Genetic variability and character association for biometrical traits in Blackgram (*Vigna mungo* (L.) Hepper)

P. Gowsalya, D. Kumaresan*, D. Packiaraj and J.R. KannanBapu,Department of Pulses

Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore 641 003
*e-mail: dkumaresan1@rediffmail.com

Abstract
In the present investigation, eleven quantitative characters were evaluated in eighty genotypes of blackgram during *Rabi* 2014-15 seasons to assess the genetic variability and character association. The genotypes differed significantly for all the characters studied. The highest GCV recorded for number of branches per plant, seed yield per plant, number of clusters per plant, branch length, number of pods per plant and plant height. High heritability was recorded for branch length, number of branches, plant height, clusters per plant, seed yield per plant, number of pods per plant and pod length. The highest genetic advance as percent of mean was recorded for number of branches, seed yield per plant, cluster per plant, branch length, pods per plant and plant height. High heritability coupled with high genetic advance was observed for branch length, number of branches, plant height, clusters per plant, seed yield per plant and number of pods per plant. Seed yield per plant was positively and significantly correlated with pods per plant, clusters per plant, number of seeds per pod, plant height, branch length, 100 seed weight, number of branches and pod length at both phenotypic and genotypic level. The characters pods per plant, number of seeds per pod and 100 seed weight exerted high positive direct association with seed yield. Number of pods per plant showed highly positive indirect effect on seed yield via number of clusters per plant, number of branches, plant height and branch length. Hence, selection based on number of pods per plant, number of seeds per pod and hundred seed weight would result in improving the seed yield of blackgram.

Key words: Variability, heritability, genetic advance, correlation, blackgram

Introduction

Blackgram (*Vigna mungo*(L). Hepper, 2n=22), known as urdbean, is an important grain legumes for its nutritional quality and the suitability to cropping system.The major portion of blackgram is utilized in making dal, curries, soup, sweets and snacks. The food values of urdbean lie in its high and easily digestible protein. Its seeds contain approximately 25-28% protein, 1.0 -1.5% oil, 3.5 – 4.5% fiber, 4.5 – 5.5% ash and 62 – 65% carbohydrates on dry weight basis. Like other pulses, it also enriches the soil fertility, improves the soil structure and used as green fodder for cattle.Though, India is the world's largest producer of blackgram, it imports a large amount to meet the growing domestic needs. But the productivity in India is low as compared with world's average. Blackgram is grown in varying agro-ecological conditions and cropping systems with diverse cultural practices, so it needs appropriate plant type for each growing situation. The breeding progress has been slow and uneven because several desirable traits need to be combined for developing appropriate plant type for a particular growing region and cropping system. Development of high yielding varieties of crops requires information on nature and magnitude of genetic variability present in the available population, which is a pre-requisite to adopt an effective breeding programme.

Although India is the largest producer of blackgram, it productivity is lower (469 kg/ha) than the world average. One of the factors responsible for the poor productivity of blackgram is lack of stable cultivars. In any crop breeding, selection of promising plant is important. An association study gives information about the contribution of different characters towards seed yield. Seed yield is a complex trait and is influenced by number of component traits.The study on inter-relationship between the component traits and seed yield will formulate an effective and viable breeding programme for improvement of yield in a short time. Studies on correlation values indicate the intensity and direction of association of a character with yield. Path analysis identifies the yield components which directly and indirectly influence the yield. Hence, the present research work was undertaken to assess the genetic variability, correlation and path coefficients estimates of economically important plant characteristics and to

determine the characteristics contributing to seed yield in blackgram

Materials and Methods
The experimental material comprised of 80 blackgram genotypes which were raised in a Randomized Block Design with three replications at New area of Millets Breeding Station, Department of Pulses, Centre for Plant Breeding and genetics, Tamil Nadu Agricultural University, Coimbatore during *Rabi* 2014-15 season. In each replication, genotype was sown in a single row of four meter length with spacing of 30 x 10 cm. The package of practices recommended in the crop production guide was followed.   Eleven quantitative traits *viz*., days to 50% flowering, days to maturity, plant height, number of branches, branch length, pod length, number of seeds per pod, number of pods per plant, number of clusters per plant, 100 seed weight and seed yield per plant were recorded for five randomly selected plants in each of the accessions per replication. The statistical analysis and variance due to different sources was worked out according to Panse and Sukhatme (1967). Phenotypic and genotypic coefficients of variation were calculated based on the method advocated by Burton (1952). Heritability and genetic advance as per cent of mean were estimated as per formula given by Johnson *et al.* (1955).The phenotypic and genotypic correlation coefficients were calculated from phenotypic and genotypic variances and covariances and path coefficients analyses were worked out as suggested by Dewey and Lu (1959).

Results and Discussion
The analysis of variance was carried out for eleven quantitative characters and the results are presented in Table 1. The variance due to treatment was significant for all eleven characters studied. This gives the evidence of magnitude of variability among genotypes were differed significantly for all characters studied. The estimates of phenotypic coefficient of variation were higher than the corresponding genotypic coefficient of variation for all the characters which indicating that the environment factors influencing the characters studied (Table 2). This findings are in accordance with the study done by Umadevi and Ganesan (2005), Pervin *et al*., (2007), Sowmini and Jayamani (2013), Ramya *et al*., (2014) and Vinoth and Jayamani (2014). The highest PCV recorded for number of branches per plant (30.24) followed by seed yield per plant (27.04), clusters per plant (22.94), branch length (20.64) and pods per plant (20.59) suggesting that sufficient phenotypic variability was present for these traits.   The results are in agreement with

findings of Vijaya Kumar *et al*. (2015) for number of branches per plant and seed yield per plant.The highest GCV recorded for number of branches per plant (29.18) followed by seed yield per plant (25.04) and number of clusters per plant (21.44), branch length (19.96), number of pods per plant (19.03) and plant height (16.90) indicating the presence of variation for these characters and improvement could be possible through selection of these characters. Similar results are reported by Vijaya Kumar *et al*. (2015), Panigrahi *et al*. (2014) for number of branches per plant, number of clusters per plant, number of pods per plant and yield per plant.

Quantitative characters are influenced more by the environment. The phenotype observed will not be transmitted to another generation entirely. So, study on heritable portion of variability is necessary. Heritability is a good index of transmission of characters from parents to their offspring and helps us as a tool for selecting elite genotypes from diverse genetic population. It gives an exact idea of heritable portion of variability. In the present study, highest heritability was recorded for branch length (93.4), number of branches (93.0), plant height (89.2), clusters per plant (87.3), seed yield per plant (85.7), number of pods per plant (85.4) and pod length (78.1) indicating that these characters may serve as effective selection parameters during breeding programme for the improvement of blackgram productivity. Panigrahi *et al*. (2014) reported similar results for seed yield per plant, number of clusters per plant and number of pods per plant. The moderate heritability was recorded for 100 seed weight (43.7) and number of seeds per pod (43.6) indicating that selection of these characters are likely to accumulates more additive genes leading to further improvement of their performance. Similar results are reported by Vijaya Kumar *et al*. (2015).Genetic advance predicts the genetic gain under selection. Genetic advance as percentage of mean is more reliable index for understanding the effectiveness of selection in improving the traits because its estimated value is derived by involvement of heritability, phenotypic standard deviation and intensity of selection. The highest genetic advance was recorded for number of branches per plant (57.99), seed yield per plant (47.77), cluster per plant (41.28), branch length (39.76), pods per plant (36.23) and plant height (32.8).   Top priority should be given for these characters while formulating selection strategies and selection of these characters may be effective. Similar results were reported in blackgram by Vijaya Kumar *et al*. (2015) for seed yield per plant, clusters per plant and pods per plant. Moderate genetic advance as percent of mean was reported for pod

length (16.70), 100 seed weight (10.26) and number of seeds per pod (10.05). However, estimation of heritability along with genetic gain is more useful in predicting the resultant effect from selecting the best individual. In the present study, high heritability coupled with high genetic advance was observed for branch length, number of branches, plant height, clusters per plant, seed yield per plant and number of pods per plant. This indicates that most likely the heritability is due to additive gene effects and hence selection may be effective for these characters. It may be suggested that for additive effects pedigree or modified pedigree method of selection is followed.

The genotypic and phenotypic correlation coefficients among different characters of blackgram genotypes are presented in Table 3. In the present study, seed yield per plant was positively and significantly correlated with number of pods per plant, clusters per plant, number of seeds per pod, plant height, branch length, 100 seed weight, number of branches and pod length at both phenotypic and genotypic level. Similar results have been reported by Gupta *et al*.(2003) and Shivade *et al*.(2011). Positive association for pods per plant, seeds per pod and 100 seed weight was reported by Kingshlin and Vanniarajan (2000), Umadevi and Ganesan (2005), Konda *et al*. (2008). Hence, the seed yield can be improved if the characters namely number of pods per plant, clusters per plant; seeds per pod, plant height and 100 seed weight were given importance during selection process. Days to 50% flowering and days to maturity showed non-significant and positive correlation with seed yield.

Plant height exhibited high positive and significant association with 100 seed weight, clusters per plant, number of pods per plant, number of seeds per pod, pod length, number of branches and branch length. A strong positive and significant association exists between days to 50% flowering and days to maturity. A strong inter correlation was studied among clusters per plant with pods per plant, number of seeds per pod with clusters per plant and number of pods per plant. Hence, increasing the plant height would increases the number of branches and branch length which results in more number of clusters, pods and seeds per pod owing to strong positive and significant inter-correlation among them. Hence these characters can be improved through single selection programme. Pod length showed negative correlation with days to 50% flowering, days to maturity and number of branches. Seeds per pod showed negative and non significant association with days to 50% flowering and days to maturity. Negative association among yield components may be due to negative linkages

and that needs to be broken through recombinant breeding.

When more number of variables was considered in correlation, the association becomes more complex and does not have meaningful interpretation. Hence, genotypic correlation partitioned into direct and indirect effects to specify the cause and their relative importance (Table 4), the characters namely number of pods per plant, number of seeds per pod and 100 seed weight exerted high positive direct association with seed yield. Therefore selection on these characters will be useful in increasing the seed yield of blackgram. Similar results were reported by Chauhan *et al*. (2007) and Lal and Singh (2014). Days to maturity and number of cluster per plant exerted direct negative effect on seed yield. This result was similar with Panigrahi *et al.* (2014). The negative direct effect indicated that these characters had low association and selection based on these characters would not be effective. Number of pods per plant showed high positive indirect effect on seed yield *via* number of clusters per plant, number of branches, plant height and branch length. Seed yield is highly complex trait, thus indirect selection based on major component traits may increase the efficiency of breeder. The estimate of residual effect was moderate with 0.3557 which indicated the inadequacy of the characters chosen for the study. This indicates that some other characters have been left in the present study, for better understanding of the causal factors responsible for achieving high yield.

The study revealed that number of pods per plant had high direct contribution on seed yield. It was positively and significantly correlated with seed yield per plant. Selection of more number of pods per plant with more number of seeds per pod and hundred seed weight would result in improving the seed yield of blackgram

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Table 1. Analysis of variance for quantitative characters of blackgram

source	df	Mean squares										
		Days to 50% flowering	Days to maturity	Plant height	Branch length	No of branches	Pod length	Seeds per pod	Clusters per plant	Pods per plant	100 seed weight	Yield per plant
Replication	2	7.11	6.62	1.30	0.69	0.02	0.06	0.02	1.75	11.37	0.42	1.85
Treatment	79	12.27**	11.45**	104.49**	104.49**	1.20**	0.65**	0.86**	21.15**	160.85**	0.72**	31.41**
Error	158	7.63	7.48	4.03	2.36	0.02	0.05	0.26	0.97	8.67	0.21	1.64

* Significance at 5% level   ** Significance at 1% level

Table 2. Mean, range, phenotypic (PCV) and genotypic (GCV) coefficient of variation, heritability (broad sense) and genetic advance for quantitative characters in blackgram

SI.No	Characters	Mean	Range	PV	GV	EV	PCV %	GCV %	ECV%	h² (%)	GA	GA%
1	Days to 50% flowering	36.92	30.0-39.7	9.17	1.54	7.63	8.20	3.36	7.48	16.8	1.05	2.85
2	Days to maturity	66.28	61.7-69.0	8.80	1.32	7.48	4.42	1.71	4.08	15.0	0.91	1.37
3	Plant height	34.22	20.1-54.2	37.52	33.48	4.03	17.89	16.90	5.87	89.2	11.26	32.8
4	Branch length	23.58	13.2-37.7	36.40	34.04	2.36	20.64	19.96	5.26	93.4	11.62	39.76
5	No of branches	2.19	1.0-3.3	0.42	0.39	0.02	30.24	29.18	7.95	93.0	1.24	57.99
6	Pod length	4.88	3.6-7.9	0.25	0.20	0.05	10.37	9.17	4.84	78.1	0.81	16.70
7	Seeds/ pod	6.09	5.0-7.3	0.46	0.20	0.26	11.17	7.38	8.39	43.6	0.61	10.05
8	Clusters /plant	14.25	7.3-19.3	7.70	6.72	0.97	22.94	21.44	8.15	87.3	4.99	41.28
9	Pods/ plant	37.42	22-55.7	59.39	50.72	8.67	20.59	19.03	7.86	85.4	13.55	36.23
10	100 Seed weight	5.46	4.2-6.7	0.38	0.16	0.21	11.39	7.53	8.54	43.7	0.56	10.26
11	Seed yield/ plant	12.57	5.7-21.7	11.56	9.92	1.64	27.04	25.04	10.20	85.7	6.00	47.77

Table 3. Genotypic and Phenotypic correlation coefficients among the eleven characters of blackgram

S.No	Characters		Days to 50% flowering	Days to maturity	Plant height	Branch length	No of branches	Pod length	Seeds/ pod	Clusters/ plant	Pods/ plant	100 seed weight	Seed yield / plant
1	Days to 50% flowering	G	**1.0000**	1.0046**	0.1496	0.1574	0.2609**	-0.2275**	-0.0408	0.1520	0.2139	0.0516	0.1546
		P	**1.0000**	0.9880**	0.0928	0.0870	0.0967	-0.1474	-0.0256	0.0439	0.0634	-0.0164	0.0222
2	Days to maturity	G		**1.0000**	0.1532	0.1618	0.2848**	-0.1618	-0.0079	0.1625	0.2180**	0.0191	0.1515
		P		**1.0000**	0.0913	0.0852	0.0993	-0.1167	-0.0237	0.0450	0.0635	-0.0109	0.0190
3	Plant height	G			**1.0000**	1.0040**	0.2702**	0.3412**	0.3303**	0.5018**	0.4702**	0.5578**	0.6033**
		P			**1.0000**	0.9929**	0.2408**	0.2873**	0.2600**	0.4465**	0.4110**	0.3254**	0.5372**
4	Branch length	G				**1.0000**	0.2663**	0.3383**	0.3341**	0.4979**	0.4657**	0.5517**	0.5998**
		P				**1.0000**	0.2477**	0.2918**	0.2556**	0.4530**	0.4183**	0.3324**	0.5427**
5	No of branches	G					**1.0000**	-0.0897	0.2293**	0.4276**	0.4056**	0.0408	0.3877**
		P					**1.0000**	-0.0833	0.0164	0.1502	0.3882**	0.3470**	0.3309**
6	Pod length	G						**1.0000**	0.3662**	0.3527**	0.3257**	0.3944**	0.3977**
		P						**1.0000**	0.3872**	0.2900**	0.2772**	0.2653**	0.3985**
7	Seeds /pod	G							**1.0000**	0.4985**	0.4671**	0.0392	0.7161**
		P							**1.0000**	0.3031**	0.2753**	-0.0142	0.5605**
8	Clusters/ plant	G								**1.0000**	0.9503**	0.0773	0.8480**
		P								**1.0000**	0.9357**	0.2112	0.7942**
9	Pods/ plant	G									**1.0000**	0.0647	0.8738**
		P									**1.0000**	0.2129	0.8271**
10	100 seed weight	G										**1.0000**	0.4027**
		P										**1.0000**	0.3831**
11	Seed yield / plant	G											**1.0000**
		P											**1.0000**

** Significance at 1% level   P- Phenotypic correlation coefficient
* Significance at 5% level   G– Genotypic correlation coefficient

Table 4. Direct and indirect effect of ten quantitative characters on seed yield in blackgram

S. No.	Characters	Days to 50% flowering	Days to maturity	Plant height	Branch length	No of branches	Pod length	Seeds Per pod	Clusters per plant	Pods per plant	100 seed weight	Genotypic correlation with Yield
1	Days to 50% flowering	**0.2036**	0.2012	0.0189	0.0177	0.0197	-0.0300	-0.0052	0.0089	0.0129	-0.0033	0.0222
2	Days to maturity	-0.2219	**-0.2246**	-0.0205	-0.0191	-0.0223	0.0262	0.0053	-0.0101	-0.0143	0.0024	0.0190
3	Plant height	0.0020	0.0020	**0.0221**	0.0219	0.0053	0.0063	0.0057	0.0098	0.0091	0.0072	0.5372
4	Branch length	0.0080	0.0078	0.0908	**0.0914**	0.0226	0.0267	0.0234	0.0414	0.0383	0.0304	0.5427
5	No of branches	0.0036	0.0037	0.0089	0.0092	**0.0371**	-0.0031	0.0056	0.0144	0.0129	0.0006	0.3309
6	Pod length	-0.0008	-0.0006	0.0015	0.0016	-0.0004	**0.0054**	0.0021	0.0016	0.0015	0.0014	0.3985
7	Seeds/ pod	-0.0092	-0.0085	0.0932	0.0917	0.0539	0.1389	**0.3586**	0.1087	0.0987	-0.0051	0.5605
8	Clusters /plant	-0.0029	-0.0030	-0.0297	-0.0302	-0.0259	-0.0193	-0.0202	**-0.0666**	-0.0623	-0.0141	0.7942
9	Pods/ plant	0.0434	0.0434	0.2811	0.2861	0.2374	0.1896	0.1883	0.6401	**0.6841**	0.1457	0.8271
10	100 seed weight	-0.0036	-0.0024	0.0709	0.0724	0.0036	0.0578	-0.0031	0.0460	0.0464	**0.2179**	0.3831

Diagonal values indicates direct effects   Residual effect = 0.3557