

Original Research Article

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Study on Genetic Variability, Heritability and Genetic Advance in Garden Pea (*Pisum sativum* var. *hortense* L.)

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ABSTRACT

An experiment was conducted to derived information on genetic variability, heritability and genetic gain in the twenty six genotypes including check in garden pea during 2016-17 at the Field Experimentation Centre of the Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad. The observations were recorded on various yield and yield contributing characters. Analysis of variance showed the significant variability for all the studied characters expect number of primary branches per plant. High heritability was recorded for all characters except protein content (53.36) which was medium heritability. High values of GCV and PCV were observed for characters viz., pod yield per plant (20.84 and 22.12) pod yield per plot (20.84 and 22.12) and days to first flowering (21.14 and 21.26) and which indicates the presence of high genetic variation. High heritability coupled with high genetic advance observed for the traits viz., pod yield (g/plant), pod yield per plot (g/plot), plant height and days to first flowering which indicates presence of additive gene action and demands for population improvement by selection. The genotypes with specific characters can be utilized for hybridization programme.

Keywords

Variability, GCV,
PCV, Heritability,
Genetic advance,
Garden pea.

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Introduction

Botanically, pea belongs to the genus *Pisum* and species *sativum*, which is further divided into two cultivated varieties, *hortense* and *arvense*. The garden pea, *P. sativum* L. ($2n=2x=14$) comes under the variety *hortense* (Ambrose, 1995; Zohary and Hopf, 2000). The garden pea is also known as the common pea and is one of the most important vegetable in the world. It is an annual herbaceous crop of the family *Fabaceae*. According to Blixt (1970), the Mediterranean is the primary centre of diversity with

secondary centre in Ethiopia. Peas are starchy but, high in fiber, protein, vitamins (vitamin A, C, K and B complex vitamins such as folic acid, pantothenic acid, niacin, thiamine and pyridoxine), minerals (iron, magnesium, phosphorus and zinc) and lutein (a yellow carotenoid pigment that benefits vision). The dry pea seeds are rich source of proteins (about 19-27%) and are free of anti-nutritional substances (Pettersen *et al.*, 1997). The development of an intensive breeding and improvement program needs detailed

biological information and an understanding of genetic variation for yield and its components. There, must be a thorough knowledge of the existence of genetic variability, the mode of inheritance of economic characters, heritability, the kind of gene action and the relative magnitude of additive, dominance and total genotypic and phenotypic variance of the population. Considering the availability of genetic variability, there is scope of yield and quality improvement and there by develop export potential of garden peas. Hence, the present investigation is carried out for various economic traits and to measure the extent of variability, heritability, genetic advance and their genetic makeup in garden peas.

Materials and Methods

The present investigation was carried out at the horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Science and Technology, Allahabad. The experimental material comprised of twenty six genotypes including check, which were collected from different source (Table 1).

The genotypes were grown in a randomized block design with three replicates during winter season keep line to line distance of 60 cm. and plant to plant distance of 20 cm during the year 2016-2017. Five competitive plants were selected at randomly tagged from each plot to record observation on various characters *viz.*, plant height, number primary of branches, days to first flowering, days to 50 per cent flowering, days to pod setting, days to first pod picking, number of pods per cluster, number of pods per plant, pod length (cm), pod width (cm), average pod weight (g), pod yield per plant (g), pod yield per plant (g), pod yield per plot (g), number of seed per pod, seed yield per plant (g), shelling (%), moisture content in pods (%), fibre content (Bidwell and Bopst, 1921) and protein content

(Lowry *et al.*, 1951). The analysis of variance was done as suggested by Panse and Sukhatme (1978). The genotypic and phenotypic coefficients of variation were worked out according to the given by Robinson *et al.*, (1949). Heritability in broad sense and expected genetic advance on the basis of percent of mean were worked out according to the method advocated by Burton and Devane (1953) and Johnson *et al.*, (1955), respectively.

Results and Discussion

The mean sum of square in ANOVA revealed high variability among 26 genotypes for all the characters (except the number of primary branches per plant) at 5% and 1% level of probability (Table 2). The highly significant differences might be endorsed to their genetic makeup of germplasm lines and various regions from where they have been collected. The results of present investigation are in accordance with Jaiswal *et al.*, (2015), Gowher *et al.*, (2013) and Kumar *et al.*, (2017).

The mean performance of various genotypes has also showed good range of variability for various characters, which were studied in present investigation (Table 2). The range record for plant height (47.71-97.51), number of primary branches (2.13- 3.13), plant spread (30.33- 37.93), days to first flowering (34.73- 61.21), days to 50% flowering (40.00- 67.73), days to pod setting (38.00- 67.73), days to pod picking (54.33- 90.67), number of pods per cluster (1.33- 2.00), number of pods per plant (7.80- 15.87), pod length (6.17- 10.53), pod width (1.28- 2.23), average pod weight (3.70- 8.49), pod yield per plant (40.40- 90.47), pod yield per plot (484.85- 1085.68), number of seeds per pod (4.73- 8.64), seed yield per plant (9.50- 13.63), shelling (36.33- 54.00), moisture content in pods (68.67- 84.33), fibre content (8.27- 13.52) and protein

content (25.17- 34.50). The characters under investigation were analyzed for genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance as percent of mean (Table 3). In the present study it was observed that magnitude of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters under study which is an indicator of additive effect of the environment on the expression of the trait.

It is also observed that the low range between PCV and GCV so it reveals that these traits have low sensitivity to environmental effects and it is reducible. Similar findings were also reported by Katoch *et al.*, (2016), Siddika *et al.*, (2013), Kumar *et al.*, (2013) and Ahmad *et al.*, (2013).

Genotypic coefficient of variation (GCV) ranged from 4.9% to 21.14%. Higher magnitude of GCV was recorded for days to first flowering (21.14%), followed by pod yield per plot (20.84%), pod yield per plant (20.84%), number of pods per plant (20.66%), average pod weight 19.84% and plant height (19.29%).

Similar findings were also reported by Afreen *et al.*, (2017), Katoch *et al.*, (2016), Jaiswal *et al.*, (2015), Kumar *et al.*, (2015), Ahmad *et al.*, (2014), Asfakun *et al.*, (2013), Kumar *et al.*, (2013) and Pal and Singh (2013). The moderate amount of GCV were recorded for Days to 50% flowering (18.55%), Days to pod setting (18.12%), fibre content (13.33%), pod width (13.28%), number of seeds per pod (12.90%), pod length (12.08%), days to first pod picking (12.06%), number of pods per cluster(9.50%), shelling per cent(9.30%) and seed yield per plant (8.36%). The results were similar conformity by Georgieva *et al.*, (2016). The low amount of GCV were recorded for protein content (7.88%), plant

spread (5.84%), Moisture content in pods (5.52%) and number of primary branches per plant (4.90%). High values of GCV are an indication of high genetic variability among the genotypes and thus the scope for improvement of these characters through simple selection would be better.

Phenotypic coefficient of variation (PCV) ranged from 5.23% to 22.12%. Higher magnitude of PCV was recorded for pod yield per plot (22.12%), followed by pod yield per plant (22.12%), number of pods per plant(21.86%), days to first flowering (21.26%) and pod yield per plant (20.01).

Similar findings were also reported by Katoch *et al.*, (2016), Jaiswal *et al.*, (2015), Kumar *et al.*, (2015), Ahmad *et al.*, (2014) Asfakun *et al.*, (2013), Kumar *et al.*, (2013) and Pal and Singh (2013).

The moderate amount of PCV was recorded for plant height (19.36%), days to 50% flowering (18.76%), days to pod setting (18.22%), days to first pod picking (15.02%), fibre content (14.37%), pod width (14.11%), number of seeds per pod (13.25%), pod length (12.81%), number of pods per cluster(11.10%), protein content (10.78%) and seed yield per plant (10.53%). Similar finding was also reported by Georgieva *et al.*, (2016). The low amount of PCV were recorded for shelling (9.98%), plant spread (6.54%), moisture content in pods (5.98%) and number of primary branches per plant (5.23%). In the present study it was observed that magnitude of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the characters under study which is an indicator of additive effect of the environment on the expression of the trait. Similar findings were also reported by Katoch *et al.*, (2016), Siddika *et al.*, (2013), Kumar *et al.*, (2013) and Ahmad *et al.*, (2014).

Table.1 List of genotypes were used in the present investigation

Sl. No.	Treatments	Genotype Symbol	Name of Genotypes	Source
1	T1	G ₁	VRP-22	IIVR, Varanasi
2	T2	G ₂	VRPMR-11	IIVR, Varanasi
3	T3	G ₃	VRT-12-1	IIVR, Varanasi
4	T4	G ₄	PC-531	IIVR, Varanasi
5	T5	G ₅	Jawahar Pea-54	JNKVV, Jabalpur
6	T6	G ₆	J.Pea-71	JNKVV, Jabalpur
7	T7	G ₇	Arkel	IARI, New Delhi
8	T8	G ₈	Arka Karthik	IIHR, Bangalore
9	T9	G ₉	NSM-6	JNKVV, Jabalpur
10	T10	G ₁₀	Azad Pea-5	CSAUA&T, Kanpur
11	T11	G ₁₁	VRP-7	IIVR, Varanasi
12	T12	G ₁₂	Pusa Pragati	IARI, New Delhi
13	T13	G ₁₃	VRPMR-10	IIVR, Varanasi
14	T14	G ₁₄	Arka Pramod	IIHR, Bangalore
15	T15	G ₁₅	Bonneville	IARI, New Delhi
16	T16	G ₁₆	Swarna Mukti	CSAUA&T, Kanpur
17	T17	G ₁₇	Rachna	CSAUA&T, Kanpur
18	T18	G ₁₈	Hara Bona	HAU, Hisar
19	T19	G ₁₉	Ajad Pea -3	CSAUA&T, Kanpur
20	T20	G ₂₀	Arka Priya	IIHR, Bangalore
21	T21	G ₂₁	BL-1(Bidar Local-1)	Bidar (KA)Local
22	T22	G ₂₂	Hissar Harit	HAU, Hisar
23	T23	G ₂₃	S-10	HAU, Hisar
24	T24	G ₂₄	Azad Pea-1	CSAUA&T, Kanpur
25	T25	G ₂₅	JM-1	JNKVV, Jabalpur
26	T26	G ₂₆	BL-2	Bidar Local (KA)

Table.2 Analysis of variance for various characters in garden pea genotypes

Sl. No.	Traits	Mean sum of squares		
		Replications	Genotypes	Error
1	Plant height (cm)	4.15	467.69**	1.21
2	Number of primary branches per plant	1.67	0.28	0.23
3	Plant spread (cm)	4.37	12.76*	1.01
4	Days to first flowering	7.89	305.77**	1.07
5	Days to 50% flowering	7.13	277.63**	2.05
6	Days to pod setting	2.30	259.64**	0.96
7	Days to first pod picking	63.76	264.50**	41.14
8	Number of pods per cluster	0.06	0.09*	0.01
9	Number of pods per plant	0.12	18.76**	0.72
10	Pod length (cm)	0.35	3.15*	0.13
11	Pod width (cm)	0.05	0.14*	0.01
12	Average pod weight (g)	0.82	3.44*	0.02
13	Pod yield per plant (g/plant)	114.75	553.82**	22.46
14	Pod yield per plot (g/plot)	16520.88	79749.12**	3234.52
15	Number of seeds per pod	0.03	2.51*	0.05
16	Seed yield per plant(g/Plant)	1.32	3.18*	0.52
17	Shelling (%)	1.55	63.01**	3.04
18	Moisture content in pods (%)	5.51	55.89*	3.08
19	Fibre content (%)	0.57	6.66*	0.34
20	Protein content (%)	38.32	20.53**	4.63

*Significant at 5% level of probability, ** Significant at 1% level of probability

Table.3 Mean, Range, Coefficient of variations (GCV and PCV), Heritability, Genetic Advance and Genetic Advance as Per cent of mean for 20 Characters of garden pea genotypes

Sl. No.	Characters	Mean	Range		Coefficient of variance		h ² (b.s.)	Genetic Advance	Genetic Advance as % mean
			Min.	Max.	GCV (%)	PCV (%)	(%)		
1.	Plant height (cm)	64.65	47.71	97.51	19.29	19.36	99.23	25.59	39.58
2.	Number of primary branches per plant	2.64	2.13	3.13	4.90	5.23	89.65	4.12	10.13
3.	Plant spread (cm)	33.91	30.33	37.93	5.84	6.54	79.51	3.64	10.72
4.	Days to first flowering	46.46	34.73	61.20	21.14	21.26	98.95	20.65	43.33
5.	Days to 50% flowering	53.17	40.00	67.33	18.55	18.76	97.82	19.53	37.80
6.	Days to pod setting	50.86	38.00	67.73	18.12	18.22	98.90	19.02	37.12
7.	Days to first pod picking	71.57	54.33	90.67	12.06	15.02	64.41	14.27	19.93
8.	Number of pods per cluster	1.70	1.33	2.00	9.50	11.10	73.26	0.29	16.75
9.	Number of pods per plant	11.87	7.80	15.87	20.66	21.86	89.31	4.77	40.22
10.	Pod length (cm)	8.31	6.17	10.53	12.08	12.81	88.96	1.95	23.47
11.	Pod width (cm)	1.58	1.28	2.23	13.28	14.11	88.52	0.41	25.73
12.	Average pod weight (g)	5.38	3.70	8.49	19.84	20.01	98.31	2.18	40.53
13.	Pod yield/plant (g/plant)	63.86	40.40	90.47	20.84	22.12	88.75	25.83	40.44
14.	Pod yield per plot (g/plot)	766.32	484.85	1085.68	20.84	22.12	88.75	309.92	40.44
15.	Number of seeds per pod	7.03	4.73	8.64	12.90	13.25	94.75	1.82	25.86
16.	Seed yield/ plant (g/plant)	11.26	9.50	13.63	8.36	10.53	63.03	1.54	13.67
17.	Shelling (%)	48.09	36.33	54.00	9.30	9.98	86.81	8.58	17.85
18.	Moisture content in pods (%)	76.05	68.67	84.33	5.52	5.98	85.11	7.97	10.48
19.	Fibre content (%)	10.88	8.27	13.52	13.33	14.37	86.04	2.77	25.48
20.	Protein content (%)	29.23	25.17	34.50	7.88	10.78	53.36	3.46	11.85

GCV measures the amount of variation present in a particular character but it doesn't provide an idea about the proportion of heritable variation present in the total variation therefore, heritability estimates were calculated in the present study. In the present study heritability estimates were high for all the studied character as categorized (Low <30%; Moderate 30-60%; high >60%) by Johnson *et al.*, (1955). The estimates of heritability (%) in broad sense for 20 characters studied, which range from 53.36% to 99.23% hence, high heritability (broad sense) was recorded for all the characters. Similar results were noticed by Afreen *et al.*, (2017), Georgieva *et al.*, (2016), Jaiswal *et al.*, (2015); Kumar *et al.*, (2015); Ahmad *et*

al., (2014); Siddika *et al.*, (2013); Habtamu and Million (2013); Kumar *et al.*, (2015); Pal and Singh (2013); Fikreselassie, (2012); Guleria *et al.*, (2009); Sharma *et al.*, (2003) and Kumarai *et al.*, (2008).

The estimates of genetic advance for 20 characters studied, which range from 0.29% to 309.92% (Table 3). High genetic advance was recorded for pod yield per plot (309.92%), pod yield per plant (25.83%), plant height (25.59%) and days to first flowering (20.65%). The moderate genetic advances were recorded for the characters such as days to 50% flowering (19.53), days to pod setting (19.02) and days to first pod picking (14.27%). The low estimates of

genetic advance were observed for shelling (8.58%), moisture content in pods (7.97%), number of pods per plant (4.77%), number of primary branches per plant (4.12%), plant spread (3.64%), protein content (3.46%), fibre content (2.77%), average pod weight (2.18%), pod length (1.95%), number of seeds per pod (1.82%), seed yield per plant (1.54%), pod width (0.41%) and number of pods per cluster (0.29%).

High heritability coupled with high genetic advance were noted for average pod weight (g), days to 50% flowering, days to pod setting, number of pods per plant, pod yield per plot (g/plot), pod yield per plant (g/plant), plant height (cm), days to first flowering, pod length(cm), pod width (cm), no. of seeds per pod and fibre content (%) suggesting there by that these traits could be considered as reliable indices for selection and higher responses of this trait could be expected from selection. Similar findings were also reported by Georgieva *et al.*, (2016); Katoch *et al.*, (2016); Jaiswal *et al.*, (2015); Ahmad *et al.*, (2014), Fikreselassie (2012) and Mahanta *et al.*, (2001).

The genetic advance (as per cent per mean) varied from 10.13% to 43.33% (Table 3). The higher genetic advance (as per cent of mean) was recorded for days to first flowering (43.33%) followed by average pod weight (40.53%), pod yield per plot (40.44%), pod yield per plant (40.44%), number of pods per plant (40.22%), plant height (39.58%), days to 50% flowering(37.80%), days to pod setting (37.12%), number of seeds per pod (25.86%), pod width (25.73%), fibre content (25.48%) and pod length (23.47%), whereas lower genetic advance was recorded for number of primary branches per plant (10.13) followed by moisture content in pods (10.48%), plant spread (10.72%), protein content (11.85%), seed yield per plant (13.67%), number of pods per cluster

(16.75%) and shelling (17.85%). Similar findings were also reported by Georgieva *et al.*, (2016); Katoch *et al.*, (2016); Jaiswal *et al.*, (2015); Ahmad *et al.*, (2014), Fikreselassie (2012); Guleria *et al.*, (2009); Akhilesh *et al.*, (2007 and Kalloo *et al.*, (2005).

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