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A Boll Weevil Oviposition Suppression Factor in Cotton[1]

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ABSTRACT

The rate of boll weevil, *Anthonomus grandis* Boheman, oviposition was tested on 252 cotton lines, *Gossypium hirsutum* L. and *G. barbadense* L., in a nonreplicated mass screening procedure. Boll weevil oviposition was reduced in 26 lines. Replicated tests were performed on six of these by using the A & M laboratory strain and a Mississippi field strain of weevils. The two strains ranked the six cotton lines in relatively the same order. We obtained F_1 hybrids of each of the 26 lines by crossing them with 'Deltapine Smooth Leaf' (DPSL) and tested the hybrids for oviposition with the A & M strain in replicated tests. Significant differences were found. Oviposition values ranged from 49 to 178% of the commercial DPSL parental line. 'S. I. Seaberry' produced the lowest oviposition rate. Inheritance studies with S. I. Seaberry × DPSL were conducted in the F_1, F_2, and backcross progeny. Difficulty was experienced in testing individual F_2 backcross plants since the test required many squares. We did, however, determine that the ability of S. I. Seaberry to suppress boll weevil oviposition was under genetic control.

Additional index words: resistance, *Gossypium hirsutum* L., *Anthonomus grandis*.

THE oviposition rate of an insect is critical to its population dynamics. Cotton, *Gossypium hirsutum* L. and *G. barbadense* L., is the primary and only cultivated host of the boll weevil, *Anthonomus grandis* Boh. Thus, reducing the rate of boll weevil oviposition by changing the genotype of the cotton plant should lower the reproductive potential of the insect. The rate of boll weevil oviposition on various cotton lines can be evaluated in the laboratory by using a technique we have described (1).

Early efforts to evaluate cotton germ plasm for resistance factors that might be useful in the control of the boll weevil were centered around a study of morphological characters. Hunter and Pierce (3) listed a number of plant characteristics which, when incorporated into a variety, would cause the weevils to exhibit nonpreference for the plant. Some of these are hairy stalks and stems, thick carpel wall, tendency to retain fruit, and determinate growth pattern. Wessling (10) found that the mutant gene (R_1) for red plant color conferred a degree of resistance, as measured by the percent squares with egg punctures. Jones et al. (4) noted that the red plant color in Empire Red resulted in no fewer oviposition punctures than a green commercial variety. Frego, a bract mutant controlled by a single recessive gene, (*fg*), has narrow twisted bracts in contrast to the flat enclosing bracts of normal plants. A combination of the frego bract and red plant color in one line of cotton resulted in a significant reduction in oviposition. Hunter et al. (2) found that frego bract inhibits feeding and oviposition at low insect population levels, possibly because the bract is radically different from a normal bract which provides the weevil a place for resting, feeding and oviposition. Lincoln and Waddle (5) found that weevils definitely preferred normal cotton plants over frego. In one test weevils punctured squares of frego plants only 25% as much as a nonfrego variety.

Stephens (6) found that hairy plants were less preferred. Wannamaker (9) found that Pilose (H_2) pos-

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sesses some resistance to the boll weevil. Wessling (11) showed that increasing the number of Pilose plants in a mixture of hairy and glabrous plants reduced the total number of egg punctures.

Stephens (7) in laboratory tests reported that a glanded strain with two genetic factors for hairiness (H_1) and H_2) was preferred for oviposition to a glabrous and completely glandless strain when the weevils were given a choice between the two types. When given no choice, oviposition was similar on all strains. He speculated that the glands stimulated oviposition and that the hairy trait, combined with the glandless trait in one variety, would be a strong deterrent to oviposition. Stephens and Lee (8) showed that weevils exhibited no preference for buds of red or green cotton in laboratory experiments. They studied four lines in field plots: hairy, hairy-glandless, red-hairy-glandless, and a commercial Upland variety which was non hairy, glanded, and green. Two incompletely dominant genes govern hariness; two recessives govern absence of glands; and a single incompletely dominant gene governs red color. Weevils did not discriminate between the hairy and hairy-glandless strains. Data from the red-hairy-glandless was inconclusive; however, preliminary results indicated that the red character in hairy strains might increase resistance to boll weevil attack. None of the data from field or laboratory work indicated that the weevils exhibited any preference for glanded or glandless plants.

The literature surveyed demonstrated that the weevil has definite preferences for oviposition sites and that the amount of oviposition may be influenced by various characters in the cotton plant, causing the boll weevil to oviposit fewer eggs on some varieties than on others. Early workers approached the boll weevil control problem from several angles. Most of the work involved the evaluation of morphological characters for certain aspects of resistance to the weevils. Some of these characters appear to impart some resistance to the plant; however, none of the morphological characters thus far studied appear to give high levels of resistance.

The object of this study was (*1*) to screen a large number of cotton lines for the rate of boll weevil oviposition and (*2*) to conduct genetic studies with those lines which caused low oviposition by the boll weevil.

MATERIALS AND METHODS

1. Nonreplicated mass screening. We planted 252 cotton lines in plots two rows by 6.1 m (20 ft). They represented a broad germ plasm base, as may be seen by the following listing: 16 commercial varieties or breeder strains, 8 introductions from India and 17 from Turkey, 19 type stocks from the regional collection, 184 random lines from the regional collection. 6 glandless lines, and 2 nectariless lines.

We used A & M laboratory-reared weevils and a modification of our standard oviposition test. The test period was 4 days. We tested 40 to 125 lines, unreplicated, each week during the 5-week test period, selecting for further study lines on which the wevil oviposited less than 50% as many eggs as the mean of all lines in the test each period.

2. Comparison of selected lines with A & M laboratory and Mississippi field weevils. In order to verify the use of A & M laboratory weevils to simulate field weevils, six of the best lines from the mass screening were tested with both strains of weevils. Three replications were used and the test ran 8 days.

3. Inheritance studies: A. F_1's of 26 selected lines with 'Deltapine Smooth Leaf.' A genetic study was initiated to determine if the oviposition suppression factor was inherited. The 26 lines chosen from the mass screening were crossed with Deltapine Smooth Leaf (DPSL) and the resulting F_1's tested in our standard replicated oviposition test with A & M weevils.

This test series was run in three groups. Deltapine Smooth Leaf was included in each group as a control. Comparisons of eggs oviposited can only be made of lines tested within a single group; the T/DPSL ratio should be used for between-group comparisons. The T/DPSL ratio is obtained by dividing the number of eggs produced on a line in the test by the number produced on DPSL.

Inheritance Studies: B. Intercrosses of selected lines. 'Russian Sea Island' (SA 698), 'Sea Island Seaberry' (SA 192), D_2 glandless, and Deltapine Smooth Leaf were chosen for use in special genetic studies involving intercrosses. These were crossed in all possible combinations. Two of these lines were *G. barbadense* L. and were also crossed with 'Pima S-2' (*G. barbadense* L.). Four replications of our standard oviposition test with A & M weevils were run on these lines for 9 days.

RESULTS AND DISCUSSION

1. Nonreplicated mass screening. The testing of the the 252 lines yielded 26 selections on which the weevils oviposited less than 50% as many eggs as the mean of all the lines on test. Two *G. barbadense* varieties were among the selections. This was unexpected since in previous tests weevils had preferred the G. barbadense ('Pima S-1') over *G. hirsutum* L. cotton for oviposition and feeding, (1).

2. Comparison of selected lines with A & M and Mississippi field weevils. Replicated screening of the selections was undertaken to determine if the differences previously noted were real, and to compare oviposition of weevil strains. Six selections plus the control line DPSL were tested in replicated studies with A & M laboratory and Mississippi field weevils (Table 1). The number of eggs per female per day obtained from the A & M weevils was about twice as high as those from the Mississippi field strain. S. I. Seaberry was the lowest in boll weevil oviposition of any of the lines tested with Mississippi field weevils, and was next to the lowest in the screening with A & M weevils. The cotton lines were ranked generally in the same order by both weevil strains.

3. Inheritance studies: A. F_1's of selected lines with Deltapine Smooth Leaf. The 26 lines selected in the initial screening were crossed as males to Deltapine Smooth leaf.

Table 2 presents the 26 F_1's, arrayed according to the mean oviposition response, and expressed as mean eggs per female per day. The values are readings taken from three tests, and the DPSL value for each test is also given. The 20 means in test 3 were analyzed statistically by using Duncan's New Multiple Range Test; the S. I. Seaberry $\times$ DPSL combination was found to be significantly different from DPSL and

Table 1. Oviposition values of two strains of boll weevils on seven selected cotton lines. Based on three replications of an 8-day test.

Cotton line	Eggs/female/day		Eggs as % of DPSL	
	A & M weevils	Miss. field weevils	A & M weevils	Miss. field weevils
G. hirsutum Tashkent	15.30	7.46	126	98
CB 2540	11.98	6.92	99	92
Extreme Okra Nankeen	10.01	5 57	83	73
D_2 glandless	8.33	4.72	69	62
Russian S. I.	9.70	----	80	--
S. I. Seaberry	9.45	2.96	78	39
Deltapine Smooth Leaf	12.10	7.64	100	100

Table 2. Mean oviposition values of the A & M weevil strain when tested on the F_1 of each of 26 selected lines crossed with DPSL.

Cotton line	No. reps.	Mean eggs/ female/day	T/DPSL*
	Test 1		
Acala glandless × DPSL	2	8.26	1.78
D_2 glandless × DPSL	2	6.98	1.51
5 wilds × ISI × DPSL	2	6.75	1.46
Acala N28-5 × DPSL	2	5.35	1.16
DPSL	2	4.62	1.00
CB2678 × DPSL	2	3.40	0.74
	Test 2		
DPSL	2	8.46	1.00
UA 7-21 × DPSL	2	6.30	0.74
Tidewater 372-4 × DPSL	2	5.71	0.67
	Test 3		
GSP 2-6-14 #26 × DPSL	4	8.48 a†	1.05
G. hirsutum 7-6-14 #18 × DPSL	4	8.28 a	1.02
DPSL	4	8.08 a	1.00
C_6 × DPSL	4	7.81 a	0.97
Upland UA 7-1 × DPSL	4	7.32 a	0.90
Texas Rust Brown × DPSL	4	7.15 ab	0.88
Acala Shafter Sta. × DPSL	4	7.14 ab	0.88
Wacona PL-1 × DPSL	4	7.07 ab	0.88
Hurley Long Boll × DPSL	4	6.87 ab	0.85
Bobshaw 454 × DPSL	4	6.69 ab	0.83
Stoneville 5 T196-10 × DPSL	4	6.67 ab	0.82
G. hirsutum Tashkent × DPSL	4	6.64 ab	0.82
Piedmont Cleveland 2-1 × DPSL	4	6.62 ab	0.82
Sutured Apex × DPSL	4	6.22 ab	0.77
Acala 1-13-3-1 × DPSL	4	5.98 ab	0.74
Russian S. I. × DPSL	4	5.93 ab	0.73
Marshall Cotton × DPSL	4	5.63 ab	0.70
CB2540 × DPSL	4	5.58 ab	0.69
Extreme Okra Nankeen × DPSL	4	5.24 ab	0.65
S. I. Seaberry × DPSL	4	3.98 b	0.49

* Mean eggs per female per day on test line divided by mean eggs per female per day on DPSL. † Those means followed by the same letter are not significantly different at the 0.05 level using Duncan's New Multiple Range Test.

resulted in a 51% reduction in oviposition. The Russian S. I. × DPSL of group 3 was much higher than in previous tests and only had a reduction in oviposition of 23%; however, it still remains in the lower 25% of the lines tested.

Inheritance studies: B. Intercrosses with best lines. In 1965 the screening program was directed toward retesting in a large replicated test some of the high and low lines and the F_1 combinations between these lines. Those selected were Russian S. I., S. I. Seaberry, Pima S-2, D_2 glandless, and DPSL.

The results of the screening are presented in Table 3. Column 1 presents the total egg production for each line tested. The highest line is D_2 glandless followed closely by DPSL. Egg production on S. I. Seaberry and Russian S. I. is approximately equal. The difference in total eggs produced on S. I. Seaberry and DPSL is approximately 1,000. The mean egg production on S. I. Seaberry is 6.29 whereas it is 10.83 on DPSL. Weevils oviposited only 58% as many eggs on S. I. Seaberry as on DPSL.

The F_1 combinations in this table were screened at the same time as the parents; therefore, the results obtained are directly comparable to the parents. Comparison of the seven F_1's and consideration of their parental response showed that the S. I. Seaberry × DPSL cross was the best for future genetic study. Also, the S. I. Seaberry plant type and fruiting habit was more desirable than Russian Sea Island.

Two conclusions may be drawn from the data collected thus far. First, the oviposition suppression factor is under genetic control. Second, the low oviposition character does not appear to behave as a simple dominant to high oviposition, because in the cross low by high (as is typified in S. I. Seaberry × DPSL) the F_1 always occupied a somewhat intermediate position between the two parents.

Table 3. Mean oviposition values from tests of A & M weevils on selected lines and their respective F_1's in 1965. Based on four replications.

Cotton line	9-day total	Mean eggs/ female/day	T/DPSL*
D_2 glandless × DPSL	1963	8.72	0.80
Russian S. I. × S. I. Seaberry	1933	8.59	0.79
S. I. Seaberry × Pima S-2	1929	8.57	0.79
S. I. Seaberry × DPSL	1752	7.78	0.71
Russian S. I. × DPSL	1573	6.99	0.64
S. I. Seaberry × D_2 glandless	1558	6.92	0.63
Russian S. I. × Pima S-2	1425	6.33	0.58
D_2 glandless	2685	11.93	1.10
DPSL	2437	10.83	----
Pima S-2	2051	9.11	0.84
Russian S. I.	1560	6.93	0.64
S. I. Seaberry	1416	6.29	0.58

* Mean eggs per female per day on test line divided by mean eggs per female per day on DPSL.

Work is underway in an effort to determine the nature of the oviposition suppression factor. The efforts are being made in advanced generations of S. I. Seaberry × DPSL where the greatest promise has thus far been found. Testing of single plants in the backcross and F_2 progeny was attempted and the results were unsatisfactory. Data also indicated that a simple dominant factor was not sufficient to explain the oviposition supression factor. Accurate evaluation of the segregating plant populations will have to be made through a plant-to-row program to provide sufficient squares for an adequate test. Continued selection and backcrossing to commercial types should eventually result in plants with acceptable agronomic potential plus the oviposition supression factor.

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