Original Research Article

Genetic variability, correlation and path coefficient analysis for yield and yield components in Blackgram (*Vigna mungo* (L.) Hepper)

ABSTRACT

The goal of the current study was to calculate the genotypic correlation and genetic variability for 13 quantitative traits among 25 black-gram genotypes. The genotypes PLU-429 and PL-416 had a high seed yield. High PCV and GCV values were found for the traits biological yield per plant, harvest index, number of primary branches per plant, and number of pods per plant. The parameters of number of major branches per plant, number of pods per plant, biological yield per plant, and harvest index were found to have high heritability along with high GAM. According to association studies, there was a significant and positive genotypic and phenotypic correlation coefficient for the variable's like principal branches per plant, clusters per plant, pods per plant, and harvest index. According to a path analysis, primary branches per plant, clusters per plant, pods per plant, and harvest index both at the genotypic and phenotypic levels all contributed significantly to the highest positive direct effect. In order to improve black-gram, it would therefore be more fruitful to select the aforementioned attributes simultaneously.

Keywords: Blackgram, GCV, PCV, Correlation, Path coefficient.

INTRODUCTION

The primary source of protein in the vegetarian diet is pulses. A short-lived, self-pollinating, diploid (2n=2x=22), grain legume of the family Leguminosae with a small genome size of 0.56g/PC (574Mbp), black-gram [*Vigna mungo* (L.) Hepper] is also known as urd-bean in India Gupta and Gopalakrishna (2009). The sprouts of Blackgram are used as a vegetable, while the seeds themselves are a rich source of vitamins and minerals. Blackgram seeds are taken as food and include 25% protein and 65% carbs Ghafoor *et al.* (2001). Blackgram, which occupies around 13% of the nation's total pulse-growing land and contributes about 10% to the production of all pulses, is India's fourth-most significant pulse crop. Andhra Pradesh, Uttar Pradesh, Maharashtra, Madhya Pradesh, Tamil Nadu, Rajasthan, Orissa, and Bihar are the main growing regions for it. Blackgram is grown on 37.52 lakh ha in India in 2019–20, down from

38.18 lakh ha in 2018–19, with a yield of 2.04 million tonnes and a productivity of 651 kg/ha. The major producers of blackgram in India are the states of Madhya Pradesh (16.50 lakh/ha), Uttar Pradesh (7.01 lakh/ha), and Rajasthan (4.56 lakh/ha). With an average output of 501 kg/ha, India produces 23.4 MT of Blackgram annually from 4670,000 hectares (Ministry of Agriculture, 2020-21).

The main obstacles to black-gram genetic improvement are a lack of genetic diversity that can be exploited, a lack of ideotypes that are appropriate for various cropping systems, a poor harvest index, susceptibility to biotic and abiotic stresses, and a lack of high-quality seeds of improved varieties. It is primarily because crossing programmes frequently use a small number of parents with a high degree of relatedness Jayamani and Sathya (2013). The degree and type of genetic variability contained in yield-contributing traits is a key factor in yield improvement success Johnson *et al*. (1955). For choosing the best genotypes, the relationship between yield and other yield variables would be helpful. The enhancement of the economically significant characters can be the basis for selection using component characters that are determined by association analysis, which assesses the relationship between distinct plant characters Hemalatha *et al*. (2017).

A statistical method for measuring the strength and association between two or more variables is correlation coefficient analysis. The component qualities that can be employed to increase maize yield can be found using estimates of the correlation coefficient.

By dividing the correlation coefficient into components of direct and indirect effects, path coefficient analysis helps the breeder determine the yield components by giving a complete grasp of the contributions of various traits. Knowing the associations of different characters with path coefficients is crucial for accumulating the best contribution of characteristics that contribute to yield Bhutia *et al*. (2016). Therefore, the goal of the current study was to analyse genetic variability and correlation coefficients in order to find the best genotypes of Blackgram for use in a breeding programme in the future.

OBJECTIVES

1. To estimate genetic variability parameters for yield and its attributing characters in Blackgram genotypes
2. To asses genotypic and phenotypic association among yield traits
3. To estimate direct and indirect effects of yield contributing characters on seed yield

MATERIALS AND METHODS

During kharif 2021, the current experiment was conducted at the Field Experimentation Center of the Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Allahabad, U.P. Row to row spacing is 30 cm, plant to plant spacing is 10 cm, and the plot size is 1 m x 1 m. A randomized block design was used with three replications. The following thirteen quantitative traits were recorded replication-by-replication data on the basis of five competitive plants chosen at random from each replication. 1) Days to 50% flowering, 2) Days to 50% pod setting, 3) Plant height, 4) Number of primary branches, 5) Number of clusters per plant, 6) Days to maturity, 7) Number of pods per plant 8) Number of seeds per plant, 9) Pod length, 10) Biological yield, 11) Seed index, 12) Harvest index, and 13) Seed yield per plant. The recorded data for each of the characters under consideration was compared to the formula proposed by Panse and Sukhatme. Additionally, several components of variance, i.e., genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance, and genetic advance as a percent mean were determined statistically using recognised methods. Standard statistical techniques were used for the analysis of variance, genotypic coefficient of variation, and phenotypic coefficient of variation. Burton, inherited traits Genetic advancement, Burton and Devane To determine genotypic and phenotypic correlation coefficients, Johnson *et al*. and Ai Jibouri *et al*. used genotypic and phenotypic variances and co-variances. The method suggested by Dewey and Lu was used to conduct the route coefficient investigation.

Table: 1 List of experimental material used in the present investigation

S.No	GENOTYPES	S.No	GENOTYPES
1	PLU-110	14	VBN-8
2	TBG-104	15	TLU-326
3	ADT-3	16	LBG-752
4	IPU-99-16	17	IPU-94-1
5	PLU-25	18	SNTP-02
6	PDU-3	19	KC-153
7	PL-416	20	KU-58
8	PKRV-03	21	IPU-10-26
9	PGRU-95016	22	PU-19
10	UH-85-2	23	KU-99-16
11	CO-6	24	H-1
12	VBN-6	25	SHEKHAR-2 (check)
13	PLU-429		

RESULTS AND DISCUSSION

1. **Analysis of variance**

From the experiment described in RBD, an analysis of variance for 13 quantitative features was obtained. The analysis of variance indicated significant variations among all 13 features under study at 1% level of significance. Similar results were found by Panda *et al*. (2017), Anu *et al*. (2017), and Tanveer *et al*. (2018), which revealed substantial mean sum of squares values for all the Blackgram characters tested.

2. **Mean performance of genotypes**

The genotypes PLU-429 (8.06gm), PL-416 (7.37gm), VBN-8 (7.29gm), and IPU-99-16 (7.227gm), which had the highest seed output per plant based on mean performance, are thus recognised as promising lines with high yield potential and good quality for replacing SHEKAR-2 (check) (6.72gm). TLU-326 had the earliest day to 50% flowering and the earliest day to 50% pod setting. PL-416 had the most primary branches, clusters per plant, and harvest index, and CO-6 had the highest biological production.

3. **Genetic variability**

The phenotypic coefficient of variation was found to be larger than the genotypic coefficient of variation, which suggests that the environment may have an impact on the manifestation of the character under study. The plant height, pod length, and seed yield were the variables with the greatest variations between GCV and PCV. The findings of Mehra *et al.* (2016), Bishnoi *et al.* (2017), Hemalatha *et al.* (2017), Bandi *et al.* (2018), and Sarvani *et al.* concur with those of the experiment (2020).

4. **Heritability and Genetic Advance:**

The range of heritability (in the broad sense) was 21.756 to 85.509. The number of major branches per plant (85.509), number of pods per plant (73.841), biological yield (72.282), harvest index (71.379), and number of seeds per pod were shown to have the highest heritability's (70.222). There is no evidence of low or moderate heritability in these traits. The present study's high heritability values for the traits under consideration showed that those traits were less influenced by the environment and helped in the effective selection of traits based on phenotypic expression by using a simple selection method. These high heritability values also suggested the potential for genetic improvement. According to Johnson *et al.* (1955), genetic gain would be more helpful in estimating the effectiveness of selection than just heritability estimates alone.

Harvest index had the highest estimated genetic advance, whereas pod length had the lowest. It is possible to directly use characters with high heritability and high predicted genetic advance to enhance such characters. The function of additive gene action is also indicated by qualities with high heritability but low genetic progress, and these features may be utilised as an extra selection criterion if necessary.

The range of genetic progress as a percentage of the mean was 2.74% to 36.36%.

Number of primary branches, harvest index, and biological yield per plant all showed high genetic advance as a percent of mean, whereas Days to 50% pod initiation showed the lowest genetic advance.

5. Estimates of Correlation coefficient analysis

The number of major branches per plant (0.354*), harvest index (0.264*), pods per plant (0.482**), and clusters per plant (0.292*) all significantly positively correlated with seed yield per plant in the current study, indicating a strong relationship between these features and yield. The link between the correlation and the quantity of seeds per pod (0.1004), seed index (0.600), pod length (0.250), days to 50% blooming (0.0926), days to maturity (0.928), and days to fifty percent pod initiation (0.928) was positive but not statistically significant (0.0413). Plant height has a substantial negative correlation (-0.248*). negatively but insignificantly correlated with biological yield (-0.0014). Therefore, while choosing characters to increase yield, these characters should be given top consideration. These outcomes are consistent with earlier conclusions made by Shanthi *et al.* (2019), Baisakh *et al.* (2014), Shivade *et al.* (2011), and Parveen *et al.* (2011).

In the current study, the number of primary branches per plant (0.753*), the harvest index (0.542**), the number of pods per plant (0.725**), the number of clusters per plant (0.565*), the number of seeds per pod (0.277*), and the length of the pod (0.235*) all significantly correlated positively with grain yield per plant. It demonstrated the close relationship between these features and the yield. The correlation revealed a strong non-significant relationship between the days to maturity (0.0109) and the seed index (0.0121). Plant height has a substantial negative correlation (-0.301*). negatively but insignificantly correlated with biological yield (-0.0733). Therefore, while choosing characters to increase yield, these characters should be given top consideration. These findings are consistent with those made earlier by Patel *et al.* (2014) and Shanthi *et al.* (2019). Other characteristics with favourable correlations to seed yield include days to 50% flowering, days to 50% pod setting, number of primary branches, and harvest index, according to research by Parveen *et al.* (2011) and Prasad *et al.* (2015). The genotypic correlation coefficients for the yield and its contributing characters were typically higher than their phenotypic correlation coefficients, indicating that genetic factors at both the genotypic and phenotypic levels were largely responsible for the association. Significantly positive correlations were also found for the number of primary branches per plant, the number of clusters per plant, the number of pods per plant, and the harvest index.

6. Path Coefficient Analysis

A thorough examination of the diagonal values revealed a positive direct relationship between the number of primary branches per plant (0.0059), the number of clusters per plant (0.1733), the number of pods per plant (0.3124), the number of seeds per plant (0.1566), the biological yield per plant (0.01964), and the harvest index (0.3242) with seed yield per plant. Negative correlation between seed yield per plant and days of 50% blooming (-0.0775), days of 50% pod initiation (-0.1834), plant height (-0.3473), and pod length (-0.0451). Additionally, Kumar *et al.* (2014), Sowmya sree *et al.* (2018), and Khan *et al.* reported on same findings (2020).

A thorough analysis of the diagonal values revealed a positive direct relationship between seed yield per plant and the number of days to fifty percent pod initiation (0.0801), primary branches per plant (0.02064), pods per plant (1.4091), seeds per pod (0.7903), clusters per plant (0.0698), pod length (0.1169), and days to maturity (-0.1240). Days to 50% flowering (-0.5177), biological yield (-0.0499), plant height (-0.3836), seed index (-0.5851), harvest index (-0.1934), and seed yield per plant all showed negative direct effects. Additionally, the number of seeds per pod showed larger, positive values and indirect impacts through the majority of the component features, indicating a significant contribution to the plant's grain output, which was consistent with earlier findings by Tank *et al.* (2019). The findings of the path coefficient analysis showed that both phenotypic and genotypic levels, when compared with parameters like primary branches per plant, number of clusters per plant, number of pods per plant, and harvest index, had positive direct effects on grain yield per plant.

Table 2: Estimates of genetic parameters for component characters in Blackgram

S.No.	TRAITS	GCV	PCV	h^2 (Broad Sense) %	Genetic Advance 5%	Gen. Adv as % of Mean 5%
1	**Days to fifty percent flowering**	3.054	3.964	59.351	2.222	4.846
2	**Days to fifty percent pod setting**	2.085	3.267	40.719	1.486	2.74
3	**Days to maturity**	2.522	3.644	47.896	2.318	3.595
4	**Plant height (cm)**	4.593	8.238	31.089	3.118	5.276
5	**Number of primary branches per plant**	19.092	20.646	85.509	1.83	36.368
6	**Number of clusters per plant**	7.027	9.782	51.601	1.174	10.398
7	**Number of pods per plant**	12.332	14.352	73.841	5.015	21.831
8	**Number of seeds per pod**	9.125	10.889	70.222	0.85	15.752
9	**Pod length (cm)**	3.839	7.038	29.747	0.18	4.313
10	**Seed yield per plant (g)**	3.272	7.015	21.756	0.202	3.144
11	**Biological yield per plant (g)**	12.252	14.411	72.282	4.388	21.458
12	**Harvest Index (%)**	13.353	15.805	71.379	7.429	23.239
13	**Seed Index (g)**	8.514	11.212	57.661	0.575	13.318

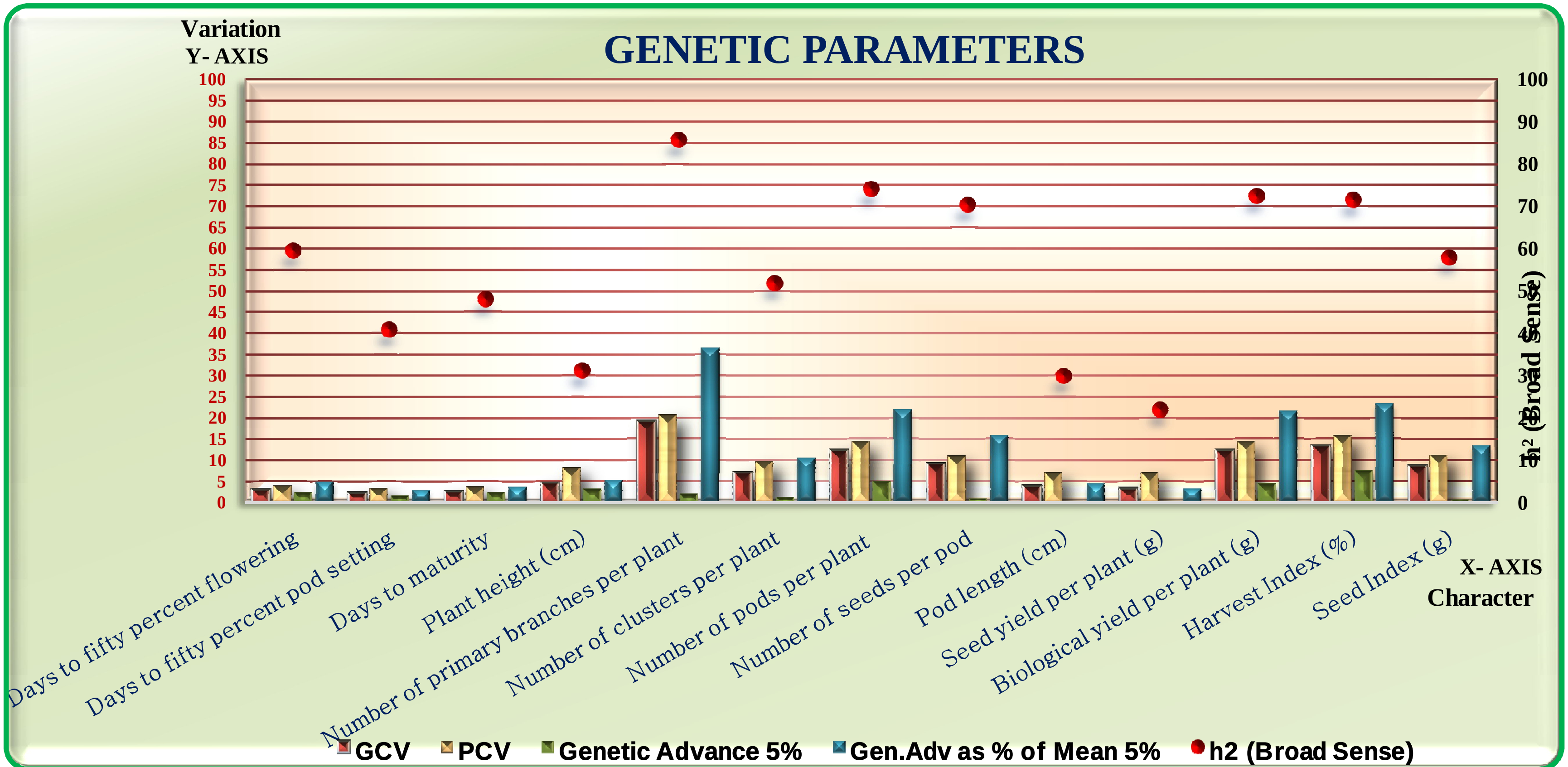


Fig. 1: Graph depicting GCV, PCV, Genetic advance and Heritability for 13 Quantitative characters of Blackgram Genc

Table 3: Phenotypic Correlation Coefficient for yield and its related traits in 25 Blackgram genotypes

TRAITS	Days to fifty percent flowering	Days to fifty percent pod initiation	Days to maturity	Plant height (cm)	Number of primary branches per	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	1.0000	0.603**	0.241*	-0.1825	0.1923	0.260*	0.351*	0.1172	0.0276	-0.0133	-0.0228	-0.0163	0.0926
Days to fifty percent pod initiation		1.0000	0.430**	-0.275*	0.0227	0.1969	0.242*	-0.0092	-0.0642	-0.1213	0.1126	-0.1805	0.0413
Days to maturity			1.0000	-0.1650	0.0083	-0.0008	0.252*	-0.1757	0.0475	-0.1500	0.231*	-0.1753	0.0928
Plant height (cm)				1.0000	0.1807	0.1037	-0.1513	-0.0201	-0.1003	-0.0698	-0.0212	-0.254*	-0.248*
Number of primary branches per					1.0000	0.331*	0.462**	0.1343	-0.0361	0.0338	0.1541	0.232*	0.354*
Number of clusters per plant						1.0000	0.419**	-0.1729	0.0496	0.2101	-0.1283	0.0946	0.292*
Number of pods per plant							1.0000	-0.1393	0.0323	0.0405	0.1400	0.1400	0.482**
Number of seeds per pod								1.0000	-0.1158	-0.1418	0.1885	0.1741	0.1004
Pod length (cm)									1.0000	-0.0204	0.0527	-0.0817	0.0250
Biological yield per plant (g)										1.0000	-0.778**	0.2255	-0.0014
Harvest Index (%)											1.0000	-0.1999	0.264*
Seed Index (g)												1.0000	0.0600
Seed yield per plant (g)													1.00 00

Table 4: Genotypic Correlation Coefficient for yield and its related traits 25 Blackgram genotypes

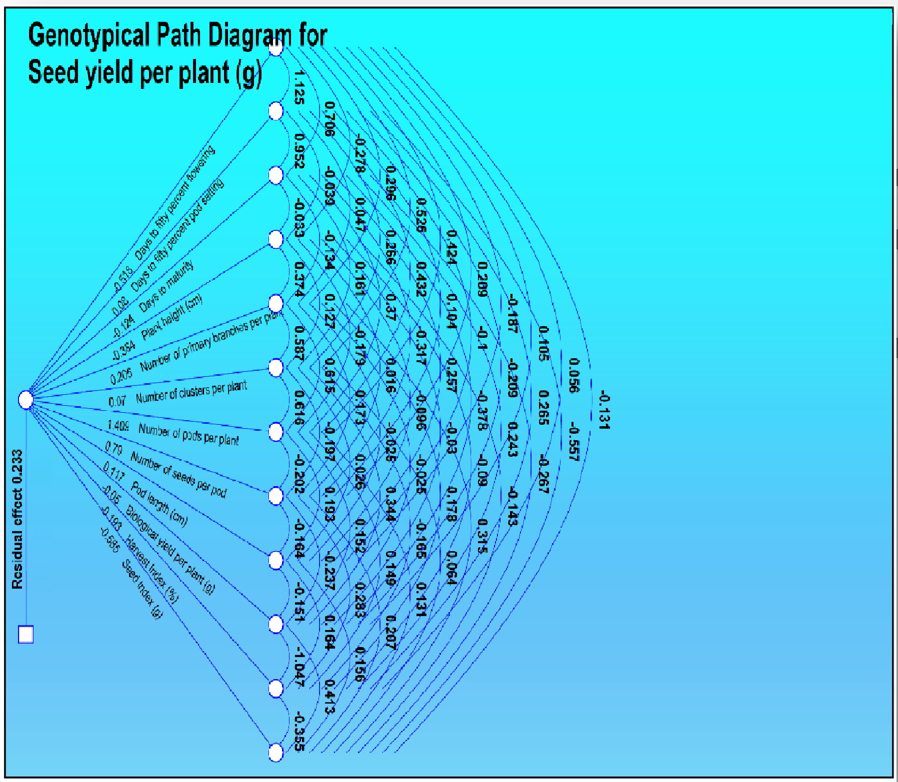
TRAITS	Days to fifty percent flowering	Days to fifty percent pod initiation	Days to maturity	Plant height (cm)	Number of primary branches per	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	1.0000	0.652**	0.706**	-0.278*	0.296*	0.525**	0.424**	0.2093	-0.1871	0.1046	0.0558	-0.1310	0.491**
Days to fifty percent pod initiation		1.0000	0.952**	-0.0392	0.0467	0.266*	0.432**	0.1042	-0.0997	-0.2093	0.265*	-0.557**	0.387**
Days to maturity			1.0000	-0.0333	-0.1336	0.1608	0.370*	-0.317*	0.257*	-0.378**	0.243*	-0.267*	0.0121
Plant height (cm)				1.0000	0.374**	0.1273	-0.1786	0.0156	-0.0962	-0.0304	-0.0895	-0.1433	-0.301*
Number of primary branches per					1.0000	0.587**	0.615**	0.1729	-0.0247	-0.0247	0.1783	0.316*	0.753**
Number of clusters per plant						1.0000	0.616**	-0.1970	0.0255	0.344*	-0.1650	0.0636	0.565**
Number of pods per plant							1.0000	-0.2025	0.1934	0.1520	0.1492	0.1314	0.725**
Number of seeds per pod								1.0000	-0.1644	-0.237*	0.283*	0.2071	0.277*
Pod length (cm)									1.0000	-0.1514	0.1644	0.1559	0.235*
Biological yield per plant (g)										1.0000	-1.047**	0.413**	-0.073 3
Harvest Index (%)											1.0000	-0.355*	0.542**
Seed Index (g)												1.0000	0.0109
Seed yield per plant (g)													1.0000

Table 5: Phenotypic Path coefficient for yield and its related traits in 25 Blackgram genotypes

TRAITS	Days to fifty percent flowering	Days to fifty percent pod initiation	Days to maturity	Plant height (cm)	Number of primary branches per	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	**-0.0775**	-0.0467	-0.0187	0.0141	-0.0149	-0.0201	-0.0272	-0.0091	-0.0021	0.0010	0.0018	0.0013	0.0926
Days to fifty percent pod initiation	-0.1105	**-0.1834**	-0.0788	0.0504	-0.0042	-0.0361	-0.0443	0.0017	0.0118	0.0222	-0.0207	0.0331	0.0413
Days to maturity	0.0014	0.0025	**0.0059**	-0.0010	0.0000	0.0000	0.0015	-0.0010	0.0003	-0.0009	0.0014	-0.0010	0.0928
Plant height (cm)	0.0634	0.0953	0.0573	**-0.3473**	-0.0628	-0.0360	0.0525	0.0070	0.0348	0.0242	0.0074	0.0883	-0.248*
Number of primary branches per	0.0333	0.0039	0.0014	0.0313	**0.1733**	0.0574	0.0801	0.0233	-0.0063	0.0059	0.0267	0.0402	0.354*
Number of clusters per plant	0.0630	0.0477	-0.0002	0.0251	0.0802	**0.2422**	0.1014	-0.0419	0.0120	0.0509	-0.0311	0.0229	0.292*
Number of pods per plant	0.1096	0.0754	0.0787	-0.0473	0.1443	0.1308	**0.3124**	-0.0435	0.0101	0.0127	0.0437	0.0437	0.482**
Number of seeds per pod	0.0184	-0.0014	-0.0275	-0.0032	0.0210	-0.0271	-0.0218	**0.1566**	-0.0181	-0.0222	0.0295	0.0273	0.1004
Pod length (cm)	-0.0012	0.0029	-0.0021	0.0045	0.0016	-0.0022	-0.0015	0.0052	**-0.0451**	0.0009	-0.0024	0.0037	0.0250
Biological yield per plant (g)	-0.0026	-0.0238	-0.0295	-0.0137	0.0066	0.0413	0.0080	-0.0279	-0.0040	**0.1964**	-0.1528	0.0443	-0.0014
Harvest Index (%)	-0.0074	0.0365	0.0749	-0.0069	0.0499	-0.0416	0.0454	0.0611	0.0171	-0.2523	**0.3242**	-0.0648	0.264*
Seed Index (g)	0.0029	0.0323	0.0314	0.0455	-0.0415	-0.0169	-0.0250	-0.0312	0.0146	-0.0403	0.0358	**-0.1789**	0.0600
Seed yield per plant (g)	0.0926	0.0413	0.0928	-0.248*	0.354*	0.292*	0.482**	0.1004	0.0250	-0.0014	0.264*	0.0600	**1.0000**

TRAITS	Days to fifty percent flowering	Days to fifty percent pod initiation	Days to maturity	Plant height (cm)	Number of primary branches per	Number of clusters per plant	Number of pods per plant	Number of seeds per pod	Pod length (cm)	Biological yield per plant (g)	Harvest Index (%)	Seed Index (g)	Seed yield per plant (g)
Days to fifty percent flowering	**-0.5177**	-0.5826	-0.3655	0.1440	-0.1533	-0.2720	-0.2194	-0.1084	0.0969	-0.0542	-0.0289	0.0678	0.491**
Days to fifty percent pod initiation	0.0901	**0.0801**	0.0763	-0.0031	0.0037	0.0213	0.0346	0.0083	-0.0080	-0.0168	0.0212	-0.0446	0.387**
Days to maturity	-0.0875	-0.1180	**-0.1240**	0.0041	0.0166	-0.0199	-0.0459	0.0393	-0.0319	0.0469	-0.0302	0.0331	0.0121
Plant height (cm)	0.1067	0.0150	0.0128	**-0.3836**	-0.1436	-0.0488	0.0685	-0.0060	0.0369	0.0117	0.0343	0.0550	-0.301*
Number of primary branches per	0.0611	0.0096	-0.0276	0.0773	**0.2064**	0.1211	0.1269	0.0357	-0.0051	-0.0051	0.0368	0.0651	0.753**
Number of clusters per plant	0.0367	0.0185	0.0112	0.0089	0.0410	**0.0698**	0.0430	-0.0138	0.0018	0.0240	-0.0115	0.0044	0.565**
Number of pods per plant	0.5972	0.6081	0.5214	-0.2517	0.8667	0.8686	**1.4091**	-0.2853	0.2726	0.2142	0.2103	0.1852	0.725**
Number of seeds per pod	0.1654	0.0823	-0.2504	0.0123	0.1367	-0.1557	-0.1600	**0.7903**	-0.1299	-0.1874	0.2236	0.1637	0.277*
Pod length (cm)	-0.0219	-0.0117	0.0301	-0.0112	-0.0029	0.0030	0.0226	-0.0192	**0.1169**	-0.0177	0.0192	0.0182	0.235*
Biological yield per plant (g)	-0.0052	0.0104	0.0189	0.0015	0.0012	-0.0172	-0.0076	0.0118	0.0076	**-0.0499**	0.0522	-0.0206	-0.0733
Harvest Index (%)	-0.0108	-0.0512	-0.0471	0.0173	-0.0345	0.0319	-0.0289	-0.0547	-0.0318	0.2025	**-0.1934**	0.0687	0.542**
Seed Index (g)	0.0766	0.3259	0.1560	0.0838	-0.1846	-0.0372	-0.0769	-0.1212	-0.0912	-0.2415	0.2079	**-0.5851**	0.0109

Seed yield per plant (g)	0.491**	0.387**	0.0121	-0.301*	0.753**	0.565**	0.725**	0.277*	0.235*	-0.0733	0.542**	0.0109	**1.0**



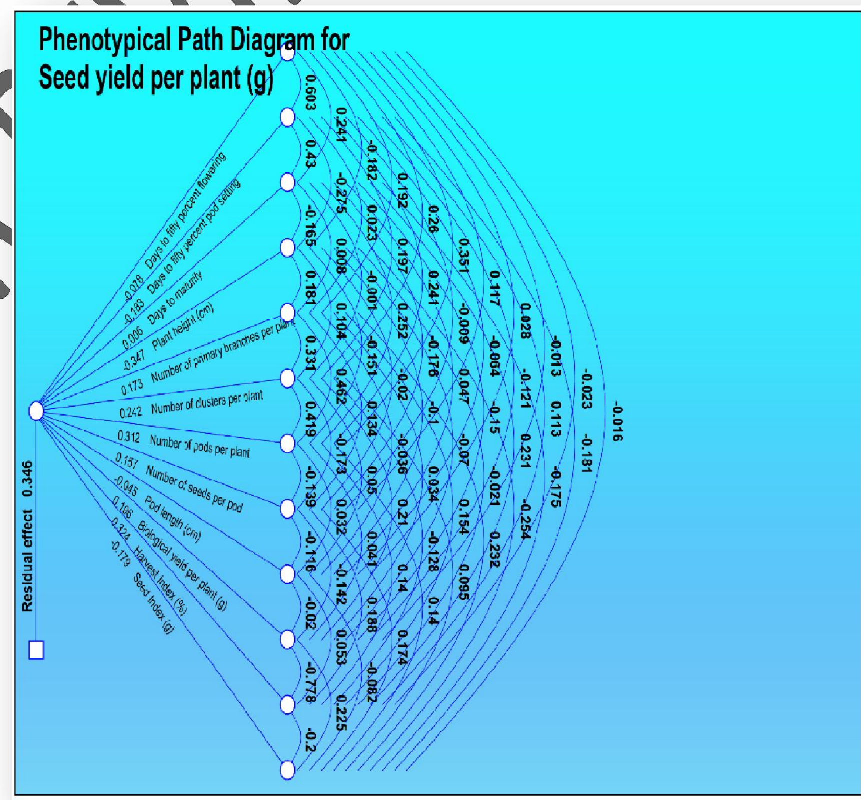


Fig. 2: Genotypic path diagrams for seed yield per plant

Fig.3: Phenotypic path diagrams for seed yield per plant

CONCLUSION

According to the findings of the current experiment, there were substantial differences between the 25 genotypes according to Analysis of Variance, suggesting the possibility of choosing promising lines from the available germplasm. Among all the genotypes, the genotypes PLU-429, PL-416, and IPU-99-16 had the highest documented seed yield. For the number of major branches and harvest index, high PCV, GCV, heritability, and genetic progress as a percentage of mean were recorded. At both the genotypic and phenotypic levels, there were significant positive associations for primary branches per plant, number of clusters per plant, number of pods per plant, and harvest index. Additionally, there were positive direct effects on grain yield per plant for these variables. For further crop yield increase in Blackgram, the study's findings would be very helpful.

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