GENERAL COMBINING ABILITY OF INSECT RESISTANT COTTON GERMPLASM

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Abstract

In order to be commercially acceptable, pest resistant cultivars must combine high lint yield and fiber quality with pest resistance properties. The task of combining yield, fiber quality, and pest resistance would be facilitated by information on the breeding value of available pest resistant genotypes. The objective of this study was to identify pest resistant genotypes that have high general combining ability (GCA) with adapted Midsouth cultivars. Two groups of pest resistant genotypes were evaluated for GCA using a line by tester scheme. In Group 1, DES936 and 'Stoneville 907' had the highest GCA for lint yield. In Group 2, WC22NSS (developed in Arizona) and MAR NLBCDCAG8S-2-90 (developed in Texas) had the highest GCA for lint yield. Findings from Group 2 suggest that utilizing germplasm from outside the Midsouth may be beneficial to breeders seeking to increase yield as well as incorporate pest resistance traits into high yielding backgrounds.

Introduction

Numerous traits that provide a significant level of pest resistance are available in cotton. These traits include nectariless, high glanding, early maturity, various pubescence types, and other measurable resistance not explained by morphological or phenological characters. However, few of these traits are exploited in commercial cotton cultivars. In order to be commercially acceptable, a pest resistant genotype must combine pest resistance with high lint yield and acceptable fiber quality.

The task of combining pest resistance with high yield and fiber quality would be facilitated by knowing which pest resistant breeding lines offer the greatest promise in producing progeny that meet these criteria. Genotypes with higher general combining ability (GCA) for desired traits are thought to have a greater probability of producing progeny with those desired traits. Tang et al. (1993) reported GCA estimates in the F_2 generation for several pest resistant strains. The objective of the study was to compare general combining ability for yield and fiber quality among additional genotypes possessing known pest resistance properties and identify resistant genotypes that combine well with cottons adapted to the Midsouth.

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 1:480-482 (1997)
National Cotton Council, Memphis TN

Materials and Methods

Crosses were made among 2 groups of pest resistant genotypes (lines) and 2 groups of cultivars adapted to the Midsouth (testers) in a "line by tester" mating scheme (i.e. *n* lines crossed to each of *m* testers to give *n* x *m* combinations). Group 1 consisted of 12 lines possessing various insect resistance traits and 4 testers ['Deltapine 5409', 'Paymaster H1244' (H1244), 'Stoneville 474' (ST474), and 'Suregrow 125']. Group 2 consisted of 16 nectariless or high glanding lines, 4 from each of the major cotton growing regions, and 4 testers [(Deltapine 0227 (DP0227), 'Paymaster H1277', 'Stoneville 495', and 'Suregrow 404']. Cultivar testers were used as pollen parents in all cases.

Crosses for Groups 1 and 2 were made in the field at Stoneville, MS, in 1994 and 1995, respectively. The F_1 generation of both groups was grown in a winter nursery in Tecoman, Mexico, and F_2 seed harvested as selfed bulks.

Unselected F_2 and F_3 bulk populations from crosses were evaluated in yield trials at Stoneville, MS. Parents were not included in these tests. Yield trials were planted in randomized complete blocks with a plot size of 2 (40 inch) rows x 40 ft. Plots were harvested mechanically and seed cotton yield determined. Sub-samples of seed cotton were obtained for lint fraction and fiber quality determination. Lint yields were calculated from seed cotton yield and lint fraction. In 1995, F_2 populations from Group 1 were planted at 2 Stoneville locations. One of these locations included 3 replications and the other included 4 replications. Data from these locations were analyzed as a single test with 7 replications. In 1996, F_3 populations of Group 1 and F_2 populations of Group 2 were evaluated in tests consisting of 4 replications at one location.

Data were subjected to line x tester analysis of variance (Singh and Choudhary, 1976) using Agrobase 4.0 software (Mulitze, 1990). Since the objective of this study was to identify pest resistant genotypes that combine well with parents adapted to the Midsouth, only general combining ability, rather than specific combining ability or various genetic effects, will be emphasized.

Results and Discussion

Tables 1 and 2 present line x tester analysis of variance for lint yield, lint percent and fiber quality for Groups 1 and 2, respectively. In all cases, the effect of lines was highly significant, and the effect of testers was significant in all cases except upper half mean fiber length (UHM) in Group 1. Thus, certain lines (and testers) showed significant predicted superiority for use as parents. In most cases, the line x tester interaction was also significant, indicating that lines did not respond equally in combination with different testers.

Table 3 presents GCA estimates for yield and fiber quality of lines and testers in Group 1. The GCA estimates for lint yield from F_2 and F_3 evaluations differed substantially both among lines and among testers. Since tests were conducted in different years, it cannot be determined if this difference in GCA was due to changes in performance as individuals in the populations approached homozygosity (i.e. loss of heterosis) or if the difference in GCA was due to the different environments experienced in the 2 years. In 1995 (F_2 evaluation), H1244 and progeny from crosses including H1244 had a high incidence of a wilting disease, known locally as bronze wilt, the cause of which has not yet been determined. In 1996, the incidence of this disease was much lower. This disease or conditions associated with it could well have caused differences in performance among populations.

Among lines in Group 1, only DES936 [early maturing, tarnished plant bug tolerant (Bridge, 1990)] and 'Stoneville 907' (nectariless) had large, positive GCA for lint yield in both years. DES119-5 (nectariless, sub-okra leaf from W.R. Meredith) and MD51ne [nectariless (Meredith, 1993)] had positive GCA for lint yield in both years, but this effect was large for these genotypes only in 1996. MD51ne also had the highest GCA for fiber length and strength among lines. Among testers, ST474 had the highest GCA for lint yield in both years, but also had high GCA for micronaire (undesirable) and negative GCA for fiber strength.

Table 4 presents GCA estimates for yield and fiber quality of lines and testers in Group 2. Lines with the highest GCA for lint yield included WC22NSS [nectariless incorporated into 'Deltapine 120' via backcross (Wilson, 1992)], MAR NLBCDCAG8S-2-90 (nectariless line from K. El-Zik), and H86211 (nectariless line from J. Mitchell, Paymaster Cottonseed). These lines were developed in and presumably adapted to the West, Texas, and the Midsouth regions, respectively. The GCA estimates of these two lines from the West and from Texas were significantly higher than that of the best GCA line from the Midsouth. It would appear, based on early generation performance, that use of parents from outside the Midsouth may be useful in increasing yield as well as in incorporating genes for pest resistance. Lines from the Southeast included two high glanding genotypes (NC88-90 and NC88-95) which were extremely tall and late maturing at Stoneville, and two nectariless lines developed from obsolete cultivars, Auburn 56 and Coker 201 (Shepherd, 1982). More modern and/or elite material from the Southeast could be more competitive in crosses than the lines used in this study. Among testers in Group 2, DP0227 had the highest GCA for lint yield.

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Table 1. Line by tester analysis of variance for lint yield, lint percent, and fiber quality of F2 populations in Group 1, combined across 2 fields at Stoneville, MS in 1995.

		Mean squares[1]				
Source	df	Lint yield	Lint percent	UHM length	Mic	HVI Stren.
Total	335					
Reps	6	916**	56.6**	1.3**	0.86**	51.6
Crosses	47	136**	11.0**	1.0**	0.75**	21.4
Lines (L)	11	219**	25.4**	3.8**	1.44**	76.4
Testers (T)	3	584**	15.5**	0.1ns	2.53**	12.6
L x T	33	67**	5.7**	0.1ns	0.35**	3.8*
Residual	282	14	1.4	0.1	0.09	1.7
Mean		1014	37.1	1.14	4.54	29.0
R-squared		75.7	67.9	72.0	62.2	72.8
CV		11.5	3.23	2.37	6.47	4.56

[1] MS lint yield/1000, MS length x 100

Table 2. Line by tester analysis of variance for lint yield, lint percent and fiber quality of F2 populations in Group 2, at Stoneville, MS, in 1996.

		Mean squares[1]				
Source	df	Lint yield	Lint percent	UHM length	Mic	HVI Stren.
Total	255					
Reps	3	385**	13.8**	1**	94.7**	99.8**
Crosses	63	47**	2.6**	1**	8.0**	35.4**
Lines (L)	15	157**	5.7**	3**	15.8**	89.5**
Testers(T)	3	78**	12.4**	3**	30.1**	43.8**
L x T	45	8ns	1.0**	1*	4.0*	16.6ns
Residual	189	6	0.3	<1	2.7	18.4
Mean		940	37.7	1.13	4.85	28.5
R-squared		78.2	89.9	78.4	77.7	30.3
CV		8.3	1.5	1.7	3.4	15.1

[1] MS lint yield/1000, MS length x 100

Table 3. Estimates of general combining ability of pest resistant lines and adapted testers in Group 1 for lint yield, lint percent and fiber quality.

Genotype	Lint yield F2	Lint yield F3	Lint pct.	Mic	UHM Leng.	HVI Stren
Lines						
DES936	133	97	1.43	0.28	0.021	-0.28
Stoneville 907	102	68	1.22	0.18	0.019	0.28
LA850082	94	-67	0.47	0.12	-0.002	-1.62
PM HS200	49	-109	-0.10	-0.07	0.007	0.29
DES119-5	21	60	0.02	0.02	0.006	-0.15
LA910081	4	-44	-0.51	-0.17	0.027	1.27
MD51ne	2	102	0.57	0.02	0.059	3.88
Timok 811	-26	-168	0.48	0.02	-0.033	-1.42
MAR CDRIQ..	-33	80	-1.30	-0.11	-0.013	0.89
MAR CBCHU.	-80	102	-1.15	-0.56	-0.043	-2.02
La. HG063	-97	-5	0.39	-0.03	0.030	0.66
MHR-15	-168	-111	-1.50	0.29	-0.077	-1.76
Standard error	22	21	0.23	0.06	0.005	0.25
Testers						
Stoneville 474	67	16	0.30	0.18	-0.002	-0.22
Suregrow 125	43	7	0.43	0.04	0.004	-0.42
Deltapine 5409	10	-38	-0.43	0.03	-0.003	0.24
P'master H1244	-120	14	-0.30	-0.24	0.001	0.40
Standard error	13	12	0.13	0.03	0.003	0.14

Table 4. Estimates of general combining ability of pest resistant lines and adapted testers in Group 2 for lint yield, lint percent and fiber quality.

Genotype	Orig.[1]	Lint yld	Lint pct.	Mic	UHM length	Fiber Stren.
Lines						
WC22NSS	W	124	1.70	0.02	-0.036	-0.35
MAR NLBCD...	TX	116	0.95	-0.08	0.024	0.94
H86211	MS	91	-0.59	0.29	0.028	0.36
MAR NC5H...	TX	73	-0.95	-0.13	0.001	0.26
DES119-5	MS	65	-0.24	0.19	-0.010	0.71
MAR NLBG8...	TX	50	-0.31	-0.01	-0.002	0.44
C21S78-2	TX	34	-0.14	-0.20	0.016	-1.26
Deltapine 5415ne	W	28	-0.13	-0.06	-0.011	-0.39
WC24NSS	W	13	0.00	0.02	0.014	-.003
DES5678ne	MS	10	0.15	0.10	-0.026	0.07
DES24ne	MS	-1	0.30	0.13	0.008	0.21
WC20NSS	W	-35	-0.16	0.18	0.006	0.76
AUB201	SE	-74	-0.44	-0.12	-0.006	-0.36
AUB56	SE	-100	-0.75	-0.11	-0.035	-0.56
NC88-90	SE	-198	-0.39	-0.15	0.025	-1.11
NC88-95	SE	-198	2.10	-0.07	0.004	0.34
Standard error		19	0.20	0.06	0.007	0.43
Testers						
Deltapine 0227		30	0.71	-0.05	-0.011	0.17
Paymaster H1277		26	0.33	-0.10	0.003	-0.73
Suregrow 404		-13	-0.60	0.12	-0.003	0.99
Stoneville 495		-44	-0.43	0.03	0.011	-0.42
Standard error		10	0.10	0.03	0.003	0.21

[1] Origins: MS = Midsouth, SE = Southeast, TX = Texas, W = West