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Genetic Variability, Heritability, Genetic Advance and Association Studies in Blackgram [*Vigna mungo* (L.) Hepper]

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Abstract

Background: In Tamil Nadu blackgram is cultivated in 4.02 lakhs hectare with the production of 2.25 millon tonnes and productivity of 559 kg/ha. Even though it has great importance, blackgram cultivation is ignored as minimum attention is given towards its genetic improvement. There are various reasons for the low production of crop like lack of genetic variability, absence of suitable ideotype, susceptibility to biotic and abiotic stresses and planting in marginal areas of farming. Hence, it is important to improve the productivity of blackgram.
Methods: The present investigation was carried out on 44 blackgram genotypes at field experimentation site of Regional Research Station, Tamil Nadu Agricultural University, Aruppukkottai, Virudhunagar District, to study genetic variability, heritability, genetic advance and correlation and path effects of seven important yield contributing traits including yield trait.
Result: Highest GCV and PCV value observed for seed yield per plant and for plant height. High heritability coupled with high genetic advance as percent of mean were recorded for plant height and seed yield (kg/ha) and selection of these traits was useful for further improvement in plant breeding programme. Association analysis revealed that seed yield exhibited significant and positive correlated with plant height and number of pods/plant. Yield component traits *viz*., plant height, number of pods/plant, 100 seed weight and single plant yield were highly correlated among themselves. It was observed that plant height and number of pod/plant had the maximum positive direct effects on seed yield. The indirect effect of plant height on grain yield was positive through days to maturity, days to fifty percent flowering and number of pods per plant. Hence selection of plants based on plant height and number of pods/ plant will help the improvement of seed yield in blackgram.

Key words: Blackgram, Genetic association, Genetic variability, Path analysis, Seed yield.

Introduction

Pulses are the major source of dietary protein in the vegetarian diet. It is popularly known as “urd bean” is an important short duration and self-pollinated legume crop with a small genomic size of 0.56 g/PC (574 Mbp) (Gupta and Gopalakrishna, 2009). It is rich source of protein (25-28%), carbohydrates (62-65%), fibre (3.5-4.5%), ash (4.5-5.5%), oil (0.51.5%), amino acids like lysine, vitamins similarly thiamine, niacin, riboflavin, iron and phosphorus (Sohel *et al*., 2016). Since it is a leguminous crop, it improves the soil fertility status by fixing atmospheric nitrogen and thus stops soil erosion. India is considered to be the largest producer as well as consumer of blackgram. The major producing states are Andhra Pradesh, Maharastra, Madhya Pradesh, Tamil Nadu, Uttar Pradesh. During 2020-21, India accounts for about 22.30 million tonnes annually from 41.43 lakh hectare area with an average productivity of 538 kg/ha. In Tamil Nadu blackgram is cultivated in 4.02 lakhs hectare with the production of 2.25 million tonnes and productivity of 559 kg/ha. Despite its great importance, blackgram cultivation is ignored as minimum attention is given towards its genetic improvement. There are various reasons for the low production of crop like lack of genetic variability, absence of suitable ideotype, susceptibility to biotic and abiotic stresses and planting in marginal areas of farming. Hence, it is important to improve the productivity of blackgram. The main limits in black-gram genetic enhancement are lack of

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available genetic variability, absence of appropriate ideotype for different cropping systems, low harvest index, susceptibility to biotic and abiotic stresses and non-availability of good quality seeds of improved varieties. It is mainly due to the repeated usage of limited parents with high degree of similarity in crossing programmes (Jayamani and Sathya, 2023). The success of any yield improvement programme mainly depends upon the level and nature of genetic variability available in yield contributing characters (Johnson *et al*., 1955). This can be attained by studying the genetic architecture of the crop. The information of the inheritance of various quantitative and qualitative characters through the estimation of genetic parameters like phenotypic and genotypic coefficients of variability, heritability and genetic advance is a necessity in conducting an effective breeding programme. Before starting any breeding programme, it is essential to access the nature and magnitude of genetic variability in the population to improve the yield and its related traits (Singh *et al*., 2016). Knowledge of genetic variability, heritability and genetic advance is essential to frame selection criteria for improvement of seed yield. Heritability is the heritable portion of phenotypic variance which is good index of transmission of traits from parents to their offspring. Heritability in broad-sense affords an idea about the additive and non-additive gene action in the expression of particular characters. The estimations of heritability along with genetic advance are more important than genetic advance alone to know the resulting effect of the best individuals (Johnson *et al*., (1955). Association between yield and other yield contributing attributes would be useful for choosing the better genotypes. Association analysis measures the mutual relationship between various plant traits and determines contributing characters on which selection can be based on improvement in the economically significant traits (Hemalatha *et al*., 2017). Keeping in view these points, the present investigation is conducted to assess the variability, heritability, in broad sense and genetic advance to identify superior black-gram genotypes for future exploitation in breeding programmes.

MATERIALS AND METHODS

The present investigation was carried out during *Rabi*, 2020-21 at Regional Research Station, Tamil Nadu Agricultural University, Aruppukottai, Virudhunagar District, Tamil Nadu. Experimental material consists of 44 blackgram genotypes were sown in Randomized Block design in two replications, two rows of each genotype in each replication with 4 m length. Row to row and plant to plant distance was kept at 30 cm and 10 cm, respectively. Standard production techniques were followed to get a healthy crop. Data was recorded on seven quantitative characters *viz*., days to maturity, days to first flowering, days to 50% flowering, plant height (cm), number of pods per plant, 100 seed weight (g) and seed yield (kg/ha). The observations for days to maturity, days to first flowering, days to 50% flowering and seed yield where observations were recorded for whole plot basis. The various genetic estimates *viz*., GCV and PCV were calculated by adopting the formulae given by Burton (1952), while calculating heritability, GA as per cent mean the formulae given by Johnson *et al*. (1955) was adopted.

RESULTS AND DISCUSSION

Analysis of variance revealed that significant differences were existed in the genotypes studied and it is represented in Table1. The variability on genetic parameters for seven biometrical characters is presented in Table 2. The PCV was higher than GCV for all the characters under study which indicated that the environmental factors influencing the characters studied. The same findings were reported by Panigrahi *et al*. (2014); Deepshika *et al*. (2014); Babu *et al*. (2016); Priyanka *et al*. (2016); Hemalatha *et al*. (2017) and Gomathi *et al*. (2021). The estimate of GCV and PCV were grouped as low (10%), moderate (10-20%) and high (more than 20%) as suggested by Burton and Devane (1953). The estimated GCV and PCV helped in getting a clear understanding of the variability present among various genotypes. Higher magnitude of GCV was recorded for seed yield (24.43%) followed by plant height (20.81%) and moderate GCV was observed in number of pods/plant (19.32%) and low magnitude of GCV was observed in 100 seed weight (8.82%), days to maturity (3.32%), days to first flowering (2.58%) and days to fifty percent flowering (2.50%). Higher magnitude of PCV was recorded in seed yield (kg/ha) (27.84%) followed by number of pods/plant (24.29%) and plant height (22.59%). Moderate GCV was observed in 100 seed weight (10.20%) and low magnitude of variability was observed for days to fifty percent flowering (4.08%), days to maturity (3.97%) and day to first flowering (3.12%).

Table 1: Analysis of variance.

Characters	Mean sum of squares		
	Replication (Degrees of freedom=01)	Treatments (Degrees of freedom=43)	Error (Degrees of freedom=43)
Days to maturity	7.68	14.95	2.64*
Day to first flowering	0.01	1.90	0.36*
Days to 50% flowering	1.14	4.23	1.93*
Plant height (cm)	3.60	82.25	6.74*
No. of pods/plant	0.01	17.53	3.94*
100 seed weight	0.00	0.32	0.05*
Seed yield (kg/ha)	1845.56	56220.38	7313.63*

Highest GCV and PCV value for seed yield per plant (24.43%, 27.84%) and for plant height (20.81%, 22.59%). Highest GCV and PCV value for seed yield per plant (24.43%, 27.84%) and for plant height (20.81%, 22.59%). The maximum value of GCV and PVC shows as existences of high variability presented in these traits. Moderate GCV and high PCV was recorded for number of pods/plant (19.32%, 24.29%) whereas low GCV and moderate PCV (8.82% and 10.20%) were revealed for 100 seed weight, this indicates as the trait more influenced by environment. Low GCV and PCV observed for days to maturity (3.32% and 3.97%) for days to first flowering (2.58%, 3.12%) and for days to fifty percent flowering (2.50%, 4.08%) indicating minimum variability exist in these traits, but slightly higher PCV than GCV which mean less influenced by the environmental factors.

The estimates of heritability in broad sense for yield and attributing characters have been presented in Table 2. The prediction regarding heritability in broad sense was made as suggested by Robinson (1949) for low (less than 50%), moderate (50-70%) and high (more than 70%) heritability estimates. In the present study high estimates of heritability were observed for plant height (84.86%), seed yield (kg/ha) (76.98%), 100 seed weight (74.73%) and days to maturity (70.03%) and Similar findings were reported by Priya *et al*. (2018) and Gomathi *et al*., (2021) for above said traits except days to maturity. Moderate estimates of heritability were observed for days to first flowering (68.06%) and number of pods/plant (63.28%) and low estimates of heritability was observed for days to fifty flowering (37.39%). Similar findings were reported by Dharmendra Kumar *et al*., (2017). As per reference Johnson *et al*. (1955) genetic advance as percentage of mean (GAM) was grouped if the values ranged from 0-10% are considered low, 10-20% are moderate and 20% and above are high. Genetic advance as percent of mean were recorded higher value for seed yield (kg/ha) (44.15%), plant height (39.49%) and number of pods/plant (31.66%) and moderate value for 100 seed weight (15.70%) whereas low for days to maturity (5.73%), days to first flowering (4.38%) and days to fifty percent flowering (3.15%). These findings are similarly with the result of as reported by Priya *et al*. (2018) and Kasarla Chaithanya *et al*. (2019) respectively. High heritability coupled with high genetic advance as percent of mean were recorded for plant height (84.86%, 39.49%) and seed yield (kg/ha) (76.98%, 44.15%). High heritability and moderate genetic advance as percent of mean were recorded for 100 seed weight (74.73%, 15.70%). Furthermore findings were reported by Priya *et al*. (2018). Moderate heritability and high genetic advance as per cent of mean were recorded for number of pods/plant (63.28%, 31.66%). Present study concluded on the basis of high heritability coupled with high genetic advance as per cent of mean were recorded for plant height and seed yield (kg/ha) and high heritability and moderate genetic advance as percent of mean were recorded for 100 seed weight and selection of these traits was useful for further improvement in plant breeding programme.

Correlation coefficients were computed to assess the magnitude of association existed between seed yield and other contributing traits and are furnished in Table 3. Association pattern of seed yield exhibited significant and positive correlation with plant height (Priya *et al*., 2018 and Priya *et al*., 2021) and number of pods per plant (Shanthi *et al*., 2019; Saran *et al*., 2023 and Gomathi *et al*., 2021). It advocated that increase in growth related traits like plant height and pod characters might contribute to high yields in black gram. This situation meant that to select high yielding genotypes of black gram, it was essential to consider the above characters with their increasing magnitude. It helped in simultaneous improvement of all the positively correlated characters. 100 seed weight exhibited significant negative genotypic correlation with seed yield. The other trait under study namely, days to maturity showed positive and non-significant correlation with yield it clearly indicated that these traits had weak association with seed yield. Whereas, days to first flowering and days to fifty percent flowering showed negative and non- significant correlation with seed yield. The negative and non-significant association among the traits had a complex linkage relation among the pair of combinations and had a weak association with yield. Similar findings were reported by (Sohel *et al*., 2016 and Shanthi *et al*., 2019).

From the inter correlation studies, the trait of days to maturity had significant positive correlation with plant height and significant negative association with 100 seed weight.

Table 2: Genetic components of variance for various quantitative traits.

Particulars	Days to maturity	Days to first flowering	Days to 50% flowering	Plant height (cm)	No. of pods/plant	100 seed weight (g)	Seed yield (kg/ha)
G mean	74.66	33.99	42.95	29.53	13.49	4.20	640.13
Range	67-83	31-36	39-46	18.3-41.0	8.1-21.6	3.4-4.0	273-980
PV	8.79	1.13	3.08	44.49	10.74	0.18	31767.00
GV	6.16	0.77	1.15	37.76	6.79	0.14	24453.37
EV	2.64	0.36	1.93	6.74	3.94	0.05	7313.63
PCV (%)	3.97	3.12	4.08	22.59	24.29	10.20	27.84
GCV (%)	3.32	2.58	2.50	20.81	19.32	8.82	24.43
h^2 (%)	70.03	68.06	37.39	84.86	63.28	74.73	76.98
GAM (%)	5.73	4.38	3.15	39.49	31.66	15.70	44.15

Table 3: Genotypic correlations of various quantitative traits.

Character	Days to maturity	Days to first flowering	Days to 50% flowering	Plant height (cm)	No. of pods/plant	100 seed weight (g)	Seed yield (kg/ha)
Days to maturity	1.000	0.128	-0.159	0.321*	-0.120	-0.372*	0.176
Days to first flowering		1.000	0.434*	-0.017	-0.243	0.197	-0.213
Days to 50% flowering			1.000	0.197	-0.061	0.297*	-0.084
Plant height (cm)				1.000	0.412*	-0.478*	0.701*
No. of pods/plant					1.000	-0.150	0.579*
100 seed weight (g)						1.000	-0.403*
Seed yield (kg/ha)							1.000

Table 4: Direct and indirect effects of various traits on seed yield at genotypic level.

Character	Days to maturity	Days to first flowering	Days to 50% flowering	Plant height (cm)	No. of pods/plant	100 Seed weight (g)	Seed yield (kg/ha)
Days to maturity	-0.0008	-0.0075	0.0243	0.1915	-0.0369	0.0056	0.1760
Days to first flowering	-0.0001	-0.0588	-0.0662	-0.0103	-0.0746	-0.0029	-0.2130
Days to 50% flowering	0.0001	-0.0255	-0.1525	0.1173	-0.0187	-0.0045	-0.0838
Plant height (cm)	-0.0003	0.0010	-0.0300	0.5961*	0.1265	0.0072	0.7006*
No. of pods/plant	0.0001	0.0143	0.0093	0.2456	0.3072*	0.0022	0.5787*
100 seed weight (g)	0.0003	-0.0116	-0.0454	-0.2851*	-0.0459	-0.0150	-0.4026*

Residual effect: 0.6111.

The trait days to first flowering had positive and significant correlation with the traits *viz*., days to fifty percent flowering. Days to fifty percent flowering were positive and significant association with traits like 100 seed weight (Priya *et al*., 2018). The traits plant height was positive and significant association with number of pods per plant (Sohel *et al*., 2016) and Priya *et al*., 2018) and significant negative association with 100 seed weight. From the above facts, it was clear that the yield component traits *viz*., plant height, number of pods per plant, hundred seed weight and single plant yield were highly correlated among themselves. Hence simultaneous selection for the above mentioned traits will be more worthwhile to bring improvement in blackgram breeding.

The estimates of correlation coefficients shown only the relationship between yield components, but did not show the direct and indirect effects of different traits on seed yield. This is because the attributes which are in association do not exist by themselves, but are linked to other components. But the result of path coefficient analysis for grain yield and yield contributing components can describe genotypic correlations to direct and indirect effects. In the present study, path coefficient analysis was performed using correlation coefficient to determine the direct and indirect influence of six traits on yield (Table 4). It was observed that plant height (0.5961) and number of pod per plant (0.3072) had the maximum positive direct effects on yield per hectare. Hence, selection based on these traits would be effective in increasing the seed yield. These positive direct effects observed with seed yield were in accordance with earlier findings of (Hakim, 2008; Kanimozhi *et al*., 2015; Priya *et al*., 2018 and Shanthi *et al*., 2019). Remaining traits noticed negligible effect on seed yield per plant. The indirect effect of plant height on grain yield was positive through days to maturity, days to 50% flowering and number of pods per plant. The remaining traits had negligible effects on seed yield. Hence selection of plants based on plant height and number of pods per plant will be helpful for improvement of seed yield in blackgram. The findings are accordance with the (Priya *et al*., 2018 and Shanthi *et al*., 2019).

CONCLUSION

In the present investigation, high heritability coupled with high genetic advance as per cent of mean were recorded for plant height and seed yield (kg/ha) and selection of these traits was useful for further improvement in plant breeding programme. Association analysis revealed that seed yield exhibited significant and positive correlated with plant height and number of pods/plant. Yield component traits *viz*., plant height, number of pods/plant, 100 seed weight and single plant yield were highly correlated among themselves. It was observed that plant height and number of pod/plant had the maximum positive direct effects on seed yield. The indirect effect of plant height on grain yield was positive through days to maturity, days to fifty percent flowering and number of pods per plant. Henceforth, selection of plants based on plant height and number of pods/plant will help the improvement of seed yield in blackgram and further study.

Conflict of interest

All authors declare that they have no conflicts of interest.

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