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Evaluation of Foreign and Domestic Cotton Cultivars and Strains for Boll Weevil Resistance[1]

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ABSTRACT

Forty-four domestic and introduced cotton (*Gossypium hirsutum* L.) cultivars and strains were evaluated in the laboratory for resistance to the boll weevil, *Anthonomus grandis* Boh. Oviposition by the boll weevil was significantly lower in squares (flower buds) from eight cottons ('Lasani 11,' 'AC 134,' 'Albar 627,' G077-2, 'BP 52/NC 63,' TX-LY-18-72, DES-HERB 16, and DES-ARB 16) than in squares from the commercial cultivar, 'Deltapine 16.' Five of the eight were introductions. Oviposition was not significantly lower in any entry than in 'Stoneville 213,' another commercial cultivar. There was no significant correlation between terpenoid aldehyde content in squares of 10 entries and rate of oviposition. The potential of the entries in breeding for increased resistance to boll weevil is discussed.

Additional index words: ***Anthonomus grandis*** **Boh., *Gossypium hirsutum* L., Oviposition suppression, Terpene content.**

THE larva and adult boll weevil (*Anthonomus grandis* Boh.) feed on the cotton square (flower bud). Adults chew through the calyx and unopened petals of the square and feed on anthers. Eggs are deposited through these feeding holes. Abscission of the square 5 to 9 days after oviposition results from larval feeding and developing within the square (Hunter and Pierce, 1912; Coakley et al., 1969). Abscission also results if

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squares are fed upon heavily by adult weevils. In late season, when squares become scarce, young bolls serve as feeding and oviposition sites.

Ovipositional preference studies conducted by Buford et al. (1967) showed that some cotton lines received fewer oviposition punctures than others. Buford et al. (1968) demonstrated that this reduction in oviposition was under genetic control in at least some of the lines. Jenkins et al. (1969) showed that results from oviposition trials in laboratory experiments were generally in accord with those from field tests. However, some cottons (i.e., frego bract and red leaf strains) that exhibited field resistance were not detected in laboratory tests. McCarty (1974), using test procedures developed by Buford et al. (1967), demonstrated that the squares of two lines, DES-HERB 16 and DES-ARB 16, received significantly fewer oviposition punctures than the commercial cultivar, 'Deltapine 16.' It was suggested that this resistance was due to reduced numbers of anthers in the flower buds of the former lines. Reddy and Weaver (1975) stated that the absence of pollen in male-sterile cottons reduced oviposition and levels of emergence by the boll weevil.

The objectives of the present studies were to compare 44 foreign and domestic cotton cultivars and strains for oviposition suppression of the boll weevil and to determine whether terpenoid aldehyde content of the buds altered oviposition rates.

MATERIALS AND METHODS

All entries used in the study are classified as *G. hirsutum* L. The lines DES-HERB 16 and DES-ARB 16 combine the genome of *G. hirsutum* with the cytoplasm of the diploid species *G. herbaceum* L. and *G. arboreum* L., respectively. Forty-four entries from 12 countries (Greece, Bulgaria, the U.S.S.R., Pakistan, Thailand, Chad, Mali, Cameroon, Uganda, Zambia, Australia, and the United States) were tested. American cottons in the tests were Delta-type cultivars and various breeding lines, including several from high terpenoid and glandless breeding programs. Thirty of the 34 foreign cotton cultivars and strains included in these studies were previously characterized for their agronomic, fiber, disease resistance, and morphological characters relative to selected U.S. cultivars (Samayoa-Armienta, 1974).

The 44 cottons (Table 1) were planted on 29 Apr. 1976, in single-row plots 6.09 m long in a randomized complete-block design with four replications. Standard farm practices for the area were used. Pesticide application schedules were adjusted so that no pesticides were used during a 5-day period preceding the collection of squares for testing.

A modification of the procedure developed by Buford et al. (1967) was used to test for levels of oviposition. The laboratory in which the feeding and oviposition tests were conducted was maintained at 27.8 ± 1.1 C, 60 ± 5% relative humidity and under constant lighting. Beginning 29 July 1976, 3,000 newly emerged weevils were obtained from the R. T. Gast Rearing Facility at Mississippi State Univ. Four lots of approximately equal numbers were placed in 30.5 cm^3 screened cages, and fed fresh, debracted Deltapine 16 cotton squares daily for 4 days. During this period the weevils mated, and oviposition began.

On the 5th morning after emergence, mated females were placed singly into 2.54 cm^3 plastic cages. These cages were then placed in 2.54 cm deep paper boxes with open tops, and arranged in a single layer on a table. Six cotton squares from each entry in each replication were debracted, sized to reduce variability, refrigerated immediately, and held overnight for testing. One square was then placed in each of the cages containing a female weevil.

On four successive mornings, the squares from the previous day were removed from the plastic cages, placed in labeled containers and replaced with fresh squares. Each square exposed to weevils was inspected microscopically, and the number of apparent oviposition punctures recorded. The female boll weevil seals egg punctures. All such punctures were recorded as oviposition punctures. Everett and Ray (1962), Leigh and Lincoln (1964), Buford et al. (1967), and McCarty (1974) have reported close correlations between occurrence of sealed punctures and eggs. The entire procedure described above was repeated weekly for 4 weeks.

Because contents of the pigment glands of the cotton plant do confer resistance to some insects (Quaintance and Brues, 1950; Cook, 1906; Lukefahr and Houghtaling, 1969; Lukefahr et al., 1971), we sought to determine if there was a relationship between terpenoid content of squares and oviposition preference. Using procedures developed by Carruth (1918) and modified by Smith (1967), we determined terpenoid aldehyde levels for 10 entries. On 2 Aug. 1976, squares were taken at random from 30 plants per entry.

Table 1. Cultivars and strains, plant introduction numbers, countries of origin, and mean number of eggs oviposited/weevil/day for 44 cottons.

Cultivar and strain	P.I. no.	Origin	Mean oviposition puncture/weevil/day*
			no.
CX 349	324467	U.S.S.R.	12.7 a
137-F	274465	U.S.S.R.	11.7 ab
138-F	274466	U.S.S.R.	11.6 ab
152-F	324469	U.S.S.R.	11.6 a-c
6111	362156	Bulgaria	11.3 a-d
Deltapine 16	–	U.S.A., Miss. (Delta and Pineland Co.)	11.1 a-d
CA(68)41	365540	Uganda	11.0 a-e
CA(68)36	365539	Uganda	10.8 a-e
BC_2F_4DPL-16 × T-209	–	U.S.A., Miss. (J. N. Jenkins)	10.8 a-e
10E	361150	Greece	10.7 a-e
4521	362155	Bulgaria	10.6 a-f
4S 180	361151	Greece	10.5 a-g
SK 14	365544	Thailand	10.4 a-h
SK 32	365545	Thailand	10.4 a-h
3996	365543	Bulgaria	10.3 b-h
Allen 333-61	365535	Mali	10.2 b-h
108-F	324468	U.S.S.R.	10.2 b-h
3279	365542	Bulgaria	10.1 b-h
LSS	365530	Pakistan	9.9 b-i
C-1211	324466	U.S.S.R.	9.9 b-i
AC 307	365528	Pakistan	9.8 b-i
HG-BR-8-N	–	U.S.A., Tex. (M.J. Lukefahr)	9.8 b-i
Stoneville 213	–	U.S.A., Miss. (Stoneville Pedigreed Seed Co.)	9.7 b-j
73	362154	Bulgaria	9.6 b-j
AH(67)M	365536	Uganda	9.5 b-j
BPA 68	365538	Uganda	9.5 b-j
HL-1	365534	Cameroon	9.4 b-j
HG 9	362157	Chad	9.3 c-j
Pak 51	365532	Pakistan	9.2 d-j
M4 (N.T. Sind)	365531	Pakistan	9.1 d-j
G002-7-1	356811	Australia	9.1 d-j
MO-HG	–	U.S.A., Mo. (W.P. Sappenfield)	9.1 d-j
SATU 65	366541	Uganda	9.0 d-j
BC_2F_4DPL-16 × T-25	–	U.S.A., Miss. (J.N. Jenkins)	9.0 d-j
BC_2F_4DPL-16 × T-80	–	U.S.A., Miss. (J.N. Jenkins)	9.0 d-j
BJA 592	362158	Chad	8.9 d-j
G077-2	356812	Australia	8.8 e-j
DES-ARB-16	–	U.S.A., Miss. (V.G. Meyer)	8.8 e-j
TX-LY-18-72	–	U.S.A., Tex. (L.S. Bird)	8.3 f-j
Albar 627	–	Zambia	8.3 f-j
AC 134	365527	Pakistan	8.2 g-j
DES-HERB-16	–	U.S.A., Miss. (V.G. Meyer)	8.1 h-j
BP 52/NC 63	365537	Uganda	7.7 ij
Lasani 11	365529	Pakistan	7.4 j

* Means followed by the same letter do not differ significantly at the 0.05 probability level as determined by Duncan's Multiple Range Test.

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Table 2. Percentages of terpenoid aldehydes in flower buds of 10 selected test cottons.

Cultivar or strain	Terpenoid aldehydes†
	%
6111	0.48
C-1211	0.52
BJA 592	0.57
Deltapine 16	0.58
CA(68)36	0.66
SATU 65	0.67
Stoneville 213	0.69
CA(68)41	0.74
MO-HG	1.03
HG-BR-8-N	1.28

† Expressed as a percentage of freeze-dried square (flower-bud) powder.

RESULTS AND DISCUSSION

Table 1 presents the mean number of apparent ovipositions per weevil per day on each test cotton. Buford et al. (1968) showed that a laboratory adapted strain of weevil oviposited 2.44 times as many eggs as a field strain. Their studies showed also that evaluation of cotton lines with the laboratory strain of weevil correlated well with varietal differences from evaluations using wild weevils.

Because we used a laboratory strain of weevil, the oviposition levels obtained during this study are probably much higher than expected under field conditions. The mean number of eggs deposited per day ranged from 7.4 for 'Lasani 11" to 12.7 for 'CX 349' (Table 1). Oviposition in squares from eight of the test cottons (Lasani 11, 'AC 134,' 'Albar 627,' G077-2, 'BP 52/NC63,' TX-LY-18-72, DES-HERB 16, and DES-ARB 16) was significantly lower than that in squares from Deltapine 16. Oviposition was not significantly lower in squares from any of the test cottons than in squares from Stoneville 213. The two lines, DES-HERB 16 and DES-ARB 16, in which McCarty (1974) had demonstrated reduced oviposition, again had significantly fewer eggs oviposited in their squares than did Deltapine 16. The glandless line, TX-LY-18-72, also had significantly fewer eggs deposited in its squares than did Deltapine 16. Of the eight cottons with significantly fewer eggs than Deltapine 16, five were introductions (Table 1).

Oviposition suppression was indicated in several of the cottons tested. In Lasani 11, oviposition was about two-thirds of that in Deltapine 16. Oviposition suppression shows a compounding effect; that is to say, insect populations build more slowly on such cultivars even though levels of resistance may be fairly low.

In Table 2 are listed the levels of terpenoid aldehydes extracted from squares of 10 selected test cottons. Except for HG-BR-8-N and MO-HG, both high-terpenoid lines, the terpenoids were considerably less than 1.0% of the dry weight of the square. The correlation between number of eggs oviposited on the lines and the amount of terpenoids in their squares ($r=-0.31$) was not significant at the 0.05 probability level. This result suggests that the range of terpenoids in the entries had no appreciable effect upon weevil oviposition.

Because the cottons under test were diverse as to origin, the probability is good that the low levels of resistance recorded are due to different genetic factors. It should therefore be possible to enhance resistance by intercrossing resistant stocks and testing their products for response to oviposition by the insect. It may also be possible to enhance resistance by crossing the resistant stocks to selected cultivars. Our results suggest that Stoneville 213 may be a better recurrent parent than Deltapine 16, although the slightly lower oviposition damage in the former cultivar did not differ significantly from that in the latter one. It may be profitable to test other improved cultivars for their response to boll weevil oviposition, to determine which ones may be the best parents.

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