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Combining Ability Analysis for Yield and Attributing Traits in Field Pea (*Pisum sativum* L.)

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A B S T R A C T

In the present investigation 7 parents and 21 F_1 hybrids of field pea were evaluated in a randomized complete block design in three replication to estimate combining ability of genotypes by using diallel fashion for the yield and yield attributing characters at instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur during the *Rabi* December 2017 to March 2018. Combining ability analysis indicated contribution of non additive gene effect playing an important role for most of the characters and the analysis of variance due to general combining ability (gca) and specific combining ability (sca) revealed highly significant for most of the characters. The parent Indira Matar-1 was recorded as the best general combiner for secondary branches per plant, seed per pod seed per plant and seed yield per plant. The crosses Aman x KPMR 400 was recorded as the best combiner for days to maturity, seed per plant, 100 seed weight, seed yield per plant and biological yield per plant.

Introduction

Legumes are critical harvests around the world, and they impactsly affect farming, condition, creature and human nourishment (Graham and Vance, 2003). Legumes can team up advantageously with trademark soil-borne microorganisms called rhizobia, enabling it to fix environmental nitrogen, improve the physical state of the soil, and potentially ensure them against some parasitic pathogens (Chakraborty *et al.*, 2003). Field pea (*Pisum sativum* L.) is one of the world's oldest domesticated crops cultivated before 10^{th} and 9^{th} millennia BC (Zohary *et al.*, 2000). *Pisum sativum* comprise of both the wild species (*P. fulvum and P. eratius*) and developed species (*P. abyssinicum*) started from the Mediterranean locale, principally in the Middle East (Ellis *et al.*, 2011).Field pea is rich in high quality protein and also good source of phosphorus, calcium and vitamins specifically vitamin A and D. Peas are highly nutritive having high percentage of protein (6.2g/100g of fresh weight) and carbohydrates (16.9g/100g of fresh weight) along with essential minerals, vitamins A, B and C (Makasheva, 1983) and provide a major portion of the nutritive proteins to the poor masses, majority of which are vegetarian. As a result of static pulse production and repeated increase in population, the per capita

availability of pulses has decline considerably. The per capita per day availability of pulses in 1951 was 60 g that dwindled down to a provisional level of 47.2 g in the year 2014. The per capita per year availability shows the same decreasing trend from 22.1 kg in 1951 to 17.2 kg in 2014. However the increase trend shows during 2017 both in per capita per day (52.9 g) and per capita per year (19.3 kg) respectively (Anonymous 2012). This can be improved through using various breeding methods among the population. Therefore, the aim of present investigation was on combing ability analysis of field pea for enhancing yield and its attributes.

Materials and Methods

The experimental material consisted of seven parents viz., Ambika, Indira Matar, Pant P250, Aman, IPFD 15-8, IGP 2018-1 and KPMR 400. These parents are crossed in diallel fashion to develop 21 F_1 crosses during *Rabi* 2016-17. In subsequent year 7 parents and their 21 F_1's were evaluated in a Randomized Block Design with 3 replication during *Rabi* 2016-17.Combining ability and gene for each phenotype was estimated for yield and its attributes following a procedure Jinks and Hayman (1954). The data were analyzed following model suggested by Griffing (1956) as well as Hayman (1954) for combining ability analysis.

Results and Discussion

"The GCA variance of parents and SCA variance of hybrids for the different characters are important basic criteria for the selection or hybridization programme. The variances due to general combining ability for different characters under study and their ratio are presented in Table 1." The analysis of variance due to general combining ability (GCA) revealed high for number of secondary branches per plant (10.69), no. of pod per plant (2.50), seed per plant (70.29), biological yield per plant (17.14). The SCA variance was found highest for Days to maturity (4.01), secondary branches per plant (30.15), pod per plant (17.45), seed per plant (639.07), 100 seed weight (2.06), seed yield per plant (12.54), harvest index (9.06), and dal recovery (3.04).

Genetic component of variance due to SCA was found highest for number of seeds per plant (639.07) followed by biological yield per plant (65.97), number of secondary branches per plant (30.15), number of pods per plant (17.45), seed yield per plant (12.45), days to maturity (4.01) and 100 seed weight (2.06).

Study of GCA and SCA variance revealed that variance due to SCA was more than the GCA variance in all studied characters except for days to 50% flowering, days to maturity, 100 seed weight and protein content, indicating the non-additive nature of gene action hence suggesting the, possibility of exploiting heterosis for these traits in field pea.

The comparative variances due to general combining ability and specific combining ability for different characters under study and their ratio presented in the Table 2 revealed that non additive genetic variances accomplished an important role in the expression of different traits, which indicated the predominance of non-additive gene action in the inheritance of above mentioned traits.

Study of GCA effects explained that, parent Indira Matar-1 was best combiner for secondary branches per plant, seed per pod, seed per plant, seed yield per plant and biological yield per plant. IPFD 15-8 was found best combiner for days to maturity, pod per plant, and seed per plant (Table 3 and 4).

Table.1 ANOVA for combining ability analysis for seed yield, its components in pea

S. No.	Source of variation	Mean Sum of Square (Hybrids)		
		GCA	SCA	Error
		Degree of Freedom		
		6	21	54
1	Days to 50% flowering	1.45**	1.44**	0.24
2	Days to maturity	4.59**	4.34**	0.34
3	No. of primary branches per plant	0.04	0.37**	0.06
4	No. of secondary branches per plant	98.52**	32.47**	2.32
5	No. of pods per plant	35.81*	30.80**	13.35
6	No. of seeds per pod	0.15	0.30**	0.07
7	No. of seeds plant	769.85**	776.34**	137.28
8	100 seed weight (g)	0.67	2.49**	0.42
9	Seed yield per plant (g)	12.67**	13.76**	1.23
10	Biological yield plant(g)	170.79**	82.51**	16.54
11	Pod length (cm)	0.04	0.12**	0.03
12	Harvest index (%)	7.79**	10.27**	1.22
13	Swelling Capacity	0.02**	0.01*	0.01
14	Swelling Index (%)	0.00	0.001**	0.001
15	Protein content (%)	0.77**	0.73**	0.22
16	Dal Recovery (%)	2.04**	3.28**	0.24

Table.2 Estimates of genetic components of variances for yield and its attributes in field.

S. No.	Characters	σ^2 gca	σ^2 sca	σ^2 gca/ σ^2 sca
1.	Days to 50% flowering	0.13	1.20	**0.11**
2.	Days to maturity	0.47	4.01	**0.12**
3.	No. of primary branches per plant	0.00	0.31	**-0.01**
4.	No. of secondary branches per plant	10.69	30.15	**0.35**
5.	No. of pods per plant	2.50	17.45	**0.14**
6.	No. of seeds per pod	0.01	0.23	**0.04**
7.	No. of seeds per plant	70.29	639.07	**0.11**
8.	100 seed weight (g)	0.03	2.06	**0.01**
9.	Seed yield per plant (g)	1.27	12.54	**0.10**
10.	Biological yield per plant(g)	17.14	65.97	**0.26**
11.	Pod length (cm)	0.00	0.09	**0.01**
12.	Harvest index (%)	0.73	9.06	**0.08**
13.	Swelling Capacity	0.00	0.01	**0.31**
14.	Swelling Index (%)	0.00	0.00	**0.34**
15.	Protein content (%)	0.06	0.52	**0.12**
16.	**Dal Recovery (%)**	**0.20**	**3.04**	**0.07**

Table.3 Specific combining ability effects of hybrids for yield and its contributing traits in field pea

Hybrids	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Indira Matar-1 xAmbika	-0.99*	-0.92	-0.91**	-9.36**	-0.86	-0.58*	-23.35*	-1.06	-2.64*	3.32	0.26	-4.07**	0.04	-0.02	2.14**	-1.07*
Indira Matar-1 xAman	0.42	0.31	-0.07	-8.16**	-3.47	-0.43	-30.15**	-0.47	1.76	-5.41	-0.48**	4.01**	-0.02	-0.02	-0.68	-0.48
Indira Matar-1 xIPFD 15-8	-1.44**	-2.10**	0.32	-3.21*	7.51*	0.24	41.45**	-0.36	0.19	4.95	-0.34*	-1.26	-0.13	0.00	-0.16	0.34
Indira Matar-1 xPant P250	1.86**	4.16**	-0.09	-6.93**	7.78*	-0.17	14.13	-0.01	0.63	5.73	-0.30	-1.45	0.08	0.01	-1.06*	1.79**
Indira Matar-1 xIGP 2018-1	0.49	0.53	0.17	-1.38	8.68*	-0.65*	3.59	-0.38	3.83**	10.60**	-0.02	0.81	-0.01	0.05**	-0.15	0.25
Indira Matar-1 xKPMR 400	-0.51	-0.81	-0.53*	-4.54**	-1.58	-0.34	-17.01	-0.91	3.70**	10.14*	0.29	0.97	0.06	0.02	0.52	1.30**
Ambika x Aman	-0.99*	-1.03	-0.40	-2.39	0.14	0.14	5.55	1.11	5.07**	12.22**	0.15	1.94	0.06	0.02	-0.54	2.40**
Ambika x IPFD 15-8	1.49**	1.90**	0.20	4.78**	-3.11	-0.53*	-35.75**	2.67**	1.94	-2.99	0.16	3.46**	0.09	0.03	-0.55	-2.55**
Ambika x Pant P250	-0.88	-1.51**	-0.55*	0.29	-5.73	-0.60*	-41.24**	-0.84	-0.74	-6.43	0.20	0.91	0.07	-0.02	-0.70	-1.89**
Ambika x IGP 2018-1	1.42**	2.53**	-0.06	0.84	-0.38	0.03	1.16	-0.82	4.53**	12.26**	0.04	1.10	0.08	-0.01	-0.52	-0.30
Ambika xKPMR 400	0.75	0.86	-0.88**	-3.44*	6.25	-0.22	8.32	-0.34	-0.05	-8.04*	0.55**	2.90**	-0.08	-0.01	-1.37**	-0.07
Aman x IPFD 15-8	1.23*	2.45**	0.60*	-0.35	1.39	0.06	6.81	-2.19**	4.79**	9.01*	0.02	2.85**	0.00	0.03*	-0.01	1.50**
Aman x Pant P250	-0.81	-0.95	0.19	-0.07	-3.89	-0.56*	-35.82**	0.91	-2.51*	-10.34**	0.19	0.42	0.18*	0.02	1.26**	0.80
Aman x IGP 2018-1	-0.51	-1.92**	0.12	-0.19	-4.32	0.40	2.08	-0.32	2.32*	2.66	-0.27	1.92	0.08	0.00	0.24	-2.99**
Aman xKPMR 400	1.16*	2.75**	-0.03	0.43	-1.36	0.71**	25.98*	1.53*	2.52*	5.38	0.11	1.41	-0.01	0.03*	-0.42	-1.23*
IPFD 15-8 x Pant P250	-1.66**	-2.69**	-0.55*	1.66	-8.91*	0.21	-19.94	-1.02	2.65*	-0.52	0.30	3.54**	0.09	0.00	0.01	1.09*
IPFD 15-8 x IGP 2018-1	0.31	1.01	-0.06	-0.46	-7.24*	0.29	-7.74	4.06**	-3.42**	-14.96**	-0.03	1.05	-0.02	-0.02	0.23	-0.80
IPFD 15-8 x KPMR 400	-0.03	-1.99**	-0.88**	-2.07	-0.38	-0.41	-21.91*	1.19	2.94**	9.52*	0.12	0.59	-0.08	-0.01	-0.52	2.46**
Pant P 250x IGP 2018-1	1.27**	1.60**	0.09	0.82	3.59	0.32	26.82*	-0.46	-0.05	0.02	0.22	-0.06	0.02	-0.02	0.76	2.56**
Pant P 250xKPMR 400	-1.06*	-1.73**	-0.07	-3.45*	-1.34	-0.59*	-27.77*	-1.09	1.65	-0.18	0.23	2.59*	0.13	0.00	0.98*	-1.31**
IGP 2018 x KPMR 400	1.23*	2.31**	0.53*	0.76	-2.65	-0.29	-18.37	-1.39*	-2.72*	-11.42**	0.10	1.09	-0.07	0.00	0.57	2.45**

*, ** differ significantly at 5 and 1 per cent level of probability, respectively.

1. Days to 50% flowering
2. Days to maturity
3. No. of primary branches per plant
4. No. of secondary branches per plant
5. No. of pods per plant
6. No. of seeds per pod
7. No. of seeds per plant1
8. 100 seed weight (g)
9. Seed yield per plant
10. Biological yield per plant
11. Pod length (cm)

2. Harvest index (%)
13. Swelling index (%)
14. Swelling capacity
15. Protein Content (%)
16. Dal Recovery

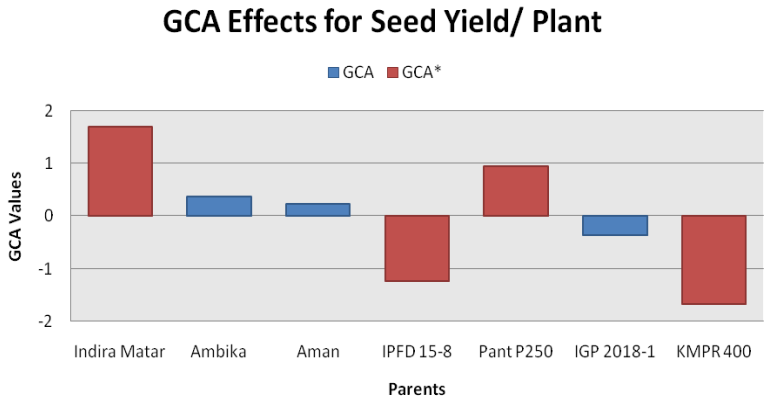
Table.4 General combining ability effects of parents for yield and its contributing traits in field pea

Parents	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Lines																
Indira Matar-1 -1	-0.19	-0.71**	-0.03	7.36**	0.98	0.23**	9.27*	-0.20	1.70**	4.54**	0.00	0.61	-0.01	0.00	-0.25	0.16
Ambika	-0.45**	-0.38*	0.10	-0.97*	-0.74	-0.01	-1.37	0.04	0.37	4.23**	-0.13*	-0.81*	-0.01	-0.01**	0.28	-0.73**
Aman	-0.19	-0.60**	0.02	-2.05**	1.31	0.07	7.84*	0.09	0.23	3.52**	0.04	-0.96**	0.07**	-0.01**	0.14	0.74**
IPFD 15-8	0.66**	1.14**	-0.01	-1.11*	3.00*	-0.04	9.00*	0.39	-1.23**	-1.90	0.07	-0.97**	0.04	0.01**	0.14	-0.45**
Pant P250	-0.30	-0.12	-0.05	-0.29	-2.71*	0.03	-5.85	-0.33	0.96**	-0.42	0.02	1.41**	-0.09**	0.00	-0.11	0.09
IGP 2018-1	0.40	0.84**	-0.09	-2.05**	-2.06	-0.15	-15.38**	0.27	-0.36	-2.80*	-0.01	0.48	0.02	0.01	-0.49**	-0.02
KPMR 400	0.07	-0.16	0.06	-0.89	0.20	-0.13	-3.50	-0.26	-1.67**	-7.16**	0.01	0.24	-0.01	0.01	0.29	0.21

*, ** differ significantly at 5 and 1 per cent level of probability, respectively.

1. Days to 50% flowering
2. Days to maturity
3. No. of primary branches per plant
4. No. of secondary branches per plant
5. No. of pods per plant
6. No. of seeds per pod
7. No. of seeds per plant
8. 100 seed weight (g)
9. Seed yield per plant
10. Biological yield per plant
11. Pod length (cm)
12. Harvest index (%)
13. Swelling index (%)
14. Swelling capacity
15. Protein Content (%)
16. Dal Recovery

Graph.1 Showing that parent Indira Matar-1was best general combiner for seed yield per plant



On the basis of SCA effects, the best cross combination was Ambika x IPFD 15-8 was observed as superior combiner for number of secondary branches per plant, 100 seed per plant and harvest index. The cross Indira Matar-1x IGP2018-1 for pod per plant, seed per plant, seed yield per plant, biological yield per plant. The cross Aman x KPMR 400 was suggested as desirable specific combiner for days to maturity, seed per plant, 100 seed weight, seed yield per plant and biological yield per plant. Comparative *per se* performance revealed that genotypes Indira Matar-1and IPFD 15-8 were higher yielder. Among the hybrid cross combinations Indira Matar-1x IGP 208-1, Indira Matar-1x KPMR 400, Ambika x Aman, Ambika x IGP 2018-1, Aman x IPFD15-8, Aman x KMPR400, and IPFD15-8 x pant P 250 were best combiners for seed yield.

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