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Research Note

Genetic variability, correlation and path coefficient analysis for yield and yield components in blackgram (*Vigna mungo* (L.) Hepper)

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Abstract
Nature of variation and association of seven yield component traits with yield and among themselves were studied using 112 genotypes of blackgram. Considerable variations among the genotypes were observed for all the characters under study. Heritability estimates were high for all the characters. High heritability with high genetic advance for plant height, primary branches per plant, pods per plant, 100- seed weight and yield per plant indicated additive gene action. Selection in these traits would be effective for improvement of blackgram while days to flowering showed high heritability with low genetic advance indicating nonadditive gene action. Correlation analysis indicated highly significant positive correlation between pods per plant, clusters per plant.

Key words
Blackgram, Correlation, Heritability, Variability

Blackgram [*Vigna mungo* (L.) Hepper] is an important food legume crop of Indian sub-continent although it has low productivity due to low genetic potential of the existing cultivars. The effectiveness of selection for a character depends on the amount of genetic variation present in the population. For creating genetic variability for yield and attributing characters, induced mutation is one of the potential methods. However, selection based on seed yield, a polygenically controlled complex character, is usually not much effective, rather it should be based on yield components. Knowledge of variability, heritability and genetic advance of yield and yield component traits of blackgram indicates the scope of improvement through selection (Deepalakshmi and Kumar 2004, Kumar and Mishra 2004, Veeramani *et al.* 2005). Information on correlation among yield components helps in selection of optimum character combination for yield improvement of blackgram (Kumar *et al.* 2003, Gupta *et al.*2003, Singh and Singh 2003). Path coefficient analysis, on the other hand, is an efficient statistical technique specially designed to quantify the interrelationship of different components and their direct and indirect effects on seed yield. Through this technique yield contributing characters can be ranked and specific traits producing a given correlation can be heeded.

The present study was carried out at the Department of Plant Breeding & Genetics, Agricultural College & Research Institute, Killikulam, Tamil Nadu, India from 2013- 2015. Seeds of 112 genotypes of Blackgram collected from different sources were utilized for present study. The experiment was laid out in randomized block design with two replications. Each genotype was grown in a plot of four rows of 3m length each with inter-row spacing of 30 cm and intra-row spacing of 15 cm. Recommended agronomic practices and need based plant protection measures were taken. Five randomly taken plants were considered to record data for days to 50 per cent flowering, plant height (cm), number of primary branches per plant, number of clusters per plant, number of pods per plant, pod length (cm), number of seeds per pod, 100 seed weight (g), protein content and yield per plant (g).

The data were subjected to statistical scrutiny by the usual method of analysis of variance (Panse and Sukhatme, 1967). Genotypic (GCV) and phenotypic (PCV) co-efficient of variation were calculated based on the formula advocated by Burton (1952). Heritability in broad sense was calculated according to Lush (1940) and expressed in percentage. The genetic advance (GA) as per cent of mean was classified according to Robinson *et al.* (1949). Phenotypic and genotypic correlations were worked out using the formulae suggested by Falconer (1967). The direct and indirect effect of yield attributing traits on grain yield were calculated through path co-efficient analysis as suggested by Wright (1921)

Analysis of variance (Table 1) exhibited significant differences among 112 genotypes for all the ten characters, indicating presence of considerable amount of genetic variability among the genotypes. The character plant height showed moderate PCV and GCV indicating that there is scope for improvement of this trait (Table 2). The genotypic coefficients of variation for all characters studied were lesser than phenotypic coefficient of variation indicating masking effects of environment. Higher magnitude of phenotypic coefficient variation was recorded for number of clusters per plant (30.33 %). Higher magnitude of genotypic coefficient of variation was recorded for the traits number of clusters per plant (28.18 %). that indicates the presence of exploitable genetic variability for these traits. Both the PCV and GCV estimates were lowest (4.55 and 4.48) for days to fifty percent flowering (5.95 and 4.67 %). .Similar findings had been reported by Ramya *et al*. (2014).Sowmini and Jayamani (2013) reported high PCV and GCV values for number of clusters per plant and number of pods per plant.

In the present study, all the traits showed high heritability estimates, which was based on both additive and non additive variance and the selection based on heritability alone may not be useful. Similar findings were reported by Vinoth and Jayamani (2014) for plant height, primary branches per plant, pods per plant, 100 seed weight and seed yield per plant in blackgram.Among the characters, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, hundred seed weight, protein content and seed yield per plant recorded high heritability along with high genetic advance as percentage of mean. The results were in accordance with the findings of Baisakh *et al*. (2014) and Reddy *et al*. (2011) in blackgram. High heritability with low genetic advance is observed for the character of days to fifty percent flowering. This was supported by Baisakh *et al*. (2014).

Estimation of correlation coefficients between different pair of traits under study revealed that not all traits are correlated to each other or with seed yield (Table 3). Considering the correlation between seed yield per plant and other characters, it was found that seed yield was positively and significantly correlated with number of pods per plant, plant height, number of primary branches per plant, number of clusters per plant, and hundred seed weight. This result was in close agreement with those obtained by earlier workers *viz.*, Venkatesan *et al*. (2004) and Shivade *et al*. (2011) in blackgram. Leninkumar *et al*. (2015) reported positive and significant correlation for number of pods per plant, number of primary branches per plant, number of clusters per plant, and hundred seed weight.

Days to 50% flowering exhibited high positive and significant correlation at both phenotypic and genotypic levels with plant height followed by protein content. Plant height exhibited positive and significant correlation with pod length, hundred seed weight and protein content. This was in confirmation with the findings of Rahim *et al*. (2010) for plant height in blackgram.

In the present investigation, number of pods per plant had high direct effect on seed yield per plant (Table 4). Plant height and number of primary branches had positive moderate and low direct effect on seed yield respectively. This was in accordance with the earlier findings of Srividhya *et al.* (2005 b), Punia *et al*. (2014). Among all characters, Days to 50 % flowering, number of seeds, hundred seed weight and protein content had negative direct effect. Konda *et al*. (2008) observed the similar findings for hundred seed weight and protein content in blackgram.

The number of clusters per plant exhibited positive and high indirect effects through number of pods per plant on seed yield per plant. This was similar with earlier findings of Venkatesen *et al*. (2004) and Bharthi *et al*. (2014) in blackgram. Hence, from the above finding it may be concluded that selection for number of pods per plant, number of clusters per plant and plant height should be given importance to increase the seed yield in blackgram.

The effect of residual factor over the seed yield (0.778) suggested that different characters other than the character considered in the study influence seed yield. However, there might be a few more characters other than the character studied in the present investigation, which might have been responsible to influence the seed yield. This was supported by Thippani *et al*. (2013) in green gram.

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Table 1. Analysis of variance for different characters in blackgram

S. No.	Characters	Grand mean	Genotype MSS	Error MSS	SD	CV%
1	Days to 50 % flowering	34.97	6.99**	1.66	1.87	3.69
2	Plant height (cm)	43.75	125.78**	2.56	7.90	3.66
3	No. of primary branches per plant	4.18	2.08**	0.22	1.00	11.31
4	No. of clusters per plant	5.32	4.86**	0.35	1.56	11.19
5	No. of pods per plant	27.26	109.24**	3.22	7.40	6.59
6	Pod length (cm)	4.70	0.21**	0.021	0.32	3.11
7	No. of seeds per pod	7.24	0.78**	0.14	0.60	5.34
8	100 seed weight (g)	4.69	0.99**	0.03	0.70	3.98
9	Protein content (g)	23.08	15.34**	1.00	2.76	4.34
10	Seed yield per plant (g)	7.81	4.76**	0.29	1.543	6.96

Table 2. Estimates of variability, heritability and genetic advance for blackgram genotypes

Character	PV	GV	PCV (%)	GCV (%)	h^2 (%)	GA	GA % of mean
Days to 50 % flowering	4.33	2.67	5.95	4.67	61.63	2.64	7.55
Plant height (cm)	64.17	61.61	18.31	17.94	96.00	15.84	35.82
No. of primary branches per plant	1.15	0.93	25.64	23.01	80.54	1.78	42.91
No. of clusters per plant	2.61	2.25	30.32	28.18	86.38	2.87	81.41
No. of pods per plant	56.23	53.09	27.51	26.71	94.27	14.56	53.83
Pod length (cm)	0.12	0.09	7.31	6.71	81.89	0.57	12.67
No. of seeds per pod	0.46	0.32	9.44	7.78	68.03	0.95	13.50
Hundred seed weight (g)	0.52	0.48	15.32	14.79	93.25	1.38	31.21
Protein content (g)	8.17	7.17	12.39	11.60	87.73	5.16	22.38
Seed yield per plant (g)	2.53	2.23	20.35	19.13	88.29	2.89	39.10

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Table 3. Correlation among yield and yield influencing ten quantitative traits of blackgram

Characters		Days to first flowering	Plant height	Number of primary branches per plant	Number of cluster per plant	Number of pods per plant	Pod length	Number seeds per pod	Hundred seed weight	Protein content	Seed yield per plant
Days to 50 % flowering	G	1.000	0.599**	-0.048	-0.316**	0.049	0.019	-0.135	-0.070	0.298**	-0.032
	P	1.000	0.465**	-0.053	-0.225*	0.042	0.003	-0.080	-0.050	0.275**	-0.006
Plant height	G		1.000	-0.058	-0.292**	0.078	0.254**	-0.182*	0.243**	0.209*	0.134
	P		1.000	-0.053	-0.266**	0.077	0.232**	-0.126	0.236**	0.190*	0.121
Number of primary branches per plant	G			1.000	0.474**	0.371**	-0.342**	0.585**	0.098	0.087	0.136
	P			1.000	0.402**	0.351**	-0.278**	0.546**	0.075	0.075	0.094
Number of cluster per plant	G				1.000	0.607**	-0.229*	0.456**	-0.063	-0.161	0.324**
	P				1.000	0.570**	-0.144	0.346**	-0.081	-0.141	0.286**
Number of pods per plant	G					1.000	-0.161	0.242**	0.109	0.078	0.524**
	P					1.000	-0.138	0.209**	0.101	0.059	0.488**
Pod length	G						1.000	0.095	0.024	-0.148	-0.076
	P						1.000	0.065	0.010	-0.146	-0.068
Number of seeds per pod	G							1.000	-0.058	-0.035	-0.080
	P							1.000	-0.050	-0.031	-0.076
Hundred seed weight	G								1.000	-0.021	0.029
	P								1.000	-0.007	0.026
Protein content	G									1.000	-0.121
	P									1.000	-0.109
Single plant yield	G										1.000
	P										1.000

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

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Table 4. Path coefficient analysis showing direct and indirect effects of ten quantitative traits of blackgram

Character	Days to 50 % flowering	Plant height (cm)	No.of primary branches per plant	No.of clusters per plant	No. of pods per plant	Pod length (cm)	No. of seeds per pod	100 seed weight (g)	Protein content (g)	Correlation coefficients with seed yield per plant(g)
Days to 50 % flowering	**-0.164**	0.132	-0.006	-0.020	0.026	0.000	0.042	0.008	-0.050	-0.032
Plant height (cm)	-0.098	**0.22**	-0.007	-0.018	0.041	0.006	0.056	-0.030	-0.035	0.135
No. of primary branches per plant	0.007	-0.012	**0.131**	0.030	0.197	-0.008	-0.182	-0.012	-0.014	0.137
No.of clusters per plant	0.052	-0.064	0.062	**0.063**	0.324	-0.005	-0.142	0.007	0.027	0.324
No. of pods per plant	-0.008	0.017	0.048	0.038	**0.534**	-0.003	-0.075	-0.013	-0.013	0.525
Pod length (cm)	-0.003	0.055	-0.044	-0.014	-0.085	**0.023**	-0.029	-0.002	0.025	-0.074
No. of seeds per pod	0.022	-0.040	0.076	0.028	0.129	0.002	**-0.312**	0.007	0.005	-0.083
100 seed weight (g)	0.011	0.053	0.012	-0.003	0.058	0.000	0.018	**-0.125**	0.003	0.027
Protein content (g/100g)	-0.049	0.046	0.011	-0.010	0.041	-0.003	0.010	0.002	**-0.170**	-0.122

Direct effects on Diagonal Residual effect = 0.77