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Study on Genetic Parameters and Performance of Garden Pea (*Pisum sativum* L.) Genotypes for Yield and its Components (Under Northern Transitional Belt of Karnataka, India)

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A B S T R A C T

The present investigation was carried out to study genetic parameters and performance of thirty four and forty eight genotypes of garden pea in *kharif* and *rabi* season, respectively, during 2017. Genotypes were grown in RBD design with two replications at Main Agricultural Research Station, UAS, Dharwad. Analysis of variance revealed significant differences among the genotypes, for all the characters studied, indicating the presence of considerable amount of variability in the material. During *kharif* season, the genotypes *viz.*, DWDP-0007, DWDP-0023, Arkel, AP-3 and IIPR 45-UB-40 recorded high mean performance for pod yield per plant, pod length and number of seeds per pod. During *rabi* season, the genotypes *viz.*, Jhunjhunu Matar, DWDP-0003, IIPR 45-UB30, Kashi Agethi and VRP-5 recorded high mean performance for pod yield per plant, pod length, number of seeds per pod and weight of 100 fresh seeds. Hence, these genotypes could be utilized in the hybridization programmes to bring pod yield improvement in garden pea. The estimates of genetic parameters revealed that GCV and PCV were high for days to first flowering, plant height, days to 50 % flowering (during both seasons), pod yield (during *kharif*), weight of hundred fresh and dry seeds (during *rabi*), indicating presence of high variability and less influence of environment on their expression. High heritability (broad sense) coupled with high genetic advance as per cent of mean was observed for plant height, days to first flowering, days to 50 % flowering, number of branches per plant (during both seasons), pod yield (during *kharif*), pod length, weight of hundred fresh and dry seeds (during *rabi*), indicating that simple selection would be helpful for the improvement of these characters as these are governed by additive gene action. Number of pods per plant, number of seeds per pod (during *kharif*), number of seeds per pod and protein content (during *rabi*) showed moderate heritability and genetic advance.

Introduction

Garden pea (*Pisum sativum* L.) (2n=2x=14) is one of the most important leguminous vegetable grown for their delicious, nutritious seeds throughout the world. It belongs to the family Fabaceae and sub family papilionaceae. In India, pea is cultivated on an area of 4.98

lakh ha with a production of 48.11 lakh tonne and the productivity is 9.70 t/ha. India ranks 1st in the production of pea. Uttar Pradesh stands first in area and production. It is 2.18 lakh ha area and production is 24.81 lakh tonne, followed by Madhya Pradesh and Jharkhand. In Karnataka, area and production is about 1.54 thousand ha and 20.37 thousand tonne respectively, with a productivity of 13.26 t/ha (Anonymous, 2016).

Pea is known because of its rich nutritive value. It is a rich source of carbohydrate, protein, vitamins (A and C) and minerals like calcium and magnesium. According to National Institute of Nutrition, Hyderabad nutritive value of green pea (per 100 g of edible portion) is: protein- 7.20 g, carbohydrate- 15.90 g, fat- 0.10 g, fiber- 4.00 g, calcium- 20.00 mg, magnesium- 34.00 mg, carotene- 83.00 µg, thiamine- 0.25 mg, riboflavin- 0.01 mg, niacin-0.80 mg.

High fiber content in pea improves bowel health and peristalsis. The niacin in peas helps to reduce the production of triglycerides, which results in less bad cholesterol. The dried and powdered seed has been used as a poultice on the skin, where it has an appreciable effect on many types of skin complaint including acne and wrinkled skin. Different compounds present in pea like coumestrol, pisum saponins I and II, pisimosides A and B and phenolic acids helps in prevention of stomach cancer.

The major constraints of pea production include low productivity due to non-availability of location specific varieties suitable for year round cultivation. Hence, there is an urgent need to evaluate the germplasm of pea to select high yielding genotypes which can be adopted as such for commercial production or can be incorporated in the future breeding programmes for improvement of yield. Estimates of parameters of variability importantly, heritability and genetic gain are reliable indicators for improvement of characters in a particular genetic material through selection. Keeping these in view, the present study was taken up to estimate the genetic parameters in gaeden pea genotypes to identify the superior genotypes for pod yield.

Materials and Methods

The research was conducted at Network Project on Onion and Garlic site, Department of Horticulture, Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, in *kharif* and *rabi* season, during 2017. The experimental material for the present investigation consisted of thirty four and fourty eight garden pea genotypes, during *kharif* and *rabi* season, respectively. The experiment was laid in RBD design with two replications with spacing of 45 cm between rows and 30 cm between plants. Five plants were selected at random from each replication and data were recorded for characters *viz.*, plant height, days to first flowering, days to 50 per cent flowering, number of branches per plant, number of pods per plant, pod yield per plant, pod length, pod width and number of seeds per pod for both seasons. Observation on weight of hundred fresh and dry seeds, protein content and total soluble solids content was recorded during *rabi* season only. Genetic parameters like variance, genotypic and phenotypic coefficient of variation, heritability and genetic advance as per cent of mean were calculated as per the standard procedure given by Singh and Choudhary (1979).

Results and Discussion

Analysis of variance revealed significant differences among the thirty four and fourty eight genotypes, for all the ten and fourteen characters studied during *kharif* and *rabi* season respectively, indicating the presence of considerable amount of variability in the

material (Table 1 and 2). The genotypes DWDP-0007, DWDP-0023, Arkel, AP-3 and IIPR 45-UB-40 recorded high mean performance for pod yield per plant, pod length and number of seeds per pod during *kharif* season (Table 3). During *rabi* season (Table 4), number of pods per plant was found maximum in genotype DWDP-0009, pod length was reorded maximum in genotype Kashi Agethi, number of seeds per pod and weight of hundred fresh seeds was found highest in genotype VRP-5. Pod yield per plant was found highest in genotypes Jhunjhunu Matar, DWDP-0003, IIPR-45-UB-30, Kashi Agethi and Kedia Matar.

Based on the mean performance of genotypes, genotypes DWDP-0007, AP-3, Arkel and IIPR-44-UB-40 were good performer during *kharif* season. The genotypes, Jhunjhunu Matar, Kashi Agethi and VRP-5 had good performance during *rabi* season. Hence, these genotypes can be selected as promising parent to develop high yielding progeny for yield improvement in garden pea.

The mean performance of all genotypes during *kharif* and *rabi* season, were studied. Investigation indicates significant differences for all the characters among the genotypes. Yield during both growing season was not good and low yield was found for all genotypes, because weather parameters (high temperature and low relative humidity) were not favorable for potential yield of the crop. During *rabi* season yield was comparatively high then *kharif* season, because of availability of comparatively cool and favorable climatic condition to boost the yield of garden pea.

In the present study, the estimates of PCV for all the characters were higher than the estimates of GCV, which may be due to the interaction of genotypes with the environment. During *kharif* season (Table 5), the highest estimates of coefficients of variation were registered for pod yield per plant followed by days to first flowering, plant height 40 DAS and days to fifty per cent flowering (Devi *et al.,* 2017). A higher estimate of genotypic and phenotypic coefficients of variation indicates the presence of ample variability among the genotypes for these characters. Similar finding were reported by Mehta *et al.,* (2005), Lal *et al.,* (2011) and Afreen *et al.,* (2017), in garden pea.

The moderate estimates of GCV and PCV were recorded for number of pods per plant followed by plant height 75 DAS and pod length during *kharif* season, indicating the less variability among the genotypes for these characters. These results are in agreement with the findings of Sureja *et al.,* (2000), Singh *et al.,* (2003), Ramesh *et al.,* (2002) and Chaudhary *et al.,* (2010), in garden pea.

During *rabi* season (Table 6), weight of hundred fresh seeds followed by plant height 60 DAS, weight of hundred dry seeds and days to first flowering showed maximum phenotypic and genotypic coefficient of variation. A higher estimate of genotypic and phenotypic coefficients of variation indicates the presence of ample variability among the genotypes for these characters.

Therefore, simple selection for these characters could be effective for bringing further improvement in garden pea. These results are in accordance with the studies of Mehta *et al.,* (2005), Lal *et al.,* (2011) and Afreen *et al.,* (2017), in garden pea.

Moderate estimates of GCV and PCV was observed for number of branches per plant followed by days to fifty per cent flowering, number of seeds per pod, pod length and TSS content during *rabi* season indicated the less variability among the genotypes for these characters.

Table.1 Analysis of variance for ten characters in thirty four garden pea genotypes grown during *kharif* season

Sl. No.	Character	Mean sum of squares		
		Replication (df: 1)	Genotype (df: 33)	Error (df: 33)
1	Plant height 40 DAS (cm)	33.82	178.93**	4.29
2	Plant height 75 DAS (cm)	52.95	142.47**	11.27
3	Days to first flowering	15.05	288.63**	18.27
4	Days to 50 % flowering	7.77	285.76**	17.84
5	No. of branches per plant	2.11	1.43**	0.20
6	No. of pods per plant	2.60	17.31**	6.43
7	Pod length (cm)	0.04	1.29**	0.20
8	Pod width (cm)	0.01	0.01**	0.00
9	No. of seeds per pod	0.14	1.23**	0.37
10	Pod yield per plant (g)	31.79	74.09**	15.39

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

Table.2 Analysis of variance for fourteen characters in fourty eight garden pea genotypes grown during *rabi* season

Sl. No.	Character	Mean sum of squares		
		Replication (df: 1)	Genotype (df: 47)	Error (df:47)
1	Plant height 60 DAS (cm)	0.91	366.01**	36.83
2	Plant height 90 DAS (cm)	178.76	344.97**	38.98
3	Days to first flowering	5.04	235.95**	7.63
4	Days to 50 % flowering	0.66	221.58**	6.94
5	No. of branches per plant	7.04	0.90**	0.19
6	No. of pods per plant	45.54	11.57**	4.21
7	Pod length (cm)	0.10	1.98**	0.14
8	Pod width (cm)	0.06	0.02**	0.00
9	No. of seeds per pod	0.16	1.58**	0.43
10	Weight of 100 fresh seeds (g)	4.90	153.49**	0.17
11	Weight of 100 dry seeds (g)	3.97	17.17**	0.10
12	TSS content (ºbrix)	1.40	23.99**	0.30
13	Protein content (%)	0.02	4.85**	1.33
14	Pod yield per plant (g)	49.95	82.68**	39.90

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

Table.3 Mean performance of thirty four genotypes of garden pea (*Pisum sativum* L.) for ten characters grown during *kharif* season

Sl. No.	Genotypes	Plant height 40 DAS (cm)	Plant height 75 DAS (cm)	Days to first flowering	Days to 50 % flowering	No. of branches per plant	No. of pods per plant	Pod length (cm)	Pod width (cm)	No. of seeds per pod	Pod yield per plant (g)
1	DWDP-0001	15.50	43.84	48.00	53.00	5.00	17.17	7.32	1.11	6.95	16.50
2	DWDP-0002	19.17	48.83	39.50	43.50	3.50	17.84	7.14	1.11	6.95	19.67
3	DWDP-0003	15.50	35.50	39.00	44.00	4.00	17.84	7.19	1.01	6.67	27.67
4	DWDP-0004	33.67	64.00	24.00	33.50	6.00	23.67	4.93	0.84	5.23	18.50
5	DWDP-0005	30.67	63.67	46.50	51.00	5.00	21.84	6.46	1.12	5.67	18.83
6	DWDP-0006	38.34	60.50	49.00	55.00	4.00	20.83	6.23	1.10	6.45	21.84
7	DWDP-0007	47.50	58.00	43.50	49.50	4.50	23.84	6.10	1.02	5.84	30.34
8	DWDP-0008	45.83	64.00	58.00	65.50	5.00	23.67	6.18	1.07	6.56	14.67
9	DWDP-0009	38.67	58.00	25.00	33.00	4.50	25.83	5.70	0.92	5.89	12.17
10	DWDP-0011	39.33	57.84	59.00	65.00	5.50	21.50	6.48	1.18	6.95	26.33
11	DWDP-0012	38.83	58.84	53.50	60.00	5.00	20.67	6.37	1.07	6.95	21.34
12	DWDP-0014	46.34	70.34	59.00	70.50	6.00	22.50	5.98	0.99	6.12	18.34
13	DWDP-0015	46.84	64.00	47.50	54.00	5.50	20.17	6.12	1.04	6.17	22.09
14	DWDP-0018	33.17	63.17	49.00	55.50	5.50	20.17	6.46	1.19	5.73	12.17
15	DWDP-0019	54.67	71.17	52.00	59.50	4.50	25.00	5.83	1.14	5.61	11.84
16	DWDP-0021	40.50	58.33	58.50	63.50	5.00	23.83	6.01	1.15	6.22	21.00
17	DWDP-0023	25.67	51.50	36.00	41.00	5.50	18.17	8.10	1.03	8.11	30.34
18	GS-10	33.17	56.83	35.50	41.00	5.50	20.17	7.42	1.07	7.22	27.50
19	PSM-13	21.84	47.67	24.50	30.50	4.50	14.67	7.49	1.22	7.56	25.67
20	Kedia Matar	37.17	54.00	32.50	40.00	6.00	17.00	7.35	1.03	7.72	26.67
21	Kashi Agethi	29.17	49.17	24.00	31.50	5.00	15.17	8.05	1.16	8.23	27.50
22	Arkel	29.33	44.34	23.00	28.50	4.50	15.00	8.13	1.20	8.06	29.34
23	AP-1	33.17	50.50	33.50	40.00	4.00	20.17	7.63	1.22	7.78	19.00
24	AP-3	19.00	44.67	24.00	32.00	3.50	15.50	7.52	1.24	7.34	29.50
25	VRP-5	24.50	41.84	23.00	30.50	4.50	15.50	7.89	1.18	7.72	24.50
26	VRP-6	29.50	48.00	23.50	32.00	3.00	17.50	7.45	1.21	6.78	17.17
27	PC-531	34.67	48.50	35.50	41.50	4.50	19.17	7.10	1.03	6.39	20.84

Table.3 (Conti…)

Sl. No.	Genotypes	Plant height 40 DAS (cm)	Plant height 75 DAS (cm)	Days to first flowering	Days to 50 % flowering	No. of branches per plant	No. of pods per plant	Pod length (cm)	Pod width (cm)	No. of seeds per pod	Pod yield per plant (g)
28	IIPR-37	28.17	46.17	56.50	63.50	4.00	19.83	6.65	1.16	6.61	16.34
29	IIPR-36	29.33	45.34	45.00	51.00	4.50	19.67	6.85	1.04	6.50	9.17
30	IIPR-43	29.00	49.67	38.00	42.50	3.00	18.83	7.25	1.10	6.34	18.34
31	IIPR- 44- UB-40	34.67	52.50	38.00	44.00	4.50	20.17	8.20	1.07	7.61	28.34
32	IIPR -45-UB-30	30.67	45.84	37.50	42.50	3.00	19.50	7.59	1.10	7.56	24.67
33	DWDP-0024	20.17	53.83	43.50	50.00	3.50	18.00	6.80	1.17	6.78	11.17
34	46- Local	29.00	51.67	52.50	58.50	4.50	20.34	7.42	1.14	6.72	24.50
	Mean	32.43	53.59	40.50	46.96	4.59	19.73	6.92	1.10	6.79	21.29
	Range (Lowest to Highest)	15.50 to 54.67	35.50 to 71.17	23.00 to 59.00	28.50 to 70.50	3.00 to 6.00	14.67 to 25.83	4.93 to 8.20	0.84 to 1.24	5.23 to 8.23	9.17 to 30.34
	C.V. (%)	6.39	6.27	10.55	9.00	9.95	12.86	6.54	2.48	9.05	18.43
	F ratio	41.68	12.63	15.80	16.02	6.90	2.69	6.32	21.01	3.26	4.81
	F Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	S.Em. ±	1.47	2.37	3.02	2.99	0.32	1.79	0.32	0.02	0.43	2.77
	C.D. @ 5%	4.22	6.83	8.70	8.59	0.93	5.16	0.92	0.06	1.25	7.98
	C.D. @ 1%	5.66	9.18	11.68	11.54	1.25	6.94	1.24	0.07	1.68	10.73

Table.4 Mean performance of fourty eight genotypes of garden pea (*Pisum sativum* L.) for fourteen characters grown during *rabi* season

Sl. No.	Genotypes	Plant height 60 DAS (cm)	Plant height 90 DAS (cm)	Days to first flowe-ring	Days to 50% flowe-ring	No. of branc-hes per plant	No. of pods per plant	Pod length (cm)	Pod width (cm)	No. of seeds per pod	Weight of 100 fresh seeds (g)	Weight of 100 dry seeds (g)	TSS content (°brix)	Protein content (%)	Pod yield per plant (g)
1	DWDP-0001	41.83	59.67	49.50	54.00	5.00	9.33	6.68	1.08	5.83	38.70	18.00	27.10	13.82	19.17
2	DWDP-0002	36.50	58.34	47.00	51.50	4.50	10.72	7.42	1.03	5.56	30.20	10.60	32.25	10.79	24.84
3	DWDP-0003	32.34	54.33	47.00	52.00	4.00	10.22	7.44	1.01	5.89	29.75	9.15	23.90	14.11	35.95
4	DWDP-0004	52.34	68.50	32.00	40.50	5.50	18.39	4.74	0.75	5.45	16.10	8.65	31.60	13.91	24.89
5	DWDP-0005	69.67	85.33	62.50	67.50	5.00	11.84	5.63	1.11	5.34	20.75	9.40	24.15	16.62	20.89
6	DWDP-0006	60.00	75.00	62.50	68.00	4.50	13.28	5.74	1.06	5.95	23.00	10.55	33.60	15.23	26.06
7	DWDP-0007	60.67	83.33	63.00	68.00	4.00	12.67	5.33	0.95	5.11	24.05	8.60	25.00	13.19	28.61
8	DWDP-0008	67.33	85.17	52.50	59.50	6.00	16.11	5.39	0.98	5.67	14.25	13.90	26.95	14.11	27.33
9	DWDP-0009	53.84	78.00	31.50	38.50	3.50	21.39	4.33	0.77	5.33	14.75	7.40	23.55	16.36	23.89
10	DWDP-0010	36.34	55.17	63.00	69.50	3.50	10.39	6.51	1.17	5.28	35.05	13.15	26.35	15.29	17.67
11	DWDP-0011	67.17	90.50	61.00	66.50	4.50	13.95	5.92	1.12	6.39	25.30	11.60	25.15	16.24	32.39
12	DWDP-0012	73.83	91.50	57.50	64.50	5.00	15.84	5.61	1.05	5.39	16.10	13.90	31.10	14.00	27.45
13	DWDP-0013	51.50	61.50	51.00	57.00	3.00	13.84	5.70	1.09	5.39	23.05	13.25	24.35	15.21	26.00
14	DWDP-0014	65.50	85.34	62.50	68.50	4.00	12.62	5.67	0.99	5.61	20.55	8.05	27.60	12.77	20.56
15	DWDP-0015	68.83	89.50	62.00	68.00	4.00	13.72	5.67	0.98	5.34	22.05	17.10	26.90	12.78	27.84
16	DWDP-0016	56.17	76.67	67.50	72.00	3.50	11.89	5.22	0.96	5.73	20.90	17.70	28.70	14.66	17.17
17	DWDP-0017	55.83	76.67	56.50	64.00	4.00	12.11	6.02	1.07	5.83	35.40	15.50	25.70	15.88	19.23
18	DWDP-0018	72.17	94.00	57.00	63.50	4.50	12.61	5.40	0.97	5.17	26.95	13.65	26.80	16.63	16.28
19	DWDP-0019	68.67	93.50	55.00	62.50	4.00	14.45	5.38	1.05	6.34	30.60	14.50	19.45	13.93	25.06
20	DWDP-0020	46.50	66.17	47.00	55.00	3.00	13.61	5.55	1.03	6.34	20.60	11.25	23.20	15.65	15.95
21	DWDP-0021	65.67	85.67	59.50	67.00	4.00	13.22	5.60	1.09	6.06	21.60	10.65	24.60	16.51	25.06
22	DWDP-0022	50.00	66.67	65.50	71.50	4.00	12.28	6.07	1.15	5.89	19.50	10.50	29.45	14.43	20.84
23	DWDP-0023	38.00	60.50	47.00	52.00	3.50	9.89	7.68	1.01	7.67	41.55	13.50	30.30	15.34	34.06
24	GS-10	38.34	62.33	48.00	54.00	3.50	9.72	7.28	1.05	7.34	26.65	9.60	25.70	17.14	32.17
25	PSM-13	37.50	56.17	31.00	37.00	3.50	10.83	7.52	1.23	7.17	38.55	18.95	31.20	16.14	31.72
26	Udaipuri Matar	54.17	72.34	61.50	66.50	4.00	11.61	5.94	1.14	5.67	28.65	14.65	29.40	13.94	20.84
27	Jhunjhunu Matar	30.50	54.33	55.00	59.50	4.00	11.17	6.94	1.03	5.50	26.25	11.50	26.20	13.45	37.06
28	Kedia Matar	35.17	55.17	47.50	55.00	3.50	9.89	7.12	1.01	6.84	36.25	11.45	28.20	14.37	35.00
29	Kashi Agethi	37.00	59.33	35.00	42.50	3.00	10.95	8.15	1.20	7.67	42.05	17.85	31.70	16.08	35.23
30	Arkel	40.17	64.17	31.50	37.00	3.50	9.62	7.83	1.22	7.89	40.95	14.80	29.70	18.39	32.73
31	DWDP-0025	54.83	75.00	66.00	72.50	3.50	11.67	6.69	1.16	6.23	23.05	10.20	28.30	15.15	26.06
32	DWDP-0026	37.34	59.84	47.00	55.00	3.00	10.56	7.59	1.17	7.45	28.75	11.45	30.30	16.71	21.95
33	DWDP-0027	29.34	51.84	66.00	73.00	4.00	10.10	7.40	1.06	7.38	26.91	9.49	25.72	17.64	32.59
34	AP-1	40.17	59.50	54.00	60.50	4.00	11.67	7.58	1.20	7.34	22.00	12.60	29.35	15.25	23.23
35	AP-3	40.00	60.67	34.00	42.00	3.50	9.45	7.44	1.21	7.28	44.50	11.70	30.25	17.26	31.06

Table.4 (Cont…)

Sl. No.	Genotypes	Plant height 60 DAS (cm)	Plant height 90 DAS (cm)	Days to first flowering	Days to 50% flowering	No. of branch-es per plant	No. of pods per plant	Pod length (cm)	Pod width (cm)	No. of seeds per pod	Weight of 100 fresh seeds (g)	Weight of 100 dry seeds (g)	TSS content (ºbrix)	Protein content (%)	Pod yield per plant (g)
36	VRP-5	36.17	57.00	31.50	39.00	4.50	10.56	8.14	1.18	8.11	46.50	16.95	32.65	16.55	31.12
37	VRP-6	33.33	57.00	39.50	47.50	3.50	9.56	7.25	1.20	7.23	44.55	13.90	28.80	14.85	26.45
38	PC-531	33.67	56.67	56.00	62.00	3.50	10.23	7.20	1.00	6.67	24.15	9.40	26.50	14.69	19.67
39	VL Matar-47	36.50	59.50	66.00	72.00	3.50	9.27	7.64	1.19	7.56	44.46	11.72	30.83	16.57	32.74
40	Local Collection	48.33	69.84	66.00	72.50	4.00	10.83	5.77	0.97	5.78	18.15	12.65	35.60	16.02	12.78
41	IIPR-37	37.67	55.50	60.00	67.00	4.00	12.17	6.17	1.09	6.06	20.90	9.40	21.30	15.10	20.84
42	IIPR-36	35.67	53.50	62.50	68.50	3.00	12.06	6.49	1.04	6.34	22.85	11.40	23.75	19.27	16.23
43	IIPR-43	34.84	56.83	59.50	64.00	3.50	9.50	7.14	1.08	5.89	34.05	8.10	26.25	15.31	18.56
44	IIPR- 44- UB-40	34.67	55.33	48.50	54.50	3.00	10.89	8.08	1.04	7.84	23.55	9.60	21.85	15.74	27.67
45	IIPR -45-UB-30	36.17	57.84	50.00	55.00	3.00	9.34	7.61	1.03	6.67	26.05	9.75	22.80	17.07	35.67
46	IIPR-42-Local	29.17	49.84	52.50	60.00	4.00	12.34	7.46	1.01	7.89	28.85	10.60	27.00	16.07	23.89
47	DWDP-0024	35.50	56.50	60.00	66.50	3.00	10.00	6.49	1.12	6.67	25.55	9.50	22.90	14.16	15.00
48	46- Local	36.83	55.50	49.00	56.00	4.00	12.11	7.34	1.10	6.89	18.95	10.75	28.00	14.72	25.11
	Mean	46.53	66.93	52.85	59.17	3.88	11.88	6.56	1.06	6.37	27.79	12.05	27.33	15.31	25.47
	Range (Lowest to Highest)	29.17 to 73.83	49.84 to 94.00	31.00 to 67.50	37.00 to 73.00	3.00 to 6.00	9.27 to 21.39	4.33 to 8.15	0.75 to 1.23	5.11 to 8.11	14.25 to 46.50	7.40 to 18.95	19.45 to 35.60	10.79 to 19.27	12.78 to 37.06
	C.V. (%)	13.04	9.33	5.23	4.45	11.27	17.28	5.81	5.59	10.34	1.48	2.74	2.02	7.54	24.80
	F ratio	9.94	8.85	30.89	31.91	4.74	2.75	13.70	5.81	3.65	901.78	157.10	79.01	3.64	2.07
	F Prob.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	S.Em. ±	4.29	4.41	1.95	1.86	0.31	1.45	0.27	0.04	0.47	0.29	0.23	0.39	0.82	4.47
	C.D. @ 5%	12.21	12.56	5.56	5.30	0.88	4.13	0.77	0.12	1.33	0.83	0.67	1.11	2.32	12.71
	C.D. @ 1%	16.29	16.76	7.42	7.07	1.17	5.51	1.02	0.16	1.77	1.11	0.89	1.48	3.10	16.96

Table.5 Mean, coefficient of variation, heritability (broad sense), genetic advance as per cent of mean for ten characters in garden pea (*Pisum sativum* L.) grown during *kharif* season

Sl. No.	Characters	Mean	Range		Variance		Coefficient of variation		Herita-bility (Broad sense) (%)	Genetic advance (GA)	Genetic advance as per cent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)			
1.	Plant height 40 DAS (cm)	32.43	15.50	54.67	87.32	91.61	28.81	29.51	95.31	18.79	57.94
2.	Plant height 75 DAS (cm)	53.59	35.50	71.17	65.60	76.87	15.11	16.36	85.33	15.41	28.76
3.	Days to first flowering	40.50	23.00	59.00	135.18	153.45	28.70	30.58	88.09	22.48	55.50
4.	Days to 50 % flowering	46.96	28.50	70.50	133.96	151.80	24.64	26.23	88.25	22.39	47.70
5.	No. of branches per plant	4.59	3.00	6.00	0.61	0.82	17.09	19.77	74.68	1.39	30.42
6.	No. of pods per plant	19.73	14.67	25.83	5.43	11.87	11.82	17.47	45.79	3.25	16.47
7.	Pod length (cm)	6.92	4.93	8.20	0.54	0.75	10.67	12.51	72.69	1.29	18.74
8.	Pod width (cm)	1.10	0.84	1.24	0.00	0.00	7.84	8.23	90.91	0.16	15.41
9.	No. of seeds per pod	6.79	5.23	8.23	0.42	0.80	9.62	13.21	53.10	0.98	14.45
10.	Pod yield per plant (g)	21.29	9.17	30.34	29.34	44.74	25.44	31.42	65.59	9.03	42.45

Table.6 Mean, coefficient of variation, heritability (broad sense), genetic advance as per cent of mean for fourteen characters in garden pea (*Pisum sativum* L.) grown during *rabi* season

Sl. No.	Characters	Mean	Range		Variance		Coefficient of variation		Herita-bility (Broad sense) (%)	Genetic advance (GA)	Genetic advance as per cent of mean (%)
			Min.	Max.	Genotypic	Phenotypic	Genotypic (%)	Phenotypic (%)			
1.	Plant height 60 DAS (cm)	46.53	29.17	73.83	164.59	201.42	27.56	30.49	81.71	23.89	51.33
2.	Plant height 90 DAS (cm)	66.93	49.84	94.00	152.99	191.97	18.48	20.70	79.69	22.47	33.98
3.	Days to first flowering	52.85	31.00	67.50	114.15	121.79	20.21	20.88	93.73	21.30	40.31
4.	Days to 50% flowering	59.17	37.00	73.00	107.32	114.26	17.50	18.06	93.92	20.68	34.95
5	No. of branches per plant	3.88	3.00	6.00	0.35	0.54	15.41	19.09	65.18	0.99	25.63
6.	No. of pods per plant	11.88	9.27	21.39	3.67	7.89	16.14	23.64	46.61	2.69	22.70
7.	Pod length (cm)	6.56	4.33	8.15	0.92	1.06	14.63	15.74	86.39	1.83	28.01
8	Pod width (cm)	1.06	0.75	1.23	0.00	0.01	8.66	10.30	70.62	0.15	14.99
9.	No. of seeds per pod	6.37	5.11	8.11	0.57	1.00	11.90	15.76	56.99	1.17	18.51
10.	Weight of 100 fresh seeds (g)	27.79	14.25	46.50	76.66	76.83	31.50	31.54	99.78	18.01	64.83
11.	Weight of 100 dry seeds (g)	12.05	7.40	18.95	8.83	8.64	24.23	24.38	98.74	5.97	49.60
12.	TSS content (ºbrix)	27.33	19.45	35.60	11.84	12.14	12.59	12.75	97.50	7.00	25.61
13.	Protein content (%)	15.31	10.79	19.27	1.75	3.09	8.66	11.48	56.88	2.06	13.45
14.	Pod yield per plant (g)	25.47	12.78	37.06	21.38	61.29	18.16	30.74	34.90	5.62	22.09

Between both seasons, compare to *kharif* season, more variability was observed in *rabi* season, for characters like number of pods per plant, pod length, pod width and number of seeds per pod.

All characters, exhibited relatively low magnitude of differences between PCV and GCV during both seasons, indicating less environmental influence on these characters. Thus, the characters showing maximum phenotypic coefficient of variation would be considered, while making selection in spite of influence of environment to a certain extent. These findings of genotypic and phenotypic coefficients of variation are in consonance with the reports of Sureja *et al.,* (2000), Singh *et al.,* (2003), Ramesh *et al.,* (2002) and Chaudhary *et al.,* (2010), in garden pea.

Heritability measures the relative amount of heritable portion of variability. It is a good index of the transmission of characters from parents to offspring. The perusal of the Table 5, revealed the estimates of heritability in broad sense for ten characters studied during *kharif* seaon, which range from 45.79 to 95.31 per cent. High heritability was recorded for plant height 40 DAS followed by pod width, days to fifty per cent flowering (Tiwari and Roopalavanya, 2012; Afreen *et al.,* 2017), days to first flowering (Habtamu and Million, 2013), plant height 75 DAS (Singh *et al.,* 1993), number of branches per plant, pod length and pod yield per plant (Gudadinni *et al.,* 2017). These results are in correspondences with the findings of Lavanaya *et al.,* (2010), Lal *et al.,* (2011), Gupta *et al.,* (2006), Sharma *et al.,* (2007), Guleria *et al.,* (2009), Singh *et al.,* (2011) and Sharma and Sharma (2013).

In *rabi* season (Table 6), highest heritability was observed for weight of 100 fresh seeds followed by weight of 100 dry seeds (Pratap *et al.,* 1992 and Singh *et al.,* 1993), TSS content, days to fifty per cent flowering (Tiwari and Roopalavanya, 2012), days to first flowering (Habtamu and Million, 2013), pod length, plant height 60 DAS, plant height 90 DAS (Singh *et al.,* 1993), pod width and number of branches per plant. The result of high heritability estimates for above characters were also reported by Lavanaya *et al.,* (2010), Lal *et al.,* (2011), Gupta *et al.,* (2006), Sharma *et al.,* (2007), Guleria *et al.,* (2009), Singh *et al.,* (2011) and Sharma and Sharma (2013). This higher heritability value indicates that tentatively there might be additive gene effect for these characters. It showed that the characters having high value of heritability were least affected by the environmental modification and signified that the phenotypes were the true representative of their genotypes and selection based on phenotypic performance would be reliable.

Heritability estimates along with genetic advance are more useful than heritability alone in predicting the effectiveness of selection. Further, the heritability estimates coupled with expected genetic advance as per cent of mean indicates the mode of gene action in choosing an appropriate breeding methodology. During *kharif* season, high heritability coupled with high genetic advance as per cent of mean recorded for plant height (Gudadinni *et al.,* 2017), days to first flowering, days to 50 per cent flowering, number of branches per plant and pod yield per plant indicates, additive gene action is involved in the genetic control of these traits. Hence, simple selection may help in improving these traits. These findings were well documented by Gupta *et al.,* (2006) and Sharma *et al.,* (2007), in garden pea.

During *rabi* season, maximum genetic advance were recorded for plant height 60 DAS, plant height 90 DAS (Lal *et al.,* 2011 and Singh, 1995), days to first flowering and days to fifty per cent flowering. Moderate

value of genetic advance was observed for weight of 100 fresh seeds. Higher heritability values along with high genetic advance indicated more scope exists for improvement of these characters by selection methods. These findings were well documented by Gupta *et al.,* (2006) and Sharma *et al.,* (2007), in garden pea.

During *kharif* season, moderate heritability and genetic advance as per cent of mean were recoded for number of pods per plant and number of seeds per pod. These findings were in consonance with the studies of Guleria *et al.,* (2009) and Singh *et al.,* (2011), in garden pea. High heritability coupled with moderate genetic advance as per cent of mean were recorded for pod length and pod width suggesting that the trait is controlled by both additive and non-additive gene action.

During *rabi* season, maximum genetic advance as per cent of mean was registered for weight of 100 fresh seeds followed by plant height 60 DAS, weight of 100 dry seeds, days to first flowering, days to fifty per cent flowering, plant height 90 DAS, pod length, number of branches per plant, TSS content, number of pods per plant and pod yield per plant (Gudadinni *et al.,* 2017). Moderate values of genetic advance as per cent of mean were observed for number of seeds per pod, pod width, and protein content. These results indicated additive gene effects controlling the inheritance of these characters and simple selection schemes would be sufficient for the improvement of such characters. These findings were in consonance with the studies of Guleria *et al.,* (2009) and Singh *et al.,* (2011), in garden pea.

From the above discussion it can be concluded that, high estimates of GCV, PCV, heritability (broad sense) and genetic advance as per cent of mean were recorded for plant height, days to first flowering, days to 50 per cent flowering, pod yield per plant during both seasons, *kharif* and *rabi*. These results are in line with the findings of Pallavi and Pandey (2013) for days to 50 per cent flowering and pod yield per plant, indicating that simple selection would be helpful for the improvement of these traits as these are governed by additive gene action. Characters like number of pods per plant (during *kharif*) and number of seeds per pod (during both seasons), recoded moderate heritability and modrate genetic advance as per cent of mean and suggesting that characters are governed by both additive and non-additive gene action.

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