INHERITANCE OF RESISTANCE

TO THRIPS IN PEANUTS

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CHAPTER I

INTRODUCTION

Peanuts are one of America's basic crops and are grown in many countries throughout the world. Since the seeds of this legume are high in protein (25-30%), it has a high potential as a plant-protein diet supplement for undernourished world populations. Peanuts are an important crop in Oklahoma and other Southern states. The production and use of peanuts is increasing and will continue to increase as researchers develop new varieties with more desirable end-use characteristics.

The tobacco thrips insect, *Frankliniella fusca* (Hinds), causes considerable damage to the developing foliar buds of peanuts up to the flowering stage. At later stages of plant growth, foliar damage is less important and thrips feed largely on pollen.

In recent years the development of plant varieties resistant to insect attack has attracted much attention as a method of pest control. Perhaps the most important feature of resistant varieties is the stabilizing effect they have on production. This is important to the grower and to the country. Reasonable harvests every year are preferred to the economic hardships associated with extreme fluctuations in yield.

A knowledge of inheritance of plant resistance to a given insect is basic to intelligent planning of breeding programs designed to develop insect-resistant varieties.

A good source of resistance to thrips needs to be found in peanuts and the mode of inheritance established in order to have efficient breeding programs to incorporate resistance in agronomic peanut varieties.

Two peanut introductions were used in this study as parental varieties. One parent P.I. 268633, known in the Oklahoma inventory as P-844, is quite susceptible to thrips. The other parent P.I. 290597, P-947, is only moderately resistant to thrips. Although crosses were attempted between P-844 and P-326, a variety with a moderately high level of resistance, no seed were obtained and the study was continued with the lower level of resistance. F_1 and F_2 generations, including reciprocals, were obtained between P-844 and P-947. The three types of plant resistance to insects, preference, antibiosis and tolerance, were measured on the parental, F_1 and F_2 generations.

CHAPTER II

LITERATURE REVIEW

The descriptive terms "possum ear" and "pouts" have been used to characterize damage done by thrips on peanuts (Wilson and Arant 1949). Because "pouts" resembled damage done by leafhoppers this term was discontinued (Shear and Miller 1941). Thrips damage is most evident on the leaflets of seedlings before anthesis. Leuck and Hammons (1967) showed that thrips might be largely pollen feeders at later stages of plant growth. Also, Borden (1815) and Osborn (1888) indicated that pollen and plant floral parts were a source of food for thrips. Of the various species of thrips, the tobacco thrips, Frankliniella fusca (Hinds), was the dominant species attacking peanuts in Alabama, Texas, Georgia, North Carolina, South Carolina and Oklahoma (Eden and Brogden 1960, Harding 1959, Young 1969).

Went (1940) suggested that aphids removed a proportion of the auxins along with the sap that they took up and that all growth due to auxins was decreased. Evans (1941) found that in the case of the cabbage aphid feeding on cabbage, besides a reduction in auxins, there was often a marked decrease in carbohydrates, proteins and other constituents of the plant. Such loss might contribute to the stunting or other type of injury. Thrips have rasping-sucking mouthparts differing from aphids, but they remove sap from the plant in the same way. Where infestations are severe, stunting occurs and the damaged peanuts recover slowly and perhaps incompletely (Arant 1951).

A number of investigators (Leuck et al 1967, Poos et al 1947) have reported yield decreases in peanuts ranging from 36% to 45% due to infestation of thrips. By using systemic insecticides to control thrips, Hyche and Mount (1958) obtained pod yield increases ranging from 240 to 617 lbs/acre. The fluctuation in yield may have been caused by the peanut variety used, and its interaction with thrips and with other insect species, even under conditions where no insecticide was used. However, these men worked largely, it is assumed, with a single variety. Arant (1951) and Poos et al (1947) pointed out that soil fertility, rainfall, and other weather conditions as well as infestation level affected the amount of thrips injury.

Plant-insect relationships were established by Painter in 1951. He defined resistant plants as those that are inherently less damaged or less infested than others under comparable environmental conditions in the field.

Mumford (1931) and Snelling (1941) both attempted to classify the factors affecting the resistance of plants to insect pests. The categories proposed were of little practical use. Painter (1951) classified plant-insect relationships into three basic categories: non-preference, antibiosis, and tolerance. Non-preference denotes the group of plant characters and insect responses that lead to or away from the use of a particular plant or variety as a host. Antibiosis is the tendency to prevent, injure or destroy insect life. Tolerance denotes that the plant shows the ability to grow and reproduce itself or to recover from injury to a marked degree in spite of supporting a population approximately equal to that damaging a susceptible host. These three characteristics may be controlled by genetic factors and are frequently modified by various ecological conditions and other genes.

Jones et al (1934) reported that in onions a differential thickness in the wall of the epidermal cells was important in resistance to the onion thrips, Thrips tobaci (Lind). The onion thrips showed a preference for varieties of onions with flat leaves which offered a shelter for the insect where the leaves came together (Jones et al 1934).

McIndoo (1935) showed that odor was a primary reason for difference in attractiveness of various host plants of the beetle.

Kottur and Maralihalli (1931) associated thrips resistance with hairy varieties of cotton, although hairy leaves sometimes made the ginning operation more difficult.

Varieties of peas with yellow-green foliage were more resistant to the aphid than those with blue-green foliage (Searls 1935, Cody 1941).

Block (1941) and Painter (1951) reported that preference for feed or oviposition sites might depend on visual, tactile, gustatory, or olfactory stimuli which attract or repel the insect. Antibiosis might result from physical characteristics of the plant or chemical factors, whether toxins, lack of nutrients, or other necessary behavior stimulants. Tolerance was thought to be affected by growth hormones as well as gross morphology and tissue structure of the plant.

Procedures for determining preference, antibiosis, and tolerance of peanuts to thrips were proposed by Walton and Matlock (1968). Preference tests were made in a three-foot cylindrical rotating cage for three days. Berlese funnels were used for collecting thrips from leaflets of each plant. Antibiosis and tolerance of plants were tested by caging 30 larvae on a leaf for a period of seven days. The number of thrips surviving were recorded as an index to antibiosis, and numerical ratings of leaf damage were used as a measure of tolerance.

Young (1969) ran preference tests for two days instead of three days and she gave very detailed descriptions for the methods used for testing preference, antibiosis and tolerance.

Ivanoff (1945) reported on the inheritance of resistance to the melon aphid, Aphid gossypii Glov. Plants of F_1 hybrids between resistant and susceptible plants were resistant and the F_2 progeny segregated in a typical Mendelian ratio of three resistant to one susceptible, indicating a single factor difference between resistant and susceptible varieties.

Hughes (1947) found that in a cross between the cantaloupe variety, Smith's Perfect (aphid-resistant) and V-I, a strain of Hales' best (aphid-susceptible), the resistance was inherited as a Mendelian dominant. In the F_2 generation there were 158 resistant and 63 susceptible plants. Cartwright and Wiebe (1936) indicated that the resistance of Dawson wheat to Hessian fly depended on two dominant genes, designated as H_1 and H_2. Shands and Cartwright (1953) identified three additional genes for resistance, H_3, H_4, and H_5.

Crosses between Northern Spy and other aphid-resistant apple varieties gave varying percentages of susceptible plants depending on the variety. Differences in resistance in the hybrids ranged all the way from practical immunity to complete susceptibility. A few crosses between susceptible parents gave rise to a small number of highly resistant progeny, indicating the presence of recessive genes for resistance according to Crane et al (1936).

Research on the genetics of insect resistance has not been nearly as extensive as the genetics of resistance to fungal or bacterial diseases. Nevertheless, enough information is known to indicate that the inheritance of insect resistance differs in no major way from the inheritance of disease resistance (Allard 1960).

CHAPTER III

MATERIALS AND METHODS

Hand crosses were made in the green house by conventional methods between two peanut introductions, P.I. 268633 (P-844) and P.I.290597 (P-947). F_1 hybrids, including the reciprocals, were obtained and grown to the F_2 generation. Vegetative cuttings were taken from the two parents and the F_1 hybrids to maintain the F_1's while getting the F_2 seed.

P-844 is susceptible to thrips and P-947 is moderately resistant according to Young (1969), who screened some of the available peanut germ plasm for reaction to thrips. P-947 is a runner type peanut with relatively small leaflets and the plants are dark green. P-844 is a Spanish type with larger leaflets than P-947 and the leaf color is lighter green than P-947. The F_2 progeny could be easily distinguished. Segregation in the F_2 gave assurance that the materials used for testing were crosses.

Cuttings were used for testing antibiosis, tolerance, and preference of the F_1's. The F_2 materials tested were young plants grown from F_1 seeds. Because of physical limitations in handling the thrips, the tests had to be run in segments. However, the two parents and a check variety, Starr, a known susceptible, were included in each segment.

The thrips used in the resistance tests were *Frankliniella fusca* (Hinds) reared in the laboratory by methods described by Kinzer (1968).

The methods used for testing preference, antibiosis, and tolerance were those of Young (1969), with slight modification.

The tests were conducted from March 13, 1969, through June 1, 1969. A total of 149 plants were tested. All tests were conducted in a room where light and temperature were controlled. The temperature was maintained at $80 \pm 2^{\circ}F$. Daylight fluorescent bulbs provided 2000 foot-candles of light for 12 consecutive hours of each 24 hour period.

Preference Tests

Plants were tested when they were about three weeks old and in the six-leaf stage of growth. Potted plants were exposed to adult thrips in a cylindrical rotating cage and the number of thrips on each entry were counted at the end of a two-day period.

The rotating cage was designed to equalize light intensity and direction, and cancel any other biasing factors. The cage was 36 inches in diameter and 14 inches in height. The bottom of the cage was made of masonite; the walls were of transparent cellulose nitrate plastic, and the top was glass. There were two circular metal rims at the top and bottom to support the walls. The glass top was removable and was sealed to the metal rim with strip caulking compound during testing. The cage was mounted on a turntable which rotated at 0.125 rpm. A squirrel-cage fan forced air through a two-inch pipe in the center of the cage floor for continuous ventilation. Sixteen cloth-covered holes were evenly spaced around the top of the cage walls for air outlets.

Twenty plants were tested at one time in the rotating cage. These plants consisted of the two parents, the check variety, Starr, and 17 F_2 plants. Single potted plants of each of the 20 entries were arranged in a circle in the cage equidistant from the center and from adjacent plants. Relative positions of the entries in the circle were at random. Seven hundred adult thrips were released from a petri dish on a platform just above the air inlet of the cage. The lid of the cage was then sealed in place. At the end of two days each plant was cut off just above the crown and placed in a one gallon Berlese funnel. Each plant was heated for one hour with a 60-watt light bulb which was fixed in the lid of the funnel to drive the thrips into an attached test tube containing 60% alcohol. To carry adhering thrips into the alcohol, a fine spray of water was used to wash the buds and the inside of the funnel. It should be explained that the plants were cut so that two nodes would be left above the crown from which new branches could develop. This made it possible to save the individual F_2 plants for use in the breeding program.

The alcohol solution was filtered to concentrate the thrips in one plane for counting with a binocular dissecting microscope. The upper portion of the alcohol was first decanted into a funnel with filter paper. Then a saturated NaCl solution was added to the test tube causing the thrips to float and heavier debris to sink. The upper portion containing the thrips was again decanted through filter paper. A grid was placed over the filter paper for counting thrips under the microscope and a thumb punch tally counter used to facilitate accurate counting.

Antibiosis and Tolerance Tests

Antibiosis and tolerance were tested by caging 30 larvae on a leaf for a period of seven days. The numbers of thrips surviving and dying were recorded for calculating an index of antibiosis, and the visual damage to the leaf was rated as a measure of tolerance.

When the fifth or sixth leaf on each plant was completely unfolded, it was used for testing. In order to facilitate caging, two of the four leaflets on a leaf were clipped off. The cage was made up of a 5-inch segment of dialysis tubing which was 0.0001 inch thick and had a flat width of 1.73 inches.

The procedure for making a cage was as follows: the dialysis tubing was placed over the leaf and gently pressed against the caulking compound which was molded around the petiole about 0.5 inch below the axial leaflet. A small incision was cut into the tubing and caulking compound with scissors, and the tubing was folded over the depth of the cut. After thrips larvae were introduced into it, a fold was made at the opposite end of the cage. In this way the adhesive surface of the tape was not exposed to the interior of the cage and the thrips did not become firmly attached to it.

Larvae were used for infesting caged leaves eight days after oviposition. In order to count and transfer the thrips easily to testing cages, the rearing cage which contained larvae was clipped off from the peanut plant and shaken over a smooth black surface. An aspirator operated by a slight vacuum was used to pick up the larvae. A piece of 0.25 inch copper tubing was attached to the aspirator. The tip of the tubing was covered by a piece of hard-finish 100 mesh fabric so that the larvae were sucked on the surface of the cloth. The small rigid aspirator tip could be manipulated accurately to pick up one larva at a time. The electric motor of the vacuum apparatus could be turned off and on with a foot switch. When the tip on which larvae were held was inserted into the leaf cage, the vacuum was turned off and the tube was tapped gently to dislodge the larvae from the fabric.

At the end of seven days, each cage was cut open and the numbers of live thrips and dead thrips were counted by removing each one with a fine sable brush. One day later or on the same day the upper and lower surfaces of both leaflets were rated for damage on an 8-point scale with 8 being the most severe damage and 1 being no observed damage. There were no 1 or 8 ratings observed in this study. Two judges made independent ratings of the four surfaces and the average of the eight ratings was treated as a unit observation for this test.

CHAPTER IV

RESULTS AND DISCUSSION

Comparisons of antibiosis, tolerance, and preference between the two parents, P-947 and P-844, are summarized in Table 1. The mean number of surviving thrips was 20.26 for P-947 and 19.89 for P-844. There was no significant difference between them. Mean percentage of dead thrips for P-947 and P-844 were 9.59 and 9.56, respectively, and the difference between parents was not significant. The two ways used to estimate antibiosis probably resulted in different estimates, because the thrips which were introduced into the cages were not exactly 30 each time.

The mean leaf damage rating of P-947 was 4.6 and P-844 was 3.0. The difference between them was statistically significant. This indicated that P-947 had weaker tolerance response to thrips damage than did P-844. Once the leaf was damaged, the damage could not be repaired. On obligatory feeding, ratings for thrips damage were larger. The rating for thrips damage ranged from 3-7 for P-947 and 2-4 for P-844 as shown in Table 14. This indicated that P-947 was easier to injure by thrips than Starr or the two groups of F_1's and F_2's.

The mean number of thrips recovered from P-844 was 11.60 while 8.44 were recovered from P-947. This shows that thrips preferred P-844 more than P-947. P-947 was more resistant to thrips than P-844 since it was preferred less. It could drive away thrips through some mech-

Table 1. Comparison of antibiosis, tolerance, and preference between the parents.

Material	Antibiosis			Tolerance		Preference	
	No. of plants	Thrips dead %	Thrips alive %	No. of plants	Leaf damage rating	No. of plants	No. of thrips recovered
P-947	15	9.59	20.26	15	4.60	9	8.44
P-844	18	9.56	19.89	18	3.00	10	11.60
$P \leq 0.05$	—	ns	ns	—	significance	—	ns

anism or repellents under natural conditions. Although its tolerance response was weak it still showed resistance to thrips. P-844 attracted a large number of thrips. Even though P-844 was tolerant it eventually suffered severe thrips damage.

These two parents were selected based on field studies for more than two years under natural conditions. According to field records of thrips damage, P-947 was rated moderately resistant and P-844 was rated susceptible. Although the tolerance response of P-947 was markedly weak on obligatory feeding by thrips it was resistant to thrips due to being less preferred and P-844 was susceptible due to the attraction of more thrips for feeding, oviposition, shelter or the combination of the three.

F_1 Derived From P-947 x P-844 and Their Reciprocals

The F_1's were tested by cuttings. The results are shown in Table 2. Antibiosis of F_1's derived either from P-947 x P-844 or its reciprocal was stronger than their parents. Tolerance responses of the F_1's were higher than their parents. Their rating averaged less than 3.0, while the mean ratings of the parents were all above 3.0. The preference test showed that the F_1's decreased in preference compared to their parents.

Since the F_1's seemed to obtain the characteristic of tolerance from the P-844 parent, tolerance might be considered dominant over non-tolerance. But it should be noticed that on obligatory feeding, tolerance accompanied mean surviving thrips. If the number of dead larvae in a cage were large, the damage rating of the plant tested should be low, because fewer thrips fed on it. In this case it was not a hereditary difference but rather an effect which accompanied antibiosis. The

Table 2. Comparison of antibiosis, tolerance, and preference between the F_1 derived from P-947 x P-844 and its reciprocal.

Material	Antibiosis			Tolerance		Preference	
	No. of plants	Thrips dead %	Thrips alive %	No. of plants	Leaf damage rating	No. of plants	No. of thrips recovered
P-947 x P-844 (F_1)*	10	40.68	10.20	10	2.9	11	8.73
P-844 x P-947 (F_1)	4	79.78	2.25	4	2.0	4	4.00
$P \leq 0.05$	---	Significance	Significance	---	Significance	---	ns

*The first parent listed is female and the second is the male. This procedure was used throughout the thesis.

preference test showed that F_1's tended toward the parent with low preference. Therefore, the less preferred characteristics might be controlled by dominant genes. The mean numbers of thrips recovered from F_1's derived from P-947 x P-844 and from P-844 x P-947 were opposite to that recovered from corresponding F_2's. When the preference test was conducted on the F_1's, the plants were too tall to put into the cage. After the lid of the cage was covered, most plants touched the lid and bent down so that the plants twisted together. This could easily influence the data on preference of the thrips for an individual plant. The results of preference tests with the F_2's were more reliable because the plants were in earlier stages of growth. However, the F_1's preference tended toward the low preference parent P-947. This fact agreed well with the results obtained from the F_2's.

Comparison between the reciprocal F_1's showed a maternal effect for antibiosis and tolerance. When P-947, which had relatively low tolerance, was used as the female, the F_1 exhibited less tolerance than did the reciprocal F_1 which had the more tolerant P-844 as the maternal parent. This difference obtained was statistically significant at the 0.5 level of probability.

Although the parents showed no difference for antibiosis, the reciprocal F_1's were distinctly different. When P-844 was used as the female parent, considerably more antibiosis was obtained. The differences were significant for both the mean percentage of dead thrips and the mean surviving thrips.

Variances of both damage rating and mean percentage of dead larvae were analyzed for five kinds of materials: Starr, P-947, P-844, P-947 x P-844 (F_1), and P-844 x P-947 (F_1). The results are shown in Tables 3, 4, 5, and 6. They were not statistically different but

Table 3. Damage rating of thrips on peanuts from five kinds of materials

Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
Starr	3	8	22	21.333	0.667
P-844	3	11	41	40.333	0.667
P-947	3	12	62	48.000	14.000
P-947 x P-844 (F_1)	10	29	89	84.100	4.900
P-844 x P-947 (F_1)	4	8	16	16.000	
Totals	23	68	230	209.766	20.234

Table 4. Analysis of variance of damage rating from the data summarized in Table 3

Source of variation	df	SS	MS	F
Among treatments	4	8.7226	2.1806	1.6169 (ns)
Within treatments	15	20.2340	1.3489	
Total	19	28.9566		

Table 5. Mean percentage of dead larvae from five kinds of materials

Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
Starr	3	108	4858.58	3888.0000	970.5800
P-844	3	63.4	2190.28	1339.8500	850.4300
P-947	3	125.1	7679.69	5216.6700	2463.0200
P-947 x P-844 (F_1)	10	406.8	25134.20	16548.6240	8585.5760
P-844 x P-947 (F_1)	4	319.1	26163.09	25456.2024	760.8876
Totals	23	1022.4	66025.84	52449.3464	13576.4936

Table 6. Analysis of variance for the percentage of dead larvae of the data summarized in Table 5

Source of variation	df	SS	MS	F
Among treatments	4	7001.4438	1750.3609	1.9339 (ns)
Within treatments	15	13576.4936	905.0995	
Totals	19	20577.9374		

were very close to the 0.05 significance level.

Based on the F_1 results, there seemed to be no cytoplasmic influence on preference.

Variances of the number of thrips recovered from the five kinds of materials, Starr, P-844, P-947, P-947 x P-844 (F_1) and P-844 x P-947 (F_1) were analyzed. The results are shown in Tables 7 and 8 and indicated no significant difference among the treatments.

F_2's Derived From P-947 x P-844 and From Their Reciprocal

It was realized in the beginning of handling the F_2 materials that the F_2's would not give data from which the mode of Mendelian inheritance of resistance could be worked out, because antibiosis and tolerance in the F_1 were influenced by the cytoplasm as well as by genes. The F_2's were still useful to attempt to identify dominant or recessive characters. If most of the individuals in the F_2 inherited a specific character which belonged to a certain parent, this character would be considered to be controlled by dominant genes. However, F_2 progenies derived from P-947 x P-844 and P-844 x P-947 still showed differences in a specific character as did the F_1's. This provides additional evidence that the cytoplasm may be influencing these characters.

The results of comparisons of antibiosis, tolerance, and preference between the two groups of F_2's are shown in Table 9. In general, the F_2's showed the same tendency as the F_1's except for the mean number of thrips recovered from the groups of plants. The probable cause of this situation has already been discussed. The F_2's derived from P-947 x P-844 had slightly less antibiosis than those derived from P-844 x P-947, both in mean percentage of dead larvae and surviving

Table 7. Number of thrips recovered from five kinds of materials

Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
Starr	1	13	169	169	
P-844	2	14	100	98	2
P-947	1	7	49	49	
P-844 x P-947 (F_1)	5	20	106	80	26
P-947 x P-844 (F_1)	11	96	1320	837.818	482.182
Totals	20	150	1744	1233.818	510.182

Table 8. Analysis of variance for the number of thrips recovered for the data summarized in Table 7

Source of variation	df	SS	MS	F
Among treatments	4	108.818	27.2045	0.5332 (ns)
Within treatments	10	510.182	51.0182	
Total	14	619.000		

Table 9. Comparison of antibiosis, tolerance, and preference between two groups of F_2 derived from P-947 x P-844 and its reciprocal

Material	Antibiosis			Tolerance		Preference	
	No. of plants	Thrips dead %	Thrips alive %	No. of plants	Leaf damage rating	No. of plants	No. of thrips recovered
P-947 x P-844(F_2)	38	11.99	19.05	38	3.76	38	8.55
P-844 x P-947(F_2)	35	15.77	17.80	35	3.48	35	9.97
$P \leq 0.05$	—	ns	ns	—	ns	—	ns

thrips. This situation resembled the F_1's exactly, although the two groups of F_2's in Table 9 were not significantly different. The percentage of dead larvae either in F_2's derived from P-947 x P-844 or P-844 x P-947 was greater than their parents. This could be due to the accumulative effect of genes.

Variances for antibiosis comparisons among the F_2's, P-947, P-844 and Starr were analyzed and the results are shown in Tables 10 and 11. No significant differences were obtained.

Mean leaf damages were 3.76 and 3.48 for the F_2's derived from P-947 x P-844 and its reciprocal, respectively. The difference was not statistically significant. Both F_2 groups tended slightly toward the more tolerant parent P-844. This again suggests that the tolerance character was dominant over non-tolerance. The damage ratings for both groups of F_2's were larger than for their corresponding F_1's. These results would be expected if dominance were involved.

The data and analysis of variance for the damage ratings are presented in Tables 12 and 13. P-947 with a mean damage rating of 4.6 was the least tolerant among the five kinds of materials. This difference was significant at the 0.01 level of significance. The other four kinds of materials showed no significant difference.

The range in damage ratings for the F_2's derived from P-947 x P-844 was 2 to 6, while those derived from P-844 x P-947 was 3 to 7 as shown in Table 14. Both showed larger ranges than either their parents or the F_1's. This could result from segregation.

The mean number of thrips recovered from the F_2's derived from P-947 x P-844 and P-844 x P947 were 8.55 and 9.97, respectively. These results differed from the results obtained in the corresponding F_1's. The ranges in number of thrips recovered in the various materi-

Table 10. Mean percentage of dead larvae from five kinds of materials

Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
Starr	16	210.72	4008.5750	2775.1824	1233.3926
P-844	18	172.09	2793.7321	1645.2760	1148.4561
P-947	15	143.98	2552.6400	1382.0160	1170.6240
P-947 x P-844 (F_2)	38	455.75	15356.4127	5466.0016	9890.4111
P-844 x P-947 (F_2)	35	552.07	17515.1621	8708.0367	8807.1254
Totals	122	1534.61	42226.5219	19976.5127	22250.0092

Table 11. Analysis of variance for the mean percentage of dead larvae of the data summarized in Table 10

Source of variation	df	SS	MS	F
Among treatments	4	673.0077	134.6015	0.6654 (ns)
Within treatments	110	22250.0092	202.2728	
Total	114	22923.0169		

Table 12. Thrips damage rating on peanuts from five kinds of materials

Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
Starr	16	53	189	175.563	13.437
P-844	18	57	187	180.500	6.500
P-947	15	69	341	317.400	23.060
P-947 x P-844 (F_2)	38	143	567	538.132	28.868
P-844 x P-947 (F_2)	35	122	456	425.257	30.743
Totals	122	444	1740	1636.852	103.148

Table 13. Analysis of variance for thrips damage ratings on peanuts of the data summarized in Table 12

Source of variation	df	SS	MS	F
Among treatments	4	20.982	5.2440	5.59**
Within treatments	110	103.148	0.9377	
Total	114	124.130		

** Indicates significance at the 0.01 level of probability.

Table 14. Results of antibiosis and tolerance tests measured after seven days exposure to thrips in cages

Item	Material						
	P-947	P-844	P-947/P-844 (F_1)	P-844/P-947 (F_1)	P-947/P-844 (F_2)	P-844/P-947 (F_2)	Starr
No. of cages	15	18	10	4	38	35	16
No. larvae dead	2.13	2.15	5.80	8.24	2.18	3.17	3.13
No. larvae alive	20.26	19.89	10.20	2.25	19.05	17.80	18.75
Percentage of larvae dead	9.59	9.56	40.68	79.775	11.99	15.77	13.17
Damage rating	4.6	3.0	2.9	2.0	3.7	3.4	3.3
No. larvae dead (range)	0-8	0-6	2-13	5-11	0-8	0-11	0-7
Damage rating (range)	3-7	2-4	2-4	2-2	2-6	2-7	2-6

als in the five preference tests conducted are shown in Table 15. The analysis of variances indicated no significant differences among the F_2's, P-844, P-947 or Starr.

Table 15. Number of thrips recovered from F_2 leaflet samples in five preference tests

Test No.	Material	No. of plants	No. of thrips (range/plant)
1	P-947xP-844 (F_2)	11	3-18
	P-844xP-947 (F_2)	6	3-35
	P-844	1	17
	P-947	1	5
	Starr	1	14
2	P-947xP-844 (F_2)	10	4-18
	P-844xP-947 (F_2)	6	5-15
	P-844	2	8-16
	P-947	1	15
	Starr	1	2
3	P-947xP-844 (F_2)	8	1-19
	P-844xP-947 (F_2)	9	3-19
	P-844	1	9
	P-947	1	2
	Starr	1	9
4	P-947xP-844 (F_2)	9	2-14
	P-844xP-947 (F_2)	6	3-34
	P-844	2	3-24
	P-947	2	6--8
	Starr	1	2
5	P-844xP-947 (F_2)	8	1-14
	P-844	4	5-16
	P-947	4	5-18
	Starr	4	4-29

Table 16. Number of thrips recovered from five kinds of materials in five tests

Test No.	Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
1	Starr (ck)	1	14	196	196	
	P-844	1	17	289	289	
	P-947	1	5	25	25	
	P-947x P-844(F_2)	11	109	1315	1080.0909	234.9091
	P-844x P-947(F_2)	6	88	2044	1290.6667	753.3333
	Totals	20	233	3869	2880.7576	988.2424
2	Starr (ck)	1	2	4	4	
	P-844	2	24	320	288	32
	P-947	1	15	225	225	
	P-947x P-844(F_2)	10	87	917	756.900	160.100
	P-844x P-947(F_2)	6	50	480	416.667	63.333
	Totals	20	178	1946	1690.567	255.433
3	Starr (ck)	1	9	81	81	
	P-844	1	9	81	81	
	P-947	1	2	4	4	
	P-947x P-844(F_2)	8	69	859	595.125	263.875
	P-844x P-947(F_2)	9	82	946	747.111	198.889
	Totals	20	171	1971	1508.236	462.764

Table 16 (Continued)

Test No.	Treatment	No. of replicates (1)	Total of each treatment (2)	SS of treatment (3)	CF of treatment (4)	(3)-(4)
4	Starr (ck)	1	0	0	0	
	P-844	2	24	576	288	288
	P-947	1	8	64	64	
	P-947x P-844(F_2)	9	53	475	312.111	162.889
	P-844x P-947(F_2)	6	65	1567	204.167	862.833
	Totals	19	150	2682	1368.278	1313.722
5	Starr (ck)	4	52	1078	676.000	402
	P-844	4	42	526	441.000	85
	P-947	4	40	498	400.000	98
	P-844x P-947(F_2)	8	52	484	338.000	146
	Totals	20	186	2586	1855.000	731.000

Table 17. Analyses of the variance of the data summarized in Table 16

Test No.	Source of variation	df	SS	MS	F
1	Among treatments	4	166.3076	41.5940	0.4209 (ns)
	Within treatments	10	988.2424	98.8242	
	Total	14	1154.5500		
2	Among treatments	4	106.367	26.5917	1.041 (ns)
	Within treatments	10	255.433	25.5433	
	Total	14	361.800		
3	Among treatments	4	46.186	11.5465	0.2495 (ns)
	Within treatments	10	462.764	46.2764	
	Total	14	508.950		
4	Among treatments	4	184.068	46.0170	0.3502 (ns)
	Within treatments	10	1313.722	131.3720	
	Total	14	1497.790		
5	Among treatments	3	125.200	61.3560	0.6715 (ns)
	Within treatments	8	731.000	91.3750	
	Total	11	856.200		

CHAPTER V

SUMMARY

In a study on the inheritance of thrips resistance in peanuts, two peanut accesions were used as parents. P.I. 290597, or P-947, was moderately resistant to thrips while P.I. 268633, or P-844, was susceptible to thrips.

Antibiosis, tolerance, and preference for thrips were tested on the parents as well as the reciprocal F_1's and F_2's in order to determine any differences in resistance and to attempt to determine the transmission of the resistance character to their offspring.

The P-947 parent was resistant to thrips due to non-preference. Its tolerance response was relatively weak. Once the leaves of this plant were damaged, the damage could not be repaired. On obligatory feeding, P-947 suffered significantly more damage than P-844.

P-844 was susceptible to thrips due to an attraction of relatively large numbers of thrips for feeding or for other purposes. But P-844 was significantly more tolerant than P-947.

The parents had identical antibiosis as measured by the percentage of dead larvae.

There were differences between reciprocal crosses both in antibiosis and tolerance, and the inheritance seemed to follow the maternal line. This indicates that the cytoplasm may have a strong influence on the factors being studied.

Antibiosis of both the F_1 and F_2 showed a possible accumulative effect of genes. Since most plants tended to be more tolerant than the parental average, this indicates possible dominance for tolerance over non-tolerance.

The five kinds of materials were used as five treatments for analyses of variance for mean percentage of dead larvae, mean damage rating, and mean number of thrips recovered. There were no significant differences among the five kinds of materials in these three basic resistance traits in the F_1 portion of this study. In the F_2 only the damage rating of parent P-947 was significantly different from the other four kinds of materials. Antibiosis and preference showed no significant differences among the five kinds of materials. These data indicate that the parents were too similar genetically for thrips resistance, resulting in progenies that showed only small significant differences.

By using the techniques employed in this study with germ plasm more diverse in its resistance, one should be able to establish the mode of inheritance. Once established, appropriate methods for transferring resistance to commerical varieties can be determined.

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