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Study of Variability and Genetic Diversity of 50% Heading Date and Seed Yield in Blackgram (*Vigna mungo* L.)

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ABSTRACT

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The present investigation involves study of variability and genetic diversity of few developmental characters such as date of maximum flower per plant (DMF), number of seeds per plant (NSPP) and seed weight per plant (SWPP) in blackgram (*Vigna mungo* L.). These three quantitative characters were studied in 24 lines and three years under different environmental conditions. The model proposed by Perkins and Jinks was followed in this study. In the analysis, greater portion of total phenotypic variation (σ^2p) appeared to be due to the environmental variations (σ^2e). The highest heritability (h^2 b) (0.8181) was found for SWPP, while the highest genetic advance (G.A.=172.5508), high genetic advance of percentage (G.A.%=332.5627) and high genetic co-efficient of variability (G.C.V.=161.4381) were estimated in NSPP. The present investigation deals with the analysis of phenotypic, genotypic and environmental co-efficient of variability, range, mean with standard error, heritability (in broad sense), genetic advance and genetic advance of percentage. Genetic co-efficient of variability was very much pronounced and varied from treatment to treatment, year to year and lines to lines for all the characters, which indicates that the characters were quantitative in nature and under polygenic control. Therefore, further research would be undertaken for improving the characters of this pulse.

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INTRODUCTION

In terms of total production, blackgram (*Vigna mungo* L.) is considered as one of the important pulse crops in Bangladesh. More than 80% people of Bangladesh are suffering from malnutrition, which is due to deficiency in protein, vitamin, calcium, etc. in their daily diets. The caloric value of blackgram is same as that of rice (Anonymous, 1966). The dry seed (100gm) contains about 10.9% moisture, 24 gm protein, 1.4 gm fat, 59.6 gm carbohydrate, 0.9 gm crude fibre, 3.2 gm minerals, 154 mg calcium, 385 mg phosphorus, 3.8 mg iron and 4.8% ash. An increased production of blackgram grains is one of the best ways of overcoming the protein malnutrition in our people. Not only because of their high nutritive value, pulses also play a unique role in our agriculture by dint of their ability to fix N_2 from atmosphere in collaboration with bacteria, like *Rhizobia sp.* Young plants and its dry stem and husks are good sources of animal food as these are rich in nitrogenous materials (Rahman and Parh, 1988).

The cultivation of blackgram is much neglected and little work has been done for the improvement of this crop in Bangladesh. Its per acre yield is low in our country. On this ground blackgram cultivation should be taken with care in the country following new scientific methods. The qualitative and quantitative improvement of blackgram depends on variability and genetic diversity of the available gene pool and its manipulation. This should be created by multiple crossing between diverse lines of *Vigna mungo* (L.) However, in addition to the conventional methods of plant breeding such as introduction, selection and hybridization have opened up several new opportunities for creation of genetic variability, genetic diversity and selection of desirable traits.

The present investigations of variability and genetic diversity therefore, consist of genetic analysis of yield and yield components of the three characters, such as NSPP, SWPP and DMF in 24 lines and three years under different environmental conditions of blackgram (*Vigna mungo* L). The analyses also include the phenotypic, genotypic and environmental co-efficient of variability, heritability (in broad sense), genetic advance and analysis of variance.

MATERIALS AND METHODS

The experiment was conducted during the Kharif crop season in 1996-97, 1997-98 and 1998-1999. Three quantitative characters such as, date of maximum flower per plant (DMFPP), number of seeds per plant (NSPP) and seed weight per plant (SWPP) of blackgram (*Vigna mungo* L.) from twenty-four lines have been used for this study.

Materials (seed) for the present investigation collected from the Biometrical Genetics Laboratory, Department of Genetics and Breeding, University of Rajshahi, Bangladesh and the field was at adjoining to the third science building of Rajshahi University. The seeds were sown in randomized block design. The experimental field was comprised of an area of 855 × 995 sq. c.m. and consisted of three replications, 72 plots, 216 rows and 1080 plants. Regular weeding and hoeing was done when seedlings were twenty-one to twenty-three c.m. in height and five plants were selected from each of the rows. The data were collected on individual plant basis. Observations were recorded for different quantitative characters from the twenty-four lines. All the measurements were done in C.G.S. system. The collected data were analyzed for variability and genetic diversity following the biometrical techniques as developed by Mather (1949) based on the mathematical model of Fisher *et al.* (1932) and that of Eberhart and Russell (1966) and Jinks and Perkins (1968).

RESULTS AND DISCUSSION

Three quantitative characters, such as date of maximum flower per plant (DMF), number of seeds per plant (NSPP) and seed weight per plant (SWPP) of 24 lines of blackgram have been described.

A. Variability

The highest and lowest range of DMF were observed for ln.-11(41.8 to 73.2) and in ln.-4 (30.6 to 78.6), For NSPP **t**he highest range was shown by ln.-14 (8.8 to 111.4) and the lowest range was shown by ln.-21(1.4 to 93.0) and the SWPP showed the highest range of 0.38 to 4.08 in ln.-16, while, the lowest range was exhibited in the ln.-21 with a value of 0.037 to 4.60 (Table1A to 1C).

The highest value of mean with standard error for DMF was 55.44±16.37 in ln.-8 and the lowest value was found for ln.-19 with a value of 47.67±16.27, For NSPP the highest and lowest value was observed in ln.-24 (63.91±50.48) and in ln.-1 (40.09±29.92) and l**n**.-2 showed the highest value (3.02±2.06) and the lowest value was recorded in ln.-1 (1.66±1.24) for SWPP (Table 1A to C).

For DMF ln.-24 showed the highest (53.40) and ln.-11 (31.24) lowest standard deviation performance, NSPP exhibited highest value of 151.45 for lin.-24 while, the lowest value was 44.41 in ln.-15 and for SWPP the highest standard deviation was recorded as 6.97 in ln.-15 and the lowest value was 3.71 in ln.-1 (Table 1A to 1C).

The results of co-efficient of variability in percentage (CV %) in different lines, each line showed a remarkable difference for different characters. The highest co-efficient of variability in percentage was found in ln.-13 with a value of 107.52 and the lowest estimate was 59.54 in ln.-11 in DMF, the highest and the lowest value for NSPP were shown in ln.-15 and ln.-16 with a value of 237.54 and 160.78 and SWPP, the highest value were exhibited with a value of 256.87 in ln.-20 while, the lowest estimate was 132.15 for the ln.-6 (Table 1A to 1C).

B. Analysis of variance

In the analysis the line (L) was significant for all the characters. The replication (R) item was significant for the character SWPP. The characters DMF and NSPP were non-significant. The item year (Y) also appeared to be significantly different from each other as indicated by the highly significant year (Y) item for all the characters. The line (L) did not interact with the replication (R) as was indicated by the non- significant interaction item (L×R) for all the characters. The interaction items (L×Y) were, non-significant for all the characters. The interaction items (R×Y) was significant for all the characters showing that replication did not interacted differently in different years. The interaction (L×R×Y) was recorded to be significant for all the characters, which showed that the lines, replication and year interacted among themselves (Table 2A to 2C).

C. Components of variation

Phenotypic variation ($\sigma^2_{\ P}$) always exhibits the greater value than those of other variations like σ^2_g, $\sigma^2_{\ L\times Y}$, $\sigma^2_{V\times R\times Y}$ and σ^2_w as estimated for all the characters; because the phenotypic variation is the joint product of $\sigma^2_{\ L\times Y}$, $\sigma^2_{R\times Y,}$ $\sigma^2_{L\times R\times Y}$ and σ^2_w. Table 3 to 5 indicate the greater portion of phenotypic variation ($\sigma^2_{\ P}$) appeared mostly due to the error variation (σ^2_w). The highest phenotypic variation (σ^2_p) was shown by NSPP with a value of 11286.41 and the lowest phenotypic variation (σ^2_P) was noted for SWPP with a value of 26.88. The highest genotypic variation ($\sigma^2_{\ g}$) with a value of 83.76 for NSPP and lowest with a value of 0.22 for SWPP respectively. The remaining characters exhibited their σ^2_g value of 8.79 for DMF. The highest line × year (L×Y) interaction variation ($\sigma^2_{\ LXY}$) was recorded for all the character NSPP with the value of –248.56 and the lowest was estimated for SWPP with a value of –0.53. For other character the interaction value recorded was –22.99 for DMF. The highest line × replication × year (L×R×Y) interaction variation ($\sigma^2_{\ L\times R\times Y}$) was recorded for the character NSPP with a value of 10481.94 and the lowest was estimated for SWPP with a value of 25.12 and other character exhibited their $\sigma^2_{\ L\times R\times Y}$ value of 2042.37 for DMF. Error variation (σ^2_w) was in greater portion contained phenotypic variation for all the characters (DMF, NSPP and SWPP). The highest value of error variation was 969.27 for NSPP and that the lowest value was 2.07 for SWPP. The remaining character exhibited a value of 32.0778 for DMF.

D. Coefficient of variability

The highest co-efficient of phenotypic variation (PCV) was recorded for NSPP with a value of 21752.66 while that the lowest value was found as 1085.06 for SWPP. For remaining character for DMF it was 3961.5200 DMF (Table 4).The highest co-efficient of genotypic variation (GCV) was estimated for the character NSPP with value of 161.44 and the lowest was recorded for SWPP with value of 8.88. The GCV for the remaining character was 16.92 for DMF. Negative (L×Y) interaction co-efficient of variability was estimated for all the characters. The highest L×Y interaction co-efficient of variability was shown by NSPP with a value of –479.06 and the lowest was estimated for SWPP with a value of –21.46. The remaining co-efficient of variation was estimated for the character DMF with a value of –44.22. The highest L×R×Y interaction co-efficient of variability was found 20202.18 for NSPP, while the lowest was estimated for SWPP with a value of 1014.14. The remaining value was 3927.15 for DMF. Negative (L×R) interaction co-efficient of variability were estimated for all the characters. The character, NSPP with a value of –6628.78 showed the highest L×R co-efficient of variability and with a value of –333.43 showed the lowest L×R co- efficient of variability. On the other hand, the highest R×Y co-efficient of variability estimated was for NSPP with a value of 22.04 and the lowest was estimated as 1.80 for SWPP. Error co-efficient of variability was always high than those of $LXY_{CV,}$ $LXR_{CV,}$ RXY_{CV} and $LXRXY_{CV.}$ The highest ECV estimated for the character NSPP with a value of 1868.10 and the lowest ECV was noted for DMF with a value of 61.68. The remaining value was for SWPP (83.49).

Table 1A. Range, mean with standard error (SE) and co-efficient of variability in percentage (CV %) over years for DMF of twenty-four lines in blackgram (*Vigna mungo* L.).

Line	Range	Mean with standard error (SE)	CV%	SD
In.-20	38-81.6	53.3778 ±15.4564	86.8700	46.3693
In.-13	40-81.4	54.6889±16.1999	88.8657	48.5997
In.-21	37-86.2	53.3111±17.6522	99.3352	52.9567
In.-19	31.2-73.8	47.6667±16.2710	102.4050	48.8131
In.-22	36.2-84.6	54.5111±17.5988	96.8542	52.7963
In.-9	37.2-77.6	50.2889±14.2190	84.8237	42.6569
In.-17	35.6-71	49.2444±13.6983	83.4507	41.0948
In.-5	36.6-76.8	49.7556±12.4575	75.1121	37.3725
In.-12	37-81	54.9778±15.9570	87.0733	47.8710
In.-16	33.6-76.2	51.0444±13.3479	78.4490	40.0438
In.-7	38.8-80.2	52.5778±17.0363	97.2060	51.1089
In.-1	35.8-73.2	50.0444±13.7129	82.2042	41.1386
In.-24	33.2-80.4	49.6667±17.8006	107.5205	53.4019
In.-4	30.6-78.6	52.1111±16.4393	94.6397	49.3178
In.-2	37.2-76.6	54.1556±15.7671	87.3435	47.3014
In.-6	35.6-69.8	50.1111±12.0695	72.2562	36.2084
In.-11	41.8-73.2	52.4667±10.4124	59.5372	31.2372
In.-15	31.6-69.4	49.1556±12.5322	76.4833	37.5966
In.-18	38.2-79.2	53.4444±16.9052	94.8939	50.7155
In.-8	40-82.4	55.4444±16.3709	88.5801	49.1127
In.-3	37.2-73.2	53.4222±14.1781	79.6190	42.5342
In.-14	38-78.6	53.5333±15.8675	88.9213	47.6025
In.-10	35-81.8	51.6889±15.3800	89.2646	46.1399
In.-23	36.2-86.4	51.1778±15.5250	91.0065	46.5751

Table 1B. Range, mean with standard error (SE) and co-efficient of variability in percentage (CV%) over years for NSPP of twenty-four lines in blackgram (*Vigna mungo* L.)

Line	Range	Mean with standard error (SE)	CV%	SD
In-20	6-117.6	49.7111±36.4517	219.9815	109.3552
In-13	3-130.2	53.5111±38.4717	215.6844	115.4151
In-21	1.4-93	47.9778±34.0456	212.8837	102.1369
In-19	4.8-121.8	55.3778±38.8770	210.6095	116.6309
In-22	3.8-91.8	48.1556±33.7969	210.5479	101.3906
In-9	3.4-106	55.3778±35.0713	189.9929	105.2139
In-17	7-77.8	43.6889±26.5660	182.4216	79.6980
In-5	5.4-96	53.8444±32.4926	181.0359	97.4777
In-12	5-98.6	52.6444±36.7908	209.6565	110.3724
In-16	11.6-78.4	44.0889±23.6288	160.7808	70.8865
In-7	4.4-101.7	54.7222±38.4858	210.9884	115.4575
In-1	5.8-85.4	40.0889±29.9129	223.8495	89.7388
In-24	2.6-157.8	63.9111±50.4826	236.9662	151.4477
In-4	7.5-102.8	51.7333±34.4493	199.7706	103.3479
In-2	5.8-145.2	59.9556±44.1796	221.0616	132.5388
In-6	3.2-86.8	44.6222±30.7729	206.8898	92.3188
In-11	3.8-115.4	60.1333±41.9677	209.3733	125.9031
In-15	3.6-126.6	56.4667±44.7110	237.5437	44.7110
In-18	4.2-99.6	53.5556±35.0157	196.1457	105.0470
In-8	3-80.4	42.5000±28.8636	203.7431	86.5908
In-3	7.4-128.4	61.0333±41.7581	205.2557	125.2743
In-14	8.8-111.4	54.0889±37.8325	251.7194	113.4975
In-10	2.4-114.4	44.2444±34.3539	232.9375	103.0618
In-23	2.2-113.6	53.9111±38.0261	211.6045	114.0783

Table 1C. Range, mean with standard error (SE) and co-efficient of variability in percentage (CV %) over years for SWPP of twenty-four lines in blackgram (*Vigna mungo* L.)

Line	Range	Mean with standard error (SE)	CV%	SD
In-20	0.24-6.64	2.2900±1.9608	256.8734	5.8824
In-13	0.14-5.96	2.8144±2.0429	217.7658	6.1288
In-21	0.037-4.84	2.6630±1.8416	207.4690	5.5249
In-19	0.16-5.30	2.7627±1.8444	200.2787	5.5331
In-22	0.10-4.50	2.6467±1.7765	201.3602	5.3294
In-9	0.09-4.58	2.2389±1.4215	190.4685	4.2644
In-17	0.18-3.82	1.9978±1.4240	213.8402	4.2721
In-5	0.18-4.48	2.3322±1.4962	192.4663	4.4887
In-12	0.20-5.20	2.8722±1.9259	201.1629	5.7778
In-16	0.38-4.08	2.3478±1.4235	181.8937	4.2705
In-7	0.16-5.38	2.4589±1.7634	215.1409	5.2901
In-1	0.07-3.34	1.6567±1.2386	224.2832	3.7157
In-24	0.037-4.60	2.2419±1.5123	202.3685	4.5369
In-4	0.22-4.86	2.4000±1.7261	215.7625	5.1783
In-2	0.18-5.96	3.0178±2.0609	204.8711	6.1826
In-6	0.10-4.90	2.2389±1.7325	132.1452	5.1975
In-11	0.14-4.78	2.6527±1.8068	204.2410	5.4179
In-15	0.15-6.68	2.9078±2.3243	239.7964	6.9728
In-18	0.08-4.80	2.5044±1.7963	215.1733	5.3888
In-8	0.10-5.34	2.3444±1.8584	237.8050	5.5751
In-3	0.15-4.92	2.7811±1.9335	208.5650	5.8004
In-14	0.24-5.62	2.9400±2.0504	209.2245	6.1512
In-10	0.26-4.20	2.0822±1.4161	204.0246	4.2482
In-23	0.06-4.32	2.1456±1.5983	223.4760	4.7949

Table 2A. Anova of G×E Interaction of Twenty-four Lines of Blackgram for DMF

Item	Df	SS	MS	(F) LR
Variety (V)	23	4691.2661	203.9681	6.2227
Replication (R)	2	881.7356	440.8678	13.7437
Year (Y)	2	223822.5022	111911.2511	3488.7446
R×V	46	7040.2245	153.0484	4.7712
V×Y	46	455352.0571	9898.9578	308.5922
R×Y	4	4752.7301	1188.1825	37.0406
R×V×Y	92	942441.7384	10243.9319	319.3465
Within error(W)	864	27715.2	32.0778	

Table 2B. Anova of G×E Interaction of Twenty-four Lines of Blackgram for NSPP

Item	Df	SS	MS	(F) VR
Line(L)	23	42076.9186	1829.4312	1.8874
Replication(R)	2	1067.9130	533.9565	0.5509
Year (Y)	2	1087142.868	543571.4340	560.8055
R×L	46	82274.0907	1788.5672	1.8453
L×Y	46	2283924.378	49650.5300	51.2247
R×Y	4	9366.1910	2341.5478	2.4158
R×L×Y	92	4910865.885	53378.9770	55.0714
Within error(W)	864	837448.40	969.2690	

Table 2C. Anova of G×E interaction of Twenty-four Lines of Blackgram for SWPP

Item	Df	SS	MS	(F) VR
Line(L)	23	131.2699	5.7074	2.7592
Replication(R)	2	17.1459	8.5730	2.0685
Year (Y)	2	294.2748	147.1374	2.0685
R×L	46	174.1508	3.7859	1.8303
L×Y	46	5506.6753	119.7103	57.8730
R×Y	4	29.7187	7.4297	3.5918
R×L×Y	92	11747.0692	127.6855	61.7285
Within error(W)	864	1787.2135	2.0685	

Table 3. Phenotypic (σ^2_p), genotypic ((σ^2_g), interactions ((σ^2_{LXY}, σ^2_{LXRXY}) and within error ((σ^2_w) components of variation of three quantitative characters of twenty-four lines in blackgram

Characters	h^2_b	GA	GA%
DMF	0.4270	18.1231	34.8478
NSPP	0.7422	172.5508	332.5627
SWPP	0.8181	0.4530	18.2860

Table 4. Phenotypic (PCV) genotypic (GCV) interactions (L×Rcv,×Ycv, R×Ycv and L×R×Ycv) and within error (ECV) co-efficient of variability of three quantitative characters of twenty-four lines in blackgram

Characters	PCV	GCV	L×Rcv	L×Ycv	R×Ycv	L×R×Ycv	ECV
DMF	3961.5200	16.9163	-1293.5414	-44.2220	18.5250	3927.1453	61.6804
NSPP	21752.6578	161.4381	-6628.7896	-479.0636	22.0404	20202.1802	1868.1030
SWPP	1085.0563	8.8766	-333.4275	-21.4629	1.8044	1014.1444	83.4982

Table 5. Heritability (h^2_b), genetic advance (GA) and genetic advance of percentage of mean (GA%) for three quantitative characters of twenty-four lines in blackgram.

Characters	(σ^2_p)	(σ^2_g)	(σ^2_{LXY})	(σ^2_{LXRXY})	(σ^2_w)
DMF	2060.2479	8.7976	-22.9983	2042.3708	32.0778
NSPP	11286.4100	83.7625	-248.5631	10481.9416	969.2690
SWPP	26.8801	0.2199	-0.5317	25.1234	2.0685

E. Heritability (h^2_b)

The highest heritability with a value of 0.82 was found for SWPP and the lowest was exhibited by DMF with a value of 0.43. The remaining character exhibited the value of heritability of 0.74 for NSPP.

F. Genetic advance (GA)

The character NSPP showed the highest genetic advance with a value of 172.55, while the lowest value of genetic advance was recorded for SWPP with a value of 0.45. The remaining character followed with their high to low value like 18.12 for DMF.

G. Genetic advance expressed as percentage of mean (GA%)

The highest GA% was noted for NSPP with a value of 332.56, while the lowest GA% was recorded as 18.29 for SWPP. In other character GA% as calculated was 34.85 for DMF.

CONCLUSION

Study of variability and genetic diversity has a great importance in blackgram. In the present investigation three economically important characters viz. date of maximum flower (DMF), number of seeds per plant (NSPP) and seed weight per plant (SWPP) of twenty-four lines in blackgram were studied.

All the genetic models in the study of quantitative characters include certain assumptions in order to make statistical procedure simple. Fisher (1918) studied the genetic variance in relation to environmental effects and he was the first to provide statistical methods of partitioning the total variation into genetic and environmental components. With the development of first (mean) and second (variance and co-variance) degree statistics two distinct lines developed for the measurement of continuous variation. First, Mather (1949) developed biometrical technique based on mathematical methods of Fisher *et al.* (1932).

The range of variation was wide and pronounced in the lines for all the traits, which indicates that the characters are quantitative in nature and under polygenic control. Mean with standard error showed differences between the lines and co-efficient of variability in percentage (CV%) were varied from line to line and also year to year, which indicated certain degree of variability for the characters studied which are prerequisite in breeding research.

In the analysis of variance, line (L) item was significant for all the three characters, indicating that there were differences among the twenty-four lines, which justifies their inclusion as materials in this study. Significant year item referred that each year is differentiated from each other. On the other hand, the interaction items were found to be significant.

Analysis of components of variation indicates that greater portion of phenotypic variation was appeared to be due to the error variation. Most of the characters show considerably low genotypic variations. Overall the highest genotypic variation was found for number of seeds per plant followed by date of maximum flower.

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