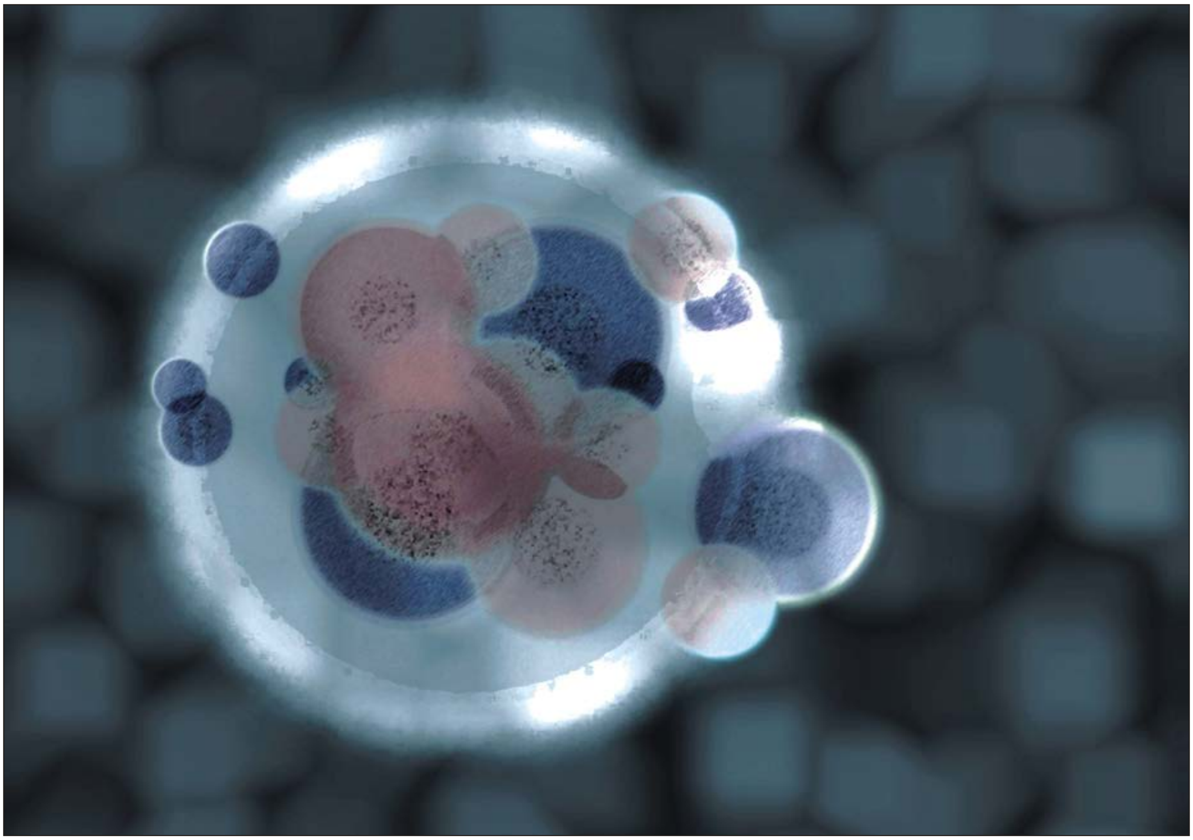

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Study of Genetic Variability and G×E Interaction of Some Quantitative Traits in Blackgram [*Vigna mungo* (L.) Hepper]

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Abstract: In order to compute the genetic variability and genotype-environment interaction, an investigation was carried out with twenty-four lines of blackgram for five yield and yield contributing characters, such as plant height at first flower (PHFF), number of branches at maximum flowers (NBMF), number of pods per plant (NPd/P), pod weight per plant (PdW/P) and seed weight per plant (SW/P). A wide range of variability was observed for all these traits. Heritability in broad sense (h^2_b) with genetic advance (GA) and genetic advance express as percentage of mean (GA%) were comparatively low. Joint regression analysis revealed that G×E item was significant for PHFF and PdW/P. Line-5 for PHFF, line-4 for NBMF and line-8 for NPd/P and PdW/P considered as stable genotypes having unit regression coefficient and non significant $\bar{S}^2 d_I$ values.

Key words: Heritability, genetic advance, G×E interaction, blackgram

INTRODUCTION

Grain legume comprising pulses and major oil seeds are an important group of crops in South and South-East Asia because of their high nutritive value, nitrogen fixation capacity, wide adaptability and amenability to varying cropping patterns. Grain legume constitutes an important component in the farming system of Bangladesh from the point of view of crop ecology and human an animal nutrition. Most of the people of Bangladesh are dependent on pulses as the source of dietary protein. An increased production of pulse grains is one of the best ways of overcoming the wide spread of protein malnutrition in our people. Pulses cover more than 5% of the total cropped area (Elias, 1991). It covers an area of about 7.3 lakh ha (BBS, 1991). Among pulses, one of the main edible pulse crops of Bangladesh is blackgram [*Vigna mungo* (L.) Hepper]. Blackgram grain contains about 25% protein, 56% carbohydrate, 2% fat, 4% minerals and 0.4% vitamins. The present consumption of pulses in our country is about 12 g/day/person which is much lower than the FAO/WHO recommendation, i.e., 80 g/day/person. In Bangladesh regarding production, blackgram is the fourth major pulse crop and also third position in per acre yield (BBS, 2004). Though blackgram plays a significant role in our national economy and in the diet, it is much neglected and generally cultivated as a low yielding rain fed kharif crop. On this ground blackgram cultivation should be taken with care in the country.

Genetic diversity can be defined as the extent to which the heritable characters of plants differ within a group of plants. Heritability estimates along with genetic gain is more helpful than the heritability value alone in predicting the result for selection the best individuals (Johnson *et al*., 1955). Genotype-environment interaction, an important source of phenotypic variation, is of great importance in the development and evolution of plant cultivars. As it is under the control of genes, the breeders are able to select suitable genotypes in advance generations by growing them under different environmental conditions.

Keeping in view the importance of genetic variability and G×E in plant breeding, the aim of the present research work is as follows:

- To find out heritability (h^2_b), genetic advance (GA) and genetic advance expressed as percentage of mean (GA%) of 24 lines of blackgram and
- To find out suitable variety which showed similar performance in a wide range of environments.

MATERIALS AND METHODS

Twenty-four lines of blackgram were evaluated on four environmental conditions for five yields and yield component viz.,plant height at first flower (PHFF), number of branches at maximum flower (NBMF), number of pods per plant (NPd/P), pod weight per plant (PdW/P) and seed

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weight per plant (SW/P). In this study four years viz., 2001, 2002, 2003 and 2004 were considered as four environments. The seeds of twenty-four lines of blackgram were grown in randomized complete block design. The experimental field was comprised of an area of 855×995 sq. cm in the four years. Three replications were considered for each year. A replication, with a size of 265×995 sq. cm consists of twenty-four plots. Each plot having three rows, which was 120 cm in length and 60 cm in width. The gap between replications, plots, rows and hills were 45, 25, 30 and 20 cm, respectively. Each row had seven hills and each hill contained 2/3 plants. The observations were recorded on a sample of nine randomly selected plants from each plot for five characters. For the study of genetic variability the collected data were analyzed following the biometrical techniques as developed by Mather (1949) based on mathematical model of Fisher *et al.* (1932) and for the study of G×E interaction, collected data were analyzed following the Freeman and Perkins (1971) model.

RESULTS AND DISCUSSION

In the present study, the mean values were highly significant with their respective standard error for all the characters and wide ranges of variation among the mean values were obtained (Table 1), suggesting that characters studied are quantitative in nature and under polygenic control. These results are in agreement with the finding of Malhotra *et al.* (1974), Deb (1994) and Sarker (2005). The highest and the lowest range was obtained for PdW/P in line-23 and the SW/P in line-1, respectively. The degree of co-efficient of variability in percentage (Table 1) was indicated by the range of variation. High co-efficient of variability in percentage was found for PdW/P in line-23, while low co-efficient of variability in percentage was estimated for NBMF in line-18, characters indicating high co-efficient of variability in percentage may likely be improved through breeding research.

In the analysis of variance (Table 2) the main item line (G) was significant for all the characters except SW/P. Significant line item indicated that twenty-four lines of blackgram were significantly different from each other. The item replication was significant for all characters. Haque (1997), Hoque (1997) and Deb and Khaleque (2004) obtained similar results in chickpea and Sarker (2005) in blackgram. It is also evident that the environment i.e., year item was significant for all characters, which indicated that environment was significantly different. The interaction between line and environment (G×E) was significant for all characters. Significant G×E interaction indicated that environment interacted with the lines. These results are in agreement with the investigation of Nahar (1997) and Deb and Khaleque (2004).

Table 1: Range, mean with standard error (SE) and co-efficient of variability (CV%) in percentage of five quantitative characters in 24 lines of blackgram

	Characters								
	PHFF			NBMF			NPd/P		
Lines	Ranges	Mean±SE	CV (%)	Range	Mean±SE	CV (%)	Range	Mean±SE	CV (%)
1	19.06-34.66	25.7895±1.4526	98.1874	4.56-9.56	6.3467±0.3989	30.0905	8.66-16.22	11.1933±0.6252	41.8977
2	14.41-33.10	22.8467±6.6456	193.307	4.98-7.89	6.3217±0.2865	15.5824	8.11-19.11	10.6958±0.9321	30.1878
3	14.52-29.84	22.8383±1.3104	90.2184	4.56-11.56	6.4583±0.5622	58.7261	8.33-22.00	13.6192±1.4608	188.0355
4	17.48-27.64	21.9758±0.9357	47.8065	3.80-8.10	6.4058±0.4152	32.2933	7.33-14.33	10.7125±0.6818	52.066
5	17.26-28.58	22.6342±0.9462	47.4704	4.15-8.11	6.1075±0.4001	31.4487	4.56-16.44	10.7208±1.0173	115.8398
6	14.33-29.2	22.0408±1.3544	99.8817	3.98-9.22	6.6633±0.4202	31.7971	7.33-21.55	12.0350±1.2657	159.744
7	12.57-28.65	20.8025±1.4238	116.9392	4.44-8.44	6.1900±0.3659	25.9606	7.11-14.00	10.0258±0.7247	62.8637
8	12.72-32.39	21.4867±1.7185	164.9345	3.78-8.17	6.3817±0.4187	32.9706	6.00 -24.66	13.4958±1.6809	251.224
9	16.40-29.02	21.8183±0.9837	53.2255	3.56-7.22	6.0558±0.2806	15.5987	4.33-20.33	11.1925±1.3301	189.6829
10	8.75-24.69	19.1808±1.7010	181.0091	3.88-7.55	5.8942±0.2863	16.6825	8.11 -15.00	11.7375±0.7877	63.429
11	13.48-28.6	20.6983±1.3828	110.852	4.44-8.32	5.8808±0.3480	24.7129	6.89-15.22	11.3417±0.7153	54.1416
12	19.57-32.28	25.5117±1.1020	57.1245	5.55-7.78	6.4467±0.2323	10.0467	6.20-24.55	12.7742±1.6993	271.2663
13	17.84-30.51	22.5367±1.1253	67.4273	4.50-8.66	6.5892±0.4144	31.2772	6.67-27.88	12.4125±1.7293	289.1008
14	13.57-33.12	24.0342±1.5599	121.494	3.50-7.56	5.6683±0.4069	35.0481	8.11 -17.89	12.7017±0.9644	87.8605
15	13.3-30.94	23.8433±1.5949	128.0143	4.25-9.12	6.8133±0.4065	29.1092	5.22-15.67	11.5533±1.1601	139.7801
16	15.33-30.60	21.9267±1.2556	86.2747	4.56-7.11	5.7350±0.2490	12.9706	6.67-19.22	10.7858±1.0864	131.3115
17	15.81-31.43	24.2092±1.5431	118.0273	4.55-0.22	6.5433±0.4485	36.8975	7.33-28.44	12.9800±1.7407	280.1122
18	17.64-28.72	21.4492±0.9838	54.1534	4.65-7.21	6.1008±0.2157	9.153	6.56-15.33	10.1942±0.8454	84.1266
19	18.03-27.41	21.9358±0.8975	44.0628	3.98-6.89	5.5700±0.2229	10.7041	6.78-17.22	11.3492±1.0717	121.4434
20	12.57-28.78	21.0833±1.4161	114.1388	4.56-8.67	6.3492±0.3187	19.2026	5.22-24.44	12.1008±1.4386	205.2357
21	16.76-29.53	23.0850±1.0396	56.1821	3.21-8.56	5.9317±0.4281	37.0677	7.00-21.78	13.4058±1.2538	140.708
22	15.52-32.24	21.6467±1.3172	96.1859	4.68-7.56	5.8150±0.2577	13.7058	5.55-23.33	10.3883±1.3723	217.5412
23	13.58-27.66	20.9550±1.2097	83.8036	4.56-7.55	6.1567±0.2492	12.1069	9.11-18.00	12.4700±0.9469	86.2747
24	16.57-25.53	21.5152±0.9500	50.3412	4.28-6.98	5.9633±0.2200	9.7382	6.67-16.00	11.7775±0.8191	68.3590

Table 1: Continued

	Characters					
	PdW/P			SW/P		
Lines	Ranges	Mean±SE	CV (%)	Range	Mean±SE	CV (%)
1	2.43-6.17	4.0575±0.3169	29.7035	1.38-2.63	2.0708±0.1325	10.1685
2	1.90-6.30	4.0192±0.3568	38.009	1.29-4.46	2.2025±0.2543	35.2245
3	3.07-11.11	4.7150±0.6687	113.7941	1.20-3.93	2.4908±0.2413	28.0472
4	2.23-6.67	3.9933±0.3816	43.7617	1.27-3.86	2.0950±0.1997	22.8401
5	1.01-6.39	3.9625±0.5097	78.6634	0.77-17.45	3.3292±1.3007	586.0192
6	2.68-6.13	4.2250±0.3083	27.0014	1.48-4.64	2.2642±0.2610	36.1132
7	0.96-5.71	3.3142±0.4022	58.5665	0.79-2.81	1.7958±0.1750	20.468
8	1.08-8.03	4.7183±0.7297	135.4068	0.72-4.55	2.2458±0.3003	48.1833
9	1.14-9.99	4.007±0.7078	149.9265	0.91-3.73	2.1750±0.2301	29.2025
10	2.06-6.38	3.6333±0.3873	49.542	1.05-2.90	1.9250±0.1881	22.0652
11	1.34-5.66	3.4642±0.3368	39.2919	1.16-2.88	2.0342±0.1398	11.5343
12	2.33-7.04	4.2175±0.4014	45.8497	1.44-4.68	2.3767±0.2588	33.8291
13	2.43-8.14	4.2450±0.5105	73.6736	1.40-5.30	2.3475±0.3277	54.8925
14	2.74-7.14	4.3450±0.3950	43.093	1.47-4.20	2.5258±0.2557	31.0713
15	2.35-7.06	4.4308±0.4454	53.7373	1.26-5.91	2.5642±0.3740	65.4655
16	2.33-7.44	4.1233±0.5088	75.3549	1.53-5.01	2.1750±0.2720	40.8071
17	2.81-8.96	4.4067±0.5321	77.0862	1.20-19.3	4.1517±1.4254	587.2305
18	1.70-6.38	3.6817±0.4107	54.9656	1.43-8.84	2.5892±0.5908	161.7983
19	1.84-8.42	4.0542±0.5672	95.2383	1.39-3.17	2.1208±0.1703	16.4168
20	1.36-8.29	4.0350±0.6250	116.1642	0.89-4.50	2.1842±0.2876	45.434
21	1.82-11.36	4.6908±0.7052	127.2375	0.97-3.13	2.3042±0.1755	16.0488
22	1.49-6.05	3.5742±0.4663	72.9932	1.03-4.02	1.7925±0.2297	35.3109
23	2.03-43.49	7.9033±3.2745	1627.987	1.42-4.77	2.4575±0.2658	34.4993
24	1.07-7.78	3.8658±0.4866	73.4874	0.87-2.90	1.9808±0.1776	19.1081

Table 2: Analysis of variance of five quantitative characters in 24 lines of blackgram

		F-value				
Sources	df	PHFF	NPBFF	NPd/P	PdW/P	SW/P
Replication (R)	2	254.0035*	152.6069**	75.6400*	28.0168*	10.7768*
Line (G)	23	8.8327*	2.8043**	1.7141*	36.4646*	1.3061^{ns}
Year (E)	3	158.4544*	72.6326**	28.9834*	13.1899*	3.1894*
G×E	69	7.0846*	2.1487**	1.9291*	1.4271*	1.2279*
Error	190					

*,** and ns indicates significant at 5%, 1% level and non significant, respectively

Table 3: Phenotypic (σ^2_p), genotypic (σ^2_G), environment (σ^2_E), interactions (σ^2_{GE}) and within error (σ^2_e) components of variation of five quantitative characters in 24 lines of blackgram

Characters	σ^2_p	σ^2_G	σ^2_E	σ^2_{GE}	σ^2_e
PHFF	10.4653	0.4804	7.2108	6.6876	3.2973
NBMF	0.6746	0.0256	0.4669	0.1797	0.4693
NPd/P	10.3484	-0.1435	3.1135	2.4810	8.0109
PdW/P	6.5555	0.0748	0.9605	0.8077	5.6730
SW/P	2.4765	0.0149	0.0696	0.1738	2.2878

The analysis of components of variation (Table 3) showed a wide range of phenotypic variation for all the characters in twenty-four lines of blackgram. Khaleque *et al.* (1991), Deb (1994) and Deb and Khaleque (2004) made a similar record in a number of characters in different crops. In the present analysis, phenotypic component of variation (σ^2_p) was higher than genotypic (σ^2_G), environment (σ^2_E), interactions (σ^2_{GE}) and error components of variation (σ^2_e). Phenotypic variation is the joined product of genotype, environmental and within error variation. The highest phenotypic variation was observed for PHFF, while the lowest phenotypic variation was observed in NBMF. On the other hand, the highest and the lowest genotypic variation were recorded in PHFF and NPd/P, respectively. The character PHFF showed the highest σ^2_{GE} values, while the character SW/P showed the lowest σ^2_{GE} values. Again, the highest and the lowest σ^2_e values were recorded as 8.0109 and 0.4693 for NPd/P and NBMF, respectively. For plant breeder larger genotypic value of any character is always helpful for effective selection. These results are in supported by the different workers viz., Samad (1991), Deb (1994), Nahar and Khaleque (1996) and Nahar (1997) and Aycicek and Yildirim (2006).

Table 4 showed that phenotypic coefficient of variability (PCV) was greater than the genotypic (GCV) and within error coefficient of variability (ECV). The character PdW/P showed the highest PCV and ECV

Table 4: Phenotypic (PCV), genotypic (GCV) and within error (ECV) co-efficient of variability of five quantitative characters in 24 lines of blackgram

Characters	PCV	GCV	ECV
PHFF	46.8323	2.1498	14.7555
NBMF	10.9104	0.4140	7.5900
NPd/P	88.1766	-1.2227	68.2592
PdW/P	154.7240	1.7654	133.8951
SW/P	105.7701	0.6364	97.7108

Table 5: Heritability (h^2_b), genetic advance (GA) and genetic advance expressed as percentage of mean (GA%) of five quantitative characters in 24 lines of blackgram

Characters	h^2_b	GA	GA (%)
PHFF	4.5904	0.3059	1.3689
NBMF	3.7948	0.0642	1.0384
NPd/P	-1.3867	-0.0919	-0.7831
PdW/P	1.1410	0.0602	1.4209
SW/P	0.6017	0.0195	0.8328

Table 6: Joint regression analysis following Freeman and Perkins (1971) model of five quantitative characters in 24 lines of blackgram

		F-value				
Sources	df	PHFF	NBMF	NPd/P	PdW/P	SW/P
Genotype (G)	23	1.8035*	1.2749^{ns}	0.8686^{ns}	1.1382^{ns}	0.9299^{ns}
Environment (E)	3	35.1528*	13.7061*	15.4013*	3.1306*	3.4391*
Combined regression	1	132.4293*	5.5653^{ns}	0.2678^{ns}	7.5375^{ns}	0.1287^{ns}
Residual (1)	2	0.7845^{ns}	5.4355*	20.3744*	0.9847	4.8468*
Interaction (G×E)	69	1.2916*	0.7903^{ns}	1.0593^{ns}	1.1802*	1.1142^{ns}
Heterogeneity of regression	23	0.5575*	1.28367^{ns}	0.7415^{ns}	0.2723^{ns}	3.0789*
Residual (2)	46	0.5151*	0.7220^{ns}	1.1592*	1.5558 *	0.6581^{ns}
Error between replicates	96					

*and ns indicates significant at 5% level and non significant, respectively

values, while the character NBMF showed the lowest PCV and ECV values. Again, the values of 2.1498 and -1.2227 were recorded as the highest and the lowest GCV for PHFF and NPd/P, respectively. Khurana and Sandhu (1972) obtained the highest PCV and GCV values for seed yield per plants and NPd/P in Soybeen (*Glycin max* L.). Singh and Mehndiratta (1970) studying cowpea and found the highest GCV for Npd/P. Similar results were obtained by Samad (1991), Deb (1994), Nahar (1997), Deb and Khaleque (2004) and Alam *et al.* (2004) for different characters in different crops.

The estimates of heritability and genetic advance give the heritable portion of variation. Heritability estimates in the present materials are generally low in almost all the characters (Table 5). Under the study, the character PHFF exhibited high heritability in comparison to other characters. Low heritability might be due to high environmental effects in the present study. A low heritability estimates were also obtained in field bean by Coyne (1968) for seed yield and yield components and in wheat by Chaturvedi and Gupta (1995), Mehta *et al.* (1997), Fida *et al.* (2001) and Aycicek and Yildirim (2006). Chandra (1968) observed that the heritability to be affected by environment in gram. Podder (1993), Deb (1994), Nahar (1997) and Deb and Khalaque (2004) obtained low heritability (h^2_b) with genetic advance (GA) and genetic advance express as percentage of mean (GA %) for different characters in different crops. Majid *et al.* (1982) studied blackgram and found highest GA and GA% for number of pods per plant suggesting that the direct selection for the character would be effective for the improvement of yield.

The results of the analysis of variance for regression (joint regression) according to Freeman and Perkins (1971) model for five quantitative characters of blackgram are shown in Table 6. It was observed from the Table that line item i.e., genotype was found to be non-significant for all the characters except PHFF. Islam *et al.* (2004) found similar result in chilli. Environment item was found to be significant for all characters indicating that there was a real difference between the environments. Similar results were obtained by Islam *et al.* (2002 and 2003). Combined regression were found to be non significant for all the characters except PHFF in comparison to residual-1. Significant combined regression indicated that environments were well measured. Residual (1) item was significant for the characters NBMF, NPd/P and SW/P suggesting that environmental index adequately is the index of additive environmental effect. Significant residual (1) for different characters was noted by Islam (2002) in chilli. Significant G×E interaction for PHFF and PdW/P indicated that genotypes were interacted with the environments differently. There are several reports of G×E interaction in different crops by

Table 7: Regression analysis following Freeman and Perkins (1971) model of five quantitative characters in 24 lines of blackgram

	Characters								
	PHFF			NBMF			NPd/P		
Lines	Mean	b_i	$\bar{S}^2d_i$	Mean	b_i	$\bar{S}^2d_i$	Mean	b_i	$\bar{S}^2d_i$
1	25.7875	0.8888	3.2936	6.3467	0.0633	-0.943	11.1933	0.9159*	-12.86
2	22.84667	2.4242*	-0.269	6.3217	0.5003*	-0.6054	10.6958	0.9427	-10.49
3	22.83833	2.3465*	-12.03	6.4583	0.6062	-0.1271	13.6192	0.6117	3.6295
4	21.97583	1.4702*	-10.66	6.4058	1.0443*	-0.9413	10.7125	0.7826	-11.07
5	22.63417	1.0856*	-10.72	6.1075	0.5135*	-0.3701	10.7208	1.2635*	-15.24
6	22.04083	2.0335*	-10.45	6.6633	0.0005	-1.0467	12.035	0.6901	20.245
7	20.8025	0.7481	-3.012	6.19	1.3747*	-0.889	10.0258	-0.3206	-14.07
8	21.48667	2.2199	4.0715	6.3817	0.1277*	-1.0418	13.4958	1.0005	-3.089
9	21.81833	0.2805*	-11.22	6.0558	0.2042	-0.6894	11.1925	1.9421	-5.608
10	19.18083	2.3084	30.25	5.8942	0.2824	-0.377	11.7375	0.1983	-10.46
11	20.69833	1.1753	8.6171	5.8808	0.8119*	-0.4603	11.3417	0.2159	-10.74
12	25.51167	1.4903*	-7.679	6.4467	0.1379	-0.8407	12.7742	1.8215	22.118
13	22.53667	1.5051*	-12.11	6.5892	0.1875	-0.3451	12.4125	0.3506	34.745
14	24.53417	2.1583*	-0.925	5.6683	1.4553*	-0.4726	12.7017	-0.602	-7.524
15	23.84333	2.2489*	-12.24	6.8133	0.0608	1.13178	11.5533	0.0864	4.0677
16	21.92667	1.1417	-0.918	5.735	0.334*	-0.6834	10.7858	-0.5418	-0.318
17	24.20917	1.7477*	-6.188	6.5433	0.5421*	-0.6882	12.98	-1.8515	25.42
18	21.44917	0.3869	-1.767	6.1008	0.0709	-0.8109	10.1942	1.018	-7.825
19	21.93583	0.6869	-7.26	5.57	0.4643*	-0.8206	11.3492	1.3552	-5.181
20	21.08333	1.4425*	-4.359	6.3492	0.8023*	0.02199	12.1008	0.7014	18.86
21	23.085	1.1968	4.9049	5.9367	0.067	-0.5377	13.4058	0.7664*	-12.83
22	21.64667	1.4476*	-11.58	5.815	0.4042*	-0.9386	10.3883	0.406	13.092
23	20.955	1.0637	-2.215	6.1567	0.6264*	-0.7808	12.47	-0.7302	-10.21
24	21.515	0.9913	-1.992	5.9633	0.5719*	-0.9624	11.7775	-0.3276	-12.37

Table 7: Continued

	Characters					
	PdW/P			SW/P		
Lines	Mean	b_i	$\bar{S}^2d_i$	Mean	b_i	$\bar{S}^2d_i$
1	4.0575	0.719*	-9.0119	2.0715	0.7914*	-1.9966
2	4.0192	0.7672*	-9.4614	2.2025	-0.3872	-1.8471
3	4.715	-0.2489*	-9.1691	2.4908	-1.1368	-1.2966
4	3.9933	0.5427*	-9.3697	2.095	-0.3594	-1.57
5	3.9625	0.8833*	-9.3711	3.3292	9.9864*	-0.2757
6	4.225	0.382*	-9.2767	2.2642	-0.4402	-0.7693
7	3.3142	0.3031*	-9.3468	1.7958	0.5124*	-2.0494
8	4.7183	1.0803*	-7.8856	2.2458	-0.845*	-2.0375
9	4.0097	1.4889*	-8.9324	2.175	0.6451*	-1.5732
10	3.6333	0.3947*	-8.9305	1.925	-0.0883	-1.5679
11	3.4642	0.561*	-8.3356	2.0342	0.2981	-2.0492
12	4.2175	0.3613	-7.9565	2.3767	-1.0924	-1.2992
13	4.245	0.2538	-7.0053	2.3475	-1.217	-0.4595
14	4.345	-0.144	-8.173	2.5258	0.3236	-0.9976
15	4.4308	0.3711*	-9.0738	2.5652	-0.6206	0.25938
16	4.1233	0.4138	-7.9448	2.175	0.5924	-1.2887
17	4.4067	-0.7231	-6.0188	4.1517	-0.4456	0.10935
18	3.6817	0.8504*	-8.1611	2.5892	-1.7335	0.5641
19	4.0542	0.8139*	-8.3876	2.1213	-0.1599	-1.643
20	4.035	0.5998	-6.3655	2.1842	0.6975	-1.1023
21	4.6908	0.5336*	-8.4267	2.3042	-0.3304	-2.0541
22	3.5742	0.7362*	-8.3147	1.7925	-0.2889	-0.9187
23	7.9033	-0.854	139.868	2.45	0.3774	-2.037
24	3.8658	0.635*	-8.2587	1.9814	0.877*	-2.0417

several researchers viz., Ananda (1968), Nandipuri *et al.* (1971), Singh and Singh (1976), Chaudhury and Paroda (1979), Khan *et al.* (2000) and Islam *el al.* (2002a, 2004) Heterogeneity of regression item was found to be non significant for all the characters except PHFF and SW/P. On the other hand, residual (2) item was significant for PHFF, NPd/P and PdW/P indicating that genotypes showed linear performance to the environments in which they were grown. Islam (2002) studied chilli and found similar result.

The results of the regression analysis are shown in Table 7. According to Freeman and Perkins (1971) model a desirable stable genotype should have: (I) high mean over all the environments, (ii) less standard error with unit regression coefficient (b_i = 1.0) and (iii) deviation from regression need to be zero or nearly zero ($\bar{S}^2d_i$ = 0). Following above conditions, line-5 for PHFF, line-4 for NBMF, line-8 for NPd/P and PdW/P were considered as stable genotypes having unit regression co efficient (b_i), non-significant deviation from regression ($\bar{S}^2d_i$) and high mean. Hence, line-5, line-4 and line-8 exhibited significant linear response to the changing environments for PHFF, NBMF and PdW/P, respectively. So, above these lines may be selected as stable genotypes for respective traits for further breeding research. This results are almost same as obtained by different workers in some other crops like maize by Momtaz *et al.* (1972), jute by Khandaker *et al.* (1989), groundnut by Alam *et al.* (1994), lentil by Islam *et al.* (2002b), chickpea Islam *et al.* (2003) and chilli by Islam *et al.* (2004).

Quantitative character called complex character, as it is control by many genes. The variation within quantitative characters is due to its complex inheritance and to the influence of environment (Fehr, 1978). The genotype×environment variance components were most important source of phenotypic variance for all the traits observed. Thus, the heritability estimates for all the characters found were low levels.

As a results, the low heritability and high G×E interactions indicated that yield and yield components are inherited in blackgram. Therefore, pure line selection for improved yield and yield components has a low achievement chance. Using family selection method one may increase success in breeding for improvement in the seed yield.

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