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Heterosis for Green Pod Yield and Attributing Traits in Vegetable Pea [*Pisum sativum* (L.) var. *hortense*]

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ABSTRACT: The important factor that reduces vegetable pea production is the low-yielding potential of old varieties and the lack of stability for yield. The heterosis is widely utilized for the selection of superior cross combinations, this study was conducted to estimate the magnitude of heterosis for green pod yield and yield attributing characters. A diallel analysis (excluding reciprocal) was designed aiming towards the identification of the best heterotic crosses for green pod yield per plant and quality traits in vegetable pea. The present study was conducted at the Main Experimental Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.), India, during *Rabi*, 2020-21 (Y_1) and 2021–22 (Y_2). Forty-five hybrids were developed through diallel mating design by using ten parental lines excluding reciprocals. Appreciable heterosis was found over better parent and standard variety for all the traits under study in desirable direction. For early maturity trait s*i.e.*, days to 50% flowering, days to first picking and node to first pod appearance negative heterosis is desirable, for this the cross combinations $P_5 \times P_6$,$P_6 \times P_7$ and $P_5 \times P_{10}$ exhibited the highest significant heterosis over better parent and standard variety. Crosses $P_5 \times P_6$, $P_5 \times P_7$, $P_6 \times P_{10}$ and $P_6 \times P_7$ may be exploited commercially after evaluation for profitable yield in vegetable pea. Significant heterobeltiosis and economic heterosis indicate the importance of heterosis breeding for developing high-yielding hybrids/varieties.

Keywords: Biochemical**,** Diallel mating, economic heterosis,heterobeltiosis, protein, sugars.

INTRODUCTION

Garden pea [*Pisum sativum* (L.) var. *hortense*] is a member of the Leguminosae family. Near East and Ethiopia are regarded as secondary habitats, with the Mediterranean serving as the garden pea's primary source of origin (Blixt, 1970). It is prominent among leguminous vegetable crops due to its high nutritive value, particularly proteins and other health-building substances like carbohydrates vitamin A, vitamin C calcium and phosphorus. It is also rich in lysine, which is a limiting essential amino acid in cereals. It is grown commercially as a winter crop in the northern Indian plains and as a summer crop in the high hills. Green peas are eaten as a cooked vegetable and they are also used fresh, canned or frozen while ripe dried peas are used as a whole, split, or made into flour.

India is second in the world for vegetable production behind China, and it contributes 10.80 million hectares and 196.26 million tonnes of vegetables to the world's production overall. Vegetable peas are grown on an average of 10.04 tonnes per hectare in India, where they cover 0.573 million hectares and produce 5.823 million tonnes (Anon., 2021). In India, it is grown extensively in Uttar Pradesh, Madhya Pradesh, Himachal Pradesh, Jharkhand, Punjab, Haryana, Rajasthan, Maharashtra, Bihar, and Karnataka, contributing to 67% of the total production. Uttar Pradesh is the highest vegetable pea-producing state in India. This crop is grown on 0.218 million hectares in Uttar Pradesh, producing 2.481 million tonnes and productivity is 11.360 tonnes per hectare (Anon., 2018).

The key element that lowers the output of vegetable peas is the probable poor yield of older varieties and the lack of yield stability. Hybridization is a crucial breeding strategy for overcoming yield limitations. Garden pea is a self-pollinated crop and recombinant breeding is the most appropriate approach for combining various desirable traits like long and lush green pods with high yield potential (Sood and Kalia, 2006). The estimates of heterosis may be utilized in determining the potential of parents for the production of transgressive segregants in segregating generations (Sharma and Bora 2013). The present experiment was undertaken to estimate the magnitude of heterosis for green pod yield and yield attributing characters in garden pea. The exploitation of heterosis/hybrid vigour in crop plants for significant enhancement in yield and other quantitative characteristics is a time-tested approach in crop improvement. The estimation of heterosis for yield and its attributing traits would be useful to judge the best hybrid combination for exploitation as superior hybrids.

MATERIALS AND METHODS

The present investigation was undertaken to study the magnitude of heterosis for fruit yield and its components in vegetable pea. The present study was carried out at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya (U.P.), India, during *Rabi*, 2020-21 (Y_1) and 2021–22 (Y_2). The experimental materials comprised ten promising and diverse purelines and varieties of vegetable pea selected based on genetic variability from the different sources of germplasm stock maintained in the Department of Vegetable Science. The selected parental lines*i.e*.; Azad Pea-1 (P_1), Azad Pea-2 (P_2), Azad Pea-4 (P_3), Kashi Samridhi (P_4), Kashi Nandini (P_5), Kashi Mukti (P_6), Kashi Udai (P_7), NDVP-2 (P_8), NDVP-4 (P_9) and Azad Pea-3 (P_{10}) were crossed in all possible cross combinations, excluding reciprocals, during the year, 2019-20 to get 45 F_1's for the study of heterobeltiosis and economic heterosis. Azad Pea-3 was used as a standard variety for comparison of yield and attributing traits.

The experiments were conducted in a Randomized Complete Block Design (RBD) with three replications to assess the performance of 45 F_1 hybrids and their 10 parental lines of vegetable pea. Observations were recorded for eighteen economic traits including biochemical traits, *viz.* days to 50% flowering, days to first picking, plant height (cm), node to first pod appearance, nodes per plant, pod length (cm), pod girth (cm), number of seeds per pod, number of pods per plant, shelling percentage (%), number of pods per 100g, 100 green seed weight (g), protein content (%), total soluble solids, reducing sugars (%), non-reducing sugar (%), total sugars (%) and green pod yield per plant (g). The magnitude of heterosis was studied using the information on various quantitative and quality traits. Heterosis expressed as per cent increase or decrease in the mean values of F_1's (hybrid) over better-parent (heterobeltiosis) and standard variety (standard heterosis) was calculated according to the suggested method. The formulas used for the estimation of heterosis are as follows:

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

$$\text{(b) Standard heterosis (\%)} = \frac{\overline{F_1} - \overline{SV}}{\overline{SV}} \times 100$$

Where, $\overline{F_1}$ is the mean value of F_1, $\overline{BP}$ is the mean value of better-parent and $\overline{SV}$ is the mean value of standard variety.

The significance of heterosis was tested by 't' tests as given below:

$$\text{'t' (Heterobeltiosis)} = \frac{\overline{F_1} - \overline{BP}}{SE}$$

$$\text{'t' (Standard heterosis)} = \frac{\overline{F_1} - \overline{SV}}{SE}$$

SE of heterosis over better-parent and standard variety $= \sqrt{Me/r}$

Where, Me is the error mean square, r is the number of replications, SE is the standard error of the treatments mean and (t) is the table value of (t) at 5% or 1% level of significance at error degree of freedom. The calculated 't' value was compared with table value 't' at error *d.f.* at 5% and 1% level of probability for testing the significance of heterosis.

RESULTS AND DISCUSSION

The degree of heterosis is measured as the superiority of F_1 hybrids over the better parent (heterobeltiosis) and standard variety. The possibility of exploitation of hybrid vigour depends on feasibility of hybrid seed production at commercial scale. Heterobeltiosis is an indicator of level of transgressive segregants as superiority of hybrids helps in the identification of promising cross combinations having potential to produce the highest level of transgressive segregants in conventional crop improvement programme. In the present study, heterosis is reported over better parent (heterobeltiosis) and standard variety over season pooled.

For the trait days to 50% flowering, heterosis in the negative direction is desirable as it imparts early flowering. Significantly negative heterosis over better parent and standard variety was observed in respect of days to 50% flowering. The maximum and significant negative heterosis over better parent (-16.67%) followed by (-15.81%) and standard variety (-22.00%) followed by (-21.20%) were observed in the cross $P_5 \times P_6$ and $P_5 \times P_7$. Out of 45 crosses, six crosses over better parent and six crosses over standard variety exhibited significant negative heterosis for days to 50 % flowering in over season (pooled). Early flowering in vegetable pea hybrids due to negative heterotic effect to a considerable amount has been reported earlier by Rebika (2017); Galal *et al*. (2019).

The crosses with negative significant heterosis were considered as desirable for the trait days to first picking. The maximum and significant negative heterosis (-13.85%) followed by (-13.64%) over better parent was observed in the cross $P_5 \times P_6$ and $P_6 \times P_7$. The crosses that proved better for this character over standard variety were $P_5 \times P_6$ (-20.38) followed by $P_5 \times P_7$ (-19.91) in over season (pooled). Out of 45 crosses, significant and negative heterosis was observed in six crosses over better parent as well as over standard in over season (pooled). Similar findings were also observed by Yadav *et al*. (2018); Kumar *et al.* (2019).

For plant height, the highest heterosis over better parent was recorded in the cross $P_5 \times P_6$ (16.04) followed by $P_6 \times P_7$ (14.01) and $P_5 \times P_7$ (13.15) while, maximum heterosis over standard variety was recorded in cross $P_2 \times P_3$ (78.24) followed by $P_2 \times P_{10}$ (73.59) and $P_2 \times P_4$ (71.72) in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in three crosses over better parent and thirty crosses over standard variety in over season (pooled). The results are in conformity with Sharma and Bora (2013), Bisht and Singh (2010).

The best crosses which exhibited highest heterotic effect over better parent for the character number of seeds per pod were $P_7 \times P_{10}$ (17.56) followed by $P_6 \times P_{10}$ (16.63) and $P_6 \times P_7$ (16.60). The crosses proved better for this character over standard variety were $P_7 \times P_{10}$ (17.78) followed by $P_6 \times P_7$ (16.83) and $P_6 \times P_{10}$ (16.63) in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in nine crosses over better parent as well as over standard variety in over season (pooled). The findings of Bisht and Singh (2010); Joshi *et al.* (2016) supported the above results.

For the character number of pods per plant (Table 1) the crosses that proved superior were $P_5 \times P_6$ (44.71) followed by $P_5 \times P_7$ (44.11) and $P_6 \times P_7$ (43.02) over better parent and $P_5 \times P_7$ (25.98) followed by $P_5 \times P_6$ (25.73) and $P_5 \times P_{10}$ (25.06) over standard variety showing significant magnitudes of heterotic effects in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in thirteen crosses over better parent and twenty crosses over standard variety in over season (pooled). The results are in conformity with Kumar *et al.* (2019); Joshi *et al.* (2016).

The best crosses which exhibited highest heterotic effect over better parent for the character 100 green seed weight were $P_6 \times P_7$ (17.54) followed by $P_5 \times P_{10}$ (17.42) and $P_7 \times P_{10}$ (17.26). The crosses proved better for the character over standard variety were $P_5 \times P_{10}$ (17.56) followed by $P_7 \times P_{10}$ (17.26) and $P_6 \times P_{10}$ (17.25) in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in six crosses over better parent as well as over standard variety in over season (pooled). Similar results were reported by Borah (2009); Amani (2021).

For protein content the crosses $P_7 \times P_{10}$ (14.52) recorded maximum heterosis over better parent followed by $P_5 \times P_{10}$ (12.48) and $P_6 \times P_{10}$ (11.65) while, over standard variety maximum heterosis were exhibited by the crosses $P_5 \times P_{10}$ (18.00) followed by $P_5 \times P_6$ (15.64) and $P_7 \times P_{10}$ (14.52) in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in six crosses over better parent and nine crosses over standard variety in over season (pooled). The findings of Yadav *et al*. (2015); Yadav *et al.* (2018) supported the above result.

For the trait green pod yield per plant, the cross $P_5 \times P_7$ (41.38) showed highest heterosis over better parent followed by $P_5 \times P_6$ (41.06) and $P_6 \times P_7$ (39.94) while, the cross $P_7 \times P_{10}$ (34.58) recorded maximum heterosis over standard variety followed by $P_6 \times P_{10}$ (34.57) and $P_5 \times P_7$ (29.67) in over season (pooled). Out of 45 crosses, significant and positive heterosis was observed in twenty-six crosses over better parent and ten crosses over standard variety in over season (pooled). The findings are in accordance with that of Kumari and Sharma (2019); Kumar *et al*. (2019).

Table 1: Estimates of heterosis (%) over better parent (BP) and standard variety (SV) for over season pooled.

Sr. No.	Hybrids	Days to 50% flowering		Days to first picking		Plant height	
		BP	SV	BP	SV	BP	SV
1.	$P_1 \times P_2$	5.67 *	19.20 **	4.39 *	12.80 **	-9.39 **	53.16 **
2.	$P_1 \times P_3$	7.09 **	20.80 **	4.17 *	12.56 **	-13.52 **	54.39 **
3.	$P_1 \times P_4$	9.93 **	24.00 **	5.48 **	13.98 **	-0.68	31.50 **
4.	$P_1 \times P_5$	16.67 **	9.20 **	13.30 **	4.98 *	-1.37	14.80 **
5.	$P_1 \times P_6$	15.81 **	8.40 **	11.31 **	4.98 *	0.46	16.93 **
6.	$P_1 \times P_7$	15.68 **	9.20 **	11.34 **	4.74 *	3.77	20.79 **
7.	$P_1 \times P_8$	5.67 *	19.20 **	3.51	11.85 **	-2.43	13.57 **
8.	$P_1 \times P_9$	6.38 **	20.00 **	4.17 *	12.56 **	-0.48	15.84 **
9.	$P_1 \times P_{10}$	9.20 **	9.20 **	5.21 **	5.21 **	-2.12	13.93 **
10.	$P_2 \times P_3$	-1.23	28.00 **	0.61	17.30 **	-0.16	78.24 **
11.	$P_2 \times P_4$	0.62	30.40 **	2.24	19.19 **	1.59	71.72 **
12.	$P_2 \times P_5$	30.34 **	22.00 **	22.51 **	13.51 **	0.56	69.98 **
13.	$P_2 \times P_6$	31.62 **	23.20 **	20.85 **	13.98 **	0.06	69.13 **
14.	$P_2 \times P_7$	28.81 **	21.60 **	20.40 **	13.27 **	1.54	71.63 **
15.	$P_2 \times P_8$	0.31	30.00 **	1.42	18.25 **	1.37	71.34 **
16.	$P_2 \times P_9$	0.00	27.60 **	0.82	16.35 **	0.93	70.61 **
17.	$P_2 \times P_{10}$	18.40 **	18.40 **	14.22 **	14.22 **	2.70	73.59 **
18.	$P_3 \times P_4$	0.62	30.40 **	0.6	18.72 **	-6.06 **	67.70 **
19.	$P_3 \times P_5$	28.63 **	20.40 **	23.02 **	13.98 **	-3.98 *	71.42 **
20.	$P_3 \times P_6$	29.06 **	20.80 **	20.35 **	13.51 **	-5.75 **	68.26 **
21.	$P_3 \times P_7$	27.54 **	20.40 **	19.65 **	12.56 **	-4.92 **	69.75 **
22.	$P_3 \times P_8$	-0.62	28.80 **	1.01	18.01 **	-5.83 **	68.11 **
23.	$P_3 \times P_9$	0.63	28.40 **	1.64	17.30 **	-4.72 **	70.11 **
24.	$P_3 \times P_{10}$	20.80 **	20.80 **	12.09 **	12.09 **	-5.87 **	68.04 **
25.	$P_4 \times P_5$	36.32 **	27.60 **	26.09 **	16.82 **	-2.59	28.97 **
26.	$P_4 \times P_6$	35.47 **	26.80 **	23.87 **	16.82 **	-4.63	26.27 **
27.	$P_4 \times P_7$	32.20 **	24.80 **	23.93 **	16.59 **	-0.06	32.32 **
28.	$P_4 \times P_8$	0.62	30.80 **	1.62	18.72 **	-7.22 **	22.84 **
29.	$P_4 \times P_9$	3.45	32.00 **	2.67	18.48 **	-5.00 *	25.78 **
30.	$P_4 \times P_{10}$	24.40 **	24.40 **	16.11 **	16.11 **	-4.57	26.35 **
31.	$P_5 \times P_6$	-16.67 **	-22.00 **	-13.85 **	-20.38 **	16.04 **	6.53 *
32.	$P_5 \times P_7$	-15.81 **	-21.20 **	-13.33 **	-19.91 **	13.15 **	3.62
33.	$P_5 \times P_8$	11.97 **	4.80	8.97 **	0.71	1.94	-3.00
34.	$P_5 \times P_9$	11.11 **	4.00	9.49 **	1.18	-4.48	-0.42

35.	$P_5 \times P_{10}$	-10.68 **	-16.40 **	-12.05 **	-18.72 **	4.08	4.08
36.	$P_6 \times P_7$	-13.68 **	-19.20 **	-13.64 **	-18.96 **	14.01 **	4.67
37.	$P_6 \times P_8$	14.10 **	6.80 **	9.09 **	2.37	4.04	-1.00
38.	$P_6 \times P_9$	11.97 **	4.80	9.09 **	2.37	-6.96 *	-3.01
39.	$P_6 \times P_{10}$	-10.68 **	-16.40 **	-12.88 **	-18.25 **	3.37	3.37
40.	$P_7 \times P_8$	13.68 **	6.40 *	9.09 **	2.37	5.26	0.16
41.	$P_7 \times P_9$	14.53 **	7.20 **	9.34 **	2.61	-1.98	2.18
42.	$P_7 \times P_{10}$	-9.83 **	-15.60 **	-11.87 **	-17.30 **	4.76	4.76
43.	$P_8 \times P_9$	2.19	30.40 **	2.46	18.25 **	-6.84 *	-2.88
44.	$P_8 \times P_{10}$	24.80 **	24.80 **	14.69 **	14.69 **	-0.22	-0.22
45.	$P_9 \times P_{10}$	22.00 **	22.00 **	13.27 **	13.27 **	-3.29	0.82
No. of crosses with significant (+) heterosis		**29**	**33**	**28**	**33**	**3**	**30**
No. of crosses with significant (-) heterosis		**6**	**6**	**6**	**6**	**13**	**0**
Range of heterosis		**-16.67 to 36.32**	**-22.00 to 32.00**	**-13.85 to 26.09**	**-20.38 to 19.19**	**-13.52 to 16.04**	**-3.01 to 78.24**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 1: Contd…

Sr. No.	Hybrids	Node to first pod appearance		Nodes per plant		Pod length	
		BP	**SV**	**BP**	**SV**	**BP**	**SV**
1.	$P_1 \times P_2$	7.36 **	29.48 **	-1.94	30.56 **	-4.55 *	-7.06 **
2.	$P_1 \times P_3$	10.83 **	33.67 **	-7.15 *	27.70 **	-3.72 *	-6.26 **
3.	$P_1 \times P_4$	13.19 **	36.52 **	5.22	38.49 **	-3.49	-6.03 **
4.	$P_1 \times P_5$	12.05 **	12.80 **	2.49	21.68 **	8.70 **	7.82 **
5.	$P_1 \times P_6$	10.73 **	12.40 **	7.00	27.03 **	6.95 **	6.91 **
6.	$P_1 \times P_7$	12.99 **	12.80 **	6.11	25.98 **	4.33 *	5.65 **
7.	$P_1 \times P_8$	12.08 **	35.18 **	5.83	30.09 **	-4.16 *	-6.68 **
8.	$P_1 \times P_9$	6.11 *	27.97 **	-7.08 *	26.65 **	-3.57	-6.11 **
9.	$P_1 \times P_{10}$	12.90 **	12.90 **	0.64	19.48 **	8.21 **	8.21 **
10.	$P_2 \times P_3$	1.95	40.20 **	-0.56	36.77 **	-10.98 **	-27.56 **
11.	$P_2 \times P_4$	-3.12	35.18 **	2.51	36.49 **	-13.69 **	-28.78 **
12.	$P_2 \times P_5$	29.95 **	30.82 **	-6.24	24.83 **	-19.74 **	-20.38 **
13.	$P_2 \times P_6$	27.39 **	29.31 **	-8.46 *	21.87 **	-21.50 **	-21.53 **
14.	$P_2 \times P_7$	29.70 **	29.48 **	-2.30	30.09 **	-22.05 **	-21.07 **
15.	$P_2 \times P_8$	7.37 **	36.68 **	1.87	35.63 **	-12.17 **	-28.40 **
16.	$P_2 \times P_9$	0.00	34.34 **	1.47	38.30 **	-18.37 **	-27.90 **
17.	$P_2 \times P_{10}$	29.98 **	29.98 **	-3.59	28.37 **	-21.34 **	-21.34 **
18.	$P_3 \times P_4$	-3.65	34.44 **	5.83	45.56 **	-1.76	-18.93 **
19.	$P_3 \times P_5$	29.12 **	29.98 **	-3.61	32.57 **	-11.58 **	-12.29 **
20.	$P_3 \times P_6$	36.63 **	38.69 **	-5.56	29.89 **	-11.38 **	-11.41 **
21.	$P_3 \times P_7$	29.53 **	29.31 **	0.97	38.87 **	-11.31 **	-10.19 **
22.	$P_3 \times P_8$	5.39 *	34.17 **	-0.56	36.77 **	0.56	-18.02 **
23.	$P_3 \times P_9$	-0.75	33.33 **	2.22	40.59 **	-6.87 **	-17.75 **
24.	$P_3 \times P_{10}$	29.31 **	29.31 **	-1.53	35.43 **	-11.37 **	-11.37 **
25.	$P_4 \times P_5$	29.28 **	30.15 **	2.76	35.24 **	-11.62 **	-12.33 **
26.	$P_4 \times P_6$	28.71 **	30.65 **	0.44	32.19 **	-11.91 **	-11.95 **
27.	$P_4 \times P_7$	29.87 **	29.65 **	6.97 *	40.78 **	-11.42 **	-10.31 **
28.	$P_4 \times P_8$	6.71 *	35.85 **	4.64	37.73 **	0.09	-17.40 **
29.	$P_4 \times P_9$	0.00	34.34 **	-2.73	32.57 **	-6.61 **	-17.52 **
30.	$P_4 \times P_{10}$	28.31 **	28.31 **	5.66	39.06 **	-11.15 **	-11.15 **
31.	$P_5 \times P_6$	-20.33 **	-19.93 **	16.49 **	11.48 **	14.05 **	14.01 **
32.	$P_5 \times P_7$	-22.32 **	-22.45 **	13.25 **	9.04 *	12.89 **	14.31 **
33.	$P_5 \times P_8$	15.83 **	16.42 **	-15.21 **	4.22	-2.89	-3.66 *
34.	$P_5 \times P_9$	11.67 **	12.23 **	-22.35 **	5.83	-3.27	-4.05 *
35.	$P_5 \times P_{10}$	-18.93 **	-18.93 **	9.84 *	9.84 *	14.43 **	14.43 **
36.	$P_6 \times P_7$	-18.96 **	-19.10 **	13.29 **	9.07 *	14.55 **	15.99 **
37.	$P_6 \times P_8$	18.83 **	19.43 **	-9.56 **	11.17 *	-4.05 *	-4.08 *
38.	$P_6 \times P_9$	17.67 **	18.26 **	-20.11 **	8.88 *	-3.40	-3.44
39.	$P_6 \times P_{10}$	-19.10 **	-19.10 **	16.91 **	16.91 **	16.07 **	16.07 **
40.	$P_7 \times P_8$	19.67 **	20.27 **	-9.49 **	11.25 *	-4.11 *	-2.90
41.	$P_7 \times P_9$	18.17 **	18.76 **	-23.29 **	4.55	-3.88 *	-2.67
42	$P_7 \times P_{10}$	-16.25 **	-16.25 **	13.91 **	13.91 **	16.70 **	18.17 **
43	$P_8 \times P_9$	-0.51	29.98 **	-16.38 **	13.96 **	-4.28 *	-15.46 **
44	$P_8 \times P_{10}$	30.65 **	30.65 **	1.17	24.36 **	-13.40 **	-13.40 **
45	$P_9 \times P_{10}$	29.15 **	29.15 **	-7.92 *	25.50 **	-8.28 **	-8.28 **
No. of crosses with significant (+) heterosis		**32**	**39**	**7**	**42**	**10**	**10**
No. of crosses with significant (-) heterosis		**6**	**6**	**11**	**0**	**27**	**32**
Range of heterosis		**-22.32 to 36.63**	**-22.45 to 40.20**	**-23.19 to 16.91**	**4.22 to 45.56**	**-22.05 to 16.70**	**-28.78 to 18.17**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 1: Contd…

Sr. No.	Hybrids	Pod girth		Number of seeds/pod		Number of pods/plant	
		BP	SV	BP	SV	BP	SV
1.	$P_1 \times P_2$	-3.36	-2.19	-9.94 **	-11.66 **	-19.56 **	-21.67 **
2.	$P_1 \times P_3$	-2.24	-1.05	-10.33 **	-12.05 **	-26.77 **	-21.23 **
3.	$P_1 \times P_4$	-2.64	-1.46	-4.68	-6.50 **	-24.43 **	-20.41 **
4.	$P_1 \times P_5$	7.60 **	8.91 **	7.80 **	5.74 *	27.72 **	10.96 *
5.	$P_1 \times P_6$	7.20 **	8.50 **	7.41 **	5.35 *	35.13 **	15.43 **
6.	$P_1 \times P_7$	7.20 **	8.50 **	3.24	3.44	22.44 **	7.03
7.	$P_1 \times P_8$	-2.64	-1.46	-4.48	-6.31 *	-4.82	-22.43 **
8.	$P_1 \times P_9$	-2.80	-1.62	-4.68	-6.50 **	-10.81	-22.85 **
9.	$P_1 \times P_{10}$	7.44 **	8.74 **	5.74 *	5.74 *	10.17 *	10.17 *
10.	$P_2 \times P_3$	0.00	-10.20 **	1.37	-29.45 **	-8.60	-1.68
11.	$P_2 \times P_4$	4.06	-8.58 **	-13.38 **	-29.45 **	0.36	5.70
12.	$P_2 \times P_5$	-7.29 **	-7.37 **	-12.47 **	-16.83 *	17.28 **	14.20 **
13.	$P_2 \times P_6$	-8.09 **	-7.13 **	-14.45 **	-16.25 **	8.36	5.51
14.	$P_2 \times P_7$	-8.17 **	-7.21 **	-16.60 **	-16.44 **	16.47 **	13.40 **
15.	$P_2 \times P_8$	0.37	-11.82 **	3.31	-28.49 **	-0.94	-3.55
16.	$P_2 \times P_9$	1.66	-10.69 **	-9.68 **	-30.40 **	-0.75	-3.36
17.	$P_2 \times P_{10}$	-8.74 **	-8.74 **	-16.25 **	-16.25 **	14.26 **	14.26 **
18.	$P_3 \times P_4$	-3.16	-13.04 **	-10.09 **	-26.77 **	3.18	10.99 *
19.	$P_3 \times P_5$	-7.29 **	-7.37 **	-12.27 **	-16.63 **	5.92	13.94 **
20.	$P_3 \times P_6$	-8.25 **	-7.29 **	-15.63 **	-17.40 **	0.56	8.17
21.	$P_3 \times P_7$	-8.25 **	-7.29 **	-18.51 **	-18.36 **	5.80	13.81 **
22.	$P_3 \times P_8$	-0.81	-10.93 **	0.27	-30.21 **	-7.39	-0.38
23.	$P_3 \times P_9$	-0.45	-10.61 **	-8.93 **	-29.83 **	-5.18	2.00
24.	$P_3 \times P_{10}$	-6.80 **	-6.80 **	-16.83 **	-16.83 **	4.01	11.88 *
25.	$P_4 \times P_5$	-8.59 **	-8.66 **	-7.24 **	-11.85 **	9.06	14.86 **
26.	$P_4 \times P_6$	-8.89 **	-7.94 **	-10.55 **	-12.43 **	8.30	14.07 **
27.	$P_4 \times P_7$	-7.93 **	-6.96 **	-10.50 **	-10.33 **	7.16	12.86 **
28.	$P_4 \times P_8$	2.14	-11.17 **	-8.22 **	-25.24 **	1.84	7.26
29.	$P_4 \times P_9$	4.10	-9.47 **	-9.15 **	-26.00 **	2.74	8.21
30.	$P_4 \times P_{10}$	-7.37 **	-7.37 **	-9.75 **	-9.75 **	8.57	14.35 **
31.	$P_5 \times P_6$	10.74 **	11.90 **	16.41 **	13.96 **	44.71 **	25.73 **
32.	$P_5 \times P_7$	9.54 **	10.69 **	13.93 **	14.15 **	44.11 **	25.98 **
33.	$P_5 \times P_8$	0.00	-0.08	0.20	-4.78	0.58	-12.61 *
34.	$P_5 \times P_9$	0.08	0.00	0.00	-4.97 *	1.79	-11.57 *
35.	$P_5 \times P_{10}$	11.50 **	11.50 **	14.91 **	14.91 **	25.06 **	25.06 **
36.	$P_6 \times P_7$	10.02 **	11.17 **	16.60 **	16.83 **	43.02 **	25.03 **
37.	$P_6 \times P_8$	-1.84	-0.81	-1.76	-3.82	-2.41	-16.63 **
38.	$P_6 \times P_9$	-3.04	-2.02	-4.57	-6.58 **	-5.86	-18.57 **
39.	$P_6 \times P_{10}$	10.26 **	11.42 **	16.63 **	16.63 **	22.31 **	22.31 **
40.	$P_7 \times P_8$	-1.52	-0.49	-4.39	-4.21	-3.55	-15.68 **
41.	$P_7 \times P_9$	0.48	1.54	-4.01	-3.82	-3.19	-15.37 **
42.	$P_7 \times P_{10}$	11.06 **	12.23 **	17.56 **	17.78 **	22.24 **	22.24 **
43.	$P_8 \times P_9$	2.05	-11.26 **	-9.43 **	-30.21 **	-2.09	-15.30 **
44.	$P_8 \times P_{10}$	-11.98 **	-11.98 **	-24.86 **	-24.86 **	-14.39 **	-14.39 **
45.	$P_9 \times P_{10}$	-11.01 **	-11.01 **	-18.93 **	-18.93 **	-8.24	-8.24
No. of crosses with significant (+) heterosis		**10**	**10**	**9**	**9**	**13**	**20**
No. of crosses with significant (-) heterosis		**14**	**24**	**23**	**31**	**4**	**13**
Range of heterosis		**-11.98 to 11.50**	**-13.04 to 12.23**	**-24.86 to 17.56**	**-30.40 to 17.78**	**-26.77 to 44.71**	**-21.67 to 25.98**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 1: Contd…

S. No.	Hybrids	Shelling percentage		Number of pods/100 g		100 green seed weight	
		BP	SV	BP	SV	BP	SV
1.	$P_1 \times P_2$	-1.58	-6.51 **	9.31 **	11.48 **	-6.89 *	-11.65 **
2.	$P_1 \times P_3$	2.37	-5.26 **	10.18 **	12.36 **	-5.11	-9.96 **
3.	$P_1 \times P_4$	1.70	-6.27 **	11.88 **	14.10 **	-4.75	-9.61 **
4.	$P_1 \times P_5$	1.69	-0.67	-5.76	-5.86	-2.80	-2.68
5.	$P_1 \times P_6$	0.00	-2.90	-6.23	-5.82	-0.35	-1.93
6.	$P_1 \times P_7$	-2.25	-1.89	-4.08	-5.98	1.63	0.14
7.	$P_1 \times P_8$	1.72	-6.25 **	9.47 **	11.64 **	-4.91	-9.77 **
8.	$P_1 \times P_9$	2.37	-5.50 **	5.16	7.24 *	-5.51 *	-10.34 **
9.	$P_1 \times P_{10}$	-1.17	-1.17	-4.86	-4.86	-2.03	-2.03
10.	$P_2 \times P_3$	0.87	-4.19 *	2.54	29.17 **	-2.98	-14.78 **
11.	$P_2 \times P_4$	-2.24	-7.15 **	2.06	28.57 **	-1.71	-13.67 **
12.	$P_2 \times P_5$	-0.04	-2.36	20.76 **	20.64 **	-9.07 **	-8.96 **
13.	$P_2 \times P_6$	0.26	-2.64	19.73 **	20.26 **	-6.69 *	-8.18 **
14.	$P_2 \times P_7$	-2.59	-2.24	22.36 **	19.94 **	-7.21 **	-8.57 **
15.	$P_2 \times P_8$	0.64	-4.41 *	2.67	29.33 **	-2.36	-10.73 **

16.	$P_2 \times P_9$	2.24	-2.89	-1.05	24.66 **	-2.57	-12.39 **
17.	$P_2 \times P_{10}$	-2.95	-2.95	20.44 **	20.44 **	-9.67 **	-9.67 **
18.	$P_3 \times P_4$	0.75	-6.76 **	-0.16	25.77 **	-1.60	-15.63 **
19.	$P_3 \times P_5$	-2.81	-5.07 **	20.50 **	20.38 **	-10.70 **	-10.59 **
20.	$P_3 \times P_6$	-1.40	-4.25 *	19.95 **	20.48 **	-8.57 **	-10.02 **
21.	$P_3 \times P_7$	-4.46 **	-4.11 *	23.13 **	20.70 **	-8.04 **	-9.39 **
22.	$P_3 \times P_8$	3.44	-4.26 *	2.59	29.23 **	-3.47	-11.74 **
23.	$P_3 \times P_9$	2.81	-4.85 **	1.90	28.37 **	-0.60	-10.62 **
24.	$P_3 \times P_{10}$	-2.38	-2.38	20.62 **	20.62 **	-8.89 **	-8.89 **
25.	$P_4 \times P_5$	-1.77	-4.04 *	25.36 **	25.23 **	-10.47 **	-10.36 **
26.	$P_4 \times P_6$	0.26	-2.64	25.16 **	25.71 **	-7.15 **	-8.62 **
27.	$P_4 \times P_7$	-4.09 *	-3.74 *	27.85 **	25.31 **	-7.96 **	-9.31 **
28.	$P_4 \times P_8$	1.00	-7.28 **	0.80	30.77 **	-3.09	-11.40 **
29.	$P_4 \times P_9$	2.68	-5.21 **	1.92	29.65 **	-1.12	-11.08 **
30.	$P_4 \times P_{10}$	-3.28	-3.28	25.15 **	25.15 **	-10.25 **	-10.25 **
31.	$P_5 \times P_6$	10.35 **	7.79 **	-14.19 **	-13.82 **	14.61 **	14.74 **
32.	$P_5 \times P_7$	10.02 **	10.44 **	-13.81 **	-15.52 **	16.37 **	16.51 **
33.	$P_5 \times P_8$	6.10 **	3.64 *	2.43	4.46	-1.41	-1.29
34.	$P_5 \times P_9$	5.34 **	2.90	-0.53	1.44	-0.47	-0.36
35.	$P_5 \times P_{10}$	12.67 **	12.67 **	-14.02 **	-14.02 **	17.42 **	17.56 **
36.	$P_6 \times P_7$	12.25 **	12.68 **	-8.87 **	-10.68 **	17.54 **	15.81 **
37.	$P_6 \times P_8$	5.52 **	2.47	8.43 **	10.58 **	1.57	-0.05
38.	$P_6 \times P_9$	4.79 **	1.75	3.29	5.34	2.71	1.08
39.	$P_6 \times P_{10}$	12.74 **	12.74 **	-11.98 **	-11.98 **	17.25 **	17.25 **
40.	$P_7 \times P_8$	2.11	2.48	12.71 **	8.18 *	2.07	0.56
41.	$P_7 \times P_9$	2.04	2.42	13.08 **	8.54 **	-0.91	-2.36
42.	$P_7 \times P_{10}$	11.80 **	12.23 **	-6.04	-9.82 **	17.26 **	17.26 **
43.	$P_8 \times P_9$	-2.86	-10.33 **	-0.08	27.11 **	-1.97	-10.37 **
44.	$P_8 \times P_{10}$	-8.98 **	-8.98 **	23.70 **	23.70 **	-6.45 *	-6.45 *
45.	$P_9 \times P_{10}$	-7.77 **	-7.77 **	24.78 **	24.78 **	-9.99 **	-9.99 **
No. of crosses with significant (+) heterosis		**10**	**7**	**21**	**31**	**6**	**6**
No. of crosses with significant (-) heterosis		**4**	**21**	**5**	**6**	**16**	**29**
Range of heterosis		**-8.98 to 12.74**	**-10.33 to 12.74**	**-14.19 to 27.85**	**-15.52 to 30.77**	**-10.70 to 17.54**	**-15.63 to 17.56**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 1: Contd…

Sr. No.	Hybrids	Protein content		Total soluble solids		Reducing sugars	
		BP	**SV**	**BP**	**SV**	**BP**	**SV**
1.	$P_1 \times P_2$	-1.14	-9.92 **	-1.29	-9.46 **	3.28	-8.70
2.	$P_1 \times P_3$	-5.12 **	-13.54 **	-1.48	-13.48 **	-6.56	-17.39 **
3.	$P_1 \times P_4$	-4.31 **	-7.40 **	3.66	-9.57 **	3.28	-8.70
4.	$P_1 \times P_5$	-3.53 **	1.20	0.00	2.72	2.74	8.70
5.	$P_1 \times P_6$	-2.62 *	-7.89 **	1.62	3.90	-3.08	-8.70
6.	$P_1 \times P_7$	-3.88 **	-4.47 **	-2.36	-2.25	16.90 **	20.29 **
7.	$P_1 \times P_8$	-5.68 **	-14.06 **	5.01 *	-10.87 **	11.48 *	-1.45
8.	$P_1 \times P_9$	-5.02 **	-13.45 **	-3.89	-9.57 **	3.03	-1.45
9.	$P_1 \times P_{10}$	1.04	1.04	6.03 **	6.03 **	15.94 **	15.94 **
10.	$P_2 \times P_3$	-1.15	-14.82 **	-2.71	-10.76 **	15.09 *	-11.59 *
11.	$P_2 \times P_4$	-4.54 **	-7.63 **	-2.84	-10.87 **	12.50 *	-8.70
12.	$P_2 \times P_5$	-7.16 **	-2.60 **	-2.99	-0.35	-4.11	1.45
13.	$P_2 \times P_6$	-3.48 **	-8.70 **	1.04	3.31	-4.62	-10.14 *
14.	$P_2 \times P_7$	-5.80 **	-6.38 **	-3.31	-3.19	2.82	5.80
15.	$P_2 \times P_8$	-2.24 *	-15.76 **	-5.54 *	-13.36 **	5.00	-8.70
16.	$P_2 \times P_9$	-0.98	-13.72 **	-4.40	-10.05 **	-0.00	-4.35
17.	$P_2 \times P_{10}$	-2.56 **	-2.56 **	-5.91 **	-5.91 **	5.80	5.80
18.	$P_3 \times P_4$	-11.03 **	-13.91 **	0.27	-11.94 **	12.50 *	-8.70
19.	$P_3 \times P_5$	-16.21 **	-12.10 **	-2.07	0.59	-9.59 *	-4.35
20.	$P_3 \times P_6$	-8.88 **	-13.80 **	-3.47	-1.30	1.54	-4.35
21.	$P_3 \times P_7$	-8.19 **	-8.76 **	-6.02 **	-5.91 **	2.82	5.80
22.	$P_3 \times P_8$	-5.40 **	-19.26 **	4.58	-8.16 **	10.00	-4.35
23.	$P_3 \times P_9$	-4.23 **	-16.55 **	1.01	-4.96 *	6.06	1.45
24.	$P_3 \times P_{10}$	-7.15 **	-7.15 **	-2.84	-2.84	5.80	5.80
25.	$P_4 \times P_5$	-0.77	4.09 **	-2.42	0.24	10.96 *	17.39 **
26.	$P_4 \times P_6$	-1.12	-4.32 **	-3.35	-1.18	23.08 **	15.94 **
27.	$P_4 \times P_7$	0.95	0.33	-5.43 *	-5.32 *	12.68 **	15.94 **
28.	$P_4 \times P_8$	-1.14	-4.33 **	2.03	-10.99 **	23.33 **	7.25
29.	$P_4 \times P_9$	-2.92 **	-6.06 **	-3.39	-9.10 **	4.55	0.00
30.	$P_4 \times P_{10}$	1.01	1.01	-5.91 **	-5.91 **	20.29 **	20.29 **
31.	$P_5 \times P_6$	10.23 **	15.64 **	19.45 **	22.70 **	34.25 **	42.03 **
32.	$P_5 \times P_7$	8.13 **	13.44 **	17.61 **	20.80 **	42.47 **	50.72 **
33.	$P_5 \times P_8$	-1.06	3.79 **	-0.69	2.01	12.33 **	18.84 **
34.	$P_5 \times P_9$	-0.01	4.89 **	-0.46	2.25	2.74	8.70

35.	$P_5 \times P_{10}$	12.48 **	18.00 **	19.10 **	22.34 **	42.47 **	50.72 **
36.	$P_6 \times P_7$	10.65 **	9.96 **	19.54 **	22.22 **	39.44 **	43.48 **
37.	$P_6 \times P_8$	-0.75	-6.11 **	2.77	5.08 *	16.92 **	10.14 *
38.	$P_6 \times P_9$	-2.23 *	-7.51 **	8.32 **	10.76 **	15.15 **	10.14 *
39.	$P_6 \times P_{10}$	11.65 **	11.65 **	18.38 **	21.04 **	42.03 **	42.03 **
40.	$P_7 \times P_8$	1.53	0.90	-4.60 *	-4.49 *	12.68 **	15.94 **
41.	$P_7 \times P_9$	-0.12	-0.74	2.95	3.07	8.45	11.59 *
42.	$P_7 \times P_{10}$	14.52 **	14.52 **	20.66 **	20.80 **	43.66 **	47.83 **
43.	$P_8 \times P_9$	-1.57	-14.24 **	-8.29 **	-13.71 **	3.03	-1.45
44.	$P_8 \times P_{10}$	-5.25 **	-5.25 **	-7.09 **	-7.09 **	-4.35	-4.35
45.	$P_9 \times P_{10}$	-2.09 *	-2.09 *	-3.78	-3.78	-1.45	-1.45
No. of crosses with significant (+) heterosis		**6**	**9**	**9**	**9**	**21**	**17**
No. of crosses with significant (-) heterosis		**24**	**30**	**7**	**20**	**1**	**3**
Range of heterosis		**-16.21 to 14.52**	**-19.26 to 18.00**	**-8.29 to 20.66**	**-13.71 to 22.70**	**-9.59 to 43.66**	**-17.39 to 50.72**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

Table 1: Contd…

Sr. No.	Hybrids	Non reducing sugar		Total sugars		Green pod yield per plant	
		BP	SV	BP	SV	BP	SV
1.	$P_1 \times P_2$	-6.62 **	-13.21 **	-6.15 **	-13.06 **	-6.60	-19.27 **
2.	$P_1 \times P_3$	-4.82 *	-11.54 **	-4.83 *	-11.83 **	-5.71	-18.50 **
3.	$P_1 \times P_4$	-13.32 **	-19.44 **	-12.46 **	-18.90 **	1.54	-11.04 **
4.	$P_1 \times P_5$	8.20 **	6.23 **	7.91 **	6.28 **	30.00 **	19.25 **
5.	$P_1 \times P_6$	5.14 *	2.43	4.75 *	1.88	33.48 **	20.77 **
6.	$P_1 \times P_7$	4.88 *	-0.38	5.45 **	0.58	30.51 **	19.16 **
7.	$P_1 \times P_8$	-2.53	-9.42 **	-1.87	-9.09 **	-3.07	-16.21 **
8.	$P_1 \times P_9$	0.33	-6.76 **	0.93	-6.49 **	0.56	-13.08 **
9.	$P_1 \times P_{10}$	-1.29	-1.29	-0.51	-0.51	14.76 **	14.76 **
10.	$P_2 \times P_3$	2.73	-22.78 **	3.36	-22.22 **	-3.05	-16.62 **
11.	$P_2 \times P_4$	-5.05	-27.18 **	-4.04	-26.26 **	-1.07	-13.33 **
12.	$P_2 \times P_5$	-18.87 **	-20.35 **	-18.10 **	-19.34 **	14.01 **	4.58
13.	$P_2 \times P_6$	-17.77 **	-19.89 **	-17.14 **	-19.41 **	12.91 **	2.16
14.	$P_2 \times P_7$	-7.11 **	-11.77 **	-6.66 **	-10.97 **	13.83 **	3.93
15.	$P_2 \times P_8$	1.01	-24.07 **	1.92	-23.30 **	2.45	-14.56 **
16.	$P_2 \times P_9$	-5.15	-28.70 **	-3.74	-27.56 **	2.48	-14.54 **
17.	$P_2 \times P_{10}$	-18.30 **	-18.30 **	-17.17 **	-17.17 **	4.76	4.76
18.	$P_3 \times P_4$	1.58	-22.10 **	2.25	-21.43 **	10.98 **	-2.77
19.	$P_3 \times P_5$	-14.00 **	-15.57 **	-13.70 **	-15.01 **	13.60 **	4.20
20.	$P_3 \times P_6$	-12.55 **	-14.81 **	-12.09 **	-14.50 **	10.11 *	-0.37
21.	$P_3 \times P_7$	-11.83 **	-16.25 **	-11.04 **	-15.15 **	14.68 **	4.71
22.	$P_3 \times P_8$	2.03	-23.77 **	3.38	-22.80 **	-2.31	-15.98 **
23.	$P_3 \times P_9$	-1.02	-26.04 **	0.87	-24.68 **	2.32	-12.00 **
24.	$P_3 \times P_{10}$	-13.90 **	-13.90 **	-12.99 **	-12.99 **	5.21	5.21
25.	$P_4 \times P_5$	-12.61 **	-14.20 **	-11.36 **	-12.70 **	14.64 **	5.16
26.	$P_4 \times P_6$	-14.03 **	-16.25 **	-12.31 **	-14.72 **	14.44 **	3.54
27.	$P_4 \times P_7$	-9.43 **	-13.97 **	-8.40 **	-12.63 **	14.10 **	4.18
28.	$P_4 \times P_8$	-3.17	-25.74 **	-1.41	-24.24 **	-0.76	-13.05 **
29.	$P_4 \times P_9$	0.59	-22.85 **	1.88	-21.72 **	5.54	-7.53 *
30.	$P_4 \times P_{10}$	-14.05 **	-14.05 **	-12.41 **	-12.41 **	4.41	4.41
31.	$P_5 \times P_6$	30.70 **	28.32 **	30.99 **	29.00 **	41.06 **	29.37 **
32.	$P_5 \times P_7$	28.92 **	26.58 **	29.74 **	27.78 **	41.38 **	29.67 **
33.	$P_5 \times P_8$	-2.86	-4.63 *	-1.98	-3.46	13.99 **	4.56
34.	$P_5 \times P_9$	-2.86	-4.63 *	-2.49	-3.97 *	15.10 **	5.58
35.	$P_5 \times P_{10}$	29.92 **	29.92 **	30.95 **	30.95 **	30.94 **	30.94 **
36.	$P_6 \times P_7$	30.55 **	27.18 **	31.53 **	27.92 **	39.94 **	28.34 **
37.	$P_6 \times P_8$	-3.66	-6.15 **	-2.67	-5.34 **	17.51 **	6.32
38.	$P_6 \times P_9$	-1.87	-4.40 *	-0.96	-3.68	15.62 **	4.61
39.	$P_6 \times P_{10}$	26.58 **	26.58 **	27.27 **	27.27 **	34.57 **	34.57 **
40.	$P_7 \times P_8$	-1.52	-6.45 **	-0.91	-5.48 **	15.90 **	5.82
41.	$P_7 \times P_9$	-1.12	-6.07 **	-0.68	-5.27 **	10.41 **	0.81
42.	$P_7 \times P_{10}$	29.31 **	29.31 **	30.23 **	30.23 **	34.58 **	34.58 **
43.	$P_8 \times P_9$	4.41	-22.63 **	5.23 *	-21.57 **	5.67	-18.48 **
44.	$P_8 \times P_{10}$	-18.68 **	-18.68 **	-18.11 **	-18.11 **	-15.44 **	-15.44 **
45.	$P_9 \times P_{10}$	-16.78 **	-16.78 **	-16.02 **	-16.02 **	-12.90 **	-12.90 **
No. of crosses with significant (+) heterosis		**9**	**7**	**9**	**7**	**26**	**10**
No. of crosses with significant (-) heterosis		**17**	**33**	**17**	**33**	**2**	**16**
Range of heterosis		**-18.87 to 30.70**	**-28.70 to 29.92**	**-18.11 to 31.53**	**-27.56 to 30.95**	**-15.44 to 41.38**	**-19.27 to 34.58**

*, ** Significant at 5 per cent and 1 per cent probability levels, respectively.

CONCLUSION

On the basis of heterosis analysis, among the cross combinations $P_5 \times P_6$, $P_5 \times P_7$ and $P_6 \times P_7$ exhibited significant negative heterosis over better parent as well as standard variety for days to 50% flowering and days to first picking. Three hybrids depicted significant and desirable (positive) heterosis over standard variety (Azad Pea-3) for total fruit yield per plant *viz.*, $P_5 \times P_6$, $P_5 \times P_7$ and $P_6 \times P_{10}$. These hybrids also depicted significant and desirable (positive) heterosis over their respective better parent. The high heterotic response of these hybrids was resulted due to positive heterosis of yield attributing character number of pods per plant, number of seeds per pod and number of pods per 100 g. The heterotic effect for total fruit yield per plant can be considered as an outcome of the direct effect of these attributes and indirect effects of the other yield contributing characters *i.e.*, pod length, pod girth, shelling percentage and 100 green seed weight.

FUTURE SCOPE

Based on the above findings it may be suggested that crosses $P_5 \times P_6$, $P_5 \times P_7$ and $P_6 \times P_7$ can be exploited in future breeding programmes for earliness and crosses $P_7 \times P_{10}$, $P_6 \times P_{10}$, $P_6 \times P_7$ and $P_5 \times P_7$ may be exploited for high green pod yield. Parents P_5, P_6, P_7 and P_{10} could be utilized for earliness as well as high yield in future breeding plans. The preponderance of dominant gene action along with over dominance in the parents for most of the traits suggests that heterosis breeding followed by selection from segregating generations might be more rewarding in vegetable pea.

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