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Hybrid Vigor (F1) and Inbreeding Depression (F2) for Some Economic Traits in Crosses Between Glandless and Glanded Cotton

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Abstract: Eight parents in eight cross combinations were studied for heterosis in F1 a nd inbreeding depression in F2 populations for seedcotton yield, number of bolls per plant, ginning outturn percent and staple length. Seedcotton yield and number of bolls expressed considerable amount of heterosis, however, hybrids showing higher magnitudes of heterosis were generally associated with higher amount of inbreeding depression suggesting dominant genes functioning for these traits. Small amount of heterosis, lower magnitude of inbreeding depression for lint percent and staple length indicated that additive genes were responsible for the expressions of these traits. Hybrid vigor recorded in F1 in respect of seedcotton yield per plant ranged from 14.9 to 88.7%, whereas in bolls per plant, ginning outturn and staple length, the range was 13.5 to 91.6, -0.57 to 4.29 and -5.92 to 5.23% respectively.

Key words: Inbreeding depression, heterosis, dominant genes, additive genes

Introduction

Crosses between inbred lines show vigor and productiveness in F1 generation (Shull, 1908), but with increasing homozygosity due to selfing, vigor and productiveness reduces by 50% in each generation because of inbreeding depression (Falconer, 1989). Heterosis and inbreeding depression are complementary to each other and the two phenomenons are usually observed in the same studies. Thus, the character, which shows high heterosis due to dominant allelic factors proportionally show high inbreeding depression because of fixation of allelic genes with, increased homozygosity. Gunaseelain and Krishna Swami (1988), Vyahalkar *et al*. (1984) and Bhatade (1984) also reported that high heterosis was generally associated with high inbreeding depression.

In polyploids like cotton, it may not hold true that complex traits show less depression than the simpler traits. Aycock and Wilsie (1968) found that in auto-tetraploid alfalfa, the yield decreased twice as much as predicted. This response according to them was attributed to a decrease in favorable interactions among multiple alleles due to inbreeding and abnormal segregation at meiosis because of higher ploidy. Gupta and Singh (1987) and Katageri *et al*. (1992) recorded 81.85, 12.2, 69.4 and 5.4 percent inbreeding depression for seedcotton yield, boll weight, number of boils and staple length respectively. Present studies were therefore carried out to provide information on heterosis, type of gene action and relative inbreeding depression for simpler and more complex traits of upland cotton.

Materials and Methods

Three cotton leaf curl virus disease resistant varieties viz., CIM-435, CIM-443 and CIM-448, five exotic glandless varieties F-280 gl, F-281 gl, Gregg-25V, Glandless Rex and Gossypol free seed were crossed during 1997. The F1 seed from 8 cross combinations was grown in 1998 to raise F2 population and fresh crosses were also attempted to compare F1s and F2s simultaneously. In 1999, F1 and their F2 populations combined with parents were grown in a Randomized Complete Block design with four replications. Two rows of F1s and three rows of F2s and parents were planted in each replication. Twenty-five plants from each replication, totaling 100 plants of each parent, F1 and F2 were selected at random and treated as index plants for recording the data. The standard analysis of variance method developed by Gomez and Games (1984) was adopted. Hybrid vigor compared with respective high parents was calculated for F1 and F2 hybrids as under:

$$\text{High parent heterosis for F1} = \frac{\text{F1-HP}}{\text{HP}} \times 100$$

$$\text{High parent heterosis for F2} = \frac{\text{F2-HP}}{\text{HP}} \times 100$$

where F1 and F2 were the mean values of first and second filial generations and HP being the high parent value for each economic trait.

The inbreeding depression in F2 population was determined as percent decrease (-) of F2 against their respective F1 hybrids as under:

$$\text{Inbreeding depression} = \frac{\text{F2-F1}}{\text{F1}} \times 100$$

The observations were recorded on number of bolls per plant, seedcotton yield per plant (gm), lint percent and staple length (mm).

Results and Discussion

The mean performance of F1 hybrids, F2 population and their parents has been depicted in Table 1. The mean squares from the analyses of variance are presented in Table 2 that demonstrates significant differences among F1, F2 and the parents for all the four traits under investigation. In the mean performance, all the 8 F1 hybrids set more bolls, gave higher seedcotton yield, ginned better and gave longer fibers than their respective parents, whereas majority but not all the F2s were superior to their respective parents for these traits. The data of heterosis in the F1 and F2 and the percentage of inbreeding depression in F2 for all the traits are depicted in Table 3. For number of bolls per plant the average heterosis in F1 was 56.9 percent, however the maximum heterosis of 91.6 percent was shown by CIM-435 x Gregg-25V followed by CIM-443 x Gregg-25V (87.5%). F2 population although manifested 3.96% average heterosis, nevertheless, two, out of eight combinations suffered from considerable amount of inbreeding depression. Minimum

Table 1: Mean performance of Parents, F1 and F2 hybrids for four economic characters

Sr. No.	Parents/hybrids	Bolls per plant	Seedcotton yield/plant (g)	GOT percent	Stale length (mm)
P1	CIM-435	20	60.5	35.3	29.1
P2	C1M-443	22	65.3	35.0	27.7
P3	CIM-448	24	70.5	36.8	28.5
P4	F-280 gl	37	110.7	35.0	28.7
P5	F-281 gl	35	105.5	34.7	28.9
P6	Gregg-25V	24	73.3	34.3	27.3
P7	Glandless Rex	29	88.0	37.4	26.7
P8	Gossypol free seed	30	90.3	37.5	28.7
Hybrids					
H1	F1 = CIM-435 x F-281 gl	57	173.3	35.0	29.3
F2 =	-do-	38	102.5	34.5	27.5
H2					
F1 = C1M-435 x Gregg-25V		46	138.5	35.5	29.3
F2 =	-do-	31	91.5	34.8	27.3
H3	F1 = CIM-443 x F-280 gl	42	127.2	34.5	30.2
F2 =	-do-	28	88.5	33.5	28.4
H4	F1 = CIM-443 x Gregg-25V	45	136.4	36.5	28.3
F2 =	-do-	30	92.3	35.1	27.1
H5	F1 = CIM-448 x F-281 gl				
F2 =	-do-	43	131.0	37.5	27.5
H6 F1 = CIM-448 x Glandless Rex		27	90.5	35.9	26.7
F2 =	-do-	46	137.3	37.7	27.6
H7	F1 = CIM-448 a Gregg-25V	32	93.5	36.0	27.0
F2 =	-do-	34	102.1	38.0	29.0
H8	F1 = CIM-448 x Gossypol Free seed	23	77.5	36.8	27.9
F2 =	-do-	53	159.2	37.5	27.0
	L50 10.05)	8.31	19.53	0.152	1.142

Table 2: Mean squares from analyses of variance for four economic characters

Source of variation	Degrees of freedom	Mean squares			
		Bolls per plant	Seedcotton yield per plant	GOT	Staple length
Replication	3	9.45	84.71	2.587	1.093
Hybrids and parents	23	55.15**	265.30**	2.974**	3.851**
Error	69	12.51	55.23	0.841	1.013

** = Significant at 5% level

Table 3: Heterosis in F1 hybrids and inbreeding depression in F2 population

Character	Name of Hybrid	Mother parent	Pollen parent	F1 hybrids	F2 population	% increase (+) or decrease (-) over high parent		Inbreeding depression in F2 hybrids
						F1	F2	
Bolls per plant								
	CIM-435 x F-281 91	20	35	57	38	62.8	8.6	-33.3
	CIM-435 x Gregg-25V	20	24	46	31	91.6	29.2	-32.6
	CIM-443 x F-280 gl	22	37	42	28	13.5	-24.3	-33.3
	CIM-443 x Gregg-25V	22	24	45	30	87.5	25.0	-33.3
	CIM-448 x F-281	24	35	43	27	22.9	-22.9	-37.2
	CIM-448 x Glandless Rex	24	29	46	32	58.6	10.3	-30.4
	CIM-448 x Gregg-25V	24	24	34	23	41.7	-4.2	-32.4
	CIM-448 x Gossypol Free seed	24	30	53	33	76.7	10.0	-37.7
	Mean:	22.5	29.8	45.8	30.3	56.9	3.96	-33.8
Seed cotton yield per Plant (g)	CIM-435 x F-281 gl	60.5	105.5	173.3	102.5	64.3	-2.8	-40.9
	CIM-435 x Gregg-25V	60.5	73.3	138.3	91.5	88.7	24.8	-33.9
	CIM-443 x F-280 gl	65.3	110.7	127.2	88.5	14.9	-20.1	-30.4
	CIM-443 x Gregg-25V	65.3	73.3	136.4	92.3	86.1	25.9	-32.4
	CIM-448 x F-281	70.5	105.5	131.0	90.5	24.2	-14.2	-30.9
	CIM-448 x Glandless Rex	70.5	88.0	137.3	93.5	56.0	6.3	-31.9
	CIM-448 x Gregg-25V	70.5	73.3	102.1	77.5	39.3	5.7	-24.2
	CIM-448 x Gossypol Free seed	70.5	90.3	159.2	99.5	76.3	10.2	-37.5
	Mean:	67.1	90.0	138.1	92.0	56.2	4.5	-32.8
Ginning outturn (%)	CIM-435 x F-281 gl	35.3	34.7	35.0	34.5	-0.84	-2.27	-1.42
	CIM-435 x Gregg-25V	35.3	34.3	35.5	34.8	0.56	-1.42	-1.97
	CIM-443 x F-280 gl	35.0	35.0	34.8	33.5	-0.57	-4.29	-3.74
	CIM-443 x Gregg-25V	35.0	34.3	36.5	35.1	4.29	0.29	-3.84
	C1M-448 x F-281	36.8	34.7	37.5	35.9	1.90	-2.45	-4.27
	CIM-448 x Glandless Rex	36.8	37.4	37.7	36.0	0.80	-3.74	-4.51
	CIM-448 x Gregg-25V	36.8	34.3	38.0	36.8	3.26	0	-3.16
	CIM-448 x Gossypol Free seed	36.8	37.5	37.5	36.0	0	-2.17	-4.00
	Mean:	36.0	35.3	36.6	35.3	1.18	-2.08	-3.36

Table 4: Heterosis in F1 hybrids and inbreeding depression in F2 population

Character	Name of Hybrid	Mother parent	Pollen parent	F1 hybrids	F2 population	% increase (+) or decrease (-) over high parent		Inbreeding depression in F2 hybrids
						F1	F2	
Staple length (mm)	CIM-435 x F-281 gl	29.1	28.9	29.3	27.5	0.68	-5.50	-6.14
	CIM-435 x Gregg-25V	29.1	27.3	29.3	27.3	0.68	-6.19	-6.83
	CIM-443 x F-280 gl	27.7	28.7	30.2	28.4	5.23	-1.05	-5.96
	CIM-443 x Gregg-25V	27.7	27.3	28.3	27.1	2.17	-2.17	-4.24
	CIM-448 x F-281	28.5	28.9	27.5	26.7	-4.84	-7.61	-2.91
	CIM-448 x Glandless Rex	28.5	26.7	27.6	27.0	-3.16	-5.26	-2.17
	CIM-448 x Gregg-25V	28.5	27.3	29.0	27.9	1.75	-2.11	-3.79
	CIM-448 x Gossypol Free seed	28.5	28.7	27.0	26.0	-5.92	-9.41	-3.70
	Mean:	28.5	28.0	28.5	27.2	2.26	-4.46	-4.47

and maximum depressions were noted in CIM-448 x Glandless Rex and CIM-448 x Gossypol free seed combinations, respectively, On an average, the inbreeding depression in F2 was about halfway smaller to that of heterosis expressed in the F1. These results coincide with the theoretical assumptions that vigor and productiveness in F2 reduces by 50 percent in each selfing generation. It is also interesting to note that combination CIM-448 x Gossypol free seed manifested third maximum heterosis for number of bolls also suffered from maximum inbreeding depression. Our results that high heterosis was generally associated with high inbreeding depression are in conformity with those of Gunaseelain and Krishna Swami (1988) and Wang and Pan (1991).

The association of heterosis and inbreeding depression suggested that dominant and over-dominant genes are responsible for number of bolls. Katageri *et al*. (992) also recorded 34.5 to 69.4 percent inbreeding depression for this trait. Majority of the F1s has shown above 50 percent heterosis suggesting that these hybrids can be useful for hybrid cotton development. High inbreeding depression for number of bolls in F2 could be explained by abnormal segregation at meiosis due to higher ploidy and dissociation of favorable dominant factors due to selfing (Table 4).

Almost same trend of heterosis and inbreeding depression was noted for seedcotton yield also. Average heterosis for this trait recorded was 56.2% whereas the range was 14.9 to 88.7%. Highest heterosis (88.7%) for seedcotton yield was manifested by combination CIM-435 x Gregg-25V followed by CIM-443 x Gregg-25V (86.1%) and CIM-448 x Gossypol free seed (76.3%). The results suggest that parent Gregg-25V may be rated as good general combiner and may be used in hybrid cotton production successfully. Maximum inbreeding depression (-40.9%) in F2 was observed in CIM-435 x F-281 gl combination followed by CIM-448 x Gossypol free seed (-37.5%) for seedcotton yield per plant. The results for this trait have also proved that those combinations, which manifested maximum heterosis also suffered from maximum inbreeding depression. These results confirm the previous studies by Gunaseelain and Krishna Swami (1988) and Wang and Pan (1991).

As regards ginning outturn percent, only two combinations recorded negative heterosis in F1 generation where the maximum positive heterosis of 4.29% was manifested by combination CIM-443 x Gregg-25V. In F2 generation only the same combination gave positive heterosis otherwise the rest of the combinations manifested negative heterosis. For staple length, three combinations out of eight, recorded negative heterosis in F1 while all the combinations gave negative heterosis in F2 generation.

References

Aycock, M.K. and C.P. Wilsie, 1968. Inbreeding *Medicago sativa* L. by sib-mating. II. Agronomic traits. Crop Sci., 8: 481-485.

Bhatade, S.S., 1984. Heterosis and inbreeding depression for some economic traits in *Gossypium arboretum* Linn. Indian J. Agric. Sci., 54: 261-266.

Falconer, D.S., 1989. Introduction to Quantitative Genetics. 3rd Edn., Longman, England, ISBN: 9780470211625, pp: 248-263.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agriculture Research. 2nd Edn., John Wiley and Sons Inc., New York, USA., Pages: 680.

Gunaseelain, T. and R. Krishna Swami, 1988. Heterosis and inbreeding depression in the intra-racial crosses of *G. hirsuturn* L. J. Indian Soc. Cotton Improv., 13: 5-10.

Gupta, S.P and T.H. Singh, 1987. Heterosis and inbreeding depression for seed cotton yield and some seed and fibre attributes in upland cotton (*Gossypium hirsutum* L.). Crop Improv., 14: 14-17.

Katageri, I.S., S.N. Kadapa, B.M. Khadi, M.R. Eshanna and R.B. Naik, 1992. Hybrid vigor arid inbreeding depression in the intraracial crosses of *Gossypium hirswum* L. Karnataka Agric. Sci., 5: 1-3.

Shull, G.H., 1908. The composition of a field of maize. Rep. Am. Breeders Assoc., 4: 296-301.

Vyahalkar, G.R., N.L. Bhale and L.A. Deshpande, 1984. Heterosis in multiple environments and inbreeding depression for seed-cotton yield and halo length in *Gossypium arboretum* Linn. Indian J. Agric. Sci., 54: 901-907.

Wang, X.D. and J.J. Pan, 1991. Genetic analysis of heterosis and inbreeding depression in upland cotton. Acta Agron. Sin., 17: 18-23.