acre were as follows: DDT, one pound active ingredient; endrin, one-third pound active ingredient; and DDT plus endrin at one pound and one-third pound respectively. An untreated check was included in the test.

The materials were applied as emulsion sprays on August 16, August 23, and August 31. Two per cent of the plants were infested by the lesser cornstalk borer before treatment was initiated. Though no infestation records were kept during the test, records of yield in grams of shelled peanuts were obtained by harvesting the four inside rows in each plot.

The results of this test are presented in Table 17. The yield in grams of shelled peanuts is given for each treatment and the check. There was no significant increase in yield over the check when endrin and DDT were applied for control of the lesser cornstalk borer. Since the test was conducted under drouth conditions, it is probable that differences due to insecticide treatments were obscured by low plot yields caused by lack of rainfall.

TABLE 17. -- Results of a spray test for the control of the lesser cornstalk borer. Figures denote yield in grams of shelled peanuts.

Treatment	Lbs. Active Ingredient Per Acre	Replications 1	2	3	4	Total
DDT	1.0	640	225	553	775	2193
Endrin	0.3	388	178	626	419	1611
DDT + Endrin	1.0 + 0.3	556	278	573	562	1969
Check	--	538	189	636	289	1652

Analysis of Variance

Source of Variation	D. F.	S. S.	M. S.	F. Test
Treatments	3	56, 995	18, 998. 33	N. S.
Replications	3	340, 424	113, 474. 66	8. 72 **
Error	9	117, 016	13, 001. 17	
Total	15	514, 435		

Test 2. Two similar spray tests were conducted for the control of the lesser cornstalk borer. Nine treatments were replicated four times, using plots sixty-five feet long and four rows wide. All treatments were randomized in each replicate. Materials were applied with a tractor-mounted, six-row sprayer. The three nozzles on each extremity of the sprayboom were plugged, allowing the sprayer to treat four rows only.

The insecticides applied as emulsion sprays were DDT and Guthion, each being sprayed at the rate of one pound technical per acre. Phosdrin, demeton and chlorthion were sprayed at the rate of one-half pound technical per acre. Endrin was used at the rate of .4 pound per acre. The DDT-Guthion combination was applied in the amount of one pound active material per acre of each material. The toxaphene-DDT combination was applied at the rate of one-half pound and one pound active material per acre respectively.

Test A was sprayed four times on July 17, 24, 28, and August 6. Test B was sprayed three times on August 22, September 1 and 8. Infestation records were taken before and after spraying test A. (Table 18.) None of the treatments used controlled the lesser cornstalk borer in the soil.

At the end of the growing season, yield records were taken from the treated plots and analyzed statistically. No significant differences between the treatments were obtained. (Table 19.)

At the time test B was started, the plants were suffering from drought and high temperatures. Some of the plants were no taller than three or four inches and were devoid of peanuts. This condition was general throughout the area. No infestation records were obtained since plants selected at random were observed to be heavily infested. Yield data were taken and analyzed, but no significant differences were observed between treatments. (Table 20.)

Test 3. Although dust applications were not recommended in this area due to prevalent winds, an experiment was conducted in Comanche County utilizing dusts to control the lesser cornstalk borer.

Six treatments were applied in a randomized plot arrangement. Each treatment was replicated four times. The plots were three rows wide and twenty-four feet long. Only the middle row was treated, since two buffer rows were provided on each side of the treated row to keep the effect of insecticide drift to a minimum.

Two per cent endrin dust was applied at the rate of fifteen pounds per acre; 5% DDT dust and 10% DDT dust were applied each at the rate of ten pounds per acre. Two and one-half per cent heptachlor dust at the rate of ten pounds per acre and calcium arsenate at ten pounds per acre were applied. Two different dust applications were made on July 20 and August 1. At the outset of this experiment there was an infestation of lesser cornstalk borers averaging 15%; by harvest time the infestation averaged 80% in all the plots.

TABLE 18. -- Number of plants infested per 100 plants examined from each treatment. Test A.

Treatment	Date Record Taken July 16	Aug. 9	Total
Check	29	58	87
Guthion + DDT	36	41	77
Endrin	37	38	75
Toxaphene + DDT	25	34	59
Demeton	47	33	80
Chlorthion	30	32	62
Guthion	32	36	68
DDT	28	42	70
Phosdrin	26	45	71

Analysis of Variance

Source of Variation	D. F.	S.S.	M.S.	F Test
Treatments	8	306	38.25	N.S.
Dates	1	265	265.00	3.56**
Error	8	596	74.50	
Total	17	1,167		

TABLE 19. -- Insecticides used and yields obtained for the control of the lesser cornstalk borer. Test A. Stephenville, Texas. Plot yield in grams of shelled peanuts.*

Treatment Spray	Replications 1	2	3	4	Treatment Total	Yield in Lbs./A
Check	18.5	1.5	19.5	43.5	83.0	14.9
DDT-1#/A.	48.5	45.0	3.0	23.5	120.0	21.6
Phosdrin-1/2#/A.	0.0	1.0	6.0	69.5	76.5	13.8
Demeton-1/2#/A.	35.0	14.0	11.0	36.0	96.0	16.2
Guthion/DDT-1#/A.	0.0	14.5	8.0	55.0	77.5	14.0
Endrin-.4#/A.	30.5	8.0	30.0	56.0	124.5	22.4
Chlorthion-1/2#/A.	7.0	11.5	23.0	13.5	55.0	9.9
Guthion-1#/A.	4.5	3.0	1.5	10.5	19.5	3.5
Toxaphene-DDT-.5-1#/A.	2.5	3.0	6.0	34.0	45.5	8.2
	146.5	101.5	108.0	341.5	697.5	

* Harvested area: Two 40-inch rows 20 feet long -- 4 Reps= 1/81.675 acre.

Analysis of Variance

Source of Variation	D. F.	S. S.	M. S.	F Test
Treatments	8	2, 320.74	290.09	N. S.
Replications	3	4, 269.35	1, 423.11	N. S.
Error	24	5, 727.60	238.65	
Total	35	12, 317.69	238.65	

Spray dates: **July 17**
" 24-1-1/2" rain. Sprays on for 5 hours.
" 28
Aug. 6

TABLE 20. -- Insecticides used and yields obtained for the control of the lesser cornstalk borer. Test B. Stephenville, Texas. Plot yields in grams of shelled peanuts. *

Treatment Spray	Lbs. Active Ingredient Per Acre	Replications 1	2	3	4	Yield in Lbs./A.
Check		15.5	19.5	110.0	8.5	27.6
DDT	1.0	2.0	0.5	31.0	39.5	13.1
Phosdrin	0.5	150.5	22.0	82.5	11.0	47.9
Systox	0.5	3.0	39.5	25.5	9.0	13.9
Guthion + DDT	1.0	71.5	101.5	28.5	3.5	36.9
Endrin	0.4	1.5	21.0	85.0	3.0	19.9
Chlorthion	0.5	0.5	88.0	24.5	22.5	24.4
Guthion	1.0	2.5	118.0	12.5	83.0	38.9
Toxaphene + DDT	1.0	78.0	183.0	47.5	4.0	56.3
Totals		325.0	593.0	447.0	184.0	

* Harvested Area: Two 40-inch rows 20 feet long -- 4 Reps = 1/81.675 acre.

Spray Dates: August 22, September 1 and 8.

Analysis of Variance

Source of Variation	D.F.	S. S.	M. S.	F Test
Treatments	8	13,970.98	1,746.37	N. S.
Replications	3	10,120.98	3,373.66	N. S.
Error	24	52,526.02	2,188.58	
Total	35	76,617.98		

The plants in this test also suffered from lack of moisture and extreme heat throughout the growing season. Plots were harvested and the yield data were analyzed statistically. No significant differences were observed between treatments. (Table 21.)

Test 4. Another test for the control of the lesser cornstalk borer was initiated in the latter part of July when the peanut plants were in bloom.

The insecticides used were dieldrin, DDT, endrin, and heptachlor. These insecticides were applied to the soil in the following dosages: dieldrin, two pounds active ingredient per acre; DDT, one pound active ingredient per acre; endrin, one-half pound active ingredient and heptachlor, at the rate of four pounds active ingredient per acre. Heptachlor and dieldrin were in granular form, while DDT and endrin were in dust form. The dust formulations were further mixed with talc to add bulk and facilitate the spreading of the material on the ground.

The materials were applied by hand near the main stem of the plant and hoed into the soil. The plants were from four to eight inches in height and blooming.

The experiment was designed in a randomized block arrangement with four replications. Each plot was twenty-five feet long and four 40-inch rows wide.

Table 22 summarizes the results of this test. No significant differences were noted in the yield of the treated plots over the yield in the check plots.

TABLE 21. -- Insecticides applied as dusts for the control of the lesser cornstalk borer and yields in grams of shelled peanuts.* Downing, Texas.

Treatment Dust	Lbs. Active Ingredient Per Acre	Replications 1	2	3	4	Yield in Lbs./A.
Check		197.0	106.5	172.0	51.5	159.8
Endrin	0.3	149.5	182.0	270.0	243.5	256.3
5% DDT	0.5	200.5	119.5	169.0	224.5	216.4
10% DDT	1.0	278.5	184.0	112.0	211.0	238.2
Heptachlor	0.25	141.0	141.5	181.5	244.0	214.7
Ca. Arsenate	10.0	84.5	102.0	228.5	137.0	167.4
Totals		1051.0	835.5	1133.0	1111.5	

* Harvested Area: One 38-inch row 25-feet long.
4 reps = 1/137.56 acre.

Analysis of Variance

Source of Variation	D.F.	S. S.	M. S.	F Test
Treatments	5	19,905.24	3,981.04	N. S.
Replications	3	9,248.70	3,082.90	N. S.
Error	15	52,683.68	3,512.24	
Total	23	81,837.62		

Applications: July 20, August 1.

TABLE 22. -- Results of insecticides applied to soil for the control of the lesser cornstalk borer. Yields in grams of shelled peanuts. Downing, Texas.

Treatment	Lbs. Active Ingredient Per Acre	Replications 1	2	3	4	Aver. Yld. Per Acre
DDT	1.0	638	644	352	247	470
Endrin	0.5	581	606	608	415	552
Heptachlor	4.0	572	292	521	307	423
Dieldrin	2.0	567	379	278	490	428
Check	--	367	471	456	731	506

Analysis of Variance

Source of Variation	D. F.	S. S.	M. S.	F Test
Treatments	4	47,462.50	11,865.62	N. S.
Replications	3	36,498.80	12,166.27	N. S.
Error	12	295,472.70	24,622.72	
Total	19	379,434.00	--	

SUMMARY

The lesser cornstalk borer, Elasmopalpus lignosellus Zeller, has been recognized as a pest of cultivated plants for nearly one hundred years. It attacks many plants, some of which, such as Johnson grass and Colorado grass, are considered noxious weeds. But the borer attacks only sporadically and in isolated areas such major economic crops as cotton, and thus is of relatively minor economic importance. This "non-economic" aspect has been instrumental in keeping the pest in an obscure position, and consequently few workers have studied its biology and control. This study was conducted to determine the biology and control of the lesser cornstalk borer in the peanut-producing area of northeast Texas.

P. C. Zeller first described the lesser cornstalk borer in 1848 from specimens collected in the South American countries of Brazil, Uruguay and Columbia. For his description he also used a female moth collected from "Carolina" in this country. Zeller's original description named the borer Pempelia lignosella. Blanchard in 1852 established the genus Elasmopalpus, which has been accepted as the proper genus for this species.

Zeller in 1872 recorded this species as occurring in Texas. He described two varieties, incautella and tartarella, based on color variations.

Berg in 1875 and Zeller in 1881 published papers dealing with the synonomy of this insect. In 1890 G. D. Hulst, in his monograph on the Phycitidae, redescribed the species lignosellus and placed it under the

genus Elasmopalpus for the first time while also recognizing Zeller's two varieties incautellus and tartarellus.

The egg of the lesser cornstalk borer is ovate in shape, averaging .39 mm. in width and .58 mm. in length. When first deposited, the egg was greenish white but it turned pink in eight to twenty-four hours, changing to a crimson just prior to hatching. The incubation period averaged 2.8 days.

The larva of this species had a wide range of host plants, generally restricted to legumes and grasses. The first summer larvae were found feeding on volunteer peas in late June or the middle of July. The feeding characteristic of the larvae is to bore into the root or stem of the plant immediately below the soil surface and tunnel upward into the main stem for a distance of up to three inches. Tubes constructed from sand and excrement are found radiating horizontally from the attacked stalk, immediately below the soil surface. The larvae when not feeding are usually found inside these tubes.

Six instars were recognized for the larvae of the lesser cornstalk borer. The following were the average body length and head capsule measurements in millimeters for the respective instars: I, 1.6 and .22; II, 3.6 and .31; III, 5.6 and .45; IV, 7.9 and .64; V, 10.4 and .88; VI, 16.1 and 1.20. The duration of the larval stage averaged fourteen days during June and July, seventeen days during August, and thirty days in September.

The pupae were of the obtected type, pale green in color, with yellowish abdominal segments when newly formed. The length of the pupae averaged 8.4 mm. and the width 2.1 mm. The pupae generally were found near the crown of the peanut plant below the soil surface either in a loose cocoon or in a cocoon formed as part of the exit tube attached to the underground portions of the plant. The duration of the pupal stage averaged 7.5, 9.25 and 13.5 days for the months of July, August and September, respectively.

The moths of the lesser cornstalk borer were active after sundown and in the early part of the night. Attempts to collect the moths by light traps or bait traps were not successful. Adult longevity averaged 7.26 days.

The stage of development in which the lesser cornstalk borer overwinters in the Stephenville area is probably the late larval or the pupal stage.

An experiment to determine the effect of moisture on larval activity and development did not give conclusive results, though there is some indication that larvae of the lesser cornstalk borer do not become readily established in a humid environment.

Damage to the peanut plant caused by feeding of the lesser cornstalk borer did not increase the incidence of southern blight on peanuts.

Various experiments were conducted for the control of the lesser cornstalk borer. Results from using black-eyed peas as a trap crop showed that this insect exhibited no preference for the black-eyed peas over peanuts.

A spray test using emulsifiable formulations of DDT, endrin and DDT plus endrin for the control of the lesser cornstalk borer was conducted.

No significant difference between treatments was found when peanut yields were analyzed statistically.

Two additional spray tests designed to control this insect used emulsifiable concentrates of Guthion, Guthion plus DDT, DDT, toxaphene plus DDT, phosdrin, demeton, chlorthion and endrin. In both tests no significant differences between treatments were noted when peanut yields were analyzed statistically.

Endrin, DDT, heptachlor and calcium arsenate applied as dusts to peanut plants for the control of lesser cornstalk borer did not give significant differences between treatment when the yields were analyzed statistically.

Heptachlor and dieldrin granules as well as DDT and endrin dusts were applied to peanut plants at blooming time. There was no significant difference between treatments when the yields were analyzed statistically.

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