RESISTANCE OF WILD SPECIES OF *ARACHIS* AND PEANUT CULTIVARS TO LESSER CORNSTALK BORER

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RESISTANCE OF WILD SPECIES OF *ARACHIS* AND PEANUT CULTIVARS TO LESSER CORNSTALK BORER

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CHAPTER I

INTRODUCTION

The lesser cornstalk borer, Elasmopalpus lignosellus (Zeller), is a major pest of peanuts,[1] Arachis hypogaea (L), throughout the peanut growing areas of the United States. The larvae bore into the stem under the ground towards the terminal bud, causing dead hearts in the older plants and death in the case of seedlings. They also feed on the pods and pegs causing heavy losses in yield.

Peanuts are known by several names; in some parts of the world they are called goober, pindar, groundnut, and earthnut.

Countries that lead in peanut production are India, Mainland China, Nigeria, Senegal, the United States, Indonesia, and Brazil. In the United States, the states that lead in peanut production are Georgia, North Carolina, Texas, Alabama, Virginia and Oklahoma.

The southwestern states, Arkansas, Louisiana, New Mexico, Oklahoma and Texas produce 1/5 of the nation's peanut crop with Oklahoma's crop valued at over $37.5 million in 1972. It is the third most important cash crop in the south, being exceeded only by cotton and tobacco.

Peanuts are used for human consumption in the form of whole nuts, peanut butter, peanut confectionaries, peanut oil for such things as salad oil, margarine, and shortening. After crushing and extracting oil,

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[1]As suggested by the common name, E. lignosellus has a number of host plants but in Oklahoma the major damage to crops is to peanuts.

the remaining peanut meal is a source of high protein concentrate used as a versatile source of livestock feed. Peanut hay is an excellent high protein feed, ranking close to alfalfa in feed value.

In India growing the plant protects the soil from wind and water erosion during the winter and spring.

The lesser cornstalk borer can be controlled with insecticides, but insecticides leave toxic residues. Moreover, the profit of an unirrigated crop is marginal and it is often uneconomical to use insecticides. For this reason alternative methods of protecting crops from insects are being sought; resistant varieties, not having these disadvantages, eliminate the problem of continual insecticide control programs. They provide an excellent method of pest management and control, and are also inexpensive, and relatively permanent.

The objective of this study was to develop techniques for screening peanuts for resistance against the lesser cornstalk borer and to identify germ plasm for further testing. There were two main approaches in that other species in the genus *Arachis* were evaluated as were seedlings of advanced breeding material and cultivars.

CHAPTER II

LITERATURE REVIEW

The Lesser Cornstalk Borer, *Elasmopalpus lignosellus*

The lesser cornstalk borer was originally described by Zeller in 1872. In 1884 and again in 1893, C. V. Riley listed it as injurious to the stalk of corn. Chittenden (1903) of the Bureau of Entomology reported complaints received in 1899 of injury to beans by the insect in Alabama and South Carolina, and also to peanuts in Georgia.

The lesser cornstalk borer attacks more than forty different plants including peanuts, broomcorn, sorghum, alfalfa, cowpeas, beans, corn, peas, soybeans, vetch, grasses, small grains, cantaloupes, cotton, peppers, tomatoes, strawberries, and sweet potatoes (Walton, et al., 1964).

Luginbill and Ainslie (1917) described the eggs as oval in shape and white when first deposited but turning orange at the end of the incubation period. They observed six to seven larval instars.

The pupa is bluish green when freshly formed and starts turning black preceding emergence. There is sexual dimorphism in the pupae. The tip of the male pupa is rounded and that of the female is irregular. The last segment of the female pupa has two lines dividing it. In the case of the male there is one line on the last segment only (Stone, 1968). The cocoon is cylindrical, compact, lined throughout on the inside very smoothly with silk and covered with sand and dirt.

There is sexual dimorphism in the adults. The forewing of the male has a lighter color in the center as compared to its borders, and there is a distinct spot in the center. In the case of the female the color is darker and uniform throughout with no discernible black spot.

Biology

The life cycle is shortest under dry conditions and when summer temperatures are highest. Low temperatures extend the development period (Leuck, 1966).

Regional biological studies have been reported by Luginbill and Ainslie (1917), with specimens collected from Lakeland, Fla., and Columbia, S.C., Sanchez (1960) and King, et al. (1961) reported the biology in Texas, Walton, et al. (1964) in Oklahoma and Dupree (1965) in the Piedmont area of Georgia.

The life cycle as observed in Tifton, Georgia, by Leuck (1966) in August, 1963 took 43 $\pm$ 3.5 days from egg deposition through mean adult longevity. In the field, eggs hatched in three days; they were deposited singly on both the top and underneath surfaces of leaves, on stems, and in the soil. The larval period took 19.6 $\pm$ 2.0 days. The pupal period was approximately 10.2 days in length.

It has been observed that the ideal temperature for the growth and development of the insect is 80^{o}F. The best humidity range if 50-60% R. H. Overwintering is done mostly in the pupal stage. The maximum and minimum temperatures the insect can withstand have not been recorded. Fourteen hours of light and 8 hours of darkness seem to be ideal for insect propagation.

The fifth and sixth instar larvae are voracious chewers. From observations made in the field this seems to be the most destructive stage of development (Dupree, M., 1965).

Distribution

This species is limited in its distribution to the Western Hemisphere. It occurs throughout practically all of South America having been reported from widely separated localities in all parts of the continent. The list as given by Hulst (1890) includes Venezuela, Columbia, Brazil, Argentina (Buenos Aires), Chile, and Pologonia. In North America, while the range is not so great, the borer is reported to occur over the entire southern half of the United States. It has been commonly reported from the states bordering the Gulf of Mexico and the southern Atlantic Coast. It has been encountered causing injury in Arizona. Forbes (1905) reports it as having been taken at various points in Southern Illinois. Webster (1906) observed some of the moths years ago in Lafayette, Indiana. In addition to the localities mentioned above there are specimens in the National Museum bearing the following locality labels indicating that the moths have been taken at Cohasset, Mass.; Clemson College, S.C.; Miami, Palm Beach, and Lakeland, Fla.; New Orleans, La.; Dallas, Brownsville, Sanibal, Kerrville, Victoria, and Burnet County, Tex.; and San Diego, Cal. It undoubtedly occurs throughout Mexico and has been reported from the Bahama Islands (Luginbill and Ainslie, 1917).

Major Parasites and Predators

According to recorded observations, the lesser cornstalk borer apparently suffers little from natural enemies. One parasite, a hymenopteron (Luginbill and Ainslie, 1917), determined as *Neoprestomeris sp.* has been reared in the laboratory at Columbia, S.C. This parasite emerged Sept. 1, 1914, from the larvae collected at Columbia, S.C. Another parasite was reared by R. N. Wilson at Gainesville, Fla., September 11, 1916, which was determined by Gahan as *Orgilus laeviventris* Cress. Gahan believes it probable that the parasite of *Elasmopalpus lignosellus* recorded by Chittenden as *Orgilus mellipis* Say was in reality *O. laeviventris*.

A list of the insect parasite species collected from both the Piedmont and Coastal Plain Region of Georgia since 1954, includes 2 parasitizing the egg *Telenomus sp.* (Scelionidea, Hymenoptera), and *Chelonus sp.* (Braconidae, Hymenoptera), and five larval parasites, *Pristomerus paeifieus melleus* Cushman (Ichneumonidae, Hymenoptera), *Orgilus sp.* (Braconidae, Hymenoptera), *Stomatomyia floridensis* Townsend (Tachanidae, Diptera). *Bracon millitor* has only been collected in the Piedmont region (Leuck and Dupree, 1965).

Cultural Control

Isley and Miner (1944) pointed out that there are several generations a year and it is entirely possible that a large population will develop by the midsummer regardless of the number of overwintering stages destroyed. Nevertheless, the authors found that complete destruction or removal of living plant residue in the fields some weeks before planting was the most promising method of preventing serious outbreaks. The success of this method is predicated on the fact that partly grown larvae hatched from eggs laid after the seedling plants are established do not have time to develop to destructive size before the plants have passed the most susceptible stage of growth.

In California, successful control of the larvae has been obtained by carefully timed irrigation applied in two ways. In the case of sorghum, seeds are often planted in a flat planted for flood irrigation (similar to that used in alfalfa) as opposed to the planting in row for furrow-irrigation. Although not all larvae are killed, sufficient protection is obtained to insure a satisfactory plant stand.

A second method in which irrigation water is utilized to reduce an infestation has been only partly investigated to date; however, on light and sandy soils, it offers some promise of success. According to this method, seed of the susceptible crops are planted in the bottom of the irrigation furrow (Reynolds, et al., 1959).

Land kept free of weed hosts for a period of time (8-10 weeks) before planting resulted in the most effective borer control. Insecticides used in combination with this practice were of no benefit. Significant control with insecticide was obtained in plots where weeds were allowed to grow until planting time, thus producing heavy infestations. When compared to the untreated check, all insecticides reduced the number of borer-killed plants significantly. However, fewer plants were killed in the untreated areas of the clean fallow plots than in the most effective insecticide treatment of the weed grown area (Dupree, 1964).

Chemical Control

Wilson and Kelsheimer (1955) and Kelsheimer (1955) reported that Chlordane was effective as a 5% dust at the rate of 25 lbs. per acre on cowpeas.

On peanuts grown under sprinkler irrigation, accumulated data shows that granulated forms of insecticide are generally as effective as sprays in combating this insect. Endrin, Telodrin[R], parathion and DDT were most effective in reducing the larval damage to the pegs and nuts. Residual effectiveness of these insecticides proved limited under irrigation conditions imposed in these tests. Effective control was also obtained when the insecticides were applied as sprays under pressures of 30 to 40 p.s.i. at the rate of 5 to 20 gallons per acre (Harding, 1960).

In general the systemic insecticides fail to control soil insects (Arthur and Arant, 1956). The location of the damage should be considered in chemical control.

The Extension Service, College Station, Texas (1972) suggested the use of diazinon at the rate of 2.0 lbs. per acre granular in irrigated peanuts, Dyfonate[R] 1.5 lbs. per acre granular or parathion 0.5-0.75 lbs. per acre spray in the case of dryland peanuts.

Peanuts

Agronomic Characteristics

The cultivated peanut, *Arachis hypogaea* (L.), is a member of the family Leguminosae. The peanut is believed to be a native of Brazil from where it was introduced to other parts of the world (Martin and Leonard, 1967). All evidence points to an origin somewhere in South America.

It is known in the wild state; several related species bearing little resemblance to cultivated forms are found in Brazil and nearby countries. There is great morphological diversity in the wild types. There also appears to be genetic diversity in cultivated types.

As indicated in the introduction, the goals sought in the experiment were genetic characters and not ready-made resistant varieties.

Resistance was sought in plant varieties of the same crop species and in related species.

Genetic factors in varieties from the original home of the insect and areas where plant varieties are of maximum variability of the crop are promising sources of genetic diversity (National Academy of Sciences, 1971). The first area depends on the possibility of natural selection for resistance; the second depends on the fact that in areas where visible characters show great diversity, there also may be wide differences in physiological characters that could be the basis of resistance. Plant material to be studied may be secured from other research men working on the same crop, from the United States Department of Agriculture, which maintains germ plasm nurseries or storage of available varieties of many crop plants, and through the help of the Food and Agriculture Organization of the United Nations.

The oil content of peanut seeds varies from 44 to 50 percent in different varieties. Peanuts are rich in proteins and vitamins A, B and some members of the B_2 group. Being a legume with root nodules, it can synthesize atmospheric nitrogen and thereby improve the soil fertility.

The Indian Council of Agricultural Research (1966) reports that the peanut crop has an average growing season of 124 days. The water requirement is 26.1 acre inches. The daily water requirement is 0.21 acre inches.

Pests and Diseases

The common insects that attack peanuts are corn earworm, cutworms, fall armyworm, spider mites, thrips, and rednecked peanutworm. Common soil inhabiting fungi found in Oklahoma peanut soils include *Rhizoctonia* solani, Pythium spp. Fusarium spp. Sclerotium rolfsii, and Aspergillus niger (Oklahoma State University Extension, 1972).

Botanical Description

The peanut is an annual plant with well developed tap root system. The plant may be low and prostrate, as in the running types or upright and bushy, as in the case of the bush types. The stems are thick angular, branching, and hairy. The leaves are pinnately compound. The flowers are axillary sessile, and orange to yellow in color. The ovary, at the base of a long, narrow calyx tube has one to several ovules, and bears a long thread-like style, terminated by a very small stigma.

After the ovules are fertilized, the stamens and corolla fall off; then the flower stalk (internode between ovary and recepticle) elongates, bends downwards, and carries the developing ovary several inches into the ground. This process is common referred to as pegging. Once buried, the ovary ripens. The fruit is large, oblong, reticulate indehiscent legume with one to several ovoid seeds (Robbins, 1931).

Interaction of Peanuts and the Lesser Cornstalk Borer

Leuch (1967) investigated the lesser cornstalk borer damage to peanut plants. Two types of damages were recognized; one was caused by minute larvae that fed on the vegetative bud and flower axils, on the stems at ground level, on living leaves touching the soil, and leafy debris under the plant. The second type of damage was caused by larvae feeding on and in the pods and pegs. This type of damage reduces yield and crop quality.

Host plant resistance to the subterranean feeder group has been investigated by Campbell and Emery (1966) and Alexander and Smith (1966). However, insects like the lesser cornstalk borer feed on all portions of the plant.

Leuck (1967) found that artificial application of a given number of eggs per plant once a year failed to produce significant differences in percent of damaged pods among plant types or among varieties. He also suggested that uncultivated wild peanuts, Arachis spp., are promising as persistent summer forage legume. Arachis glaborata Burth is a plant introduction, P.I. 118457, that established well in Florida and withstood grazing there. Blickensderfer, et al. (1964) found that it has a crude protein and mineral content approaching that of alfalfa (Prine, 1964).

Leuck and Harvey (1968) devised a method of laboratory screening of peanuts for resistance to the lesser cornstalk borer. Infestations were made by applying 12-13 eggs to each block of seedlings. The data showed that survival varied widely among varieties.

Experiments conducted by Smith (1970) using peanut lines with a reported degree of resistance for the southern corn rootworm in replicated field tests have met with limited success because of the variations in natural infestations. To eliminate as much variation as possible, experiments using known numbers of laboratory reared rootworm larvae were initiated in the greenhouse.

Resistance

Plant resistance to insects was defined by Snelling (1941) as including "those characteristics which enable a plant to avoid, tolerate or recover from the attacks of insects that would cause greater injury to other plants of the same species". Painter (1951) defined resistance as "the relative amount of heritable qualities passed by the plant which influence the ultimate degree of damage done by insects". According to Beck (1965) it is defined as "the collective heritable characteristics by which a plant species, race, clone, or individual may reduce the possibility of successful utilization of that plant as a host by an insect species, race, biotype or individual". According to the National Academy of Sciences (1971), "Plants or animals that are inherently less damaged or less infested by a pest, than others, under comparable environments in the field are called resistant".

Painter (1951) classified resistance, as seen in the field, according to 3 mechanisms: preference, tolerance and antibiosis. Preference denotes the group of plant characters that lead to or away from the use by an insect of a particular plant or variety for oviposition, food, or shelter or a combination of the three. Antibiosis denotes the ability of the plant to prevent injury or to destroy insect life. Tolerance is the ability the plant shows to grow and produce or to repair to a marked degree while supporting a population approximately equal to that damaging a susceptible host. Tolerance is the most permanent type of resistance because there is no possible likelihood of producing biotypes.

Resistant crops, once developed, require little expense or effort on the grower (Packard and Martin, 1952). Resistant crops provide more permanent control than insecticides and are especially valuable where the margin of profit for a crop is small and the acreage large (Painter, 1951). The degree of resistance may vary from low to a high level. There are only a few cases where complete control is achieved by the resistant crop alone. Varieties with low level of resistance provide some protection and are best utilized as a part of integrated control programs. Moreover the effect of resistant varieties is cumulative and persistent (National Academy of Sciences, 1971).

CHAPTER III

MATERIALS AND METHODS

During the summer and fall of 1972 cultivated varieties of peanuts and wild species of *Arachis* were tested in the greenhouse for resistance to the lesser cornstalk borer, (*Elasmopalpus lignosellus*). Tests were conducted at the Entomology greenhouse on the Oklahoma State University campus. The seeds and wild species of *Arachis* were tested in several experiments. The entries were identified by their Oklahoma peanut accession numbers (P-No's); when available, other names of entries were used. Table 1 gives various identification numbers of wild species, their taxonomic section, specific names where known, and their origin.

All factors that could cause the overall damage level to differ were kept as constant as possible. The level of infestation was always uniform; all plants on the bench were infested at the same time (between the 2 and 4 leaf stage) and there were similar weather conditions for that group. Blow sand was used as the soil medium in all cases.

Damage Rating Scale

Damage was evaluated on a 5-point scale which is reviewed below:

1. apparently healthy;
2. seed leaf (terminal bud) damage or branches missing, plant otherwise healthy;
3. one or 2 branches killed;

4. beginning to show wilt; and

5. dead or dying.

Wooden benches 10' long, 3' wide and 7" deep were constructed. A 5" deep bed of blow sand provided adequate substrate for root growth and moisture management. Plastic sewer pipe 3" in diameter was cut to a length of 6" to produce sleeves in which plants could be grown. These were pushed into the sand in such a manner that half the sleeve was above the sand, and three inches deep in the sand. Sand was filled in the sleeve until a margin of 1" was left from the top. This discouraged the insect from climbing out of the sleeve. A diagrammatic drawing of a single sleeve in position on the bench is shown in Figure 1 (see Appendix).

A spacing between sleeves of 9" x 12" was given in the case of cuttings where 4 replications were used and 7" x 12" where 5 replications were taken into consideration. Randomized block designs were used. Two glass sleeves were placed on opposite sides of the bench and treated in the same manner as the plastic sleeves as a guide for moisture control.

Cuttings of 14 wild species of *Arachis* were made. Cut ends were treated with a fungicide and planted in square plastic containers, 4" x 4" x 4", filled with coarse sand. Six cuttings of each entry were made. All 6 were planted in one plastic container. Each cutting had a terminal bud and had fresh growth. The cuttings were gently pulled to make certain that they were firm in the sand. The plastic containers were then placed in a mist chamber to strike roots for approximately one month. In the mist chambers, mist was blown in every 10 minutes for 15 seconds during the day and every 2 hours for 15 seconds at night. The cuttings were then taken out of the mist chambers and transplanted into sleeves. They were fertilized with Peters water soluble (21-7-7). Four and one-half grams of the fertilizer was dissolved in one gallon of water and 10 ml of this was poured in the sleeve.

Watering was never done from the top, but was done between the sleeves so that the water could seep up into the sleeves. This was done to avoid adverse moisture effects on the insects and also to maintain uniformity of moisture in the sleeves.

As soon as the transplanted cuttings had become established, 10 first instar larvae were placed on the plant. Watering was continued in the manner described above, until one plant among the 40 died. The plants were assigned a visual rating. All plants that had a rating above one were pulled and observations such as webbing (the larvae form a tunnel of silk and soil extending from feeding site), terminal bud damage, presence of larvae and pupae were noted. Plants that had a rating of 2 were replanted in sleeves on the bench. Thus, all plants that had a rating of one and 2 remained on the bench and were refertilized. When they had become established, they were subjected to the attack of 5 third-instar larvae. Visual ratings for damage were again taken when one plant on the bench had died. Observations on the presence of webbing, terminal bud damage, presence of larvae and pupae were made.

In the case of peanut cultivars, tests of uniformity were conducted using the commercial variety "Comet". It was found that the system was workable and there were no differences due to locations on the bench. It was also found that when the seedlings were infested with 5 larvae per plant the chances of escaping infestation had been greatly reduced.

Seeds were planted in sleeves about an inch deep. In case the seeds on the experimental bench failed to germinate, the sleeves from a nursery bench were transferred to the experimental bench. The seedlings were infested between the 2 and 4 leaf stage. After several tests it appeared that best ratings could be made when one "Comet" plant on the bench had died. "Comet" was used as a check. Webbing, terminal bud damage and presence of larvae and pupae were also noted.

Rearing Techniques

The rearing techniques followed the general pattern for maintenance of laboratory populations of Lepidoptera. The oviposition chambers were transparent, 12 cm. x 9 cm. x 6 cm., filled one-fourth with perlite and covered with wet paper towel, fastened by a rubber band. The chambers were in an incubator maintained at 30^{o}C and 50% relative humidity. The moths laid their eggs on the paper. The papers were changed every 2 to 3 days and the eggs began to hatch in another 2 to 3 days. This meant that the larvae used for infestation may have been 1 to 2 days old without any plant food at the time they were used to infest the plants.

The original colony had been brought from Texas but was augmented with field-collected larvae from Oklahoma during the summer of 1972; therefore potential amount of inbreeding should be of little concern.

The artificial medium appeared to be quite adequate in that the pupae and adults were quite comparable to wild individuals in size. Sufficient care was taken to disinfect and sterilize media and other components in the rearing programs so that disease was a very minimal problem if any at all.

CHAPTER IV

RESULTS AND DISCUSSION

Before any varieties were compared, the variety, Comet, was used in uniformity tests. In the first test 3 first-instar larvae per plant were used as the infestation level and significant differences as determined in an AOV test using rows and columns of plants, were found among the plants. There were several seedlings that did not show any evidence of damage. Uniformity tests using an infestation level of 5 larvae per seedling were conducted and significant differences in the rating as tested by the same method were not found. Therefore an infestation level of 5 larvae per seedling was selected to conduct experiments.

During the experiments it was noticed that when larval infestations were made at varying stages of plant growth, those on later stages of plant growth survived best. It was also found that when infestation was done in early stages of growth there was maximum amount of damage. The plants were killed and the larvae did not grow to maturity.

Results of Plant Material Propagated by Cuttings

Among entries in first experiment including wild *Arachis* relatives, P-2368, *Arachis pusilla* was found almost immune when grown from cuttings, however in later tests it was found to be susceptible when grown from seedlings. These tests were not recorded because most varieties had poor germination but three seedlings of P-2368 did show damage. It has not been possible to cross P-2368 with other varieties.[1] This species is an annual in its land of origin, Brazil. Brazil is also considered as one of the possible homes of the lesser cornstalk borer. P-2368 attaches itself firmly in the soil. It produces seeds in very small numbers which are very small in size as compared to Comet. It is naturally self pollinated.

The next entry in level of resistance to the lesser cornstalk borer was P-258. There was no terminal bud damage in this entry. P-258 is also difficult to cross with other varieties.

The wild peanut introductions appeared to have varying levels of resistance to the lesser cornstalk borer when compared to *Arachis hypogaea*. In spite of infesting the wild types with 10 larvae per plant as compared to the cultivated types which were infested with 5 larvae per plant, the wild types showed a high degree of resistance when compared to the cultivated types.

The ratings for cuttings of wild species of *Arachis* are shown in Table 2. The cuttings were made on July 25, 1972 and the rating was done on October 12, 1972. The results of reinfestation with third instar larvae of cuttings of wild species of *Arachis* which rated one or 2 in initial screening are given in Table 3. The retransplantation was done on October 12, 1972 and the rating was done on November 27, 1972. The resistance complex of wild species of *Arachis* grown from cuttings is summarized in Table 4. The numbers in the brackets indicate ratings of reinfestation with third instar larvae which rated one or 2 in initial screenings.

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[1]Personal communication with Dr. Donald J. Banks on March 24, 1973.

Based on the results of initial screening and re-infestation, the relative resistance of the entries tested is considered to be as follows: P-2368, P-258, P-2350, P-1538, P-1301, P-2578, and P-2013.

Table 5 shows the ratings of a second planting of wild cutting. The cuttings were made on December 28, 1972 and rating was done on March 12, 1973. Results confirmed that P-2368 was almost immune as indicated by the fact that there were only 2 larvae found in 5 replications at an infestation level of 10 larvae per plant. The larvae were in their second instar, small and extremely weak. This indicates that the lesser cornstalk borer does not prefer to feed or is not able to gain nourishment from feeding on this plant material. Replicate 5 had a rating of 5. This plant had died due to pathological reasons. The next in level of resistance in this test was P-246. The results were compared to those for Comet and it was found that the plants mentioned above had a high order of resistance.

Leuck (1967) recognized a type of damage caused only by minute larvae that fed on the vegetative bud and flower axils. In the experiments I conducted it was found that the insect is capable of attacking the terminal bud of the plant in the sixth and seventh instar stages. It was also observed that when the plant has an erect growth the terminal bud damage is usually less as in the case of P-2578. When the plant has a prostate growth habit, terminal bud damage was found to be maximum as in the case of P-2013. It could be inferred from the results obtained that the insect prefers to stay near the soil.

There are several other wild peanut introductions that need to be tested if more work is done with material which can be grown only from cuttings.

Results of Plant Material Grown From Seeds

All seeds tested were found to be relatively susceptible to the attack of the insect. However there are a few that appeared to show tolerance as compared to the variety Comet which we choose to use as a standard.

In Table 6 the entries that had higher resistance than Comet were P-1755, P-1757 and P-1759. This series was planted on October 5, 1972 and rated on November 11, 1972. In the entries mentioned above, no larvae were found and the range of the ratings runs from 3 to 5. The average rating in these cases was below the standard Comet. In the case of Comet we found that the average rating was 3 and the number of larvae found was 4. This gives an indication that the entries mentioned above appear to be more resistant than Comet.

In Table 7 the entries that had higher resistance than Comet were P-384 and P-410. This series was planted on March 13, 1973 and rated on April 19, 1973. Both entries had a rating of 3 but the number of larvae found was below the number found on Comet. Comet, in this case, had an average rating of 3.2 and 6 larvae were found which is higher than the entries which have been mentioned above.

In Table 8 the entry that appeared to possess more resistance than Comet was P-47. This series was planted on March 11, 1973 and rated on April 21, 1973. The average rating of P-47 was 2.6 as compared to Comet which was 3.2. No larvae were found in P-47 whereas 4 larvae were found in Comet.

In Table 9 the entry that exhibited more resistance than Comet was P-2415. This series was planted on January 24, 1973 and rated on February 16, 1973. All replications of this entry had a rating of 3 and 2 larvae were found. Comet in this case had an average rating of 4.2, the range was 3 to 5 and 6 larvae were found. As compared to Comet, P-2415 was found to be more resistant in this experiment.

The entries that had higher resistance than Comet in Table 10 were P-332, P-337, and P-351. This series was planted on March 19, 1973 and rated on May 11, 1973. In this case the average rating for Comet was 4.6 and the number of larvae found was 11. The entries mentioned above had a lower rating and fewer larvae were found.

The entries that exhibited a higher rate of resistance than Comet in Table 11 were P-468 and P-484. P-484 had an average rating of 3 and the total number of larvae found was 3. In P-468, 3 larvae were found and the average raing was 3.5. Comet in this case had an average rating of 3.4 and 7 larvae were found. This shows that the varieties mentioned above are slightly more resistant than or equal to Comet based on the rating and the number of larvae present. This series was planted on March 26, 1973 and rated on May 15, 1973.

One entry, P-671, had higher resistance than Comet in Table 12. This series was planted on April 16, 1973 and rated on May 21, 1973. The average rating of P-671 was 2.8 and 3 larvae were found. The average rating for Comet was 3.4 and the number of larvae found was 4.

In Table 13 the entries that exhibited more resistance than Comet were P-900 and P-2339. This series was planted on April 26, 1973 and rated on June 5, 1973. All replications of these entries had a rating of 3 and 3 or 4 larvae were found. Comet in this case had an average rating of 4.2 and the number of larvae found was 4.

CHAPTER V

SUMMARY

Seventy-three peanut cultivars and 10 species of *Arachis* were tested for resistance against the lesser cornstalk borer. Several aspects were taken into consideration in measuring the degree of resistance: a visual rating, number of larvae or live pupae present, presence of webbing and terminal bud damage. Entries were divided into 10 experiments that were conducted in the Controlled Environmental Research Laboratory on the Oklahoma State University campus in Stillwater.

Several species of *Arachis* were found to be resistant to the lesser cornstalk borer when compared to Comet, a commercially grown variety. P-2368 (P.I. 338448), a selection of *Arachis pusilla*, was found to be highly resistant when grown from cuttings; however, it was susceptible in the seedling stages. It may be difficult to cross P-2368 with other varieties or species. The next cutting in level of resistance was P-258 (P.I. 262814).

In general the wild types were more resistant than the cultivated types. There were several varieties of *Arachis hypogaea* that showed a low level of resistance and should be tested for tolerance. They were P-47 (P.I. 237509), P-332 (P.I. 259800), P-337 (P.I. 259637), P-351 (P.I. 268599), P-384 (P.I. 268680), P-410 (P.I. 268716), P-468 (P.I. 274267), P-484 (P.I. 262022), P-671 (P.I. 268747), P-900 (P.I. 259603), P-1755 (Rusty), P-1757 (N.C.4), P-1759 (Virescent), P-2339 (Florunner) and

P-2415 (K4551-70).

Breeding for development of peanut varieties resistant to the lesser cornstalk borer appears to be encouraging. A reasonable level of tolerance appears to be present in the germ plasm. More critical studies should be undertaken to determine if genes are present that can increase resistance to the lesser cornstalk borer.

LITERATURE CITED

Alexander, M. W., and J. C. Smith. 1966. Resistance to the southern corn rootworm in peanuts. Virginia J. Sci. 17(4): 240.

Arthur, B. Wayne, and F. S. Arant. 1956. Control of soil insects attacking peanuts. J. Econ. Entomol. 49(1): 68-71.

Beck, S. D. 1965. Resistance of plants to insects. Ann. Rev. Entomol. 10: 207-232.

Blickensderfer, C. B., H. T. Haynsworth, and R. D. Rouch. 1964. Wild peanut a promising forage legume for Florida. Crops and Soils, 17(2): 19-20.

Campbell, W. V., and D. A. Emery. 1966. Resistance of peanuts to an insect complex. Proc. 4th. Nat. Peanut Res. Conf. 108 p.

Chittenden, F. H. 1903. The principal injurious insects in 1902. U. S. Dept. Agr. Year Book for 1902. 726-733.

Dupree, M. 1964. Insecticidal and cultural control of the lesser corn-stalk borer. Georgia Agricultural Experimental Station, University of Georgia, College of Agriculture, Mimeograph Series, N.S. 197, 21 p.

Dupree, M. 1965. Observations on the life history of lesser cornstalk borer. J. Econ. Entomol. 58(6): 1156-7.

Forbes, S. A. 1905. A monograph of insect injuries to Indian Corn, Part II. Ill. State Ent. 23rd Rpt. 273 p.

Harding, James A. 1960. Control of lesser cornstalk borer attacking peanuts. J. Econ. Entomol. 58(4): 664-667.

Hulst, G. D. 1890. The Pycitidae of North America. In Trans. Amer. Ent. Soc., V. 17, p. 93-228, pl. 6-8 (not seen).

Indian Council of Agricultural Research. 1966. Hand book of agricultural research, New Delhi. 219-228.

Isley, D., and F. D. Miner. 1944. The lesser cornstalk borer, a pest of fall beans. Jour. Kansas Ent. Soc. 17(2):51-7.

Kelsheimer, E. G. 1955. The lesser cornstalk borer. Florida Grower and Rancher. 63(2):20-36.

King, D. R., J. A. Harding, and B. C. Langley. 1961. Peanut insects in Texas. Texas Agr. Exp. Sta. Misc. Pub. 550. 1-14.

Leuck, D. B., and M. Dupree. 1965. Parasites of the lesser cornstalk borer. J. Econ. Entomol. 58(4): 779-780.

Leuck, D. B. 1966. Biology of the lesser cornstalk borer in South Georgia. J. Econ. Entomol. 59(4):797-801.

Leuck, D. B. 1967. Lesser cornstalk borer damage to peanut plants. J. Econ. Entomol. 60(6):1549-1551.

Leuck, D. B., R. O. Hammons, L. W. Morgan, and J. E. Harvey. 1967. Insect preference for peanut varieties. J. Econ. Entomol. 60(6): 1546-1549.

Leuck, D. B., and J. E. Harvey. 1968. Methods of laboratory screening of peanut germ plasm for resistance to the lesser cornstalk borer. J. Econ. Entomol. 61(2):583-584.

Luginbill, P., and Ainslie. 1917. The lesser cornstalk borer. U.S.D.A. Bur. Entomol. Bull. 539. 1-27.

Martin, J. H., and W. H. Leonard. 1967. Principles of field crop production. 2nd. Edition. New York: McMillan. 689-704.

National Academy of Sciences. 1971. Principals of plant and animal pest control. Vol. 3. National Academy of Sciences, Washington, D.C. 64-98.

Oklahoma State University Extension. 1972. Peanut production guide for Oklahoma. Circular E-608. 1-21.

Packard, C. M., and J. H. Martin. 1952. Resistant crops the ideal way. U.S.D.A. Year Book. Washington, D.C. 429-436.

Painter, R. H. 1951. Insect resistance in crop plants. New York: McMillan Co. 520 p.

Prine, G. M. 1964. Forage possibilities in the genus Arachis. Proc. Soil Crop Sci. Florida. 24: 187-196.

Reynolds, H. T., L. D. Anderson, and L. A. Anders. 1959. Cultural and chemical control of lesser cornstalk borer in Southern California. J. Econ. Entomol. 51(1): 63-66.

Riley, C. V. 1884. Catalogue of the exhibit of economic entomology at the Worlds Industrial and Cotton Exposition, New Orleans 1884-'85. 95 p.

Riley, C. V. 1893. Catalogue of the exhibit of economic entomology at the Worlds Columbia Exposition, Chicago, Ill., 1893, under the direction of the Entomologist. U.S. Dept. Agr. Div. Ent. Bull. 31, O. S. 121 p.

Robbins, W. W. 1931. Botany of crop plants. 3rd Edition. Philadelphia: P. Blackenstons Son and Co., Inc. 441-444.

Sanchez, L. O. 1960. The biology and control of the lesser cornstalk borer, Elasmopalpus lignosellus (Zeller). Unpublished Ph.D. Thesis, Texas A and M University, College Station. (Not seen).

Smith, John C. 1970. Preliminary evaluation of peanut lines for resistance to the Southern Corn Rootworm in the greenhouse. J. Econ. Entomol. 63(1): 324-325.

Snelling, R. O. 1941. Resistance of plants to the insect attack. Bot. Rev. 7: 543-586.

Stone, K. J. 1968. Reproductive biology of the lesser cornstalk borer. I. Rearing technique. J. Econ. Entomol. 61: 1712-1714.

Walton, R. R., Ralph S. Matlock, and James P. Boyd. 1964. Effect of the lesser cornstalk borer on peanuts in Oklahoma. Processed Series P. 474. 1-10.

Webster, F. M. 1906. The principal injurious insects of 1905. U.S. Dept. of Agr. Year Book for 1905. 628-636.

Wilson, J. W., and E. G. Kelsheimer. 1955. Production of southern peas (cowpeas) in Florida. II. Insects and their control. Florida Agric. Expt. Sta. Bul. 557. (Not seen).

Zeller, P. C. 1872. Beitrage zur kenntnigs der nordamerikamschen nachialter besonders der microlepidopteran. In Verhandl. K. K. Zool. Bot. Gesells. Wien, Bd 22. 446-566.

A P P E N D I X

Table 1. Wild species of *Arachis* screened for lesser cornstalk borer resistance

Okla. No.	Collection Nos.	P.I. Nos.	Taxonomic Section	Species	Origin
P-246	GKP 9882	262286	Rhizomatosae	*sp.*	Rio Verde, Mato Grosso, Brazil
P-258	GKP 9567	262814	Rhizomatosae	*sp.*	Encarnación, Paraguay
P-1301	GKP 10538	323936	Caulorhizae	*repens*	Dolabela, Minas Gerais, Brazil
P-1538	GKP 10017	262141	Axonomorphae	*cardenasii*	Roboré, Bolivia
P-1553	GKP 10602	276235	Axonomorphae	*chacoense*	Puerto Casado, Paraguay
P-2013	HL 323(GK 12787)	338314	Caulorhizae	*pintoi*	Jequitinhonha River, Bahia, Brazil
P-2350	GKP 9570	262817	Rhizomatosae	*sp.*	Trinidad, Paraguay
P-2359	GK 10596c	276233	Rhizomatosae	*sp.*	Horqueta, Paraguay
P-2368	GK 12881	338448	Triseminalae	*pusilla*	Joazeiro, Bahia, Brazil
P-2578	GKP 9788	262790	Erectoides	*angustifolia*	Campo Grande, Mato Grosso, Brazil

Table 2. Evaluation of cuttings of wild species of *Arachis* infested with 10 first instar lesser cornstalk borers per plant.

Okla. No.	Visual Ratings and Other Observations[a]			
	R1	R2	R3	R4
P-246	2-0	4-W,T	5-0	2-0
P-258	3-W	2-0	2-0	2-0
P-1301	3-T	2-0	1-X	2-T
P-1538	3-0	2-0	3-T,L	2-0
P-1553	2-0	3-0	3-T	2-0
P-2013	3-W,T,L	5-0	2-W,T	4-T
P-2350	2-0	1-X	3-T	1-X
P-2359	3-W,T	2-0	3-W,L,T	2-0
P-2368	1-X	1-X	2-W	1-X
P-2578	1-W	3-W	3-W	1-X

[a] W = webbing present; T = terminal bud damage; L = larvae found; 0 = no larvae or pupae found; X = did not pull out; kept on bench for further infestation with grown larvae.

Table 3. Results of re-infestation with 5 third instar larvae on cuttings of wild species of *Arachis* which rated 1 or 2 in initial screening.

Okla. No.	Visual Ratings and Other Observations[a/]			
	R1	R2	R3	R4
P-246	3-0,W,T	5-0,W	---	---
P-258	2-0	2-0	2-0	---
P-1301	5-0,W	3-0,W,T	3-0,W,T	---
P-1538	2-0	3-0,W	---	---
P-1553	3-0,W	5-0,W	---	---
P-2013	4-0,W	---	---	---
P-2350	3-0,T	2-0	2-0	---
P-2359	2-0	4-0,W	---	---
P-2368	1-0	1-0	1-0	1-0
P-2578	5-0,W	3-0,W	---	---

[a/] W = webbing present; T = terminal bud damage; L = larvae present; 0 = no larvae or pupae found.

Table 4. Plant resistance complex of wild species of Arachis (tested), for lesser cornstalk borer.

Okla. No.	R1	R2	R3	R4	Terminal Bud Damage	Webbing	Larvae Found
P-246	2(3)[a]	2(5)	4	5	2	3	0
P-258	2(2)	2(2)	2(2)	3	0	1	0
P-1301	1(3)	2(5)	2(3)	3	4	3	0
P-1538	2(3)	2(3)	3	3	1	1	1
P-1553	2(5)	2(3)	3	3	1	2	0
P-2013	3	5	2(4)	4	3	3	1
P-2350	1(2)	1(2)	2(3)	3	2	0	0
P-2359	2(4)	2(2)	3	3	2	3	1
P-2368	1(1)	1(1)	1(1)	1(1)	0	1	0

[a] First number indicates visual rating on October 12, 1973; the number in parenthesis indicates the rating following reinfestation with 5 third-instar larvae of the plants that rated 1 or 2 in the first test.

Table 5. Re-test of wild cuttings infested with 10 first instar larvae per plant.

Okla. No.	Visual Ratings and Other Observations[a]				
	R1	R2	R3	R4	R5
P-238	5-L,W	5-O,W	5-O,W	5-O,W	3-L,W,T
P-246	1-O,W	3-O,W	5-O,W	2-O,L	1-O,W
P-1301	5-O,W	5-O,W	2-L,L,W	1-L,W	5-L,W
P-1538	5-O	5-O	3-L,W	2-O,W	3-O,W
P-2013	5-O,W	4-O,W	4-L,L,W	5-L,W	2-L,W
P-2364	1-O,W	1-O,W	3-L,W	5-O,W	3-L,W
P-2368	1-O,W	2-O,L	1-O,L	1-O	5-O,W
Comet	5-L,T,W	5-O,W	5-O,W	2-O,W	2-L,W

[a] W = webbing present; T = terminal bud damage; L = larvae present; O = no larvae or pupae found.

Table 6. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: October 5, 1972; Infested: October 17, 1972; Rated: November 11, 1972.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-12	3.0	3-3	5	3
P-291	3.0	3-3	5	2
P-204	3.2	2-5	5	1
P-1755	2.4	1-3	5	0
P-1757	2.5	1-3	3	0
P-1759	2.4	1-3	5	0
P-2397	3.8	3-5	4	2
P-2398	3.8	3-5	5	5
Comet	3.0	3-3	5	4

Table 7. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: March 13, 1973; Infested: March 23, 1973; Rated: April 19, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-373	3.0	3-3	5	6
P-384	3.0	3-3	5	1
P-386	3.4	3-5	5	4
P-393	3.8	3-5	5	8
P-400	3.0	3-3	5	5
P-410	3.0	3-3	5	2
P-416	3.0	3-3	4	3
P-420	3.0	3-3	5	4
P-433	3.4	3-5	5	3
P-458	3.0	3-3	5	5
Comet	3.2	3-4	5	6

Table 8. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer, Planted: March 11, 1973; Infested: March 23, 1973; Rated: April 21, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-14	3.8	3-5	5	4
P-47	2.6	1-3	4	0
P-144	3.6	3-5	5	3
P-190	4.0	2-5	5	4
P-439	3.0	3-3	5	4
P-460	2.8	2-3	5	5
P-461	3.8	3-5	5	7
P-467	3.6	3-5	5	1
Comet	3.2	3-5	5	7

Table 9. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: January 24, 1973; Infested: February 8, 1973; Rated: February 16, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-405	3.8	3-5	5	0
P-2401	3.0	3-3	5	3
P-2402	3.8	2-5	5	5
P-2403	3.8	3-5	5	2
P-2404	3.4	3-5	5	4
P-2415	3.0	3-3	5	2
P-2419	3.2	3-4	5	9
P-2421	4.0	3-5	5	4
Comet	4.2	3-5	5	6

Table 10. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: March 19, 1973; Infested: April 2, 1973; Rated: May 11, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-214	4.2	3-5	5	4
P-322	4.2	3-5	5	6
P-330	3.8	3-5	5	5
P-332	3.4	3-5	5	3
P-337	3.4	3-5	5	2
P-339	4.2	3-5	5	7
P-351	4.0	3-5	5	3
P-352	4.4	3-5	5	8
P-360	4.4	3-5	5	5
P-365	5.0	3-5	5	10
Comet	4.6	3-5	5	11

Table 11. Peanuts (Arachis hypogaea) screened for lesser cornstalk borer. Planted: March 26, 1973; Infested: April 9, 1973; Rated: May 15, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-468	3.0	3-5	5	3
P-470	3.8	3-5	5	11
P-473	3.6	3-5	5	12
P-484	3.5	3-5	5	3
P-495	3.6	3-5	5	5
P-511	3.0	3-5	5	7
P-528	4.0	3-5	5	5
P-557	3.0	3-5	5	6
Comet	3.4	3-5	5	7

Table 12. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: April 16, 1973; Infested: April 24, 1973; Rated: May 21, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-594	3.8	3-5	5	8
P-626	3.4	3-4	5	3
P-632	3.6	3-5	5	5
P-653	3.4	3-4	5	5
P-659	3.0	3-3	5	4
P-660	3.6	3-5	5	8
P-666	3.4	3-5	5	5
P-671	2.8	2-3	5	3
P-676	3.0	3-3	5	6
P-690	3.6	3-5	5	4
Comet	3.4	3-5	5	4

Table 13. Peanuts (*Arachis hypogaea*) screened for lesser cornstalk borer. Planted: April 26, 1973; Infested: May 7, 1973; Rated: June 5, 1973.

Okla. No.	Average Rating	Range	No. of Plants With Webbing	No. of Larvae Found
P-714	3.2	3-4	5	5
P-777	3.6	3-5	5	6
P-788	3.2	3-4	5	5
P-800	3.4	3-5	5	6
P-843	3.4	3-4	5	9
P-871	3.2	3-4	5	5
P-874	3.8	3-5	5	7
P-876	3.6	3-5	5	9
P-900	3.0	3-3	5	3
P-2339	3.0	3-3	5	4
Comet	4.2	3-5	5	4

Table 14. Peanut accessions screened for resistance to lesser cornstalk borer.

Oklahoma P-No.	P.I. Number or Other Identity
0012	Pearl
0014	162524
0047	237509
0144	234417
0190	Valencia seln.
0204	NC4X
0214	242100
0238	262842
0246	262286
0291	Purple Krinkle
0322	259805
0330	152125
0332	259800
0337	259637
0339	259678
0351	268599
0352	268601
0360	268616
0364	268633
0365	268635
0373	268647
0384	268680
0386	268686
0393	268692
0400	268706
0405	268708
0410	268716
0416	268739
0420	268742
0433	268789
0439	268808
0458	270784
0460	270789
0461	270804
0467	271022
0468	274267
0470	261989
0473	Tifton 6, NRM 1
0484	262022
0495	262046
0511	261933
0528	261985
0557	247378
0565	248597
0594	268654
0626	268704

Table 14. Continued.

Oklahoma P-No.	P.I. Number or Other Identity
0632	268711
0653	268730
0659	268737
0660	268738
0666	268743
0671	268747
0676	268754
0690	268773
0714	268796
0736	268818
0788	259821
0800	261921
0831	268595
0838	268617
0843	268632
0863	268687
0871	268752
0874	268759
0877	268781
0876	268780
0892	259719
0894	259754
0900	259603
0976	139918
1301	323936
1538	262141
1755	Rusty
1757	NC4
1759	Virescent
2013	338314
2339	Florunner
2368	338448
2397	268689
2398	268661
2401	MS 539
2402	5009-70
2403	5009-70
2404	2386-68
2415	K4551-70
2419	259747
2421	350680

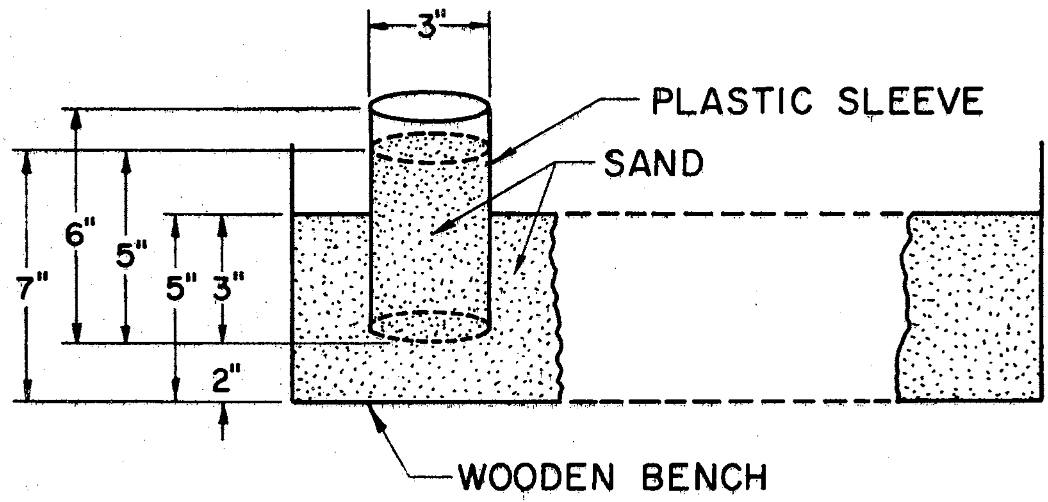

Figure 1. A Diagrammatic Drawing of a Single Sleeve in Position on the Bench

VITA

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