Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 21(3) September-December 2023]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology, Pantnagar

PANTNAGAR JOURNAL OF RESEARCH

Vol. 21(3) September-December 2023

CONTENTS

To assessment about the combining ability and heterosis studies in pea [*Pisum sativum* L. var. *hortense*]

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ABSTRACT: Pea is one of the most important pulse crops. It is a self-pollinated crop with chromosome number 2n = 2x=14. The primary centre of origin is Mediterranean region. It is used as fresh and processed frozen vegetables in India and abroad. To improve the yield levels in this crop, studies on combining ability and heterosis are a method to select suitable parents based on their general and specific combing ability and heterotic effects for use in further breeding programmes. During the present investigation crosses were made in line x tester mating fashion during 2018-2019 and the data was investigated in 2019-20 at Vegetable Research Farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, for obtaining 30 crosses. 30 hybrids and their parents (10 lines and 3 testers), were grown. The general combining ability was significant for all characters in line x tester analysis; the genotypes KS-701 and KS-283 showed highest GCA effect among all genotypes along with highest mean performance respectively indicated these genotypes were good general combiners for green pod yield. Such lines can be utilized as suitable parents for hybridization programme. The cross combinations KS-802 x PSM-3 and C-18-1 x AP-3 showed high SCA effect for green pod yield per plant so it can be utilized for heterosis breeding.

Key words: Garden pea, general combining ability, heterosis Line x tester, specific combining ability

Garden pea (*Pisum sativum* L. var. *hortense*) also known as sweet pea belongs to the family Fabaceae is important cool season vegetable crop grown for its fresh shelled green seeds rich in protein (7.2 %), vitamins and minerals. The green seeds are used as vegetable or can be used after processing (canning, freezing and dehydration). India ranks second next to China both in terms of area and production.

The success in genetic improvement depends upon nature, magnitude and interrelationship of heritable and non-heritable component of variation of economic characters. General combining ability is primarily function of additive gene action and additive×additive interaction while specific combining ability is primarily due to non-additive genetic variance and non-allelic interactions. The estimate of combining ability effect and their relative magnitude of genetic variance guide selecting the best parents for hybridization. Heterosis is the Superiority of F_1 hybrid over both of its parents in terms of yield or some other characters which could be exploited for develop to hybrids.

MATERIALS AND METHODS

The field experiments were developed during *Rabi season* 2018-2019. The experimental material comprised 13 diverse genotypes (10 lines and 3 testers) of garden pea C-18-1, C-18-2, C-18-3, KS-283, KS-701, KS-702, KS-801, KS-802, KS-601 and KS-285 and tester AP-3, AP-1, and PSM-3 obtained from vegetable research farm of Chandra Shekhar Azad University of Agriculture and Technology, Kanpur. A set of 30 crosses (10 line and 3 testers) were made during *Rabi* 2019-20. The 30 crosses along with their 10 parents were grown in randomized block design with 3 replications during *Rabi* 2019-2020. Experimental data were recorded on five competitive plants in each replication for the traits under study which were randomly selected from each plot. Data were recorded for Days to 50 per cent flowering, Plant height (cm), Pod length (cm), Pod width (cm), First fruiting node, Number of branches per plant, Inter-nodal length, Number of seeds per pod, Number of pods per plant, Green pod yield per plant (g) and Shelling percentage (%).

The recorded data were analysed using the method given by Panse and Sukhatme (1984). Combining ability analysis was carried out following the method suggested by Kempthorne (1957).

RESULTS AND DISCUSSION

Analysis of variance

The analysis of variance for all the 11 characters was carried out for testing the significance among the treatments presented in (Table 1) Highly significant differences for all the characters were observed among lines and testers. Highly significant variances were noted for lines vs. testers for all the characters except days to 50% flowering, number of branches per plant and first fruiting node. The hybrid vs. parent's significant differences for all the character except green pod yield per plant (g). It reflected significant variability in the experimented material. It was also found by Mehta *et al.* (2005), Sharma and Kalia (2002) and Kumar *et al.* (2010)

Combining ability analysis

Combining ability refers to the capacity or ability of a genotype to transmit superior performance to its crosses. Data presented in (Table 2) show the gaining general combining ability has been equated with additive gene action and specific combining ability with non-additive gene action. The analysis of variance for combining ability revealed highly significant for all characters. Gupta and Singh (2005) & Kumar *et al.* (2020) also observed the similar results. Specific combining ability variance was found significant for all the characters, and same result was also found by Kumar *et al.* (2020). Line×tester analysis of 30 crosses obtained by crossing 10 lines with 3 testers was carried out and the total variance due to crosses was partitioned into females (lines), males (testers) and interaction females vs. males (lines vs. testers) and error source.

General combining ability (GCA) effect

The GCA effect of the parents presented in (Table 3) is a measure of additive gene action. GCA effect include both additive and additive x additive type of gene action which represents fixable genetic variance and additive parental effect as measured by GCA effect are of practical importance and value, which cannot be manipulated. Based on comparison of GCA effect with mean performance, good general combiners were KS-701 and KS-283 for green pod yield per plant; KS-601 and AP-3 days to 50 percentage flowering, C-18-3 and C-18-1for plant height, KS-801 for number of first fruiting node,KS-

Table 1: Analysis of Variance for parents and F_1 for 11 yield characters derived from in 10 Line x 3 Tester cross in pea

Characters	DF	DF 50%	PH	PL	PW	NBP	FFN	IL	NSP	NPP	SP	GYP
Replication	2	0.98	22.35	0.33	0.008	0.02	0.13	0.02	0.00	0.19	1.78	3.59
Genotype	42	70.81**	1226.09**	3.94**	0.037**	0.65**	7.69**	7.02**	6.42**	65.58**	56.96**	1023.73**
Parents	12	93.39**	344.15**	4.68**	0.059**	0.68**	3.17**	1.09**	4.78**	38.87**	39.03**	1404.70**
Females (lines)	9	80.09**	376.33**	1.81**	0.063**	0.77**	2.63**	0.85**	1.72**	10.07**	47.89**	1680.71**
Males (tester)	2	197.33**	101.53**	16.90**	0.060**	0.58**	7.00**	1.37**	20.80**	58.23**	6.78**	57.93**
Line vs. Tester	1	5.20	539.72**	6.13**	0.023**	0.08	0.38	2.69**	0.30**	259.38**	23.84**	1614.18**
Cross vs. Parent	1	149.55**	447.01**	3.83**	0.030**	0.88**	24.39**	40.82**	4.60**	267.50**	41.73**	3.85
Error	84	2.10	6.70	0.33	0.001	0.01	0.08	0.04	0.05	2.04	3.66	11.29

*Significant at 5%; **Significant at 1%

Table 2: Analysis of variance for combining ability for different 11 characters in pea

Characters	DF	DF 50%	PH	PL	PW	NBP	FFN	IL	NSP	NPP	SP	GYP
Replication	2	0.84	18.12	0.15	0.006	0.01	0.07	0.03	0.01	0.13	1.63	2.35
Crosses	29	58.75**	1617.90**	3.64**	0.028**	0.64**	8.98**	8.30**	7.16**	69.67**	64.90**	901.26**
Females (lines)	9	51.15**	2124.43**	3.30**	0.026**	0.70**	6.37**	10.78**	3.47**	101.42**	93.63**	2377.86**
Males (tester)	2	260.01**	1973.39**	27.12**	0.082**	0.33**	16.67**	13.92**	34.74**	95.09**	8.13	193.51**
Line vs Tester	18	40.18**	1325.13**	1.20	0.024**	0.64**	9.44**	6.44**	5.94**	50.98**	56.85**	241.60**
Error	58	2.28	7.30	0.33	0.001	0.01	0.08	0.04	0.05	2.43	3.30	8.11

*Significant at 5%;**Significant at 1%

Table 3: Estimates of general combining ability (GCA) effect of line (female) and testers (male) for different 11 parents in pea

S.N.	Parents	DF 50%	PH	PL	PW	NBP	FFN	IL	NSP	NPP	SP	GYP
						Line						
1	C-18-1	0.32	-12.18**	-0.30	-0.03**	0.05	-0.77**	-0.44**	-0.25**	-2.48**	2.26**	-24.72**
2	C-18-2	0.43	-11.23**	0.11	-0.03**	0.26**	-0.58**	-0.54**	-0.51**	-1.89**	3.03**	-16.27**
3	C-18-3	-0.68	-14.49**	0.11	-0.11**	-0.02	0.77**	-0.06	-1.15**	-1.87**	1.26*	-21.31**
4	KS-283	-0.34	1.21	0.88**	-0.02	-0.09*	1.40**	-0.46**	0.74**	-1.59**	6.26**	13.86**
5	KS-701	-2.23**	-5.72**	0.07	0.01	-0.01	0.04	0.08	-0.07	0.18	0.48	19.74**
6	KS-702	3.77**	22.44**	-0.53**	0.01	0.14**	-0.45**	1.72**	0.18*	7.31**	-3.97**	12.29**
7	KS-801	2.88**	32.15**	-1.26**	0.06**	-0.05	-1.46**	2.07**	-0.50**	4.81**	-1.63**	12.66**
8	KS-802	1.77**	-0.61	-0.08	0.01	0.52**	0.12	-0.21**	0.20**	-1.76**	-2.74**	-7.78**
9	KS-601	-4.01**	-6.68**	0.64**	0.09**	-0.45**	0.71**	-1.57**	0.73**	-2.43**	-2.08**	9.47**
10	KS-285	-1.90**	-4.89**	0.33	0.03*	-0.35**	0.21*	-0.59**	0.64**	-0.29	-2.86**	2.06*
						Tester						
11	AP-3	-3.31**	-1.99**	0.84**	-0.01	-0.09**	-0.08	-0.14**	1.07**	-1.83**	0.60	-2.89**
12	AP-1	0.99**	8.92**	0.20	0.06**	-0.02	0.78**	0.74**	0.01	1.73**	-0.33	1.00
13	PSM-3	2.32**	-6.93**	-1.03**	-0.05**	0.11**	-0.70**	-0.60**	-1.08**	0.10	-0.27	1.89**
	SE (sij)	0.504	0.901	0.191	0.012	0.035	0.095	0.068	0.071	0.519	0.606	0.949
	SE (sij-sij)	0.276	0.493	0.104	0.007	0.019	0.052	0.037	0.039	0.284	0.332	0.520

*Significant at 5%; **Significant at 1%

601 and PSM-3 for inter- nodal length, AP-3 for number of seed per pod, KS-283 for pod length, KS-283 for shelling percentage Its supported by Kumar *et al.* (2020), Gupta and Singh(2005). Further, the varieties showing good general combining ability for particular component may be used in breeding improvement for particular component thereby affecting improvement in yield. Varieties KS-701 and KS-283 show good general combining ability for yield and appear to be worthy of exploitation in practical plant breeding. It is suggested that segregating population involving these lines may be developed through multiple crossing for isolating high yielding varieties. It is observed by Gupta and Singh (2005) and Kumar *et al*. (2020).

Specific combining ability (SCA) effect

Specific combining ability effects of the parents presented in (Table 4), representing non-additive component of genetic variance would contribute much for improvement of crops. Specific combining ability represents the dominance and epistasis component of variance, which is non-fixable hence; its exploitation in the case of commercial exploitation of heterosis is only feasible. Based on significant SCA effects the good cross combination namely KS-802 x PSM-3, C-18-1 x AP-3 for green pod yield per plant, KS-601 x AP-3, KS-701 x AP-3 for days to 50 percentage flowering while KS-801 x PSM-3, KS-702 x PSM-3 were good cross combination for plant height. The good cross combination for inter-nodal length were KS-702 x PSM-3 and KS-283 x AP-1, KS-701 x AP-1 and KS-702 x AP-1 for number of first fruiting node, while KS-601 x AP-1 and KS-283 x AP-3 for number of seed per pod. The good cross combination for pod length were KS-702 x AP-3 and KS-285 x PSM-3, KS-802 x AP-1 and C-18-1 x AP-1 for pod width while KS-701 x PSM-3 and C-18-1 x AP-1 for shelling percentage. The good cross combination for pod yield per plant is KS-802 x PSM-3, C-18-1 x AP-3 for green pod yield per plant, and may be used for selection of transgressive segregants. It is supported by Katoch *et al.* (2019) and Kumar *et al.* (2017).

Estimation of heterosis effect of parents

The effects of the parents presented in (Table 5a and Table 5b), heterosis for an increase or decrease in performance of F_1 to their parents. Heterosis, measured in per cent as the superiority over the better or superior parent is thus an important parameter in such studies. The most important step in the exploitation of heterosis is to know its magnitude and direction. In the present investigation heterosis

Table 4: Estimates of Specific Combining ability (SCA) effect of promising crosses along with GCA status of their Parents of different traits in pea

S.N.	Hybrids	DFF	PH	PL	PW	NBP	FFN	IL	**NSP**	**NPP**	**SP**	**GYP**
1	C-18-1×AP-3	2.64**	0.34	-0.21	-0.04	-0.08	1.28**	0.10	-1.65**	1.03	-0.49	12.60**
2	C-18-1×AP-1	-0.32	-7.46**	0.35	0.13**	-0.34**	-0.52**	-0.81**	1.07**	-2.63**	6.78**	-5.59**
3	C-18-1×PSM-3	-2.32**	7.12**	-0.14	-0.09**	0.42**	-0.76**	0.71**	0.57**	1.60	-6.29**	-7.00**
4	C-18-2×AP-3	2.87**	6.83**	0.14	-0.05 *	-0.55**	-0.58**	0.73**	0.24	2.18 *	1.07	8.14**
5	C-18-2×AP-1	-1.10	-15.41**	-0.30	0.03	0.34**	1.87**	-0.73**	0.34**	-2.01 *	1.33	6.48**
6	C-18-2×PSM-3	-1.77 *	8.58**	0.16	0.02	0.21**	-1.30**	0.00	-0.58**	-0.17	-2.40 *	-14.62**
7	C-18-3×AP-3	0.31	2.76	0.19	-0.04	0.69**	0.12	-0.09	-1.42**	0.87	6.51**	-3.82 *
8	C-18-3×AP-1	1.01	-9.59**	0.18	0.02	-0.29**	0.15	-0.28 *	0.67**	-1.34	-3.22**	-7.81**
9	C-18-3×PSM-3	-1.32	6.84**	-0.37	0.02	-0.40**	-0.26	0.37**	0.75**	0.47	-3.29**	11.63**
10	KS-283×AP-3	1.31	-12.17**	0.04	-0.01	-0.24**	0.34 *	-0.03	1.68**	1.83 *	3.51**	-2.95
11	KS-283×AP-1	0.01	-14.30**	0.56	-0.02	-0.31**	1.59**	-1.92**	-0.23	-2.25 *	-2.56 *	2.47
12	KS-283×PSM-3	-1.32	26.47**	-0.61	0.03	0.55**	-1.93**	1.94**	-1.45**	0.41	-0.96	0.48
13	KS-701×AP-3	-5.47**	10.76**	-0.73 *	0.04 *	0.69**	-0.85**	0.24 *	0.49**	3.51**	-2.04	-1.32
14	KS-701×AP-1	-2.43**	-6.47**	0.82 *	-0.04	-0.27**	-2.23**	0.04	-0.13	-3.08**	-5.11**	3.41 *
15	KS-701×PSM-3	7.90**	-4.29**	-0.09	-0.01	-0.41**	3.09**	-0.28 *	-0.36**	-0.42	7.16**	-2.09
16	KS-702×AP-3	0.53	-13.28**	0.97**	0.11**	-0.45**	-0.01	-0.09	0.59**	-6.17**	-1.60	-3.25
17	KS-702×AP-1	-1.77 *	37.37**	-0.86 *	-0.11**	0.02	-2.22**	2.78**	-1.97**	7.88**	0.67	3.20
18	KS-702×PSM-3	1.23	-24.09**	-0.11	0.00	0.44**	2.23**	-2.69**	1.39**	-1.71	0.93	0.05
19	KS-801×AP-3	1.09	-12.84**	0.17	0.00	-0.28**	1.59**	-1.44**	0.60**	-4.99**	-4.60**	0.83
20	KS-801×AP-1	-1.54	44.33**	-0.61	0.00	0.65**	-1.55**	2.68**	-1.70**	9.31**	1.00	0.50
21	KS-801×PSM-3	0.46	-31.49**	0.44	0.00	-0.37**	-0.03	-1.24**	1.10**	-4.33**	3.60**	-1.32
22	KS-802×AP-3	3.87**	18.09**	0.54	-0.09**	0.18**	-0.97**	0.06	0.25 *	-0.20	-1.16	-18.06**
23	KS-802×AP-1	0.23	-11.36**	-0.63	0.17**	0.08	-0.41 *	-0.33**	-0.96**	-1.73	-0.22	3.22
24	KS-802×PSM-3	-4.10**	-6.73**	0.10	-0.07**	-0.26**	1.38**	0.27 *	0.71**	1.93 *	1.38	14.84**
25	KS-601×AP-3	-6.36**	-3.26 *	-0.33	0.03	0.03	-0.59**	0.42**	0.38**	0.93	-4.16**	5.44**
26	KS-601×AP-1	5.34**	-8.35**	0.57	-0.02	0.06	1.55**	-0.30 *	1.75**	-2.09 *	2.44 *	-2.31
27	KS-601×PSM-3	1.01	11.61**	-0.24	-0.01	-0.08	-0.96**	-0.12	-2.13**	1.16	1.71	-3.13
28	KS-285×AP-3	-0.80	2.76	-0.77 *	0.04 *	0.02	-0.32	0.09	-1.15**	1.01	2.96**	2.40
29	KS-285×AP-1	0.57	-8.75**	-0.07	-0.15**	0.06	1.78**	-1.14**	1.16**	-2.06 *	-1.11	-3.57 *
30	KS-285×PSM-3	0.23	5.99**	0.85 *	0.11**	-0.08	-1.46**	1.05**	0.00	1.05	-1.84	1.17
	SE (sij)	0.872	1.560	0.330	0.021	0.061	0.164	0.118	0.124	0.899	1.049	1.644
	SE (sij-sij)	1.233	2.206	0.467	0.029	0.086	0.232	0.166	0.175	1.272	1.483	2.325

*Significant at 5%; **Significant at 1%

DFF= Days to 50 per cent flowering, PH= Plant height (cm), PL= Pod length (cm), PW= Pod width (cm), FFN= First fruiting node, NBP= Number of branches per plant, INL= Inter-nodal length, NSP= Number of seeds per pod, NPP= Number of pods per plant, SP=Shelling percentage (%) and GYP= Green pod yield per plant (g)

over economic and mid parent have been worked out. It is evident from the result that cross combination showed significant and negative heterosis over economic parent in desirable direction and was observed in KS-701 x AP-1, KS-283 x AP-1 and KS-702 x AP-1 for green pod yield per plant,C-18-2 x AP-1, KS-701 x PSM-3 and C-18-3 x AP-1 for crosses KS-702 x AP-1 , KS-801 x AP-1 and KS-702 x PSM-3 showed significant and positive heterosis for number of pod per plant; crosses KS-283 x AP-3, KS-601 x AP-1 and KS-601 x AP-3 showed positive and desirable heterosis over economic parent for pod width, number of seed per pod, shelling percentage and pod yield per plant showed undesirable negative significant. It's supported by Kumar *et al*. (2016) and Singh and Dhall (2018).

CONCLUSION

In present investigation the general combining ability was significant for all characters in line and tester KS-283 indicated that the genotypes KS-701 and KS-283 showed highest GCA effect among all genotypes along with highest mean performance respectively indicated these genotypes were good

Table 5a: Heterosis (%) over Economic parent (EP) and mid parent (MP) for 11 characters in10 Line x 3 Tester cross in pea

S.No	Hybrids	Days to 50% flowering		Plant height (cm)		Pod length (cm)		Pod width (cm)		Number of branches per plant	
		MP	EP	MP	EP	MP	EP	MP	EP	MP	EP
1	C-18-1×AP-3	8.21**	33.02**	-2.61	-3.82	-4.07	-7.65	-8.40**	-1.70	-14.22**	7.61
2	C-18-1×AP-1	-3.25	36.71**	-2.36	0.31	-4.67	-8.61	3.45	14.56**	-35.01**	-4.14
3	C-18-1×PSM-3	-5.77**	34.86**	3.80	-1.38	-1.38	-26.78**	-22.56**	-9.09**	0.41	50.90**
4	C-18-2×AP-3	13.62**	33.96**	6.08 *	6.07*	-1.10	0.32	-1.87	-3.18	-1.45	-9.09
5	C-18-2×AP-1	-1.01	34.86**	-12.45**	-8.99**	-12.07**	-11.05	5.17**	7.91**	31.77**	50.90**
6	C-18-2×PSM-3	-1.00	36.71**	5.80 *	1.82	1.65	-19.23**	-8.93**	-0.96	28.65**	50.90**
7	C-18-3×AP-3	9.31**	23.85**	-0.81	-3.68	0.02	0.96	-2.84	-7.61**	61.41**	50.90**
8	C-18-3×AP-1	4.53 *	37.62**	-6.60**	-5.59*	-6.57	-6.06	1.99	1.26	-18.11**	-5.38
9	C-18-3×PSM-3	1.03	34.86**	1.95	-4.82	-4.85	-24.87**	-11.42**	-6.13**	-18.99**	-4.14
10	KS-283×AP-3	7.34**	27.51**	-7.99**	-2.64	5.99	7.55	1.74	1.26	-30.15**	-10.95
11	KS-283×AP-1	-1.00	35.77**	-0.70	9.01**	5.10	6.27	1.44	4.21*	-40.45**	-10.95
12	KS-283×PSM-3	-2.31	35.77**	39.22**	42.09**	1.65	-19.23**	-8.31**	0.52	-0.95	50.90**
13	KS-701×AP-3	-5.04	3.68	10.52**	18.60**	-9.64 *	-9.35	5.35**	6.43**	21.29**	50.90**
14	KS-701×AP-1	-2.88	23.85**	-0.97	10.20**	0.35	0.32	0.47	5.69*	-34.55**	-4.14
15	KS-701×PSM-3	20.57**	55.97**	-11.11**	-7.95*	-0.84	-22.32**	-10.38**	-0.22	-35.77**	-4.14
16	KS-702×AP-3	16.41**	36.71**	19.98**	24.06**	6.47	2.34	8.61**	11.60**	-8.21	-10.33
17	KS-702×AP-1	4.73 *	42.21**	91.66**	105.79**	-20.50**	-23.80**	-6.47**	-0.22	2.92	23.69**
18	KS-702×PSM-3	12.00**	54.13**	3.51	3.15	-4.16	-28.91**	-11.09**	0.52	28.46**	57.70**
19	KS-801×AP-3	18.40**	35.77**	15.35**	37.55**	-5.24	-13.92	3.82 *	7.17**	-29.76**	-10.95
20	KS-801×AP-1	5.52 *	40.37**	84.99**	127.92**	-21.59**	-29.01**	4.84 *	12.34**	1.39	50.90**
21	KS-801×PSM-3	10.88**	49.53**	-8.03**	6.21*	0.36	-30.92**	-8.24**	4.21*	-36.78**	-4.14
22	KS-802×AP-3	23.89**	40.37**	14.72**	35.12**	3.56	2.55	-2.71	-2.44	21.94**	52.75**
23	KS-802×AP-1	8.01**	42.21**	-9.25**	10.49**	-15.56**	-16.68*	16.63**	21.21**	2.31	50.90**
24	KS-802×PSM-3	0.34	33.96**	-16.17**	-4.41	1.29	-22.00**	-13.39**	-4.66*	-7.82 *	38.53**
25	KS-601×AP-3	-0.47	-3.67	-7.40**	-1.29	2.46	0.96	-2.79	11.60**	-12.32 *	-17.13**
26	KS-601×AP-1	21.91**	40.37**	-3.75	6.43*	5.72	3.83	-4.78**	13.08**	-23.61**	-10.95
27	KS-601×PSM-3	12.94**	32.11**	8.78**	11.90**	7.22	-17.96*	-15.75**	5.69*	-25.39**	-10.95
28	KS-285×AP-3	1.19	17.44**	5.58 *	9.09**	2.92	-7.01	5.14**	8.65**	-22.65**	-10.95
29	KS-285×AP-1	-1.02	33.02**	0.91	8.27**	3.99	-6.38	-7.73**	-1.70	-30.13**	-4.14
30	KS-285×PSM-3	-0.34	35.77**	7.26**	6.80*	32.12**	-9.67	-2.71	10.13**	-31.52**	-4.14
	SE	1.024		1.830		0.408		0.027	1.182	0.073	

*Significant at 5%; **Significant at 1%

Table 5b: Heterosis (%) over Economic parents (EP) and mid parents (MP) for 11 characters in 10 Line x Testers cross in pea.

S. No	Hybrids	First fruiting node		Inter node length (cm)		Number of seeds per pod		Number of pods per plant		Shelling percentage		Green pod yield / plant (g)	
		MP	EP	MP	EP	MP	EP	MP	EP	MP	EP	MP	EP
1	C-18-1×AP-3	3.25	10.82**	15.09**	22.37**	-26.02**	-29.96**	4.22	-12.59**	5.00	8.89	0.50	-16.67**
2	C-18-1×AP-1	-19.01**	0.41	14.06**	22.11**	-5.94**	-10.70**	7.65	-13.04**	16.90**	22.96**	-15.66**	-27.39**
3	C-18-1×PSM-3	-31.34**	-18.74**	38.62**	26.58**	3.82	-29.15**	-0.03	-2.44	-12.11**	-5.93	-15.32**	-27.78**
4	C-18-2×AP-3	-13.88**	-7.67**	35.13**	36.58**	-8.01**	-11.05**	4.62	-5.56	9.22**	14.07**	0.88	-13.67**
5	C-18-2×AP-1	4.16*	28.97**	19.43**	21.32**	-19.94**	-22.38**	5.41	-8.12	6.29*	12.60**	-0.84	-11.99**
6	C-18-2×PSM-3	-34.51**	-22.51**	22.51**	5.26	-22.66**	-45.72**	-10.80**	-7.27	-3.09	4.44	-17.17**	-27.16**
7	C-18-3×AP-3	10.66**	14.91**	19.44**	27.37**	-37.08**	-37.90**	-2.29	-10.76*	14.58**	22.22**	-15.20**	-26.42**
8	C-18-3×AP-1	3.59	24.76**	35.73**	45.53**	-25.21**	-26.00**	7.31	-5.32	-8.90**	-1.49	-18.27**	-26.49**
9	C-18-3×PSM-3	-9.64**	3.84	39.11**	27.37**	-13.65**	-37.67**	-9.13*	-4.55	-10.44**	-1.49	-0.43	-11.25**
10	KS-283×AP-3	9.77**	24.32**	17.75**	18.42**	29.73**	20.46**	3.49	-5.73	19.58**	26.67**	-3.36	0.61
11	KS-283×AP-1	13.72**	47.68**	-8.93*	-7.89*	-8.00**	-14.32**	4.71	-7.84	3.45	11.11*	0.29	7.59**
12	KS-283×PSM-3	-25.73**	-7.67**	85.33**	58.42**	-11.51**	-41.29**	-8.08*	-3.66	5.08	14.82**	0.28	6.77*
13	KS-701×AP-3	-9.20**	-3.80	27.44**	39.74**	11.81**	-2.88	9.64*	8.25	4.58	1.49	-2.75	6.25*
14	KS-701×AP-1	-26.20**	-9.55**	43.26**	57.89**	-11.32**	-22.73**	0.30	-4.06	-6.02	-7.40	0.26	12.72**
15	KS-701×PSM-3	13.56**	32.85**	20.87**	14.21**	2.67	-38.02**	-10.96**	0.12	19.56**	20.00**	-2.12	9.25**
16	KS-702×AP-3	-16.56**	-0.03	68.31**	74.21**	9.09**	1.09	4.79	-2.11	-5.30	-7.40*	-2.96	-0.78
17	KS-702×AP-1	-37.64**	-14.87**	162.37**	173.16**	-36.81**	-41.29**	87.56**	69.42**	-3.73	-4.44	1.47	6.97*
18	KS-702×PSM-3	-9.92**	17.90**	6.15	-6.05	28.89**	-14.67**	15.63**	23.88**	-4.76	-3.71	0.63	5.27*
19	KS-801×AP-3	4.70*	6.50*	38.77**	47.89**	7.22**	-6.74**	2.14	-7.43	-10.87**	-8.89*	0.58	2.55
20	KS-801×AP-1	-31.30**	-18.74**	160.83**	179.47**	-38.07**	-45.96**	88.60**	65.07**	-2.14	1.49	0.09	5.22*
21	KS-801×PSM-3	-27.60**	-18.30**	54.36**	41.32**	22.26**	-26.00**	-1.21	3.09	1.75	7.40*	0.19	4.52
22	KS-802×AP-3	-9.23**	-4.24	21.79**	27.37**	11.76**	-2.53	-5.13	-14.70**	-14.47**	-3.71	-25.52**	-26.95**
23	KS-802×AP-1	-8.76**	11.48**	33.64**	40.53**	-19.09**	-29.15**	7.75	-6.46	-15.58**	-3.71	-9.21**	-8.08**
24	KS-802×PSM-3	-1.49	14.91**	35.16**	21.05**	27.83**	-22.38**	-1.76	1.83	-13.74**	0.00	0.86	1.31
25	KS-601×AP-3	-2.10	6.50*	18.50**	1.05	15.38**	5.05*	-2.27	-12.79*	-12.46**	-8.89*	5.19**	3.61
26	KS-601×AP-1	11.42**	39.71**	22.82**	5.53	18.95**	8.67**	3.75	-10.64*	-1.75	3.71	-0.94	0.72
27	KS-601×PSM-3	-20.38**	-4.57	6.49	-25.26**	-21.51**	-49.34**	-6.80	-4.06	-4.83	2.22	-0.09	0.77
28	KS-285×AP-3	-1.99	3.84	8.43*	18.42	-11.48**	-13.86**	3.77	-3.78	2.90	5.18	4.36*	-4.22
29	KS-285×AP-1	11.54**	36.61**	-0.44	9.21	3.11	0.62	9.52*	-1.83	-9.29**	-5.93	-0.77	-5.78**
30	KS-285×PSM-3	-27.89**	-15.64**	39.79**	31.58**	5.11*	-25.53**	-2.11	4.18	-12.28**	-7.40*	4.57*	-1.57
	SE	0.200		0.150		0.151		1.011		1.352		2.376	

*Significant at 5%; **Significant at 1%

general combiners for green pod yield. Such lines can be utilized as suitable parents for hybridization programme. SCA effects is indication of non-additive gene action, the cross combinations KS-802 x PSM-3 and C-18-1 x AP-3 showed high SCA effect for green pod yield per plant so it can be utilized for heterosis breeding. The genotypes of vegetable pea can be used as parent in hybrid and recombination breeding programme for generating good materials. Superior crosses should be studied for isolating superior plant types in F_2 and subsequent generations. Also, the parent KS-701 and KS-283 should be involved in the crossing programme.

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Received: December 9, 2023
Accepted: December 27, 2023