Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 7 [1] December : 119-124

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Manifestation of economic heterosis for seed cotton yield and its component traits in American cotton (*Gossypium hirsutum* L.)

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ABSTRACT

Present study was conducted to assess the extent of economic heterosis for seed cotton yield and its component traits in 50 F_1 hybrids of American cotton (Gossypium hirsutum L.) developed by crossing 5 females with 10 males in line x tester mating fashion during Kharif 2015. These hybrids along with 15 parents and one standard check HHH 223 were planted during kharif, 2016 at CCS HAU, Cotton Research Station, Sirsa. Analysis of variance revealed mean sum of squares due to parents and hybrids was highly significant for all the characters, indicated the presence of variability among hybrids and their parents. Results showed that maximum economic heterosis ranged from -17.88% to 46.04%, -33.40% to 38.02% for number of bolls per plant, -7.41 % to 14.84% for boll weight, -9.67% to 7.94% for days to first flower, -12.10% to 14.42% for plant height -70.59 to 37.25% and -33.99 to 29.00% for number of monopods and sympods per plant respectively.Highest heterosis for seed cotton yield was recorded by the hybrid H1226 x SR-38 (46.04%) followed by H1300 x Gregg 45 (43.16%), H1098i x PUSA 31 (39.53%), H1300 x PUSA 31 (38.18%) and H1117x SR-38 (37.73). These hybrids also reported high positive significant heterosis either for number of bolls or boll weight. Thus, necessity of special devotion so as to exploit high heterotic values for seed cotton yield and its component traits in these hybrids. Study also revealed good scope for isolation of pure lines among the progenies of other heterotic F_1 hybrids.

Key words: *Gossypium hirsutum, Seed cotton yield, Economic heterosis, Line x Tester analysis.*

Received 16.08.2017 Revised 09.10.2017 Accepted 23.11. 2017

INTRODUCTION

Cotton appreciates a pre-eminent commercial cash crop in the country, being the principal raw material for a flourishing textile industry and popularly known as the "White Gold". Cotton grown nearly more than 100 countries in the world in which India occupies the foremost position in cotton acreage. Cotton plays a key role in the national economy in terms of generation of direct and indirect employment of about more than 60 million people in the agricultural and industrial sectors of cotton production and processing, textile and related exports which accounts for nearly 16 per cent of India's export earnings.It is grown in nearly 10.5 million hectares which is almost 34.6 per cent of the world cotton acreage with a total production and productivity of 35.1 million bales and 568 kg/ha. respectively [1].Therefore, there is a need to improve the productivity of cotton crop by developing a high yielding adaptable cotton variety or hybrid. Cotton is highly amenable for heterosis breeding and commercial exploitation of heterosis has achieved a remarkable success in India. Therefore, present investigation was undertaken to estimate the extent of economic heterosis over standard check hybrid HHH 223 for seed cotton yield and its attributing traits to obtain information on heterotic potential as to develop hybrids in American cotton.

MATERIALS AND METHODS

Selection of parental line

Parental materials used in present investigation were selected based on their genetic diversity. Large number of germplasm accessions studied among which five diverse female lines *viz*., HGMS-1, H1098i, H1117, H1226&H1300 and ten male lines were selected based on their agronomical superiority *viz*., PUSA 31, AVB SM-277, Sudan arbancotton, LRA 5166, Gregg 45, SR 38, N 65, GCA 182, MESR-17 and GJHS-16.

Hybrid development

Selected diverse material comprising of fifteen parents (5 lines + 10 testers) were grown in the field (crossing block) during Kharif 2015-16 and crossing were made by Line xTester mating fashion results fifty F_1 hybrids were obtained. Some of the buds of parents were also selfed for used to grow in next generation.

Field layout

Fifty F_1 hybrids and their fifteen parents along with single standard check hybrid HHH223 were grown in the field at CCS HAU Cotton Research Station, Sirsa during Kharif 2016-17. Each entry was sown in randomized block design (RBD) with three replications. Each entry i.e. parents and hybrids were grown by adopting a spacing of 67.5 cm between rows and 60 cm between the plants in a row.

Data analysis

All the recommended practices were adopted for all entries from sowing to till harvesting. Five competitive plants were randomly selected and tagged from each treatment in each replication and data were recorded for seed cotton yield & its component traits *viz*., days to first flower, plant height (cm), number of monopods, number of sympods, bolls/plant and boll weight (g).

Statistical analysis:

Data on 66 entries for mean values of five randomly selected plant for each character ineach replication were analyzed for analysis of variance, estimation of standard error and critical difference. The Line xTester analysis of heterosis was also performed. Heterosis was also calculated in terms of per cent increase (+) or decrease (-) of the F1 hybrids against standard check hybrid value.

RESULTS AND DISCUSSION

Analysis of variance (ANOVA) revealed that mean sum of squares due to parental genotypes were highly significant for all the ten characters that has been obtained are presented in Table 1. This indicated that the genotype selected for the present study were quite appropriate for further genetically analysis as considerable amount of variability existed in the experimental material under study.

Table 1.Analysis of variance showing mean square for yield contributing traits in American cotton

Source of variation	d.f.	Days to first flower	Plant Height (cm)	Number of monopods /plant	Number of sympods /plant	Number of bolls /plant	Boll weight (g)	Seed cotton yield / plant (g)
Replication	2	1.03	200.19	1.98	0.52	16.77	0.06	105.57
Treatment	64	**12.76****	**275.46****	**4.24 ****	**19.52****	**157.88****	**0.09****	**901.93****
Error	128	4.79	80.84	0.47	1.89	26.29	0.03	95.86
C.D.		**3.51**	**14.56**	**1.11**	**2.20**	**8.45**	**0.25**	**15.81**
C.V.		**3.81**	**6.06**	**13.43**	**10.14**	**11.36**	**4.70**	**8.35**

*Significant at P=0.05, **Significant at P=0.01

Table 2.Range and mean performance of parents for seed cotton yield and its component traits in American cotton

S. No.	Characters	Range	Mean Performance	Parents recoding yield	
				Lowest	Highest
1	Days to first flower	54.00-62.08	57.34	MESR -17	GCA 182
2	Plant height (cm)	122.08-156.25	142.98	SR-38	H1117
3	Number of monopods per plant	1.92-5.33	3.72	SR-38	Gregg 45
4	Number of Sympods per plant	7.50-14.25	11.03	GJHS-16	AVB SM-277
5	Number of bolls per plant	28.30-52.08	43.75	GJHS-16	Gregg 45
6	Boll weight (g)	2.94-3.53	3.25	H1226	N 65
7	Seed cotton yield per plant	77.65-120.68	105.03	GJHS-16	Gregg 45

Mean performance for the seed cotton yield was recorded on 15 genotypes and their 50 hybrids along with standard check HHH223.Seed cotton yield is the most important characters and its range for parents varied from 77.65g to 120.68g with overall mean performance 105.03g (Table 2).Previous researchers reported that predominance of additive as well as non-additive gene action was important for inheritance of seed cotton yield & its yield attributes and could vary widely with plant variety and growing conditions. Highest mean performance for seed cotton yield per plant was registered by the hybrid H1226 x SR-38 (155.33g),while the lowest mean value by hybrid H1117 x Sudan arbancotton (87.34g).The overall mean performance of hybrids for seed cotton yield per plant was 121.28g (Table 3). Similar type of findings was reported by Pushpam *et al*., [7] and lingaraja *et al*., [4] for seed cotton yield.

Number of bolls per plant &boll weight is another important yield contributing traits of cotton and are enormously useful for increasing the seed cotton yield. Among parents, number of bolls per plant were ranged from 28.30 (GJHS-16) to 52.08 (Gregg 45) with overall mean 43.75 (Table 2). Highest and lowest mean values reported in hybrids were 30.42 in H1117 x Sudan arbancotton and 63.03 in H1226x SR-38 with overall average 48.35 (Table 3). Sivia *et al*., [9] observed number of bolls per plant was varied from 17.33 to 41.00, this is lesser than the value of present results.

Overall mean performance of parents for boll weight was 3.25g, whereas the range varied from 2.94g (H1226) to 3.53g (N 65) (Table 2). Out of 50 hybrids, maximum boll weight was reported by the hybrid H1098i x LRA5166 (3.64g), while the minimum by hybrids H1226 x GJHS-16 (3.03g).The overall mean performance of hybrids for this character was 3.40 g (Table 3). Sivia*et al*., (2017) observed mean boll weight was varied from 2.13g to 3.38g and this reported that present study significantly exploited the heterosis than earlier studies.

Table 3. Range and mean performance of hybrids for seed cotton yield and its component traits in American cotton

Sr. No.	Characters	Range	Mean Performance	Parents recoding yield	
				Lowest	Highest
1	Days to first flower	52.17-62.33	56.86	H1300 x AVB SM-277	HGMS-1 x GCA 182
2	Plant height (cm)	129.00-167.92	150.16	H1098i x SR-38	H1117 x LRA 5166
3	Number of monopods per plant	1.25-5.83	4.26	H1098i x MESR -17	H1300 x SR-38
4	Number of Sympods per plant	9.08-17.75	14.12	H1117 x Sudan arbancotton	H1226 x GCA 182
5	Number of bolls per plant	30.42-63.03	48.35	H1117 x Sudan arbancotton	H1226x SR-38
6	Boll weight (g)	3.03-3.64	3.40	H1226 x GJHS-16	H1098i x LRA 5166
7	Seed cotton yield per plant	87.34-155.33	121.28	H1226 x GJHS-16	H1226 x SR-38

Range of monopods per plant was varied from 1.25 to 5.33, parental genotypes exhibiting that values being SR-38 and Gregg 45 respectively (Table 2). Overall mean value of monopods for parents was 3.72. Among the hybrids, H1098i x MESR -17 recorded the lowest value1.25,while the highest value 5.83 by hybrid H1300 x SR-38 (Table 3). The mean performance of hybrids for number of monopods was 4.26.Sympods per plant in parents had a ranging from 7.50 in GJHS-16 to 14.25 in AVB SM-277 (Table 2). Among the hybrids, H1117 x Sudan arbancotton and H1226 x GCA 182 were recorded the lowest and highest sympods per plant of 9.03 and 17.75, respectively (Table 3). Mean values of sympods per plant for hybrids was 14.12. Rathva *et al*., [8] reported similar results for monopods and sympods/plant.

Among parents,plant height was varied from 122.08 cm (SR-38) to 156.25 cm (H1117) (Table 2). Maximum and minimum values recorded in hybrids were 129.00 cm in H1098i x SR-38 and 167.92 cm in H1117 x LRA 5166 (Table 3). Overall average plant height of parents and hybrids was 142.98 cm and 150.16 cm, respectively. Days to first flower in parents ranging from 54.00 in MESR-17 to 62.08 in GCA 182 (Table 2). Range of hybrids varied from 52.17 (H1300 x AVB SM-277) to 62.33 (HGMS-1 x GCA 182) in respect of days to first flower and the mean performance was 56.86 days (Table 3). Pushpam *et al.,* [7], reported similar type of results for plant height and Days to first flower.

Heterosis might be positive or negative, depending on the magnitude of hybrid mean value. The key objective of heterosis breeding is to achieve a quantum jump in yield of crop plants. In the present investigation, economic heterosis of 50 hybrids were estimated over standard check hybrid (HHH223) for different characters presented in Table 4. Among which five hybrids *viz*; H1226 x SR-38 (46.04%) followed by H1300 x Gregg 45 (43.16), H1098i x PUSA 31 (39.53%), H1300 x PUSA 31 (38.18%) and H1117 x LRA 5166 (30.92%) registered more than 30% positive significant economic heterosis over check.Thus, the necessity of special devotion so as to exploit high heterotic values for seed cotton yield in these hybrids. Economic heterosis for seed cotton yield and its correlated traits in American cotton has also been reported earlier by Jaiwar *et al.,* [3], Dave *et al*., [2], Pushpam *et al.,* [7], and Sivia *et al*., [9].

For number of bolls per plant, highest heterotic effect was recorded in H1226 x SR-38 (38.02%) followed by H1300 x Gregg 45 (30.72) H1226 x GCA 182 (29.37%) and H1300 x Sudan arbancotton (29.01%). These hybrids also showing high heterosis for seed cotton yield, pinpointing that increased number of bolls were mainly responsible for increase in seed cotton yield. Similar results were reported by Lingaraja *et al*., [4]. Hence these crosses need special attention for their further testing over locations for commercial utilization.

Hybrids *viz*; H1098i x LRA 5166 (14.84%) followed by H1226x SR-38 (13.56%), H1300 x Gregg 45 (13.42%), H1117 x PUSA 31 (12.65%) and H1300 x Sudan arbancotton (12.49%) registered high heterotic effect over check for boll weight, identifying them correlation between boll weight and seed cotton yield and importance of boll weight for increased seed cotton yield. Similar type of results obtained by Patil *et al*., [6], Dave *et al*., [2] and Pushpam *et al*., [7].

Earliness in flowering is desirable and hence the cross combinations having negative heterosis for days to first flower were desirable. Hybrids, H1300 x AVB SM-277 (-9.67%) and H1117 x MESR -17 (-7.65%) were reported the desirable (negative) significant heterosis for Days to first flower over check.

In case of plant height, maximum heterosis for tallness was shown by hybrids, H1117 x LRA 5166 (14.42%) followed by H1226 x PUSA 31 (11.98%), H1117 x MESR-17 (11.58%) and H 1098i x LRA 5166 (10.55%).

Table 4. Manifestation of economic heterosis in hybrids (%) for seed cotton yield and its component traits in upland cotton

Crosses	Days to first flower	Plant Height	Number of monopods /plant	Number of sympods /plant	Number of bolls /plant	Boll weight	Seed cotton yield /plant
HGMS-1 x PUSA 31	2.74	0.06	-11.76	-13.40	-11.28	4.82	0.38
HGMS-1 x AVB SM-277	2.89	-0.68	1.96	10.83	-9.31	2.06	3.14
HGMS-1 x Sudan arbancotton	-3.46	-2.56	**29.41***	4.77	-9.13	5.20	-6.14
HGMS-1 x LRA 5166	-0.87	**10.34***	-7.84	9.01	7.29	6.88	**20.49***
HGMS-1 x Gregg 45	3.61	8.46	23.53	6.59	**18.24***	6.11	**25.90***
HGMS-1 x SR-38	-2.60	-4.09	**-31.37***	12.04	-14.35	0.00	-1.02
HGMS-1 x N 65	-4.62	6.53	13.73	12.04	-2.56	4.32	14.88
HGMS-1 x GCA 182	**7.94***	5.62	**33.33***	4.77	-2.01	5.51	5.47
HGMS-1 x MESR -17	1.44	7.33	**-41.18***	12.65	-9.31	4.01	9.64
HGMS-1 x GJHS-16	-1.44	-4.32	25.49	**20.52***	-12.60	1.66	0.14
H1098i x PUSA 31	-3.32	-2.67	**29.41***	-16.42	**26.27***	**9.15***	**39.53***
H1098i x AVB SM-277	-3.90	1.87	21.57	**-26.11***	**20.25***	-4.10	2.78
H1098i x Sudan arbancotton	-2.16	-6.08	-13.73	-0.68	12.98	**9.66***	**28.49***
H1098i x LRA 5166	-0.72	**11.55***	**31.37***	**19.90***	-2.01	**14.84***	0.74
H1098i x Gregg 45	-1.15	3.98	-13.73	-14.61	**18.46***	5.87	**29.61***
H1098i x SR-38	-3.46	**-12.10***	25.49	14.46	7.11	7.56	**20.24***
H1098i x N 65	**-6.78***	5.91	13.73	**18.70***	**14.96***	**8.41***	**26.14***
H1098i x GCA 182	-1.30	-7.61	**-37.25***	-5.52	-10.23	7.55	14.70
H1098i x MESR -17	-2.89	9.03	**-70.59***	15.67	12.62	**8.07***	**27.37***
H1098i x GJHS-16	-1.44	-6.70	**33.55***	**25.97***	-5.48	6.71	0.13
H1117x PUSA 31	-2.45	3.63	23.53	**19.91***	9.48	**12.65***	7.15
H1117 x AVB SM-277	-3.32	6.19	**-27.45***	**21.73***	-4.57	**-7.41***	-10.02
H1117 x Sudan arbancotton	0.58	3.07	**-39.22***	**-33.99***	**-33.40***	-0.03	**-17.88***
H1117 x LRA 5166	-4.62	**14.42***	**-43.14***	13.25	**19.04***	**12.26***	**30.92***
H1117 x Gregg 45	4.47	**11.47***	19.61	12.04	12.40	7.95	6.27
H1117 x SR-38	-3.03	6.47	**-27.45***	**-31.56***	**22.11***	**11.54***	**37.73***
H1117 x N 65	1.73	8.46	-5.88	12.04	-1.10	**10.69***	1.45
H1117 x GCA 182	1.73	7.33	3.92	-13.40	-8.22	3.68	-6.39
H1117x MESR -17	**-7.65***	**11.58***	**-31.37***	-3.10	**20.65***	**8.99***	**26.26***
H1117 x GJHS-16	4.18	2.78	-19.61	2.96	3.28	**10.18***	-2.56
H1226 x PUSA 31	-3.17	**11.98***	11.76	-17.03	7.90	7.90	13.44
H1117 x AVB SM-277	-4.76	-0.34	7.84	12.04	-7.31	3.67	-4.48
H1226 x Sudan arbancotton	-2.45	-1.76	-25.49	3.56	8.97	**10.04***	**24.36***
H1226 x LRA 5166	-1.15	-1.19	**-27.45***	**-18.24***	**-20.88***	**9.42***	**-17.79***
H1226 x Gregg 45	**-6.78***	-4.60	0.00	5.38	4.74	7.90	14.41

H1226 x SR-38	0.00	**-12.04***	**29.41***	10.83	**38.02***	**13.56***	**46.04***
H1226 x N 65	-2.16	-5.17	23.53	**-32.78***	-6.21	**8.97***	17.90
H1226 x GCA 182	2.31	5.74	**29.41***	**29.00***	**29.37***	7.41	**29.28***
H1226 x MESR -17	-5.34	-0.62	**-37.25***	15.67	9.85	8.01	**20.73***
H1226 x GJHS-16	3.90	4.66	5.88	-12.19	-6.21	-4.50	-14.21
H1300 x PUSA 31	-4.18	7.33	**-27.45***	-1.89	**20.14***	**11.88***	**38.18***
H1300 x AVB SM-277	**-9.67***	-6.59	**29.41***	15.07	**26.23***	**10.07***	**25.17***
H1300 x Sudan arbancotton	-3.90	0.51	**32.46***	**19.31***	**29.01***	**12.49***	**25.55***
H1300 x LRA 5166	-3.32	3.63	13.73	0.53	15.87	5.36	14.26
H1300 x Gregg 45	-1.73	9.31	-3.92	**-22.48***	**30.72***	**13.42***	**43.16***
H1300 x SR-38	-4.04	0.80	**37.25***	7.19	7.66	**12.44***	**21.59***
H1300 x N 65	-0.87	1.08	**29.41***	**-17.03***	-2.01	0.53	12.26
H1300 x GCA 182	0.58	2.78	11.76	12.65	8.79	**10.89***	**23.65***
H1300 x MESR -17	-4.18	3.07	**-45.10***	1.74	13.35	**11.45***	**22.85***
H1300 x GJHS-16	-1.88	0.51	5.88	**18.70***	2.91	**8.34***	9.24
Minimum	**-9.67**	**-16.81**	**-70.59**	**-45.49**	**-33.40**	**-7.41**	**-17.88**
Maximum	**7.94**	**14.42**	**37.25**	**29.00**	**38.02**	**14.84**	**46.04**

*Significant at P=0.05.

While the maximum heterosis in negative direction was recorded by hybrids H1098i x SR-38 (-12.10%) and H1226 x SR-38 (-12.04%).These finding was in accordance with the results obtained by Pushpam *et al*., [7] and Rathva *et al*., [8].

Out of fifty hybrids, twelve hybrids reported highly positive significant heterosis for number of monopods. Among whichH1300 x SR-38 (37.3%), H1098i x GJHS-16 (33.6%), HGMS-1 x GCA 182 (33.3%)and H1098i x LRA 5166 (31.4%) were registered maximum positive significant heterosis for this trait. Those hybrids showed high heterosis for number of monopods were also reported high heterosis for number of bolls per plant, thus this trait seems to play role in increased number of bolls. For number of sympods, maximum economic heterosis over check hybrid were recorded by the hybrids, H1226 x GCA 182 (29.00%) followed by H 1098i x GJHS-16 (25.97%), H1117 x AVB SM-277 (21.73%) and HGMS-1 x GJHS-16 (20.52%). Similar type of results was reported by Jaiwar *et al*., [3], Lingaraja *et al*., [4] and Monicashree *et al.,* [5].

CONCLUSION

Hybrids *viz*; SR-38 x H1226 (46.04%) followed by H1300 x Gregg 45 (43.16%), H1098i x PUSA 31 (39.53%), H1300 x PUSA 31 (38.18%) and H1117x SR-38 (37.73) were recorded high heterotic values for seed cotton yield and its component traits like number of bolls and boll weight with high per se performance. Thus, necessity of special devotion so as to exploit high heterotic values for seed cotton yield and its component traits in these hybrids and developing desirable genotypes for improving yield parameters. Study also revealed good scope for isolation of pure lines among the progenies of other heterotic F_1 hybrids.

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Citation of this Article
Bankar A.H., K.S. Nirania, O. Sangwan, Sagar and Ankit Kumar. Manifestation of economic heterosis for seed cotton yield and its component traits in American cotton (*Gossypium hirsutum* L.). Bull. Env. Pharmacol. Life Sci., Vol 7 [1] December : 119-124.

