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Identification of heterotic hybrids for yield and its components over environments in inter and intra specific crosses of rainfed cotton (*Gossypium* spp.)

SEEMA K. ARBAD*, D. B. DEOSARKAR AND H. V. PATIL

Department of Agricultural Botany, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani - 431 402

**E-mail : arbadseema03@gmail.com*

ABSTRACT : An investigation was carried out with line x tester design to know the magnitude of heterosis in rainfed cotton for yield and yield contributing characters. Forty (inter (H x B) and intra *hirsutum*) hybrids along with 14 parents and 2 checks (Bunny and NHH 44) were evaluated at 3 different locations. The magnitude of heterobeltosis and heterosis for all the characters in the present study was highly appreciable. Considering the average heterotic effects over 3 environments, the highest positive significant heterosis over commercial hybrid Bunny for seed cotton yield/plant (g) was noticed in the cross PH 1060 x PH 1009 (64.89 %) followed by PH 1024 x PH 1009 (58.03 %), for days to 50 per cent flowering was noticed in the cross PH 1024 x PH 1009 (-19.41 %) followed by PH 1060 x PH 1009 (-16.67 %), for plant height (cm) was noticed in the cross NH 665 x RHCB 001 (41.19 %), for bolls/plant was noticed in the cross PH 1060 x PH 1009 (63.06%) followed by NH 656 x NH 615 (53.13 %). Hybrids PH 1060 x PH 1009 and PH 1024 x PH 1009 also showed significant heterosis over the environments for days to 50 per cent flowering, days to maturity, plant height (cm), sympodia/plant, bolls/plant, boll weight (g) and ginning outturn over Bunny.

Key words: Line x tester analysis, rainfed cotton, standard heterosis

Cotton is one of the prominent industrial and economic crop of India. The average productivity of cotton in India is the lowest among the major cotton growing nations of the world. To meet the requirement of the ever growing population of the country with limited land resources, breeding programmes should aim at increasing the productivity per unit area. Hybridization is the most potent technique for breaking yield barriers and evolving genotypes with higher yield potential. It is grown in tropical and sub tropical regions of more than 80 countries the world over. India is the pioneer country for the cultivation of hybrids on commercial scale. The phenomenon of hybrid vigour in cotton is being exploited successfully since, the release of commercial intra *hirsutum* and inter specific hybrids *viz.,* H 4, DCH 32 and Varalaxmi and few others. In recent years, the manifestation of heterosis has received increased attention from cotton breeders. High heterosis has been reported in cotton at inter-specific and intra specific levels, both in diploid and tetraploid cotton. The present investigation was undertaken to find out the extent of heterosis for the seed cotton yield and yield contributing characters in rainfed cotton.

MATERIALS AND METHODS

Fourteen promising varieties/genotypes were selected as parents on the basis genetic variation for morphological characters and fibre properties. The experimental material consisted

of 10 female parents belongs to *hirsutum* sp. *i.e.*, PH 348, PH 1024, PH 1075, PH 1060, NH 630, NH 635, NH 656, NH 665, PH 330 and PH 1070 and 4 male parent *i.e.,* PH 1009, NH 615 (2 belongs to *hirsutum* sp.), Suvin and RHCB 001 (2 belongs to *barbadense* sp.) crossed in a line x tester design at Cotton Research Station, Parbhani during *kharif,* 2012. Forty crosses along with their parents and 2 checks (Bunny and NHH 44) were evaluated during *kharif,* 2013 at 3 different locations *viz.,* Cotton Research Station (M. B. Farm), Parbhani (E_1), Cotton Research Station, Nanded (E_2) and Agricultural Research Station, Badnapur (E_3). Each entry was accommodated in 2 row plot of 6 m length with a spacing of 60 x 60 cm in a randomized block design (RBD) with 2 replications. Package of practices recommended to the region were followed. Observation were recorded on 11 characters, namely days to 50 per cent flowering, days to maturity, plant height (cm), monopodia/plant, sympodia/plant, bolls/plant, boll weight (g), seed index (g), ginning percentage, harvest index (%) and seed cotton yield/plant (g). Data were subjected to analysis of variance for mean performance and heterosis over better parent, standard check and standard hybrid was calculated.

RESULTS AND DISSUCTION

The analysis of variance revealed that the hybrids differed significantly in all environments for all the characters except monopodia/plant under study indicating presence of considerable genetic variability between the genotypes. The results indicated that the phenomenon of heterosis was of a general occurrence, however, the magnitude varied with the characters. The pooled range of heterobeltiosis, standard heterosis, mean of hybrids and hybrids showing high heterobeltiosis and standard heterosis for all characters under study are presented in Table 1.

The variation for days to 50 per cent flowering over the environments in the cross combinations was ranged from 58.83 (PH 1024 x PH 1009) to 82.17 days (NH 665 x RHCB 001) (Table 2). Thirty four and 21 crosses recorded significant and negative heterosis over better parent and check Bunny over the location (Table 1). The highest negative heterosis over the environments was observed in the intra *hirsutum* cross NH 665 x PH 1009 (-17.75%) over better parent and the intra *hirsutum* cross PH 1024 x PH 1009 over commercial hybrid Bunny (-19.41 %) followed by PH 1060 x PH 1009 (-16.67 %) and PH 330 x PH 1009 (-16.21 %). The results are akin to the findings of Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

Early maturity is beneficial in rainfed cotton cultivation because it escapes moisture stress at the time of boll development. In case of days to maturity, the range of mean value among the hybrids was observed from 150.83 (PH 1024 x PH 1009) to 185.17 days (NH 665 x RHCB 001) over the environments (Table 1). The highest negative heterosis was observed in the intra *hirsutum* cross NH 665 x NH 615 (-12.63%) over better parent and the intra *hirsutum* cross PH 1024 x PH 1009 over commercial hybrid Bunny (-13.40 %) over the environments. Seventeen hybrids showed significant negative heterosis over checks Bunny for days to maturity (Table 1). Same results were also obtained by other Balu *et al.,* (2012), Patil *et al.,* (2012), Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015). Plant height has a great importance which determines plant stature and vigour of the plant.

Table 1. Pooled range of *per se* performance, heterobeltiosis and standard heterosis of hybrids and F_1 s showing high heterobeltiosis and standard heterosis

Sr. No.	Characters	*Per se* performance	Range of heterobeltiosis (%)	F_1 s showing high heterobeltiosis (%)	Range of standard heterosis (%)	F_1 s showing high standard heterosis (%)
1	Days to 50 per cent flowering	58.83 to 82.17	-17.75 to 14.44	NH 665 x PH 1009 (-17.75) NH 630 x PH 1009 (-17.46) NH 665 x NH 615 (-16.91) PH 1024 x RHCB 001(-16.60) NH 656 x PH 1009 (-16.14)	-19.41 to 12.56	PH 1024 x PH 1009 (-19.41) PH 1060 x PH 1009 (-16.67) PH 330 x PH 1009 (-16.21) NH 656 x PH 1009 (-14.61) PH 1075 x PH 1009 (-14.38)
2	Days to maturity	150.83 to 185.17	-12.63 to -0.29	NH 665 x NH 615 (-12.63) NH 630 x PH 1009 (-11.43) PH 1075 x PH 1009 (-10.14) PH 1060 x Suvin (-9.74) PH 1024 x Suvin (-8.93)	-13.40 to 6.32	PH 1024 x PH 1009 (-13.40) PH 1060 x PH 1009 (-12.44) PH 330 x PH 1009 (-11.39) PH 1075 x PH 1009 (-10.91) NH 656 x PH 1009 (-10.62)
3	Plant height (cm)	89.33 to 141.57	-9.98 to 29.68	NH 665 x RHCB 001(29.68) PH 1060 x Suvin (27.14) PH 1075 x RHCB 001(26.02) NH 665 x Suvin (25.41) PH 348 x RHCB 001 (21.44)	-10.90 to 41.19	NH 665 x RHCB 001(41.19) PH 1075 x RHCB 001(37.20) PH 1060 x Suvin (34.41) NH 665 x Suvin (32.58) PH 348 x RHCB 001 (32.21)
4	Monopodia/ plant	2.23 to 3.80	-34.21 to 11.36	PH 1024 x Suvin (-34.21) PH 330 x Suvin (-33.33) NH 665 x RHCB 001(-31.03) NH 665 x Suvin (-29.82) NH 330 x Suvin (-28.95)	-30.21 to 18.75	NH 635 x NH 615 (-30.21) PH 1024 x PH 1009 (-28.13) PH 330 x PH 1009 (-27.08) PH 330 x NH 615 (-26.04) NH 656 x NH 615 (-23.96)
5	Sympodia/ plant	14.27 to 27.40	-8.58 to 71.90	NH 656 x NH 615 (71.90) NH 665 x RHCB 001 (59.92) NH 635 x RHCB 001 (44.36) PH 1024 x PH 1009 (38.12) PH 1060 x NH 615 (35.28)	-11.93 to 69.14	NH 665 x RHCB 001 (69.14) PH 1075 x RHCB 001 (58.85) NH 635 x RHCB 001 (52.67) PH 1060 x Suvin (50.21) PH 330 x RHCB 001 (46.09)
6	Bolls/plant	15.00 to 41.20	-31.88 to 107.16	NH 635 x RHCB 001 (107.16) NH 656 x NH 615 (61.05) PH 1060 x PH 1009 (44.56) PH 1070 x Suvin (43.72) NH 656 x Suvin (42.28)	-40.63 to 63.06	PH 1060 x PH 1009 (63.06) NH 656 x NH 615 (53.83) PH 1024 x PH 1009 (45.38) PH 1070 x PH 1009 (38.65) PH 1060 x NH 615 (37.60)

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7	Boll weight (g)	2.38 to 4.16	-38.08 to 20.29	PH 330 x NH 615 (20.29) PH 330 x RHCB 001 (19.40) NH 635 x RHCB 001 (16.17) PH 330 x Suvin (14.78) PH 1075 x RHCB 001 (8.72)	-22.33 to 36.00	PH 1024 x PH 1009 (36.00) PH 348 x PH 1009 (32.63) PH 330 x PH 1009 (31.26) PH 1070 x PH 1009 (30.17) PH 1060 x PH 1009 (27.45)
8	Ginning percentage	31.44 to 43.31	-13.55 to 16.00	NH 665 x RHCB 001 (16.00) NH 665 x Suvin (14.66) NH 635 x NH 615 (12.50) PH 348 x Suvin (10.76) PH 330 x PH 1009 (10.08)	-8.89 to 25.49	NH 635 x NH 615 (25.49) NH 656 x NH 615 (22.94) PH 1060 x NH 615 (21.86) PH 330 x PH 1009 (19.73) PH 330 x NH 615 (19.57)
9	Seed index (g)	6.21 to 12.02	-34.77 to 2.24	PH 1075 x Suvin (2.42) PH 1075 x RHCB 001 (-1.33) PH 348 x RHCB 001 (-1.56) PH 1070 x NH 615 (-2.52) PH 1075 x PH 1009 (-4.28)	-26.51 to 42.27	PH 1075 x RHCB 001 (42.27) PH 348 x RHCB 001 (41.93) PH 1075 x Suvin (41.66) NH 630 x RHCB 001 (33.65) PH 348 x Suvin (29.27)
10	Harvest index (%)	17.08 to 50.22	-33.31 to 83.60	NH 635 x NH 615 (83.60) PH 330 x PH 1009 (76.05) PH 1060 x NH 615 (74.48) PH 1024 x PH 1009 (72.07) NH 635 x PH 1009 (72.02)	-45.51 to 60.18	PH 1024 x PH 1009 (60.18) PH 330 x PH 1009 (57.89) NH 635 x PH 1009 (54.28) PH 1024 x NH 615 (50.56) PH 1075 x PH 1009 (49.65)
11	Seed cotton yield/plant (g)	34.68 to 105.48	-39.15 to 95.94	NH 635x RHCB 001 (95.94) NH 656 x NH 615 (47.60) PH 1024 x PH 1009 (42.71) PH 1070 x Suvin (40.82) PH 1060 x PH 1009 (40.40)	-45.79 to 64.89	PH 1060 x PH 1009 (64.89) PH 1024 x PH 1009 (58.03) NH 656 x NH 615 (53.13) PH 1070 x PH 1009 (48.16) PH 1060 x NH 615 (40.47)

For plant height (cm), the range of mean value among the hybrids was recorded to be lowest (89.33 cm) in NH 665 x NH 615 to maximum (141.57 cm) in NH 665 x RHCB 001 (Table 1). The interspecific cross NH 665 x RHCB 001 exhibited the highest positive significant pooled heterosis over better parent (29.68 %) and Bunny (41.19%). Sixteen and 19 hybrids exhibited significant positive heterosis over better parent and commercial hybrid Bunny, respectively (Table 1). The results are akin to the findings of Shekhar *et al.,* (2012), Patil *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

As monopodial branches in cotton are vegetatively growing branches so that less monopodial branches are not desirable in cotton. In case of monopodia/plant, on the basis of mean performance the intra *hirsutum* hybrid NH 635 x NH 615 (2.23) recorded minimum monopodia/ plant over the location. The range of heterosis over better parent was from –34.21 (PH 1024 x Suvin) to 11.36 per cent (PH 1070 x PH 1009) and over commercial hybrid Bunny was from –30.21 (NH 635 x NH 615) to 18.75 per cent (PH 1070 x RHCB 001) over the location. Same results were also obtained by other Balu *et al.,* (2012), Patil *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

Sympodial branches are flower / boll bearing branches hence, sympodial branches/ plant is one of the important yields contributing character. The range of mean value among the cross combinations for sympodia/plant over the location was from NH 630 x NH 615 (14.27) to NH 665 x RHCB 001 (27.40). Thirty and twenty nine hybrids showed positively significant heterosis over better parent and Bunny, respectively over the location. The range of heterobeltiosis was from -8.58 (NH 656 x PH 1009) to 71.90 per cent (NH 656 x NH 615) however, the range of heterosis over Bunny was from -11.93 to 69.14 per cent (Table 1) over the environments. The results are akin to the findings of Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Patil *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

Bolls/plant is one of the important yield contributing characters which is directly associated with seed cotton yield/plant. For bolls/plant, the range of mean value among the hybrids was noticed from 15.00 (NH 630 x RHCB 001) to 41.20 (PH 1060 x PH 1009) (Table 1). The highest positive significant heterosis over better parent was noticed in the interspecific cross NH 635 x RHCB 001 (107.16 %) over the locations. Among the intraspecific crosses, the cross PH 1060 x PH 1009 (63.06 %) followed by NH 656 x NH 615 (53.83 %) and PH 1024 x PH 1009 (45.38 %) and among the interspecific crosses, cross PH 1070 x Suvin (31.40 %) recorded the highest positive significant heterosis over the locations over commercial hybrid Bunny. Fifteen and 14 hybrids performed significantly positive heterosis over better parent and Bunny, respectively over the location. The same result assembled by other researchers Geddam *et al.,* (2011), Balu *et al.,* (2012), Patil *et al.,* (2012), Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013), Kannan and Saravanan (2015) and Sonawane *et al.,* (2015).

Now a day's farmers preference is towards big boll size, because bigger boll size is easy for picking. In case of boll weight, on the basis of mean performance the hybrid PH 1024 x PH 1009 (4.16 g) recorded highest boll weight in all the environments. The highest positive significant heterosis was recorded by the intra *hirsutum* cross PH 330 x NH 615 over better parent (20.29 %) and the intra *hirsutum* cross PH 1024 x PH 1009 over check Bunny (36.00 %) followed by PH 348 x PH 1009 (32.63 %) and PH 330 x PH 1009 (31.26 %) over the location. Seven and

nineteen hybrids performed positively significant heterosis over better parent and check Bunny, respectively. Same results were also obtained by other Balu *et al.,* (2012), Patil *et al.,* (2012), Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

Ginning outturn is important parameter from the point of mill owner because it determines the economic returns. In cotton considerable premium attaches to ginning outturn. So genotypes with high ginning percentage are desirable. The range mean performance of ginning percentage over 3 environments varied from 31.44 to 43.31 per cent in the hybrids. The interspicific cross NH 665 x RHCB 001 (16.00 %) recorded maximum heterosis over better parent whereas, the intraspecific cross NH 635 x NH 615 (25.49 %) followed by NH 656 x NH 615 (22.94 %) and PH 1060 x NH 615 (21.86 %) exhibited the highest positive heterosis over the check Bunny over the environments. Nine hybrids were promising over better parent and 23 over Bunny over the locations. The results are akin to the findings of Nidagundi *et al.,* (2012), Patil *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

Seed index has positive correlation with seed cotton yield. In case of seed index, the interspecific hybrid PH 1075 x RHCB 001 exhibited highest mean performance (12.02 g) whereas, the hybrid NH 635 x NH 615 recorded lowest value for seed index (6.21 g) over the environments. The interspecific cross PH 1075 x RHCB 001 exhibited positive significant heterosis over Bunny (42.27%). Twenty two hybrids over Bunny recorded significantly positive heterosis over the location. However, none of the hybrid recorded positive significant heterosis over better parent. The same results were assembled by other researchers Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

On the basis of mean performance the intra *hirsutum* hybrid PH 1024 x PH 1009 (50.22 %) recorded highest harvest index over the locations (Table 1). The positive significant heterosis over the environments was recorded by the intra *hirsutum* cross NH 635 x NH 615 (83.60 %) over better parent and the intra *hirsutum* cross PH 1024 x PH 1009 over check Bunny (60.18 %). Same results were also obtained by other Balu *et al.,* (2012), Patil *et al.,* (2012), Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013) and Sonawane *et al.,* (2015).

For seed cotton yield/plant, the range of mean performance over the locations among the hybrids was recorded from NH 630 x RHCB 001 (34.68) to PH 1060 x PH 1009 (105.48 g). The interspecific cross NH 635 x RHCB 001 showed maximum significant heterosis over better parent (95.94 %). Fifteen crosses exhibited significant positive heterobeltiosis over the locations. However, 17 crosses exhibited significant positive heterosis over Bunny. Among intra *hirsutum* crosses, the cross PH 1060 x PH 1009 (64.89 %) followed by PH 1024 x PH 1009 (58.03 %) and NH 656 x NH 615 (53.13 %) recorded the highest positive significant heterosis over Bunny in all 3 environments (Table 1). However, among the interspecific crosses, the cross PH 1070 x Suvin (37.86 %) followed by NH 656 x Suvin (31.42 %). The same result assembled for seed cotton yield and yield contributing characters by other researchers Geddam *et al.,* (2011), Tuteja *et al.,* (2011a), Balu *et al.,* (2012), Patil *et al.,* (2012), Nidagundi *et al.,* (2012), Shekhar *et al.,* (2012), Tuteja *et al.,* (2013), Choudhary *et al.,* (2014), Kannan and Saravanan (2015) and Sonawane *et al.,* (2015).

Among the intra *hirsutum* crosses, the

high yielding intra *hirsutum* cross combinations PH 1060 x PH 1009, PH 1024 x PH 1009 and NH 656 x NH 615 showed positive significant heterosis for most of the yield and yield contributing traits over the locations. Whereas, among the interspecific crosses, the cross PH 1070 x Suvin and NH 656 x Suvin showed positive significant heterosis over the locations for the yield and fibre quality. If these crosses were studied in further generation, there is ample scope for developing productive inter and intraspecific hybrids with desirable cross combination of seed cotton yield and its component characters having superior fibre quality.

REFERENCES

Balu. A., Kavithamani, P.D., Ravikesavan, R. and Rajarathinam, S. 2012. Heterosis for seed cotton yield and its quantitative characters of *Gossypium barbadense* L. *J. Cotton Res. Dev.,* **26** : 37-40.

Choudhary, R., Solanki, B. G., Choudhary, R., Singh, A. K. and Khandelwal, V. 2014. Heterosis in single cross inter and intra specific hybrids of *desi* cotton in relation to seed cotton yield and its contributing characters. *The Bioscan.* **9** : 839-43.

Geddam, S. B., Khadi, B. M., Mogali, S., Patil, R. S., Katageri, I. S., Nadaf, H. L. and Patil, B. C. 2011. Study of heterosis in genetic male sterility based diploid cotton hybrids for yield, yield component and fibre quality characters. *Karnatka J. Agric. Sci.,* **24** : 118-24.

Kannan, N. and Saravanan, K. 2015. Heterosis for seed cotton yield, yield contributing characters and fibre quality parameters in intraploid cotton (*G. hirsutum* L.) and (*G. barbadense* L.). *Internat. J. Dev. Res.,* **5** 4545-48.

Nidagundi, J. M., Patil, S. S., Salimath, P. M., Kajjidoni, S. T., Patil, B. C. and Hegde, M. G. 2012. Heterobeltosis in multiple environments for seed cotton yield and yield attributes in cotton (*Gossypium hirsutum* L.). *Karnatka J. Agric. Sci.,* **25** : 301-04.

Patil, S. A., Naik, M. R., Pathak, V. D. and Kumar, V. 2012. Heterosis for yield and fibre properties in upland cotton (*Gossypium hirsutum* L.). *J. Cotton Res. Dev.,* **26** : 26-29.

Shekhar, L., Khadi, B. M., Patil, R. S., Katageri, I. S., Vamadevaiah, H. M., Chetti, M. S. and Nadaf, H. L. 2012. Study of heterosis in thermo sensitive genetic male sterility (TGMS) based diploid cotton hybrids for yield, yield component and fibre quality characters. *Karnatka J. Agric. Sci.,* **25** : 312-21.

Sonawane, H. S., Patil, S. S., Patil, S. C. and Magar, N. M. 2015. Heterotic studies for yield and its component traits in desi cotton (*G. arboreum* L.). *J. Cotton Res. Dev.,* **29** : 229-31.

Tuteja, O. P. and Agrawal, M. 2013. Heterosis for seed cotton yield and other traits in GMS based hybrids of American cotton. (*G. hirsutum* L.). *Cotton Res. J.,* **5** : 131-41.

Tuteja, O. P., Verma, S. K. and Banga, M. 2011a. Heterosis for seed cotton yield and other traits in GMS (Genetic male sterility) based hybrids of (*Gossypium hirsutum* L.) cotton. *J. Cotton Res. Dev.,* **25** : 14-18.

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