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Heterosis in bottle gourd (*Lagenaria siceraria*) over two varied seasons

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Abstract Combining ability and heterosis studies carried out through line x tester method using 10 lines and 3 testers. The expression of significant and desirable heterobeltiosis and standard heterosis in general and specific combining ability effect was examined. The 9 and 3 crosses exhibited positive and significant heterobltiosis and standard heterosis marketable yield per plant, respectively. The crosses had positive, negative and average *sca* effect for this character in almost same frequencies. Similar trends were also observed for most of the other characters, which suggested that there was a no apparent relationship between manifestations of heterosis with *sca* effect. However majority of crosses showing positive and significant heterobeltiosis and standard heterosis for marketable yield per plant in the two environments involved high x high general combiner parent followed by high x low and high x medium combination. This suggested existence of some correlation between heterosis of crosses, *gca* effect of their parents in which the involvement of at least one good general combiner parent appears very important for expression of high heterotic responses not only for marketable yield per plant, but also most of the other characters under study.

Keywords : Combining ability, Heterosis, Bottle gourd (*Lagenaria siceraria*)

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Introduction

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.) is an important vegetable crop in India. It thrives well in hot humid weather condition but it can be grown in diverse low temperature condition also Maurya *et al.*, 1993; Singh *et al.*, 1996). In India wide range of genetic variability available in this crop but unfortunately very little attention has been paid for its genetic improvement and commercial cultivation. There is thus good scope for improvement in yield and other character of bottle gourd through breeding. Bottle gourd, a cross pollinated crop, exhibit high heterosis in its crosses (Tyagi, 1973, Sirohi *et al.*, 1985, Maurya *et al.*, 1993; Singh *et al.*, 1996; Maurya *et al*., 2003). In the present study an attempt was made to gather information on the extent of heterobeltiosis over better parent and standard heterosis in 7 important characters in bottle gourd.

Material and Method

The experiment material comprised of 10 lines namely NDBG-4(L1), NDBG-5(L2), NDBG-10(L3), NDBG-27(L4), NDBG-56(L5), NDBG-104(L6), Pusa Naveen(L7), PSPL(L8), Punjab Komal(L9), and NDBG-6(L10) and three tasters NDBG-1C(T1), BTG-1(T2), and NDBG-1(T). The 30 F1s and their 13 parents (10 lines + 3 testers) were grown during summer E1 (from 15th march to 15th June) and rainy season (E2 from 10th June to 21st Aug. 1996) in the RBD with three replication. Each entry was sown in single row of 3 meter and plant to plant spacing of 50 cm. Observation were recorded on six plants for 7 quantitative traits.

Result and Discussion

The observation revealed that the promising hybrids are expected to exhibit higher heterosis over their better parents as well as standard check in unfavourable agro climatic condition than in favourable environment (Maurya, 1994). Heterobeltiosis and standard heterosis of five top ranking crosses for marketable yield given in (Table 1). Based on standard heterosis of the two sets

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Table 1. Top ranking five cross combinations for different characters based on per se performance, standard heterosis heterobeltiosis and s.c.a. effects in E1 and E2

Characters	Environments	Five best cross combinations based on per se performance	Five best cross combinations based on heterosis over standard parent	Five best cross combinations based on heterosis over better parent	Five best cross combinations based on desirable s.c.a effects	Characters	Environments	Five best cross combinations based on per se performance	Five best cross combinations based on heterosis over standard parent	Five best cross combinations based on heterosis over better parent	Five best cross combinations based on desirable s.c.a effects
Marketable yield per plant	E1	L9 x T1 5.13	L9 x T1 26.90	L4 x T2 55.46	L3 x T4 0.66	Days to first harvest	E1	L9 x T2 50.00	L9 x T2 -5.66	L3 x T4 -10.98	L6 x T2 -3.39
		L9 x T2 5.10	L9 x T2 26.32	L10 x T2 52.96	L10 x T4 0.60			L9 x T1 50.67	L9 x T1 -4.40	L5 x T4 -8.09	L3 x T4 -3.08
		L3 x T4 4.77	L3 x T4 18.07	L2 x T2 39.32	L2 x T1 0. 59			L3 x T4 51.33	L3 x T4 -3.14	L10 x T1 -5.29	L9 x T1 -2.31
		L6 x T4 4.53	L6 x T4 12.05	L3 x T4 33.36	L6 x T4 0.53			L6 x T2 51.33	L6 x T2 -3.14	L2 x T4 -4.62	L2 x T2 -2.06
		L6 x T2 4.38	L6 x T 8.33	L2 x T1 24.33	L7 x T2 0.47			L2 x T2 51.33	L2 x T2 -3.14	L8 x T1 -4.23	L5 x T4 -1.86
	E2	L9 x T2 3.76	L9 x T2 63.15	L4 x T1 128.26	L9 x T2 0.73		E2	L9 x T4 53.33	L9 x T4 -3.61	L4 x T1 -11.92	L7 x T2 2.34
		L9 x T4 3.02	L9 x T4 30.92	L5 x T2 101.94	L3 x T1 0.60			L9 x T2 54.67	L9 x T2 -1.20	L8 x T1 -8.81	L4 x T1 2.20
		L5 x T4 2.93	L5 x T4 26.88	L2 x T2 78.18	L4 x T1 0.48			L7 x T2 54.67	L7 x T2 -1.20	L5 x T1 -8.02	L1 x T4 1.36
		L7 x T4 2.88	L7 x T4 24.86	L2 x T1 77.39	L7 x T4 0.36			L3 x T2 54.67	L3 x T2 -1.20	L5 x T4 -5.68	L10 x T4 1.32
		L5 x T2 2.78	L5 x T2 20.52	L8 x T1 68.21	L5 x T2 0.27			L5 x T2 55.33	L5 x T2 0.00	L5 x T2 -5.68	L3 x T2 1.30
Average length of edible fruit	E1	L3 x T4 44.05	L3 x T4 34.86	L7 x T4 11.61	L7 x T4 3.29	Average weight of edible fruit	E1	L2 x T1 0.97	L2 x T1 16.26	L10 x T2 9.42	L2 x T1 0.09
		L8 x T1 43.47	L8 x T1 33.10	L7 x T1 5.05	L6 x T2 2.85			L10 x T2 0.96	L10 x T2 14.08	L7 x T4 5.77	L10 x T2 0.06
		L3 x T1 42.57	L3 x T1 30.33	L4 x T1 4.26	L2 x T2 2.66			L4 x T2 0.94	L4 x T2 11.97	L2 x T1 5.26	L8 x T4 0.04
		L5 x T4 42.95	L5 x T4 29.97	L5 x T4 1.24	L4 x T1 2.58			L3 x T4 0.93	L3 x T4 10.34	L5 x T2 4.40	L5 x T2 0.03
		L8 x T4 42.47	L8 x T4 27.47	L2 x T2 0.16	L5 x T4 1.74			L4 x T1 0.51	L4 x T1 8.23	L4 x T2 4.30	L3 x T4 0.02
	E2	L3 x T4 51.89	L3 x T4 20.11	L5 x T1 8.10	L1 x T2 2.30		E2	L9 x T4 1.00	L9 x T4 16.39	L9 x T4 13.35	L9x T4 0.10
		L8 x T4 50.50	L8 x T4 16.90	L5 x T4 5.53	L4 x T1 2.24			L2 x T2 0.97	L2 x T2 12.58	L5 x T1 8.00	L2 x T2 0.05
		L10 x T4 49.73	L10 x T4 15.12	L4 x T1 4.26	L10 x T4 1.42			L5 x T1 0.96	L5 x T1 11.69	L1 x T1 4.24	L4 x T2 0.05
		L3 x T2 49.34	L3 x T2 14.22	L10 x T4 3.25	L5 x T1 1.15			L3 x T4 0.95	L3 x T4 10.21	L2 x T2 4.06	L1 x T1 0.05
		L3 x T1 49.07	L3 x T1 13.58	L5 x T2 2.54	L3 x T2 0.91			L3 x T1 0.95	L3 x T1 10.21	L2 x T4 3.16	L8 x T4 0.04

Characters	Environments	Five best cross combinations based on per se performance	Five best cross combinations based on heterosis over standard parent	Five best cross combinations based on heterosis over better parent	Five best cross combinations based on desirable s.c.a effects
Number of fruits per plant	E1	L9 x T2 6.14	L9 x T2 27.12	L2 x T2 38.29	L10 x T4 0.76
		L9 x T1 6.00	L9 x T1 24.15	L4 x T2 36.52	L7 x T2 0.69
		L6 x T4 5.30	L6 x T4 9.66	L10 x T2 21.75	L6 x T4 0.64
		L3 x T4 5.16	L3 x T4 6.83	L6 x T4 20.38	L3 x T4 0.60
		L7 x T2 5.14	L7 x T2 6.42	L3 x T4 19.35	L5 x T4 0.57
	E2	L9 x T2 4.43	L9 x T2 64.81	L4 x T1 141.54	L3 x T1 0.58
		L1 x T4 3.39	L1 x T4 25.90	L5 x T2 87.16	L4 x T1 0.55
		L7 x T4 3.32	L7 x T4 23.30	L8 x T1 77.81	L7 x T4 0.42
		L5 x T4 3.24	L5 x T4 20.45	L2 x T2 74.93	L1 x T4 0.36
		L9 x T4 3.01	L9 x T4 11.90	L2 x T1 74.35	L5 x T2 0.29
Number of branches per plant	E1	L4 x T4 23.63	L4 x T4 49.83	L x T4 67.45	L4 x T4 5.64
		L7 x T2 20.60	L7 x T2 30.60	L7 x T2 30.60	L7 x T2 3.79
		L8 x T2 20.60	L8 x T2 30.58	L2 x T4 25.63	L8 x T2 2.67
		L1 x T2 20.39	L1 x T2 29.25	L5 x T4 25.18	L9 x T1 2.05
		L1 x T1 20.17	L1 x T1 27.25	L3 x T4 24.57	L1 x T1 1.76
	E2	L10 x T4 16.82	L10 x T4 19.01	L8 x T2 59.40	L8 x T2 2.49
		L8 x T2 16.59	L8 x T2 17.41	L2 x T2 52.72	L10 x T4 1.81
		L6 x T2 16.39	L6 x T2 15.94	L6 x T2 45.62	L9 x T4 1.69
		L3 x T1 15.61	L3 x T1 10.45	L3 x T1 29.79	L6 x T2 1.63
		L9 x T4 15.57	L9 x T4 10.14	L10 x T4 24.93	L3 x T1 1.49

Characters	Environments	Five best cross combinations based on per se performance	Five best cross combinations based on heterosis over standard parent	Five best cross combinations based on heterosis over better parent	Five best cross combinations based on desirable s.c.a effects
Vine length	E1	L10 x T4 5.88	L10 x T4 67.30	L3 x T4 29.49	L10 x T4 0.94
		L4 x T4 5.76	L4 x T4 63.70	L10 x T4 23.60	L3 x T4 0.65
		L8 x T1 5.69	L8 x T1 61.90	L9 x T2 21.17	L1 x T1 0.49
		L2 x T1 5.57	L2 x T1 58.29	L4 x T4 18.69	L9 x T1 0.46
		L4 x T2 5.56	L4 x T2 58.10	L5 x T1 14.70	L5 x T1 0.46
	E2	L8 x T2 9.93	L8 x T2 38.73	L2 x T2 24.30	L1 x T2 0.76
		L2 x T2 9.58	L2 x T2 33.85	L8 x T2 19.01	L7 x T1 0.71
		L8 x T4 9.37	L8 x T4 30.91	L1 x T2 15.21	L7 x T4 0.68
		L1 x T2 9.32	L1 x T2 30.12	L2 x T4 14.18	L4 x T4 0.61
		L2 x T1 9.15	L2 x T2 27.84	L8 x T4 12.30	L8 x T2 0.68

of five top yielding cross combinations in the two season it may be concluded that certain hybrid combination such as L9 x T2 may show consistently good performance over the environments but there is likelihood that a breeder may encounter different set of elite hybrids for different environmental conditions, suggesting, therefore, the need for proper identification of environment specific hybrids. With respect to days to first harvest, another important trait, the range of upper and lower limit of heterobeltiosis as well as standard heterosis were more or less of similar order (Table 1) in both the seasons. However, it was noticeable that the lowest negative standard heterosis, - 5.66% in E1 and -3.61% in E2 was recorded with the second top yielding cross combinations L9 x T2 (E1) and L9 x T4 (E2), respectively (Table1). It was also important to record that most of the crosses showing significant and positive heterobeltiosis and standard heterosis for marketable yield per plant in two environments, also exhibited significant and positive estimates of hererosis for the number of fruits per plant (Table 1), suggesting thereby positive heterosis in some important yield components contributed to over all heterosis for marketable yield per plant. Observation on high heterosis for marketable yield per plant, number of fruits per plant, days to first harvest have also been reported by Jankiram and Sirohi (1987); Sirohi *et al.* (1987), Maurya *et al.* (1993) and Maurya (1994); Pitchaimuthu and Sirohi (1994).

A critical reviews of estimates of standard and better parent heterosis for the 7 characters across the two environments clearly indicated that the expression of heterosis showed considerable variation not only from character to character but also from one environment to another environment. The range of heterosis, number and identity of crosses exhibiting significantly negative and positive standard and better parent heterosis for different characters showed considerable differences from summer season to rainy season. This indicated that the genotype x environment interaction played an important role in expression of heterotic responses in F1's for all the characters under study.

The five best crosses selected on the basis of per se performance, standard heterosis, heterobeltiosis and s.c.a (Table 1) were not always common for most of the characters in two environments. Maurya (1994) also encountered similar observation. Similarly the five best crosses selected on the basis of heterobeltiosis and *s.c.a* effects were not common in majority of cases in the two environments. This indicates that the ranking of the crosses on the basis of heterobeltioses and *s.c.a.* effects showed considerable variation for all the character in the two environments. The crosses L3 x T4 in E1 and L5 x T2 in E2 were the only crosses which appeared among the best five crosses selected on the basis of *per se* performances, standard heterosis, heterobeltiosis and *s.c.a.* effect for marketable yield per plant. These two crosses merit special attention as they have great potential for exploitation in breeding programme.

The expression of significant and desirable heterobeltiosis and standard heterosis in general and specific combining ability effect was also examined. In case of marketable yield per plant the crosses exhibiting positive and significant heterobltiosis (9 in E1, 16 in E2) and standard heterosis (3 in E1, 5 in E2) were found to posses positive, negative and average *s.c.a.* effect for this character in almost same frequencies. Similar trends was also observed for most of the other characters, which suggested that there was a no apparent relationship between manifestation of heterosis with s.c.a. effect. However majority of crosses showing positive and significant heterobeltiosis and standard heterosis for marketable yield per plant in the two environments involved high x high general combiner parent followed by high x low and high x medium combination. This suggested existence of some correlation between heterosis of crosses *g.c.a.* effect of their parents in which the involvement of at least one good general combiner parent appears very important for expression of high heterotic responses not only for marketable yield per plant, but also most of the other characters under study.

सारांश

संयोजन क्षमता एवं ओज का अध्ययन 10 पित्रों के साथ 3 परीक्षक को समाहित कर लाइन x टेस्टर विधि से किया गया। सार्थक एवं वांछित ओजबतिता एवं प्रमाणिता ओज का प्रदर्शन सामान्य एवं विशिष्ट संयोजन क्षमता के प्रभाव को भी आंका गया। बाजार योग्य उपज प्रति पौध में 9 संकर घनात्मक एवं सार्थक ओजवलिता तथा तीन संकर घनात्मक प्रमाणिता ओज का प्रदर्शन किया। बाजार योग्य उपज हेतु संकरण जो घनात्मक एवं सार्थक ओजवलिता तथा प्रमाणिता ओज प्रदर्शित किये उनमें घनात्मक, ऋणात्मक एवं असिता विशिष्ट संयोजन क्षमता उसी बारम्बारता में स्पष्ट हुई। अन्य गुणों में भी इसी तरह का झुकाव पाया गया जो कि सत्यापित करता है कि ओज एवं विष्टि संयोजन का दर्शित संबंध नहीं रहा। यद्यपि बहुतायत संकर दो वातावरण में बाजार योग्य उपज प्रति पौध में घनात्मक सार्थक ओजवलिता एवं प्रमाणिता ओज पाये गये जो कि उच्च x उच्च संयोजक चित्र उसके बाद उच्च निम्न एवं उच्च मध्यन संयोजक है। इससे यह प्रकट होता है कि ओज संकरण एवं सामान्य संयोजक के चित्राों में कुछ सह संबंध है। कम से कम एक चित्र एक सामान्य संयोजक चित्र है जो कि उच्च ओज के लिए उत्तरदायी है तथा न ही केवल बाजार योग्य उत्पादन हेतु बल्कि अन्य अध्ययन किये गये गुणों के लिए भी जिम्मेदार है।

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