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Study of Quantitative Traits and Association for Yield and its Components in Black Gram (*Vigna mungo* (L.) Hepper) Genotypes

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A B S T R A C T

The present investigation was undertaken in 23 genotypes of blackgram [*Vigna mungo* (L.) Hepper] to study the genetic variability parameters, correlation and path analysis during *Kharif,* 2019 in Randomized Block Design with three replications. The observations were recorded for fourteen quantitative characters to study genetic variability, heritability, genetic advance, correlation and path analysis. The analysis of variance indicated significant differences among twenty three genotypes for all the characters studied. On the basis of mean performance, the highest seed yield per plant was observed for the blackgram genotypes SU-Urd-23 followed by VBN-6, SU-Urd-34 and SU-Urd-33.The estimates of PCV for all characters were higher than the estimates of GCV indicating the presence of environmental component along with genetic component. High GCV and PCV were observed for number of clusters per plant, number of pods per plant, harvest index, seed yield per plant indicating high variability for these traits. High heritability coupled with high genetic advance as per cent of mean was recorded for plant height, number of clusters per plant, number of pods per plant and harvest index. This indicates the preponderance of additive gene action and hence phenotypic selection would be more effective for further improvement of these traits. Correlation association studies revealed that the characters number of clusters per plant, number of pods per plant, number of pods per cluster, number of seeds per pod and harvest index showed significant and positive correlation with seed yield per plant indicating that selection based on these characters would bring about simultaneous improvement in the seed yield. Path analysis revealed that number of clusters per plant, number of pods per plant, number of pods per cluster and harvest index hadtrue relationship by establishing significant positive associations and positive direct effects on seed yield per plant.

Introduction

Blackgram [*Vigna mungo* (L.) Hepper] is an annual leguminous crop belongs to family Fabaceae and sub-family Papilionaceae with a chromosome number of 2n=22 (Dana, 1980) and originated from Indian continent (De Candolle, 1882, Vavilov, 1926 and Zukovskij, 1962). It is popularly known as "urdbean or mash. It is an important self-pollinating

diploid grain legume (Naga *et al.,* 2006) domesticated from *V. mungo* var. silvestris (Lukoki *et al.,* 1980).

Black gram is an economically important grain legume crop in Asia, widely cultivated on marginal lands with low inputs during Kharif, Rabi and Zaid seasons. A seed of blackgram is the most important product which is consumed in the form of dal (whole or split, husked and unhusked) or parched. Many South Indian dishes as dosa and idli have blackgram as main ingredient. The urd flour is also used in making papad and dahi-vada.

Pulses are the chief and cheapest sources of plant-based dietary protein for the vegetarian people. Protein content in pulses ranges from 20-40% as compared to 8-12% of cereals. Moreover, they are an excellent source of lysine, an essential amino acid with an average of 65 ± 7 mg/g as compared to 29 ± 7 mg/g in cereals and fairly supplies a good quantity of vitamins (thiamine, riboflavin, niacin and vitamin B6) and much needed minerals *viz.,* iron, zinc, calcium and phosphorus

India is the largest producer and consumer of blackgram, with an area about 50.31 lakhs hectares, production of 32.84 lakhs tons and productivity of 653 kg ha^{-1}. In Uttar Pradesh, it is grown in an area about 5.88 lakh hectares with a production of 3.05 lakh tons and a productivity of 520 kg ha^{-1} (Directorate Pulse Development, Ministry of Agriculture and Farmers Welfare Annual Report (2018-19)).

Seed yield is a complex trait and is the resultant product of various morphological, physiological and biological components. Hence it is important to know the genetic architecture and nature of gene action governing yield and its component traits to increase the yield per unit area. At the study of inheritance of these traits through the estimation of different genetic parameters like components of variances, genotypic and phenotypic coefficients of variability, heritability and genetic advance is helpful for framing an effective breeding programme.

Materials and Methods

The experiment was carried out in the Field Experimentation Centre of Department of Genetics and Plant Breeding, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P, India. The experimental materials for the present study consisted of 23 genotypes of black gram. The experiment was laid out in a Randomized Block Design (RBD) with three replications. The experimental material was planted in three replications. Each replication consisted of 23 genotypes randomized and replicated within each block.

The observations were recorded for fourteen quantitative characters *viz.* days to 50% flowering, days to 50% pod setting, days to maturity, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, number of pods per clusters, number of seeds per pod, pod length, 100 seed weight, biological yield per plant, harvest index, seed yield per plant.

Mean values were computed and data were analysed for analysis of variance as suggested Fisher (1936) given in table 1. Phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were given by Burton (1952). Heritability in broad sense was given by Lush (1949) and Burton and Devane (1953). Genetic advance was given by Lush (1949) and Johnson *et al.,* (1955). Correlation coefficients are estimated as suggested by Al Jibouri *et al.,* (1958) and the path analysis was calculated as suggested by Dewey and Lu (1959).

Results and Discussion

The analysis of variance carried out 14 quantitative characters revealed significant differences among the genotypes for all the characters (Table 1). Hence it was concluded that there is scope for ample genetic variation among the genotypes under study and further statistical analysis was carried out. On the basis of mean performance, the highest seed yield per plant was observed for the blackgram genotypes SU-Urd-23 followed by VBN-6, SU-Urd-34 and SU-Urd-33.

The PCV was higher than GCV for all the characters under study which indicated that the environmental factors influencing the characters studied. High GCV was recorded for number of clusters per plant (30.944), number of pods per plant (23.207) and harvest index (22.023). Moderate GCV was recorded for plant height (19.89), number of branches per plant (12.762), number of pods per cluster (13.343) and seed yield per plant (16.971). Low GCV was recorded was recorded for days to 50% flowering (7.929), days to 50% Pods Setting (7.191), days to maturity (5.608), number of seeds per pod (5.753), pod length (4.734), 100 seed weight (5.429) and biological yield per plant (8.417) (Table 2).

The phenotypic coefficient of variation (PCV) ranged from 5.732% for 100 seed weight to 33.056% number of clusters per plant. The PCV estimates would show that the phenotypic variability was low (below 10%) for days to 50% flowering (8.711), days to 50% Pods Setting (7.848), days to maturity (6.178), number of seeds per pod (8.019), pod length (8.273), 100 seed weight (5.732) and biological yield per plant (9.636). High PCV (>20%) for plant height (20.277), number of branches per plant (21.569), number of clusters per plant (33.056), number of pods per plant (26.615) number of pods per cluster (22.781), harvest index (25.61) and seed yield

per plant (24.528) (Table 2). High phenotypic and genotypic coefficients of variability were observed for number of clusters per plant, number of pods per plant, harvest index, seed yield per plant indicating high variability for these traits. Moderate to low coefficients of variability was noticed for remaining traits revealing the presence of moderate variability.

The estimates of heritability (%) in the broad sense for 14 characters studied, which range from 32.74 to 96.222%. High heritability (broad sense) was recorded for characters i.e., plant height (96.222%), days to 50% flowering (82.855), days to 50% Pods Setting (83.959), days to maturity (82.376), number of clusters per plant (87.631), number of pods per plant (76.03), 100 seed weight (89.691), biological yield per plant (76.297) and Harvest index (73.948). Moderate heritability (broad sense) was recorded for character number of branches per plant (35.011), number of pods per cluster (34.307), number of seeds per pod (51.471), pod length (32.74) and seed yield per plant (47.871).

In the present study, the GA as % of mean ranged from 5.58% (pod length) to 59.673% (number of clusters per plant). It was low (below 10%) for plant height (5.58%), number of seeds per pod (8.503) and moderate GA as % of mean (10-20) for days to 50% flowering (14.867), days to 50% Pods Setting (13.574), days to maturity (10.484), number of branches per plant (15.556), number of pods per cluster (16.1), 100 seed weight (10.591), biological yield per plant (15.146). While high GA as % of mean (above 20%) recorded in plant height (40.192), number of clusters per plant (59.673), number of pods per plant (41.685), harvest index (39.012), seed yield per plant (24.188). High heritability coupled with high genetic advance as per cent of mean was recorded for plant height, number of clusters

per plant, number of pods per plant and harvest index which is indicative of the fact that, there is lesser influence of the environment in expression of these characters and prevalence of additive gene action in their inheritance, hence they are amenable for simple selection. A high genetic gain can be achieved from phenotypic selection.

Genotypic correlation between seed yield per plant and other characters showed the positive significant genotypic association with number of clusters per plant (0.820**), number of

pods per plant (0.750**), number of pods per cluster (0.650**), number of seeds per pod (0.470**) and harvest index (0.857**).

Phenotypic correlation between seed yield per plant and other characters showed the positive significant genotypic association with number of clusters per plant (0.665**), number of pods per plant (0.719**), number of pods per cluster (0.338**), number of seeds per pod (0.358**), pod length (0.419**) and harvest index (0.798**) (Table 3–5).

Table.1 Analysis of variance for seed yield and its components in Black gram

Characters	Replication	Treatment	Error
	(df=2)	(df=22)	(df=48)
Days to 50% flowering	5.261	39.03**	2.518
Days to 50% Pods Setting	6.971	46.838**	2.804
Days to maturity	6.971	44.858**	2.986
Plant height (cm)	0.884	271.399**	3.509
Number of branches per plant	0.4805	0.355**	0.136
Number of clusters per plant	1.8965	69.981**	3.145
Number of pods per plant	0.0395	101.557**	9.658
Number of pods per cluster	0.689	0.305**	0.119
Number of seeds per pod	0.086	0.44**	0.105
Pod length (cm)	0.836	0.161**	0.065
100 seed weight (g)	0.0065	0.143**	0.005
Biological yield/plant (g)	0.2655	6.541**	0.614
Harvest index (%)	2.046	190.227**	19.991
Seed yield/plant (g)	0.126	3.906**	1.04

** Significance at 1% level

Table.2 Genetic parameters for 14 characters of 23 blackgram genotypes

Characters	Grand Mean	GCV (%)	PCV (%)	Heritability (%)	Genetic Advance	Genetic Advance as % of Means
Days to 50% flowering	44.00	7.929	8.711	82.855	6.542	14.867
Days to 50% Pods Setting	53.28	7.191	7.848	83.959	7.232	13.574
Days to maturity	66.62	5.608	6.178	82.376	6.985	10.484
Plant height (cm)	47.51	19.89	20.277	96.222	19.095	40.192
Number of branches per plant	2.12	12.762	21.569	35.011	0.33	15.556
Number of clusters per plant	15.25	30.944	33.056	87.631	9.102	59.673
Number of pods per plant	23.85	23.207	26.615	76.03	9.942	41.685
Number of pods per cluster	1.87	13.343	22.781	34.307	0.301	16.1
Number of seeds per pod	5.81	5.753	8.019	51.471	0.494	8.503
Pod length (cm)	3.77	4.734	8.273	32.74	0.21	5.58
100 seed weight (g)	3.948	5.429	5.732	89.691	0.418	10.591
Biological yield/plant (g)	16.699	8.417	9.636	76.297	2.529	15.146
Harvest index (%)	34.205	22.023	25.61	73.948	13.344	39.012
Seed yield/plant (g)	5.759	16.971	24.528	47.871	1.393	24.188

Table.3 Genotypic and phenotypic correlation coefficients of Black gram genotypes

Characters		DP50	DM	PH	PB	CPP	PPP	PPC	SPP	PL	HSW	BY	HI	GY
Days to 50% flowering	G	0.790**	0.786**	0.214NS	0.054NS	-0.324**	-0.191NS	-0.699**	0.506**	-0.085NS	-0.183NS	0.147NS	-0.143NS	-0.125NS
	P	0.808**	0.798**	0.205NS	0.007NS	-0.268*	-0.129NS	-0.382**	0.285*	0.010NS	-0.144NS	0.104NS	-0.109NS	-0.073NS
Days to 50% Pods Setting	G		0.901**	-0.159NS	-0.108NS	-0.249*	-0.150NS	-0.609**	0.562**	0.363**	-0.232NS	-0.217NS	0.157NS	0.060NS
	P		0.993**	-0.130NS	-0.060NS	-0.208NS	-0.099NS	-0.362**	0.330**	0.272*	-0.184NS	-0.171NS	0.139NS	0.057NS
Days to maturity	G			-0.158NS	-0.149NS	-0.237*	-0.143NS	-0.597**	0.521**	0.344**	-0.245*	-0.230NS	0.164NS	0.064NS
	P			-0.130NS	-0.066NS	-0.192NS	-0.087NS	-0.338**	0.318**	0.266*	-0.186NS	-0.175NS	0.143NS	0.071NS
Plant height (cm)	G				-0.512**	0.148NS	0.145NS	0.144NS	-0.258*	-0.463**	-0.339**	0.844**	-0.353**	0.076NS
	P				-0.240*	0.135NS	0.127NS	0.063NS	-0.178NS	-0.270*	-0.311**	0.736**	-0.300*	0.048NS
Number of branches/plant	G					-0.223NS	-0.441**	-0.908**	0.072NS	0.269*	0.532**	-0.400**	-0.070NS	-0.454**
	P					-0.062NS	-0.133NS	-0.225NS	0.199NS	-0.025NS	0.329**	-0.203NS	0.042NS	-0.057NS
Number of clusters/plant	G						0.449**	0.455**	-0.141NS	-0.185NS	-0.272*	0.010NS	0.726**	0.820**
	P						0.477**	0.320**	-0.076NS	-0.097NS	-0.234NS	-0.039NS	0.678**	0.665**
Number of pods/plant	G							0.392**	-0.133NS	-0.104NS	-0.439**	0.316**	0.470**	0.750**
	P							0.397**	-0.038NS	-0.019NS	-0.324**	0.202NS	0.546**	0.719**
Number of pods/cluster	G								-0.622**	-0.694**	-0.220NS	0.181NS	0.033NS	0.650**
	P								-0.202NS	-0.318**	-0.059NS	0.034NS	0.133NS	0.338**
Number of seeds/pod	G									0.552**	-0.123NS	-0.242*	0.259*	0.470**
	P									0.111NS	-0.071NS	-0.147NS	0.192NS	0.358**
Pod length (cm)	G										-0.052NS	-0.345**	0.320**	-0.374**
	P										-0.080NS	-0.217NS	0.158NS	0.419**
100 seed weight (g)	G											-0.569**	-0.098NS	-0.387**
	P											-0.467**	-0.030NS	-0.198NS
Biological yield/plant (g)	G												-0.404**	0.072NS
	P												-0.385**	0.003NS
Harvest index (%)	G													0.857**
	P													0.798**

G = Genotypic correlation coefficient. P = Phenotypic correlation coefficient. *Significant at 5% level, **Significant at 1% level

Table.4 Direct and indirect effects between yield and its related traits in 23 Black gram genotypes at genotypic level

Characters	DF50	DP50	DM	PH	PB	CPP	PPP	PPC	SPP	PL	HSW	BY	HI
Days to 50% flowering	**0.39691**	0.73649	-0.62072	0.00384	0.0033	-0.12971	-0.06164	-0.2816	-0.06778	-0.0281	-0.04422	0.04338	-0.07495
Days to 50% Pods Setting	0.3136	**0.93214**	-0.79027	-0.00286	-0.00657	-0.0998	-0.04838	-0.24551	-0.07526	0.12048	-0.05593	-0.0642	0.08237
Days to maturity	0.31191	0.93261	**-0.78988**	-0.00283	-0.00907	-0.09508	-0.046	-0.24046	-0.0698	0.11394	-0.05908	-0.06803	0.08577
Plant height (cm)	0.0851	-0.14841	0.12482	**0.01793**	-0.03109	0.05926	0.04675	0.05784	0.0346	-0.15363	-0.08198	0.24944	-0.18469
Number of branches/plant	0.02154	-0.10088	0.1179	-0.00918	**0.06075**	-0.08931	-0.14223	-0.36564	-0.00963	0.08906	0.1284	-0.11834	-0.03674
Number of clusters/plant	-0.12852	-0.23222	0.18747	0.00265	-0.01354	**0.40059**	0.1448	0.18331	0.01893	-0.06147	-0.06578	0.00308	0.38027
Number of pods/plant	-0.07587	-0.13987	0.11268	0.0026	-0.0268	0.17989	**0.32245**	0.15789	0.01776	-0.03439	-0.10595	0.09352	0.24592
Number of pods/cluster	-0.27741	-0.56801	0.47143	0.00257	-0.05513	0.18227	0.12637	**0.4029**	0.08332	-0.23004	-0.05319	0.05346	0.01719
Number of seeds/pod	0.20082	0.52371	-0.41156	-0.00463	0.00437	-0.0566	-0.04276	-0.2506	**-0.13396**	0.18309	-0.02961	-0.07144	0.13584
Pod length (cm)	-0.03363	0.33862	-0.27136	-0.00831	0.01631	-0.07424	-0.03343	-0.27945	-0.07395	**0.33166**	-0.01245	-0.10191	0.16759
100 seed weight (g)	-0.07265	-0.2158	0.19317	-0.00609	0.03229	-0.10908	-0.14142	-0.08872	0.01642	-0.0171	**0.24158**	-0.16831	-0.05144
Biological yield/plant (g)	0.05823	-0.20238	0.18172	0.01513	-0.02431	0.00417	0.10198	0.07284	0.03237	-0.1143	-0.13751	**0.29569**	-0.21164
Harvest index (%)	-0.05682	0.14665	-0.12939	-0.00633	-0.00426	0.29095	0.15145	0.01322	-0.03476	0.10616	-0.02374	-0.11953	**0.52357**

Residual Effect = 0.07888

Table.5 Direct and indirect effects between yield and its related traits in 23 Black gram genotypes at phenotypic level

Characters	DF50	DP50	DM	PH	PB	CPP	PPP	PPC	SPP	PL	HSW	BY	HI
Days to 50% flowering	**-0.00138**	-0.20086	0.3002	0.02565	0.00054	-0.00251	-0.02249	-0.07492	-0.03058	0.00054	-0.00488	0.02292	-0.08566
Days to 50% Pods Setting	-0.00111	**-0.24845**	0.37358	-0.01629	-0.00445	-0.00195	-0.01726	-0.07099	-0.03537	0.0149	-0.0062	-0.03785	0.10894
Days to maturity	-0.0011	-0.24677	**0.37612**	-0.01633	-0.00491	-0.0018	-0.0152	-0.06629	-0.03412	0.01458	-0.00628	-0.03862	0.11183
Plant height (cm)	-0.00028	0.0323	-0.04903	**0.12532**	-0.01777	0.00127	0.02214	0.01228	0.01913	-0.01479	-0.0105	0.16252	-0.23492
Number of branches/plant	-0.00001	0.01492	-0.02492	-0.03002	**0.07418**	-0.00058	-0.02335	-0.04407	-0.02139	-0.00139	0.01112	-0.04485	0.03302
Number of clusters/plant	0.00037	0.05175	-0.07231	0.01693	-0.00458	**0.00936**	0.08339	0.06278	0.00814	-0.00531	-0.00792	-0.00863	0.53126
Number of pods/plant	0.00018	0.02451	-0.03267	0.01586	-0.0099	0.00446	**0.17496**	0.07802	0.00406	-0.00104	-0.01094	0.04453	0.4273
Number of pods/cluster	0.00053	0.08985	-0.12701	0.00784	-0.01665	0.00299	0.06954	**0.1963**	0.02172	-0.0174	-0.002	0.00747	0.10434
Number of seeds/pod	-0.00039	-0.08193	0.11962	-0.02234	0.01479	-0.00071	-0.00662	-0.03975	**-0.10728**	0.0061	-0.00239	-0.03234	0.15036
Pod length (cm)	-0.00001	-0.06766	0.1002	-0.03388	-0.00188	-0.00091	-0.00332	-0.06243	-0.01196	**0.05472**	-0.00269	-0.04792	0.12401
100 seed weight (g)	0.0002	0.04561	-0.06993	-0.03893	0.02442	-0.00219	-0.05665	-0.01163	0.00758	-0.00435	**0.03379**	-0.10309	-0.02319
Biological yield/plant (g)	-0.00014	0.0426	-0.06581	0.09228	-0.01507	-0.00037	0.0353	0.00665	0.01572	-0.01188	-0.01578	**0.22071**	-0.30156
Harvest index (%)	0.00015	-0.03456	0.05371	-0.0376	0.00313	0.00635	0.09547	0.02616	-0.0206	0.00866	-0.001	-0.085	**0.78306**

Residual Effect = 0.16582

Correlation association studies revealed that the characters number of clusters per plant, number of pods per plant, number of pods per cluster, number of seeds per pod and harvest index showed significant and positive correlation with seed yield per plant indicating that selection based on these characters would bring about simultaneous improvement in the seed yield.

Path analysis revealed that number of clusters per plant, number of pods per plant, number of pods per cluster and harvest index had true relationship by establishing significant positive associations and positive direct effects on seed yield per plant. Considering the nature and magnitude of character association and their direct and indirect effects, it can be inferred that improvement of seed yield per plant is possible through simultaneous selection of these traits. The residual effect permits precise explanation about the pattern of interaction of other possible components of yield and in the present study, the residual effect is 0.07888 indicating that the characters included in present investigation had contributed around 93 per cent of variability pertaining to the dependent variable i.e., seed yield per plant.

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