E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 754-757
Received: 15-09-2025
Accepted: 21-10-2025

Vishal R Gore
Pulses Research Unit, Dr. PDKV, Akola, Maharashtra, India

Dr. Vijaykumar L Gawande
Pulses Research Unit, Dr. PDKV, Akola, Maharashtra, India

Vaibhav G Gulhane
Pulses Research Unit, Dr. PDKV, Akola, Maharashtra, India

Corresponding Author:
Vishal R Gore
Pulses Research Unit, Dr. PDKV, Akola, Maharashtra, India

Genetic variability studies in *rabi* pigeon pea (*Cajanus cajan* L. Millsp.)

Vishal R Gore, Vijaykumar L Gawande and Vaibhav G Gulhane

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12k.4474

Abstract
This study aims to identify varieties/genotypes with high yield and production and suitable for *rabi* season. The present experiment was conducted in *rabi* season for determining genetic variability, heritability, genetic advance, and correlation among yield and its contributing traits in forty four genotypes of pigeon pea. The analysis of variance revealed that mean squares due to genotypes were highly significant for all the characters under study which indicated that there were inherent genotypic differences among the genotypes. *Per se* performance, range and coefficient of variation showed considerable variation for all the ten traits indicating scope for improvement in desired direction. From the variability studies, higher magnitude of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for harvest index, pods per plant and grain yield per plant, moderate magnitude of GCV and PCV for plant height, days to 50% flowering, primary branches and seeds per pod indicating that these traits could be used for yield improvement under *rabi* pigeon pea breeding programme. High heritability coupled with high genetic advance was observed for days to 50% flowering, plant height and pods per plant which indicated predominance of additive gene action and scope for direct selection. Days to 50% flowering and primary branches were significantly and negatively correlated but pods per plant, pod length and 100 seed weight showed positive association with grain yield. Thus, these traits were identified as most important yield attributing components for selection in *rabi* pigeon pea. On the basis of *per se* performance, it has been concluded that among forty four genotypes the genotypes PDKV Ashlesha, Asha, AKTE 1644, and AKTE 1902 were found superior in terms of yield per plant whereas, ICPL 87 and PAU 881 were found to be earlier than other varieties.

Keywords: *Rabi* pigeon pea, GCV, PCV, heritability, genetic advance, correlation

Introduction
India holds a significant position in global pulse production and consumption. Pigeon pea which originated in India, is the second most significant pulse crop in India after chickpea (Pandey *et al*., 2016) [5]. It has diversified uses as food, feed, fodder and fuel. It has been recognized as a valuable source of protein for the vegetarians in their daily diet (Vanisree *et al*., 2013) [8]. It contains high levels of proteins and important amino acids such as methionine, lysin and tryptophan. It is a legume crop which has ability to fixes atmospheric nitrogen symbiotically by forming a relationship with *Rhizobium* species bacteria which enhance fertility of soil. The residual effect of pigeon pea cultivation on subsequent cereal crops can be equivalent upto 40 kg Nha^{-1} (Kumar Rao *et al*., 1983) [4].

The success of any breeding programme relies on the extent of heritable variability present in the material. Enhancing yield potential is the primary objective for a plant breeder when developing a new variety. However, yield is a polygenic trait, influenced by multiple factors as genotype and environment.

The increasing demand for pigeon pea and the limited available area for expansion, research efforts should now concentrate on genetically enhancing yield through innovative genetic approaches to achieve higher production and productivity of pigeon pea in *kharif* and *rabi* season as well.

It is crucial to evaluate the variation within a crop. Various genetic parameters such as GCV, PCV, and heritability can be used for this assessment. Correlation studies play a vital role in determining the interrelationships among various traits, providing valuable insights into the

contribution of each trait to the genetic composition of a crop. Analyzing the correlation between yield and its attributes, along with assessing the direct and indirect effects of each component trait on yield, aids breeders in identifying traits that significantly contribute to yield, thereby facilitating substantial genetic advancements.

The lack of adoption of improved management practices and insufficient scientific research have resulted in low productivity and production levels, so this study aimed to identify varieties or genotypes with high yield and production which will be suitable for *rabi* season.

Materials and Methods

The experimental material consisted of 44 varieties/genotypes of pigeon pea *viz*, C 11, IPA 2012-1, Azad, IPL 15F, KPL 44, Amar, MA 6, IPA 203, Kudrat 3, PKV Tara, PDKV Ashlesha, Vipula, Asha, BSMR 736, BSMR 853, JKM 189, Pusa 9, NPMK 1505, ICAKTM 19424, ICAKTM 19428, AKTM 1918, AKTM 1917, AKTE 12-04, AKTE 1604, AKTE 16-12, AKTE 1644, AKTE 1901, AKTE 1902, AKTE 1904, AKTE 1905, Pusa Arhar 16, Pusa 992, Pusa 991, PAU 881, AKT 8811, IPA 15-06, Renuka, BDN 716, BDN 711, Phule Rajeshwari, Phule Trupti, ICPL 87, ICPL 85063 and ICPL 332WR which were grown in randomized block design at the field of department of Agricultural Botany, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *rabi* 2023-2024. Each entry was sown in 3.0 m long two rows at spacing 45 cm x 15 cm with three replications.

Observations on five randomly selected plants were recorded for plant height, primary branches, pods per plant, seeds per pod, pod length, 100 seed weight, grain yield per plant and harvesting Index. However, all the plants in a plot were considered for recording to days to 50% flowering and days to maturity.

The data were subjected for analysis of variance as per the method suggested by Panse and Sukhatme (1967) [6]. The coefficients of variation for different characters were estimated by formula as suggested by Burton and De Vane (1953) [2]. Heritability (h^2), genetic advance (GA) and genotypic and phenotypic correlation coefficients were analysed as per the methods given by Allard (1960) [1], Robinson *et al.* (1949) [7] and Johnson *et al*. (1955) [3].

Results and Discussion

The analysis of variance (Table 1) revealed that mean squares due to genotypes were highly significant for all the characters under study which indicated that there were inherent genotypic differences among the genotypes. Considerable range of variation was observed for all the traits indicating scope for improvement in desired direction (Table 2).

For all the ten characters, phenotypic variance was higher than its corresponding genotypic variance (Table 3). The difference in magnitude of phenotypic and genotypic variance among the above mentioned characters indicated that environment have played some role in the expression of characters.

High genotypic and phenotypic coefficients of variation were recorded for harvest index, pods per plants, grain yield per plant. Characters having moderate genotypic and phenotypic coefficient of variability were days to 50% flowering, plant height, primary branches, seeds per pod. While, some characters like 100 seed weight and pod length exhibited low genotypic coefficient variation with moderate phenotypic coefficient variation. However, low genotypic and phenotypic coefficient of variation was recorded for days to maturity.

The high magnitude of heritability was recorded for seeds per pod, harvest index, days to 50% flowering, pod length, pods per plant, plant height, days to maturity, grain yield per plant, 100 seed weight and primary branches. Genetic advance as *per cent* of mean was recorded as high for harvest index, pods per plant, grain yield per plant, days to 50% flowering, plant height, seeds per pod. Moderate genetic advance as *per cent* of mean was recorded for primary branches, pod length, 100 seed weight and days to maturity.

High heritability coupled with high genetic advance was recorded for days to 50% flowering, plant height and pods per plant, which indicated that the predominance of additive gene action in the expression of these characters which could be utilized through selection for the genetic improvement of these characters.

The mean performance of forty four genotypes and the range of variance for yield and yield related traits are presented in Table 2. All the genotypes varied significantly for the traits seed yield per plant. The highest seed yield per plant was recorded in genotype PDKV Ashlesha (19.46 g) followed by Asha (16.13 g), AKTE 1644 (15.46 g) and AKTE 1902 (15.33 g). The high yield of the genotype PDKV Ashlesha was attributed by higher number of pods per plant. The genotype Pusa Arhar 16 was the earliest to flowering (61 days), Whereas, maximum period for flowering (130.33 days) was taken by genotype IPL 15F. Genotype ICPL 87 took the shortest duration of time (117 days) for maturity followed by PAU 881 (122 days). IPA 203 recorded as the tallest plant (133 cm) and highest 100 seed weight (11.6 g). The highest number of primary branches were observed in genotype Amar (11.66) followed by MA 6 (11.33). However, highest seeds per pod and pod length were observed in the genotype NPMK 1505 (5.9 and 6.62). Maximum and minimum harvest index were found between Pusa Arhar 16 (31.42) and Amar (7.48). This variability among genotypes may be considered for inclusion in the breeding program to develop high yielding varieties or through recombination breeding for *rabi* season.

Out of ten characters pairs the magnitude of genotypic correlation coefficient was higher than the corresponding phenotypic correlation coefficients (Table 4).

It is evident that days to 50% flowering showed significant and positive correlation with days to maturity, plant height, primary branches and 100 seeds weight at both genotypic and phenotypic levels. However, days to 50% flowering showed negative correlation with pods per plant, seeds per pod, pod length and harvest index at both genotypic and phenotypic levels. But grain yield per plant showed significant and negative correlation at genotypic level only. Days to maturity exhibited significant and positive correlation with plant height and primary branches at both genotypic and phenotypic level. But seeds per pod, pod length and harvest index showed significant and negative correlation at both genotypic and phenotypic levels. It showed significant and positive correlation with 100 seed weight at genotypic level only. Plant height showed significant and positive correlation with primary branches and 100 seeds weight at both genotypic and phenotypic level. It had significant and negative correlation with seeds per pod and harvest index at both genotypic and phenotypic levels. But plant height showed significant and negative correlation with pod length at genotypic level only. Primary branches showed significant and negative correlation with pods per plant, seeds per pod, pod length, grain yield per plant and harvest index at both genotypic and phenotypic levels. It showed significant and negative correlation with 100 seeds weight at genotypic level only. Pods per plant exhibited significant and positive correlation with grain yield per

plant and harvest index at both genotypic and phenotypic levels. Seeds per pod showed significant and positive correlation with pod length and harvest index at both genotypic and phenotypic levels. Pod length showed significant and positive correlation with grain yield per plant at genotypic level only. 100 seeds weight exhibited significant and negative correlation with harvest index at both genotypic and phenotypic levels and significant and positive correlation with grain yield per plant at genotypic level only. Grain yield per plant showed significant and positive correlation with harvest index at both genotypic and phenotypic levels.

Table 1: Analysis of variance for various characters in *rabi* pigeon pea.

Sources	df	Mean sum of squares									
		Days to 50% flowering	Days to maturity	Plant height	Primary branches	Pods per plant	Seeds per pod	Pod length	100 seed weight	Grain yield per plant	Harvest Index
Replications	2	2.81	2.72	2.18	2.56	2.86	0.59	2.18	2.78	0.92	2.74
Treatments	43	29.73**	15.35**	18.85**	6.76**	20.09**	34.96**	24.51**	10.92**	15.02**	29.94**
Error	86	3.22	2.23	4.05	0.461	3.23	0.07	0.09	0.28	0.72	1.02

**: Significant at 1% level of probability

Table 2: Mean performance for various characters in *rabi* pigeon pea

Sr. No.	Genotypes	Days to 50% flowering	Days to maturity	Plant height	Primary branches	Pods per plant	Seeds per pod	Pod length	100 seed weight	Grain yield per plant	Harvest index
1	C 11	90.00	146	95.2	11**	64.333	3.8	4.467	8.713	9.6	17.537
2	IPA 2012-1	123.00	149	121	9.733	44.067	3.767	4.513	8.223	8.267	10.943
3	Azad	125.333	145.333	129.4**	11.26**	69	4	4.547	10.28	14.2	12.033
4	IPL 15F	130.333	151	116.867	10.2	39.8	3.667	5.397	9.953	8.4	8.033
5	KPL 44	125.333	145.333	115.333	10.66**	42.8	3.9	4.243	9.057	9.337	12.927
6	Amar	126.333	151	129.33**	11.66**	42.467	3.8	4.66	8.873	8.733	7.483
7	MA 6	127.00	153	129**	11.33**	57.533	3.4	4.32	9.903	9.8	10.473
8	IPA 203	126.00	146	133**	9.8	42.787	3.7	4.68	11.6**	7.8	11.46
9	Kudrat 3	132.00	155	107.2	8.533	41.467	3.867	4.95	11.5**	9.02	12.273
10	PKV Tara	91.00	138.667	94.533	10	56.2	3.7	4.727	8.61	11.533	20.997
11	PDKV Ashlesha	85.667	137	103	8.267	116.13**	4	5.477	10.147	19.46**	21.63
12	Vipula	83.00	134	103.8	7.667	59.667	4	4.633	9.513	13.07	21.777
13	Asha	81.667	134	91.933	8.8	75.27	3.4	4.463	10.813	16.133	21.707
14	BSMR 736	90.667	135.667	94.133	7.867	58.263	4.2	4.797	9.44	11.6	23.213
15	BSMR 853	91.667	135	92.867	9.4	56.737	4	4.31	8.143	8.197	19.523
16	JKM 189	91.333	143.667	105.067	10.2	50.133	4	4.163	9.513	10.203	17.31
17	Pusa 9	122.667	153	122.4	9.8	50.6	3.6	4.347	10.533	9.8	11.547
18	NPMK 1505	90.333	135.667	93.333	8.8	70.8	5.9**	6.627**	9.483	12.733	23.877
19	ICAKTM 19424	89.333	133.333	93.167	10.53**	57.733	3.6	4.707	9.22	13.467	22.98
20	ICAKTM 19428	87.00	132	86.8	10.46**	66.667	3.567	4.893	8.55	13	26.047
21	AKTM 1918	84.333	135	98.733	10	48.933	4.3	5.26	9.373	12.53	20.083
22	AKTM 1917	88.333	135.333	89.533	10.66**	56.13	3.8	4.68	9.32	9.403	21.857
23	AKTE 12-04	89.667	131.333	85.733	10.267	65.467	4.2	4.167	8.49	11.8	26.467
24	AKTE 1604	91.333	135.333	87.467	10.067	59.337	4	5.11	7.797	8.8	23.073
25	AKTE 16-12	87.333	135.333	91.067	8.867	57.6	4.2	4.56	9.053	10.8	23.633
26	AKTE 1644	88.333	130.667	89.533	8.033	73.067	4.433	4.68	10.467	15.467	27.453
27	AKTE 1901	85.00	134.667	87.467	8.933	71.933	3.8	5.08	10.343	14.063	22.233
28	AKTE 1902	89.333	137	90.533	9.933	71.733	4.5	4.837	8.117	15.333	20.757
29	AKTE 1904	82.00	133.667	90.733	7.967	61.933	4.3	4.673	9.043	12.2	21.38
30	AKTE 1905	87.00	134.667	93	8.367	78.067	3.8	4.54	8.457	13.333	22.4
31	Pusa Arhar 16	61**	123.667	49.4	11.533**	54	4.2	4.557	7.807	7.343	31.42**
32	Pusa 992	71.00	123	74.633	7.467	45.067	4.333	4.87	9.577	7.8	18.81
33	Pusa 991	84.667	129.667	89.433	8.867	54.867	4.733	4.517	8.04	8.667	19.967
34	PAU 881	72.333	122**	84.767	8.8	46.333	4.8	5.567	9.96	9.133	17.367
35	AKT 8811	90.00	135.667	97.8	8.333	64.133	4.033	5.283	9.927	12.4	24.133
36	IPA 15-06	86.00	128.333	87.3	7.533	40.33	4.8	5.563	8.647	7.603	19.127
37	Renuka	87.333	130	99.033	8.533	64.733	4.2	5.447	10.087	14.533	24.91
38	BDN 716	88.00	128.333	80.8	7.733	50.197	4.6	4.32	10.313	9.133	24.427
39	BDN 711	91.333	128.333	69.1	8	49.533	4.233	5.007	10.35	9.733	23.23
40	Phule Rajeshwari	91.333	140	88.6	7.533	67.733	3.933	4.66	7.66	11.8	23.487
41	Phule Trupti	92.333	142	92.067	8.6	77.863	3.8	4.95	9.17	14.867	18.983
42	ICPL 87	73.667	117**	55.667	10	31.87	4.633	5.123	9.163	6.667	29.723**
43	ICPL 85063	98.00	142	104	10	49.913	4	4.72	8.637	12.003	17.943
44	ICPL 332WR	93.333	140.333	97.333	9.667	50.333	3.733	4.537	9.3	11.87	18.977
	General mean	94.61	136.97	96.16	9.35	58.03	4.07	4.81	9.34	11.17	19.91
	SEM	3.22674	2.23191	4.0508	0.46134	3.23311	0.07673	0.09461	0.28917	0.7252	1.0217
	CD (5%)	8.49992	5.87934	8.05272	1.21527	8.5167	0.20212	0.24921	0.76173	1.91034	2.69136
	Range	61-132	117-155	49.4-133	7.4-11.6	31.8-116.1	3.4-5.9	4.1-6.6	7.66-11.6	6.66-19.46	7.48-31.42
	C.V.%	5.9	2.82	7.29	8.53	9.64	3.26	3.4	5.35	11.24	8.89

Table 3: GCV, PCV, heritability, genetic advance and genetic advance as percent means in *rabi* pigeon pea

	Days to 50% flowering	Days to maturity	Plant height	Primary branches	Pods per plant	Seeds per pod	Pod length	100 seed weight	Grain yield per plant	Harvest Index
GCV	18.28	6.17	17.80	11.84	24.34	10.98	9.54	9.75	24.31	27.63
PCV	19.22	6.79	19.24	14.6	26.18	11.45	10.13	11.12	26.78	29.02
Heritability (bs)	90.55	82.72	85.61	65.79	86.44	91.89	88.69	76.78	82.38	90.61
GA	33.91	15.84	32.62	1.85	27.05	0.88	0.89	1.64	5.08	10.78
GA%	35.84	11.57	33.92	19.79	46.62	21.68	18.51	17.59	45.45	54.17

Table 4: Genotypic and phenotypic correlations matrix

PCM / GCM	Days to 50% flowering	Days to maturity	Plant height	Primary branches	Pods per plant	Seeds per pod	Pod length	100 seed weight	Grain yield per plant	Harvest index
Days to 50% flowering	1	0.790**	0.769**	0.296**	-0.245**	-0.392**	-0.183*	0.291**	-0.158	-0.789**
Days to maturity	0.929**	1	0.783**	0.293**	-0.060	-0.486**	-0.229**	0.151	0.000	-0.742**
Plant height	0.907**	0.891**	1	0.217*	-0.026	-0.375**	-0.156	0.297**	0.089	-0.766**
Primary branches	0.414**	0.441**	0.355**	1	-0.191*	-0.319**	-0.239**	-0.150	-0.212*	-0.272**
Pods per plants	-0.284**	-0.053	-0.052	-0.222*	1	-0.040	0.110	-0.020	0.844**	0.381**
Seeds per pod	-0.425**	-0.564**	-0.447**	-0.400**	-0.059	1	0.533**	-0.118	-0.076	0.355**
Pod length	-0.201*	-0.268**	-0.176*	-0.335**	0.138	0.593**	1	0.134	0.137	0.136
100 seed weight	0.349**	0.235**	0.346**	-0.247**	-0.003	-0.112	0.154	1	0.128	-0.250**
Grain yield per plant	-0.196*	-0.010	0.072	-0.229**	0.858**	-0.109	0.173*	0.201*	1	0.301**
Harvesting Index	-0.874**	-0.840**	-0.886**	-0.348**	0.309**	0.380**	0.168	-0.287**	0.240**	1

*Significant at 5%, ** Significant at 1%

Conclusion and Implications

From the variability studies, higher magnitude of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for harvest index, pods per plant and grain yield per plant, moderate magnitude of GCV and PCV for plant height, days to 50% flowering, primary branches and seeds per pod indicating that these traits could be used for yield improvement under *rabi* pigeon pea breeding programme.

High heritability coupled with high genetic advance was observed for days to 50% flowering, plant height and pods per plant indicated predominance of additive gene action and scope for direct selection. Moderate heritability with moderate genetic advance was found for days to maturity and harvest index and high heritability with low genetic advance in seeds per pods show that less effective through direct selection for yield.

Days to 50% flowering and primary branches were significantly and negatively correlated but pods per plant, pod length and 100 seed weight showed positive correlation with grain yield. Thus, these traits were identified as most important yield attributing components for selection in *rabi* pigeon pea.

On the basis of *per se* performance and various statistical analyses performed, it has been concluded that among forty four genotypes the genotypes PDKV Ashlesha, Asha, AKTE 1644, and AKTE 1902 were found superior in terms of yield per plant. ICPL 87 and PAU 881 were found to be earlier than other varieties. It can be considered as potential genotypes for incorporation in pigeon pea breeding program as well as recommended for further multilocation testing followed by release for commercial cultivation during *rabi* season.

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