Assessment of Genetic Diversity for Yield Component Traits and Grain Yield of Blackgram [*Vigna Mungo (L.) Hepper*]

ABSTRACT

Due to its high nutritional content and ability to supply a diet rich in protein, pulses hold a special place in Indian agriculture**.** In contrast to the world's production of cereals, pulses are grown seldom in low-fertile soils under conditions of moisture stress, which eventually hides their actual yield capability due to inadequate management approaches.The current study's objective is to estimate the genetic parameters of 13 yield attributing traits in 20 genotypes of urd bean to choose more yield-contributed characters in urd bean. Number of pods per plant revealed high estimates of PCV, GCV and heritability. In the Metroglyph study, superimposition of genotypes was seen because to the near closeness of two variables used to display the genotypes. In this classification analysis made based on number of pods per plant and harvest index for all the 20 genotypes of urd bean form four complexes. Out of 20 genotypes,4 genotypes like IC-331226, IC-261173, IC-385718, and IC-426495 were recorded highest index score and fell into different complex, hence used as parents for getting good combinations for future hybridization programmes.

Keywords*: harvest index, pulses, urd bean, yield*

INTRODUCTION

Black gram (*Vigna mungo (L.) Hepper*), commonly known as Urdbean. It is the short-duration, nutritious pulse crops are crucial and are cultivated in all three seasons under a variety of agroclimatic circumstances. It belongs to the Leguminosae family'sand is a diploid species with the chromosome number 2n=2x=22. Its scientific name is *Vigna mungo (L.) Hepper*.Blackgram originated in central Asia (India), and *Vigna mungo* var.*silvestris* ismost likely its progenitor. India is largest consumer and producer of urdbean.It has a high fiber content, high protein content (mostly globulins), and low levels of cysteine and methionine. However, they have more lysine than cereal.Urd bean seeds comprises of 24%–26% protein, 60% carbs, 1.5% fat, 3.2% minerals, and 10%–11% moisture. In addition, it has high levels of iron (9.1 mg per 100 gm), phosphorus (385 mg per 100 gm), and calcium (154 mg per 100 gm). Black grams have a calorific value of 347 kcal per 100 gm.The total covered area by urd bean in India is 5.196 lakh ha (12.84 lakh acres) during 2023-24 and the production was 17.68 lakh tonnes during 2022-23 (source: www.agricoop.nic.in). The assessment of germplasm is perhaps one of the most significant natural resources for providing the necessary traits to produce high-yielding, input-responsive cultivars that are tolerant to a variety of abiotic and biotic stresses. Consequently, carefully assessing germplasms in light of the current environment is necessary to identify donors with the quality characteristics required to be enhanced in future breeding programs. Thus, by computing several genetic characteristics including genotypic, phenotypic, and environmental variances as well as their coefficients of variability, genetic progress, and heritability, it is crucial to capitalize on the genetic diversity that currently exists. Studying the inheritance of different developmental-cum productive traits is mostly beneficial.The technique of metro glyph and index score analysis was developed by Anderson [1] to examine the pattern of morphological variation in blackgram genotypes.

1.1 Objectives

I. To estimate variability, heritability and genetic advance for yield and yield attributing components.
II. To find out the best possible genotypes for grain yield and its components.

III. To identify the genetic diversity among 20 black gram genotypes for grain yield characters.

MATERIALS AND METHODS

The experiment material for the present investigation was carried out at central research farmof Genetics and Plant Breeding Department, Naini Agricultural Institute, SHUATS, Prayagraj, UP, during Kharif 2023.For the investigation, a total of 20 blackgram genotypes were employed.3 replications of the Randomized Block Design (RBD) were used to raise the genotypes. In 3 replications plant to plant spacing is 10 cm and row to row spacing is 30cm with plot size 1mx1m.for this blackgram recommended plant protection and agronomical practice were adapted.Replication-specific data were gathered for the following thirteen (13) quantitative traits based on 5 competitive plants chosen at random from each replicationin agroclimatic conditions of Prayagraj regionmentioned in (Table 2.), observation were recorded for traits: Days to 50% flowering, Days to 50% pod setting, Days to maturity, Plant height (cm), Number of primary branches, Number of clusters per plant, Number of pods per plant, Pod length (cm), Number of seeds per pod, Seed Index, Harvest Index (%), Biological yield (g), Seed yield per plant (g). During the experiment, used genotype were mentioned in (Table 1).

Table 1. List of 20 genotype of blackgram used in the present experiment.

Sl. No	GENOTYPES	Sl. No	GENOTYPES
1	IC-395519	11	IC-385718
2	IC-251913	12	IC-331226
3	IC-410049	13	IC-261173
4	IC-321654	14	IC-331903
5	IC-325256	15	IC-330861
6	IC-261175	16	IC-330885
7	IC-328904	17	IC-38971
8	IC-250256	18	IC-334268
9	IC-398744	19	IC-305255
10	IC-393807	20	IC-426495

Using the formula, the variance of all the recorded data for the characters under examination was examined. Furthermore, using the proper statistical technique, the genetic parameters genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), broad sense heritability, genetic advancement as a percentage of mean, and correlation analysis were examined. Phenotypic, genotypic, and environmental variation were among these extra variables that contributed to variance.

Table 2. Analysis of Variance for 13 quantitative characters of Blackgram genotypes

ANOVA Summary				
Sl. No.	**Source**	**Mean Sum of Squares (MSS)**		
		Replication	**Treatment**	**Error**
	Degrees of freedom	**2**	**19**	**38**
1	Days to 50% flowering	4.4770	8.523**	3.517
2	Days to 50% pod setting	6.6180	8.389**	3.317
3	Days to maturity	20.2540	32.641**	13.394
4	Plant height (cm)	36.6140	101.868**	12.236
5	Number of primary branches	0.4250	4.077**	0.368
6	Number of clusters per plant	1.0350	16.93**	0.824
7	Number of pods per plant	5.1050	149.933**	5.356
8	Pod length (cm)	0.0550	0.201**	0.08
9	Number of seeds per pod	0.0180	0.305**	0.125
10	Seed Index	0.0390	0.171**	0.07
11	Harvest Index (%)	0.540	198.34**	9.527
12	Biological yield (g)	0.0890	54.666**	3.53
13	Seed yield per plant (g)	0.1420	0.66*	0.318

RESULTS AND DISCUSSION

The ample opportunity for improvement of these traits including seed yield supplied a procedure of careful selection is applied to the material. Due to various source of material taken as well as environmentalexert an influence affecting the phenotypes, the presence of variability may be rather substantial. The critical difference (C.D.) at 5% and 1%, the mean values, the coefficient of variation (C.V.), the standard error of the mean (Sem+), and range of 20genotypes are displayed, showing a wide range of variation for each examined attribute. Based on the mean performance, Seed yield per plant ranged from 5.55 g (IC-395519) to 7.8 g (IC-410049) with the mean of 6.51. The genotypes IC-410049 (7.8 g), IC-38971 (6.86 g) and IC-251913 (6.85 g) recorded highest seed yield. Whereas, the genotypes IC-395519 (5.55 g), IC-261175 (5.93 g) and IC-321654 (6.12 g) recorded minimum seed yield per plant. Similar reports were also presented by for plant height [8] [12].

3.1 Variability

In the current study, all attributes had phenotypic coefficients of variation that were larger than correspondinggenotypic coefficients of variation, suggesting that the environment had an impact. High estimations of GCV and PCV were found among the 13 quantitative characteristics:no. of pods per plant (24.88, 26.22) followed by harvest index (22.23, 23.86), biological yield (21.55, 23.68), no. of clusters per plant (18.39, 19.76) respectively. Moderate estimations of GCV and PCV were recorded for characteristics: plant height (11.11,13.19), no of primary branches (9.57, 10.91) and seed yield per plant (5.19, 10.10) whereas the low estimation of GCV and PCV were observed in days to 50% pod setting (2.61, 4.50), days to 50% flowering (3.15, 5.56), and days to maturity (3.20, 8.52)shown in (Table 3.) [2] [5].

3.2 Heritability

In the current study, estimations of high heritability in broad sense (h2) were observed as number of pods per plant (89.99 %) followed by, harvest index (86.85 %), number of clusters per plant (86.69 %) , biological yield (82.84 %) and number of primary branches (77.08 %). Estimations of moderate heritability in broad sense was observed as Plant height (70.95 %) followed by, days to 50% pod setting (33.76 %) and pod length (33.27) whereas, the estimations of low heritability in broad sense were recorded as seed yield per plant (26.43 %) followed by, seed index (32.16), and days to 50% flowering (32.17 %). By using a simple selection method based on phenotypic expression, the high heritability values of the traits under consideration in this study suggest that the scope of genetic improvement can be effectively explored. These traits are also less influenced by the environment shown in (Table 3.). Similar finding is reported by Kamannavar and Sanjeev [11] [16].

3.3 Genetic advance as a percentage mean (GAM)

The evaluation of genetic advance as percent mean is classified as high (>20%), moderate (10to 20%) and low (<10%) proposed byJohnson [8].

In the current study, no. of pod per plant (48.62%) was recorded as high estimates of heritability combined with high genetic advance as percent of mean followed by harvest index (42.68%), biological yield (40.41%), and no. of cluster per plant (35.28%). While the moderate estimation of genetic advance as percent of mean was recorded in plant height (19.28 %) followed by number of primary branches (17.32%) and pod length (5.77%) and the low estimates of genetic advance as percent mean was recorded in days to 50% pod setting (3.13%), days to 50% flowering (3.68%), days to maturity (3.93%) and number of seeds per pod (4.60%). Shown in [Table 3]. Similar findings are reported by Bhanuprasad and Chubatemsu[2] [3].

3.4 Metroglyph Analysis

Metroglyph analysis is a partially graphical technique used to evaluate themorphological variation patterns across a significant number of germplasm lines. ThefindingsfromAnderson[2]. The scatter diagram (Table 6)disclosed that 4 complexes could be distinguished based upon morphological variation. Complex-IV was represented by 2 genotypes with higher no. of pods per plant with high harvest index [7] [13].

Complex-I was exhibited by 7 genotypes and described as Moderate no. of pods per plant with moderate harvest index.

Complex-II was exhibited by 6 genotypes and described as moderate no. of pods per plant with high harvest index.

Complex-III was exhibited by 4 genotypes and described as lower no. of pods per plant with low harvest index.

Complex-IV was exhibited by 2 genotypes and described as higher no. of pods per plant with high harvest index.

The range of variability for characters, their values for index score and signs with rays are presented in (Table 4.). It was observed that maximum variability was in harvest index (27.55-43.81) followed by number of pods per plant (20.84-34.98), number of clusters per plant (10.22-14.97), plant height (43.36-55.01) and biological yield (14.89-23.43). These traits thus were most variable for classificatory analysis in blackgram. Similar findings are reported by Bhanuprasad and Nadarajan[2] [14].

The mean performance and total index score of 20 genotypes are presented in (Table 5.). The total index score was varied from 23 (IC-261175, IC- 250256, IC-393807) to 30 (IC-331226) with a mean of 26.5. The highest index score was 30 which was observed only in one genotype (IC-331226) followed by an index score of 29 in IC-261173. While the least index score of 23 was observed in three genotypes (IC-261175, IC-250256, IC-398744). Similar findings are reported by Bhareti [3] [10].

A frequency diagram showed the index score values for all the characters (Figure1). The values of index score ranged from 23 to 30. Maximum genotypes (8) had index score of 25 followed by 4 genotypes having index score of 27. Minimum frequency (1 genotype) occurred for index score of 24, 29 and 30. Similar findings reported by Punitha and Jha [15] [9].

Table 3. Genetic parameters for 13 quantitative characters in Blackgram genotypes

Sl. No.	GeneticParameters	GCV	PCV	h^2 (Broad Sense)	GA	GAM
1	Daysto50%flowering	3.15	5.56	32.174	1.51	3.68
2	Daysto50%pod setting	2.61	4.50	33.763	1.56	3.13
3	Daysto maturity	3.35	5.89	32.387	2.97	3.93
4	Plantheight (cm)	11.11	13.19	70.945	9.48	19.28
5	Numberof primary branches	9.57	10.91	77.078	2.01	17.32
6	Numberofclusters perplant	18.39	19.76	86.696	4.44	35.28
7	Numberofpods perplant	24.88	26.22	89.999	13.57	48.62
8	Podlength (cm)	4.86	8.42	33.274	0.24	5.77
9	Numberof seeds perpod	3.93	6.90	32.32	0.29	4.60
10	Seed Index	4.37	7.71	32.166	0.21	5.11
11	Harvest Index(%)	22.23	23.86	86.853	15.23	42.68
12	Biologicalyield(g)	21.55	23.68	82.842	7.74	40.41
13	Seed yield per plant (g)	5.19	10.10	26.427	0.36	5.50

Table 4. Index scores and signs used for characters for metro glyph analysis of 20 genotypes of Blackgram

Sl.No.	Character	Range of Mean	Score 1	Sign	Score 2	Sign	Score 3	Sign
			Value <		Value from - to		Value >	
1	Days to 50% flowering	37.67-44.67	39.28		39.28-42.65		42.65	
2	Days to 50% pod setting	47-53	48.09		48.09-51.44		51.44	
3	Days to maturity	70-81	72.32		72.32-78.92		78.92	
4	Plant height (cm)	39.87-63.47	43.36		43.36-55.01		55.01	
5	Number of primary branches	9.07-14	10.45		10.45-12.78		12.78	
6	Number of clusters per plant	7.47-16.2	10.22		10.22-14.97		14.97	
7	Number of pods per plant	15.33-39.2	20.84		20.84-34.98		34.98	
8	Pod length (cm)	3.73-4.71	3.87		3.87-4.38		4.38	
9	Number of seeds per pod	5.57-6.87	5.92		5.92-6.55		6.55	
10	Seed Index	3.8-4.6	3.94		3.94-4.42		4.42	
11	Harvest Index (%)	23.38-52.16	27.55		27.55-43.81		43.81	
12	Biological yield (g)	12.53-27	14.89		14.89-23.43		23.43	
13	Seed yield per plant (g)	5.55-7.8	6.04		6.04-6.98		6.98	

Table5. Meanand Indexscorefor 13 quantitative traitsfor 20 blackgramgenotypes

Sl. No.	Genotypes	Days to50 % flowering	Days to 50%podsetting	Days tomaturity	Plantheight(cm)	Number ofprimarybranches	Number ofclusters perplant	Number ofpodsperplant	Podlength(cm)	Number ofseedsperpod	SeedIndex	HarvestIndex(%)	Biologicalyield(g)	Seed yieldperplant(g)	TotalIndexScore
1	**IC-395519**	41(2.00)	48.67 (2.00)	72(1.00)	48.27(2.00)	11.53 (2.00)	15.4(3.00)	35.73 (3.00)	4.33(2.00)	6.27(2.00)	3.8 (1.00)	33.61 (2.00)	17.13 (2.00)	5.55(1.00)	25.00
2	**IC-251913**	39.33 (2.00)	47(1.00)	75 (2.00)	51.8(2.00)	12.73 (2.00)	10.93 (2.00)	25.4 (2.00)	4.71 (3.00)	6.6 (3.00)	4.3 (2.00)	36.85 (2.00)	18.47 (2.00)	6.85(2.00)	27.00
3	**IC-410049**	39(1.00)	49(2.00)	76 (2.00)	49.53 (2.00)	12.73 (2.00)	12.73 (2.00)	29.8 (2.00)	3.73 (1.00)	5.8 (1.00)	4.47(3.00)	31.05 (2.00)	23.27 (2.00)	7.8 (3.00)	25.00
4	**IC-321654**	41(2.00)	51(2.00)	76.67 (2.00)	49.4(2.00)	14(3.00)	7.47(1.00)	15.33(1.00)	4.06(2.00)	6.27(2.00)	4.03(2.00)	39.74 (2.00)	15.67 (2.00)	6.12(2.00)	25.00
5	**IC-325256**	42.33 (2.00)	51(2.00)	72 (1.00)	63.47 (3.00)	12.87 (3.00)	11.8(2.00)	20.67 (1.00)	4.43(3.00)	6.6 (3.00)	3.83(1.00)	23.56 (1.00)	27(3.00)	6.3 (2.00)	27.00
6	**IC-261175**	41(2.00)	49.67 (2.00)	70.33 (1.00)	48.73 (2.00)	12(2.00)	14.07 (2.00)	25.53(2.00)	3.79(1.00)	6.27(2.00)	4.03(2.00)	33.05 (2.00)	18.33 (2.00)	5.93(1.00)	23.00
7	**IC-328904**	41.33 (2.00)	47.33 (1.00)	75.33 (2.00)	46.67 (2.00)	9.93(1.00)	12(2.00)	23.27 (2.00)	4.05(2.00)	6.27(2.00)	4.1 (2.00)	34.53 (2.00)	18.13 (2.00)	6.18(2.00)	24.00
8	**IC-250256**	38.67 (1.00)	49.67 (2.00)	78(2.00)	39.87(1.00)	10.27 (1.00)	10.67 (2.00)	22.33 (2.00)	3.98(2.00)	5.57(1.00)	4.47(3.00)	42.03 (2.00)	15.8(2.00)	6.66(2.00)	23.00
9	**IC-398744**	40(2.00)	49.67 (2.00)	77(2.00)	43.13(1.00)	9.07(1.00)	11.73 (2.00)	27.67 (2.00)	4.19(2.00)	5.8 (1.00)	4.4 (2.00)	24.06 (1.00)	26.4(3.00)	6.29(2.00)	23.00
10	**IC-393807**	39.33 (2.00)	51.67 (3.00)	78(2.00)	58.8(3.00)	12.33 (2.00)	12.73 (2.00)	24.87 (2.00)	4.24(2.00)	5.87(1.00)	4.2 (2.00)	23.38 (1.00)	26.93 (3.00)	6.22(2.00)	27.00
11	**IC-385718**	41.33 (2.00)	50(2.00)	81 (3.00)	44.6(2.00)	11(2.00)	14.93 (2.00)	31.6(2.00)	4.17 (2.00)	6.13(2.00)	4.23(2.00)	50.14 (3.00)	13.93 (1.00)	7.05(3.00)	28.00
12	**IC-331226**	39.67 (2.00)	49.67 (2.00)	75(2.00)	55.8(3.00)	12(2.00)	13.2(2.00)	37.2(3.00)	4.33 (2.00)	6.87(3.00)	4.57(3.00)	31.19 (2.00)	20.73 (2.00)	6.42(2.00)	30.00
13	**IC-261173**	41.67 (2.00)	53(3.00)	76.67 (2.00)	52.47(2.00)	11.2(2.00)	15.13 (3.00)	37.6(3.00)	4.21(2.00)	6.53(2.00)	4.03(2.00)	36.98 (2.00)	18.2(2.00)	6.76(2.00)	29.00

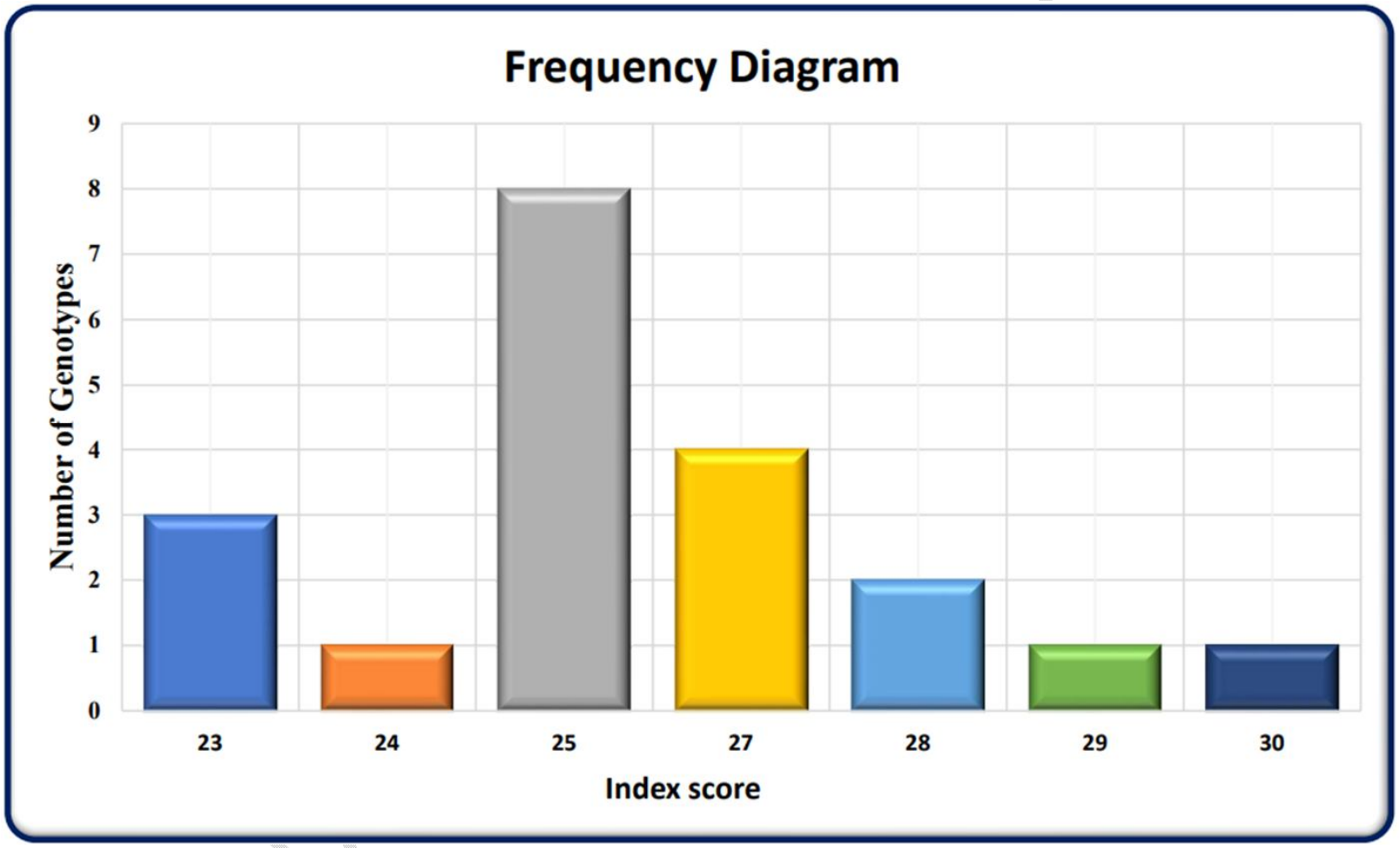
14	**IC-332903**	44.67 (3.00)	50.67 (2.00)	72(1.00)	46.13(2.00)	11.47 (2.00)	16.2(3.00)	32.53 (2.00)	4.41(3.00)	6.4 (2.00)	3.9 (1.00)	52.16 (3.00)	12.53 (1.00)	6.52(2.00)	27.00
15	**IC-330861**	42.33 (2.00)	52.67 (3.00)	80.67 (3.00)	41.33 (1.00)	10.47 (2.00)	9.67(1.00)	19.67 (1.00)	3.95(2.00)	6.27(2.00)	4.03(2.00)	40.05 (2.00)	17(2.00)	6.76(2.00)	25.00
16	**IC-330885**	42.67 (3.00)	49.33 (2.00)	79.67 (3.00)	52.6(2.00)	12.4(2.00)	9.47(1.00)	20.73(1.00)	3.81(1.00)	6.47(2.00)	4.1 (2.00)	38.48 (2.00)	16.73 (2.00)	6.39(2.00)	25.00
17	**IC-38971**	41.33 (2.00)	47.33 (1.00)	70(1.00)	44.4(2.00)	11.33 (2.00)	14.47 (2.00)	37.07 (3.00)	3.85(1.00)	6.13(2.00)	4.03(2.00)	45.93 (3.00)	15.27 (2.00)	6.86(2.00)	25.00
18	**IC-334268**	37.67 (1.00)	48(1.00)	72 (1.00)	48.53 (2.00)	12.47 (2.00)	15.67 (3.00)	39.2 (3.00)	4.29 (2.00)	6.33(2.00)	4.07(2.00)	32.68 (2.00)	20.47 (2.00)	6.71(2.00)	25.00
19	**IC-305255**	42.33 (2.00)	51(2.00)	77 (2.00)	45.27 (2.00)	10.73 (2.00)	13.4(2.00)	30.8 (2.00)	3.81 (1.00)	6.33(2.00)	4.4 (2.00)	37.65 (2.00)	17.47 (2.00)	6.57(2.00)	25.00
20	**IC-426495**	42.67 (3.00)	49(2.00)	78 (2.00)	52.93 (2.00)	11.73 (2.00)	10.27 (2.00)	21.13 (2.00)	4.19(2.00)	5.93(2.00)	4.6 (3.00)	26.56 (1.00)	23.67 (3.00)	6.21(2.00)	28.00

Table 6. Distribution of genotypes in different complex in metro glyph analysis

Complex	Nameofcomplex	Number oflines	Nameoflines	Range andaveragesc ore
I	Moderatenumberofpodsperplantwithmoderat eharvest index	7	IC-251913,IC-321654,IC-261175,IC-328904,IC-250256,IC-330861andIC-330885	23.00-27.00 (24.57)

II	Moderate number of pods per plant with higherharvestindex	6	IC-395519,IC-410049,IC-331226,IC-261173,IC-334268andIC-305255	25.00-30.00 (26.50)
III	Lower number of pods per plant with lowerharvestindex	4	IC-325256, IC-398744, IC-393807 and IC-426495	23.00-28.00 (26.25)
IV	Higher number of pods per plant with higherharvestindex	3	IC-385718, IC-332903andIC-38971	25.00-28.00 (26.66)

Fig. 1. Metro glyph frequency diagram showing 20 genotypes of Black gram



CONCLUSION

Based on the current study, it is concluded that among 20 genotypes of blackgram based on the mean performance IC-410049 (7.8g) was found to be higher in seed yield per plant.Number of pods per planthad recorded with high estimates of GCV, PCV and heritability. Number of pods per plantwas recorded as high estimates of heritability combined with high genetic advance as percent of mean. IC-331226, IC-261173, IC-385718,and IC-426495 were recorded highest index score and fell into different complex, hence used as parents for getting good combinations.

Disclaimer (Artificial intelligence)

Option 1:

I, Mahesh, hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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