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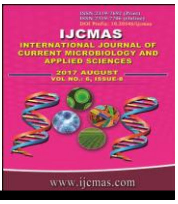

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Heterosis Study for Yield and Yield Components in Pea (*Pisum sativum* L.)

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ABSTRACT

Keywords

Heterosis, Heterobeltiosis, Seed yield, Yield components, Pea.

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Fifty five crosses derived from 11x11 dialel analysis excluding reciprocals were evaluated to know the magnitude of heterosis over better parent and standard check for seed yield and its components in pea. The manifestation of heterosis for seed yield was evidenced by superiority of hybrids ranging from 3.41 to 50.09% in the 34 crosses over better parent and 3.67 to 22.56% in 19 crosses over standard check variety. The highest significant heterosis for yield was observed in the crosses DDR-23 x HUDP-15 and Arkel x CAUP-1 over better parent and standard check respectively. It was concluded that three crosses, viz., E-6 X Arkel, Arkel x Pant P-25 and HUDP-15 were common in heterobeltiosis and standard heterosis for seed yield along with most of its yield components which have the immense potential to exploit hybrid vigour or to isolate desirable segregants.

Introduction

Pea (*Pisum sativum* L.) is a highly nutritive important rabi season legume containing high percentage of digestible protein along with carbohydrates and vitamins generally grown for vegetable purpose as well as seed purpose.

An improvement in yield of self-pollinated crops like pea is effected mainly through selection of genotypes with desirable characters from the variation through recombination followed by selection.

Exploitation of heterosis is a cheap and easy method for increasing yield in many crops as heterotic crosses may give transgressive segregants for economic traits in advanced generations. Since the legumes are strictly Self-pollinated and artificial hybridization is quite difficult, the commercial exploitation of heterosis in this species is yet limited. However, the information on this aspect in F_1s helps to identify the potential crosses for the development of varieties.

Sagar and Chandra (1977) also suggested that the manifestation of heterosis in legumes may be utilized for the selection of potential crosses in legumes for their genetic improvement. This is because of the high probability of having efficient segregants from better combinations than that from poor hybrids. Therefore in the present investigation analysis for heterosis was done for yield and yield components in pea.

Materials and Methods

Eleven genetically diverse lines of pea namely, E-6, Arkel, DDR-23, DMR-7, HUDP-15, Rachna, IPFD1-10, CAUP-1, T RCP-8, Pant P-25 and KPMR-728 were crossed by hand emasculation of female flowers in all possible combinations excluding reciprocals during rabi 2008.

An experiment comprising the parents and 55 F_1s were conducted in Randomized Block Design with three replications at the Research farm of Plant Breeding and Genetics, Central Agricultural University during rabi 2009.

All the 66 treatments were grown in single progeny row of 3m length with spacing of 45cm between rows and 20cm between plants.

All the recommended cultural practices were followed to raise the crop. The data were recorded on ten randomly selected plants on the traits viz. days to 50% flowering, days to first pod picking, primary branches per plant, number of pods per plant, pod length (cm), seeds per pod, seed yield per plant (g), 100 seed weight (g) and harvest index (%).

The mean values of each genotypes were statistically analysed to determine the significance of difference and heterosis was calculated as the increase or decrease over the better parent and standard check as suggested by Hayes *et al.*, (1995).

Results and Discussion

Results of present study revealed that there were significant differences between genotypes for all the characters. The best cross showing highest heterobeltiosis and standard heterosis for seed yield and related characters in pea is presented in table 1. Heterosis in desirable direction over better parent and standard check was observed in respect of all characters. For earliness, a negative heterosis for days to 50% flowering and days to first pod picking is desirable. The parents E-6 and Arkel and DDR-23 were early maturing and most of their F_1s also produced the significant negative heterosis for earliness.

Early flowering and days to first picking may be attributed to quicker establishment, their faster growth and development of hybrids. These findings are in close agreement with those of Mishra (1998), Shah and Muhammad (2005), Singh and Mir (2005) and Vinod and Lila (2013). The hybrid E-6 x Arkel which shows the highest significant heterobeltiosis and standard heterosis for earliness also exhibited the maximum significant positive heterosis for pod length and seeds per pod over better parent and standard check.

In the present study, the cross DDR-23 x TRCP-8 produced the top significant positive heterobeltiosis and standard heterosis for primary branches per plant. The cross DDR-23 x HUDP-15 and Arkel x CAUP-1 which shows highest significant heterobeltiosis and standard heterosis respectively for pods per plant an important yield contributing character also displayed the highest significant positive heterosis for seed yield per plant over better parent and standard check respectively.

For the character 100 seed weight the hybrid DRR-7 x Pant P-25 produced highest significant heterobeltiosis while the top standard heterosis was observed in the hybrid CAUP-1 x Pant P-25.

In case of harvest index, the cross Pant P-25 x KPMR-728 exhibited highest significant heterobeltiosis while the cross E-6 x Rachna evinced the highest positive standard heterosis.

Seed yield, the complex character decides the economic worth of the hybrids. In the present investigation manifestation of heterosis for seed yield was evidenced by the superiority of hybrids over better parent ranging from 3.41 (Rachna x CAUP-1) to 50.09 (DDR-23 x HUDP-15) per cent in 34 crosses (Table 2).

The highest positive and significant heterobeltiosis was observed in the cross DDR-23 x HUDP-15 followed by Arkel x Pant P- 25 and Arkel x KPMR-727. The majority of crosses showing heterosis for seed yield over better parent also exhibited significantly positive heterobeltiosis for pods per plant, seeds per pod and pod length. Borah (2009) also suggested that high heterotic response for seed yield per plant was mainly due to heterotic effects of seeds per pod and pods per plant. Out of the fifty five cross combinations nineteen crosses out yielded the standard check (Rachna) by 3.67 (Arkel x Pant P-25) to 22.56 (Arkel x Pant P-25) per cent which is presented in table 3. The highest significant standard heterosis was displayed by the cross Arkel x CAUP-1 followed by Arkel x KPMR-727 and HUDP-15 x KPMR-727.

High heterotic effects for yield per plant were also observed by earlier workers (Sudagar *et al.*, 1993, Sharma *et al.*, 1998; Akhilesh *et al.*, 2007). In case of standard heterosis, most of the crosses having significant heterosis for seed yield were found to register significantly positive heterosis for primary branches per plant, pod length and pods per plant

Table.1 Best crosses for several characters showing heterosis over better parent and standard check

Character	Over better parent		Over standard check	
	Cross	Heterosis (%)	Cross	Heterosis (%)
Days to 50% flowering	E-6 x Arkel	-22.43	E-6 x Arkel	-26.55
Days to first pod picking	E-6 x Arkel	-12.46	E-6 x Arkel	-18.56
No. of primary branches/plant	DDR-23 x TRCP-8	122.22	DDR-23 x TRCP-8	150.83
Pods per plant	DDR-23 x HUDP-15	75.05	Arkel x CAUP-1	49.09
Pod length (cm)	HUDP-15 x IPFD1-10	53.41	E-6 x Arkel	33.33
No. seed/ pod	E-6 x Arkel	34.21	E-6 x Arkel	33.54
Seed yield/ plant (g)	DDR-23 x HUDP-15	50.09	Arkel x CAUP-1	22.56
100 seed weight (g)	DMR-7 x Pant P-25	4.55	CAUP-1 x Pant P-25	7.16
Harvest index (%)	Pant P-25 x KPMR-727	9.70	E-6 x Rachna	6.99

Table.2 Relationship of positive heterobeltiosis for seed yield with heterotic effects for other characters

Cross	Seed yield/plant (g)	Days to 50% flowering	Days to first pod picking	No. of primary branches/plant	pods/plant	pod length (cm)	No. of seeds/pod	100 seed weight (g)	Harvest index (%)
E-6 x Arkel	26.38**	-22.43**	-12.46**	33.50**	0.17	17.14**	33.33**	-3.09**	11.15**
E-6 x DDR-23	10.58**	-5.38**	-2.58*	0.50	11.64**	5.50**	3.50**	-6.24**	0.21
E-6 x DMR-7	26.38**	-4.36**	-2.54*	-14.16**	35.27**	-5.40**	0.18	-7.78**	1.20
E-6 xRachna	12.56**	-2.20**	-5.14**	0.50	18.28**	5.50**	19.17**	-12.86**	6.99**
E-6 x IPFD1-10	42.18**	-1.73**	-2.33	16.50**	35.27**	0.17	11.17**	-15.14**	5.40*
E-6 x CAUP-1	6.83**	-10.76**	-7.81**	38.50**	4.30**	27.83**	21.27**	-2.79**	1.38
E-6 x TRCP-8	26.08**	-3.90**	-2.80*	0.54	33.33**	5.50**	0.17	0.48	12.40**
E-6 x KPMR-728	9.14**	-3.90**	-2.85*	0.40	5.37**	-0.17	-5.33**	-20.30**	2.36
Arkel x DMR-7	15.80**	-1.74	-2.26	-28.33**	11.17**	4.71**	0.17	-5.26**	4.72*
Arkel x HUDP-15	21.17**	3.21**	-0.86	66.67**	5.50**	17.14**	29.45**	-10.53**	6.31**
Arkel x IPFD1-10	31.60**	-2.17**	-5.56**	50.38**	16.67**	4.71**	5.99**	-24.23**	6.16**
Arkel x CAUP-1	14.06**	1.80**	-5.30**	0.55	30.37**	12.43**	29.20**	4.17**	-2.23
Arkel x TRCP-8	21.64**	-3.03**	-6.65**	96.78**	-0.17	4.71**	17.64**	-9.09**	10.07**
Arkel x Pant P-25	47.39**	-2.18**	-2.52	96.30**	61.17**	14.71**	16.78**	-12.71**	11.81**
Arkel x KPMR-728	45.57**	-2.25**	-2.52	0.50	31.60**	14.29**	23.46**	8.61**	14.58**
DDR-23 x HUDP-15	50.09**	0.90	0.28	94.17**	75.05**	1.340**	6.60**	-10.53**	12.19**
DDR-23 x TRCP-8	8.60**	-1.30	-4.20**	122.22**	27.83**	-6.19**	6.38**	-7.59**	9.30**
DDR-23 x Pant P-25	12.57**	0.43	-2.52	48.15**	18.76**	0.60	6.60**	-12.71**	-1.63
DDR-23 x KPMR-728	22.78**	-0.42	-1.93	0.50	36.96**	-16.67**	-18.76**	-13.04**	10.31**
DMR-7 x HUDP-15	36.97**	-0.86	-0.56	-14.16**	11.64**	5.50**	31.33**	-1.74**	11.30**
DMR x Rachna	11.11**	-0.86	-0.46	-42.93**	6.82**	16.83**	16.67**	-11.40**	5.89*
DMR x CAUP-1	3.41**	0.45	-0.28	-15.12**	-17.47**	16.67**	25.14**	-12.50**	2.13
DMR x Pant P-25	47.39**	-0.50	-0.50	-14.41**	46.91**	0.17	12.76**	15.79**	12.92**
DMR x KPMR-728	27.29**	-0.87	-2.49	-15.56**	31.60**	-0.18	6.38**	-7.26**	11.45**
HUDP-15 x CAUP-1	20.68**	-0.70	-2.23	0.56	-10.01**	-11.17**	-6.01**	-12.50**	-6.38**
HUDP-15 x Pant P-25	6.38**	0.43	-3.92**	48.15**	-12.38**	13.40**	21.41**	-5.26**	-3.38
HUDP-15 x KPMR-728	43.24**	0.78	-2.49	50.00**	37.12**	27.14**	25.14**	-8.26**	13.64**
Rachna x CAUP-1	3.41**	1.32**	-2.17	0.57	11.17**	16.83**	11.17**	-9.71**	1.32
Rachna x TRCP-8	12.56**	-1.30	-2.44	48.15**	-16.67**	-3.09**	-16.67**	4.29**	4.76*
Rachna x KPMR-728	12.67**	-0.70	-0.81	0.60	0.17	-4.76**	0.18	-1.41**	3.13
IPFD1-10 x TRCP-8	17.34**	-0.43	-3.61**	45.67**	12.76**	18.76**	12.76**	-4.55**	5.40*

Table.2 Contd.

IPFDI x Pant P-25	10.58**	0.87	-3.06*	46.87**	6.60**	20**	6.60**	-18.18**	-13.0**
IPFDI x KPMR-728	31.92**	-0.50	-3.87**	0.55	25.14**	-4.6**0	24.14**	-8.70**	7.96**
Pant P-25 x KPMR-728	36.42**	0.01	-1.93	0.65	18.76**	5.87**	18.76**	-1.43**	15.19**
S.E.	0.93	0.67	1.23	0.26	0.78	0.69	0.48	0.52	2.34

*, ** significant at p<0.05 and p, 0.01 levels, respectively

Table.3 Relationship of positive standard heterosis for seed yield with heterotic effects for other characters

Cross	Seed yield/plant (g)	Days to 50% flowering	Days to first pod picking	No. of primary branches/plant	pods/plant	pod length (cm)	No. of seeds/pod	100 seed weight (g)	Harvest index (%)
E-6 x Rachna	12.56**	-2.20**	-5.15**	66.67**	18.23**	15.09**	19.17**	-12.86**	6.99**
E-6 x CAUP-1	14.78**	-11.95**	-10.57**	130.83**	9.14**	39.45**	16.67**	-19.97**	5.12**
E-6 x TRCP-8	7.44**	-1.77**	-5.96**	67.50**	9.14**	15.09**	0.17	0.09	6.62**
Arkel x CAUP-1	22.56**	-1.80**	-8.13**	67.67**	36.43**	43.09**	22.17**	3.34**	1.37
Arkel x TRCP-8	3.75**	-3.03**	-8.13**	120.83**	-18.28**	33.27**	11.17**	-14.27**	4.41
Arkel x Pant P-25	3.67**	-0.44	-5.69**	123.33**	31.92**	46**	11.17**	-31.42**	4.41
Arkel x KPMR-728	18.56**	-0.88	-8.67**	67.50**	13.64**	45**	16.67**	7.07**	6.69
DDR-23 x CAUP-1	7.56**	-0.30	-5.96**	64.20**	22.78**	9.27**	-11**	-5.70**	5.03**
DMR-7 x Rachna	11.11**	0.45	-2.70*	8.67**	6.82**	27.45**	16.6**7	-11.40**	5.89**
DMR-7 x CAUP-1	11.11**	1.78	-0.25	66.67**	-13.64**	27.27**	11.27**	-9.99**	5.89**
DMR-7 x Pant P-25	3.83**	1.33	-0.80	66.67**	13.64**	9.27**	-11**	-5.70**	5.10**
DMR-7 x KPMR-728	3.83**	-0.87	-0.91	67**	13.56**	27.09**	-5.50**	-8.57**	2.96
HUDP-15 x KPMR-728	16.67**	3.10**	-2.61**	68**	18.42**	45.64**	11.28**	-9.56**	5.29
Rachna x CAUP-1	11.34**	1.32	-0.61	65**	11.87**	27.45**	11.30**	-7.11**	5.21**
Rachna x TRCP-8	12.56**	-1.30	-2.44	66**	18.28**	-3.09**	-16.67**	4.29**	-16.67**
Rachna x KPMR-728	12.67**	2.22	-0.81	67.5**	11.87**	9.09**	0.20	-1.41**	3.13
IPFD1-10 x KPMR-728	7.88**	1.78	1.30	64**	-18.14**	9.2**	11.17**	-9**	3.20
CAUP-1 x KPMR-728	7.56**	1.33	-0.34	67**	6.41**	9.01**	-16.67**	6.9**4	5.16**
Pant P-25 x KPMR-728	11.11**	-0.88	-8.67**	34**	0.13	21.12**	5.50**	-2.83**	6.23**
S.E.	1.02	0.83	1.52	0.45	0.86	0.78	0.51	0.67	2.34

*, ** significant at p<0.05 and p, 0.01 levels, respectively

A perusal of tables 1 and 2 reveals that seventeen crosses exhibited significant positive heterosis for seed yield over their better parent as well as standard check. These crosses were E-6 x Rachna, E-6 x CAUP-1, E-6 x TRCP-8, Arkel x CAUP-1, Arkel x TRCP-8, Arkel x Pant P-25, Arkel x KPMR-728, DMR-7 x Rachna, DMR-7 x CAUP-1, DMR-7 x Pant P-25, DMR-7 x KPMR-728, HUDP-15 x KPMR-728, Rachna x CAUP-1, Rachna x TRCP-8, Rachna x KPMR-728, IPFD1-10 x KPMR-728 and Pant P-25 x KPMR-728 While three crosses viz. E-6 x CAUP-1, Arkel x Pant P-25 and HUDP-15 x KPMR-728 were common in heterobeltiosis and standard heterosis for seed yield along with four of its components.

In conclusion, this study revealed that a single yield attribute with high heterosis is not sufficient to cause the quantum jump in the seed yield so that the plant breeders can give emphasis on yield contributing characters for the improvement of seed yield in pea. It was concluded that three crosses, viz,, E-6 X Arkel, Arkel x Pant P-25 and HUDP-15 x KPMR-728 were common in heterobeltiosis and standard heterosis for seed yield along with most of its yield components which could be exploited to get superior segregants.

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