International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664
Received: 24-07-2026, Accepted: 23-08-2026, Published: 07-09-2026
Volume 8, Issue 3, 2026, Page No. 385-390

Correlation and path coefficient analysis of yield and yield-attributing traits in blackgram [*Vigna mungo* (L.) Hepper]

K Harshitha[1*], Y Amaravathi[2], P Srivalli[3], T M Hemalatha[4]

[1] Department of Genetics and Plant Breeding, S.V.Agricultural College, Tirupati, ANGRAU, Andhra Pradesh, India
[2] Scientist, Pulses Scheme (Molecular Biology and Biotechnology), IFT, RARS, Tirupati, ANGRAU, Andhra Pradesh, India
[3] Scientist (Genetics and Plant Breeding), Agricultural Research Station, Utukur, Kadapa, ANGRAU, Andhra Pradesh, India
[4] Scientist (Plant Pathology), Institute of Frontier Technology, RARS, Tirupati, ANGRAU, Andhra Pradesh, India

DOI: https://doi.org/10.66856/ijaps.2026.8.3.8251

Abstract

The present investigation was conducted during *Rabi* 2025-26 at the Wetland Farm, S.V. Agricultural College, and Tirupati, to identify key yield-contributing traits in blackgram (*Vigna mungo* (L.) Hepper) through correlation and path coefficient analyses. The experimental material consists of twenty-eight blackgram genotypes, including three check varieties (TBG-104, TBG-129 and LBG-645), which were evaluated in a randomized block design with three replications for ten quantitative traits. The results of genotypic correlation coefficients were generally higher than the corresponding phenotypic correlations, indicating that the observed associations were predominantly governed by genetic factors. Among the traits studied, seed yield per plant exhibited significant and positive correlation with harvest index (r_g = 0.9187; r_p = 0.8123), followed by number of pods per cluster (r_g = 0.7287; r_p = 0.5898), number of seeds per pod (r_g = 0.6166; r_p = 0.4506), plant height (r_g = 0.5150; r_p = 0.4225), 100-seed weight (r_g = 0.4872; r_p = 0.3718) and pod length (r_g = 0.3778; r_p = 0.3159). Path coefficient analysis revealed that harvest index exerted the highest positive direct effect on seed yield at both the genotypic (1.1410) and phenotypic (1.1302) levels, followed by shoot biomass per plant, 100-seed weight, number of pods per cluster and pod length. The low residual effects of path analysis (0.0113 and 0.0272 at the genotypic and phenotypic levels, respectively) indicated that the selected traits accounted for most of the variation in seed yield. The present investigation revealed that harvest index, number of pods per cluster and 100-seed weight were the most important traits contributing to seed yield. Hence, these traits could be effectively utilized as selection criteria in blackgram breeding programmes for the development of superior high-yielding genotypes.

Keywords: Blackgram, correlation, path coefficient, yield attributes

Introduction

Blackgram (*Vigna mungo* (L.) Hepper) is an important self-pollinated grain legume belonging to the family fabaceae with a chromosome number of 2n = 2x = 22. It is originated in the Indian subcontinent, which is recognized as its primary centre of origin and diversity (Vavilov, 1926) [30]. India accounts for the largest share of global blackgram production and consumption owing to the crop's wide adaptability, short duration and suitability for diverse cropping systems (FAOSTAT, 2024). Urdbean is cultivated in India over 30.23 lakh ha, producing 21.06 lakh tonnes with an average productivity of 697 kg ha^{-1}. Andhra Pradesh contributes significantly, with 3.19 lakh ha under cultivation, 3.62 lakh tonnes production and higher productivity of 1135 kg ha^{-1} (Indiastat, 2024[11]-25). Blackgram is an excellent source of dietary protein (24-26%), carbohydrates (60-65%) and essential minerals, making it an important component of nutritional security (Gopalan *et al*., 2012) [8]. In addition, its symbiotic association with Rhizobium enhances biological nitrogen fixation, thereby improving soil fertility and contributing to sustainable crop production systems (Peoples *et al*., 2009) [17]. Despite its agronomic and nutritional significance, the productivity of blackgram remains below its genetic potential due to the combined effects of biotic and abiotic stresses, including mungbean yellow mosaic virus, powdery mildew, insect pests, drought and high-temperature stress (Bashir *et al*., 2006) [2]. Furthermore, seed yield is a complex quantitative trait controlled by several genes with significant genotype × environment interaction, limiting the effectiveness of direct selection for yield (Allard, 1960) [1]. Consequently, improvement of yield through the identification and selection of superior yield-contributing characters has become a major objective in blackgram breeding programmes (Priyanka *et al*., 2022) [19].

Seed yield is the cumulative expression of several interrelated morphological and physiological traits, including days to 50 percent flowering, days to maturity, plant height, number of clusters per plant, number of pods per plant, pod length, seeds per pod, hundred-seed weight and harvest index (Singh and Chaudhary, 1985) [26]. Hence, knowledge of the association among these characters is essential for formulating efficient selection strategies. Correlation analysis is an important biometrical approach for quantifying the magnitude and direction of association among traits and facilitates the identification of yield-contributing characters for indirect selection (Singh and Chaudhary, 1985) [26]. Estimation of both phenotypic and genotypic correlation coefficients provides insights into the influence of environmental factors on trait associations, with genotypic correlations generally reflecting the inherent genetic relationships more accurately than phenotypic correlations (Dhillon *et al*., 2024) [5]. Previous investigations in blackgram have consistently reported significant positive

associations of number of pods per plant, hundred-seed weight, harvest index and plant height with seed yield, indicating their importance in yield improvement programmes (Mathivathana *et al*., 2015) [14].

Although correlation analysis provides information on the degree of association among characters, it does not differentiate the direct contribution of an individual trait from its indirect influence through other correlated traits (Wright, 1921) [31]. To address this limitation, path coefficient analysis, proposed by Wright (1921) [31] and subsequently applied to plant breeding by Dewey and Lu (1959) [4], partitions correlation coefficients into direct and indirect effects, thereby providing a comprehensive understanding of the cause-and-effect relationships among yield component traits. This approach enables the identification of characters with substantial direct effects on seed yield and improves the efficiency of selection in breeding programmes. Recent studies have demonstrated that harvest index, number of pods per plant and hundred-seed weight exert significant positive direct effects on seed yield in blackgram and therefore represent reliable selection criteria for genetic improvement (Priyanka *et al*., 2022) [19]. In addition, the residual effect estimated through path coefficient analysis indicates the proportion of variation in seed yield not explained by the traits included in the model, thereby assisting in the identification of additional characters influencing yield (Dewey and Lu, 1959) [4].

Based on the above considerations, the present investigation was undertaken to estimate the correlation and path coefficients among yield and yield-attributing traits in blackgram with the objective of identifying key component characters influencing seed yield and developing efficient selection strategies for the genetic improvement of the crop.

Materials and Methods

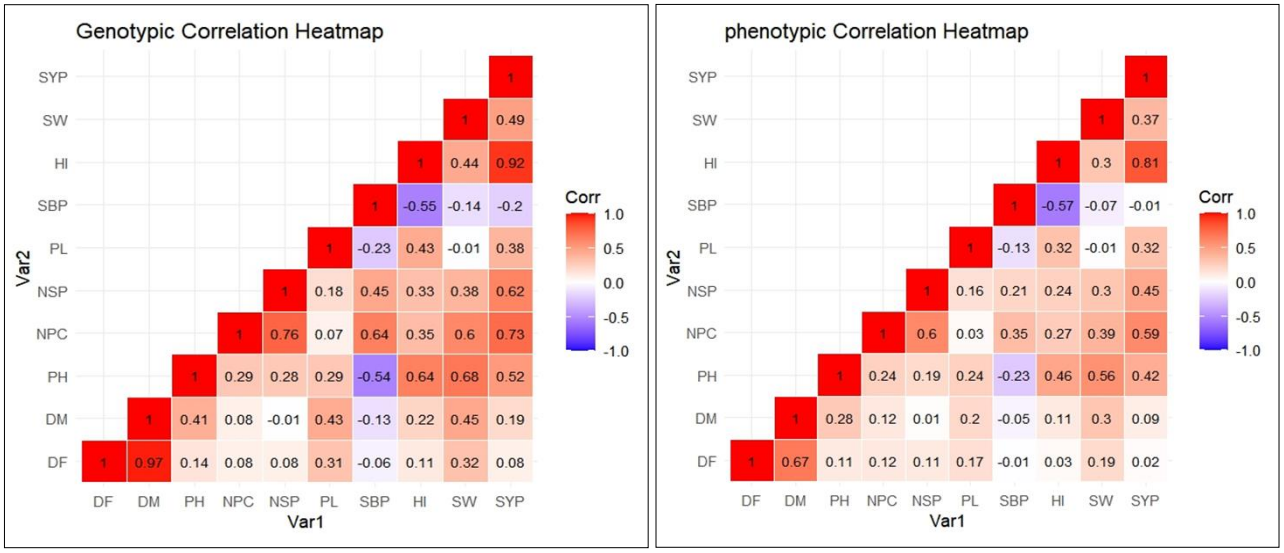
The present research was conducted during *Rabi*, 2025-26 at the Wetland Farm, S.V. Agricultural College, Tirupati. The experimental material comprised 28 blackgram genotypes, including three check varieties, TBG-104, TBG-129 and LBG-645. The experiment was laid out in a Randomized Block Design (RBD) with three replications. Each genotype was sown by hand dibbling in plots consisting of three rows of 4.0 m length, maintaining a spacing of 30 cm between rows and 10 cm between plants. The experiment was conducted on a clay loam soil of normal fertility. The field was prepared to a fine tilth through suitable tillage operations before sowing. Thinning was carried out at 10 days after sowing (DAS) to maintain a single healthy plant per hill. A basal dose of 20 kg N, 50 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied at the time of sowing. All recommended agronomic practices, including intercultural operations, crop management and plant protection measures, were followed uniformly throughout the crop growth period to ensure healthy crop establishment and optimum plant growth. Observations were recorded on ten quantitative traits, namely days to 50 percent flowering, days to maturity, plant height (cm), number of pods per cluster, number of seeds per pod, pod length (cm), shoot biomass per plant (g), harvest index (%), 100-seed weight (g) and seed yield per plant (g). Data for all traits, except days to 50 percent flowering and days to maturity, were recorded from five randomly selected competitive plants in each genotype of every replication. Observations on days to 50 percent flowering and days to maturity were recorded on a plot basis. Genotypic and phenotypic correlation coefficients were estimated for the ten quantitative traits following the method described by Johnson *et al*. (1955b) to understand the strength and direction of associations among the traits. Path coefficient analysis was performed as suggested by Dewey and Lu (1959) [4] to further determine the direct and indirect contributions of different traits towards seed yield. This analysis helped in identifying the traits that could be effectively considered as selection criteria for improving seed yield in blackgram.

Results and Discussion

Correlation coefficient analysis was carried out to determine the degree and direction of association among seed yield and its component traits. The genotypic and phenotypic correlation coefficients among all the studied characters are presented in Table 1. A perusal of the results revealed that the genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients, indicating that the associations among the traits were predominantly governed by genetic factors with comparatively less environmental influence.

Table 1: Estimation of phenotypic (r_p) and genotypic (r_g) correlation coefficients among 10 yield and its contributing traits in 28 genotypes of blackgram.

Trait	r	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods per cluster	Number of seeds per pod	Pod length (cm)	Shoot biomass per plant (g)	Harvest index (%)	100-seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	r_p	1	0.6688**	0.1127	0.1235	0.1108	0.1671	-0.0130	0.0264	0.1943	0.0237
	r_g	1	0.9705**	0.1389	0.0765	0.0777	0.3052	-0.0611	0.1064	0.3164	0.0781
Days to maturity	r_p			0.2765*	0.1170	0.0136	0.2019	-0.0498	0.1127	0.2994**	0.0933
	r_g			0.4106*	0.0777	-0.0094	0.4280*	-0.1260	0.2193	0.4528*	0.1898
Plant height (cm)	r_p				0.2352*	0.1860	0.2361*	-0.2268*	0.4622**	0.5608**	0.4225**
	r_g				0.2930	0.2816	0.2872	-0.5369**	0.6442**	0.6795**	0.5150**
Number of pods per cluster	r_p					0.5999**	0.0313	0.3495**	0.2663*	0.3948**	0.5898**
	r_g					0.7636**	0.0729	0.6401**	0.3482	0.6043**	0.7287**
Number of seeds per pod	r_p						0.1610	0.2071	0.2352*	0.2981**	0.4506**
	r_g						0.1845	0.4542*	0.3336	0.3768*	0.6166**
Pod length (cm)	r_p							-0.1264	0.3196**	-0.0134	0.3159**
	r_g							-0.2347	0.4302*	-0.0145	0.3778*
Shoot biomass per plant (g)	r_p								-0.5715**	-0.0699	-0.0102
	r_g								-0.5549**	-0.1397	-0.1955
Harvest index (%)	r_p									0.3027**	0.8123**
	r_g									0.4401*	0.9187**
100-Seed weight(g)	r_p										0.3718**
	r_g										0.4872**
Seed yield per plant (g)	r_p										1
	r_g										1



DF = Days to 50% Flowering, DM = Days to Maturity, PH = Plant Height, NPC = Number of Pods per Cluster, NSP = Number of Seeds per Pod, PL = Pod Length, SBP = Shoot Biomass per Plant, HI = Harvest Index, SW = 100-Seed Weight, SYP = Seed Yield per Plant.

Fig 1: Comparison of genotypic and phenotypic correlation heat maps among ten yield and its attributing traits in blackgram genotypes.

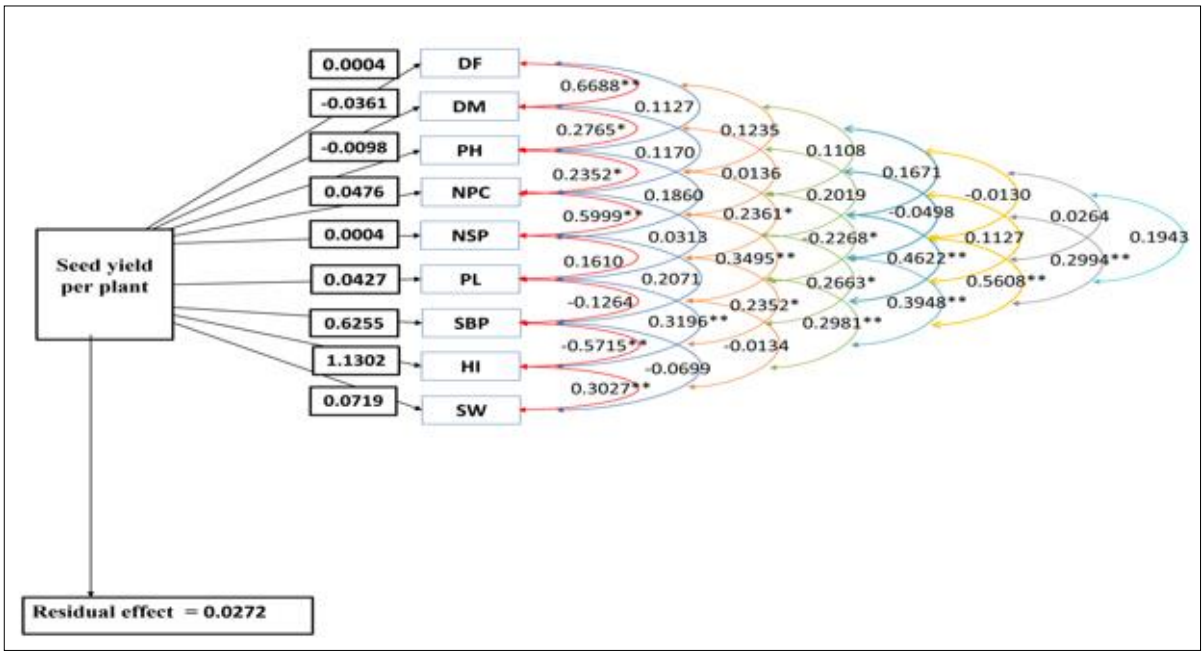
Seed yield per plant exhibited highly significant and positive association with harvest index (r_p = 0.8123**, r_g = 0.9187**), followed by number of pods per cluster (r_p = 0.5898**, r_g = 0.7287**), number of seeds per pod (r_p = 0.4506**, r_g = 0.6166**), plant height (r_p = 0.4225**, r_g = 0.5150**), 100-seed weight (r_p = 0.3718**, r_g = 0.4872**) and pod length (r_p = 0.3159**, r_g = 0.3778*) at both phenotypic and genotypic levels, indicating the possibility of improving seed yield through simultaneous selection for these characters. The strong positive association of these traits with seed yield suggests that they play an important role in determining productivity and may therefore be considered as reliable selection criteria in blackgram improvement programmes. Similar findings were also reported by Baudh *et al*. (2013) [3], Sohel *et al*. (2016b), Goswami *et al*. (2020), Panwar *et al*. (2019) [9, 16], Mohanlal *et al*. (2018a) and Sood *et al*. (2023) [28]. Days to 50 percent flowering and days to maturity exhibited positive but non-significant association with seed yield, whereas shoot biomass per plant recorded a negative and non-significant association at both phenotypic and genotypic levels. The non-significant association of these traits with seed yield indicates that their individual contribution towards yield improvement was limited under the present investigation and hence direct selection based on these traits may not be effective. Similar observations were found by Hadimani *et al*. (2019), Gomathi *et al*. (2020) [7, 10], Reddy *et al*. (2011b), Sohel *et al*. (2016b) and Prasad *et al*. (2015) [18]. Significant positive inter-character associations were observed among several yield-attributing traits, in which days to 50 percent flowering exhibited positive association with days to maturity, plant height and 100-seed weight, while days to maturity was positively associated with plant height, pod length and 100-seed weight. Likewise, plant height exhibited significant positive association with number of pods per cluster, harvest index and 100-seed weight, whereas number of pods per cluster exhibited the favourable association with number of seeds per pod, shoot biomass per plant, harvest index and 100-seed weight. Number of seeds per pod also exhibited positive association with harvest index and 100-seed weight, while pod length and harvest index were positively associated with 100-seed weight. These favourable interrelationships indicate that simultaneous improvement of these traits through selection is feasible, thereby enhancing the efficiency of indirect selection for seed yield. These results were in confirmity with the findings of Kumar *et al*. (2015b), Mathivathana *et al*. (2015) [14], Sohel *et al*. (2016b), Panwar *et al*. (2019), Shanthi *et al*. (2019) and Priyanka *et al*. (2022) [16, 19, 23]. A significant negative association was observed between shoot biomass per plant and harvest index. The negative association indicates that increased vegetative biomass alone may not necessarily contribute to higher seed yield unless accompanied by efficient partitioning of assimilates towards reproductive structures. Therefore, balanced selection for these traits is essential to achieve higher productivity. Similar findings were also reported by Priyanka *et al*. (2022) [19].

Path coefficient analysis was carried out to partition the correlation coefficients into direct and indirect effects of different yield component traits on seed yield per plant. The direct and indirect effects of seed yield and its component traits are presented in Table 2. The residual effects were low at both phenotypic (0.0272) and genotypic (0.0113) levels, indicating that the characters included in the present investigation accounted for almost the entire variability in seed yield. The low residual effects indicate that the variability in seed yield was largely explained by the traits included in the study, confirming the adequacy of the selected characters and the reliability of the path coefficient analysis for identifying effective selection criteria. Based on the direct effects, the trait harvest index exerted highest positive direct effect on seed yield at both phenotypic (1.1302) and genotypic (1.1410) levels, followed by shoot biomass per plant (*P* = 0.6255 and G = 0.4504), 100-seed weight (*P* = 0.0719 and G = 0.0821), number of pods per cluster (*P* = 0.0476 and G = 0.0123) and pod length (*P* = 0.0427 and G = 0.0296). These traits also exhibited positive association with seed yield, indicating that their correlation was largely due to their direct contribution towards yield. Hence, direct selection for these characters would be effective in improving seed yield in blackgram. Similar findings were also reported by Baudh *et al*. (2013) [3], Sohel *et al*. (2016b), Goswami *et al*. (2020), Shivade *et al*. (2011)

[9, 24], Mohanlal *et al*. (2018a), Panwar *et al*. (2019) and Sood *et al*. (2023) [16, 28]. The traits such as days to maturity (P = -0.0361 and G = -0.1418), plant height (P = -0.0098 and G = 0.0069) and number of seeds per pod (*P* = 0.0004 and G = -0.0244) exhibited negative direct effects despite showing positive association with seed yield. Likewise, shoot biomass per plant recorded a high positive direct effect but a negative correlation with seed yield, indicating that its favourable direct influence was counterbalanced by indirect undesirable indirect effects through other component traits. The present findings were in conformity with the reports of Tanveer *et al*. (2018), Goswami *et al*. (2020), Sindhu *et al*. (2023), Rathore *et al*. (2024) and Sarker *et al*. (2026) [9, 20, 22, 25, 29], These results demonstrate that correlation alone may not accurately reveal the true contribution of a character and emphasize the importance of path coefficient analysis in identifying effective selection criteria. Based on the combined interpretation of correlation and path coefficient analyses, The traits *viz.*, harvest index, number of pods per cluster, 100-seed weight and pod length emerged as the most important yield-contributing traits because of their favourable association with seed yield and positive direct effects.

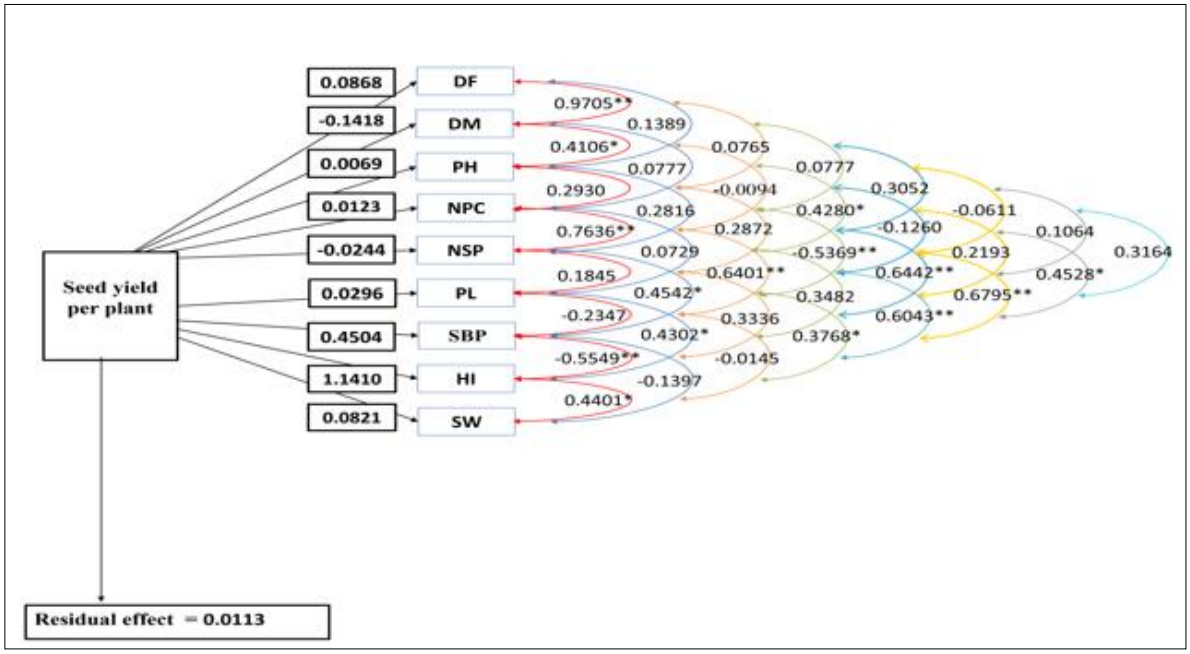
Table 2: Phenotypic (P) and genotypic (G) path coefficients for different yield components on seed yield in blackgram.

Trait	r	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of pods per cluster	Number of seeds per pod	Pod length (cm)	Shoot biomass per plant (g)	Harvest index (%)	100-seed weight (g)	Seed yield per plant (g)
Days to 50% flowering	r_p	0.0004	-0.0242	-0.0011	0.0059	0.0000	0.0071	-0.0083	0.0298	0.0140	0.0237
	r_g	0.0868	-0.1376	0.0010	0.0009	-0.0019	0.0090	-0.0275	0.1214	0.0253	0.0781
Days to maturity	r_p	0.0003	-0.0361	-0.0027	0.0056	0.0000	0.0087	-0.0312	0.1273	0.0216	0.0933
	r_g	0.0843	-0.1418	0.0028	0.0010	0.0002	0.0127	-0.0568	0.2503	0.0372	0.1898
Plant height (cm)	r_p	0.0000	-0.0010	-0.0098	0.0112	0.0001	0.0101	-0.1418	0.5224	0.0403	0.4225**
	r_g	0.0121	-0.0582	0.0069	0.0036	-0.0069	0.0085	-0.2418	0.7350	0.0558	0.5150**
Number of pods per cluster	r_p	0.0001	-0.0042	-0.0023	0.0476	0.0002	0.0014	0.2186	0.3009	0.0285	0.5898**
	r_g	0.0067	-0.0110	0.0020	0.0123	-0.0186	0.0022	0.2883	0.3973	0.0496	0.7287**
Number of seeds per pod	r_p	0.0000	-0.0005	-0.0018	0.0286	0.0004	0.0069	0.1294	0.2659	0.0214	0.4506**
	r_g	0.0067	0.0013	0.0019	0.0094	-0.0244	0.0055	0.2045	0.3806	0.0310	0.6166**
Pod length (cm)	r_p	0.0001	-0.0073	-0.0023	0.0015	0.0001	0.0427	-0.0791	0.3612	-0.0013	0.3159**
	r_g	0.0265	-0.0607	0.0020	0.0009	-0.0045	0.0296	-0.1057	0.4909	-0.0012	0.3778*
Shoot biomass per plant (g)	r_p	-0.0000	0.0018	0.0022	0.0166	0.0001	-0.0054	0.6255	-0.6459	-0.0050	-0.0102
	r_g	-0.0053	0.0179	-0.0037	0.0079	-0.0111	-0.0070	0.4504	-0.6331	-0.0115	-0.1955
Harvest index (%)	r_p	0.0000	-0.0041	-0.0045	0.0127	0.0001	0.0137	-0.3575	1.1302	0.0218	0.8123**
	r_g	0.0092	-0.0311	0.0044	0.0043	-0.0081	0.0127	-0.2499	1.1410	0.0362	0.9187**
100-seed weight (g)	r_p	0.0001	-0.0108	-0.0055	0.0188	0.0001	-0.0008	-0.0438	0.3420	0.0719	0.3718**
	r_g	0.0275	-0.0642	0.0047	0.0075	-0.0092	-0.0629	-0.0629	0.5022	0.0821	0.4872**



DF = Days to 50% Flowering, DM = Days to Maturity, PH = Plant Height, NPC = Number of Pods per Cluster, NSP = Number of Seeds per Pod, PL = Pod Length, SBP = Shoot Biomass per Plant, HI = Harvest Index, SW = 100-Seed Weight, SYP = Seed Yield per Plant

Fig 2: Phenotypic path (P) diagram for seed yield and its components in blackgram.



DF = Days to 50% Flowering, DM = Days to Maturity, PH = Plant Height, NPC = Number of Pods per Cluster, NSP = Number of Seeds per Pod, PL = Pod Length, SBP = Shoot Biomass per Plant, HI = Harvest Index, SW = 100-Seed Weight, SYP = Seed Yield per Plant

Fig 3: Genotypic path (G) diagram for seed yield and its components in blackgram.

Conclusion

The correlation and path coefficient analyses identified the traits such as, harvest index, number of pods per cluster and 100-seed weight as the most important yield-contributing traits in blackgram owing to their significant positive association with seed yield and favourable direct effects. Although shoot biomass per plant exhibited a high positive direct effect, its negative association with seed yield indicated the influence of undesirable indirect effects through other component traits. Therefore, greater emphasis should be placed on harvest index, number of pods per cluster and 100-seed weight during selection, as improvement in these traits is expected to enhance seed yield and increase the efficiency of breeding programmes aimed at developing superior high-yielding blackgram genotypes.

Acknowledgement

I gratefully acknowledge Acharya N.G. Ranga Agricultural University (ANGRAU), for providing the opportunity and necessary support to undertake this research. I sincerely thank the Department of Genetics and Plant Breeding, S.V. Agricultural College, Tirupati and my major advisor and my advisory committee for their valuable guidance, encouragement and support throughout the study.

References

1. Allard RW. Principles of Plant Breeding. John Wiley & Sons, New York., 1960, 485.
2. Bashir M, Ahmad Z, Mansoor S. Occurrence and distribution of viral diseases of mungbean and mashbean in Punjab, Pakistan. Pakistan Journal of Botany.,2006:38(4):1341-1351.
3. Baudh Bharti BB, Rajesh Kumar RK, Bind HN, Arun Kumar AK, Vijay Sharma VS. Correlation and path analysis for yield and yield components in blackgram [*Vigna mungo* (L.) Hepper]. Progressive Research.,2013:8(1):617-620.
4. Dewey DR, Lu KH. A correlation and path-coefficient analysis of components of crested wheatgrass seed production. Agronomy Journal.,1959:51(9):515-518.
5. Dhillon KS, Mittal RK, Sood VK, Chaudhary HK, Kaur K, Verma S, et al. Correlation and path analysis for yield and yield contributing traits in advance generation of blackgram (*Vigna mungo* (L.) Hepper). Plant Cell Biotechnology and Molecular Biology.,2024:25(1-2):45-52.
6. Food and Agriculture Organization of the United Nations. FAOSTAT statistical database. Rome, Italy., 2024. https://www.fao.org/faostat/.
7. Gomathi D, Shoba D, Ramamoorthy V, Pillai MA. Studies on variability, heritability, correlation and path analysis in segregating population of blackgram [*Vigna mungo* (L.) Hepper]. Legume Research.,2020:44(6):1152-1158.
8. Gopalan C, Rama Sastri BV, Balasubramanian SC. Nutritive value of Indian foods. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad., 2012, 204.
9. Goswami B, Dubey RB, Ameta KD, Singh K, Bangarwa SK. Correlation and path analysis for seed yield and its component characters in urdbean [*Vigna mungo* (L.) Hepper]. Crop Research.,2020:55(2):24-27.
10. Hadimani A, Konda CR, Kulkarni V. Correlation and path coefficient analysis for yield and yield components in Black gram (*Vigna mungo* (L.) Hepper). International Journal of Chemical Studies.,2019:7(1):2240-2243.
11. Indiastat. Area and Production of Blackgram in India., 2024-25. https://www.indiastat.com/.
12. Johnson HW, Robinson HF, Comstock RE. Genotypic and phenotypic correlations in soybeans and their implications in selection. Agronomy Journal.,1955b:47(10):477-483.
13. Kumar GV, Vanaja M, Sathish P, Vagheera P, Lakhsmi NJ. Correlation analysis for quantitative traits in blackgram [*Vigna mungo* (L.) Hepper] in different

seasons. International Journal of Scientific and Research Publications.,2015b:5(4):1-4.
14. Mathivathana MK, Shunmugavalli N, Muthuswamy A, Harris CV. Correlation and path analysis in blackgram. Agricultural Science Digest.,2015:35(2):158-160.
15. Mohanlal VA, Saravanan K, Sabesan T. Cluster and correlation analysis in blackgram (*Vigna mungo* L.) genotypes under drought. Madras Agricultural Journal.,2018a:105(7-9):381-384.
16. Panwar NK, Swarup I, Jain M, Gour L, Katara VK. Association biometrical analysis of yield and yield attributing determinants in *Vigna mungo* (L.) Hepper. International Journal of Chemical Studies.,2019:7(3):2512-2516.
17. Peoples MB, Brockwell J, Herridge DF, Rochester IJ, Alves BJR, Urquiaga S, et al. The contributions of nitrogen-fixing crop legumes to the productivity of agricultural systems. Symbiosis.,2009:48:1-17.
18. Prasad AVSD, Murugan E. Correlation analysis for seed yield and its attributes in parents and F1 generation in blackgram (*Vigna mungo* (L.) Hepper). Annals of Plant and Soil Research.,2015:17(4):391-393.
19. Priyanka M, Devi KR, Parimala K, Anuradha C. Correlation and Path Coefficient Analysis for Yield and Yield Attributing Traits in Blackgram (*Vigna mungo* (L) Hepper). International Journal of Environment and Climate Change.,2022:12(11):344-351.
20. Rathore T, Yadav RK, Rai G, Pathak S, Mishra A. Character association and path analysis for yield and its attributing traits in Urdbean genotypes and its triple test cross F1 hybrids. Journal of Scientific Research and Reports.,2024:30(7):429-436.
21. Reddy D, Venkateswarlu O, Jyothi GL, Obaiah MC. Genetic parameters and inter-relationship analysis in blackgram [*Vigna mungo* (L.) Hepper]. Legume Research.,2011b:34(2):149-152.
22. Sarker S, Banerjee S, Ghosh M, Nath R, Maji A, Pati S. Genetic variability, heritability and path analysis of growth attributes and yield components of advance blackgram genotypes under late kharif condition in red and laterite zone of West Bengal. Plant Archives.,2026:26(1):2168-2173.
23. Shanthi P, Ganesan KN, Manivannan N, Natarajan C. Correlation and path analysis in blackgram (*Vigna mungo* L.). Electronic Journal of Plant Breeding.,2019:10(3):1218-1222.
24. Shivade HA, Rewale AP, Patil SB. Correlation and path analysis for yield and yield components in blackgram [*Vigna mungo* (L.) Hepper]. Legume Research.,2011:34(3):178-183.
25. Sindhu N, Macwana SS, Boddu S, Surakanti S. Assessment of genetic variability, character association and path analysis for yield and yield attributes in blackgram (*Vigna mungo* (L.) hepper). Environment and Ecology.,2023:41(2):765-771.
26. Singh RK, Chaudhary BD. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi., 1985, 318.
27. Sohel MH, Miah MR, Mohiuddin SJ, Islam AKMS, Rahman MM, Haque MA. Correlation and path coefficient analysis of blackgram (*Vigna mungo* (L.). Journal of Bioscience and Agricultural Research.,2016b:7(2):621-629.
28. Sood R, Mittal RK, Sood VK, Sharma S. Correlation and path analysis studies for various yield and component traits in the segregating generations of black gram [*Vigna mungo* (L). Hepper]. Legume Research.,2023:46(9):1141-1147.
29. Tanveer H, Kumar A, Singh R, Singh H, Singh S, Singh R. Studies on genetic variability, character association and path analysis in blackgram [*Vigna mungo* (L.) Hepper] varieties. Trends in Biosciences.,2018:11(42):4182-4185.
30. Vavilov NI. Studies on the Origin of Cultivated Plants. Bulletin of Applied Botany and Plant Breeding.,1926:16:1-248.
31. Wright S. Correlation and causation. Journal of Agricultural Research.,1921:20(7):557-585.