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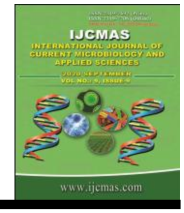

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Correlation Studies for Yield and its Components in Black Gram [*Vigna mungo* (L.) Hepper]

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Black gram is a major pulse crop and a good source of proteins and minerals. Genotypic correlation and path coefficient analysis were used to determine the effect of various traits as components of seed yield in fifty black gram genotypes. Genotypic correlations were recorded higher as compared to corresponding phenotypic correlations for majority of the traits under study indicating that there was an inherent association between these characters at genotypic level. Positive and highly significant correlation with plant height, branches per plant, clusters per plant, pods per plant, seeds per plant, pod length and straw yield; high and positive direct effect of branches per plant, pods per plant, pod length, days to maturity, straw yield and harvest index on seed yield per plant. Since, these association of characters are in the desirable direction, thus, selection practiced for the improvement in one character will automatically result in the improvement of other even though direct selection for improvement has not made for the seed yield.

Introduction

Pulses are indispensable source of protein for pre-dominantly vegetarian population of our country and they constitute a major part in our country's diet. Pulses are also known to increase the soil fertility and there by productivity of succeeding crop. Black gram [*Vigna mungo* (L.) Hepper], is very important pulse crop with somatic chromosome number 2n = 22. Black gram is also grown as fodder crop, green manure and bio agent for soil conservation. The crop also builds soil fertility by fixing about 70-90 kg nitrogen per hectare (Rathode, 2000). It is extensively grown as intercrop and mixed crop with cereals under rain fed conditions. The domestication and cultivation of staple food crop have received more attention than pulses. Pulses are being ceaselessly grown under marginal lands of low fertility and moisture stress conditions, hence genotypes are more adaptable to poor management which registers limitation on yield, this does not reflect low genetic potential but they may have higher genetic potential than cereals (Jain, 1975).

The correlation coefficient and path-coefficient analysis provide the information on the relative importance of various yield contributing characters and thus, increases the efficiency of selection for higher yields based on yield components.

Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the components characters on which selection can be based for genetic improvement of yield.

Path analysis splits the correlation coefficient into the measures of direct and indirect effects and determines the direct and indirect contribution of various characters towards yield.

Materials and Methods

The present investigation was carried out using fifty genotypes of black gram. The fifty genotypes were sown in randomized block design at the College Farm, Navsari Agricultural University, Navsari during late kharif 2018.

A spacing of 45 cm between rows and 10 cm between plants within the row was maintained.

Data was collected from five randomly selected plants tagged from each accession. Observations were recorded for thirteen quantitative traits *viz*., days to fifty percent flowering, plant height, branches per plant, clusters per plant, pods per plant, seeds per pod, pod length, 100-seed weight, seed yield per plant, days to maturity, straw yield, harvest index, and protein (%). The statistical analysis was done in windostat software to interpret the data.

The correlation coefficient was worked out to determine the degree of association of a character with seed yield and also among its components. Analysis of covariance for all possible pairs of thirteen characters was carried out using the procedure of Panse and Sukhatme (1978) for each family.

Path analysis suggested by Wright (1921) and Dewey and Lu (1959) was adopted in order to partition the genotypic correlation between variables with seed yield into direct and indirect effects of those variables on yield.

Results and Discussion

As yield is a dependent trait and is complex in inheritance due to its polygenic nature, knowledge of the extent of genetic association between different characters contributing to yield is useful in isolating the most desirable genotypes, hence estimates of phenotypic and genotypic correlations gives an idea for understanding environmental influence on heredity expression.

In the present study, genotypic correlation coefficient between thirteen pairs of traits were calculated (Table 1). Seed yield per plant had recorded a highly significant and positive correlation at both genotypic and phenotypic level with plant height, branches per plant, clusters per plant, pods per plant, seeds per pod, pod length and straw yield.

This trait had showed a significant positive correlation at genotypic level with 100-seed weight and non-significant at phenotypic level.

Seed yield per plant showed a highly significant but negative correlation at both level with days to 50% flowering. It showed a non-significant and positive correlation at both level with protein but negative with days to maturity. It had observed a significant and positive correlation with harvest index at genotypic level and highly significant at phenptypic level.

Table.1 Genotypic (r_g) and phenotypic (r_p) correlation coefficients among thirteen characters in black gram

Traits	r	DFF	PH	BP	CP	PP	SP	PL	SW	DM	SY	HI	P	SYP
DFF	r_g	**1.000**												
	r_p	**1.000**												
PH	r_g	-0.099	**1.000**											
	r_p	-0.092	**1.000**											
BP	r_g	-0.163*	0.224**	**1.000**										
	r_p	-0.124	0.197*	**1.000**										
CP	r_g	-0.134	0.065	0.567**	**1.000**									
	r_p	-0.115	0.066	0.500**	**1.000**									
PP	r_g	-0.172*	0.213**	0.707**	0.785**	**1.000**								
	r_p	-0.156	0.199*	0.639**	0.749**	**1.000**								
SP	r_g	-0.444**	0.316**	0.233**	0.351**	0.431**	**1.000**							
	r_p	-0.314**	0.200*	0.174*	0.226**	0.290**	**1.000**							
PL	r_g	-0.384**	0.576**	0.310**	0.302**	0.387**	0.755**	**1.000**						
	r_p	-0.246**	0.371**	0.253**	0.230**	0.285**	0.691**	**1.000**						
SW	r_g	-0.095	0.482**	0.242**	0.131	0.125	0.277**	0.456**	**1.000**					
	r_p	-0.089	0.449**	0.228**	0.120	0.096	0.196*	0.278**	**1.000**					
DM	r_g	0.753**	0.002	-0.116	-0.091	-0.060	-0.170*	-0.228**	-0.145	**1.000**				
	r_p	0.745**	0.003	-0.099	-0.085	-0.063	-0.110	-0.140	-0.122	**1.000**				
SY	r_g	-0.087	0.310**	0.465**	0.624**	0.710**	0.542**	0.606**	0.167*	0.100	**1.000**			
	r_p	-0.081	0.306**	0.404**	0.587**	0.670**	0.363**	0.415**	0.151**	0.097	**1.000**			
HI	r_g	-0.179*	-0.004	-0.003	-0.115	-0.144	-0.140	-0.198*	0.003	-0.358**	-0.536**	**1.000**		
	r_p	-0.159	-0.005	0.036	-0.067	-0.090	-0.048	-0.040	-0.006	-0.327**	-0.514**	**1.000**		
P	r_g	-0.128	0.287**	-0.030	-0.286**	-0.075	0.399**	0.428**	0.197*	0.044	0.176*	-0.162*	**1.000**	
	r_p	-0.112	0.282**	-0.021	-0.271**	-0.068	0.269**	0.295**	0.176*	0.045	0.173*	-0.157	**1.000**	
SYP	r_g	-0.234**	0.374**	0.606**	0.641**	0.736**	0.477**	0.562**	0.177*	-0.144	0.717**	0.170*	0.033	**1.000**
	r_p	-0.211**	0.35**	0.547**	0.615**	0.709**	0.336**	0.443**	0.147	-0.133	0.691**	0.231**	0.028	**1.000**

*, ** at 5% and 1% significance level respectively

DFF = Days to 50 % flowering; PH = Plant height (cm); BP = Branches per plant; CP = Cluster per plant
PP = Pods per plant; SP = Seeds per pod; PL = Pod length (cm); SW = 100-seed weight(g)
SYP = Seed yield per plant(g); DM = Days to maturity; SY = Straw yield (g); HI = Harvest index (%)
P = Protein (%)

Table.2 Direct and indirect effect of twelve causal variables on seed yield of black gram

Traits	DFF	PH	BP	CP	PP	SP	PL	SW	DM	SY	HI	P
DFF	**-0.051**	0.005	0.008	0.007	0.009	0.023	0.019	0.005	-0.038	0.004	0.009	0.007
PH	0.001	**-0.005**	-0.001	-0.0003	-0.001	-0.002	-0.003	-0.003	0.000	-0.002	0.000	-0.002
BP	-0.014	0.019	**0.083**	0.047	0.059	0.019	0.028	0.020	-0.010	0.039	-0.0002	-0.003
CP	0.002	-0.001	-0.010	**-0.018**	-0.014	-0.006	-0.005	-0.002	0.002	-0.011	0.002	0.005
PP	-0.012	0.015	0.051	0.056	**0.072**	0.031	0.028	0.009	-0.004	0.051	-0.010	-0.005
SP	0.054	-0.038	-0.028	-0.042	-0.052	**-0.121**	-0.091	-0.034	0.021	-0.066	0.017	-0.048
PL	-0.080	0.119	0.070	0.063	0.080	0.156	**0.207**	0.095	-0.047	0.126	-0.041	0.089
SW	0.005	-0.027	-0.014	-0.007	-0.007	-0.016	-0.026	**-0.056**	0.008	-0.009	-0.0002	-0.011
DM	0.073	0.0001	-0.011	-0.009	-0.006	-0.016	-0.022	-0.014	**0.097**	0.010	-0.035	0.004
SY	-0.086	0.306	0.458	0.616	0.701	0.535	0.598	0.165	0.099	**0.986**	-0.529	0.173
HI	-0.134	-0.003	-0.001	-0.086	-0.108	-0.105	-0.148	0.002	-0.268	-0.401	**0.748**	-0.122
P	0.007	-0.016	0.002	0.016	0.004	-0.022	-0.023	-0.011	-0.002	-0.010	0.009	**-0.055**
Correlation Coefficient	-0.234 **	0.374 **	0.606 **	0.641 **	0.736 **	0.477 **	0.562 **	0.177 *	-0.144	0.717 **	0.170 *	0.033

*and** indicate significance at significance at 5% and 1% respectively.
Residual effect: 0.1743 Bold diagonal figures are direct effect of causal factor

DFF = Days to 50 % flowering; PH = Plant height (cm); BP = Branches per plant; CP = Cluster per plant; PP = Pods per plant; SP = Seeds per pod; PL = Pod length (cm); SW = 100-seed weight(g); SYP = Seed yield per plant(g); DM = Days to maturity; SY = Straw yield (g); HI = Harvest index (%); P = Protein (%)

The result of the present study was in agreement with the findings of Makeen *et al.*, (2009) for pods per plant and days to maturity; Panigrahi and Baisakh (2014) for plant height, pods per plant and pod length; Gowsalya *et al.,* (2016) for plant height, branches per plant, clusters per plant, seeds per pod and pods per plant; Mehra *et al.*, (2016) for plant height, pods per plant and straw yield; Arya *et al.*, (2017) for clusters per plant, pods per plant, harvest index and straw yield; Kondagari *et al.,* (2017) for days to 50% flowering, days to maturity and pods per plant; Suguna *et al.*, (2017) for plant height, branches per plant, pod length, pods per plant, seeds per pod and 100-seed weight; Shamim and Pandey (2017) for straw yield.

Seed yield was considered as the reliant variable and the remaining twelve yield contributing characters were taken as independent (causal) variables. The path analysis revealed the association of these independent variables on a dependent variable (seed yield) due to their direct effect on seed yield or as consequence of their indirect effect *via* other component characters. The genotypic correlation coefficients were worked out between seed yield and each of the other twelve variables among themselves to study their direct and indirect effects on seed yield. The direct and indirect effects of these independent variables on seed yield are presented in Table 2. The results indicated that the genetic correlation was highly significant and positive for seed yield per plant and plant height, branches per plant, clusters per plant, pods per plant, seeds per pod, pod length and straw yield. Similar results were reported by Mathivathana *et al.*, (2015), Jyothsna *et al.,* (2016), Mehra *et al.*, (2016), Sohel *et al.*, (2016) and Arya *et al.*, (2017).Days to 50% flowering exhibited highly significant and negative correlation with seed yield per plant and its direct effecton seed yield per plant was found to be negative. Similar results were reported by Panigrahi and Baisakh (2014) and Arya *et al.*, (2017) for a negative direct effect of days to 50% flowering. The 100-seed weight exhibited positive and significant genotypic correlation with seed yield per plant and also showed negative direct effect on seed yield per plant. Similar result have been reported by Sohel *et al.,* (2016).The days to maturity was found to be negative and non-significant with seed yield and showed positive direct effect on seed yield per plant. Similar results were reported by Mehra *et al.,* (2016) and Arya *et al.*, (2017).The correlation between seed yield per plant and harvest index was positive and significant while the direct effect of harvest index on seed yield was found to be positive. Similar results were reported by Mathivathana *et al.*, (2015), Mehra *et al.*, (2016), Sohel *et al.*, (2016) and Arya *et al.,* (2017) for positive direct effect on seed yield per plant. Protein (%) had a positive and non-significant genetic correlation with seed yield per plant and recorded a negative direct effect on seed yield per plant. In the present study the residual effect at genotypic level was 0.1743 which suggested that there might be few more component traits responsible to influence the seed yield per plant than those studied.

In conclusion, the magnitude of genotypic correlation was recorded higher as compared to their corresponding phenotypic correlations for most of the characters, indicating the little influence of environment and the presence of inherent relationship among the characters studied. Genotypic correlation coefficient were higher than phenotypic correlation coefficients, which might be due to the masking effect of environment in the total expression of the genotypes resulting in reduced phenotypic association. On the basis of the present investigation of inter relationship, it can be presumed that for improving seed yield in black gram an ideal plant type should have traits like early maturity, high plant height, more branches per plant, higher clusters per plant, more pods per plant, seeds per pod, pod length, straw yield, harvest index and 100-seed weight. Hence, these characters could be utilized as selection criteria for improving seed yield in black gram. Seed yield is very complex character being affected by so many factors, it might not be feasible to include all the characters. Under these circumstances, provision is made for a residual path which would take care of all such factors which were excluded from such studies. For the improvement of seed yield, emphasis should be made on all yield contributing characters which are influencing it directly or indirectly. In the present study, overall picture of path analysis revealed that for improving seed yield in black gram, selection advantage should be given to straw yield, harvest index, pod length and, days to maturity.

Application of research: This research is very important as it provides basic information regarding the selection of traits for further breeding programme.

Research Category: Basic research of Genetics and Plant Breeding.

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Author agrees to submit ethical clearance certificate from the concerned ethical committee or institutional biosafety committee, if the project involves field trails/experiments/exchange of specimens, human & animal materials etc.

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