Advances in Bioresearch
Adv. Biores., Vol 13 (4) July 2022: 109-115
©2022 Society of Education, India
Print ISSN 0976-4585; Online ISSN 2277-1573
Journal's URL:http://www.soeagra.com/abr.html
CODEN: ABRDC3
DOI: 10.15515/abr.0976-4585.13.4.109115

Advances in Bioresearch

ORIGINAL ARTICLE

Studies on Characterization and Evaluation of Pea Genotypes for Yield and Yield Attributing Traits

Mahipat Singh Yadav, Eshu Katiyar and B. Gangwar
Institute of Agricultural Sciences, Bundelkhand University, Jhansi
Email: maahiseeds@gmail.com

ABSTRACT

The present investigation was conducted at Organic Research Farm, Karguanji, Institute of Agricultural Science, Bundelkhand University, and Jhansi (U.P.) during rabi season (2020-21). The experiment was laid out in Randomized Block Design with three replications. In this study the variability, direct and indirect effect, correlation coefficients and find yield attributing traits were carried out in Forty-two genotypes. The observations were recorded for fourteen characters of pea crop. The variation was highest for biological yield and see yield per plant followed by, number of pods per plant, number of seed per pod. The PCV was observed for, biological yield/plant (gm), seed yield per plant (gm), number of branches/plant, number of effective pods/plant, plant height, Seed index (gm), number of seed/pod indicating higher variability for these traits and future improvement through selection. High heritability combined with high genetic advance as a percentage of mean for characters such as biological yield/plant (gm), plant height (cm), see yield per plant (gm), shelling percentage, days to maturity, and number of effective pods/plant suggested that they can be improved through direct selection. The association study implies that the advantages of upgrading Pea genotypes through simultaneous selection for number of seed per pods. The path coefficient analysis showed that biological yield per plant were recorded highly significant and positive association with seed yield per plant. Days to 50% flowering showed significant and positive correlation with days to first flowering, number of branches/plant were the most important characters contributing towards seed yield per plant and hence purposeful and balanced selection based on these characters would be more effective for improvement in Pea. An overall examination of the yield and its components revealed that biological yield per plant, plant height, days to maturity, number of branches per plant, number of seeds per pods, number of effective pods per plant, days to 50% flowering, seed index and day to first flowering were the most important characters contributing to seed yield per plant and thus selection based on these characters (Pisum sativum L.).

Key Words: *GCV, PCV, variability, seed, Pea.*

Received 02.05.2022 Revised 25.06.2021 Accepted 18.07.2022

How to cite this article:
M S Yadav, E Katiyar and B. Gangwar. Studies on Characterization and Evaluation of Pea Genotypes for Yield and Yield Attributing Traits. Adv. Biores. Vol 13 [4] July 2022. 109-115

INTRODUCTION

Pea (*Pisum sativum* L.) had been used as a good source of nutritious food since Neolithic times [13]. It is one of the most important pulse crop of India, cultivated during winter season in northern plains and summer season in high hills and belonging to tribe- Vicieae, order- fabales, family–leguminosae (fabaceae), sub-family- papilionaceae, genus– *Pisum* and species– *sativum* with chromosome number 2n = 14. It is native of Mediterranean region with Near East and Ethiopia as secondary habitats [5]. It is cultivated in about more than 50 countries in the arid, semi-arid and temperate regions, whereas; about 90% of world field pea is grown under rainfed conditions.

Pea is a nutritious and protein-rich (19.6%) crop that is mostly used for green as a vegetable and dry seeds. Albumins and globulins [18] are the most abundant protein groups in legumes, accounting for 10-20% and 70-80% of the total protein present in the seed, respectively. When grown in different parts of the world, the chemical components of field pea varied [3]. Dry pea seed has high protein content (22.5 %) and contains all of the essential amino acids. It also has 56.5 % carbohydrates, 1.1 % fat, 2.2 % minerals, 4.5 % fiber, and essential vitamins including B_1 and B_5. Knowledge of the size and nature of genetic variability in germplasm, as well as the extent of heritable variation, is required for an effective breeding programme. The correlation studies provide information on the relationship between any two characters, because a simple correlation analysis cannot provide extensive and current knowledge in the relationship between the dependent variable and the predictor factors, route analysis was used in the majority of causal relationships. The route coefficient analysis divides correlation coefficients into direct and indirect effects, indicating the proportional importance of each causal element.

MATERIAL AND METHODS

The experimental materials consisted of 42 pea genotypes obtained from ICAR NBPGR, New Delhi (India), raised under rain fed condition in randomized Block Design with three replication at the Organic Research Farm, Karguanji, Institute of Agricultural Sciences, Bundelkhand University, Jhansi (U.P.) during *rabi* season 2020-21. A basal dose of FYM 15 t/ha was applied. The crop was sown on 3rd November 2020 and harvested during March 2021 on maturity. The genotypes were raised following spacing of 30x15 cm^2 and other recommended cultural practices as per organic management requirement. Observations were recorded on five randomly selected plants from each plot and replication. the data collected on fourteen quantitative traits viz., days to 50% germination, plant height (cm), days to first flowering, days to 50% flowering, number of branches/plant, pod length (cm), days to maturity, number of effective pods/plant, numbers of seeds/pods, seed index, biological yield/plant (gm), seed yield / plant (gm), shelling percentage and harvest index (%) were subjected to statistical analysis as per [15] and the genetic association among the traits was estimated according to the formulae described by [10,20]. The genotypic, phenotypic, environmental variance and broad sense heritability were calculated based on the method described by [6]. The path coefficients analysis was done according to [1,7] for assessing the direct and indirect effects of each traits on grain yield.

RESULT AND DISCUSSION

The study (table-1) revealed that the phenotypic coefficient of variation was higher than the corresponding genotypic coefficient of variation for all the characters, which could be due to genotype-environment interaction to some degree or another, explaining environmental factors influencing the expression of these characters. There was a high phenotypic and genotypic coefficient of variation for biological yield/plant (gm), seed yield per plant (gm), number of branches/plant, number of effective pods/plant seed index (gm), plant height, and number of seed/pods. The high values of GCV indicated greater phenotypic and genotypic variability among genotypes, as well as the responsiveness of the attributes to further improvement through selection. However, shelling percentage, harvest index (%), pod length (cm), days to maturity, days to 50% germination, days to first flowering, and days to 50% flowering showed low estimates of genotypic and phenotypic coefficients of variation, indicating the potential of heterosis breeding for their amelioration. Similar trends were reported by [2, 8].

In tables 2a and 2b, very high estimates of heritability were obtained for characters such as shelling percentage, followed by biological yield/plant (gm), and seed yield per plant (gm).However, high heritability was recorded in the characters like seed index (gm), number of seeds/pod, number of branches/plant, pods length (cm), days to maturity, plant height, indicate that the high values of broad sense heritability for these characters expressed that they were less influenced by environment conditions. It implied that selection based on phenotypic performance would be reliable high heritability combined with high genetic advance as a percentage of mean for character like biological yield/plant (gm), followed by plant height, shelling percentage, seed yield the preponderance of additive genes. It also indicated a higher response for the selection of high yielding genotypes, as these characteristics are governed by additive gene action. The findings are comparable to those of [9, 21].

High heritability supplemented with moderate genetic advancement as a percentage of mean were exhibited by biological yield/plant (gm), followed by plant height (cm), seed yield per plant (gm), shelling percentage, days to maturity, and number of effective pods/plant, which could be attributed to additive genes action conditioning their expression and phenotypic selection for their amiability. Days to first flowering, days to 50% flowering, number of branches/plants, pod length (cm), number of seed/pod, seed index (gm) and harvest index all demonstrated high heritability with low genetic advances as a percentage of mean. This revealed the predominance of non-additive gene action in the expression of these characters. The low heritability estimates combined with low genetic advance as a percentage of mean were shown by days to first flowering, days to 50% flowering, days to 50% germination and harvest index, indicating that this character was highly influenced by environmental effects and thus selection would be ineffective. Similarly reported by [11].The genotypic correlation coefficient was greater in magnitude than the corresponding phenotypic correlation coefficient, indicating a strong inherent association between the traits studied. The phenotypic expression of correlation was most likely caused by multiple influences of environmental components. Given their similarity, the phenotypic selection would be effective**.** The results are similar to the findings of [14, 17].

In table-3, the correlation coefficient of seed yield per plant was found to be highly significant and positive with biological yield per plant, number of effective pods / plant and number of seeds per pod, indicating that effective improvement in Pea yield could be achieved through these components. The yield attributing characters exhibited varying trend amongst them. The results are similar to the findings of [19]. The biological yield per plant were recorded highly significant and positive association with seed yield per plant, days to 50% flowering showed significant and positive correlation with days to first flowering, number of branches/ plant, expressed significant and positive correlation with pod length and plant height expressed significant and positive correlation with seed yield per plant significant negative association with days to 50% germination, expressed a highly significant and positive correlation with seed yield per plant, days to maturity, was recorded highly significant and negative association with number of seeds per pod, number of effective pods per plant, seed index. Which indicates that allocation and translocation of photosynthetic from the source to the sink. This indicates the importance of this character in selection almost similar results were reported in pea by [21].

Path coefficient analysis of different features contributing to seed production per plant revealed that biological yield per plant had the greatest positive direct effect, followed by, days to 50% flowering, days to first flowering, number of branches per plant, pod length, plant height. The parameters biological yield per plant, plant height, number of branches per plant and pod length had correlation coefficient values at par with their direct effect on seed yield per plant. This indicates close relationship with seed yield per plant and direct selection for this trait would result in higher breeding efficiency for improving yield. Thus, this trait might be reckoned as the most important component trait for seed yield per plant. The results are consistent with those obtained by [2,12].In contrast, the number of 50 % germination has the most negative direct effect on seed yield per plant, followed by days to maturity, number of seeds per pod, seed index, and number of effective pods per plant. However, the quantity of effective pods per plant was positively connected to it. This suggested that the indirect impact was the cause of the association and that the indirect causative factors should be evaluated concurrently for selection. The results are consistent with those obtained by [4].

An overall examination of the yield and its components revealed that the biological yield per plant, plant height, days to maturity, number of branches per plant, number of seed per pod, number of effective pods per plant, days to 50% flowering, seed index, and days to first flowering were the most important characters contributing to seed yield per plant and thus selection based on these characters would be more effective for improvement in Pea.

Table 1:- Genetic variability parameters

SN	Characters	GCV	PCV	ECV	h^2	GA	GG
1	Days to 50% Germination	13.17	15.22	7.63	74.86	1.96	23.47
2	Plant Height (cm)	24.09	24.33	3.47	97.97	36.90	49.11
3	Days to first Flowering	4.42	5.98	4.02	54.72	3.45	6.74
4	Days to 50% Flowering	5.71	6.58	3.26	75.41	6.78	10.22
5	Number of Branches/plant	27.27	28.19	7.13	93.59	1.86	54.35
6	Pod Length (cm)	14.81	15.58	4.85	90.31	1.56	28.99
7	Days to Maturity	4.50	4.63	1.06	94.73	10.30	9.03
8	Number of effective pods/plant	23.47	24.96	8.49	88.44	10.35	45.47
9	Number of seeds/pod	20.73	21.19	4.42	95.65	1.98	41.76
10	Seed index (gm)	27.55	27.57	1.19	99.81	7.99	56.69
11	Biological yield/plant (gm)	38.01	38.05	1.57	99.83	44.62	78.24
12	Seed Yield per plant (gm)	36.42	37.74	9.91	93.11	14.75	72.39
13	Shelling percentage	16.86	16.86	0.32	99.97	21.02	34.72
14	Harvest index (%)	8.16	13.18	10.35	38.34	3.74	10.41

Table-2a: Mean values for Days to 50% Germination, Plant Height (cm), Days to first Flowering, Days to 50% Flowering, Number of Branches/plant, Pod Length (cm), Days to Maturity.

S. No.	Genotype	Days to 50% Germin-ation	Plant Height (cm)	Days to first Flowering	Days to 50% Flowering	Number of Branches/ plant	Pod Length (cm)	Days to Maturity
1	G1-IC310833	7.00	76.87	46.67	62.00	4.47	5.13	110.00
2	G2-IC320964	7.67	96.77	51.33	61.67	3.68	4.40	115.67
3	G3-IC326203	7.33	105.73	48.33	62.00	4.30	4.93	104.33
4	G4-IC326267	7.33	79.20	52.33	63.67	4.56	5.20	100.33
5	G5-IC326345	8.00	79.25	45.67	56.33	4.40	5.27	112.67
6	G6-IC326395	6.67	84.57	46.33	59.67	4.37	4.87	109.67
7	G7-IC328345	7.67	85.63	50.33	57.67	2.93	5.10	119.00
8	G8-IC328514	9.33	107.53	54.33	66.00	2.70	5.33	116.67
9	G9-IC328701	7.67	67.90	51.00	60.00	2.43	4.53	115.00
10	G10-IC329410	9.33	85.00	54.67	62.33	4.43	6.43	120.67
11	G11-IC329586	10.67	46.53	50.00	67.33	4.47	7.93	113.00
12	G12-IC331093	9.33	62.62	54.33	67.00	2.30	5.27	120.33
13	G13-IC339680	8.67	60.60	52.33	65.33	4.63	5.23	114.67
14	G14-IC341387	8.00	51.05	49.00	61.33	4.30	5.07	108.67
15	G15-IC341543	10.67	91.83	51.00	69.33	2.13	5.33	114.67
16	G16-IC342020	7.33	61.87	52.33	65.33	4.47	5.53	116.67
17	G17-IC342021	8.33	100.75	51.67	70.33	4.53	5.60	118.67
18	G18-IC342022	9.33	104.67	49.67	62.67	4.33	5.43	109.33
19	G19-IC342023	10.67	100.90	46.67	63.67	4.47	6.77	103.00
20	G20-IC342024	8.67	69.93	50.33	68.33	4.14	6.03	112.67
21	G21-IC342025	7.33	59.17	48.00	69.00	3.34	5.07	109.67
22	G22-IC342026	8.00	77.82	52.67	67.33	2.46	5.53	117.67
23	G23-IC342027	8.67	74.60	51.67	65.33	2.27	6.37	112.00
24	G24- IC342028	9.67	82.10	50.67	67.67	3.06	5.63	106.33
25	G25-IC356390	10.67	107.60	46.67	64.00	3.43	5.43	104.33
26	G26-IC356395	7.67	90.67	50.67	66.33	3.78	5.53	110.33
27	G27-IC361173	8.00	58.95	51.67	68.67	4.42	4.13	119.00
28	G28-IC361879	8.67	54.40	51.33	70.00	3.19	3.73	119.33
29	G29-IC372703	9.67	58.57	55.33	70.67	2.02	4.93	120.67
30	G30-IC374690	6.67	40.43	50.67	72.33	2.16	6.43	115.33
31	G31-IC374697	7.33	90.47	57.00	70.00	2.73	6.00	117.67
32	G32-IC381053	9.33	73.57	55.00	73.33	3.60	4.70	119.67
33	G33-IC381054	7.00	62.60	52.67	70.00	4.33	4.23	114.33
34	G34-IC381055	7.33	69.23	52.33	69.33	2.53	3.83	116.33
35	G35-IC381121	8.67	72.30	52.67	70.33	2.82	5.27	118.33
36	G36-IC381155	7.33	82.93	50.67	69.00	2.32	5.30	116.33
37	G37-IC381185	9.67	61.77	53.00	66.67	2.21	7.00	121.33
38	G38-IC381450	8.00	74.85	52.00	68.67	2.58	5.33	115.00
39	G39-IC381452	6.67	84.47	53.00	69.67	2.65	6.00	117.33
40	G40-IC381453	7.33	40.12	50.33	67.67	4.83	5.13	113.00
41	G41-LC 1	8.33	60.82	52.33	69.33	2.37	5.47	116.33
42	G42-LC 2	8.67	58.80	53.33	69.00	2.47	5.37	117.67
	GM	8.34	75.13	51.24	66.34	3.42	5.38	114.13
	SE	0.37	1.50	1.19	1.25	0.14	0.15	0.70
	CD5	1.03	4.23	3.35	3.51	0.40	0.42	1.97
	CD1	1.37	5.61	4.44	4.66	0.53	0.56	2.61
	CV	7.63	3.47	4.02	3.26	7.13	4.85	1.06

Table-2b: Mean values for Number of effective pods/plant, Number of seeds/pod, Seed index (gm), Biological yield/plant (gm), Seed Yield per plant (gm), Shelling percentage, Harvest index (%).

S. No.	Genotype	Number of effective pods/plant	Number of seeds /pod	Seed index (gm)	Biological yield/plant (gm)	Seed Yield per plant (gm)	Shelling %	Harvest index (%)
1	G1-IC310833	26.80	3.45	18.44	75.52	27.56	66.41	36.50
2	G2-IC320964	28.73	4.50	13.32	82.50	26.34	71.24	31.92
3	G3-IC326203	25.27	4.45	14.38	49.38	19.28	62.14	39.08
4	G4-IC326267	32.03	5.48	11.24	85.98	28.50	68.66	33.15
5	G5-IC326345	18.24	5.37	13.22	35.67	11.11	55.50	31.12
6	G6-IC326395	36.01	4.31	21.53	49.04	15.02	58.59	30.64
7	G7-IC328345	20.25	3.46	14.21	35.68	10.58	53.33	29.68
8	G8-IC328514	19.85	3.40	16.35	34.58	9.47	63.66	27.37
9	G9-IC328701	22.27	6.48	6.54	99.61	34.69	46.32	34.81
10	G10-IC329410	36.41	4.35	18.53	91.22	34.25	67.48	37.53
11	G11-IC329586	26.17	6.22	12.20	41.59	15.17	61.28	36.51
12	G12-IC331093	27.30	3.40	12.48	35.10	12.27	61.38	34.93
13	G13-IC339680	18.33	3.23	16.34	34.62	11.79	44.25	34.09
14	G14-IC341387	20.85	4.52	10.23	61.88	24.32	50.15	39.33
15	G15-IC341543	31.88	4.41	17.47	39.38	15.43	69.24	39.19
16	G16-IC342020	19.88	5.68	17.20	91.06	32.31	50.15	35.48
17	G17-IC342021	24.33	5.62	14.33	93.98	32.87	69.29	34.99
18	G18-IC342022	28.60	3.59	13.47	51.94	20.21	61.42	38.91
19	G19-IC342023	21.60	4.40	16.49	76.59	23.12	65.47	30.22
20	G20-IC342024	20.12	3.50	14.39	55.53	22.68	68.17	40.88
21	G21-IC342025	22.27	3.37	14.20	34.45	12.97	63.57	37.66
22	G22-IC342026	7.43	4.35	13.24	54.16	20.72	68.19	38.28
23	G23-IC342027	22.93	5.65	13.24	75.65	25.58	63.57	33.78
24	G24- IC342028	15.64	6.66	14.56	79.39	27.18	58.34	34.23
25	G25-IC356390	17.48	4.27	21.14	90.82	31.20	66.43	34.37
26	G26-IC356395	20.40	5.52	14.60	52.32	20.06	62.47	38.33
27	G27-IC361173	19.53	6.88	12.38	34.95	12.25	62.35	35.00
28	G28-IC361879	20.24	4.29	5.83	35.30	10.94	40.23	30.98
29	G29-IC372703	23.24	3.74	13.31	53.52	19.02	70.11	35.56
30	G30-IC374690	18.47	4.25	18.12	55.87	20.81	68.26	37.25
31	G31-IC374697	26.53	3.41	21.27	74.03	27.22	63.51	36.80
32	G32-IC381053	19.25	5.63	9.40	37.05	15.61	43.39	42.04
33	G33-IC381054	22.94	4.32	8.54	51.73	19.88	61.22	38.47
34	G34-IC381055	27.14	5.23	6.40	57.94	21.88	72.46	37.71
35	G35-IC381121	18.89	4.45	8.32	33.93	13.31	54.46	39.31
36	G36-IC381155	21.91	4.39	18.15	43.44	17.27	81.19	39.72
37	G37-IC381185	17.89	5.59	12.48	33.45	10.62	54.55	31.78
38	G38-IC381450	17.25	5.50	12.32	36.07	13.70	53.22	38.01
39	G39-IC381452	20.39	5.27	20.15	38.56	17.56	68.52	45.61
40	G40-IC381453	26.23	5.20	14.23	102.33	35.22	25.54	34.43
41	G41-LC 1	22.23	5.41	12.54	47.53	17.72	64.74	37.32
42	G42-LC 2	23.11	5.51	15.35	52.03	18.17	61.41	34.91
	GM	22.77	4.73	14.10	57.03	20.38	60.52	35.90
	SE	1.12	0.12	0.10	0.52	1.17	0.11	2.15
	CD5	3.14	0.34	0.27	1.46	3.28	0.31	6.04
	CD1	4.16	0.45	0.36	1.93	4.35	0.41	8.00
	CV	8.49	4.42	1.19	1.57	9.91	0.32	10.35

Table 3:- Estimation of phenotypic and genotypic correlation coefficient among yield and its contributing characters in pea.

SN	Character	Days to 50% Germination	Plant Height (cm)	Days to first Flowering	Days to 50% Flowering	Number of Branches /plant	Pod Length (cm)	Days to Maturity	Number of effective pods/plant	Number of seeds/pod	Seed index (gm)	Biological yield/plant (gm)	Seed Yield per plant (gm)	Shelling percentage	Harvest index (%)
1	Days to 50% Germination		0.19	0.01	0.09	-0.11	0.42**	-0.01	-0.05	0.02	-0.03	-0.07	-0.12	0.02	-0.19
2	Plant Height (cm)	0.16		-0.18	-0.35*	0.08	0.01	-0.31*	0.16	-0.20	0.38**	0.15	0.12	0.42**	-0.13
3	Days to first Flowering	0.12	-0.13		0.64**	-0.50**	-0.00	0.77**	-0.01	0.02	-0.19	-0.10	-0.02	0.02	0.34
4	Days to 50% Flowering	0.08	-0.30*	0.46**		-0.42**	0.01	0.42**	-0.24	0.10	-0.13	-0.24	-0.14	0.11	0.60**
5	Number of Branches/plant	-0.09	0.07	-0.34*	-0.34*		-0.02	-0.45**	0.28	0.03	0.07	0.30*	0.29*	-0.26	-0.10
6	Pod Length (cm)	0.34**	0.01	-0.01	0.04	-0.02		-0.09	-0.04	0.07	0.43**	0.08	0.09	0.19	0.05
7	Days to Maturity	-0.01	-0.31*	0.53**	0.35**	-0.42**	-0.09		-0.14	-0.01	-0.17	-0.33*	-0.30*	-0.09	0.09
8	Number of effective pods/ plant	-0.05	0.15	-0.03	-0.22	0.26	-0.03	-0.12		-0.15	0.19	0.26	0.25	0.18	-0.10
9	Number of seeds /pod	0.03	-0.20	0.02	0.07	0.03	0.07	-0.01	-0.14		-0.32*	0.22	0.21	-0.17	0.04
10	Seed index (gm)	-0.02	0.37**	-0.14	-0.11	0.07	0.41**	-0.17	0.18	-0.31*		0.16	0.16	0.34*	-0.01
11	Biological yield/ Plant (gm)	-0.07	0.15	-0.07	-0.21	0.30*	0.07	-0.32*	0.25	0.21	0.16		0.99**	-0.01	-0.15
12	Seed Yield per plant (gm)	-0.12	0.11	-0.04	-0.12	0.27*	0.08	-0.27*	0.24	0.21	0.16	0.95**		0.03	0.01
13	Shelling percentage	0.02	0.42**	0.01	0.09	-0.25	0.18	-0.09	0.17	-0.16	0.34*	-0.01	0.03		0.24
14	Harvest index (%)	-0.17	-0.09	0.06	0.32**	-0.08	0.03	0.07	-0.01	0.05	-0.01	-0.10	0.20	0.15	

*, ** Significant at 5% and 1% respectively

CONCLUSION

The estimates of mean sum of the square due to genotypes were very much significant for all the features indicating the presence of genetic variability in the current materials. The mean performance of the genotypes revealed a large range of variability for all the characters. The variation was highest for biological yield per plant associated with seed yield per plant followed by number of pods per plant, number of seeds per pod for all of the characters, the PCV was greater than the GCV the high PCV and GCV were observed for biological yield/plant (gm), seed yield per plant (gm), number of branches/plant, number of effective pods/plant, plant height, seed index (gm) and number of seeds/pod, indicating greater variability for these traits and their further improvement through selection.

The high heritability combined with high genetic advance as a percentage of mean for characters such as biological yield/plant (gm) followed by plant height (cm), seed yield per plant (gm), shelling percentage, days to maturity and number of effective pods/plant suggested that they can be improved through direct selection. The association analysis suggests that the benefits of upgrading Pea genotypes by simultaneous selection for number of seed per pod.

The path coefficient study revealed that biological yield per plant had a highly significant and positive relationship with seed yield per plant, number of branches/plant were the most important characters contributing to seed yield per plant. Days to 50% flowering showed a significant and positive relationship with days to first flowering and thus purposeful and balanced selection based on these characters would be more effective for improvement in peas.

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