

Original Research Article

Combining Ability Studies in Garden Pea (*Pisum sativa* Var. *Hortense*)

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ABSTRACT

The present study entitled “Heterosis and combining ability studies in garden pea” was undertaken to estimate the combining ability effects to find out superior cross combinations for their further exploitation. Half diallel mating design was selected for the study. The experimental material comprised of eight parents *viz.*, Jawahar Mattar-2, Millenium, Palam Triloki, Palam Smool, PB-89, Arka Kartik, Palam Priya and Arkel with their twenty-eight crosses along with one check Ruchi. The parents and hybrids were randomized separately and sown using Randomized Block Design during Rabi 2015-2016. The data were recorded on the characters *viz.*, number of pods per plant, number of seeds per pod, pod weight per plant, pod weight per plot, pod weight per hectare. When SCA and heterosis performance for various characters were considered together, it was observed that hybrid Palam Smool X Arka Kartik, Millenium X Palam Smool and Millenium X PB-89 revealed highest magnitude for most of the character indicating the need for its commercial exploitation for seed yield per plant. The parents Jawahar Mattar-2 (P1), Palam Triloki (P3) and PB-89 (P5) were found to be the best general combiner for most of the characters studied and can be utilized in further breeding Programme.

Keywords

Heterosis,
Combining
ability, Garden
pea, Diallel
mating

Introduction

Pea is the commonly known as garden pea, which is used by Gregor Johann Mendel for his pioneering studies of heredity in antiquity and caused to the foundation of Modern Genetics by the principles of Mendelian genetics.

Due to research work done by Gregor Mendel and others scientists, peas have specially recognized in the history of Genetics and Plant Breeding.

Hybridization is one of the important breeding methods for breaking yield barriers. It offers for great possibilities in crop improvement than any other breeding

method and is the only effective means of combining together the desirable character of two or more varieties, by the concept of combining ability, it refers to capacity of genotype to transmit superior performance to its progeny (Sprague and Tatum, 1942).

Materials and Methods

The experimental material of the present investigation comprised of eight diverse genotypes *viz.*, Jawahar mattar-2 (P1), Millenium (P2), Palam Triloki (P3), Palam Smool (P4), PB-89 (P5), Arka Kartik (P6), Palam Priya (P7) and Arkel (P8).

Production of F₁ hybrid seed

The seeds of eight genotypes used as parents, were sown during Rabi-2014 to constitute a crossing block. Crosses were made between eight parents following 8 x 8 half diallel. For emasculation, flower bud chosen had developed to the stage just before anthers dehiscence, indicated by extension of petals beyond sepals. Flowers were emasculated in the morning or evening by tearing away with the forceps the tip of the sepal from in front of the keel. The forefinger was positioned behind the flower and thumb in front and a light pressure was applied. The exposed keel was slit-opened by tips of finger. The dia-delphous stamens were removed with the help of forceps. Pollens were obtained preferably from a freshly opened flower. The emasculated buds were pollinated using pollens from desired male parent flower with the help of brush and labelled properly. Pollination was done preferably in morning at 9.00 a.m. to 11.00 a.m.

Results and Discussion

General combining ability effects

The estimates of general combining ability effects for individual parents involved in the present investigation are presented in Table 1.

Three parents *viz.*, Millenium (P2), Palam Triloki (P3) and PB-89 (P5), exhibited highly significant positive gca effects for this character while the rest of parents showed highly significant negative gca effects which are undesirable. Millenium (P2) was the best general combiner for this character (0.48).

For number of pods per plant, the parent PB-89 (P5) was found to be the best general

combiner (4.29). It exhibited highly significant positive gca effects for this character. Also parent Palam Triloki (P3), Arkel (P8), showed significant positive gca effect. Jawahar Mattar-2 (P1), Millenium (P2) and Arka Kartik (P6) exhibited highly significant negative gca effect.

The parents Millenium (P2), Palam Triloki (P3), and PB-89 (P5) exhibited highly significant positive gca effects for number of seeds per pod. Millenium (P2) was found to be best general combiner (0.58). Rest of the parents showed highly significant negative gca effects which are undesirable.

The parents Palam Triloki (P3) and PB-89 (P5) showed highly significant positive gca effects for pod weight per plant PB-89 (P5) was the best general combiner (40.77). Rest of the parents showed highly significant negative gca effects which are undesirable.

The parents Palam Triloki (P3) and PB-89 (P5) showed highly significant positive gca effects for pod weight per plot. PB-89(P5) was the best general combiner (0.43). Rest of the parents showed highly significant negative gca effects which are undesirable. Three parents show non-significance with this character

The parents Palam Triloki (P3) and PB-89 (P5) showed highly significant positive gca effects for pod weight per hectare. PB-89 (P5) was the best general combiner (3.59). Rest of the parents showed highly significant negative gca effects which are undesirable. Three parents showed non-significance with this character

Specific combining ability effects

The estimates of specific combining ability effects for twenty-eight crosses in respect of

the characters under study are presented in Table 2. The sca estimates revealed that seven combinations had positive effects. The cross combination, Palam Smool (P4) X Palam Priya (P7) with the highest (1.21) sca effects, was the best specific combination for pod length. The negative significant sca effects were observed for twenty crosses.

Number of pods per plant is one of the yield contributing characters. Combinations with positive sca effects are therefore desired. Such effects were exhibited by fourteen crosses in the present study, which were found to be positive and highly significant. Among these fourteen crosses, Arka Kartik (P6) X Arkel (P8) was the best specific combination (9.85) followed by Millenium (P2) X PB-89 (P5) (8.36).

Number of seeds per pod is also one of the yields contributing characters, Out of twenty-eight crosses, only four crosses exhibited significantly positive sca effects. The best specific combination for this character was Palm Triloki (P3) X Arkel (P8) with highest sca effects (0.70).

This is most important qualitative trait, cross combinations with positive sca effects are therefore desired. The sca estimates revealed that thirteen combinations had positive effects. The cross combination, Palam Triloki (P3) X Arka Kartik (P6) (114.91), followed by Palam Smool (P4) X Palam Priya (P7) and Jawahar Mattar-2 (P1) X Palam Triloki (P3) with the highest sca effects, was the best specific combination for pod weight per plant.

This is most important qualitative trait, cross combinations with positive sca effects are therefore desired. The sca estimates revealed that thirteen combinations had positive effects. The cross combination, Palm Triloki (P3) X Arka Kartik (P6) with the highest

(1.39) sca effects, was the best specific combination for pod weight per plot.

Out of twenty-eight crosses, only thirteen crosses exhibited significantly positive sca effects. The best specific combination for this character was Palam Triloki (P3) X Arka Kartik (P6) (11.60) with highest sca effects followed by Palam Smool (P4) X Palam Priya (P7) (10.78), Jawahar Mattar-2 (P1) X Palm Triloki (P3) (10.26)

General combining ability effects

The average performance of a genotype in a series of hybrid combination represents general combining ability. It helps in the selection of suitable parent for hybridization. In the present investigation, it was evident from the study of gca effects, that the effects varied significantly for different characters and genotypes (Table 1).

PB-89 (P5) was the best general combiner for the character pod length, number of pods per plant, number of seeds per plant, pod weight per plant, pod weight per plot, and pod weight per hectare.

Specific combining ability effect

Specific combining ability effects represent dominance and epistatic components of variation, which are non-fixable and can be related with heterosis (Sprague and Tatum, 1942 and Rajas and Sprague, 1952). Literature indicates that, sca effects generally do not contribute much in the improvement of self-pollinated crops, except where exploitation of heterosis at commercial level is feasible.

In the present study, the reflection of gca effects in the best specific combinations for different characters is represented in (Table 2).

Table.1 Estimates of general combining ability effect for parents and F1 s in 8X8 half diallel of garden pea

Parents	Pod length (cm)	Number of pods per plant	Number of seeds per pod	Pod weight per plant (g)	Pod weight per plot (kg)	Pod weight per hectare (q)
JM-2	-0.23**	-1.57**	-0.71**	-20.81**	-0.24**	-2.02**
MILLENIUUM	0.48**	-3.03**	0.58**	-31.45**	-0.38**	-3.22**
P.TRILOKI	0.21**	0.69**	0.44**	28.00**	0.31**	2.60**
P.SMOOL	-0.11**	0.07	0.01	-3.32 *	-0.04	-0.33
PB-89	0.19**	4.29**	0.26**	40.77**	0.43**	3.59**
A.KARTIK	-0.21**	-0.48 *	-0.15 *	-5.38**	-0.02	-0.19
P.PRIYA	-0.09**	-0.61 **	-0.27**	-1.94	-0.01	-0.10
ARKEL	-0.24**	0.63 **	-0.15 *	-5.85**	-0.03	-0.31
SE (Gi) at 95%	0.02	0.44	0.16	3.55	0.05	0.47
SE(Gi—Gj) at 95%	0.03	0.67	0.25	5.37	0.08	0.71

*, ** denotes significance at 5 and 1 per cent level, respectively

Table.2 Estimates of specific combining ability effect for parents and F1 s in 8X8 half diallel of garden pea

Cross	Pod length (cm)	Number of pods per plant	Number of seeds per pod	Pod weight per plant (g)	Pod weight per plot (kg)	Pod weight per hectare (q)
JM-2(P1) XMillenium(P2)	-0.09	-0.67	0.33	30.13**	0.38**	3.16**
JM-2(P1) XP.Triloki(P3)	0.80**	7.49**	0.56 *	110.92**	1.23**	10.26**
JM-2(P1) XP.Smool(P4)	-1.64**	-1.54 *	-1.20**	-54.85**	-0.63**	-5.29**
JM-2(P1) XPB-89(P5)	-1.81 **	6.90**	-1.41**	-2.62	-0.06	-0.04
JM-2(P1) XA.Kartik(P6)	-0.43**	3.68**	0.07	71.94**	0.75**	6.32**
JM-2(P1) XP.Priya(P7)	0.26**	0.81	-0.10	-29.75**	-0.35**	-2.96**
JM-2(P1) XArkel(P8)	0.28**	-5.10**	0.47 *	-25.55**	-0.27**	-2.30**
Millenium(P2)X P.Triloki(P3)	-0.72**	-6.70**	-0.46 *	-61.58**	-0.63**	-5.25**
Millenium(P2)XP.Smool(P4)	-0.19**	-0.75	0.23	-46.65**	-0.49**	-4.13**
Millenium(P2)X PB-89(P5)	-0.74**	8.36**	0.23	60.91**	0.64**	5.35**
Millenium(P2)X A.Kartik(P6)	-1.24**	-4.22**	-0.69 **	-11.85 *	-0.16 *	-1.37 *
Millenium(P2)X P.Priya(P7)	-1.96**	6.60**	-1.59**	73.04**	0.64**	5.41**
Millenium(P2)X Arkel(P8)	0.86**	1.33 *	-0.12	-32.93**	-0.40**	-3.37**
P.Triloki(P3)X P.Smool(P4)	-1.19**	6.51**	-0.51 *	-18.55**	-0.22 **	-1.84 **
P.Triloki(P3)X PB-89(P5)	-0.43**	-1.99 **	-1.72**	-31.59**	-0.34**	-2.86**
P.Triloki(P3)X A.Kartik(P6)	-0.09 **	6.41**	0.31	114.91**	1.39**	11.60**
P.Triloki(P3)X P.Priya(P7)	-1.17**	0.36	-0.73 **	20.59**	0.20 **	1.70 **
P.Triloki(P3)X Arkel(P8)	0.66**	0.80	0.70 **	45.62**	0.53**	4.42**
P.Smool(P4)X PB-89(P5)	-0.93**	1.41 *	-1.55**	73.67**	0.90**	7.54**
P.Smool(P4)X A.Kartik(P6)	-0.49**	-4.35**	-0.71 **	-35.09**	-0.42**	-3.54**
P.Smool(P4)X P.Priya(P7)	1.21**	6.10**	0.52 *	111.63**	1.29**	10.78**
P.Smool(P4)X Arkel(P8)	-2.39**	5.25**	-1.91**	62.28**	0.71 **	5.92**
PB-89(P5)X A.Kartik(P6)	-1.08**	-0.18	-0.72 **	-30.82**	-0.31**	-2.66**
PB-89(P5)X P.Priya(P7)	-2.19**	0.61	-1.71**	-24.35**	-0.21 **	-1.82 **
PB-89(P5)X Arkel(P8)	-1.01 **	4.57**	-1.38**	3.07	0.07	0.62
A.Kartik(P6)X P.Priya(P7)	-1.18**	4.06**	-1.76**	37.67**	0.52**	4.38**
A.Kartik(P6)X Arkel(P8)	-0.33**	9.85**	-0.78 **	33.92**	0.40**	3.39**
P.Priya(P7)X Arkel(P8)	0.99**	-0.95	0.39	2.88	0.06	0.55
SE(Sij) at 95%	0.05	1.19	0.43	9.45	0.15	1.25
SE(Sij—Sik) at 95%	0.08	1.76	0.65	13.98	0.22	1.85
SE (Sij—Sk1) at 95%	0.08	1.66	0.61	13.18	0.21	1.75

P1: Jawahar Mattar-2, P2: Millenium, P3: Palam Triloki, P4: Palam Smool, P5: PB-89(P5), Arka Kartik, P7: Palam Priya, P8: Arkel. *, ** denotes significance at 5 and 1 per cent level, respectively

The best specific cross- combinations number of pods per plant was Palam Priya (P7) X Arkel (P8), pod weight per plant, pod weight per plot, pod weight per hectare was Palam Triloki (P3) X Arka Kartik (P6).

Abbreviation

gca: General combining ability, sca: Specific combining ability

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