



# GENETIC VARIABILITY AND HERITABILITY STUDIES FOR QUANTITATIVE TRAITS IN PEA (*PISUM SATIVUM* L.)

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## Abstract

A study was conducted to evaluate 26 varieties of pea (*Pisum sativum* L.) in relation to 23 different growth and yield attributing parameters. Very high genotypic and phenotypic coefficients of variation were observed for plant height and number of leaves at vegetative stage, number of tendrils, internodal length, days to first flowering, plant height and number of leaves at flowering stage, number of seeds per pod, individual pod weight, individual seed weight, pod coat weight, leaf area, 100 seed weight and shelling percentage. High heritability and high expected genetic gain were observed for number of leaves, number of tendrils, days to first flowering, plant height at flowering stage, number of leaves at flowering stage, days to 50% flowering, pod length, number of seeds per pod, individual pod weight, individual seed weight, pod coat weight, leaf area, 100 seed weight and pod yield per plant suggesting their importance in the selection programme of pea improvement.

**Key words :** Pea, genetic variability, heritability, genetic advance, pod yield.

## Introduction

Pea is one of the most important and popular vegetables grown in India. Pea is a highly nutritious vegetable containing higher percentage of digestive proteins along with carbohydrates and vitamins. Large proportion of pea is processed into canned, frozen or dehydrated peas for consumption in the off-season. Being a proteinous vegetable it forms a valuable dish in the vegetarian diet. In India, it is grown as a winter vegetable in the plains of the North and as a summer vegetable in the hills. It is an excellent food for human consumption taken into either as a vegetable or in soup. Major pea growing states are Bihar, Haryana, Punjab, H.P., Orissa, and Karnataka. In Tamil Nadu, peas is grown in the Nilgiris district and Kodaikanal hills during the winter months of the year.

Variability in the population especially for the character for which improvement is sought is a prerequisite for successful selection (Tyagi and Khan, 2008). The assessment of the variation in the yield-determining quantitative traits of crop has become primary interest in the improvement of yield. Genotypic and phenotypic coefficient of variation are useful in detecting the amount of variability present in the available genotypes.

The main purpose of estimating genetic heritability

and genetic parameters that compose the heritability estimate is to compare the expected gains from selection based on alternative selection strategies. To initiate any effective selection programme, the information on the nature and magnitude of variability present in the genetic stocks, heritability and genetic advance, is of considerable importance for a breeder. It has been found that yield contributing traits have reliable and predictable effect on grain yields in grain legumes such as, mung bean, pea and pigeon pea (Tyagi and Khan, 2008). The present investigation was taken up to ascertain the magnitude and extent of genetic variability, heritability and genetic advance of 23 characters in 26 pea varieties.

## Materials and Methods

The seeds of 26 varieties of pea were sown during the winter months 2010-11 and 2011-12 at Horticultural Research Station, Kodaikanal (Tamil Nadu), India. The varieties were evaluated in a randomized block design (RBD) with three replications. The experiment was conducted in lateritic soil applied with the recommended fertilizer dose of 60 kg N, 80 kg P and 70 kg K/ha as basal and 60 kg N/ha as top dressing 30 days after sowing. Recommended agronomic practices and plant protection measures whenever necessary were adopted for raising a good crop. Each variety was sown in four rows of 3m length of 45 cm between ridges and 10 cm between plants

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**Table 1** : Analysis of variance for 23 characters in peas.

S. no.	Characters	Mean sum of square		
		Replication 2 df	Treatment 25 df	Error 50 df
1.	Plant height at vegetative stage	7.02	43.32**	11.33
2.	Number of leaves at vegetative stage	11.94	117.87**	13.97
3.	Number of branches	0.70	1.93*	2.01
4.	First node bearing tendril	0.33	0.42*	0.37
5.	Number of tendrils	2.11	20.60**	1.23
6.	Internodal length	0.68	0.90*	0.61
7.	Days to first flowering	2.53	225.77**	2.24
8.	Plant height at flowering stage	79.56	722.77**	90.84
9.	Number of leaves at flowering stage	147.03	1004.95**	142.05
10.	Number of branches at flowering stage	16.55	20.08**	3.78
11.	First node bearing pod	0.33	7.12**	1.33
12.	Days to 50 % flowering	3.52	240.96**	3.46
13.	Pod length	0.67	5.50**	0.34
14.	Pod girth	1.69	0.70*	0.25
15.	Number of seeds per pod	0.11	5.40**	0.23
16.	Individual pod weight	0.18	11.13**	0.19
17.	Individual seed weight	0.09	0.06	0.05
18.	Pod coat weight	0.08	5.64**	0.11
19.	Leaf area	0.29	73.95**	0.42
20.	Number of pods per plant	0.49	19.83**	12.50
21.	100 seed weight	2.42	81.10**	1.42
22.	Shelling %	2.16	51.64**	1.40
23.	Yield per plant	3.00	4537.68**	0.95

\*, \*\* significant at 0.05 and 0.01 level of significance, respectively.

in two lines. Observations were recorded for 23 characters *viz.*, plant height at vegetative stage, number of leaves at vegetative stage, number of branches per node, first node bearing tendril, number of tendrils, internodal length, days to first flowering, plant height at flowering stage, number of leaves at flowering stage, number of branches at flowering stage, first node bearing pod, days to 50% flowering, pod length, pod girth, number of seeds per pod, individual pod weight, individual seed weight, pod coat weight, leaf area, number of pods per plant, 100 seed weight, shelling percentage and pod yield per plant. Data on the above component traits were subjected to statistical procedures namely analysis of variance (Panse and Sukhatme, 1985), phenotypic and genotypic co-efficient of variation (Burton, 1952), heritability in broad sense ( $h^2$ ) by Burton and De Vane (1953) and genetic advance *i.e.*, the expected genetic gain by using the procedure given by Johnson *et al.* (1955).

## Results and Discussion

The analysis of variance revealed highly significant differences among the varieties for all the 23 characters studied. The results indicated that vast genetic variability existed among the varieties for all the characters under study as the mean values of all the traits showed wide variations for the plant height at vegetative stage (14.06-29.50), number of leaves at vegetative stage (0.00-33.42), number of branches per node (5.00-8.00), first node bearing tendril (1.33-2.67), number of tendrils (2.50-16.83), internodal length (2.59-4.81), days to first flowering (28.67-57.83), plant height at flowering stage (24.83-102.12), number of leaves at flowering stage (10.00-87.67), number of branches at flowering stage (10.00-19.17), first node bearing pod (5.67-13.33), days to 50% flowering (34.50-62.67), pod length (6.91-11.11), pod girth (4.18-5.99), number of seeds per pod (3.17-10.16), individual pod weight (3.07-12.24), individual seed weight (0.11-0.29), pod coat weight (1.85-8.29), leaf area (0.00-24.70), number of pods per plant (16.04-23.59), 100 seed weight

**Table 2:** Range of mean performances for 23 characters in pea

S. no.	Characters	Character grand mean	Minimum		Maximum	
			Variety	Value	Variety	Value
1.	Plant height at vegetative stage	23.64	Punjab 88	14.06	Local Samba	29.50
2.	Number of leaves at vegetative stage	27.32	PSM-4	0.00	Local Samba	33.42
3.	Number of branches	6.86	Punjab 88	5.00	Azad P-3	8.00
4.	First node bearing tendrils	56	GS 10, Peas Welcome 2010	1.33	Local Samba	2.67
5.	Number of tendrils	4.50	Punjab 88	2.50	PSM-4	16.83
6.	Internodal length	3.56	Arka Sampoorna	2.59	PSM-3	4.81
7.	Days to first flowering	41.08	Mater Ageta 6	28.67	PSM-4	57.83
8.	Plant height at flowering stage	55.00	Khasi Nandhini	24.83	Local Samba	102.12
9.	Number of leaves at flowering stage	60.07	PSM-4	0.00	Local Samba	87.67
10.	Number of branches at flowering	14.08	Mater Ageta 6	10.00	Arka Ajit stage	19.17
11.	First node bearing pod	8.91	Khasi Utham	5.67	Pant Uphar	13.33
12.	Days to 50 % flowering	44.98	Mater Ageta 6	34.50	PSM-4	62.67
13.	Pod length	8.62	Pant Uphar	6.91	PSM-3	11.11
14.	Pod girth	4.81	GS-10	4.18	Azad P-3	5.99
15.	Number of seeds per pod	6.44	P Arkel	3.17	Peas Welcome 2010	10.16
16.	Individual pod weight	5.84	U Arkel	3.07	Azad P-3	12.24
17.	Individual seed weight	0.17	PSM-4, U-Arkel	0.11	Arka Sampoorna	0.29
18.	Pod coat weight	3.53	Khasi Samrath	1.85	Azad P-3	8.29
19.	Leaf area	10.85	PSM-4	0.00	GS10	24.70
20.	Number of pods per plant	20.78	Khasi Utham	16.04	Punjab 88	23.59
21.	100 seed weight	13.41	PSM-3	13.41	Azad P-3	33.51
22.	Shelling percentage	46.05	Peas Welcome 2010	40.00	Arka Ajit	54.00
23.	Yield per plant	119.20	Khasi Samrath	67.78	Azad P-3	235.45

(13.41-33.51), shelling percentage (40.00-54.00), yield per plant (67.78-235.45). The characters showing high range of variation indicated good scope for improvement. These findings are in accordance with those of Sharma and Bora (2013) and Dabas *et al.* (1982) in guar.

The results of coefficient of variation analysis (table 1) showed that the PCV was higher than the GCV for all the characters studied. The genotypic variances (GV) varied from 0.02 (individual seed weight) to 1512.24 (yield per plant). Kumaran *et al.* (1995), Vikas and Singh (1999), Singh *et al.* (1996), Sureja and Sharma (2000) and Kalloo *et al.* (2005) also reported high estimates of genotypic variability for yield and its contributing traits. High values of genotypic and phenotypic coefficients of variation for number of leaves at vegetative stage, number of tendrils, internodal length, days to first flowering, plant height at flowering stage, number of leaves at flowering stage, number of seeds per pod, individual pod weight, individual seed weight, pod coat weight, leaf area, 100 seed weight and shelling percentage indicated that the selection for these characters would be much effective. Similar results were reported by Singh *et al.* (2003) in peas, Dabas *et*

*al.* (1982), Reddy & Gupta (1984) in cluster beans. Phenotypic and genotypic coefficients of variation were quite low for yield per plant. The information obtained revealed that the estimates of PCV were higher than GCV indicating that the characters studied were influenced by environment to lesser extent. Thus, the selection based on phenotypic performance will be reliable.

The broad sense heritability, the proportion of genotypic variance to the phenotypic variance is an important parameter in breeding and genetics, because knowledge of numerical magnitude of heritability is of special importance for planning in breeding programmes and for the examination of experimental results (Pallavi *et al.*, 2013). Heritability (Broad sense) ranged from 01.32 to 99.94%. Days to 50% flowering, number of seeds per pod, individual pod weight, pod coat weight, leaf area, 100 seed weight, shelling percentage and pod yield per plant registered very high heritability estimates, which showed that the variability in these characters is heritable and the selection based on these characters would be effective. These observations confirm the earlier findings

**Table 3 :** Estimation of components of variance, coefficient of variation, heritability and genetic advance.

S. no.	Characters	Variance		Co-efficient of variance		Heritability (%)	Genetic advance in % of mean
		Genotype	Phenotype	Genotype	Phenotype		
1.	Plant height at vegetative stage	10.66	22.00	13.81	19.83	48.47	19.80
2.	Number of leaves at vegetative stage	34.63	48.60	21.53	25.51	71.25	37.44
3.	Number of branches	1.02	1.98	2.35	20.52	01.32	0.55
4.	First node bearing tendril	0.01	0.38	8.28	39.76	04.34	03.56
5.	Number of tendrils	6.45	7.69	56.37	61.55	83.90	106.38
6.	Internodal length	0.10	0.72	21.61	31.17	13.74	6.70
7.	Days to first flowering	74.51	76.75	21.01	21.32	97.07	42.64
8.	Plant height at flowering stage	210.65	301.50	26.38	31.56	69.87	45.43
9.	Number of leaves at flowering stage	287.63	429.68	28.23	34.50	66.94	47.58
10.	Number of branches at flowering stage	5.43	9.22	16.55	21.56	58.92	26.17
11.	First node bearing pod	1.93	3.26	15.58	20.27	59.13	24.69
12.	Days to 50 % flowering	79.16	82.63	19.78	20.20	95.80	39.88
13.	Pod length	1.72	2.06	15.21	16.68	83.15	28.58
14.	Pod girth	0.15	0.40	8.08	13.18	37.57	10.20
15.	Number of seeds per pod	1.72	1.95	20.38	21.71	88.14	39.42
16.	Individual pod weight	3.64	3.84	32.69	33.55	94.95	65.62
17.	Individual seed weight	0.02	0.03	26.04	29.13	79.92	47.97
18.	Pod coat weight	1.84	1.95	38.42	39.58	94.19	76.81
19.	Leaf area	24.51	24.93	45.59	45.98	98.29	93.11
20.	Number of pods per plant	2.44	14.95	7.51	18.59	16.34	6.25
21.	100 seed weight	26.56	27.98	32.62	32.63	94.90	49.74
22.	Shelling percentage	16.74	18.15	24.78	25.44	92.25	17.58
23.	Yield per plant	1512.24	1513.20	8.88	9.25	99.94	67.18

of Sharma and Bora (2013).

Higher estimates of heritability (broad sense) along with genetic advance as percent of mean were observed for number of leaves (71.25 and 37.44), number of tendrils (83.90 and 106.38), days to first flowering (97.07 and 42.64), plant height at flowering stage (69.87 and 45.43), number of leaves at flowering stage (66.94 and 47.58), days to 50% flowering (95.80 and 39.88), pod length (83.15 and 28.58), number of seeds per pod (88.14 and 39.42), individual pod weight (94.95 and 65.62), individual seed weight (79.92 and 47.97), pod coat weight (79.92 and 47.97), leaf area (98.29 and 93.11), 100 seed weight (94.90 and 49.74), pod yield per plant (99.94 and 67.18) indicating that these characters are least affected by environment. High heritability along with high genetic advance revealed that additive type existed in the varieties studied. Therefore, these traits can be improved by selection and genotypic variability so realized can be maintained in subsequent generation.

It was noted that some characters having high heritability did not show high genetic advance as per cent of mean. As for instance number of branches per node

(01.32 & 0.55), first node bearing tendril (04.34 & 03.56), internodal length (13.74 & 6.70) and number of pods per plant (16.34 & 6.25) expressed low heritability with low genetic advance as percent of mean, which revealed that these characters were highly influenced by environmental effects and selection would be ineffective.

Based on the above results, it was concluded that number of leaves at vegetative stage, number of leaves, days to first flowering, plant height at flowering stage, number of seeds per pod, individual pod weight, individual seed weight, pod coat weight, leaf area and 100 seed weight are the important traits for selection for yield improvement in pea.

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