



Research Article

EVALUATION OF F4 GENERATION OF BLACK GRAM FOR MATURITY AND YIELD COMPONENTS (*Vigna mungo* L. Hepper)

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Abstract: The present investigation on variability parameters, correlation and path analysis for different characteristics in germplasm of black gram [*Vigna mungo* (L.)] was undertaken during Summer-2019. Evaluation of 30 genotypes revealed moderate genetic advance as % of mean for no. of primary branches/plant, and grain yield per plant, therefore, selection may be effective for these characters. Number of branches per plant, number of pods per plant, number of seeds per pod at genotypic as well as phenotypic level showed positive significant correlation with seed yield per plant. Days to 50% flowering, number of branches per plant, 100 seed weight, harvest index showed positive direct effect on seed yield per plant at phenotypic and genotypic level.

Keywords: Black gram, Variability, Heritability, Genetic advance, Correlation coefficient, Path analysis

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Introduction

Black gram [*Vigna mungo* (L.) Hepper] is an economically important short duration grain legume characterized by relatively more palatable, nutritive, cheap source of high quality and easily digestible protein, non-flatulent than other pulses and constitute an important source of cereal based diets in Asia. It belongs to the family Fabaceae and sub family Papilionaceae and contains $2n=2x=22$ chromosomes in its somatic cells. The centre of origin of black gram is India. *Vigna radiate* var. *sublobata* is considered to be the probable progenitor of black gram (Vavilov, 1957). In India, black gram is grown over an area of 50.31 million hectares with an average production of 32.84 million tonnes with an average productivity of 655 kg/ha. In the state of Uttar Pradesh, black gram is grown over an area of 5.88 million hectares with an average production of 3.05 million tonnes with an average productivity of 520kg/ha (Directorate pulse development, Ministry of agriculture & farmers welfare-2017). Heritability estimates along with genetic advance are fairly helpful in predicting the grain under selection and in formulating suitable selection procedures. Knowledge of correlation between yield and its component traits may be helpful in selection of suitable plant type. For obtaining the information on actual contribution of each character to yield, it is necessary to partition the correlation into direct and indirect effects through path analysis. Therefore, correlation in association with path analysis would help in identifying suitable selection criteria for improving the yield. Hence, the present investigation will be undertaken to characterize the germplasm accessions, to assess the variability and to determine the interrelationship among yield and its contributing characters in black gram [1].

Material and Methods

The present experiment was carried out at 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 during Summer-2019. The experimental field was divided into 3 blocks of equal size and each row containing single genotype. The spacing of 30 cm within rows and 10 cm between the plants was followed.

All recommended agronomical cultural practices were carried out to raise a good crop. Observation were recorded based on five randomly selected plants in each genotype in each replication for all important characters viz., plant height (cm), number of primary branches per plant, number of clusters per plant, number of pod per plant, pod length (cm), number of seed per pod, 100seed weight (g), harvest index (%), biological yield (g) and seed yield per plant (g) except days to 50% flowering, days to 50% pod setting and days to maturity where the observations recorded on plot basis.

Result and Discussion

Analysis of variance indicated significant difference among the genotypes for all the traits [Table-1]. The mean sum of square due to the genotypes were significant for all the characters studied ($\alpha=0.001$), except days to 50% pod setting, harvest index shown significance difference at ($\alpha=0.005$) These findings of mean sum of squares are in accordance with the earlier findings where significant variability for yield and its components in Black gram was observed.

In the present investigation, as expected, the PCV estimates were higher than the GCV estimates. Among the 13 quantitative characters GCV ranged from 1.109% to 10.883%. The GCV estimates showed the genotypic variability was low (below 10%) for days to 50% flowering (1.858), days to 50% pod setting (1.109), days to maturity (1.538), plant height (cm) (3.963), no. of primary branches/plant (9.232), no. of clusters per plant (7.312), no. of pods per plant (3.22), pod length (cm) (3.117), no. of seeds per pod (7.243), biological yield (g) (6.618), and harvest index (%) (4.046). Moderate GCV (>10) was recorded for 100-seed weight (10.883) and grain yield (10.108).

The PCV ranged from 2.043% to 19.016%. The PCV estimates showed the phenotypic variability was low for days to 50% flowering (2.832), days to 50% pod setting (2.321), days to maturity (2.043), plant height (cm) (6.064), no. of pods per plant (5.321), pod length (cm) (5.435), biological yield (g) (9.14), and harvest index (%) (8.486). Moderate PCV (>10) was recorded for 100-seed weight (19.016) followed by grain yield per plant (14.866), seeds per pod (12.515), No. of clusters per plant (11.404) and number of primary branches per plant (11.156).

Table-1 Mean Sum of Squares for different characters in Black gram (Summer 2019)

SN	Character	Mean Sum of Squares		
		Replication (d.f=2)	Treatment (d.f=29)	Error (d.f=58)
1	Days to 50% flowering	6.13	2.78 **	0.85
2	Days to 50% Pod setting	2.87	2.35*	1.25
3	Days to Maturity	6.21	4.27**	0.87
4	Plant height (cm)	3.92	10.27**	3.18
5	No. of primary branches/plant	0.06	0.37 **	0.05
6	No. of clusters per plant	0.32	1.45**	0.47
7	No. of pods per plant	1.65	3.11**	1.14
8	Pod length (cm)	0.11	0.07**	0.03
9	No. of seeds per pod	0.56	0.84**	0.33
10	100seed weight (g),	0.05	0.92**	0.38
11	Biological yield (g)	0.17	9.37**	2.18
12	Harvest Index (%)	4.31	6.03*	3.20
13	Seed yield per plant (g)	0.025	1.02**	0.287

Table-2 Genetic parameters for 13 different characters in black gram (Summer-2019)

Characters	GCV	PCV	Heritability % (Broad sense)	GA	GA as % mean
Days to 50% flowering	1.858	2.832	43.059	1.085	2.512
Days to 50% pod setting	1.109	2.321	22.809	0.597	1.091
Days to maturity	1.538	2.043	56.685	1.654	2.386
Plant height	3.963	6.064	42.699	2.071	5.334
No. of primary branches per plant	9.232	11.156	68.473	0.558	15.737
Clusters per plant	7.312	11.404	41.112	0.756	9.658
Pods per plant	3.222	5.321	36.666	1.013	4.019
Pod length	3.117	5.435	32.882	0.14	3.681
Seeds per pod	7.246	12.515	33.521	0.49	8.642
100-seed wt.	10.883	19.016	32.752	0.504	12.83
Biological yield per plant	6.618	9.14	52.424	2.31	9.87
Harvest index	4.046	8.486	22.728	0.953	3.973
Seed yield per plant	10.108	14.866	46.228	0.696	14.157

Table-3 Correlation coefficient between yield and its related traits in 30 Black gram genotypes at Genotypic level

Character	Days to 50% Flowering	Days to 50% Pods Setting	Days to Maturity	Plant Height	Number of Primary branches Per Plant	Number of Clusters Per Plant	Number of Pods Per Plant	Number of Seeds Per Pod	Pod Length	100 Seed Weight	Biological Yield	Harvest Index	Seed Yield Per Plant (g)
Days to 50% Flowering	1	0.414*	-0.151 ^{NS}	-0.160 ^{NS}	0.065 ^{NS}	-0.032 ^{NS}	0.107 ^{NS}	0.402*	0.360*	-0.051 ^{NS}	0.071 ^{NS}	0.022 ^{NS}	-0.356*
Days to 50% Pods Setting		1	-0.314*	-0.433*	0.193 ^{NS}	-0.337*	-0.153 ^{NS}	0.231*	0.677*	0.224*	0.087 ^{NS}	0.087 ^{NS}	-0.472*
Days to Maturity			1	0.630*	-0.123 ^{NS}	0.018 ^{NS}	0.148 ^{NS}	0.110 ^{NS}	-0.348*	-0.350**	-0.048 ^{NS}	0.094 ^{NS}	-0.316*
Plant Height				1	-0.379*	0.503*	0.060 ^{NS}	0.320*	0.027 ^{NS}	-0.184 ^{NS}	0.328*	0.054 ^{NS}	0.054 ^{NS}
Number of Primary branches /Plant					1	-0.228*	-0.174 ^{NS}	-0.696*	0.455*	-0.408*	0.245*	0.440*	0.209*
Number of Clusters Per Plant						1	0.599*	0.556*	-0.051 ^{NS}	0.155 ^{NS}	0.255*	0.271**	0.064 ^{NS}
Number of Pods Per Plant							1	0.128 ^{NS}	-0.706*	-0.154 ^{NS}	0.059 ^{NS}	0.024 ^{NS}	0.480*
Number of Seeds Per Pod								1	0.014 ^{NS}	0.304*	-0.340*	-0.214*	-0.230*
Pod Length									1	0.189 ^{NS}	-0.002 ^{NS}	-0.086 ^{NS}	0.225*
100 Seed Weight										1	0.105 ^{NS}	-0.193 ^{NS}	0.136 ^{NS}
Biological Yield											1	1.007**	0.057 ^{NS}
Harvest Index												1	0.188 ^{NS}

Table-4 Correlation coefficient between yield and its related traits in 30 black gram genotypes at phenotypic level

Character	Days to 50% Flowering	Days to 50% Pods Setting	Days to Maturity	Plant Height	Number of Primary branches /Plant	Number of Clusters Per Plant	Number of Pods Per Plant	Number of Seeds Per Pod	Pod Length	100 Seed Weight	Biological Yield	Harvest Index	Seed Yield Per Plant
Days to 50% Flowering	1	0.854**	0.030 ^{NS}	-0.057 ^{NS}	0.037 ^{NS}	0.043 ^{NS}	0.002 ^{NS}	0.129 ^{NS}	-0.043 ^{NS}	-0.035 ^{NS}	0.105 ^{NS}	0.065 ^{NS}	-0.215*
Days to 50% Pods Setting		1	-0.038 ^{NS}	-0.091 ^{NS}	-0.065 ^{NS}	-0.065 ^{NS}	-0.083 ^{NS}	0.059 ^{NS}	-0.104 ^{NS}	-0.073 ^{NS}	0.065 ^{NS}	0.048 ^{NS}	-0.312*
Days to Maturity			1	0.328*	-0.055 ^{NS}	-0.009 ^{NS}	0.120 ^{NS}	0.033 ^{NS}	-0.059 ^{NS}	-0.138 ^{NS}	-0.013 ^{NS}	0.036 ^{NS}	-0.203 ^{NS}
Plant Height				1	-0.133 ^{NS}	0.159 ^{NS}	0.159 ^{NS}	0.290*	-0.098 ^{NS}	-0.088 ^{NS}	0.045 ^{NS}	0.134 ^{NS}	-0.130 ^{NS}
Number of Branches/Plant					1	-0.207 ^{NS}	-0.114 ^{NS}	-0.373*	0.238*	-0.086 ^{NS}	0.192 ^{NS}	0.243*	0.243*
Number of Clusters Per Plant						1	0.376*	0.260*	0.045 ^{NS}	0.154 ^{NS}	0.068 ^{NS}	0.043 ^{NS}	0.283*
Number of Pods Per Plant							1	0.023 ^{NS}	-0.168 ^{NS}	-0.182 ^{NS}	0.060 ^{NS}	0.010 ^{NS}	0.227*
Number of Seeds Per Pod								1	-0.093 ^{NS}	0.106 ^{NS}	-0.132 ^{NS}	-0.105 ^{NS}	-0.142 ^{NS}
Pod Length									1	0.244*	0.017 ^{NS}	0.067 ^{NS}	0.304*
100 Seed Weight										1	-0.057 ^{NS}	-0.104 ^{NS}	0.097 ^{NS}
Biological Yield											1	0.706*	-0.045 ^{NS}
Harvest Index												1	0.040 ^{NS}

Table-5 Direct and indirect effects between yield and its related traits in 30 Black gram genotypes at genotypic level

Character	Days to 50% Flowering	Days to 50% Pods Setting	Days to Maturity	Plant Height	Number of Primary branches Per Plant	Number of Clusters Per Plant	Number of Pods Per Plant	Number of Seeds Per Pod	Pod Length	100 Seed Weight	Biological Yield	Harvest Index	Seed Yield Per Plant
Days to 50% Flowering	0.1714	-0.65559	0.07009	-0.03914	0.07197	-0.02284	-0.08238	-0.22825	-0.55176	-0.04503	-0.04752	0.00263	-0.356
Days to 50% Pods Setting	0.18784	-0.64651	0.14619	-0.10578	0.21159	-0.24265	0.11778	-0.13116	-1.03847	0.16995	-0.15074	0.01024	-0.472
Days to Maturity	-0.17637	0.20304	-0.46552	0.20304	-0.13502	0.01271	-0.11343	-0.06227	0.53304	-0.30976	0.03231	0.01107	-0.316
Plant Height	-0.18782	0.28015	-0.29335	0.24412	-0.41667	0.3622	-0.04619	-0.18183	-0.04137	0.17248	0.12409	0.03855	0.054
Number of Branches Per Plant	0.07671	-0.12448	0.0572	-0.09255	0.69898	-0.16421	0.13376	0.39502	-0.69799	-0.36046	-0.16517	0.05174	0.209
Number of Clusters Per Plant	-0.03719	0.21806	-0.00823	0.1229	-0.25084	0.71943	-0.4595	-0.31553	0.07772	0.13705	-0.1714	0.03181	0.064
Number of Pods Per Plant	0.1257	0.09919	-0.06879	0.01469	-0.19148	0.43063	-0.76768	-0.07245	0.08289	-0.13593	-0.03985	0.00281	0.48
Number of Seeds Per Pod	0.47103	-0.14938	-0.05107	0.0782	-0.76479	0.39991	-0.09798	-0.56763	-0.02084	0.26857	0.22901	-0.02511	-0.23
Pod Length	0.4216	-0.43794	0.16186	0.00689	0.50036	-0.03647	0.54226	-0.00772	-0.53306	0.16703	0.00102	-0.01007	0.225
100 Seed Weight	-0.05968	-0.12431	0.16314	0.04763	-0.44818	0.11155	0.11806	-0.17247	-0.28971	0.8839	-0.07085	-0.02264	0.136
Biological Yield	0.08271	-0.14479	0.02235	-0.04501	0.26969	0.1832	-0.04545	0.19313	0.00233	0.09304	-0.6731	0.11842	0.057
Harvest Index	0.02622	-0.05632	-0.04383	0.08005	0.48375	0.1947	-0.01832	0.12126	0.13128	-0.17025	-0.6781	0.11754	0.188

In the present study, the heritability in broad sense (h^2) ranged from 22.728 to 68.473%. High heritability (broad sense) (>60%) was recorded for character no. of primary branches per plant (68.473%). Moderate heritability (broad sense) (30-60%) was recorded for characters i.e. days to 50% flowering (43.059), days to

maturity (56.685), plant height (cm) (42.699), no. of clusters per plant (41.112), no. of pods per plant (36.666), pod length (cm) (32.882), no. of seeds per pod (33.521), 100-seed weight (32.752), biological yield (g) (52.424) and grain yield per plant (46.228%).

Table-6 Direct and indirect effects between yield and its related traits in 30 Black gram genotypes at phenotypic level

Character	Days to 50% Flowering	Days to 50% Pods Setting	Days to Maturity	Plant Height	Number of Primary branches / Plant	Number of Clusters Per Plant	Number of Pods Per Plant	Number of Seeds Per Pod	Pod Length	100 Seed Weight	Biological Yield	Harvest Index	Seed Yield Per Plant
Days to 50% Flowering	0.21942	-0.408	-0.00643	0.00578	0.00195	-0.00103	0.00047	-0.01302	-0.00135	-0.00363	-0.02295	0.01357	-0.215
Days to 50% Pods Setting	0.18739	-0.47775	0.00832	0.00915	0.00347	0.00157	-0.02341	-0.00592	-0.00329	-0.00752	-0.01414	0.01007	-0.312
Days to Maturity	0.00651	0.01831	-0.21699	-0.033	-0.00293	0.00022	0.0338	-0.00329	-0.00188	-0.01424	0.00292	0.00757	-0.203
Plant Height	-0.0126	0.04348	-0.07119	-0.10059	-0.00707	-0.00384	0.04471	-0.02929	-0.00309	-0.00905	-0.00984	0.02816	-0.13
Number of Branches Per Plant	0.00805	-0.03126	0.01196	0.01339	0.05308	0.00498	-0.03202	0.00753	0.00753	-0.00889	-0.04634	0.04033	0.243
Number of Clusters Per Plant	0.00936	0.03117	0.00198	-0.01604	-0.01099	-0.02407	0.10606	-0.0263	0.00143	0.01588	-0.01478	0.00899	0.283
Number of Pods Per Plant	0.00037	0.03967	-0.02602	-0.01595	-0.00603	-0.00906	0.28187	-0.00234	-0.0053	-0.01878	-0.01311	0.00201	0.227
Number of Seeds Per Pod	0.02825	-0.02795	-0.00706	-0.02914	-0.01982	-0.00626	0.00652	-0.10111	-0.00293	0.01094	0.02872	-0.2207	-0.142
Pod Length	-0.0094	0.04976	0.01289	0.00982	0.01264	-0.00109	-0.04723	0.00939	0.03161	0.02524	-0.00375	0.01411	0.304
100 Seed Weight	-0.00771	0.03476	0.02988	0.00881	-0.00456	-0.0037	-0.05118	-0.01069	0.00772	0.10341	0.01232	-0.02175	0.097
Biological Yield	0.0231	-0.03058	0.00291	-0.00454	0.01129	-0.00163	0.01696	0.01332	0.00054	-0.00584	-0.21795	0.14788	-0.045
Harvest Index	0.0142	-0.02295	-0.00784	-0.01352	0.01022	-0.00103	0.00271	0.01065	0.00213	-0.01073	-0.15379	0.20957	0.04

Low heritability (broad sense) (<30%) was recorded for characters i.e., days to 50% pod setting (22.809) and harvest index (%) (22.728). It showed that the phenotypic variability of these characters had greater share of environment. Johnson *et al.* (1955) suggested that without genetic advance the estimates of heritability will not be of practical value and emphasized the concurrent use of genetic advance along with heritability.

In the present study, the genetic advance as percent of mean ranged from 1.091 to 15.737. It was low (>10%) for days to 50% flowering (2.512), days to 50% pod setting (1.091), days to maturity (2.386), plant height (cm) (5.334), no. of clusters per plant (9.658), no. of pods per plant (4.019), pod length (cm) (3.681), no. of seeds per pod (8.642), biological yield (g) (9.87), and harvest index (3.97). While Moderate genetic advance as % mean (10-20%) was recorded for No. of primary branches/plant (15.737), 100-seed weight (12.83) and grain yield per plant (14.157%). Moderate genetic advance was reported earlier for the 100-seed weight and seed yield per plant coupled with high heritability. Moderate heritability coupled with moderate genetic advance as percent of mean was observed for 100-seed weight and grain yield per plant and selection may be effective for these characters [Table-2]. Similar results are reported by Narasimhulu *et al.* (2013) [2].

Correlation coefficient

In general, genotypic correlation was higher than the phenotypic ones. This indicated an inherent association between various traits. In the present investigation, grain yield per plant was found to be highly significantly correlated with number of branches per plant, number of pods per plant, number of seeds per pod at both genotypic and phenotypic levels. Significant positive association of these above attributes indicated that these attributes were mainly influencing the grain yield in black gram. Thus, selection practiced for the improvement in one character will automatically result in the improvement of other character even though direct selection for improvement has not been made for the yield character. Similar results exhibiting highly significant and positive correlation between grain yield and other traits as obtained in the present investigation were in accordance with Konda *et al.* (2008) [3] and Kadam *et al.* (2008) [4].

Path coefficient analysis

Phenotypic path co-efficient is indicating the masking effect of environment. The results also revealed high residual effect for phenotypic (0.730). A detailed analysis of diagonal values showed high positive direct effect with days to 50% flowering, number of branches per plant, number of pods per plant, number of seeds per pod, 100 seed weight, harvest index. Genotypic Path coefficient analysis revealed high residual effect for genotypic (0.465). A detailed analysis of diagonal values showed direct effect for revealed high positive direct effect days to 50% flowering, plant height, number of branches per plant, number of clusters per plant, 100 seed weight, harvest index. The negative direct effects of no. of pods per plant was high followed by biological yield per plant, days to 50% pod setting, pod length, seeds per pod, days to maturity, and No. of primary branches per plant at genotypic level [Table-6]. Such negative direct effects were also reported by Hariitha and Sekhar (2002) [5], Narasimhulu *et al.* (2013), Prasanna *et al.* (2013) [6], and Kumar *et al.* (2015) [7].

Conclusion

The results from the present investigation conclude that significant differences recorded for all the characters among the 30 black gram genotypes included in the

study, indicating presence of sufficient variation among them. 100 seed weight, grain yield per plant, seed per pod, number of clusters per plant, number of branches per plant have shown moderate PCV and GCV High heritability coupled with high genetic advance as percent of mean was observed for number of branches per plant and selection may be effective for these characters. number of branches per plant, number of pods per plant, number of seeds per pod shown positive significance at both genotypic and phenotypic levels.

Application of research: Traits days to 50% flowering, number of branches per plant, 100 seed weight, harvest index shown positive direct effect on yield at phenotypic and genotypic level.

Research Category: Genetics and Plant Breeding

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Study area / Sample Collection: Field Experimentation Centre, Department of Genetics and Plant Breeding, Naini Agricultural Institute, Naini

Cultivar / Variety / Breed name: *Vigna mungo* L. Hepper

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