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HETEROSIS FOR YIELD AND ITS COMPONENT CHARACTERS IN BOLLWORM TOLERANT *GOSSYPIUM HIRSUTUM* L. × *G. BARBADENSE* L. COTTON HYBRIDS

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ABSTRACT

With the objective of reducing cost of cotton cultivation, five bollworm and aphid tolerant (JK-344, JK-345, JK-260, JK-276 and MESR-17) and one susceptible cv. S43 (Sharada) of *Gossypium hirsutum* L. were crossed with one bollworm tolerant (B 200-82-1) and two susceptible (SB-289E and SB(YF)-425) *G. barbadense* genotypes. Hybrids of JK-276 and MESR-17 with B 200–82–1 exhibited higher heterosis of 51 and 47%, respectively, for yield/plant over DCH-32. Yield increase was mainly due to significantly lower heterosis for number of bollworm damaged bolls as well as higher heterosis for number of bolls/plant. B 200-82–1 is a better and normal branching general combiner than the established cluster flowering genotypes SB-289E and SB(YF)-425. Yield and bolls per plant are controlled by nonadditive gene action, monopodial and sympodial branches by partial dominance, and boll weight by additive gene action. Hybrids JK-276 × B 200–82–1 and MESR-17 × B 200–82–1 should be tested in multilocation trials to identify a superior hybrid requiring low cost of cultivation.

Key words: Interspecific hybrids, heterosis, cotton, bollworm, tolerance.

Interspecific hybridization between the cotton species *Gossypium hirsutum* L. and *G. barbadense* L. was first effect by Mell [1], who reported better performance of hybrids in agronomic and fibre properties. Rao [2] crossed perennial *G. barbadense* and annual *G. hirsutum*, and concluded that such hybrids are suitable for growing as backyard perennial cottons. Marani [3] studied crosses involving tetraploid cottons to understand the genetics of polygenic characters contributing to heterosis. An economic method of hybridization on commercial scale for exploitation of hybrid vigour in cotton was popularised by Patel [4]. Subsequently, the first interspecific cotton hybrid Varalaxmi was released for commercial cultivation by Katarki [5], followed by a superior yielding hybrid, DCH-32, which is grown throughout South India. But these hybrids require cultivation inputs of Rs 7000 to 7500/ha [6]. Nearly 60 to 70% of this cost is due to insecticide sprays alone [7]. No new hybrid has yet been found to be superior to DCH-32 [8]. Therefore, with the main objective of reducing insecticide sprays, five bollworm and aphid tolerant, and one susceptible

G. hirsutum cotton strains were crossed with one moderately tolerant and two susceptible *barbadense* genotypes in a 6 × 3 line–tester cross.

MATERIALS AND METHODS

Five bollworm and aphid tolerant *G. hirsutum* L. strains, JK-344, JK-345, JK-276, JK-260 and MESR-17, developed by Kadapa and Thimmaiah [9] and bollworm and aphid susceptible cv. Sharada (S-43) were used as female parents. One *G. barbadense* selection, B-200-82-1, with relatively greater bollworm tolerance from the Aspee Bollworm Project, Dharwad, along with two established genotypes, SB-289E and SB(YF)-425, were used as males to create 18 interspecific cotton hybrids. These hybrids and their parent strains along with the check hybrids Varalaxmi and DCH-32 were sown in randomised block design, replicated thrice, on medium black soils at the Agricultural Research Station, Dharwad, under irrigated conditions. Each entry was sown in two-row plots of 8.4 m length.

Observations were recorded on five random plants in each replication for number of monopodia, number of sympodia, total number of effective bolls, seed cotton weight/good boll, yield, per cent bollworm damaged bolls, ginning out-turn, 100-seed weight, lint weight/100 seeds, and Bartlett's rate index of yield.

RESULTS AND DISCUSSION

Cotton hybrids occupy only 25% of cotton area, but contribute 40% to the total cotton production in India. But the cost of cultivation of hybrid cotton has increased to Rs 16000/ha under the "Telephone" system of Hybrid-4 cultivation in Gujarat [4]. Although, the recommended plant protection schedule involves a maximum of 12 sprays for Varalaxmi and DCH-32 hybrids, farmers used to apply 25 or even more insecticide sprays to check the sucking pests and bollworm. Therefore, the 18 new hybrids created were grown with one spray each against sucking pests and bollworm. Four hybrids gave highly significant and two moderately significant increase in yield ranging from 92.64 to 99.62 g seed cotton per plant, as against 65.71 g in the check hybrid DCH-32. The high yield of the five hybrids was mainly due to very low bollworm damage, which was 20.0–33.3% in the hybrids as against 44% in DCH-32. Siddhu and Sandhu [10] estimated yield loss due to bollworm to the extent of 80%. The relatively high bollworm tolerance was contributed to the hybrids by the *G. hirsutum* and *G. barbadense* parents used. The bollworm damage in the parents varied from 29.33% (JK-276) to 39.0% (MESR-17), as against 54% in the susceptible parent S-43. Similarly, *G. barbadense* line B 200-82-1 showed only 36.30% damage. The remaining two male parents (SB(YF)-425, SB-289E) exhibited 41.3–44.0% damage of bollworms. Since squares as well as young bolls damaged by bollworm drop on the ground in the susceptible varieties, the total bolls retained were also more in the five hybrids (more than 40/plant) and in the female parents (more than 16/plant) as compared to the commercial hybrid DCH-32 and cv. S-43. This shows that use of bollworm tolerant genotypes in making cotton hybrids would reduce the cost of insecticide spray by about 75%.

All the hybrids involving *G. barbadense* B 200-82-1 as male parent gave high yield (83.17–99.62 g/plant) while only one hybrid each involving SB-289E and SB (YF)-425 produced significantly higher yield than DCH-32 (Table 1). Thus, B 200-82-1 is a better general combiner than the other two established *G. barbadense* male parents, especially when the hybrids are to be grown with minimum plant protection.

Second, the male parent B 200-82-1 also gave significantly higher yield (31.63 g/plant) than the remaining two males (9.07 and 8.07 g). Therefore, it is also better for seed production as well as for providing more flowers for crossing.

Table 1. Mean values in respect of ten characters of interspecific (*G. hirsutum* × *G. barbadense*) hybrids and parents

Cross/strain	No. of monopodia	No. of sympodia	Bolls per plant	Boll weight (g)	Yield per plant (g)	Bollworm damaged bolls (%)	Ginning outturn	Seed index	Lint index	Bartlett's rate index for seed cotton yield
JK-344 × B-200-82-1	2.8**	15.6	42.15**	4.3	94.7**	32.7	29.5	11.20	4.68	0.70
JK-345 × B-200-82-1	3.0	16.5	44.20**	4.1	93.9*	33.3	29.1	10.90	4.45	0.60
JK-260 × B-200-82-1	3.0	15.4	41.00*	4.1	95.1**	22.0**	27.8	11.50	4.42	0.68
MESR-17 × B-200-82-1	2.5**	14.9	41.00*	4.1	96.7**	33.7	26.7	10.80	3.74	0.68
S-43 × B-200-82-1	2.3**	14.7	43.06	4.1	83.2*	24.0**	28.1	11.90	4.66*	0.74*
JK-276 × B-200-82-1	2.1	18.3	46.93**	3.9	99.6**	20.0**	27.7	10.30	3.94	0.73**
JK-344 × SB-289E	2.5**	15.1	40.93	3.7	77.3	36.0	23.1	10.60	3.19	0.69
MESR-17 × SB-289E	2.1**	14.7	46.60**	3.4	82.7*	32.0	28.5	09.60*	3.76	0.77*
JK-260 × SB(YF)-425	1.8**	15.3	46.47**	3.9	83.0*	27.0**	26.9	11.00	4.07	0.69
DCH-32 (check)	3.8	15.3	30.73	3.9	65.7	44.0	27.0	11.10	4.09	0.55
Varalaxmi (check)	3.2	15.6	24.46	3.4	65.0	46.0	23.9	9.60	3.02	0.59
JK-344	2.1**	10.7	16.23	4.3	42.1	31.0	36.7*	7.70	5.30	0.92
JK-345	2.2**	10.6	16.60	4.5	45.2	32.7	35.2	9.10	4.69	0.92
JK-260	1.5	10.2	18.53	4.1	41.6	37.0	33.6	9.30	4.77	0.90
JK-276	1.6	11.2	19.20	4.3	47.4	29.3	36.5*	9.10	5.27*	0.90
MESR-17	1.4	11.1	17.33	3.9	39.9	39.0	32.1	8.60	4.10	0.90
S-43	1.4	10.5	17.80	4.4	30.8	54.0	31.7	9.50	4.43	0.81
B-200-82-1	1.6**	13.1**	16.13**	2.9	31.6	30.3**	26.6**	9.70*	3.54*	0.56
SB-289E	0.09	9.6**	13.13	2.6	9.1	44.0	24.8**	8.30*	2.75*	0.65
SB(YF)-425	0.06	5.5	11.60	3.1	8.1	41.5	15.9	7.70	1.12	0.56
CD at 1%	0.64	4.89	4.79	0.76	19.42	16.79	5.35	1.57	0.92	0.23
CD at 5%	0.49	3.72	3.64	0.58	14.77	12.25	4.07	1.19	0.45	0.18

Table 2. Heterosis (%) in interspecific hybrids of cotton over

Cross	No. of monopodia			No. of sympodia			Bolls/plant			Boll weight			Yield/plant		
	MP	BP	CC	MP	BP	CC	MP	BP	CC	MP	BP	CC	MP	BP	CC
JK-344 × B-200-82-1	−51.3**	−33.3**	35.7**	31.5**	19.1	2.2	98.6**	98.0**	17.0**	18.1*	2.1	7.32	157.0**	125.0**	37.3**
JK-345 × B-200-82-1	−57.9**	−36.3**	66.7**	39.5**	26.2*	8.2	67.4**	112.0**	11.7**	10.9	−9.3	3.03	144.6**	108.0**	38.7*
JK-260 × B-200-82-1	−97.4**	−87.6**	66.7**	32.2**	17.5	0.8	167.0**	154.0**	05.9	16.9	−1.0	3.03	159.5**	128.3**	39.7**
MERS-17 × B-200-82-1	−68.7**	−58.1**	40.6**	23.3	14.0	−2.3	145.0**	136.6**	05.9	21.0*	4.0	4.55	167.2**	139.3**	47.6**
S-43 × B-200-82-1	−51.3**	−41.9**	26.1	24.2	12.0	−3.9	94.9**	085.7**	14.6**	13.5	−6.6	4.29	150.5**	127.4**	23.5
JK-344 × SB-289E	62.5**	17.6	37.2**	48.4**	46.2**	−1.4	178.0**	152.2**	−05.7	06.4	−14.5*	−6.31	202.3**	83.7**	03.1
JK-276 × SB-289E	90.0**	47.9**	37.2**	48.7**	37.9**	1.7	290.7**	169.9**	12.9**	04.0	−16.8**	−8.84	170.0**	60.8**	01.6
JK-345 × SB(YF)-425	62.1**	3.2	26.1	−2.9	42.7**	−0.9	251.2**	225.4**	12.0**	−07.1	−21.8**	−11.11	177.0**	63.3**	−01.7
C D at 1%			0.64			4.89			4.79			0.76			19.4
C D at 5%			0.49			3.72			3.64			0.58			14.8

The high yielding hybrids produced fewer monopodia (2-3/plant) than DCH-32 (3-8/plant). In addition, the number of sympodia produced on these hybrids was also somewhat higher (18.27 in cross JK-276 × B 200-82-1), indicating a smaller canopy as compared to DCH-32. The hybrids involving bollworm tolerant females were earlier (Bartelett's index 0.60–0.70) as compared to DCH-32 (0.55). Thus, the hybrids involving *G. hirsutum* strains JK-276, MESR-17, JK-260, JK-344 and JK-345 as female parents (in that order) and *G. barbadense* B 200-82-1 as male parent proved to be ideal under minimum plant protection by confirming the performance in large scale trials.

The ginning out-turn in all the entries studied was low in this experiment although seed index was normal.

Heterosis exhibited by the interspecific hybrids is presented in Table 2. All the 18 hybrids studied had significantly higher yield and boll formation over their respective better parents, indicating operation of dominance and epistatic genes in the control of these two traits. The high yield of hybrids was a result of heterosis for effective boll number per plant. Marani [3] also arrived at similar conclusions.

Compared to the commercial check, DCH-32, hybrid JK-276 × B 200-82-1 gave 51.64% higher yield/plant, closely followed by hybrid MESR-17 × B 200-82-1 with 47.55% increase in yield over DCH-32. The remaining three hybrids involving bollworm tolerant female parents also produced 37–39% higher yield than DCH-32. In the All-India Coordinated Cotton Improvement Project, not even one interspecific hybrids tested so far has surpassed the yielding ability of DCH-32 [8]. Therefore, the hybrids JK-276 × B 200-82-1 and MESR-17 × B 200-82-1 need to be tested in multilocation trials with minimum plant protection, so that a highly superior interspecific cotton hybrid could be identified within the next 1–2 years.

In this, study, number of monopodia was found to be controlled by partial dominance, and number of sympodia by nonadditive genes, since 13 hybrids deviated positively and significantly over their respective better parents. Miller and Marani

midparent (MP), better parent (BP) and commercial check (CC)

Boll shedding			Ginning out-turn			Seed index			Lint index			Bartlett's index		
MP	BP	CC	MP	BP	CC	MP	BP	CC	MP	BP	CC	MP	BP	CC
−28.0**	−35.9**	−23.9**	−6.9**	−19.7**	9.1	19.1**	15.5	0.92	5.9	−11.60	14.4	−5.4	23.9*	7.69
−27.5**	−36.8**	−12.0	−5.8**	−17.3**	7.8	18.2**	12.4	−1.80	8.1	−5.11	8.8	−10.8	−28.3**	1.54
−49.1**	−53.2**	−35.3	−7.7**	−17.3**	2.8	21.0**	18.6	3.60	6.4	−7.33	8.9	−6.8	−24.4**	−4.62
−23.7**	−31.3*	11.0	−12.5**	−20.0**	−4.9	18.0**	11.3	−2.70	−2.1	−8.78	−8.5	−6.8	−19.4	20.00
−27.5*	−37.0**	00.0	−3.7	−11.4**	4.0	23.9**	22.7	7.20	16.6	4.71	13.9	−6.6	−21.0*	−1.54
− 4.0	−43.7**	5.9	−25.0**	−37.1**	−14.5	21.8**	16.5	−4.50	−20.7	−39.81**	−22.0	−12.1	−25.0**	6.15
4.5	−23.0	12.7	14.7**	−28.4**	−3.2	26.4**	20.9	−0.90	−2.5	−25.80**	−4.4	− 9.7	−22.2**	7.69
−10.8	−37.3**	−2.9	−1.4	−28.4**	−6.7	29.3**	21.8	−4.50	23.9	−23.24*	−12.0	− 0.1	−26.1*	4.62
		16.8			05.3			1.57			0.9			0.23
		12.3			04.1			1.19			0.4			0.18

[11] reported that nature of gene action for different characters may differ from cross to cross.

From the results presented above, it is clear that two outstanding interspecific hybrids have been identified in this study, producing 47–51% higher yield than the most popular cotton hybrid DCH-32, and these new hybrids can be grown with minimum plant protection.

REFERENCES

1. P. H. Mell. 1894. Experiment in crossing for the purpose of improving the cotton fibre. Alabama Agric. Expt. Sta. Bull., **56:** 196.
2. N. Ganga Prasad Rao. 1956. Some perennial cottons of Raichur and their utilisation in cotton breeding under the Tungabhadra Project. 7th Conf. Cott. Gr. Probl. India, I.C.O.C., Bombay: 14–16.
3. A. Marani. 1963. Heterosis and combining ability for yield and yield components in diallel crosses of cotton. Crop Sci., **3:** 552–555.
4. C. T. Patel. 1971. Release of Hybrid-4 cotton. Cotton Rev., **1**(2): 1–5.
5. B. H. Katarki. 1971. Varalaxmi, high yielding hybrid cotton of quality. Indian Farming, **21**(110): 35–36.
6. K. Ramachandran, L. S. Joshi and C. B. Menon. 1980. The cost of cotton pest control in India. Outlook on Agriculture, **10:** 208–209.
7. M. Shah. 1985. The pattern of use of insecticides and its role in the cost of production of Hybrid-4. Cott. Develop., **15**(3): 15–19.
8. Anonymous. 1986. South Zonal Annual Report. All India Coordinated Cotton Improvement Project, Zonal Coordinator's Report, Dharwad.
9. S. N. Kadapa and G. Thimmaiah. 1983. Breeding for resistance to bollworm in *G. hirsutum* L. cotton. Abstr. XV Intern. Congr. Genet., Part-II, Sessions C-VB, New Delhi: 553.
10. A. S. Siddhu and S. S. Sandhu. 1977. Damage due to the spotted bollworm in relation to age of bolls of *G. hirsutum* variety, J-34. J. Res. Punjab Agric. Univ., **14:** 184–187.
11. P. A. Miller and A. Marani. 1963. Heterosis and combining ability in diallel crosses of upland cotton. Crop Sci., **3:** 441–444.