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Estimation of heterosis in bottle gourd [*Lagenaria siceraria* (Mol.) Standl.]

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ABSTRACT: The present experiment was conducted to estimate the heterosis of 45 hybrids in bottle gourd during 2020–2021 in three environments at the open field of Hi-tech unit, Rajasthan College of Agriculture, Udaipur and Krishi Vigyan Kendra, Chittorgarh (Rajasthan). Hybrid showed highest magnitude of significant relative heterosis -4.32% ($P_3 \times P_8$), heterobeltiosis -1.98% ($P_4 \times P_6$ standard heterosis $P_4 \times P_6$ (-5.29%) in desirable direction on pooled basis. Maximum number of branches per vine, the significant positive relative heterosis (35.20%), heterobeltiosis (34.55%) and economic heterosis (12.19%) on pooled basis was observed by the hybrid $P_5 \times P_7$. Highest positive and significant relative heterosis for fruit diameter on pooled basis was observed by the hybrid $P_2 \times P_3$ (17.09%), whereas hybrid $P_1 \times P_2$ (15.53%) showed maximum heterobeltiosis and hybrids $P_7 \times P_{10}$ (80.27%) exhibited significant positive economic heterosis for this trait. The hybrid $P_8 \times P_{10}$ exhibited highest significant relative heterosis (36.07%) and heterobeltiosis (32.21%), whereas hybrids $P_1 \times P_9$ expressed maximum significant economic heterosis (17.97%) for rind thickness on pooled basis. Significant positive relative heterosis (18.12%) and heterobeltiosis (17.49%) on pooled basis was observed by the hybrid $P_1 \times P_2$, whereas hybrid $P_7 \times P_{10}$ exhibited significant positive economic heterosis (86.61%) for flesh thickness on pooled basis. Maximum yield per square meter, the significant positive relative heterosis (56.83%) and heterobeltiosis (49.60%) on pooled basis were observed by the hybrid $P_6 \times P_9$. The top five F_1 hybrids showed highest economic heterosis for yield per square meter were $P_7 \times P_8$ (39.26%), $P_6 \times P_9$ (36.99%), $P_6 \times P_8$ (35.66%), $P_4 \times P_{10}$ (30.98%) and $P_4 \times P_7$ (30.96%). The most difficult bottle gourd challenges are proper pollination, fertilization, and fruit development because fruit begins to grow but does not set seeds after pollination and fertilization. As a result, proper fertilization is required for good seed set.

Keywords: Bottle gourd, Heterobeltiosis, Economic heterosis, Yield, Hybrids.

INTRODUCTION

Bottle gourd [*Lagenaria siceraria* (Mol.) Standl.] is one of the important cucurbit in the world as well as in India. The genus *Lagenaria*, which is derived from the "Greek" word "lagena" meaning "bottle", has an annual monoecious specie, *L. siceraria* (Mol.) Standl (Syn. *L. vulgaris* Ser. and *L. leucantha* Duch), (Zeven and DeWet 1982). The chromosome number of *Lagenaria* is 2n = 22 with normal meiosis of 11 bivalents, a median centromere and stable taxon cytology (Sharma *et al*. 1983; Beevy and Kuriachan 1996). Bottle gourd is a monoecious species with male and female flowers found on the same plant's leaf axils (Morimoto *et al*. 2004; Singh, 2008). In bottle gourd, the monoecious sex expression predominates and andro-monoecious genetic stock (Andromon 6) was discovered to be recessive to monoecious by a single gene (Singh *et al*. 1996). Though monoecious, bottle gourd is a highly cross-pollinating crop (Tiwari and Ram 2009).

There are three stamens, two compound and one single. Since flowers open at night, selfing and crossing must be done as early as possible in the morning. The flowers open during the night hours and anthesis takes place between 5.00 and 8.00 P.M. The pollen remains viable from the day of anthesis to the next morning. Stigma was found receptive for 36 hours before anthesis and 60 hours after anthesis under North Indian conditions (Nandpuri and Singh 1977). In South India, anthesis occurs between 9.00 A.M. and 2.00 P.M. and the stigma remains receptive for 24 hours before and after anthesis (Joshi and Gaur 1971). Bottle gourds require a warm growing season and are sensitive to frost. Its germination is best between 25–30°C and is adversely affected below 15°C. The day temperature regime of 25–35°C is favourable for the growth of the plant.

In bottle gourd, currently, increasing attention is being paid to the breeding of superior cultivars, with greater focus on the development of hybrid seeds (Dubey and Maurya 2007). Heterosis breeding is a major tool to improve the genetic architecture of bottle gourd. Identification and selection of best parental lines required to produce genetically rewarding germplasm by hybridization must be based on complete genetic potency information. Among the various mating designs, diallel cross techniques have been most frequently used to achieve a high level of heterosis in desirable direction coupled with high specific combining ability (SCA) variance and non-additive types of gene action have also been reported in several major economic traits of bottle gourd, including yield by Choudhary and Singh (1971); Sharma *et al*. (1993). Therefore, there is an urgent need to develop F_1 hybrids with commercial heterosis, earliness, desirable fruit character as per market demand, wide adaptability and resistance.

Also, screening of the parents and crosses before their use in any breeding programme is to be emphasized and combining ability analysis based on the progeny test data is very useful to evaluate the genotypes for a wide range of quantitative characteristics (Feyzian *et al*., 2009).

MATERIALS AND METHODS

The experimental material is comprised of 10 inbred lines *viz.*, DVBG-1 (P_1), VRBG-5 (P_2), VRBG-1 (P_3), DR-2017 (Long) (P_4), VRBG-2-1-1 (P_5), VRBG-34 (P_6), VRBG-27-1 (P_7), VRBG-11-1 (P_8), VRBG-59 (P_9), IC-594545 (P_{10}), 45 F_1s and 3 checks *viz*. Parag (C-1), Prince (C-2) and Mahy Warad (C-3). These 45 F_1s were obtained by crossing 10 inbred lines in a diallel mating (excluding reciprocal) design to develop a total of forty five hybrids (Table 2) in the rainy season (July to February) of 2019-2020.

Heterosis is expressed as per cent increase or decrease of F_1 over the mid-parent (MP), better parent (BP) and standard check (SC) referred as relative heterosis, heterobeltosis and standard/ economic heterosis, respectively. Heterosis, heterobeltiosis and economic heterosis were calculated according to the method suggested by Shull (1908); Fonseca and Patterson (1968); Meredith and Bridge (1972), respectively for individual as well as over the environments.

$$Heterosis\ (\%) = \frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$$

Heterobeltiosis

$$Heterobeltiosis\ (\%) = \frac{\left(\overline{F_1} - \overline{BP}\right)}{\overline{BP}} \times 100$$

Economic heterosis:

$$Economic\ heterosis\ (\%) = \frac{\left(\overline{F_1} - \overline{BC}\right)}{\overline{BC}} \times 100$$

RESULT AND DISCUSSION

A. Days to first harvest

The magnitude of relative heterosis for days to first harvest ranged from -4.32% ($P_3 \times P_8$) to 5.25% ($P_4 \times P_{10}$) on pooled basis. On pooled basis, the magnitude of heterobeltiosis for this trait ranged from -0.05% ($P_5 \times P_7$) to -1.98% ($P_4 \times P_6$). Results for standard heterosis over the best check showed that 7 hybrids obtained desirable significant values on pooled basis. Hybrid $P_4 \times P_6$ (-5.29%) showed highest magnitude of significant standard heterosis in desirable direction followed by hybrids $P_1 \times P_6$ (-4.41 %), $P_2 \times P_4$ (-3.38%) and $P_2 \times P_3$ (-3.35%) on pooled basis. Range of standard heterosis varied from -5.29% ($P_4 \times P_6$) to -0.06% ($P_5 \times P_7$). Heterosis for earliness in term of relative heterosis, heterobeltiosis and economic heterosis was in conformity with the findings of Ghuge *et al*. (2016); Doloi *et al*. (2018) in bottle gourd.

B. Number of branches per vine

The relative heterosis among the hybrids ranged from -17.31% ($P_4 \times P_8$) to 35.20% ($P_5 \times P_7$) over the environments. Hybrid P5 × P7 expressed maximum positive significant heterobeltiosis over the environment (34.53%) for number of branches per vine. The per cent of heterobeltiosis in hybrids varied from 0.15% (P4 × P7) to 34.55% (P5 × P7) on pooled basis. The magnitude of standard heterosis was positive and significant in 3 hybrids over the environments among the 45 hybrids over the best check. The highest positive and significant economic heterotic performance were observed in the hybrid $P_5 \times P_7$ (12.19%) followed by $P_4 \times P_{10}$ (9.19%) and $P_3 \times P_8$ (8.37%) over the pooled environments. Various types of heterosis were also found significant in positive direction by Dubey and Maurya (2003); Ghuge *et al*. (2016); Jayanth *et al*. (2019) while working with bottle gourd.

C. Fruit diameter (cm)

The per cent range of relative heterosis among the hybrids varied from -29.83% ($P_1 \times P_8$ to 17.09% ($P_1 \times P_3$) on pooled basis. The highest magnitude of positive heterobeltiosis was manifested by hybrid $P_1 \times P_2$ (15.53%) on pool basis. Significant standard heterosis for fruit diameter was observed in twenty two hybrids. Maximum magnitude of economic heterosis was recorded for hybrid $P_7 \times P_{10}$ (80.27%) followed by hybrid $P_8 \times P_9$ (74.11%) on pooled basis. The magnitude of standard heterosis for this trait ranged from 0.12% ($P_4 \times P_7$) to 80.27% ($P_7 \times P_{10}$) over the environments.The variation in fruit diameter among hybrids could be due to a genetically controlled gene that is governed by the cell size and intercellular space of the flesh. The work of Masud *et al*. (2006) on bottle gourd is also in consonance with this finding.

Table 1: Extent of heterosis, heterobeltiosis and economic heterosis for days to first harvest and Number of branches per vine.

		Days to first harvest			Number of branches per vine		
Sr. No.	Crosses	Heterosis	Heterobeltiosis	Economic Heterosis	Heterosis	Heterobeltiosis	Economic Heterosis
		Pool	Pool	Pool	Pool	Pool	Pool
1.	$P_1 \times P_2$	0.55		-0.61	18.90**	13.58**	
2.	$P_1 \times P_3$	-1.31	-1.27	-0.66	13.08**	9.11*	
3.	$P_1 \times P_4$	-1.11		-1.53	5.95*	2.54	
4.	$P_1 \times P_5$	-0.73	-0.54		14.70**	12.78**	
5.	$P_1 \times P_6$	-3.12**	-1.07	-4.41**	7.07*	4.24	
6.	$P_1 \times P_7$	-0.56	-0.20	-0.22	16.09**	14.70**	
7.	$P_1 \times P_8$	-1.30			-12.22**		
8.	$P_1 \times P_9$	1.77**			13.33**	12.62**	
9.	$P_1 \times P_{10}$	-0.98			18.77**	17.25**	0.18
10.	$P_2 \times P_3$	-2.18**	-0.34	-3.35**	7.81*	6.70	
11.	$P_2 \times P_4$	-1.11	-0.37	-3.38**	15.61**	7.06*	
12.	$P_2 \times P_5$	-0.44		-1.41	19.83**	16.36**	
13.	$P_2 \times P_6$	0.09		-3.11**	2.68		
14.	$P_2 \times P_7$	0.49		-1.03	-7.20*		
15.	$P_2 \times P_8$	-1.20			13.54**	3.00	
16.	$P_2 \times P_9$	0.49			15.73**	9.89**	
17.	$P_2 \times P_{10}$	2.21**			9.83**	6.23	
18.	$P_3 \times P_4$	-0.57		-1.03	-4.08		
19.	$P_3 \times P_5$	-1.22	-0.99	-0.38	8.17*	6.12	
20.	$P_3 \times P_6$	-0.49		-1.86*	21.00**	13.77**	2.63
21.	$P_3 \times P_7$	0.13			-2.43		
22.	$P_3 \times P_8$	-4.32**	-1.82*	-1.20	23.87**	13.43**	8.37**
23.	$P_3 \times P_9$	-3.48**			-12.83**		
24.	$P_3 \times P_{10}$	-2.25**			15.10**	12.46**	
25.	$P_4 \times P_5$	-0.29		-0.53	18.23**	12.57**	2.78
26.	$P_4 \times P_6$	-2.89**	-1.98*	-5.29**	-9.77**		
27.	$P_4 \times P_7$	0.81			4.69	0.15	
28.	$P_4 \times P_8$	0.38			-17.31**		
29.	$P_4 \times P_9$	1.60*			-4.53		
30.	$P_4 \times P_{10}$	5.25**			25.10**	19.58**	9.19**
31.	$P_5 \times P_6$	0.72		-0.44	19.27**	14.22**	3.04
32.	$P_5 \times P_7$	-0.59	-0.05	-0.06	35.20**	34.53**	12.19**
33.	$P_5 \times P_8$	0.27			-4.67		
34.	$P_5 \times P_9$	-0.48			22.20**	19.40**	3.32
35.	$P_5 \times P_{10}$	1.08			21.32**	20.82**	0.59
36.	$P_6 \times P_7$	-0.85		-2.53**	-1.57		
37.	$P_6 \times P_8$	0.01			4.92	2.00	
38.	$P_6 \times P_9$	2.44**			0.69		
39.	$P_6 \times P_{10}$	1.75*			16.98**	12.47**	1.46
40.	$P_7 \times P_8$	-0.77			2.21		
41.	$P_7 \times P_9$	0.41			15.66**	13.56**	
42.	$P_7 \times P_{10}$	2.56**			-4.34		
43.	$P_8 \times P_9$	-0.14			-15.59**		
44.	$P_8 \times P_{10}$	0.70			-4.43		
45.	$P_9 \times P_{10}$	-1.95**	-1.64*		9.49**	7.41*	

Table 2: Extent of heterosis, heterobeltiosis and economic heterosis for Fruit diameter (cm) and Rind thickness (mm).

		Fruit diameter (cm)			Rind thickness (mm)		
Sr. No.	Crosses	Heterosis	Heterobeltiosis	Economic Heterosis	Heterosis	Heterobeltiosis	Economic Heterosis
		Pool	Pool	Pool	Pool	Pool	Pool
1.	$P_1 \times P_2$	16.36**	15.53**		2.50	0.35	2.11
2.	$P_1 \times P_3$	11.29**	8.41**		-17.90**		
3.	$P_1 \times P_4$	4.64**	3.74*		-2.79		
4.	$P_1 \times P_5$	1.81			-3.23*		3.44
5.	$P_1 \times P_6$	1.51		19.94**	10.37**	8.78**	13.96**
6.	$P_1 \times P_7$	-10.41**		5.49**	-11.87**		
7.	$P_1 \times P_8$	-29.83**			21.72**	10.03**	11.96**
8.	$P_1 \times P_9$	-16.82**		3.80*	21.30**	15.94**	17.97**
9.	$P_1 \times P_{10}$	-18.12**		0.59	-1.25		
10.	$P_2 \times P_3$	17.09**	13.27**	3.14*	12.85**	6.46**	3.80*
11.	$P_2 \times P_4$	3.09	2.94		-0.17		
12.	$P_2 \times P_5$	11.93**	10.37**		-1.23		3.47*
13.	$P_2 \times P_6$	-13.31**		1.89	-20.55**		
14.	$P_2 \times P_7$	-11.89**		3.20*	4.88**	2.23	4.98**
15.	$P_2 \times P_8$	-7.16**		14.87**	15.56**	6.50**	3.83*
16.	$P_2 \times P_9$	-19.20**		0.33	17.88**	15.02**	12.14**
17.	$P_2 \times P_{10}$	-19.98**			0.48		
18.	$P_3 \times P_4$	5.98**	2.38		0.39		
19.	$P_3 \times P_5$	-5.55**			3.35*		2.58
20.	$P_3 \times P_6$	-13.66**		4.05**	-5.56**		
21.	$P_3 \times P_7$	-13.04**		4.43**	-1.04		
22.	$P_3 \times P_8$	-18.15**		3.70*	19.97**	17.02**	1.18
23.	$P_3 \times P_9$	-19.64**		2.17	0.24		
24.	$P_3 \times P_{10}$	-20.15**			18.37**	17.91**	2.76
25.	$P_4 \times P_5$	5.36**	4.03*		8.73**		9.02**
26.	$P_4 \times P_6$	-13.92**		1.08	16.90**	7.83**	12.96**
27.	$P_4 \times P_7$	-14.43**		0.12	-2.28		
28.	$P_4 \times P_8$	-20.46**			7.09**	3.28	
29.	$P_4 \times P_9$	-5.14**		17.68**	3.97*	1.58	
30.	$P_4 \times P_{10}$	-18.87**			19.69**	18.77**	5.12**
31.	$P_5 \times P_6$	-15.61**			-17.69**		
32.	$P_5 \times P_7$	-10.78**		3.44*	-14.69**		
33.	$P_5 \times P_8$	-14.55**		4.71**	-4.29**		
34.	$P_5 \times P_9$	-14.57**		5.07**	-1.47		0.90
35.	$P_5 \times P_{10}$	-14.96**		2.94	-8.79**		
36.	$P_6 \times P_7$	-1.16		47.81**	-0.69		3.01
37.	$P_6 \times P_8$	-4.42**		49.25**	-23.59**		
38.	$P_6 \times P_9$	6.14**	1.83	66.22**	10.78**	4.44**	9.42**
39.	$P_6 \times P_{10}$	-2.99**		50.03**	6.19**		1.90
40.	$P_7 \times P_8$	-4.16**		49.25**	0.70		
41.	$P_7 \times P_9$	4.75**	0.22	63.60**	-7.75**		
42.	$P_7 \times P_{10}$	16.87**	13.12**	80.27**	8.86**	0.63	3.33
43.	$P_8 \times P_9$	6.96**	6.66**	74.11**	-13.57**		
44.	$P_8 \times P_{10}$	-6.35**		50.63**	36.07**	32.21**	15.22**
45.	$P_9 \times P_{10}$	-7.48**		49.24**	13.03**	9.61**	1.68

Table 3: Extent of heterosis, heterobeltiosis and economic heterosis for Rind thickness (mm) and Yield per square meter (kg).

		Flesh Thickness (mm)			Yield per square meter (kg)		
Sr. No.	Crosses	Heterosis	Heterobeltiosis	Economic Heterosis	Heterosis	Heterobeltiosis	Economic Heterosis
		Pool	Pool	Pool	Pool	Pool	Pool
1.	$P_1 \times P_2$	18.12**	17.49**		-4.75		
2.	$P_1 \times P_3$	14.64**	10.34**		8.56		
3.	$P_1 \times P_4$	5.53**	5.40**		35.94**	23.00**	18.26**
4.	$P_1 \times P_5$	2.51			23.70**	23.25**	
5.	$P_1 \times P_6$	0.69		19.35**	-2.74		
6.	$P_1 \times P_7$	-10.27**		6.05**	30.52**	18.81**	12.73**
7.	$P_1 \times P_8$	-33.81**			6.97*		
8.	$P_1 \times P_9$	-19.94**		1.24	11.63**	3.27	
9.	$P_1 \times P_{10}$	-19.48**		0.34	2.75		
10.	$P_2 \times P_3$	17.57**	12.59**	2.02	-6.93		
11.	$P_2 \times P_4$	3.47	3.05		-31.76**		
12.	$P_2 \times P_5$	13.74**	10.89**		-3.20		
13.	$P_2 \times P_6$	-12.65**		3.14	-16.22**		
14.	$P_2 \times P_7$	-13.41**		1.95	-23.92**		
15.	$P_2 \times P_8$	-8.88**		14.87**	-29.21**		
16.	$P_2 \times P_9$	-22.18**			-20.89**		
17.	$P_2 \times P_{10}$	-21.60**			-47.25**		
18.	$P_3 \times P_4$	6.58**	2.47		-7.58		
19.	$P_3 \times P_5$	-6.66**			10.90*	1.18	
20.	$P_3 \times P_6$	-14.34**		4.45*	-4.79		
21.	$P_3 \times P_7$	-14.04**		4.52**	-17.94**		
22.	$P_3 \times P_8$	-20.78**		2.91	-35.99**		
23.	$P_3 \times P_9$	-21.10**		2.44	-20.92**		
24.	$P_3 \times P_{10}$	-22.92**			-27.18**		
25.	$P_4 \times P_5$	4.91**	1.88		18.71**	7.07	2.94
26.	$P_4 \times P_6$	-16.59**			27.05**	18.45**	13.88**
27.	$P_4 \times P_7$	-15.47**			37.11**	36.21**	30.96**
28.	$P_4 \times P_8$	-22.44**			10.11**	5.85	10.30**
29.	$P_4 \times P_9$	-5.83**		18.97**	13.61**	10.91**	6.64
30.	$P_4 \times P_{10}$	-21.76**			24.38**	14.43**	30.98**
31.	$P_5 \times P_6$	-15.40**			23.18**	18.85**	
32.	$P_5 \times P_7$	-10.39**		3.64*	21.42**	10.16**	4.53
33.	$P_5 \times P_8$	-15.40**		4.89**	23.27**	7.35*	11.87**
34.	$P_5 \times P_9$	-15.72**		4.44*	26.49**	16.63**	6.80
35.	$P_5 \times P_{10}$	-15.50**		3.17	7.86*		3.41
36.	$P_6 \times P_7$	-1.20		51.07**	-7.34*		
37.	$P_6 \times P_8$	-3.23**		56.01**	44.84**	30.19**	35.66**
38.	$P_6 \times P_9$	5.84**	0.89	70.57**	56.83**	49.60**	36.99**
39.	$P_6 \times P_{10}$	-3.58**		53.62**	-9.80**		
40.	$P_7 \times P_8$	-4.46**		53.70**	39.90**	33.64**	39.26**
41.	$P_7 \times P_9$	5.56**	0.40	69.74**	-16.36**		
42.	$P_7 \times P_{10}$	17.38**	12.82**	86.61**	9.34**		14.44**
43.	$P_8 \times P_9$	8.09**	8.04**	82.80**	17.99**	10.83**	15.50**
44.	$P_8 \times P_{10}$	-8.64**		52.85**	14.20**	9.08**	24.85**
45.	$P_9 \times P_{10}$	-8.65**		52.77**	2.27		5.36

D. Rind thickness (mm)

Range of relative heterosis varied from -23.59% ($P_6 \times P_8$) to 36.07% ($P_8 \times P_{10}$) for this trait on pooled basis. The highest magnitude of positive and significant heterobeltiosis was found in the hybrid $P_8 \times P_{10}$ over the environments with value of 32.21 %. In view of economic heterosis for rind thickness, 13 hybrids presumed positive and significant heterotic effects, among them hybrid $P_1 \times P_9$ (17.97%) exhibited highest magnitude followed by hybrid $P_8 \times P_{10}$ (15.22%) and P_1

$\times$ P_6 (13.96%) over the environments.significant heterobeltiosis in desirable direction for this traits has also been observed by Quamruzzaman *et al*. (2020) while working bottle gourd.

E. Flesh thickness (mm)

Mid parent heterotic effect among the hybrids varied from -33.81% ($P_1 \times P_8$) to 18.12% ($P_1 \times P_2$) on pooled basis. Heterobeltiosis, hybrid $P_6 \times P_9$ (0.89%) exhibited lowest value while hybrid $P_1 \times P_2$ (17.49%) showed highest value on pooled basis. Nineteen hybrids were found superior over the best check cultivar for flesh thickness and maximum magnitude of economic heterosis was recorded in the hybrid $P_7 \times P_{10}$ (86.61%), followed by hybrid $P_8 \times P_9$ (82.80%) $P_6 \times P_9$ (70.57%) on pooled basis. The magnitude of standard heterosis for this trait ranged from 0.34% ($P_1 \times P_{10}$) to 86.61% ($P_7 \times P_{10}$) over the environment. Ghuge *et al*. (2016) reported significant relative heterosis and standard heterosis and Mauriya and Pal (2021) reported relative heterosis, heterobeltiosis and economic heterosis for flesh thickness in bottle gourd.

F. Yield per square meter (kg)

The maximum heterotic effect over the environments (56.83%) were exhibited by hybrid $P_6 \times P_9$, whereas hybrid $P_2 \times P_{10}$ (-47.25%) recorded lowest magnitude of mid parent heterosis on pool basis. The per cent heterbeltiotic effect among the hybrids varied from 1.18% ($P_7 \times P_{10}$) to 49.60% ($P_6 \times P_9$) on pooled basis. Thirteen hybrids were found superior over the best check cultivar for the yield per square meter and maximum magnitude of economic heterosis was observed in hybrid $P_7 \times P_8$ (39.26%) followed by the hybrid $P_6 \times P_9$ (36.99%) and $P_6 \times P_8$ (35.66%) on pooled basis. The magnitude of standard heterosis for yield per square meter ranged from 2.94% ($P_4 \times P_5$) to 39.26% ($P_7 \times P_8$) over the environments.

CONCLUSION

On the basis of high economic heterosis for yield per square meter cross combination $P_7 \times P_8$ (39.26%), $P_6 \times P_9$ (36.99%), $P_6 \times P_8$ (35.66%), $P_4 \times P_{10}$ (30.98%) and $P_4 \times P_7$ (30.96%) can be exploit for improvement in yield of bottle gourd.

FUTURE SCOPE

Bottle gourd is the most popular cucurbit vegetable, it is necessary to improve the yield potential of bottle gourd varieties/hybrids or to use them in breeding programmes to increase productivity.

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Conflicts of Interest. None.

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