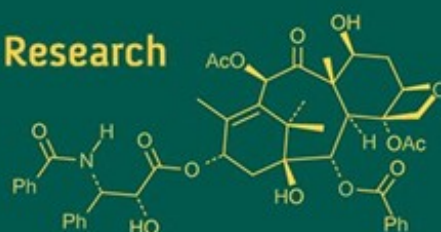


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
Indexing: Embase
IJABR 2026; SP-10(10): 865-869
www.biochemjournal.com
Received: 30-07-2026
Accepted: 24-09-2026
Published: 09-10-2026

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Deciphering genetic diversity and trait interrelationships in pigeonpea (*Cajanus cajan* (L.) Millsp.)

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sk.10389>

ABSTRACT

The research was carried out at the Agricultural Research Station, Badnapur, during the Kharif season of 2025–26, thirty eight genotypes of pigeonpea, along with two check varieties viz. BDN-711 and Godawari, were planted in a Randomized Block Design with two replications for nine quantitative characters viz. days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number seeds per pod, 100 seed weight and seed yield per plant. The analysis of variance revealed highly significant differences among the genotypes for all the characters studied, indicating the presence of substantial genetic variability. High estimates of the genotypic coefficient of variation (25.69) and phenotypic coefficient of variation (28.31) were found in seed yield per plant followed by the number of secondary branches per plant the genotypic coefficient of variation (23.84) and phenotypic coefficient variation (28.31), primary branches per plant the genotypic coefficient of variation (21.98) and phenotypic coefficient variation (24.35). Correlation analysis revealed that seed yield per plant had significant positive associations with number of primary branches, number of secondary branches and number of pods per plant at both phenotypic and genotypic levels. Path coefficient analysis indicated that number of pods per plant recorded the highest positive direct effect on seed yield per plant at both phenotypic and genotypic levels

Keywords: Pigeonpea, Genetic advance, Correlation coefficient, Path coefficient analysis

Introduction

Pulses are one of the major sources of protein in vegetarian diets. Due to their high protein content and balanced amino acid profile, they form an important part of the daily human diet. Among pulse crops, pigeonpea (*Cajanus cajan* (L.) Millsp.) is an important grain legume cultivated mainly under rainfed conditions in the semi-arid tropics. Pigeonpea belongs to the genus *Cajanus*, sub tribe *Cajaninae*, tribe Phaseoleae, sub-family Papilionaceae and family Fabaceae. It is a diploid species having 11 pairs of chromosomes ($2n = 2x = 22$) with an estimated genome size of 858 Mbp. Out of the 32 species present in the genus *Cajanus*, 18 species are reported from India (Van der Maesen, 1980). Pigeonpea is commonly known as “Arhar” or “Tur” and is widely consumed as dal, a highly preferred dish among Indian vegetarians. The crop contains about 24–25 per cent protein along with valuable minerals (Sodavadiya *et al.*, 2009) [1]. In India, a large vegetarian population depends on pigeonpea as a major source of dietary protein. The per capita protein availability in the country is estimated to be only 63.4 g per day, which is much lower than the 80 g per day recommended by WHO (Prasad *et al.*, 2013) [2]. Seed yield in pigeonpea is a complex quantitative character greatly influenced by environmental factors. For a systematic breeding programme, it is essential to understand the magnitude and nature of variability present in the population due to both genetic and environmental causes. Therefore, estimation of parameters such as genotypic coefficient of variation, heritability in broad sense and genetic advance becomes important for assessing variability among traits. Information on genetic variability and heritability is highly useful for selecting elite genotypes and planning heterosis breeding programmes (Anuradha *et al.*, 2019) [3].

Materials and methods

The research was carried out at the Agricultural Research Station, Badnapur, during the Kharif season of 2025–26, thirty eight genotypes of pigeonpea, along with two check varieties viz. BDN-711 and Godawari, were planted in a Randomized Block Design with two replications for nine quantitative characters viz. Days to 50% flowering, days to maturity, plant height, number of primary branches per plant, number of secondary branches per plant, number of pods per plant, number seeds per pod, 100 seed weight and seed yield per plant. Phenotypic coefficient correlations were computed using the formula suggested by Falconer (1960). The Path coefficient analysis was conducted as described by Dewey *et al.* (1959) [4]. The list of genotypes presented in Table 1. Each genotype was sown in single row with 4 m in length, with a spacing of

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90 cm between rows and 20 cm between plants. The data collected for individual traits were analyzed using the analysis of variance (ANOVA) method, which is typically applied to a randomized block design. This statistical technique helps to determine the significance

of differences among the genotypes in the study (Panse *et al.*, 1967) [5]. Divergence analysis was performed using the D^2 statistic, as proposed by Mahalanobis (1936) [6] and described by Rao (1952) [7].

Table 1. List of genotype of Pigeonpea.

Sr. No.	Name of genotype	Sr. No.	Name of genotype
	PT 2103	21.	AKTM-19-14
	GRG 140	21.	AKTM-19-16
	WRGE-174	21.	AKTE-19-04
	GRG 152	21.	IC 368846
	IPAME 23-2	21.	IC 368907
	AKTE-19-02	21.	IC 245478
	ICPL 22195	21.	IC 343966
	ICPL-20096	21.	IC 339051
	BDN-40-12-4-1-1	21.	BDN-2021-24-3-2
	BDN-40-109-4-1-2	21.	BDN-2021-25-3-13
	BDN-40-112-1-1-1	21.	BDN-2021-24-5
	BDN-40-96-1-1-1	21.	BDN-2021-28-2-2
	BDN-40-36-6-1-1	21.	BDN-2021-28-2-1
	BDN-40-109-6-1	21.	UPAS 120
	BDN-40-47-1-1-1	21.	BP 16-184
	BDN-40-109-12	21.	IPA 15-6
	BDN-40-25-13-1	21.	CORG 9701
	BDN-40-51-1-1	21.	WRGE 171
	ICAKTM-19424		
	PDKV Ashlesha		
Checks			
1.	BDN-711		
2.	Godawari		

Results and discussion

Analysis of variance for genetic variability

The analysis of variance indicated significant differences among the genotypes for all the characters studied, suggesting the existence of substantial genetic variability in the experimental material evaluated in the present investigation in Table 2

Variability and genetic parameters

The estimates of variability (genotypic and phenotypic coefficient of variation), heritability (broad sense), genetic advance as percent of mean for seed yield and its component characters in forty genotypes of pigeonpea were presented in Table 3

Wide ranges were observed for all characters days to 50% flowering (92.00 for UPAS 120 to 123.50 for ICPL-20096), days to maturity (134.00 for UPAS 120 to 174.00 for ICPL-20096), plant height (166.71 cm for UPAS 120 to 209.63 cm for AKTE-19-02), number of primary branches per plant (5.63 for UPAS 120 to 14.72 for BDN-40-112-1-1-1), number of secondary branches per plant (9.36 for IC368846 to 21.35 for IC 343966), number of pods per plant (35.08 for BDN-40-109-6-1 to 266.12 for ICPL 22195), number of seeds per pod (3.05 for IPAME 23-2 to 4.75 for CORG 9701), 100 seed weight (9.38 g for PT 2103 to 14.12 g for BDN-2021-24-5), seed yield per plant (30.85 g for UPAS 120 to 98.28 g for BDN-2021-24-5).

High estimates of the genotypic coefficient of variation (25.69) and phenotypic coefficient of variation (28.31) were found in seed yield per plant followed by the number of secondary branches per plant the genotypic coefficient of variation (23.84) and phenotypic coefficient

variation (28.31), primary branches per plant the genotypic coefficient of variation (21.98) and phenotypic coefficient variation (24.35). While number of pods per plant the genotypic coefficient of variation (18.57) is moderate and phenotypic coefficient variation (29.47) is high and lower PCV & GCV found in days to 50% flowering ($PCV = 5.95$; $GCV = 5.64$), days to maturity ($PCV = 5.20$; $GCV = 4.75$), plant height ($PCV = 8.24$; $GCV = 4.91$). Moderate PCV & GCV found in number of seeds per pod ($PCV = 12.10$; $GCV = 9.65$) and 100 seed weight ($PCV = 11.12$; $GCV = 9.98$).

The character viz. days to 50% flowering (90.00) showed the highest broad sense heritability, followed by days to maturity (83.00), seed yield per plant (82.00), number of primary branches per plant (81.00) and 100 seed weight (80.00). Whereas moderate heritability percentages of the characters number of secondary branches per plant (70.00). The character viz. seed yield per plant (61.52) showed the greatest genetic advance, followed by the number of secondary branches (53.00), number of primary branches per plant (52.38). The medium genetic advance was recorded by number of pods per plant (30.88) and 100 seed weight (23.64).

Correlation studies

The genotypic and phenotypic correlations for yield and its components characters studied are presented in Table 4 & 5. Seed yield per plant had significant positive associations with number of primary branches ($p = 0.4589$; $g = 0.5466$), number of secondary branches per plant ($p = 0.4650$; $g = 0.5684$), number of pods per plant ($p = 0.6054$; $g = 0.9341$) both at phenotypic and genotypic level. Number of seeds per pod ($p = 0.2860$; $g = 0.3378$) and 100 seed weight ($p = 0.2607$, $g = 0.3084$) had positive associations with Seed yield per plant both at

phenotypic and genotypic level. Days to 50% flowering ($p=-0.1025$; $g=-0.1108$), plant height ($p=-0.0905$; $g=-0.1024$), Days to maturity ($p=-0.0803$, $g=-0.0730$) had negative associations with Seed yield per plant both at phenotypic and genotypic level.

Phenotypic and genotypic path coefficient analysis

Path coefficient analysis was done to determine direct and indirect contribution of different traits towards seed yield per plant with phenotypic and genotypic level. The result were presented in Table 6 and Table 7.

In the present investigation it was found that number of pods per plant ($P = 0.5047$) recorded the highest positive direct effect on seed yield per plant followed by number of primary branches per plant ($P = 0.4083$), number of seeds per pod ($P = 0.1152$), days to maturity ($P = 0.0945$), plant height ($P = 0.0797$), and number of secondary branches per plant ($P = 0.0527$). The character days to 50% flowering ($P=-0.1686$) and 100-seed weight ($P=-0.1035$) exhibited negative direct effects.

At the genotypic level, number of pods per plant ($G = 1.1168$) also exhibited the highest positive direct effect on seed yield per plant, followed by number of primary branches per plant ($G = 0.5297$), 100-seed weight ($G = 0.3529$), days to 50% flowering ($G = 0.0895$), days to maturity ($G = 0$), The character days to maturity ($G=-0.0390$), plant height ($G=-0.0476$), number of secondary branches per plant ($G=-0.2637$), and number of seeds per pod ($G=-0.1051$), exhibited a negative direct effect at the genotypic level.

Conclusion

Significant genotype-related variations for the majority of the traits show a wide range of genetic diversity, which may be useful in the selection of superior germplasm. The environment may have an influence on these character because the phenotypic coefficients of variation were marginally larger than the genotypic coefficients of variation. The character viz. seed yield per plant, number of secondary branches per plant, number of primary branches per plant, number of pods per plant, 100 seed weight and days to 50% flowering showed moderate to high magnitudes of GCV and PCV. Suggested that choosing desirable genotypes for these character could be beneficial for enhancing seed yield in next breeding programme.

The characters viz. 100 seed weight, number of pods per plant, seed yield per plant, days to maturity and number of pods per plant to show high heritability. Seed yield per plant exhibited the greatest genetic advance as a percentage of mean, followed by number of pods per plant, number of secondary branches, 100 seed weight, number of primary branches per plant, plant height, days to 50% flowering and days to maturity. The characters days to flowering, days to maturity, plant height, number of primary and secondary branches, number of pods per plant, number of seeds per pod, 100 seed weight and seed yield per plant showed more diversity among the studied pigeonpea germplasm and greatest emphasis should be more to these traits for selection of diverse parameters in pigeonpea improvement programme.

Table 2. Analysis of variance for yield and its component characters in Pigeonpea.

Sr No	Character	Sum of squares		
		Replication (d.f.1)	Genotype (d.f.39)	Error (d.f.39)
1	Days to 50 % flowering	3.20	88.48**	4.63
2	Days to maturity	1.80	132.87**	11.92
3	Plant height	29.52	327.29**	155.74
4	Number of primary branches per plant	2.60	10.50**	1.07
5	Number of secondary branches per plant	5.62	30.55**	5.19
6	Number of pods per plant	1717.45	4649.99**	2007.55
7	Number of seeds per pod	0.02	0.37**	0.08
8	100 seed weight	0.24	3.14**	0.33
9	Seed yield per plant.	51.61	563.93**	54.75

*, ** indicates significance at 5 and 1 percent level respectively.

Table 3. Estimates of variability parameters for yield and its component characters of Pigeonpea.

Sr. No.	Name of the character	Range	σ^2_g	σ^2_p	σ^2_e	GCV (%)	PCV (%)	h^2 (h.x) (%)	G.A.	G.A. as % of mean
1	Days to 50 % flowering.	92.00-123.50	41.92	46.55	4.63	5.64	5.95	90.00	16.22	14.15
2	Days to maturity.	134.00-174.00	60.47	72.40	11.92	4.75	5.20	83.00	18.76	11.46
3	Plant height.	166.71-209.63	85.77	241.51	155.74	4.91	8.24	35.00	14.57	7.72
4	Number of primary branches/ Plant.	5.63-14.72	4.71	5.78	1.07	21.98	24.35	81.00	5.17	52.38
5	Number of secondary branches/ Plant.	9.36-21.35	12.67	17.87	5.19	23.84	28.31	70.00	7.91	53.00
6	Number of pods/ Plant.	35.08-266.12	1321.22	3328.77	2007.55	18.57	29.47	39.00	60.45	30.88
7	Number of seeds/Pod.	3.05-4.75	0.14	0.22	0.08	9.65	12.10	63.00	0.80	20.35
8	100 seed weight.	9.38-14.12	1.40	1.74	0.33	9.98	11.12	80.00	2.80	23.64
9	Seed yield /Plant.	30.85-98.28	254.59	309.34	54.75	25.69	28.31	82.00	38.21	61.52

(continued on next page)

Table 4. Estimation of phenotypic correlation coefficient in Pigeonpea.

	Days to 50% flowering	Days to maturity	Plant height	Number of primary branches/Plant	Number of secondary branches/Plant	Number of pods/ Plant	Number of seeds/Pod	100 seed weight	Seed yield /Plant.
Days to 50% flowering.	1.0000	0.8991 **	0.4251 **	0.1244	0.0329	-0.1253	-0.2902	0.0835	-0.1025
Days to maturity.		1.0000	0.4256**	0.1043	0.0468	-0.1240	-0.2358	0.1205	-0.0803
Plant height.			1.0000	-0.2351	-0.0949	-0.0643	-0.2278	-0.2013	-0.0905
Number of primary branches/Plant.				1.0000	0.5097 **	0.1801	0.0568	0.4230 **	0.4589**
Number of secondary branches/Plant.					1.0000	0.4773**	0.2017	0.4957**	0.4650**
Number of pods/Plant.						1.0000	0.2813	0.3350*	0.6054**
Number of seeds/Pod							1.0000	0.1303	0.2860
100 seed weight.								1.0000	0.2607

*, ** indicates significant and 5 and 1% level of probability respectively.

Table 5. Estimation of genotypic correlation coefficient in Pigeonpea.

	Days to 50 % flowering	Days to maturity	Plant height	Number of primary branches/Plant	Number of secondary branches/Plant	Number of pods/ Plant	Number of seeds/Pod	100 seed weight	Seed Yield per plant
Days to 50% flowering.	1.0000	0.9598 **	0.7059**	0.1563	0.0365	-0.1715	-0.3836*	0.1451	-0.1108
Days to maturity.		1.0000	0.9504**	0.1449	0.0705	-0.0862	-0.3063	0.1950	-0.0730
Plant height.			1.0000	-0.4048**	-0.5295**	-0.1612	-0.5325**	-0.3338*	-0.1024
Number of primary branches/Plant.				1.0000	0.6971**	0.3489*	0.0962	0.5848**	0.5466**
Number of secondary branches/Plant.					1.0000	0.5931**	0.2620	0.5599**	0.5684**
Number of pods/Plant.						1.0000	0.4704**	0.4459**	0.9341**
Number of seeds/Pod							1.0000	0.1904	0.3378*
100 seed weight.								1.0000	0.3084

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Table 6. Direct and indirect effect of yield and its components characters on grain yield and at phenotypic level.

	Days to 50 % flowering	Days to maturity	Plant height	Number of primary branches/ plant	Number of secondary branches/ Plant	Number of pods/ Plant	Number of seeds/Pod	100 seed weight	Correlation with Seed yield /Plant.
Days to 50 % flowering.	-0.1686	-0.1516	-0.0717	-0.0210	-0.0055	0.0211	0.0489	-0.0141	-0.1025
Days to maturity.	0.0850	0.0945	0.0402	0.0099	0.0044	-0.0117	-0.0223	0.0114	-0.0803
Plant height.	0.0339	0.0339	0.0797	-0.0188	-0.0076	-0.0051	-0.0182	-0.0161	-0.0905
Number of primary branches/ Plant.	0.0508	0.0426	-0.0960	0.4083	0.2081	0.0735	0.0232	0.1727	0.4589
Number of secondary branches/ Plant.	0.0017	0.0025	-0.0050	0.0269	0.0527	0.0252	0.0106	0.0261	0.4650
Number of pods/ Plant.	-0.0632	-0.0626	-0.0324	0.0909	0.2409	0.5047	0.1420	0.1691	0.6054
Number of seeds/Pod	-0.0334	-0.0272	-0.0262	0.0065	0.0232	0.0324	0.1152	0.0150	0.2860
100 seed weight.	-0.0086	-0.0125	0.0208	-0.0438	-0.0513	-0.0347	-0.0135	-0.1035	0.2607

Table 7. Direct and indirect effect of yield and its components characters on grain yield and at genotypic level.

Characters	Days to 50 % flowering	Days to maturity	Plant height	Number of primary branches / Plant	Number of secondary branches/ Plant	Number of pods/ Plant	Number of seeds /Pod	100 seed weight	Seed yield /Plant
Days to 50 % flowering.	0.0859	0.0859	0.0631	0.0140	0.0033	-0.0153	-0.0343	0.0130	-0.1108
Days to maturity	-0.0375	-0.0390	-0.0371	-0.0057	-0.0027	0.0034	0.0119	-0.0076	-0.0730
Plant Height.	-0.0336	-0.0452	-0.0476	0.0193	0.0252	0.0077	0.0253	0.0159	-0.1024
Number of primary branches/ Plant.	0.0828	0.0768	-0.2144	0.5297	0.3692	0.1848	0.0509	0.3098	0.5466
Number of secondary branches/ Plant	-0.0096	-0.0186	0.1396	-0.1838	-0.2637	-0.1564	-0.0691	-0.1476	0.5684
Number of pods/ Plant	-0.1915	-0.0962	-0.1800	0.3897	0.6623	1.1168	0.5253	0.4980	0.9341
Number of seeds/Pod.	0.0403	0.0322	0.0560	-0.0101	-0.0275	-0.0494	-0.1051	-0.0200	0.3378
100 seed weight.	-0.0512	-0.0688	0.1178	-0.2064	-0.1976	-0.1574	-0.0672	0.3529	0.3084

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How to cite this article: Patil U, Patil D, Gite V, Sontakke P. Deciphering genetic diversity and trait interrelationships in pigeonpea (*Cajanus cajan* (L.) Millsp.). *International Journal of Advanced Biochemistry Research*. 2026;SP-10(10):865-869. doi: <https://www.doi.org/10.33545/26174693.2026.v10.i10Sk.10389>