Unravelling the genetic variability for yield attributed traits to identify the superior and high yielding genotypes in Black gram (*Vigna mungo* L. Hepper)

Abstract

Black gram is one of the important summer pulse crops of many south Asian countries viz., India, Bangladesh, Korea, Thailand, and Pakistan. Also, Black gram served as a good protein, especially in the form of lysine which is lacking in the other pulse crops. The study of the variance of many quantitative traits paves a way to identify better genotypes concerning our needs. Nowadays, improving the yield is the foremost thing in concern of food security, which requires a stringent procedure and data analysis to identify the superior genotypes processing high-yielding characteristics. Hence an investigation was conducted on 12 black gram genotypes to gain an insight into the existing pattern of variability for quantitative traits to find out the high-yielding superior genotypes. The analysis of variance revealed that all the genotypes differed significantly among themselves for all the characters. The phenotypic coefficient of variation value was found to be higher than the genotypic coefficient of variation for all ten characters. The traits *viz.*, number of seeds per pod, number of pods per plant, and pod length recorded moderate estimates of genotypic coefficient of variation. Pod length (91.74 %) recorded the highest heritability followed by single plant yield (88.10 %), number of pods per plant (76.17 %), days to 50% flowering (71.73 %) and number of seeds per pod (62.61 %). Moderate heritability was observed for plant height (57.38 %), hundred seed weight (50.05 %), number of clusters per plant (49.22 %), number of branches per plant (43.39 %), and days to maturity (40.77%). Hence these characters could be given importance during the selection program for developing high-yielding varieties.

Key words: Variability, Heritability, Genetic Advance, Black gram

Introduction

Black gram (Pulses) belongs to the family Fabaceae and is widely consumed as food by vegetarian peoples worldwide [1]. Compared to the other cereals crops, black gram yields more protein. Also rich in lysine (a rare amino acid) with an average of 65 ± 7 mg/g of protein compared with 29 ± 7 mg/g in cereals. However, in developing countries, pulses served as the main source of protein compared to the significant dependency on animal protein [2]. India is the largest producer of black gram accounting for more than 70% of the global production followed

by Myanmar, and Pakistan. The total area covered under black gram is 37.52 lakhs ha during Kharif 2020 – 2022 in India. The states viz., Rajasthan, Maharashtra, Andra Pradesh, Karnataka, Madhya Pradesh, and Uttar Pradesh are the major producer of black gram in India.

The production of other pulses such as urad, tur, and lentils across India is estimated to be around 25 MMT in the year 2022. Where it produces about 24.5 lakh tones of urad annually from about 4.6 million ha of area, with an average production of 533 kg/ha in 2020 – 2022 [3]. In general, black gram is cultivated as follow – up – crop after rice cultivation. However its productivity is very low and the biggest constraints are lower yield and narrowed genetic base of the existing cultivars, absence of suitable genotype for different cropping systems, poor harvest index, and susceptibility to disease [4]. Thus the lack of suitable varieties and the cultivars adapting to the local environment is also one of the factors affecting production and productivity. In order to improve such pulse crops through breeding, the foremost thing is to estimate the variability present among the population and how the observable variability is inherited from one generation to the next generation. Knowledge of heritability and genetic advance reflects the scope of trait of interest through selection. The combined estimate of heritability and genetic advance is more valuable in determining the genetic gain under selection [5].

Material and Methods

The research work was carried out on the farm of Adhiparasakthi Agricultural College, Kalavai, Ranipet, Tamil Nadu and India. Experimental materials include 12 genotypes of black gram collected from the National Pulse Research Centre, Vamban. The details of genotypes were listed in **Table 1**. The genotypes were raised in the plat bed method with a spacing of 30 x 10 cm in Randomized Block Design (RBD) under the irrigated condition with two replications. Observations were recorded on Days to 50 % Flowering, Days to Maturity, Plant Height, Number of Clusters per Plant, Number of Pods per Cluster, Number of Pods per Plant, Pod Length (cm), Number of Seeds per Pod, 100 Seed Weight (g), Seed Yield per Plant (g) from five randomly selected plants on each replication for all the characters under study. To predict the variability present among the genotypes the parameters viz., GCV (Genotypic Covariance) and PCV (Phenotypic CO Variance), Heritability (h^2), and Genetic Advance (GA). The variability that existed in the population for various characters was estimated by the earlier method [6]. Heritability in a broad sense was estimated as per the earlier formula [7]. The genetic advance of the genotypes at 5% selection pressure was calculated using the formula preferred earlier [5].

Table 1. Details of Black gram genotypes and its parentages

S. No	Genotypes	Parentage	Source
1.	VBN 2	Spontaneous mutant	NPRC, Vamban, TN
2.	VBN 3	LBG 402 × LBG 17	NPRC, Vamban, TN
3.	VBN 5	VBN 1 × LBG 20	NPRC, Vamban, TN
4.	VBN 6	VBN1 × *Vigna mungo var. silvestris*	NPRC, Vamban, TN
5.	VBN 7	VBN 3 x *Vigna mungo var. silvestris*	NPRC, Vamban, TN
6.	VBN 8	VBN 3 × VBG 04-008	NPRC, Vamban, TN
7.	VBN 9	Mash114 x VBN 3	NPRC, Vamban, TN
8.	VBN 10	VBN 1 x UH04-04	NPRC, Vamban, TN
9.	VBN 11	PU31 x CO 6	NPRC, Vamban, TN
10.	ADT 5	Selection from Kanpur Variety	NPRC, Vamban, TN
11.	ADT 6	Vamban 1 × VBG 04-2006	NPRC, Vamban, TN
12.	CO 6	DU 2 × VB 20	NPRC, Vamban, TN

Results and Discussion

Analysis of variance

Analysis of variance was carried out for ten quantitative characters in 12 black gram genotypes and was furnished in **Table 2**. The study revealed that all the genotypes differed significantly among themselves for all the characters.

Table 2. Analysis of variance for different quantitative characters

Characters	Mean sum of squares		
	Replication	Genotype	Error
Days to 50 per cent flowering	0.479	12.840**	2.113
Plant height	6.545	10.203**	2.763
Number of branches per plant	0.387	0.325**	0.128
Number of clusters per plant	0.583	0.630**	0.214
Number of pods per plant	2.701	19.237**	2.601

Pod length	0.115	0.814**	0.035
Number of seeds per pod	0.100	0.923**	0.214
Days to maturity	111.415	73.001**	30.719
Hundred seed weight	0.661	0.359**	0.119
Single plant yield	0.559	0.521**	0.033

Note: * Significant at 5% level, ** Significant at 1% level

Mean performance for quantitative traits in black gram

The mean performance can be used as a criterion for selecting desirable plants and for eliminating undesirable types. The results on the mean performance of parents for different characters are presented in **Table 3.** The genotype CO 6 was found to be superior and registered maximum mean value for plant height, number of clusters per panicle, days to and hundred seed weight. The genotype VBN 10 registered maximum mean value for number of branches per plant, number of pods per plant, and single plant yield. The genotype VBN 11 recorded higher mean values for number of seeds per pods. Based on the mean values for various quantitative traits the genotypes *viz.*, CO 6, VBN 10, and VBN 11 were found to be superior. Hence these genotypes may be utilized for improvement of yield and other useful traits.

Table 3. Mean performance of ten quantitative traits of 12 genotypes in black gram

S.No	Genotypes	DFF	PH	NBP	NCP	NPP	PL	NSP	DM	HSW	SPY
1	VBN 2	32.54	22.5	2.65	3.67	20.7	4.25	4.37	58.75	3.86	4.84
2	VBN 3	36.05	29.06	3.02	4.91	24.53	4.12	4.06	70.57	4.29	4.95
3	VBN 5	37.10	29.30	2.91	6.03	28.45	4.78	5.67	70.26	5.11	5.00
4	VBN 6	32.84	24.65	3.01	6.00	22.06	4.17	5.89	62.66	3.76	4.19
5	VBN 7	38.4	21.76	2.34	5.54	23.65	5.02	6.32	64.65	4.24	5.07
6	VBN 8	34.66	24.30	3.05	6.03	27.49	4.10	5.43	47.98	4.45	5.59

7	VBN 9	36.73	30.67	4.05	5.87	26.50	5.24	7.05	65.42	4.38	5.43
8	VBN 10	38.0	27.5	5.56	6.5	30.45	5.32	6.35	72.52	4.63	6.52
9	VBN 11	35.8	28.54	4.76	6.34	29.54	4.64	7.26	70.72	4.57	6.04
10	ADT 5	37.82	26.34	3.00	6.04	25.81	5.77	6.36	68.83	4.49	4.03
11	ADT 6	38.45	26.48	3.39	6.05	29.33	4.25	5.24	70.37	4.53	5.26
12	CO 6	35.75	32.0	3.52	7.23	24.4	5.34	6.46	73.0	5.77	5.73
	Mean	**36.18**	**26.93**	**3.44**	**5.85**	**26.08**	**4.75**	**5.86**	**66.31**	**4.50**	**5.22**
	SE d	**1.45**	**1.66**	**0.35**	**0.46**	**1.61**	**0.18**	**0.46**	**5.54**	**0.34**	**0.18**
	CD (5 %)	**3.08**	**3.52**	**0.76**	**0.98**	**3.41**	**0.39**	**0.98**	**11.75**	**0.73**	**0.38**

Note: DFF– Days to fifty percent flowering; PH – Plant Height; NBP – Number of branches per plant ; NCP – Number of Clusters per Plant; NPP – Number of Pods per Plant ; PL – Pod Length ; NSP – Number of Seeds per Plant ; DM – Days to Maturity ; HSW -; Hundred Seed Weight; SPY – Single Plant Yield

Phenotypic and genotypic co-efficient of variation

A total of 12 genotypes of black gram were studied for variability in ten quantitative traits. The data were subjected to analysis of variance and it was found that the germplasm differed significantly for all the characters studied. The estimates of genotypic and phenotypic variances were worked out for all the characters. The phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation for all the characters suggesting the presence of environmental influence to some extent in the expression of these characters. Moderate GCV estimates were observed for pod length, number of pods per plant, number of seeds per pod, and single plant yield. It indicates the availability of abundant variability for these characters in black gram. These results are in accordance with the earlier researchers [8, 9, 10, 11, 12, and 13].

Heritability and genetic advance

Estimates of heritability (h^2), genetic advance, and Genetic Advance as a percent of the mean for traits of the crop are furnished in **Table 4**. The genotypes under study showed high heritability values for most of the characters under study. Estimates of heritability ranged from 40.77 to 91.74 %. Pod length (91.74 %) recorded the highest heritability followed by single plant yield (88.10 %), number of pods per plant (76.17 %), days to 50%

flowering (71.73 %) and number of seeds per pod (62.61 %). Moderate heritability was observed for plant height (57.38 %), hundred seed weight (50.05 %), number of clusters per plant (49.22 %), number of branches per plant (43.39 %), and days to maturity (40.77 %). None of the characters was found to have a low amount of heritability.

Table 4. Estimates of Variability, heritability, and genetic advance as percent of the mean for ten quantitative characters in black gram

Characters	Mean	Range	PCV (%)	GCV (%)	h^2 (BS) (%)	GAM
Days to 50% flowering	36.18	32.54 – 38.45	7.34	6.22	71.73	10.85
Plant height	26.93	21.76 – 32.00	9.28	7.03	57.38	10.97
Number of branches per plant	3.44	2.34 – 5.56	15.02	9.89	43.39	13.42
Number of clusters per plant	7.20	3.67 – 7.20	11.02	7.73	49.22	11.18
Number of pods per plant	26.08	20.70 – 30.45	12.69	11.07	76.17	19.91
Pod length	4.75	4.10 – 5.77	14.22	13.62	91.74	26.88
Number of seeds per pod	5.86	4.06 – 7.20	13.88	10.98	62.61	17.90
Days to maturity	66.31	47.98 – 73.00	10.49	6.69	40.77	8.81
Hundred seed weight	4.50	3.76 – 5.70	11.18	7.91	50.05	11.53
Single plant yield	5.22	4.03 – 6.52	11.19	10.50	88.10	20.31

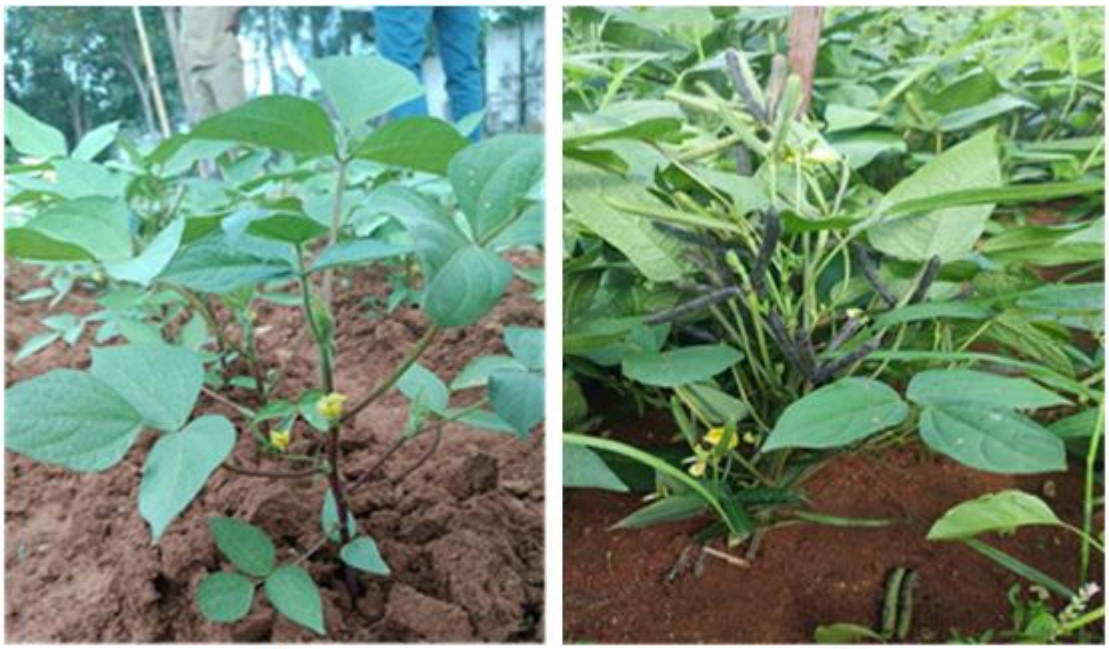

Fig. 1. Superior genotypes selected from the study. (A) Early flowering VBN 2, (B) Single plant yield VBN 10.

All the ten characters studied, recorded high heritability indicating lesser environmental influence. Among the characters studied, pod length and single plant yield recorded high heritability with high genetic advance, suggesting these characters are governed by the additive genetic effect to a great extent and improvement of these characters would be effective through phenotypic selection. Similar results were observed by the previous researchers [14, 15, 9, 16, 17, and 18].

The GAM ranged from 8.81 to 26.88 %. The highest magnitude of genetic advance was recorded by pod length (26.88 %) and single plant yield (20.31 %). A moderate amount of GAM was observed for number of pods per plant (19.91 %), number of seeds per pod (17.90 %), number of branches per plant (13.42 %), hundred seed weight (11.53 %), %), number of clusters per plant (11.18 %), plant height (10.97 %) and days to 50% flowering (10.85%). Days to maturity (8.81 %) exhibited the lowest amount of genetic advance as a percentage of the mean. The result indicates that the high heritability estimate indicates less influence of environment on respective characters. Low heritability (broad sense) indicates the predominance of no additive gene action indicating the scope for breeding. High estimates of GA coupled with a substantial amount of heritability indicate

that selection for such characters would result in the improvement of characters in the desired direction as the character is governed by additive genes. High heritability coupled with low genetic advance indicates non-additive gene action. The heritability exhibited due to the favorable influence of environment rather than genotypes and selection for such traits may not be rewarding. Hence those characters who exhibited high heritability and high genetic advance could be given importance during the selection program for developing high-yielding varieties.

Conclusion

In this study, we have studied the variability, heritability and genetic advance as per mean for the different genotypes of black gram accessions. The results revealed that traits viz., Pod length, single plant yield, Number of pods per plant, Days to 50% flowering, and Number of seeds per pod recorded the highest heritability. Likewise the characters viz., Plant height, Hundred seed weight, Number of clusters per plant, Number of branches per plant, and Days to maturity scored moderate heritability. Hence these characters could be given importance during the selection programme for developing high-yielding varieties. Finally, VBN 2 and VBN 10 recorded superiority over Early flowering and Single plant yield respectively.

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