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Genetic Analysis of Seed Traits in Pre-breeding Lines of Blackgram [*Vigna mungo* (L.) Hepper]

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ABSTRACT

Background: Visual polymorphism of the seeds is supposed to play an important role in breeding programme. Hence this study helps to estimate the genetic parameters in pre breeding lines of blackgram.

Methods: One hundred and eighty nine pre breeding lines obtained from the cross VBN (Bg) 5 × *Vigna mungo* var. *silvestris* were evaluated during *kharif,* 2019 and *rabi,* 2019-20 in a replicated trial. The seed related traits such as seed length, seed width, thickness, length width ratio, seed volume, bulk density and hundred seed weight were taken for analysis.

Result: The values of PCV were higher than the GCV indicating the environmental influence over these traits. Moderate GCV was observed for seed volume (13.03%) and hundred seed weight (10.55%). Low GCV was observed for length width ratio (5.21%), seed width (4.47%), bulk density (4.08%), seed thickness (3.54%) and seed length (2.96%). The difference between PCV and GCV was high for seed volume (6.84) followed by seed thickness (2.03) indicating the higher environmental influence over these traits. High heritability was noticed for the traits *viz.,* hundred seed weight (96.22%), seed width (96.03%), length width ratio (93.13%), bulk density (91.13%) and seed length (88.11%). High heritability along with high genetic advance as per cent of mean was observed for hundred seed weight (96.22 and 21.32 respectively) which defines the additive gene action that would help in the selection of these traits. Correlation analysis revealed that bulk density, seed thickness, seed volume, seed length and seed width had significant and positive correlation with hundred seed weight. Seed thickness and bulk density had high direct effect on hundred seed weight. Thus, results from the present study could be used to obtain bold seeded variety in blackgram.

Key words: Blackgram, Correlation, Genetic advance, Genetic variability, Heritability, Pre-breeding lines.

INTRODUCTION

Pulses are indispensible source of protein for vegetarian population in India and constitute a major part in the daily diet. Proteins in Indian diet are mainly derived from the legumes. Among the pulses, Blackgram (*Vigna mungo*) also known as urdbean or mash is predominantly grown and consumed either as whole or split seed especially as breakfast food in the form of dosa and idli (Singh, 1999) in the Indian subcontinent. Blackgram is rich in protein (24%) and other mineral nutrients (Aykroyd and Doughty, 1982). Among the variables influencing seedling growth and crop stand, seed weight along with other physical properties such as length, width, length width ratio, thickness, volume and bulk density play an important role in determining the yield as well as for designing seed processing equipments to reduce the post harvest loss which is an essential factor in dhal industry.

Bold seeds have the edge in field germination and establishment and it is also desirable for dhal industry as it can result in high dhal recovery than small seeds. The physical appearance of the seed is also a key factor and its acceptability varies greatly with consumer preference. In particular, a large seed size coupled with attractive seed coat colour fetches premium prices. Without knowing the shape and size of the seed, designing of seed processing equipments may leads to poor results (Davis and El Okene, 2009). Bulk density plays an important role in handling during storage, breakage susceptibility and hardness studies.

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Visual quality is one of the most important determinants and is considered to be the most important breeding objective to enhance the seed size. The advancement of genetic parameters helps in selection programme for the improvement of seed related traits especially yield together with seed size in blackgram. To improve the yield, direct selection might not be feasible and hence the association analysis provides an opportunity to improve the desirable characters simultaneously. Along with association analysis, path analysis shows how closely the traits associate with themselves in ultimate yield improvement in blackgram. Hence, the current study was conducted to investigate some physical properties of seeds in pre breeding lines of blackgram.

MATERIALS AND METHODS

The present study comprised of 189 pre breeding lines (F_{10})

developed from the cross between VBN (Bg) 5 × *Vigna mungo* var *silvestris* 22/10, a wild progenitor of blackgram. The experiment was laid out in a randomised block design replicated twice during *kharif,* 2019 and *rabi* 2019-20 with row length of 4 m with the row to row and plant to plant spacing of 30 × 10 cm respectively at the Department of Pulses, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore. A basal application of NPK was applied in the ratio 25:50:25 kg/ha and recommended agronomic practices were followed and harvest was done at the time of pod maturity. Observations on hundred seed weight along with other physical properties of seed such as seed length, seed width, seed length width ratio, seed thickness, seed volume, bulk density were calculated. The mean values of two seasons data was subjected for statistical analysis.

The observations were made using 10 seeds collected for each of the line from two replications and the average value was calculated for statistical analysis. Seed length (the maximum distance from top to bottom of the seed) and width (the maximum distance from the hilum to its opposite side of the seed) were calculated using graphical method. Seed thickness (the maximum distance from both sides of the hilum) was calculated using vernier calliper (0-150 mm). The ratio of seed length divided by the seed width gives the seed length to width ratio. The bulk density is the ratio of mass of the sample to its total volume and was determined by subtracting the weight of cylinder from the weight of cylinder with seeds. To achieve the uniformity in bulk density, the graduated cylinder was tapped for the seeds to consolidate. The volume occupied was then noted.

$$P_b = \frac{W_s}{V_s}$$

Where,

P_b is the bulk density in g/cm^3.

W_s is the weight of the sample in g.

V_s is the volume occupied by the sample in cm^3.

In a graduated measuring cylinder, 10 ml of water was taken and known quantity of seeds (50 nos.) was added. The rise in the measuring cylinder was noticed and represented as the volume of the seeds (Mohsenin, 1986). Hundred seed weight is measured by weighing 100 seeds using weighing balance.

The statistical analysis was carried out using the statistical software STAR 2.0.1 developed by IRRI using the formula given by Panse and Sukhatme (1967). Genetic variability parameters *viz.,* genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), genetic advance and genetic advance as per cent of mean were calculated as per the formula given by Johnson *et al.* (1955). Heritability in broad sense was calculated using the method given by Lush (1940). Correlation and path analysis were carried out based on the method proposed by Dewey and Lu (1959) and was carried out by using the statistical software GENRES 7.01 developed by Pascal Intl. software solutions.

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the seed related traits of pre breeding lines (Table 1). The traits *viz.,* seed length (4.38-5.13 mm), seed width (3.30-4.08 mm), seed length width ratio (1.11-1.46), seed thickness (2.75- 3.72 mm), seed volume (0.88-2.38 ml), bulk density (0.55- 0.74 g/cm^3) and hundred seed weight (3.27-5.92 g) exhibited ample amount of variation. A total of 88 lines for seed length width ratio and 86 lines for hundred seed weight recorded mean value above the general mean for seed length width ratio (1.29) and hundred seed weight (4.44 g) (Table 2). Seed length width ratio directly depicts the seed shape. The lines exhibiting higher mean value above the general mean for seed length width ratio indicates the seed boldness.

Transgressive segregants would be helpful to determine the extent of variability produced and also to exploit the seed related traits towards improving seed yield in blackgram (Table 2). A total of 129, 112, 109, 88, 62, 54 and 7 lines exceeded the best parent VBN (Bg) 5 for seed length, seed width, seed thickness, length width ratio, hundred seed weight, seed volume and bulk density respectively and would be useful for the improvement of seed size in blackgram. The frequency distribution represents the number of individuals within a given interval. The frequency distribution was studied using the higher order statistics *viz.,* skewness and kurtosis. Skewness implies the asymmetry of the frequency distribution curve. Kurtosis measures the peakedness of the distribution (Pearson, 1905). In this study, normal distribution was observed for seed width (0.34), length width ratio (0.01), seed thickness (-0.37), seed volume (-0.16), bulk density (-0.75) and hundred seed weight (0.33) whereas positive skewness was observed for seed length (0.40). Regarding kurtosis, all the characters were observed

Table 1: Analysis of variance for seed related traits in blackgram.

Source	df	Seed length	Seed width	Length width ratio	Seed thickness	Seed volume	Bulk density	Hundred seed weight
Environment	1	0.2100*	0.2593*	0.0029*	1.1410*	22.6997*	0.6402*	34.6115*
Replication within environment	2	0.0022	0.0036	0.0003	0.0594	0.4193	0.0001	0.0408
Genotypes	188	0.0847*	0.1090*	0.0186*	0.0957*	0.3470*	0.0032*	0.8968*
Environment × Genotype	188	0.0554*	0.0759*	0.0128*	0.0665*	0.3580*	0.0029*	0.2091*
Pooled error	376	0.0048	0.0021	0.0006	0.0367	0.1520	0.0001	0.0173

*Significant at 5% level.

as mesokurtic except for the traits seed thickness and bulk density which are leptokurtic in nature (Fig 1).

In the present study, genotypic coefficient of variation ranged from 2.96 to 13.03 per cent. GCV was found to be moderate for the traits *viz.,* seed volume (13.03%) and hundred seed weight (10.55%) whereas low GCV was shown

Table 2: Coefficient of variation, heritability (broad sense), genetic advance and genetic advance as per cent of mean for different seed related traits in blackgram.

Character	VBN (Bg)5	*Vigna mungo* var *silvestris* 22/10	Mean	Number of lines above mean values	Range	PCV %	GCV %	Heritability (h^2) %	GA as per cent of mean	Transgressive segregants over VBN (Bg) 5
Seed length (mm)	4.63	3.40	4.72	90	4.38-5.13	3.16	2.96	88.11	5.73	129
Seed width (mm)	3.60	3.20	3.67	93	3.30-4.08	4.55	4.47	96.03	9.01	112
Length width ratio	1.29	1.06	1.29	88	1.11-1.46	5.40	5.21	93.13	10.35	88
Seed thickness (mm)	3.28	2.43	3.31	97	2.75-3.72	5.57	3.54	40.50	4.65	109
Seed volume (ml)	1.88	0.50	1.75	87	0.88-2.38	19.87	13.03	43.03	17.62	54
Bulk density (g/cm³)	0.72	0.59	0.67	96	0.55-0.74	4.27	4.08	91.13	8.02	7
Hundred seed weight (g)	4.64	2.15	4.44	86	3.27-5.92	10.76	10.55	96.22	21.32	62

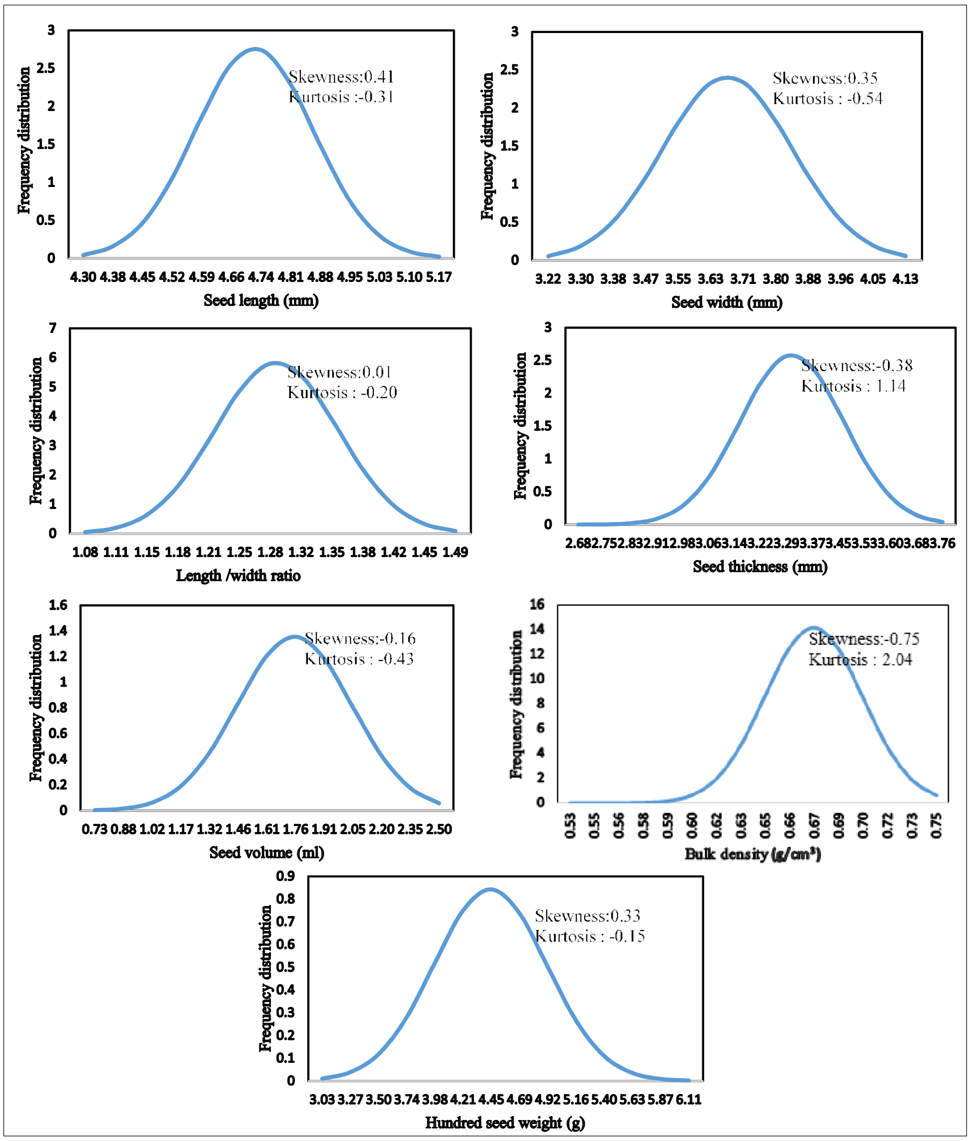

Fig 1: Frequency distribution curve for different seed related traits in blackgram.

by length width ratio (5.21%), seed width (4.47%), bulk density (4.08%), seed thickness (3.54%) and seed length (2.96%). Moderate GCV for seed width (10.64%), seed volume (19.09%) and hundred seed weight (14.42%) was observed by Latha *et al.* (2013) in horsegram. Moderate GCV for hundred seed weight (10.30%) was observed by Sulistyo *et al.* (2021) in soybean.

The trait seed width (0.08%) was observed to have the lowest difference between PCV and GCV followed by length width ratio and bulk density (0.19%). The largest difference was observed for the trait seed volume (6.84%) followed by seed thickness (2.03) which indicates higher environmental influence over these traits.

Quantitative characters are governed by polygenes and have more environmental influence naturally. Thus the observed phenotype is not entirely transmitted to further generations. Hence, it is more obvious to know the variable proportion that is heritable. The estimation of heritability value provides the transmission of variable proportions from one generation to next generation. The traits *viz.,* hundred seed weight (96.22%), seed width (96.03%), length width ratio (93.13%), bulk density (91.13%) and seed length (88.11%) were observed to have high heritability whereas seed volume (43.03%) and seed thickness (40.50%) showed moderate heritability. Heritability was high for length, width, thickness and hundred seed weight which were also observed by Sulistyo *et al.* (2021) in soybean. Gothwal *et al.* (2019) and Malik *et al.* (2011) observed high heritability for seed volume and hundred seed weight in lentil and chickpea.

High values of heritability along with genetic advance as per cent of mean indicate additive gene action where the traits could be improved through selection. In the present study, additive gene action was observed for hundred seed weight (96.22, 21.32). However, non additive gene action was also observed for seed width (96.03, 9.01), bulk density (91.13, 8.02) and seed length (88.11, 5.73). Tripati *et al.* (2012), Latha *et al.* (2013) and Gothwal *et al.* (2019) observed that seed volume and hundred seed weight had high values of heritability along with high genetic advance as per cent of mean in chickpea, horsegram and lentil respectively.

Correlation provides the idea of contribution of different seed related characters towards seed weight. The results of genotypic correlation are presented in Table 3. The traits *viz.,* bulk density, seed thickness, seed volume, seed length and seed width had significant and positive correlation with hundred seed weight suggesting that selection for the above traits will lead to indirect selection for bold seeds. The large seeds have larger endosperm which can help in the enhanced emergence ability with a larger supply of food reserve which supports earlier growth of seedlings resulting in high harvest index. Seed thickness, seed volume, seed width and seed length had significant and positive correlation with bulk density whereas, seed length, seed width and length width ratio had significant and positive correlation with seed thickness indicating the presence of sufficient amount of available food reserves which is a pre requisite for seedling development. Malik *et al.* (2011) observed that seed volume had significant and positive correlation with hundred seed weight in chickpea. Seed length, width, seed thickness and seed volume had significant and positive correlation with hundred seed weight and were also observed by Latha *et al.* (2013) in horsegram. Gupta *et al.* (2012) observed seed length and width had significant and positive correlation with hundred seed weight in castor seeds.

Table 3: Genotypic correlation coefficients among the seven seed related traits of pre breeding lines of blackgram.

	Seed length	Seed width	Length width ratio	Seed thickness	Seed volume	Bulk density	Hundred seed weight
Seed length	1.000	0.042	0.538**	0.388**	0.093	0.114*	0.353**
Seed width		1.000	-0.817**	0.139**	0.154**	0.250**	0.217**
Length width ratio			1.000	0.108**	-0.085	-0.140**	0.021
Seed thickness				1.000	0.063	0.391**	0.608**
Seed volume					1.000	0.318**	0.401**
Bulk density						1.000	0.616**
Hundred seed weight							1.000

* Significant at 5 per cent level** Significant at 1 per cent level.

Table 4: Direct and indirect effect of seven seed related traits on hundred seed weight in pre breeding lines of blackgram.

	Seed length	Seed width	Length width ratio	Seed thickness	Seed volume	Bulk density	Hundred seed weight
Seed length	0.0676	0.0052	0.0630	0.1531	0.0227	0.0409	0.353**
Seed width	0.0028	0.1270	-0.0958	0.0549	0.0377	0.0901	0.217**
Length width ratio	0.0363	-0.1038	0.1172	0.0426	-0.0207	-0.0503	0.021
Seed thickness	0.0262	0.0176	0.0126	0.3947	0.0155	0.1408	0.608**
Seed volume	0.0062	0.0195	-0.0099	0.0250	0.2454	0.1145	0.401**
Bulk density	0.0076	0.0318	-0.0164	0.1543	0.0781	0.3600	0.616**

Residual effect = 0.62.

Path analysis provides information about the direct and indirect effect of different traits towards seed yield which formulate selection criteria for developing genotypes with bold seeds. In this study, seed thickness and bulk density had high direct effect on hundred seed weight. Seed volume had moderate direct effect on hundred seed weight (Table 4).

CONCLUSION

Understanding the genetic basis of seed characteristics is the important milestone in the development of improved blackgram cultivars. Hence, the characters *viz.,* seed length, width, thickness, length width ratio, volume and bulk density contribute more for increasing the seed size which had direct impact on hundred seed weight which in turn will improve the seed yield. The extent of variability available in seed characters will provide a better scope for selection of various seed traits for industrial purpose.

Conflict of interest: None.

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