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Natural Resistance to Thrips Injury in Cotton as Measured by Differential Leaf Area Reduction[1]

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ABSTRACT

Ten entries of cotton (*Gossypium hirsutum* L.) were evaluated for 2 years to measure their relative resistance to injury from thrips (*Thripidae*). Resistance was measured as the percentage of leaf area reduction associated with thrips damage. Leaf area was determined three times at weekly intervals during each year.

Pilose (H_2) was associated with a high level of resistance to thrips. Other morphological traits such as Okra-leaf shape (L^o), Red plant color (R_1), glandless (gl_2, gl_3), nectariless (ne_1, ne_2), or smooth leaf (Sm_1^{s1}, Sm_2) did not provide the plant with resistance. Significantly less leaf area damage occurred on the pubescent 'Tamcot SP-37' cultivar than on the glabrous 'Tamcot SP-21' cultivar.

***Additional index words*: Insect resistance, Pubescence, Glabrous, Isolines, Leaf area, *Gossypium hirsutum* L.**

THRIPS (*Thripidae*) are a common early-season pest of cotton (*Gossypium hirsutum* L.). These tiny insects attack leaf buds and flowers of many plant species. In cotton, they are found most often in the terminal bud when the plant is 2 to 4 weeks old (3). They suck juices from the embryonic leaves in this bud and cause them to be curled, ragged, and irregular when they unfold. This injury retards the growth of the new leaves and stunts plant growth by reducing photosynthetic capacity. Severe infestations may result in aborted terminals and excessive branching of terminal growth. These stunted plants are generally more susceptible to seedling disease than normal seedlings (7). Favorable growing conditions, particularly warm weather, help the plant to eventually outgrow the injuries.

Watts (18) reported that at least 13 species of thrips attack cotton, but only four species cause the greatest damage. Watson (17) stated that the predominant species of thrips attacking cotton in Alabama are *Frankliniella fusca* (Hinds), *F. tritici* (Fitch), and *Thrips tabaci* Lindeman. Gaines (5) listed these species along with *F. occidentalis* Pergande) as the most common species to attack cotton in Texas.

The economic importance of injury by thrips to cotton is a controversial subject. Control of thrips on cotton seedlings generally results in such a remarkable improvement in early growth and appearance of the plants that yields apparently should be similarly improved. This is not always the case. Newson et al. (14) reported that the effects of thrips injury on crop maturity was negligible and that untreated cotton often yielded more than treated cotton. Uncontrolled thrips infestations have been reported to delay fruiting, maturity, and harvest (7, 8) and to reduce yields (4). Rummel and Quisenberry (15) have shown that controlling thrips with foliar sprays after leaf damage was observed did not effectively prevent yield losses. They demonstrated that cultivars differed in their yield response to thrips injury. Ballard (1) and Hawkins et al. (7) have reported that cotton cultivars differ in their resistance to thrips injury. Ballard observed that dense pubescence of the juvenile terminal leaves appeared to be associated with thrips resistance.

The research was conducted to evaluate a technique for measurement of resistance to thrips in cotton and to study the response of several morphological traits to injury by thrips.

MATERIALS AND METHODS

This research was conducted in the same field plots at Lubbock, Tex., over a 2-year period (1977-78). Identical entries, with one exception, were used both years. The genotypes used were Texas Marker-1 (TM-1), three isolines of TM-1 (Okra-leaf shape, Red plant color and Pilose), strain 542, DPL-16 nectariless, Paymaster B8-3502, 'Tamcot SP-37,' 'Tamcot SP-21,' and glandless.

TM-1 is a highly inbred strain of 'Deltapine 14' and has often been used as a genetic standard in cotton studies (10). The Okra-leaf phenotype is conditioned by the L^o gene and the R_1 gene controls Red plant color. Pilose has densely pubescent leaves and is conditioned by the H_2 allele. TM-1 plus these isolines were provided by R. J. Kohel.

The 542 strain has ultrasmooth (glabrous) leaves and probably contains both D_2 smoothness (Sm_1^{s1}) and the Sm_2 alleles (13). The original 542 strain obtained from F. D. Wilson was both glabrous and nectariless. The line used in this test had normal nectaries that resulted from segregation in the original strain.

The DPL-16 nectariless strain (ne_1, ne_2), obtained from W. R. Meredith, Jr., was developed by backcrossing a Stoneville nectariless strain three times into 'Deltapine 16.' Paymaster B8-3502 was an experimental strain from D. C. Hess of the ACCO Seed Co. Previous observations of this line suggested that it was highly susceptible to thrips injury (15). Tamcot SP-37 and Tamcot SP-21 were developed by L. S. Bird (2). Tamcot SP-37 is pubescent while Tamcot SP-21 is glabrous. The amount of pubescence on the SP-21 cultivar is greater than the pubescence on the 542 strain.

Due to insufficient seed, two different glandless (gl_2, gl_3) lines were used in 1977 and 1978. In 1977, a glandless strain developed in our program was used and in 1978 the commercial cultivar 'Gregg 35 W,' developed by Gregg Seed Farms, was used.

These cotton entries were planted 16 May 1977 and 12 May 1978 in a randomized block design in each of two treatment blocks. Each entry was planted in a single row plot 15 m long and replicated five times per treatment. The treatments were aldicarb applied at the rate of 0.336 kg AI/ha and no aldicarb applied. The aldicarb was applied in-furrow at planting with a granular applicator. Aldicarb is a systemic insecticide that has been shown to completely control early-season thrips injury (6, 11). These treatment blocks were separated and surrounded by fall-planted strips of wheat (*Triticum aestivum* L.), ca. 30 m wide. Thrips movement from maturing wheat to small cotton is common on the Texas High Plains. Thus, the wheat served as a source of thrips infestation for the cotton.

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Table 1. Analysis of thrips resistance in 10 entries of upland cotton.

Source	df	Mean squares 1977	Mean squares 1978
Reps (R)	4	10	54
Entries (E)	9	887**	4,755**
R × E	36	65	39
Harvest (H)	2	1,724**	11,438**
H × E	18	112*	192**
Residual	80	62	57

*,** Significant at the 0.05 and 0.01 probability levels, respectively.

Measurements of leaf areas were used to quantify thrips injury (6). Ten plants per replication per treatment were randomly harvested at weekly intervals for 3 consecutive weeks. The leaf area of each plant was determined with a leaf area meter. The first leaf area readings were taken 28 days after planting in 1977 and 26 days after planting in 1978.

The following formula was used to quantify the resistance of an entry to thrips injury:

Percent leaf area damage = 1 − (untreated leaf area)/(treated leaf area) × 100.

The lower the percentage, the more resistant the entry was to thrips injury.

RESULTS AND DISCUSSION

Mean squares from a separate analysis of variance for each year are shown in Table 1. Entries, harvest dates, and the first order interaction entries × harvest dates were statistically significant for both years. Greater thrips injury occurred in 1978 (43%) than in 1977 (18%). The average percentages of leaf area reductions for the three harvests in 1977 were 23, 18, and 12, respectively, while the values were 58, 43, and 28 in 1978.

Means for each entry for each year and harvest are shown in Table 2. A comparison among TM-1 and its isolines of Pilose, Okra leaf shape, and Red plant color, showed that the Pilose trait offered resistance to thrips damage. Also, for five of the six harvests, the pubescent Tamcot SP-37 had significantly less leaf area damage than the glabrous Tamcot SP-21. The density of trichomes on SP-37 was apparently insufficient to provide the high level of resistance to damage by thrips associated with the Pilose character. Neither the nectariless nor glandless traits appeared to offer resistance to thrips injury. In 1977, the glandless strain developed in our program had a reduction in leaf area of only 15%, whereas in 1978, Gregg 35 W was reduced by 65%. Observations on these two entries showed that our glandless strain was more pubescent than the commercial cultivar. The difference in response of these two cottons demonstrates the care that must be taken when attempting to evaluate individual morphological traits for insect resistance.

In 1978, the glandless, nectariless, 542, and Paymaster strains had greater reductions in leaf area than TM-1, especially at the first leaf sampling date. Visual ratings of the pubescence of these strains appeared to be great enough to explain these differences. However, pubescence did not appear to be great enough to explain the statistical differences between Tamcot SP-21 and these same three strains. More detailed studies are needed before these small differences can be adequately explained.

Table 2. Means and mean separations for the percentage of leaf area reduction due to thrips injury for 10 entries, three harvest dates, and 2 years.

Entry	1977 Harvest First	1977 Harvest Second	1977 Harvest Third	1978 Harvest First	1978 Harvest Second	1978 Harvest Third
	%					
Pilose (H_2)	0.8 c*	0.6 d	2.9 de	8.2 d	0.8 d	3.1 f
Okra leaf (L°)	19.5 b	12.2 c	9.0 cde	57.5 b	53.7 a	24.5 de
Red plant (R_1)	23.8 b	16.7 bc	14.1 abc	55.7 b	37.5 bc	21.2 e
TM-1	22.4 b	16.3 bc	12.3 bcd	56.2 b	43.8 b	25.3 de
Glandless (gl_2, gl_3)†	25.8 ab	17.8 bc	0.6 e	80.1 a	62.0 a	52.9 a
Nectariless (ne_1, ne_2)	28.4 ab	25.4 ab	6.1 cde	74.3 a	40.8 bc	36.4 abc
542 (Sm_1^{sl}, Sm_2)	39.2 a	24.6 ab	19.3 ab	74.0 a	54.4 a	33.2 bcd
Tamcot SP-37	17.5 b	14.9 c	8.3 cde	35.1 c	32.2 c	14.1 e
Tamcot SP-21	26.0 ab	24.1 ab	19.9 ab	64.3 b	44.5 b	35.0 bcd
Paymaster B8-3502	29.2 ab	28.6 a	23.2 a	74.0 a	60.7 a	37.2 ab

* Means within columns followed by different letters are significantly different at the 0.05 probability level based on Duncan's multiple range test. Multiple range separations were calculated from individual analyses of variance conducted on the data obtained from each harvest date and year.
† Different glandless entries were used in 1977 and 1978.

From the results presented, we concluded that measuring areas of leaves damaged by thrips and comparing them to areas of undamaged leaves is a useful quantitative approach to evaluation of genetic resistance to thrips in cotton. Heavy trichome coverage on the leaf, such as that associated with Pilose, appeared to provide the cotton plant with virtual immunity to thrips injury. None of the other morphological traits we measured provided resistance to thrips injury. The use of the Pilose trait in cotton cultivars is probably limited because (i) of its high susceptibility to damage by the bollworm (*Heliothis* sp.) (12); (ii) leaves with excessive trichomes lower lint grades by making the removal of plant trash from the lint difficult during the ginning process (16); (iii) the lint tends to be short and coarse (9). However, pubescence levels no higher than that of Tamcot SP-37, conferred by other pubescence genes, appear to offer some resistance to thrips injury.

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