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Correlation and path coefficient analysis for yield and yield components in Blackgram (*Vigna mungo* (L.) Hepper)

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Abstract
Correlation coefficient and path analysis studies were conducted for thirteen component characters including grain yield and revealed significant positive association of Grain yield had positive and highly significant association with pods per plant, 100 seed weight, grain yield per hectare, pod length, specific leaf weight observed. Further, it was found that 100 seed weight had the highest positive direct effect on grain yield followed by pod length. Hence, it would be rewarding to lay stress on these characters in selection programme for increasing the seed yield.

Keywords: Blackgram (*Vigna mungo*), correlation, path analysis

Introduction
Pulses are "nutritional powerhouse", rich in protein, high in fiber content and provide ample quantity of vitamins and minerals. Keeping in view large benefits of pulses to human health, the United Nations has proclaimed 2016 as the "International Year of Pulses". India is having the largest shares about 25% production, about 33% acreage and about 27% consuming of total pulses of the world (Arya *et al*., 2017) [2]. Black gram is a rich source of protein (20.8 to 30.5 per cent) with total carbohydrates ranging from 56.5 to 63.7 percent. It is also a good source of calcium and phosphoric acid (Asif *et al*., 2016) [3]. The major constraints in achieving higher productivity in black gram are lack of exploitable genetic variability, the absence of suitable ideotype of different cropping system and poor harvest index, susceptibility to biotic and abiotic stress, non-availability of quality seeds of improved varieties and narrow genetic base occur due to repeated usage of few parents with high degree relatedness in crossing programme (Asif *et al*., 2016) [3]. For further exploitation in breeding programs selection of suitable parents and selection of promising F1 hybrids is important. The knowledge on interrelationship of plant characters with seed yield and among themselves is of paramount importance to the breeder for making importance in the complex character like seed yield, for which direct selection is not much effective (Mathivathana *et al*., 2015) [7]. So this research effort is undertaken to ascertain the association between seed yield and its related components among sixty four different blackgram genotypes for evolving the superior high yielding ones.

Materials and Methods
In the present study, 64 genotypes of blackgram collected from different parts of the country were grown in 8 x 8 simple lattice design with two replications. Each replication consisting of three rows of three meters length with a spacing of 30 cm between rows and 10 cm between plants during *kharif* 2014 at Agriculture research Station, Bidar (Karnataka). All the recommended practices were followed to raise good crop of blackgram. Observation were recorded on five randomly selected plants from each genotype each replication for days to 50 per cent flowering, days to maturity, plant height (cm), branches per plant, cluster per plant, pods per plant, seeds per pod, pod length (cm), 100 seed weight (g), grain yield per plant (g), grain yield per hectare (kg/ha), chlorophyll content, specific leaf weight (g) and seed volume weight (g/100ml). The phenotypic and genotypic correlation coefficients were calculated from phenotypic and genotypic variances and co variances and path coefficients analyses were worked out as suggested by Dewey and Lu (1959) [4].

Results and Discussion

The phenotype of a plant was result of infection of large number of factors. Hence final yield was the sum of several component factors. Therefore, it was important to know the extent and nature of inter-relationship revealing between yield and its component characters and also among themselves. Also it necessary to know association of grain yield characters among themselves. This would be obtaining from simple correlation coefficient which helps a breeder in determining the direction and number of characters to be considers in improving yield. The present study, genotypic and phenotypic coefficient was worked out for yield characters.

The estimates of the genotypic and phenotypic correlation coefficients among 14 characters (Table 1) indicated that the genotypic correlations were higher than the corresponding phenotypic correlations. It revealed the prominence of additive and the additive x additive gene action (Falconer 1981) [5]. Correlation among yield and yield components revealed that grain yield per plant had strong positive association at genotypic and phenotypic levels with pods per plant and 100 seed weight, while pod length at genotypic level. Hence, simultaneous selection for these traits will be more reliable for deriving high yielding genotypes of blackgram. Similar results of significant positive association of grain yield per plant with pods per plant, 100 seed weight and pod length were also observed by Shivade *et al*. (2011) [12]. Contradictory reports of grain yield per plant had significant negative correlation with days to 50 per cent flowering, days to maturity at both genotypic and phenotypic level and plant height at genotypic level. Negative correlation was desirable for this trait as less number of days to flowering reduces the crop duration, this helpful in terms of economic cultivation of blackgram crop. More over it helps the crop to escape terminal drought, hence the selection can be practiced for early flowering genotypes with high seed yield to suit for scanty rain fall areas. Similar results were observed by Punia *et al*. (2014) [10]. However, in contrast to this, Om Vir and Singh (2014) [9], observed significant positive correlation between days to 50 flowering and grain yield. This positive correlation helps in selection for higher grain yield with medium duration genotypes which can suit to assured rainfall areas where moisture is not a limiting factor. Association analysis revealed that number of pods per plant, pod length and 100 seed weight were observed to be important yield contributing characters in blackgram. Hence, selection criteria should be exercised for these traits for the improvement of grain yield per plant in blackgram.

In present study, path coefficient analysis taking grain yield as dependent variable. Path analysis of grain yield was carried over involving all the characters that were correlated with yield. Path coefficient analysis revealed that the positive direct effect of pod length, 100 seed weight, grain yield per hectare and plant height relatively high. These characters also had strong positive association with grain yield, suggesting that increase in number of pods per plant, pod length and plant height would improve the grain yield of blackgram. Aijaz Ahmad *et al*. (2013) [1] and Muzibul Aloma *et al*. (2014) [8]. However, positive direct effect of chlorophyll content, seed volume weight and specific leaf weigh for grain yield. The supporting evidences lacking these traits. Whereas, negative direct effect through days to 50 per cent flowering, days to maturity, clusters per plant, pods per plant, branches per plant relatively high magnitude. These results were in conformity with findings of Reni *et al*. (2013) [11] and Singh *et al*. (2009) [13]. Further different indirect effects through plant height, days to maturity, pod length, branches per plant, clusters per plant, and pods per plant were also having considerable magnitude. Similar results were observed by Aijaz Ahmad *et al.* (2013) [1], Haritha and reddy (2012) [6]. A further negative direct effect of days to maturity was lower on grain yield but had positive indirect effect *via* branches per plant, clusters per plant and pods per plant. These results were in conformity with findings of Singh *et al*. (2009) [13]

From the present study on path coefficient analysis in blackgram, it may be concluded that improvement in grain yield per plant could be brought through by selection for component characters like pod length, 100 seed weight, plant height and grain yield per hectare. However, indirect selection through the characters like number of clusters per plant, number of pods per plant would also be effective for improvement of grain yield per plant.

Residual effect

In plant breeding, it is very difficult to have complete knowledge of all component traits of yield. The residual effect, permits precise explanation about the pattern of interaction of other possible components of yield. In other words, residual effect measures the role of other possible independent variables which were not included in the study on the dependent variables. The residual effect is estimated with the help of direct effects and simple correlation coefficients. In the present study the residual effect in 64 genotypes of blackgram for direct and indirect effects were 0.522 at phenotypic level. The residual effect is high indicates that besides the characters studied, there are some other attribute which contributes for yield.

Table 1: Phenotypic correlation co-efficient between different traits in blackgram genotypes.

Traits	DFF	DM	PHT	BPP	CPP	PPP	SPP	PL	HSW	GY (kg/ha)	CC (%)	SLW	SVW	GYPP
DFF	1	0.4850**	0.4897**	0.1009	0.0851	-0.0649	0.1789*	0.1179	0.0287	-0.1569	0.1692	0.0424	0.0704	-0.2501*
DM		1	0.4035**	-0.2463**	-0.1074	-0.1951*	0.0565	0.1552	0.1611	-0.2055*	0.2513**	-0.102	-0.1223	-0.1822*
PHT			1	-0.1388	0.2346**	-0.1192	0.1798*	0.2151*	0.1264	-0.1428	0.1588	-0.1284	-0.092	-0.1728
BPP				1	0.2160*	0.1162	0.0681	0.1383	0.153	-0.033	-0.0215	0.0902	-0.1232	0.0191
CPP					1	0.3370**	0.1101	0.1175	0.037	0.037	-0.0817	0.1236	0.059	-0.1445
PPP						1	0.126	0.1352	-0.0344	0.7471**	-0.89	0.1026	0.0797	0.2782**
SPP							1	0.0182	-0.1381	0.0044	0.1274	0.062	0.0463	-0.1275
PL								1	0.289**	0.0765	-0.0649	0.157	-0.2300**	0.1341
HSW									1	0.1645	0.0318	-0.0462	-0.1828*	0.2744**
GY(kg/ha)										1	0.0768	0.0126	0.0674	0.4981**
CC(%)											1	-0.1461	-0.0423	0.0288
SLW												1	0.0526	0.0651
SVW													1	0.0645
GYPP														1

* Significant at 5% probability ** Significant at 1% probability

Table 2: Genotypic correlation co-efficient between different traits in blackgram genotypes.

Trats	DFF	DM	PHT	BPP	CPP	PPP	SPP	PL	HSW	GY (kg/ha)	CC (%)	SLW	SVW	GYPP
DFF	1	0.5084**	0.4982**	-0.1503	0.0817	-0.0594	0.2191**	0.1529	0.016	-0.1613	0.4642**	0.0955	0.1526	-0.3222**
DM		1	0.4161**	-0.3036**	-0.1277	-0.2413**	0.0462	0.2546**	0.1937*	-0.2372**	0.5555**	-0.4826**	-0.1668	-0.2049*
PHT			1	-0.1790*	0.2460**	-0.1421	0.2105*	0.2869**	0.1313	-0.1546	0.3243**	-1.0315**	-0.1312	-0.2084*
BPP				1	0.2901**	0.1215	0.1729	0.2533**	0.1646	-0.0912	-0.1681	0.3890**	-0.1820*	-0.0329
CPP					1	0.3807**	0.1261	0.1936*	0.0417	0.0471	-0.2238	0.8719**	-0.1036	-0.1444
PPP						1	0.2005*	0.2736**	-0.0356	0.7938**	-0.1408	0.8545**	0.0625	0.4168**
SPP							1	-0.0559	-0.1729	-0.0013	0.2829**	-0.0224	0.0275	-0.1881*
PL								1	0.3978**	0.1668	-0.4959**	-0.0449	-0.3633**	0.2148*
HSW									1	0.1983*	0.1264	-0.4296**	-0.2784**	0.3236**
Y (kg/h										1	0.171	0.1758	0.049	0.6367**
CC(%)											1	-3.2740**	-0.3924**	-0.0136
SLW												1	0.5800**	0.5986*
SVW													1	0.128
GYPP														1
* Significant at 5% probability ** Significant at 1% probability														

Table 3: Direct (diagonal) and indirect effects on grain yield at phenotypic level in blackgram.

Traits	DFF	DM	PHT	BPP	CPP	PPP	SPP	PL	HSW	GY (kg/ha)	CC (%)	SLW	SVW	rp
DFF	-0.1616	-0.0784	-0.0791	0.0163	-0.0138	0.0105	-0.0289	-0.0191	-0.0046	0.0254	-0.0273	-0.0069	-0.0114	-0.2501**
DM	-0.0394	-0.0812	-0.0328	0.0200	0.0087	0.0158	-0.0046	-0.0126	-0.0131	0.0167	-0.0204	0.0083	0.0099	-0.1822*
PHT	0.0048	0.0039	0.0097	-0.0013	0.0023	-0.0012	0.0017	0.0027	0.0012	-0.0014	0.0015	-0.0012	-0.0009	-0.1728
BPP	0.0001	0.0002	0.0001	-0.0006	-0.0001	-0.0001	0.0000	-0.0001	-0.0001	0.0000	0.0000	-0.0001	0.0001	0.0191
CPP	-0.0140	0.0176	-0.0385	-0.0354	-0.1640	-0.0553	-0.0181	-0.0193	-0.0061	-0.0061	0.0134	-0.0203	0.0097	-0.1445
PPP	0.0012	0.0037	0.0023	-0.0022	-0.0064	-0.0190	-0.0024	-0.0026	0.0007	-0.0142	0.0017	-0.0020	-0.0015	0.2782**
SPP	-0.0119	-0.0038	-0.0120	-0.0045	-0.0073	-0.0084	-0.0667	-0.0012	0.0092	-0.0003	-0.0085	-0.0041	-0.0031	-0.1275
PL	0.0126	0.0166	0.0230	0.0148	0.0126	0.0145	0.0019	0.1069	0.0309	0.0082	-0.0069	0.0168	-0.0246	0.1341
HSW	0.0059	0.0331	0.0260	0.0314	0.0076	-0.0071	-0.0284	0.0595	0.2056	0.0338	0.0065	-0.0095	-0.0376	0.2744**
GY(kg/ha)	-0.0666	-0.0873	-0.0607	-0.0140	0.0157	0.3173	0.0019	0.0325	0.0699	0.4247	0.0326	0.0053	0.0286	0.4981**
CC (%)	0.0088	0.0131	0.0082	-0.0011	-0.0042	-0.0046	0.0066	-0.0034	0.0017	0.0040	0.0520	-0.0076	-0.0022	0.0288
SLW	0.0035	-0.0083	-0.0105	0.0073	0.0101	0.0084	0.0050	0.0128	-0.0038	0.0010	-0.0119	0.0814	0.0043	0.0651
SVW	0.0066	-0.0114	-0.0086	-0.0115	-0.0055	0.0074	0.0043	-0.0214	-0.0170	0.0063	-0.0039	0.0049	0.0932	0.0645
* Significant at 5% probability ** Significant at 1% probability Residual effect = 0.522 rp- correlation with grain yield per plant Bold figures represents direct effect														

Conclusion

From this study, Grain yield had positive and highly significant association with pods per plant, 100 seed weight, grain yield per hectare, pod length, specific leaf weight, whereas days to 50 per cent flowering, days to maturity plant height, number of seeds per pod had negative and highly significance correlation with grain yield. Hence, selection based on these traits would ultimately improve the grain yield. Path co-efficient analysis revealed that 100 seed weight had the highest positive direct effect on grain yield followed by pod length. Hence, it would be rewarding to lay stress on these characters in selection programme for increasing the grain yield.

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