Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2021; 10(5): 299-302
Received: 10-07-2021
Accepted: 12-08-2021

KM Preeti Sagar
Department of Genetics and Plant Breeding, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Suresh BG
Department of Genetics and Plant Breeding, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

GM Lal
Department of Genetics and Plant Breeding, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
KM Preeti Sagar
Department of Genetics and Plant Breeding, Naini Agriculture Institute, SHUATS, Prayagraj, Uttar Pradesh, India

Correlation and path analysis for yield and yield contributing traits in black gram [*Vigna mungo* (L) Hopper.]

KM Preeti Sagar, Suresh BG and GM Lal

DOI: https://doi.org/10.22271/phyto.2021.v10.i5d.14238

Abstract
Tweenty one Black Gram (*Vigna mungo* (L) Hopper) genotypes were evacuated for the estimation of genetic variability parameters, correlation coefficient, path analysis, heritability and genetic advance. The genotypes differed significantly for all the characters. Higher GCV and PCV was observed for the seed index. High heritability coupled with genetic advance as percent of mean shown by harvest index indicating the impact of additve and significant correlation along with positive direct effect on grain yield. Therefore selection based on this component traits would results improvement in grain yield of Black Gram.

Keywords: genetic variability, heritability, genetic advance, correlation analysis, path coefficient analysis

Introduction
Blackgram (*Vigna mungo* L. Hepper) is an important nutritious pulse crop occupying unique position in Indian agriculture. It belongs to family leguminoseae with chromosome number 2n=2x=22. Blackgram is reported to be originated in India**.** India is the world's largest producer as well as consumer of blackgram. It produces about 1.5 to 1.9 million tons of blackgram annually from about 3.5 million hectares ofarca, with an average productivity of 500 kg per hectare. Blackgram output accounts for about 10% of India's total pulse production ing (Ministry of Agriculture. Govt. of India). In 2014-2015, 1.61 million tons Urad production in the country is largely concentrated in five nis states viz, Uttar Pradesh (UP). Maharashtra, Madhya Pradesh, Andhra Pradesh and Tamil Nadu. These five states together contribute for about 70% of total urad production in the country (Ministry of Agriculture, Govt of of India). In U.P. Blackgram is grown in about 3.91 lakh hectares with a total production of 1.72 lakh tons (Annual Report 2014-2015). Among the states of India, Orissa ranks first in area 777 thousand hectares and production 396 thousand tones. However Punjab is a leading state in productivity with 834.9 kg/hectare (Kumar *et al*., 2002) [10]. It is a cheap source of dietary protein (24%). It also contributes 76% carbohydrate, 3-5% Fibre, 1.74% Fat and a major portion of lysine in the vegetarian diet. It is the richest sources of phosphoric acid (H3P04.). Being 5-10 times richer than other crops. Besides, being used as food for inexpensive source of dietary protein it is better to use for bean sprouts than mungbean for its longer shelf life (Mishra and Khan, 2001) Among pulses, blackgram (*Vigna mungo* L.) is an important short duration crop widely cultivated in India which give us an excellent source of easily digestible good quality protein and ability to restore the fertility of soil through symbiotic nitrogen fixation In India black gram is grown both in winter and summer as monocrop and inter crop, respectively. That is why no single plant type is appropriate for all production system. So the variability among the existing gerinplasm or the accessions is the primary need to develop appropriate plant type for specific production system. Break In originated in India where it has been in cultivation from ancient times and is one of the most highly prized pulses of India. A successful breeding programme in black gram would need information on the nature and degree of genetic divergence in the available stock for choosing the right parents for further improvement (Falconer, 1981) [5].

Material and Methods
The present investigation was carried out at the Field Experimentation Centre, Department of Genetics and Plant Breeding, SHUATS, Prayagraj (UP.) during *Kharif*-2020 the University is

situated on the left side of Prayagraj - Rewa National Highway, about 3 km away Brom Prayagni city All types of facilities necessary for cultivation of successful crop in shading field preparation inputs and irrigation facilities were provided from the Department of Genetics and Plant Breeding SHUATS, Prayagraj (U.P.). The experiment was conducted in randomized block design with 21 genotypes the genotypes were replicated 3 times Genotypes were randomly arranged in each replication divided into 156 plots. The gross area of experiment was 187.86 m2 and cash plot size was 1 x 1 m. The row to row spacing was 30 cm and plant to plan distance was 10 cm. The 5 competitive plants from each of the replication were lagged and observations were taken from these tagged plants at various stages of the crop plant growth. Data were recorded from 12 characters viz, days to 50% flowering, days to maturity, plant height cm), number of primary branches per plant, mumber of chester per plant, number of pods per plant. pod length (cm), number of seeds per pod, 100 seed weight (g), biological yield (g) harvest index and grain yield per plant(g), mean values were computed data were analysed for analysis of variance as suggested by (Fisher, 1936) [6] and coefficient of variances as well as heritability(in broad sense), as suggested by Burton and Devane (1953). The estimates of genetic advance were obtained by the formula suggested by Lush (1949) [11] and Johnson *et al*. (1955). Phenotypic and genotypic correlation and path coefficients of variation were computed as per the method given by Dewey and Lu (1959) [4].

Results and Discussion

The genotypic and phenotypic coefficient of variation, heritability and genetic advance as percent of mean for each of the characters are presented in Table-1. Considerable range in variation was observed for all characters. Phenotypic coefficient of variation values were relatively moderate than corresponding genotypic coefficient of variation for all traits under study. Phenotypic coefficient of variation (PCV) ranged from Days to maturity (3.07%) to Number of pod per plant (16.55) High PCV magnitude was recorded for Number of pod per plant (16.55) and harvest index (12.83). Moderate values of Pod Length were also observed by Kumar *et al*. (2017) Genotypic coefficient of variation which gives the extent of genetic variability in the population, ranged from (1.93 to 11.61) percent. Moderate genotype coefficient of variation was observed for seed yield (11.61) High phenotypic coefficient of variation and genotypic coefficient of variation were observed for Number Pod Per Plant and Harvest Index Similar finding were reported by Reddy *et al*. (2017) Indicating the influence of environmental factors less difference were observed between phenotypic and genotypic coefficient of variation in certain cases such as Number of pod per plant, Number of primary branches, seed yield, Harvest Index, Pod Length. Which indicating that these character were less influenced by the environmental. The estimate of heritability (%) in the broad sense for 12 characters studied. Which range from 26% to 92% High heritability (broad sense) was recorded for characters like harvest Index 92% to Number Of Cluster Per Plant (26%). The higher heritability value was registered by the characters under *viz*. Similar seed yield per plant and seed Index. Similar finding were obtained. Goswamy *et al*. (2016) Genetic advance as % of mean varied from 4.13 to 23.02 High genetic advance as % mean was recorded for harvest Index (23.02). The estimate were high genetic advance for Harvest index and plant Seed Yield Per Plant was reported by Reddy *et al*. (2017). Correlation coefficient analysis among grain yield and its contributing characters are shown in Table. 2. There was positive, significant and strong correlation of this traits with seed yield per plant, seed yield per pod, Biological yield, Harvest Index both genotypic and phenotypic levels similar results were reported by Arya *et al*. (2017) [1]. Mehra el at. (2016) [13]. Mathivathana *et al*. (2015) [12]. For Number of seed per pod, Biological yield, Number of pod per plant. Panigrahi *et al*. (2014) [14]. Also observed positive genotypic association of Biological yield, Number of pod per plant, Harvest Index Kumar *et al*. (2015) [8]. and Gowsalya *et al*. (2016) [7]. also found Number of seed per pod at phenotypic level. Path coefficient analysis was carried out by taking grain yield as dependent variable to partition the correlation coefficient into direct and indirect effect in order to determine the contributing of different characters to words the grain yield. Direct and positive effect on grain yield per plant was observed for characters like Days to 50% flowering, Number of primary branches per plant, Biological yield, Days to maturity, Harvest Index, Seed yield per plant. Similar results were reported by. Rajshekhar *et al*. (2017). Mathivathana *et al*. (2015) [12]. Arya *et al*. (2017) [1]. Days to maturity of Primary branches per plant Negative direct effect on seed yield per plant. Similar finding were reported by sridhar *et al*. (2020) [18]. In Black Gram. Hence presently study reveals that Number of pod per plant, seed yield, Harvest Index, Number of seed per pod, 100 seed wight and pod length important traits as they have directly contributed towards Grain yield, plant height, and Days to 50% flowering also had direct effect on seed yield. Therefore more emphasis should be given to these component during selection for higher yield. The Interrelationship among yield component would help in increasing the yield level.

Table 1: Genetics parameters for 12 characters of 21 blackgram genotypes.

Sr. No	Characters	Genotypic variance	Phenotypic variance	Genotypic Coefficient of variance	Phenotypic Coefficient of variance	Heritability (%) (Broad Sense)	Genetic Advance %	Genetic advance as % mean
1	Days to 50% Flowering	1.63	3.12	2.83	3.92	52	1.90	4.22
2	Days to Maturity	1.07	2.69	1.93	3.07	39	1.34	2.5
3	Plant Height	2.81	3.29	2.38	8.76	85	3.19	4.53
4	Primary Branches / Plant	4.65	12.99	3.78	6.32	35	2.66	4.66
5	No. Of Clusters /Plant	0.05	0.11	6.54	10.1	41	0.29	8.72
6	No. Of Pods/ Plant	0.54	2.03	8.54	16.55	26	0.78	9.08
7	Pod Length	2.7	5.33	7.27	10.2	50	2.41	10.66
8	No. Of Seeds / Pod	0.02	0.04	3.14	4.91	40	0.17	4.13
9	100 Seed Weight	0.13	0.32	6.18	9.63	41	0.48	8.17
10	Biological Yield	0.08	0.14	7.29	9.22	62	0.47	11.89
11	Harvest index	1.48	3.83	7.98	12.83	38	1.56	10.23
12	Seed yield/ plant	14.46	15.61	11.61	12.06	92	7.54	23.02

Table 2: Correlations Coefficient between yield and its related traits in 21 black gram genotypes at phenotypic level.

Characters	Days to 50% flowering	Days to Maturity	Plant Height	Primary Branches / Plant	Clusters/ Plant	Pods / Plant	Pod Length	Seeds / Pod	Seed index (100 Seed Weight)	Biological Yield	Harvest index	Seed yield/ plant
Days to 50% Flowering	1	0.083	0.228	0.189	0.017	0.183	-0.263*	-0.173	-0.041	-0.045	0.081	0.122
Days to Maturity		1	-0.003	-0.230	-0.041	-0.053	0.281*	0.018	0.071	-0.105	-0.041	-0.110
Plant Height			1	-0.088	0.070	0.119	-0.306*	-0.183	-0.453**	-0.057	-0.009	-0.113
Primary Branches /Plant				1	-0.077	0.100	0.003	-0.077	-0.221	0.055	0.018	0.124
Clusters / Plant					1	-0.097	-0.244*	0.110	0.042	0.303*	-0.063	0.105
Pods /Plant						1	-0.172	-0.172	-0.285*	0.379**	0.113	0.496**
Pod Length							1	0.366**	0.229	-0.140	0.027	-0.046
Seed / Pod								1	-0.102	-0.064	0.337**	0.456**
Seed index (100 Seed Weight)									1	-0.079	-0.236	-0.309*
Biological Yield										1	-0.387**	0.314*
Harvest index											1	0.580**
Seed yield / plant												1

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

Table 3: Correlations Coefficient between yield and its related traits in 21 black gram genotypes at genotypic level.

Characters	Days to 50% flowering	Days to Maturity	Plant Height	Primary Branches / Plant	Clusters/ Plant	Pods / Plant	Pod Length	Seeds / Pod	Seed index (100 Seed Weight)	Biological Yield	Harvest index	Seed yield/ plant
Days to 50% Flowering	1.000	0.182	0.157	0.060	-0.271*	0.253*	-0.768**	-0.440**	-0.112	0.020	0.134	0.124
Days to Maturity		1.000	-0.002	-0.257*	0.063	-0.100	0.478**	0.073	0.085	-0.095	-0.028	-0.117
Plant Height			1.000	0.595**	0.058	0.141	-0.620**	-0.349**	-0.549**	-0.158	0.083	-0.003
Primary Branches /Plant				1.000	-0.497**	0.080	-0.353**	-0.623**	-0.416**	0.109	-0.118	-0.115
Clusters / Plant					1.000	0.029	-0.381**	0.073	0.134	0.265*	-0.172	0.113
Pods /Plant						1.000	-0.568**	-0.266*	-0.500**	0.550**	0.104	0.591**
Pod Length							1.000	0.472**	0.314*	-0.167	-0.021	-0.212
Seed / Pod								1.000	-0.196	0.253*	0.455**	0.590**
Seed index (100 Seed Weight)									1.000	-0.096	-0.376**	-0.520**
Biological Yield										1.000	-0.653**	0.449**
Harvest index											1.000	0.594**
seed yield /plant												1

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

Table 4: Direct and indirect effects between yield and its related traits in 21 Black Gram Genotypes at Genotypic level

Characters	Days to 50% Flowering	Days to Maturity	Plant Hight	Primary Branches /Plant	Clusters /Plant	Pod /Plant	Pod Length	Seed / Pod	Seed index (100 Seed Weight)	Biological Yield	Harvest index	Seed Yield / Plant
Days to 50% Flowering	-0.0185	-0.0055	0.0126	0.0001	0.0017	-0.0049	0.0035	-0.0029	0.0025	0.0022	0.0032	-0.551**
Days to Maturity	-0.1087	-0.3661	0.0795	-0.1591	-0.0476	-0.0353	0.0097	-0.2361	0.219	0.1781	-0.1752	0.189
Plant Height	-0.1782	-0.0568	0.2615	0.0741	-0.0505	-0.06	0.069	-0.001	0.0157	0.0271	-0.031	-0.019
Primary Branches / Plant	0.0022	-0.2666	-0.1737	-0.6133	-0.2329	-0.2827	0.1729	-0.3372	0.4595	-0.1315	0.1359	-0.129
Clusters / Plant	0.0024	-0.0035	0.0053	-0.0104	-0.0273	-0.025	0.0124	-0.0033	0.0049	-0.0024	0.0003	0.12
Pods / Plant	0.062	0.0228	-0.0541	0.1087	0.2163	0.2358	-0.1535	-0.0252	-0.0913	0.054	-0.0326	0.06
Pod Length	0.0154	0.0022	-0.0216	0.023	0.037	0.0532	-0.0817	-0.0006	-0.0241	0.0535	-0.0465	0.152
Seed Per Pod	0.0583	0.2429	-0.0015	0.207	0.0456	-0.0403	0.0025	0.3766	-0.1929	-0.0049	0.0667	0.347**
Seed index (100 Seed Weight)	0.0704	0.3153	-0.0316	0.395	0.0955	0.204	-0.1557	0.2701	-0.5271	0.2082	-0.0838	-0.304*
Bio1ological Yield	-0.1373	-0.5652	0.1204	0.249	0.1032	0.2659	-0.7605	-0.0152	-0.4588	1.1617	-1.0336	-0.071
Harvest index	-0.3194	0.87	-0.2157	-0.4026	-0.0207	-0.2513	1.0338	0.3217	0.2889	-1.617	1.8174	0.621**
Residual are 0.15237												

Table 5: Direct and indirect effects between yield and its related traits in 21 black gram genotypes at phenotypic level

Characters	Days to 50% Flowering	Days to Maturity	Plant Hight	Primary Branches / Plant	Cluster /Plant	Pod / Plant	Pod Length	Seed / Pod	100 Seed Weight (seed index)	Biological Yield	Harvest index	Seed Yield / Plant
Days to 50% Flowering	-0.1657	-0.0337	0.045	0.0085	0.019	-0.0296	-0.001	-0.0176	0.0032	0.0135	0.0196	-0.347**
Days to Maturity	-0.0225	-0.1104	0.0028	-0.018	-0.0109	0.0067	0.0062	-0.0377	0.0372	0.0393	-0.0344	0.093
Plant Height	-0.0222	-0.0021	0.0818	0.0125	-0.0124	-0.0002	0.0211	-0.003	0.0149	0.0051	-0.0079	-0.021
Primary Branches / Plant	0.0011	-0.0035	-0.0032	-0.0213	-0.0054	-0.0052	0.003	-0.006	0.0067	-0.0023	0.0036	-0.009
Clusters / Plant	0.0063	-0.0054	0.0084	-0.0139	-0.055	-0.0325	0.0163	-0.0054	0.0083	-0.0039	0.0005	0.121
Pods / Plant	0.0153	-0.0052	-0.0002	0.021	0.0507	0.0858	-0.0092	-0.0012	-0.0032	0.0097	-0.0106	-0.019
Pod Length	-0.0013	0.0122	-0.0561	0.0309	0.0645	0.0233	-0.2179	-0.0106	-0.0762	0.0754	-0.0802	-0.014
Seeds / Pod	0.0209	0.0675	-0.0073	0.0556	0.0195	-0.0028	0.0096	0.1975	-0.0725	-0.0165	0.0255	0.255*

Seed index (100 Seed Weight)	0.0024	0.0417	-0.0225	0.0391	0.0188	0.0046	-0.0433	0.0455	-0.124	0.0333	-0.0144	-0.2378
Bio1ological Yield	-0.0491	-0.2141	0.0378	0.0647	0.0428	0.0683	-0.2082	-0.0504	-0.1615	0.6019	-0.4686	-0.111
Harvest index	-0.1317	0.3462	-0.107	-0.1878	-0.0107	-0.137	0.4095	0.1438	0.1292	-0.8663	1.1127	0.546**
Residual are 0.16906												

Acknowledgement
We are thankful to the Honorable Vice Chancellor, HOD, Teaching and non-Teaching staff of the Department of Genetics and Plant Breeding. Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj- 211007, U.P, for providing all necessary facilities and support.

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