Environment and Ecology 41 (4): 2237—2242, October—December 2023
Article DOI: https://doi.org/10.60151/envec/ZEJI3390
ISSN 0970-0420

Genetic Variability in Vegetable Pea (*Pisum sativum* var. *hortense*) Genotypes in Bundelkhand Region

Rudra Pratap Mishra, Sunil Kumar, Akanksha Rai, Shalu Singh, Shweta Soni, A. C. Mishra, Ajeet Singh

Received 15 April 2023, Accepted 28 July 2023, Published on 12 October 2023

ABSTRACT

This study aimed to assess the genetic variability in vegetable pea (*Pisum sativum* var. *hortense* L.) under the Bundelkhand region. A total of 25 pea accessions were collected from different regions of Uttar Pradesh and Bundelkhand and evaluated for various traits. The estimates of the mean sum of squares due to genotypes were highly significant for all the characters showing the existence of genetic variation in the source material. For the majority of the quantitative characteristics and qualitative traits, high phenotypic and genotypic coefficients of variation were observed. Most of the traits showed high heritability together with high genetic advance. Based on the mean performance the genotypes/variety Narendra Matar 2, VVP 1, JVP 1 and JVP 2 had the highest yield. The variety VVP 1 has good plant height, high seed and pod weight. The varieties JVP 1 and Kashi Nandini have taken fewer days to maturity and also yielded well so these varieties can be also recommended for use a parent for improvement of local material in the Bundelkhand region.

Keywords Genetic variability, GCV, PCV, Heritability, Genetic advance.

INTRODUCTION

Garden pea (*Pisum sativum* var. *hortense* L.), 2n=2x=14, which belongs to the family Fabaceae is one of the most important legume vegetables grown throughout the world. It is widely planted during the winter months in the tropics and subtropics as a cool season crop. It is also planted on the hills as a summer crop. It is primarily planted for the tender, immature seeds that are harvested for use as vegetables.

The vegetable pea is an annual herbaceous plant with tap roots. The stem is erect, thin, and typically single. The rachis of the pinnately complex leaves ends in a single or several branching tendrils. The base of the leaf has substantial stipules. Racemes that form the inflorescence come from the leaf axils, and the individual flowers are typical papilionaceous. Ovules (up to 13) are alternatively connected to the placenta in the monocarpellary gynoecium. Style is right-angled to the ovary and has a sticky stigma. Seeds might be smooth or wrinkled and pods can be straight or curved.

Rudra Pratap Mishra[1], Sunil Kumar[2]*, Akanksha Rai[3], Shalu Singh[4], Shweta Soni[5], A.C. Mishra[6], Ajeet Singh[7]

[2, 5] Assistant Professor, [6, 7] Professor
Department of Vegetable Science, College of Horticulture, Banda University of Agriculture and Technology, Banda, Uttar Pradesh 210001, India

Email : sunil39359@gmail.com
*Corresponding author

Garden pea seeds have a high concentration of tryptophan and lysine, two important amino acids that are deficient in cereals. Peas have the highest protein digestibility of all the pulses, at 93.3%, as opposed to the other pulses' range of 59.5 to 90.7%. It is abundant in calcium, phosphorus, vitamin A, vitamin C, protein, and carbohydrates.

An increase in the demand for protein and mineral-rich food has led to greater interest in the crop as a protein-rich source (Santalla *et al*. 2001). Being a cheap source of protein, it is regarded as poor man's meat in the developing world. Plant proteins are cheaper than animal proteins; therefore, people consume legume seeds worldwide as the main source of protein (Petchiammal and Waheeta 2014). Garden pea plays a vital role in mal-nutrition due to protein in the food diet as its protein level reaches up to 22% on a dry weight basis.

Bundelkhand region of Uttar Pradesh is predominantly a vegetarian region, therefore, the bulk of the population depends upon legumes for dietary protein.

MATERIALS AND METHODS

Experiment was carried out during the *rabi* (October-February) season of 2021 at the Vegetable Research Farm of Banda University of Agriculture and Technology, Banda, Uttar-Pradesh. The experiment was laid out by Randomized Complete Block Design (RBD) with three replications and the experimental material consisted of 25 genotypes of garden pea obtained from various places in India. The principal objectives of the investigation were to study the genetic variability, character association, path analysis, and divergence among growth, yield and quality parameters in garden pea genotypes. Five plants per treatment were selected randomly and tagged. Observations were recorded on selected tagged plants for different characters in each replication. The mean value of the data obtained from five plants in each treatment was worked out to represent a particular collection for a particular character. The data recorded on five plants per treatment was averaged and subjected to statistical analysis.

RESULTS AND DISCUSSION

Upon examining the ANOVA, the values show in the (Table 1) that there are very substantial differences between the genotypes for each of the studied characters. This may be a result of their genetic make-up and the various locations where they have been collected, which suggests that there is a significant amount of variation among the genotypes. The existence of variability is essential for crop improvement programs because the level of variability for a given character influences how successfully that trait may be improved genetically. Wide variance for different features was seen by Afreen *et al.* (2017), Bashir *et al.* (2017), 4 which is similar to the current findings (2017). However, in order to fully and conclusively explain all of the inherent genotypic variances in

Table 1. Analysis of variance (ANOVA) of 25 genotypes of garden pea for 16 characte

Sl. No.	Source of variation	Mean sum of squares		
		Replication	Treatments	Error
	DF	2	24	48
1	Days to first flower emergence	3.45	197.61**	2.30
2	Days to 50% flowering	5.17	206.04**	2.53
3	Days to first pod formation	1.97	257.53**	3.50
4	Days to first pod picking	5.61	278.80**	10.37
5	Plant height (cm)	15.1	985.80***	11.08
6	100 seed weight	1.38	131.42**	0.52
7	Shelling percent	0.24	72.15**	0.83
8	Average pod weight (g)	0.12	2.33**	0.04
9	Pod length (cm)	0.22	2.27**	0.22
10	Number of seeds perpod	0.026	3.73**	0.07
11	Yield per plant (g)	9.16	358.67**	15.30
12	Yield per plot (kg)	0.08	3.23**	0.13
13	Yield (tons/ha)	0.30	16.52**	0.76
14	TSS (Brix)	0.006	5.46*	0.47
15	Protein content (g/100 g)	0.29	1.86*	0.06
16	Total sugar (mg/ 100 g)	0.006	1.34**	0.02

Table 2. Mean performance for 16 characters of 25 genotypes of garden pea.

Sl. No.	Genotype	Plant height (cm)	100 seed weight(g)	No. of seeds per pod	Average pod weight (g)	Days to first flowering	Days to 50% flowering	Days to first pod formation	Days to first pod picking
1	GVP 1	55.0	33.0	7	4.5	50	58	74	96
2	GVP 2	52.9	37.4	8	4.5	40	46	46	72
3	GVP 3	56.1	31.1	4	3.0	38	45	48	64
4	GVP 4	50.7	43.5	7	6.7	38	43	46	68
5	Kashi Uday	52.2	42.6	7	5.5	40	47	50	72
6	Kashi Nandini	49.9	42.4	6	5.2	35	40	47	73
7	VVP 1	96.2	44.2	8	6.4	49	62	62	85
8	VVP 2	88.3	33.0	8	5.4	46	57	58	80
9	Kashi Ageti	57.4	44.0	6	6.3	40	53	52	85
10	BVP 1	48.5	37.3	6	5.0	39	42	48	75
11	BVP 2	59.1	33.0	8	4.5	50	63	70	100
12	BVP 3	64.3	34.3	8	5.3	47	53	55	82
13	BVP 4	62.6	26.1	9	4.3	50	54	61	80
14	BVP 5	51.7	32.7	7	4.9	55	62	70	89
15	KVP 1	44.3	34.8	8	4.5	49	55	60	84
16	KVP 2	111.1	30.0	7	3.7	61	67	69	87
17	KVP 3	93.1	41.6	7	4.5	53	56	57	80
18	AVP 1	83.4	54.3	6	5.5	57	63	72	95
19	AVP 2	77.3	40.0	6	5.3	42	52	55	81
20	PVP 1	56.5	37.5	8	4.9	42	51	50	71
21	PVP 2	54.9	24.7	7	4.1	39	45	46	66
22	JVP 1	60.6	29.3	6	4.3	34	46	49	65
23	JVP 2	70.1	33.4	8	5.5	59	62	61	83
24	Narendra matar 2	81.2	40.3	5.7	3.4	55.7	63.3	63.3	78.3
25	Narendra matar 4	90.6	35.2	5.9	5.1	59.0	65.7	67.7	88.3
	Mean	66.7	36.6	7.0	4.9	46.7	54.0	57.5	79.9
	CV	5.0	4.0	4.9	5.2	4.2	3.9	4.3	4.0
	CD 5%	5.5	1.2	0.4	0.3	2.5	2.6	3.1	5.3
	CD 1%	7.3	1.6	0.6	0.5	3.3	3.5	4.1	7.1

Table 2. Continued.

Sl. No.	Genotype	Pod length (cm)	Shelling %	TSS	Total sugar (mg/g)	Protein (%)	Yield per plant (g)	Yield per plot (g)	Yield per hectare (kg)
1	GVP 1	9.5	49.6	14.7	4.0	7.9	28.9	2750	6247
2	GVP 2	9.5	48.2	13.6	1.8	6.6	20.4	1935	4396
3	GVP 3	7.7	50.1	13.9	3.3	5.7	24.8	2359	5360
4	GVP 4	8.6	40.0	16.1	2.8	7.2	19.6	1863	4233
5	Kashi Uday	9.0	37.6	16.1	1.6	6.4	35.7	3394	7714
6	Kashi Nandini	8.5	38.1	16.0	2.0	7.6	40.0	3802	8643
7	VVP 1	9.2	51.3	12.3	1.6	7.8	51.1	4858	11038
8	VVP 2	8.2	49.8	13.1	1.5	7.4	21.8	2076	4717
9	Kashi Ageti	9.2	42.8	15.9	2.4	6.8	31.6	3000	6812
10	BVP 1	8.6	52.1	12.8	2.7	6.7	16.3	1548	3517
11	BVP 2	9.3	47.0	14.2	3.2	7.1	34.4	3272	7433
12	BVP 3	10.1	47.3	13.6	2.3	8.1	32.7	3102	7049
13	BVP 4	9.0	51.2	13.1	1.9	7.9	27.7	2630	5975
14	BVP 5	9.9	42.7	13.4	2.1	7.5	23.8	2261	5136
15	KVP 1	8.4	45.4	16.7	2.1	6.8	41.4	3935	8530
16	KVP 2	8.0	46.9	14.4	1.7	7.4	18.5	1754	3984
17	KVP 3	9.1	50.9	16.3	3.2	8.4	27.0	2564	5826
18	AVP 1	8.5	58.9	15.0	3.4	5.3	36.1	3431	7794
19	AVP 2	7.8	49.0	14.0	2.2	6.5	24.9	2370	5385

Table 2. Continued.

Sl. No.	Genotype	Pod length (cm)	Shelling %	TSS	Total sugar (mg/g)	Protein (%)	Yield per plant (g)	Yield per plot (g)	Yield per hectare (kg)
20	PVP 1	9.8	44.5	13.4	2.4	5.7	32.9	3130	7111
21	PVP 2	7.2	41.8	16.3	2.0	7.4	25.1	2381	5410
22	JVP 1	6.7	43.9	12.0	1.5	6.4	50.3	4783	10866
23	JVP 2	9.0	47.4	15.0	2.3	6.9	49.2	4675	10622
24	Narendra matar 2	7.2	51.8	14.6	2.3	6.2	54.3	5161.3	11726.6
25	Narendra matar 4	8.3	44.4	14.8	2.5	7.1	41.6	3956.3	8991.7
	Mean	8.6	46.9	14.4	2.3	7.0	32.4	3079.6	6980.7
	CV	5.5	2.9	4.8	6.2	4.7	12.1	12.1	12.5
	CD 5%	0.8	1.5	1.1	0.2	0.4	6.4	610.3	1437.5
	CD 1%	1.0	2.0	1.5	0.3	0.6	8.6	814.2	1917.6

the genotypes, the analysis of variance by itself is insufficient.

Mean performance of different traits

The mean performance of different traits given in (Table 2) the average plant height measured genotype KVP 2 recorded a maximum plant height, the average number of days from sowing to the appearance of the first flower was 46.74. The genotype JVP 1 had the earliest flowering (34 days), while the genotype KVP 2 had the longest flowering time (61 days). The average days of 50% flowering in the garden pea genotypes were 53.98 days after sowing. The genotype Kashi Nandini (40 days) had the earliest 50% flowering, while the genotype KVP 2 (67.33 days) had the longest time to 50% flowering. The mean value for days of first pod formation in garden pea germplasm was found at 57.50 days after sowing. Genotype PVP 2 (45.66 days) was found earliest for first pod formation, while the genotype GVP 1 (74.33 days) had maximum days for first pod formation. In garden pea germplasm, the mean value for days of first pod formation was found to be 57.50 days after sowing. The genotype PVP 2 (45.66 days) had the earliest first podformation, while the genotype GVP 1 (74.33 days) had the longest. The mean value for pod length was found 8.65 cm. Genotype BVP 3 (10.07 cm) recorded the maximum pod length, while genotype JVP 1 (6.73 cm) produced the smallest pod. The mean value for 100 seeds weight was calculated at 36.62 g. Genotype PVP 2 (54.28 g) produced maximum weighted 100 seeds, while genotype GVP 3 (25 g) produced minimum weighted 100 seeds. A weight of 4.88 grams was computed as the average pod weight. While genotype GVP 3 (2.99 g) had the lowest average pod weight, genotype GVP 4 (6.69 g) had the highest average pod weight. In the genotypes of garden pea, a mean value of 7 seeds per pod was found. The BVP 4 variety had the highest number of seeds per pod (9.33), whereas the GVP 3 variety had only 4 seeds per pod. For the number of seeds per pod, were both moderate. In the vegetable pea genotypes, the mean pod yield per plot was 3.07 kg. The genotype Narendra Matar 2 (5.16 kg) produced the maximum pods per plot, whereas BVP 1 produced the least pods per plant (1.54 kg). The mean value for pod yield per plant was 32.41 g in vegetable pea germplasm. The highest green pod yield per plant was recorded in genotype Narendra Matar 2 (54.32 g), whereas the minimum pod yield per plant was found in BVP 1 (16.27 gm). In garden pea germplasms, the mean average pod yield per hectare was 6.98 t. The genotype Narendra Matar 2 (11.72 t) had the highest green pod yield per hectare, whereas BVP 1 had the lowest yield (3.51 t). The mean value of shelling percentage in the garden pea genotypes during the trial was 46.90%. Genotype AVP 1 showed the highest percentage of shelling (58.93%). Genotype Kashi Uday had the lowest shelling percentage (37.62%). On an average 14.44 ^{o}Brix TSS content was recorded in case of seeds of garden pea germplasm. The highest total soluble solid was recorded in KVP 1 (16.66 ^{o}Brix) however, it was observed to be lowest in JVP 1 (12^{o}Brix). Protein content was found to have a mean value of 6.99 (g/100 g). Protein content ranged from KVP 3 (8.43 g/100 g) to AVP 1 (5.31 g/100 g), with KVP 3 having the highest value. The average amount of sugar per 100 g was found to be 2.34 (mg). GVP 1 had the highest value for total sugar content (4.03 mg/100 g), whereas JVP 1 had

Table 3. Estimates of genetic components of yield attributing traits for 16 characters of 25 genotypes of garden pea.

Character	Mean	Min	Max	GCV	PCV	Heritability (%)	Genetic advance (as % of mean)
Days to first flower emergence	46.74	34	61	17.26	17.56	96.60	34.94
Days to 50% flowering	53.98	39.66	67.33	15.25	15.53	96.40	30.85
Days to first pod formation	57.50	45.66	74.33	16.00	16.32	96	32.30
Days to first pod picking	79.93	64.33	99.66	11.83	12.50	89.60	23.07
Plant height (cm)	66.71	44.33	111.13	27.01	27.47	96.70	54.72
100 seed weight	36.62	24.66	54.28	18.03	18.14	98.80	36.93
Shelling percent	46.90	37.62	58.93	10.39	10.57	96.60	21.04
Average pod weight (g)	4.88	2.99	6.69	17.87	18.36	94.70	35.83
Pod length (cm)	8.64	6.73	10.07	9.55	11.03	75	17.04
Number of seeds per pod	7.00	4	9.33	15.76	16.23	94.30	31.53
Yield per plant (g)	32.41	16.27	54.32	33.00	35.15	88.20	63.86
Yield per plot (kg)	3.07	1.54	5.16	32.99	35.13	88.20	63.83
Yield (tons/ha)	6.98	3.51	11.72	32.83	35.15	87.30	63.19
TSS (Brix)	14.44	12	16.66	8.93	10.12	77.90	16.24
Protein content (g/100 g)	6.99	5.31	8.43	11.06	11.66	90	21.63

the lowest value (1.45 mg/100 g).

Genetic parameters

The genetic parameters given in (Table 3) provides the mean value, range, GCV, PCV, heritability %, and genetic advance as % of mean for various attributes of 25 genotypes of vegetable pea. Genotypic and phenotypic coefficients of variation are useful in designing selection criteria for a variable. GCV and PCV are divided into three categories, low (15%), moderate (15–30%) and high (>30%). In Table 3, the estimates of heritability (in the broad sense), genetic advance and genetic advance as a percentage of mean are shown. It identifies genetic improvement and selection response and it offers information on the proportion of total genetic variation that is transmissible. Broad-sense heritability (h^2b) values > 80% are considered high, 50–80% are considered moderate, and 50% are recorded as low. Heritability was found to range from 75 to 98.80%. 100 seed weight showed the highest heritability followed by plant height, days to first flowering, shelling percentage, days to 50% flower appearance, days to first pod formation, total sugar, average pod weight, no. of seeds per pod, protein content, days to first picking, yield per plot, yield per plant and yield per hectare.

Moderate heritability was found in the case of TSS and pod length. Genetic advance denotes the improvement in the genotypic comparison of the characters in relation to the environment. Thus, the estimates of genetic advances are of great significance to the vegetable breeders for developing suitable selection strategies. The estimates of genetic advance (%) are presented in Table 3. For genetic advance as a percent of the mean, values < 25% were considered as low, 25–40% as moderate, and > 40% as high. The estimates of genetic advance as % of mean ranged from 16.24 to 63.86%. The highest genetic advance as % showed in pod yield per plant followed by pod yield per plot, pod yield per hectare, Total sugar and plant height. Moderate genetic advance as % was noted in 100 seed weight, Average pod weight (g) , Days to first flower emergence, Days to first pod formation , Number of seeds per pod and Days to 50% flowering. The lowest genetic advance was recorded in TSS (^{o}Brix), Pod length , Shelling percent, Protein content and Days to first pod picking. The estimate of genetic parameters along with the coefficient of variation provides a sound basis to determine the variability components as well as to know the relative amount of heritable and-non heritable variation for each of the characters. From the study, minimum differences were evident between the values of GCV and PCV for most of the traits studied except yield, TSS and pod length. The existence of minimum variation between these two parameters indicated that

environment had the least effect on the expression of these characters and phenotype truly represents the genotype. In the present study, PCV is greater than GCV indicating the effect of the environment on the expression of the characters. Thus, the selection based on phenotypic performance will be reliable. Results are in accordance with the findings of Selvi *et al*. (2014), Bashir *et al.* (2017) and Lal *et al.* (2018)

Moderate estimates of GCV and PCV (11-20%) were observed for days to first flowering, days to fifty per cent flowering, days taken for first picking to first pod formation, length of the pod, average pod weight number of seeds per pod, shelling percent, TSS. Similar results were also obtained by Sharma and Sharma (2013), Khan *et al.* (2017) and Lal *et al.* (2018). Indicating the equal importance of additive and non-additive gene action. High magnitude of GCV and PCV (>20%) were observed for total sugar, yield, and plant height. This reveals the influence of the environment on these characters is negligible and the role of genotypic performance for the full expression of the phenotype. These findings are in accordance with Karnwal *et al.* (2013), Singh *et al.* (2019). The above findings depict that they are least affected by the environment and hence relied upon in the improvement of these parameters by selection.

Breeders are primarily interested in heritability, which is an indicator of transmissibility. As a character's heritability increases, environmental influences on how that character expresses itself decrease, making it easier to choose the appropriate plant.

REFERENCES

Afreen S, Singh AK, Moharana DP, Singh V, Singh P, Singh B (2017) Genetic evaluation for yield and yield attributes in garden pea (*Pisum sativum* var. *hortense* L.) under North Indian gangetic plain conditions. *Int J Curr Microbiol Appl Sci* 6(2) : 1399—1404.

Bashir I, Ishtiaq S, Fiaz S, Sajjad M (2017) Association of yield attributing traits in pea (*Pisum sativum* L.) Germplasm. University of agriculture Faisalabad.

Karnwal MK, Rai RATNA, Singh D, Singh VP, Pal M, Kumar A (2013) Genetic variability in garden pea under rainfed condition of dry temperate ecosystem. *Pantnagar J Res* 11 (2) : 219—224.

Khan MRA, Mahmud F, Reza MA, Mahbub MM, Shirazy BJ, Rahman MM (2017) Genetic diversity, correlation, and path analysis for yield and yield components of pea (*Pisum sativum* L.). *World J Agricult Sci* 13(1) : 11—16.

Lal K, Kumar R, Shrivastav SP, Kumar A, Singh Y (2018) Genetic variability, character association and path analysis of seed yield and its contributing traits in field pea (*Pisum sativum* L. var. *arvense*). *Int J Curr Microbiol Appl Sci* 7 (6) : 1815—1820.

Petchiammal C Hopper, Waheeta (2014) Antioxidant activity of proteins from fifteen varieties of legume seeds commonly consumed in India. *Int J Pharma Pharmaceut Sci* 6 (1-2) : 476—479.

Santalla M, Amurrio JM, De Ron AM (2001) Food and feed potential breeding value of green, dry and vegetable pea germplasm. *Canadian J Pl Sci* 81 (4) : 601—610.

Selvi BS, Rajangam J, Muthuselvi R (2014) Genetic variability and heritability studies for quantitative traits in pea (*Pisum sativum* L.). *Pl Arch* 14 (2) : 955—959.

Sharma BB, Sharma VK (2013) Genetic variability, heritability and genetic advance studies in garden pea under mid hill conditions of Garhwal Himalaya. *Environm Ecol* 31 (1A) : 296—301.

Singh AK, Pant SC, Paliwal A (2019) Assessment of genetic divergence and association of horticultural traits with yields in garden pea on Shivalik hills of Uttarakhand. *Int J Agricult Sci* 15 (1) : 184—189.