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Combining Ability Analysisin Field Pea (*Pisum sativum* L.)

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Abstract

The present study was conducted with 6 parent and 15 crosses of field pea during *rabi* 2019-20for estimation of combining ability of genotypes though half diallel matting design for the yield and its related traits.The analysis of variance for combining ability showed high significance for all the characters. On the basis of GCA effect among the parents, Ambika had exhibited significant positive effects for the traits *viz* seed yield per plant, harvest index (%), number of seeds per pod and number of secondary branches per plant. On the basis of SCA effects, the best cross combination was Indira Matar-1 x Ambika for the traits pod per plant, seed yield per plant, harvest index (%), number of secondary branches per plant, number of primary branches per plant, test weight (g) and number of seeds per pod.

Key words : *Combining ability, genotypes, hybrids, parent.*

Introduction

Field pea (*Pisum sativum* L. var. arvense) is an important pulse crop of India, grown in winter season and belonging to fabaceaefamilywith chromosome number 2n= 4. Pea has versatile uses as food, feed and fodder. Pea besides pulse residues are nutritious feed for livestock and milk cattle and thus, offer an added advantage to the poor farmer families.Pea are highly nutritious and are rich source of digestible protein (27.8%) along with carbohydrates (42.65%), minerals (calcium, phosphorus), vitamins, dietary fiberand anti-oxidant compounds and sugars (5.67g/100 g edible portion) (1). According to Directorate of Pulse Development in India statically data (2017-18), Global Scenario of Field pea area is 76.26 lakh ha and production 143.63 lakh tonnes. In India, about 10.59 lakh ha area with annual production of 10.11 lakh tonnes and productivity of 995 kg per ha. In Chhattisgarh, pea grown in about 0.146 lakh ha.with production 0.054 lakh tones and productivity 370 kg per ha.The genetic improvement of crop as field pea may be approached through selection or by cross development depending on the magnitude of the additive and non–additive genetic variation of the most important economical traits (2,3). One of the main methods for combining of different traits and attributes of the parent's forms is the hybridization. Combining ability such as general combining ability (GCA) and specific combining ability (SCA) studies are useful in classifying parental lines in terms of their hybrid performance (4). As well it gives opportunity to forecast which combinations will bring in consequential generations to formation of desired transgressive-segregent.

Materials and Methods

The investigations was undertaken at S.G. College of Agriculture and Research Station, Kumhrawand, Jagdalpur (C.G.) during the year 2019-20. The Experimental material comprised of 6 parents (Adarsh, KPMR-400, Prakash, Paras, Indira Matar-1 and Ambika) and their 15 crosses *viz.*, Adarsh x KPMR-400, Adarsh x Prakash, Adarsh x Paras, Adarsh x Indira Matar-1, Adarsh x Ambika, KPMR-400 x prakash, KPMR-400 x Paras, KPMR-400 x Indira Matar-1, KPMR-400 x Ambika, Prakash x Paras, Prakash x Indira Matar-1, Prakash x Ambika, Paras x Indira Matar-1, Paras x Ambika, Indira Matar-1 x Ambika). Genetically pure seeds were grown in a RBD with three replications in a plot size of 1.35 m^2 (1.5m x 90m). All recommended agronomic and plant protection practices were followed. The data were recorded for 11 characters *viz.*, days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, pod length, number of seeds per pod, 100 seed weight, harvest index and seed yield per plant. Combining ability analysis was carried out the procedure given by (5) as per the method 2 (Model II).

Estimation of GCA Effects and SCA Effects

The general combining ability effects were estimated as follows :

$$G_i = \frac{1}{n+2} Y_i + Y_{ii} \quad \frac{2}{n} Y.....$$

The specific combining ability effect :

$$S_{ij} = Y_{ij} = \frac{1}{n+1}(Y_i + Y_{ii}) + (Y_j + Y_{jj}) + \frac{2}{(n+1)(n+2)} Y...$$

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Table-1 : Analysis of variance of combing ability for field pea.

Sourced of Variation	D.F.	Days to 50% Flowering	Plant Height	Days to Maturity	No. of Primary Branches / Plant	No. of Secondary Branches / Plant	Pod Length	Pods Per Plant	Number of Seeds Per Pod	Harvest Index	Test Weight 100 Seeds	Seed Yield / Plant
Gca	5	2.433**	829.164**	1.331*	0.145**	0.195**	0.183**	13.724*	0.616**	2.771**	0.501**	2.403**
Sca	15	3.790**	159.501**	4.733**	0.776**	0.360**	0.449**	16.906*	0.263**	6.302**	0.969**	4.573**
Error	40	0.774	5.958	0.648	0.013	0.054	0.050	0.715	0.029	0.558	0.182	0.171
Var due to gca		0.21	102.90	0.09	0.02	0.02	0.02	1.63	0.07	0.28	0.04	0.28
Var due togca		3.02	153.54	4.08	0.76	0.31	0.40	16.19	0.23	5.74	0.79	4.40
Gca/sca ratio		0.069	0.670	0.021	0.022	0.058	0.042	0.100	0.313	0.048	0.051	0.063

*, ** significant at 5% and 1% levelof significance, respectively.

Table-2 : Estimate of general combining ability (GCA) effects of parents for different traits of field pea.

S. No.	Parents	Days to 50% Flowering	Plant Height	Days to Maturity	No. of Primary Branches/ Plant	No. of Secondary Branches / Plant	Pod Length	Pods Per Plant	Number of Seeds / Pod	Harvest Index	Test Weight 100 Seeds	Seed Yield / Plant
1.	ADARSH	0.29	2.63 **	0.28	0.14 **	-0.15	-0.12	-0.72 *	-0.33 **	-0.01	0.00	-0.28 *
2.	KPMR-400	0.08	1.61 *	-0.01	-0.21 **	-0.12	-0.22 **	-0.31	-0.13 *	-1.07 **	-0.06	-0.48 **
3.	PRAKASH	-0.96 **	-11.87 **	-0.35	0.11 **	-0.15	0.16 *	-1.91 **	-0.26 **	-0.11	-0.35 *	-0.63 **
4.	PARAS	0.71 *	-12.66 **	0.65*	0.04	0.07	-0.02	1.69 **	0.30 **	0.19	0.31 *	0.14
5.	INDIRA MATAR - 1	-0.08	9.24 **	-0.43	0.03	0.15	0.11	1.20 **	0.10	0.37	0.25	0.67 **
6.	AMBIKA	-0.04	11.05 **	-0.14	-0.11 **	0.20 *	0.10	0.05	0.31 **	0.64 *	-0.15	0.57 **
	SE (gi)	0.284	0.788	0.260	0.037	0.075	0.072	0.273	0.055	0.241	0.138	0.133

*, ** significant at 5% and 1% levelof significance, respectively.

Where,

G_i = gca effects of i^{th} parent

S_{ij} = sca effect of I xj^{th} cross

Y_i = Sum of all crosses with i^{th} parent

Y_{ii} = i^{th} diagonal value

Y_j = Sum of all crosses with j^{th} parent

Y_{jj} = diagonal value of j x j^{th} cross

Y.. = Grand total

n = number of parents.

Results and Discussion

The parents and hybrids exhibited considerable genetic variation for all the traits under study corroborate by analysis of variance for various characters (Table-2). Study of GCA and PCA variance revealed that variance due to SCA was more than the GCA variance in all studied characters expect for plant height (cm) and number of seeds per pod, indicating the non-additive nature of gene action.

Analysis of variance for combining ability (GCA and SCA) days to 50% flowering (2.433,3.790), plant height (829.164,159.501), days to maturity(1.331,4.733),number of primary branches per plant (0.145, 0.776), number of secondary branches per plant (0.195,0.360), pods length (0.183, 0.449), number of pod per plant (13.724,16.906) number of seed per pod (0.616, 0.263), harvest index (%) (2.771, 6.302), 100 seed weight (0.501, 0.969) and seed yield per plant (2.403, 4.573) exhibited significant differences among all the entries.

Good general combiners for yield and its attributes : Result of combining ability on the basis of GCA effect among the parents, Ambikawas found as best general combiner for the traits *viz.*seed yield per plant (0.57), harvest index (%) (0.64), number of seed per pod (0.31) and number of secondary branches per plant (0.20). Parent Paras was found as good general combiner for number of pod per plant (1.69), 100 Seeds weight (0.31) and number of seeds per pod (0.30) while, plant height (-12.66) showed significant negative association. whereas parent Indira Matar-1 was found as best general combiner for pod per plant (1.20) and seed yield per plant (0.67).Therefore, crosses involving these parents would be desirable to get superior recombinant with desirable traits along with seed yield. Similar finding have also been reported (6,7,8).

Specific combiners for yield and its attributes : On the basis of SCA effects, the best general combiner found was Indira Matar-1 x Ambika for the traits pods per plant(9.67), seed yield per plant (5.06), harvest index (%)(3.81),

Table-3 : Specific combined ability (SCA) for hybrids different traits of field pea.

S. No.	Crosses	Days to 50% Flowering	Plant Height	Days to Maturity	No. of Primary Branches/ Plant	No. of Secondary Branches / Plant	Pod Length	Pods Per Plant	Number of Seeds Per Pod	Harvest Index	Test Weight 100 Seeds	Seed Yield Per Plant
1.	ADARS x KPMR400	-1.85 **	9.93 **	-2.04 **	-0.07	0.38 **	-0.09	-0.7	0.09	-0.08	0.38 *	1.20 **
2.	ADARSH x PRAKASH	2.86 **	-22.08 **	2.96 **	0.94 **	0.24 *	0.30 **	1.10 **	-0.15 *	-1.16 **	-0.37 *	-0.61 **
3.	ADARS x PARAS	-3.14 **	-7.37 **	-2.04 **	0.81 **	-0.17	-0.1	3.31 **	-0.91 **	-0.69 *	-0.78 **	-0.69 **
4.	ADARSH x IM	0.98 *	0.55	0.71 *	-0.65 **	-0.18	1.06 **	-3.89 **	0.1	-3.60 **	-0.08	-1.34 **
5.	ADARSH x AMBIKA	-0.06	-8.91 **	-0.92 **	-0.71 **	-0.36 **	0.44 **	-2.10 **	-0.18 *	-0.83 *	0.05	-2.00 **
6.	KPMR-400 x PRAKASH	0.4	-9.36 **	0.25	-0.78 **	-0.19	0.88 **	-0.28	-0.11	-1.69 **	-0.88 **	-1.16 **
7.	KPMR-400 x PARAS	-0.27	-17.93 **	-0.75 *	0.16 **	0.26 *	0.50 **	-2.64 **	-0.04	0.17	-0.87 **	-1.21 **
8.	KPMR-400 X IM	1.19 **	3.08 **	0.67	-0.43 **	-0.41 **	-0.05	-4.50 **	-0.80 **	-1.82 **	0	-1.70 **
9.	KPMR-400 x AMBIKA	-1.52 **	-6.21 **	-2.63 **	0.04	-0.53 **	-0.23 *	-2.14 **	-0.11	-1.18 **	-1.00 **	-2.00 **
10.	PRAKASH X PARAS	1.44 **	5.33 **	-0.75 *	-0.1	0.22 *	-0.11	-2.24 **	-0.07	-1.86 **	-0.38 *	-0.34
11.	PRAKASH x IM	-1.43 **	12.10 **	-1.33 **	1.88 **	-0.19	-0.75 **	-1.94 **	0.17 *	1.54 **	-0.43 *	-0.43 *
12.	PRAKASH x AMBIKA	0.52	7.22 **	-0.96 **	-0.55 **	-0.30 **	-0.03	-0.97 **	0.12	-2.54 **	0.05	-0.98 **
13.	PARAS x IM	-1.10 **	4.22 **	-1.67 **	-0.61 **	-0.40 **	-1.04 **	-4.40 **	-0.50 **	-3.35 **	-1.06 **	-2.37 **
14.	PARAS x AMBIKA	2.19 **	22.62 **	3.38 **	0.99 **	0.35 **	-0.79 **	3.37 **	0.46 **	1.60 **	2.06 **	1.84 **
15.	I M x AMBIKA	2.98 **	-10.43 **	4.12 **	1.14 **	1.87 **	-0.20 *	9.67 **	0.87 **	3.81 **	1.10 **	5.06 **
	SE (sij)	0.780	2.164	0.714	0.101	0.206	0.197	0.749	0.151	0.662	0.378	0.366
	SE (sij-sik)	0.372	1.032	0.340	0.048	0.098	0.094	0.357	0.072	0.316	0.180	0.175

*, ** significant at 5% and 1% level.

number of secondary branches per plant (1.87), number of primary branches per plant (1.14), test weight (g) (1.10) and number of seed per pod (0.87). Cross Paras x Ambika was recorded as good specific combiner for the traits pods per plant (3.37), 100 seeds weight (2.06), seed yield per plant (g) (1.84), harvest index (%) (1.60), number of primary branches per plant (0.99) and number of secondary branches per plant (0.35).Whereas F_1's for the earliness Adarshx Paras (-314), Adarsh x KPMR-400 (-1.85), KPMR-400 x Ambika (-1.52), Prakash x Indira Matar-1 (-1.43) and Paras x Indira Matar-1 (1.10) found had highest negative SCA desirable early maturity genotypes. Selecting in F_2 generations may produced early maturating plants. Similar result finding have also been reported (9,10).

Conclusions

Hence, these parents Ambikamay therefore be used in crop breeding programme aimed at improvement of the respective traits. Further, consideration of *per se* performance in combination with combining ability estimates was reported to provide a better criteria for choice of superior parents in hybridization program. Combination involving both general and specific combining ability of the parents and particular crosses along with their per se performance would be more useful in selecting materials in the segregating generations. GCA effect revealed that the parent Ambika having significant and positive GCA effects was found to be the best combiner for most of the yield contributing traits. While on the basis of SCA Indira Matar-1 x Ambikaand Indira Matar-1 x Ambika was recorded as best specific combination for most of the yield contributing traits.

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