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Study of heterosis for yield and its related traits in Table pea (*Pisum sativum. spp. Hortense* L)

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Abstract

Present study was carried out with fifty five genotypes including ten parental lines and their forty five F1s of Table pea (*Pisum sativum. spp. Hortense* L). The per cent heterosis over mid-parent and superior parent was worked out for yield and yield related attributes. The crosses namely KS-501×E-6, KS-156×E-6, AP-3×E-6 and AP-1×E-6 over superior parent; AP-2×AP-3, AP-4×E-6, AP-2×E-6 and KS-149×AP-2 over mid parent were superior in terms of heterosis along with the mean performance of yield per plant indicating the potential of selected hybrids over existing homozygous parental lines, and exploitation of dispersion of alleles between the parents and mean directional dominance gene action in crop improvement.

Keywords: Heterosis, segregating population and Table pea

Introduction

Due to its high nutritive value, Table pea (Pisum sativum L.) is an important vegetable crop. It is a leading vegetable grown in India on a large scale. Exploitation of heterosis is a cheap and easy method for increasing yield in many crops. Cross combinations showing heterotic vigour can be utilized for developing high yielding pure lines of field pea. Therefore, in the present investigation analysis for heterosis was also done for yield and its components. In self-pollinated crops like pulses, the development of pure line varieties has been only the option. However, the extent of heterosis manifested works as an indicator for the successful development of improved cultivars. Therefore, the present investigation has been carried out for suggesting breeding strategy on the basis of above parameters.

Materials and methods

The present investigation was undertaken with ten parental lines namely AP-1, KS-156, KS-210, AP-4, KS-149, KS-205, KS-501, AP-2, AP-3 and E-6, which were crossed in half diallel fashion (excluding reciprocals) to develop forty five F1s hybrids. Each parental line was selected from different clusters of the core collection. Adaptability and stability of parents were also given due weightage in the selection procedure. These parental lines along with 45 F1s hybrids were evaluated in randomized block design with three replications in plot size of 1 m2 with standard row to row and plant to plant spacing during rabi 2010-2011 and 2011-2012 at Horticulture Research Centre of Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.). Observation were recorded on five randomly selected plants from each plot for thirteen characters namely plant height, length of first fruiting node, number of first fruiting node, number of branches per plant, length of pod, width of pod, number of seed per pod, seed per sheel ratio, number of pod per plant, protein content, dry matter, ash content, yield per plant while the data on days to flowering was recorded on the plot basis. Heterosis over mid parent and best parent were calculated and tested as per methods given by Singh and Singh (1994), and significance of heterosis was tested using t- test at 1% and 5% level of significance.

Results and discussion

The average per cent heterosis over mid parent and best parent for all studied traits has been presented in Table 1. Crosses namely KS-149×E-6, KS-205×E-6, AP-4×E-6, AP-1×AP-4, KS-156×E-6 and AP-2×E-6 express significant and desirable heterosis over both superior and mid parent for all the characters under study except days to flowering, length of first fruiting node, no. of first fruiting node and ash content. The 38 crosses for days to flowering**;** 42 crosses for length of first fruiting node; 37 crosses for no. of first fruiting node; 42 crosses for no. of branches per plant; 42 crosses for length of pod; 39 crosses for width of pod; 44 crosses for no. of seed per pod; 39 crosses for seed/shell ratio; 40 crosses for no. of pod per plant; 44 crosses for protein content; 34 crosses for dry matter; 44 crosses for ash content; 27 crosses for yield per plant were significantly superior to best parent i.e heterobeltiosis. The range of heterobeltiosis for days to flowering was -14.83 to 55.76 with two pronising crosses, KS-501×AP-2 and KS-156×AP-2; likewise plant height ranged from -20.87 to 80.89 with two promising crosses, AP-2×E-6 (80.89) and AP-2×AP-3 (52.45); length of first fruiting node ranged -28.4 to 60.22 with two promising crosses, KS-501×E-6 and AP-1 ×E-6; no. of first fruiting node ranged from -14.63 to 20.06 with two promising crosses, AP-2×E-6 and KS-149×E-6; no. of branches per plant ranged from -42.00 to 35.04 with two promising crosses, AP-3×E-6and KS-156×E-6; length of pod ranged from -13.77 to 15.78 with two promising crosses, KS-149×KS-501and AP-1 ×E-6; width of pod ranged from -11.33 to 14.52 with two promising crosses, KS-149×AP-2 and KS-149×KS-205; no. of seed per pod ranged from -25 to 44.23 with two promising crosses, KS-156×AP-2 and AP-4×AP-2; seed/shell ratio ranged from -16.93 to 16.14 with two promising crosses, AP-4×KS-149and AP-4×AP-2; no. of pod per plant ranged from -9.38 to 91.89 with two promising crosses, KS-501×E-6and AP-3×E-6; protein content ranged from -10.85 to 12.9 with two promising crosses, AP-1 ×KS-205 and KS-149×KS-205; dry matter ranged from -9.68 to 29.33 with two promising crosses, AP-1 ×AP-3 and AP-1 ×KS-205; ash content ranged from -18.64 to 22.64 with two promising crosses, AP-1 ×KS-205 and KS-156×AP-3; yield per plant ranged from -22.83 to 70.66 with two promising crosses, KS-501×E-6 and KS-156×E-6.

Twelve best crosses over best parent namely AP-1×AP-4, AP-1×KS-149, AP-1×AP-2, AP-1×AP-3, KS-210×AP-2, AP-4×KS-149, AP-4×AP-2, AP-4×E-6, KS-149×AP-2, KS-149×E-6, AP-2×AP-3, AP-2×E-6 might be competitive to commercial hybrid, therefore, can be directly utilized as hybrid after evaluating yield performance against the commercial check hybrid.

The 26 crosses for days to flowering; 28 crosses for plant height; 29 crosses for length of first fruiting node; 25 crosses for no. of first fruiting node; 42 crosses for no. of branches per plant; 36 crosses for length of pod; 34 crosses for width of pod; 36 crosses for no. of seed per pod; 22 crosses for seed/shell ratio; 30 crosses for no. of pod per plant; 38 crosses for protein content; 27 crosses for dry matter; 41 crosses for ash content; 9 crosses for yield per plant were significantly superior to mid parent. The range of heterosis over mid parent for days to flowering was -24.6 to 16.55 with two best crosses, AP-2×E-6 and KS-210×E-6; likewise plant height ranged from -28.71 to 12.28 with two promising crosses, KS-149×AP-3 and AP-1×AP-3; length of first fruiting node ranged -29.93 to 6.42 with two promising crosses, AP-1 ×KS-210 and AP-1 ×KS-501; no. of first fruiting node ranged from -14.43 to 2.68 with two promising crosses, KS-156×AP-4 and AP-1 ×KS-205; no. of branches per plant ranged from -22.04 to 14.01 with two promising crosses, AP-4×KS-149 and AP-4×AP-3; length of pod ranged from -13.77 to 15.78 with two promising crosses, KS-501×AP-3 and AP-1 ×KS-501; width of pod ranged from -5.34 to 3.65 with two promising crosses, KS-149×AP-2 and AP-2×AP-3; no. of seed per pod ranged from -11.27 to 4.9 with two promising crosses, KS-156×AP-2 and KS-205×AP-2; seed/shell ratio ranged from -7.83 to 11.93 with two promising crosses, AP-1 ×KS-149 and AP-4×KS-149; no. of pod per plant ranged from -29.67 to 11.62 with two promising crosses, KS-210×AP-2 and KS-149×KS-501; protein content ranged from -6.23 to 6.64 with two promising crosses, AP-1 ×KS-205 and KS-210×AP-3; dry matter ranged from -6.76 to 14.23 with two promising crosses, KS-149×AP-3 and AP-1 ×AP-3; ash content ranged from -14.97 to 11.06 with two promising crosses, AP-1 ×KS-205 and AP-4×AP-2; yield per plant ranged from -18.06 to 21.46 with two promising crosses AP-2×AP-3 and AP-4×E-6. Tyagi and Srivastava (1999) [1], Kumar and Tewatia (2005) [2], Ganesh *et al.* (2008) [3], Awasthi *et al.* (2009) [4], Singh *et al.* (2010) [5] and Patil *et al.* (2011) [6] also reported similar results in pea.

Heterosis breeding is suggested for the development of effective cultivars by suppressing the undesirable effect of recessive alleles of the same locus. Crosses with high heterotic potential and very low heterotic potential carrying the diverse genetic makeup may be crossed to generate variability for further selection of lines. It seems quite reasonable to look at heterobeltiosis and mid parent heterosis of crosses together across the environment and pooled over environments. Because relative heterosis is the result of the mean directional dominance; heterobeltiosis is due to dispersion of alleles between the parents that means isolation of superior true homozygous inbred line as hybrid is possible.

Table 1: Heterosis (%) over superior (S.P.) and mid parent (M.P.) for 14 characters in 10 parent diallel in Table Pea (average 2010-11 and 2011-12)

SN	Cross combination	Days to flowering		Plant height		Length of first fruiting node		No. of first fruiting node		No. of branches per plant		Length of pod		Width of pod	
		SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP	SP	MP
1	AP-1 ×KS-156	6.56**	-0.94	-1.73	0.28	4.16**	-5.11**	-1.60	-0.48	-8.21**	-0.78**	-0.53**	0.00	-1.53**	-1.53**
2	AP-1 ×KS-210	-7.02**	-3.19**	-5.88**	-1.26	-5.79**	6.42**	-5.99**	0.95	5.26**	-2.44**	2.25**	-0.55**	0.78**	0.00
3	AP-1 ×AP-4	-6.55**	-2.36**	7.29**	0.19	-3.33**	-1.56	-8.84**	-1.58**	10.66**	-9.40**	0.55**	-1.08**	0.79**	-1.17**
4	AP-1 ×KS-149	-3.27**	-0.44	0.22	-0.08	-3.51**	-1.57	-5.90**	1.13	-2.70**	-0.28**	-1.50**	1.55**	-11.33**	-5.34**
5	AP-1 ×KS-205	-4.88**	-1.73**	20.42**	0.68	-6.94**	-0.85	-3.28**	2.12**	-20.00**	-6.10**	10.43**	2.56**	1.57**	0.00
6	AP-1 ×KS-501	-0.51	0.66	-1.90	-0.36	-4.47**	5.96**	3.65**	-2.16**	-5.00**	1.06**	13.84**	2.74**	0.00	-0.38**
7	AP-1 ×AP-2	-10.58**	-1.56	-4.45**	5.32**	-11.03**	1.69**	-4.68**	-0.16	1.76**	0.00	6.75**	-0.85**	2.42**	-0.39**
8	AP-1 ×AP-3	13.76**	-5.80**	34.75**	10.15**	15.93**	2.18**	5.10**	1.19	-15.22**	-3.94**	-0.42**	0.16	-1.50**	-0.76**
9	AP-1 ×E-6	55.76**	16.55**	34.34**	-18.10**	53.50**	1.95**	9.71**	-4.33**	15.33**	0.96**	15.67**	1.43**	0.00	-0.38**
10	KS-156×KS-210	-12.13**	-2.35**	-3.77**	-1.01	-25.11**	-8.91**	-9.51**	-3.85**	13.16**	-4.18**	1.12	-2.17**	0.78**	0.00
11	KS-156×AP-4	-11.49**	-1.32	9.19**	-0.26	-12.54**	-3.17**	-3.90**	2.68**	13.11**	-16.11**	2.89**	0.68**	1.59**	-0.39**
12	KS-156×KS-149	-12.49**	-3.79**	2.93**	0.52	-5.43**	4.87**	-6.54**	-0.60	5.41**	-0.51**	-3.70**	-1.23**	-10.67**	-4.63**
13	KS-156×KS-205	-12.16**	-3.09**	31.31**	7.19**	-11.36**	2.25**	-6.20**	-2.02**	-16.00**	-8.10**	1.23**	-6.52**	0.79**	-0.78**
14	KS-156×KS-501	-8.76**	-1.28	0.84	0.36	-17.90**	-1.78**	0.46	-6.30**	0.00	-1.72**	5.30**	-5.51**	0.00	-0.38**
15	KS-156×AP-2	-13.63**	1.06	-2.81**	5.17**	-28.40**	-12.00**	-2.38**	1.15	14.71**	3.45**	8.34**	0.06	1.61**	-1.18**
16	KS-156×AP-3	8.45**	-2.70**	28.84**	2.78**	2.72**	-0.36	2.02**	-2.93**	-8.70**	-3.89**	-0.11	-0.05	-0.75**	0.00
17	KS-156×E-6	16.50**	-4.92**	48.73**	-11.88**	31.60**	-1.88**	9.82**	-5.45**	27.74**	1.74**	14.85**	0.12**	0.77**	0.38**
18	KS-210×AP-4	-0.62	-0.25	19.58**	5.84**	3.17**	-8.35**	-0.49	0.11	9.02**	-2.92**	-1.10**	0.00	1.59**	0.39**
19	KS-210×KS-149	1.42	0.21	7.97**	2.35**	5.19**	-6.37**	0.21	-0.11	-13.51**	-5.04**	-8.00**	-2.65**	-8.67**	-1.79**
20	KS-210×KS-205	0.36	-0.45	33.27**	5.11**	5.42**	-1.41	1.46	-0.36	-26.00**	-7.96**	4.91**	0.29**	0.79**	0.00
21	KS-210×KS-501	2.63**	-0.39	4.74**	1.24	1.12	-0.99	6.85**	-6.96**	-12.00**	0.00	2.20**	-4.99**	0.00	0.39**
22	KS-210×AP-2	-8.51**	-3.02**	-4.65**	0.45	-1.52	-0.19	3.19**	0.47	-5.88**	-0.62**	2.45**	-2.05**	3.23**	1.19**
23	KS-210×AP-3	19.07**	-6.12**	32.19**	1.83	19.80**	-9.51**	5.54**	-6.14**	-23.04**	-7.33**	-1.68**	1.58**	-2.26**	-0.76**
24	KS-210×E-6	7.40**	-23.66**	50.29**	-14.51**	26.50**	-29.93**	13.41**	-9.25**	5.11**	-0.35**	4.90**	-5.17**	-0.77**	-0.39**
25	AP-4×KS-149	0.78	-0.80	-4.50**	1.53	-0.24	-0.07	0.35	-0.14	-5.41**	14.01**	-2.00**	2.62**	-11.33**	-3.62**
26	AP-4×KS-205	-0.54	-1.71**	16.33**	4.83**	-5.94**	-1.50	1.82**	-0.61	-42.00**	-22.04**	7.36**	1.45**	0.00	0.40
27	AP-4×KS-501	3.25**	-0.17	-3.97**	1.71	-11.63**	-3.59**	9.59**	-5.21**	-28.00**	-10.56**	7.37**	-1.37**	-1.54**	0.00
28	AP-4×AP-2	-8.57**	-3.42**	-9.91**	5.17**	-15.25**	-4.65**	2.08**	-1.22	-11.76**	2.74**	6.75**	0.87**	1.61**	0.80**
29	AP-4×AP-3	7.82**	-15.38**	21.39**	7.09**	21.64**	5.01**	13.46**	0.23	-17.39**	7.95**	-0.63**	1.56**	-2.26**	0.39**
30	AP-4×E-6	10.84**	-21.59**	46.16**	-2.48**	42.75**	-7.50**	7.71**	-14.43**	-3.65**	1.93**	4.22**	-6.93**	-1.54**	0.00
31	KS-149×KS-205	-0.72	-0.33	25.52**	5.31**	-5.38**	-1.07	1.82**	-0.11	-16.00**	-3.45**	11.78**	0.39**	3.94**	-4.69**
32	KS-149×KS-501	3.16**	1.35	-9.48**	-7.79**	-5.21**	3.25**	14.16**	-0.71	0.00	3.90**	15.78**	0.96**	3.85**	-3.57**
33	KS-149×AP-2	-7.70**	-1.07	-5.98**	3.92**	-10.44**	0.60	1.34	-1.44**	5.88**	1.41**	11.66**	0.28**	14.52**	3.65**
34	KS-149×AP-3	23.30**	-1.38	36.88**	12.28**	17.22**	0.99	8.18**	-3.91**	-17.39**	-8.43**	2.52**	-0.05	3.01**	-3.18**
35	KS-149×E-6	9.65**	-20.85**	24.85**	-23.57**	35.57**	-12.35**	19.85**	-4.22**	20.44**	2.48**	13.08**	-4.27**	3.85**	-3.57**
36	KS-205×KS-501	2.88**	0.67	-20.87**	-6.70**	-5.39**	-1.23	5.02**	-6.69**	0.00	-11.11**	0.91**	-1.76**	-1.54**	-0.39**
37	KS-205×AP-2	-8.65**	-2.43**	-14.99**	7.27**	-8.42**	-1.25	0.22	-0.63	11.76**	-9.52**	0.00	0.00	0.81**	-0.40**
38	KS-205×AP-3	8.17**	-13.88**	1.49	-0.47	17.75**	-3.77**	3.78**	-5.86**	4.35**	0.00	-7.26**	-0.11	-2.26**	0.00
39	KS-205×E-6	9.65**	-21.25**	17.15**	-11.19**	45.10**	-11.87**	7.18**	-12.39**	27.74**	-9.56**	-1.50**	-3.81**	-1.54**	-0.39**
40	KS-501×AP-2	-14.83**	-7.22**	-7.07**	1.00	-2.94**	0.39	-14.63**	-5.81**	5.88**	-2.70**	-3.07**	-0.50**	2.42**	0.00
41	KS-501×AP-3	16.35**	-4.97**	35.91**	9.04**	30.62**	1.23	-2.64**	-0.81	-13.04**	-6.98**	-13.77**	4.87**	-0.75**	0.38**
42	KS-501×E-6	22.03**	-9.93**	19.53**	-28.71**	60.22**	-8.55**	5.60**	-2.06**	27.74**	3.86**	4.22**	1.53**	0.00	0.00
43	AP-2×AP-3	21.80**	-10.87**	52.45**	9.81**	30.20**	-3.31**	3.78**	-4.99**	-17.39**	-5.00**	-8.52**	-1.47**	-0.75**	2.72**
44	AP-2×E-6	14.79**	-24.60**	80.89**	-4.81**	50.14**	-18.45**	20.06**	-0.87	20.44**	7.49**	2.18**	-3.16**	-1.54**	0.79**
45	AP-3×E-6	7.72**	-1.18	9.90**	-14.68**	20.45**	-6.79**	6.65**	-3.07**	35.04**	0.82**	6.95*	-6.82**	0.77**	-0.38**
SE		1.00	0.85	1.28	1.07	1.02	0.87	0.91	0.77	0.13	0.10	0.17	0.14	0.07	0.07

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