Selecting Cotton for Resistance to Boll Weevil in Brazil

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ABSTRACT

The boll weevil Anthonomus grandis Boheman, is one of the major pests of cotton in Brazil. There have been many attempts to locate sources of resistance to this insect in many places where it occurs. Several researchers have mentioned primitive Gossypium hirsutum L. that have given significant reduction in oviposition punctures under laboratory tests. Some lines have imposed significant reduction in boll weevil populations under field conditions. Some progenies derived from crosses between these race stocks and cultivars Stoneville 213, PNH3 and CNPA Precoce 2, exhibited significant levels of resistance to boll weevil while maintaining good fiber and agronomic characteristics.

Introduction

Boll Weevil (*Anthonomus grandis Boheman*) is a major insect pest on cotton (*Gossypium hirsutum L.*) in Brazil and other cotton producing countries in the Americas. Pesticides used for its control have contributed significantly to increased cotton production costs and to environmental degradation. Failure to control this pest generally results in major yield losses and unprofitable production. Host plant resistance would enhance the profitability of cotton production by reducing costs and improving incomes.

Boll weevil was first recorded on cotton in Brazil in 1983. Since then, there have been many attempts to locate sources of plant resistance. (Lukefahr & Vieira, 1986). Hunter *et al.* (1965), and Jones *et al.* (1986) have adequately reviewed these attempts. Jenkins *et al.* (1978), Lambert *et al.* (1980) and McCarty *et al.* (1982) reported on numerous primitive *G. hirsutum* races that gave a significant reduction in oviposition punctures in laboratory studies but revealed only small differences under field conditions that were not consistent from year to year (Lukefahr and Vieira, 1986). According to these authors, Jones (personal communication) indicated that two primitive *G. hirsutum* races, MT-326 and MT-1180 significantly reduced boll weevil populations under field conditions. Similar results were observed in primitive *G. hirsutum* race T-277 in Brazil (Lukefahr and Vieira, 1986).

The objective of the studies reported here was to identify potential levels of resistance to boll weevil, earliness and good agronomic and fiber characteristics in progenies derived from crosses between early boll weevil susceptible cultivars (PNH3 and CNPA Precoce 2) and three boll weevil resistant lines (T-277-2-6; T-326-1 and T-1180w). Lukefahr and Vieira (1987) developed the boll weevil resistant lines by crossing primitive *G. hirsutum* races (MT-326, MT-1180 and T-277) with a commercial cultivar Stoneville 213.

Material and Methods

Experimental lines T-277-2-6; T-326-1 and T-1180w obtained by Lukefahr and Vieira (1985) were found to exhibit significant levels of resistance to natural field infestation of boll weevil. None of these lines, however, were commercially accepted since they are all late maturing and have poor fiber qualities. As one of the main objectives of Embrapa's breeding program was to combine earliness with resistance to boll weevil, a crossing scheme involving these boll weevil resistant lines and an early maturing genotype, PNH3, was initiated. From these crosses, 256 F_2 plants were selected and their progenies evaluated under field conditions for earliness and boll weevil resistance. Progenies from crosses of genotypes T-277 x PNH3 were not evaluated for boll weevil resistance. Resistance was measured as percentage of punctured squares in the field and earliness as percentage of the first harvest.

Trial 1

Progenies derived from crosses involving T-326-1 and T-1180w experimental lines with PNH3 cultivar, were evaluated in a non-replicated test against a susceptible cultivar CNPA 2H. When the progenies were all squaring, 10 adult boll weevils were released in each plot. Plots were 5.0m x 1.0m. Sampling procedure in which twenty squares were collected from each plot for 5 consecutive weeks, was initiated 7 days after the release of the adult boll weevils. Squares with egg and feeding punctures were separated, placed in distinct containers and adult emergence recorded. When 25% of squares were infested, representing the lower percentage of punctured squares, the experimental lines were selected and the whole trial sprayed. Sixty four F_4 progenies representing the lowest percentage of oviposition punctures, were selected.

Trial 2

In 1990, the 64 selected F_4 progenies were subjected to another field evaluation for boll weevil resistance. The same procedures used in Trial 1 were used in Trial 2. Fourteen strains were selected.

Trial 3

In 1992, the 14 selected strains were again evaluated under field conditions, this time in a Randomized Complete Block Design. The plots were 4m x 1m and replicated 6 times. Procedures for spraying and insect delivery were the same as for the earlier trials. When all plots were squaring, they were sampled for 6 consecutive weeks by taking 50 squares per plot for separation according to puncture type.

Selection for Yield and Other Characteristics

The main objective of the work was to combine earliness and boll weevil resistance. All the lines selected in these trials had relatively good levels of reduction to boll weevil but all of them were relatively late maturing. Another crossing process was initiated, this time with one backcross to a super-early cultivar, CNPA Precoce 2. A selection scheme for yield and fiber quality was then initiated with the progenies of the backcross. Two hundred and eighty eight plants were selected in the field. Based on their fiber analysis results, 97 were selected for further tests. The progenies of these 97 experimental lines were field tested to select the best yielding lines. The 19 best producing lines based on these field trials, named as RB1 to RB19, were selected for inclusion in elite strains trials for agronomic evaluation in comparison with other experimental lines.

Results

The results of Trail 1 are summarized in Table 1. Thirty-one of the progenies of T-1180w x PNH3 and T-326 x PNH3 crosses exhibited significant reduction in oviposition punctures relative to the susceptible check CNPA 2H. Thirty-three progenies from the T-277 x PNH3 crosses were selected on other criteria.

From these 64 selected progenies, 14 lines were chosen for testing in future trials. The seven more resistant genotypes are presented in Table 2. The highest level of resistance was observed in progenies from genotype T-277. Progenies from T-326 and T-1180w had higher infestation counts than T-277 but lower than the susceptible cultivar CNPA 2H. In every sequential week, infestations were lower in the resistant progenies. From the 64 first progenies, 11% presented some levels of resistance to boll weevil. This suggests that resistance is the result of a heritable factor that could be transferred to other genetic backgrounds.

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Table 3 presents the agronomic evaluation of the lines derived from backcrosses to CNPA Precoce 2. Earliness was recovered in the resistant genotypes. Even though no significant differences in lint production were observed among the experimental lines, some strains revealed that yield potential, earliness and fiber qualities increased to levels comparable with the check commercial cultivars.

The work on identification experimental lines with high yield potential and fiber quality will continue. It is Embrapa's objective to increase the seed from the RB3, RB11, RB12, RB13 and RB18 strains for testing in large areas and efforts are under way to determine if the nature of resistance is non-preference or antibiosis.

Conclusions

1. Cotton strains with significant levels of resistance to Boll Weevil and good agronomic and fiber qualities were developed;
2. Field tests demonstrated to be very efficient in evaluating the experimental lines for Boll Weevil resistance;
3. Selection efficiency for seed cotton yield in Northeast Brazil was in the order of 1.03% a year;
4. Progress was also made in fiber percentage and fiber properties.

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Table 1. Oviposition percentage and oviposition reduction percentage in relation to the standard (%T) in F_4 progenies.

Nº of progeny[1]	Ovipos. Percentage (%)	% T	Nº of progeny[2]	Ovipos. Percentage (%)	% T
145	0.0	100.0	131	1.8	91.6
146	15.6	30.9	136	5.0	76.8
151	6.8	69.9	139	5.0	76.8
172	5.8	74.3	140	0.0	100.0
173	6.4	71.6	141	0.0	100.0
175	6.6	70.7	142	2.4	88.8
178	5.8	74.3	64	5.6	74.0
183	7.2	68.1	67	8.2	62.0
221	1.2	46.9	70	6.4	70.3
230	8.8	61.0	116	10.4	51.8
231	3.2	85.8	80	9.6	55.5
232	3.2	85.8	93	0.0	100.0
234	7.2	68.1	99	12.0	44.4
239	6.8	69.9	117	7.0	67.5
241	6.0	73.5	119	11.8	45.3
251	7.2	68.1	CNPA 2H(S)	21.6	-
CNPA 2H(S)	22.6	-	CNPA 2H(S)	-	-

[1] Progenies from T - 1180 X PNH_3;
[2] Progenies from T - 326 X PNH_3;
S - Standard

Table 2. Weekly percentage of boll weevil infested squares in F_5 lines; total mean and percent reduction in infestation in relation to the standard.

Strains	Weekly percent infestation							
	1_a	2_a	3_a	4_a	5_a	6_a	Mean	%T
T-277-11	19.4	8.4	27.6	31.4	46.0	18.0	25.0 d	43.7
T-277-8	21.6	8.4	28.0	36.4	48.6	22.0	27.5 cd	37.0
T-1180-1	29.4	9.0	18.4	48.6	50.6	23.4	29.9 bcd	31.4
T-326-1	40.2	16.0	21.0	44.0	50.0	28.2	32.9 bc	24.5
T-277-12	33.0	16.1	24.0	57.1	57.0	24.0	35.2 b	19.3
T-1180-23	34.0	16.8	24.8	56.8	58.9	25.8	36.2 b	17.0
T-1180-18	36.6	18.1	24.2	58.6	64.3	18.4	36.2 b	17.0
CNPA 2H (S)	45.0	23.9	33.6	65.4	65.6	25.4	43.6 a	-
CV (%)							11.8	

I – Means followed by the same letter, within colunm, are not significantly different by LSD test at 0.05 probability level.

II – (S) Standard

Table 3. Adjusted means of boll weevil resistant cultivars and strains in relation to yield and other plant characteristics.

Geno-Type	Origin	Yield (kg/há)	Earliness (%)	Boll Weight (g)	Fiber percent. (%)	Fiber length (2,5%mm)	Fiber strength (gf/tex)	Fiber mat (%)	Fiber unif. (%)	Micr (ug/in)
RB_1	T-277	1937	65.3 abc	5.4 cdef	37.6 abc	28.4 ab	21.2	66.4	51.7	4.5 a
RB_2	T-277	1978	70.2 abc	5.4 cdef	38.6 abc	28.0 ab	21.3	63.1	53.5	4.3 ab
RB_3	T-277	1994	75.0 a	5.2 def	38.4 abc	30.6 a	21.6	64.8	51.1	3.8 ab
RB_4	T-277	1828	57.6 abc	4.9 ef	38.4 abc	29.7 ab	20.2	64.4	51.1	4.3 a
RB_5	T-277	1956	68.1 abc	5.5 bcdef	37.2 abc	30.3 a	21.3	65.7	49.2	3.7 ab
RB_6	T-277	1940	64.5 abc	5.1 def	39.0 abc	29.6 ab	20.4	65.7	49.3	4.1 ab
RB_7	T-277	1801	67.4 abc	5.2 def	40.0 ab	29.2 ab	20.6	63.9	50.5	4.1 ab
RB_8	T-277	1952	57.1 abc	5.3 cdef	38.6 abc	28.5 ab	23.9	61.1	50.1	3.5 b
RB_9	T-277	2022	53.6 abc	5.7 abcde	38.6 abc	29.2 ab	20.9	66.0	52.2	4.1 ab
RB_{10}	T-326	1849	68.4 abc	5.7 abcde	41.1 a	239. ab	20.7	61.4	50.6	4.0 ab
RB_{11}	T-326	2038	73.2 abc	5.2 def	39.9 abc	27.6 abc	20.2	62.5	50.2	3.8 ab
RB_{12}	T-326	2121	67.6 abc	5.5 bcdef	40.1 ab	28.3	20.2	66.1	51.9	5.0 ab
RB_{13}	T-1180	2257	63.4 abc	5.2 def	41.1 a	28.8 ab	22.6	63.3	55.3	4.2 ab
RB_{14}	T-1180	1925	59.0 abc	4.8 f	40.4 ab	28.1 ab	20.7	64.8	51.4	4.1 ab
RB_{15}	T-1180	1732	73.8 ab	5.1 def	42.6 a	28.9 ab	20.1	64.9	54.4	4.2 ab
RB_{16}	T-1180	1993	71.5 ab	5.3 cdef	37.4 abc	30.4 a	21.2	61.8	50.0	3.9 ab
RB_{17}	T-1180	1763	76.1 a	5.6 abcde	40.9 ab	30.3	23.1	62.7	54.2	3.9 ab
RB18	T-1180	2143	72.2 abc	5.9 abcd	36.7 bc	28.7 ab	21.0	63.7	53.2	3.8 ab
RB_{19}	T-1180	1781	53.8 abc	6.0 abcd	37.4 abc	30.0 ab	24.1	63.7	53.0	3.8 ab
CNPA7H	-	2038	65.5 abc	6.4 a	34.7 c	28.1 Ab	21.1	62.2	51.2	4.2 ab
CNPAP2	-	1978	78.2 a	5.7 abcde	40.9 ab	28.9 ab	19.9	64.8	50.3	3.8 ab
Mean	-	1946	64.3	51.6	38.7	28.8	21.5	64.3	51.8	4.1
F	-	1.1_{ns}	3.5**	4.8**	2.5**	2.1**	1.9_{ns}	1.3_{ns}	1.5_{ns}	2.0**
CV(%)	-	9.0	12.1	5.1	3.9	3.6	6.8	6.8	4.0	6.1

I -Means followed by the same letter, within columns, are not significantly different by tukey test at 0,05 probability level.

N_s - Nonsignificant

** - Significant at 1% level of probability