Plant Archives Vol. 15 No. 1, 2015 pp. 211-215 *ISSN 0972-5210*

GENOTYPE × ENVIRONMENT INTERACTION FOR SEED YIELD AND ITS COMPONENT TRAITS IN BLACK GRAM (*VIGNA MUNGO* L. HEPPER)

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Abstract

Thirty three black gram genotypes were evaluated over three diverse environments to identify stable genotypes for nine different characters in black gram. The stability analysis of variances of mean data revealed that the significant pooled deviation for almost all the traits except days to first flowering, number of branches per plant, number of pods per plant, number of seeds per pod and hundred seed weight indicated predominance of nonlinear component. Estimates for stability parameters revealed that no genotypes were stable for all traits studied. The genotypes COBG 683, ADT-5, ADT-3 and VBG-4 were found to have non-significant deviation from regression and around the unity regression coefficient along with desirable mean value for the trait seed yield per plant. These genotypes said to be suitable for both unfavourable/high input and favourable/low input environments for the trait seed yield per plant.

Key words : Black gram, stability, regression coefficient, mean squared deviation.

Introduction

Black gram / urd bean (*Vigna mungo* L. Hepper) is grown in various regions of India and cover practically all agro ecological zones. There are various genotypes of black gram having varying yield potential. The performance of genotypes keeps changing in varying environmental conditions. The genotypic and environmental interactions are usually present under all conditions in purelines, hybrids, synthetics or any other material used for breeding, which complicated the breeding work and forbid the progress of the crop improvement programmes (Eberhart and Russel, 1966). Thus, it is incumbent to study the performance of a crop over several or a wide range of environments. Such genotypes will be very useful for utilizing their potential for the development of stable and high yielding varieties.

Materials and Methods

Thirty three genotypes of black gram were evaluated in RBD with three replication under three diverse environments E_1: Environmental 1 (January, 2011), E_2: Environment 2 (August, 2011) and E_3: Environment 3 (January, 2012) for seed yield per plant. Mean values of five randomly selected plants from each replication were used for statistical analysis. Observations were recorded for nine characters *viz.*, days to first flowering, plant height (cm), number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per plant, hundred seed weight (g) and seed yield per plant (g). Statistical constants of mean for all the characters, regression coefficient (bi) and deviation from regression (s^2di) for the characters, where G × E interactions was significant was estimated by following the method proposed by Eberhart and Russel (1966).

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Results and Discussion

The pooled analysis of variance (table 1) revealed that higher significant differences existed among the genotypes (G) for all the traits except number of branches per plant, number of pods per cluster, number of seeds per pod and hundred seed weight. Highly significant differences were observed over environments for traits namely, plant height, number of clusters per plant, number pods per plant and seed yield per plant indicated the divergence among growing environments. The linear

Table 1 : Analysis of variance on stability parameters of black gram for nine characters studied.

Source	Df	MSS								
		Days to first flowering	Plant height	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Number of seeds per pod	Hundred seed weight	Seed yield per plant
Genotypes (G)	32	5.01**	83.00**	0.42	10.20**	0.99	79.86**	1.02	0.19	14.91**
Environment (E)	2	1.26	36.85**	0.15	3.95**	0.27	23.79**	0.41	0.08	3.78**
G × E	64	0.16	334.40**	0.19	11.31**	0.11	149.88**	0.65	0.12	7.13**
Env + (G×E)	66	1.30	27.55**	0.25	3.22**	0.27	19.85**	0.40	0.08	3.67**
Env (linear)	1	0.32	668.79**	0.38	22.63**	0.22	299.73**	1.31	0.24	14.26**
G×E (linear)	32	39.09**	83.00**	0.18	5.32**	0.13	19.29*	0.69	0.08	14.91**
Pooled deviation	33	1.33	15.65**	0.31	2.06**	0.40	19.23*	0.11	0.07	5.78**
Pooled error	198	0.78	0.58	0.12	0.57	0.08	5.05	0.17	0.05	0.15

*Significant at 5% level, **Significant at 1% level.

Table 2 : Performance of stable genotype with non-significant S^2di and around the unity bi for various traits;

S. no.	Traits	Genotype code	Genotype	Mean
1.	Days to first flowering (days)	G2	LBG 623	34.30
		G 19	**LBG 752**	**32.95**
2.	Plant height (cm)	**G 18**	**VBN 3**	**35.93**
		G 21	**COBG 683**	**31.73**
		G27	VBG 05-07	47.97
3.	Number of branches per plant	**G 1**	**COBG 662**	**2.97**
		G13	RU 8708	2.72
		G15	RU 8701	2.86
		G31	RU 8704	1.97
4.	Number of clusters per plant	G2	LBG 623	11.63
		G 23	**TMV 1**	**13.00**
		G27	VBG 05-07	9.49
		G 33	**KKB 20055**	**13.16**
5.	Number of pods per cluster	G2	LBG 623	2.59
		G 17	**VBG 4**	**3.22**
		G22	NIRMAL 7	3.16
		G29	COBG 647	2.60
		G30	VBG 05-014	2.65
6.	Number of pods per plant	G1	COBG 662	25.52
		G 3	**VBG 5**	**35.54**
		G 4	**T9**	**28.20**
		G11	VBG 05-02	25.50
		G 16	**TAU 1**	**29.47**
		G18	VBN3	25.61
		G23	TMV 1	26.33
		G28	VBG 05-008	26.73
		G 30	**VBG 05-014**	**31.62**
7.	Number of seeds per pod	**G 2**	**LBG 623**	**4.93**
		G4	T9	4.90
		G6	IC 214843	4.59
		G8	RU 8707	4.78
		G12	RU 8709	4.70
		G14	RU 8706	4.42
		G21	COBG 683	4.59
8.	Hundred seed weight (g)	**G 3**	**VBG 5**	**5.09**
		G 4	**T9**	**5.19**
		G 7	**IC 669**	**5.37**
		G 23	**TMV 1**	**5.28**
		G 26	**RU 8702**	**5.20**
		G29	COBG 647	4.97
9.	Seed yield per plant (g)	G17	VBG 4	8.93
		G15	RU 8701	5.56
		G 21	**COBG 683**	**10.53**
		G24	ADT-3	8.58
		G25	ADT-5	9.27

Table 2 continued....

Table 2 continued....

Bold Values = Favourable mean.

Table 3 : Performance of stable genotypes (seed yield per plant) for other traits.

Traits	G 15	G 17	G 21	G 24	G 25
Days to first flowering (days)	-	-	-	-	-
Plant height (cm)	-	-	Stable		-
Number of branches per plant	Stable	-	-	-	-
Number of clusters per plant	-	-	-	-	-
Number of pods per cluster	-	Stable	-	-	-
Number of pods per plant	-	-	-	-	-
Number of seeds per pod	-	-	Stable	-	-
Hundred seed weight (g)	-	-	-	-	-

Table 4 : The genotypes suitable for favourable environment with non-significant S^2di and more than the unity bi for various traits.

S. no.	Characters	Genotype code	Genotype	Mean
1.	Days to first flowering (days)	**G 4**	**T9**	**31.46**
		G 12	**RU 8709**	**33.28**
		G 14	**RU 8706**	**32.87**
		G 18	**VBN 3**	**32.95**
		G 25	**ADT-5**	**32.79**
		G27	VBG05-07	37.27
		G 28	**VBG 05-008**	**32.93**
		G29	COBG647	33.59
		G 33	**KKB 20055**	**31.48**
2.	Plant height (cm)	**G 26**	**RU 8702**	**38.73**
3.	Number of branches per plant	G11	VBG05-02	3.13
		G 16	**TAU 1**	**2.56**
4.	Number of clusters per plant	Gl0	KKB O5016	10.66
		G 15	**RU 8701**	**14.62**
		G16	TAU 1	9.77
		G18	VBN3	9.97
		G 24	**ADT-3**	**11.26**
5.	Number of pods per cluster	**G 6**	**IC 214843**	**3.52**
		G 15	**RU 8701**	**3.61**
		G21	COBG683	3.16
		G 23	**TMV 1**	**3.85**
		G27	VBG05-07	3.10
6.	Number of pods per plant	**G 8**	**RU 8707**	**35.61**
		G 9	**RU 8711**	**28.34**
		G 12	**RU 8709**	**30.82**
		G 17	**VBG 4**	**27.92**
		G 20	**COBG 653**	**29.88**
		G 21	**COBG 683**	**34.37**
		G 27	**VBG 05-07**	**29.36**

Table 4 continued....

7.	Number of seeds per pod	G1	COBG662	4.94
		G 7	**IC 669**	**5.81**
		G 9	**RU 8711**	**5.92**
		Gl0	KKB 05016	4.32
		G11	VBG05-02	3.91
		G 25	**ADT-5**	**5.95**
		G 26	**RU 8702**	**5.15**
		G31	RU 8704	4.91
8.	Hundred seed weight (g)	G1	COBG662	4.84
		G2	LBG623	5.03
		G 5	**IC 10703**	**5.45**
		G9	IC 214843	4.89
		G 10	**KKB 05016**	**5.17**
		G 11	**VBG 05-02**	**5.48**
		G 12	**RU 8709**	**5.24**
		G 13	**RU 8708**	**5.71**
		G 14	**RU 8706**	**5.28**
		G 19	**LBG 752**	**5.09**
		G20	COBG653	4.78
		G24	ADT-3	4.90
		G30	VBG05-014	4.59
9.	Seed yield per plant (g)	**G 8**	**RU 8707**	**10.91**
		G 9	**RU 8711**	**11.35**
		G 16	**TAU 1**	**10.76**

Table 4 continued....

Bold Values = Favourable mean.

contribution due to environment was highly significant for the traits plant height, number of clusters per plant, number of pods per plant and seed yield per plant. The mean square due to G × E interaction (linear) was also important for days to first flowering, plant height, number of clusters per plant, number of pods per plant and seed yield per plant. This indicated that a considerable proportion of genotype × environment interaction was contributed by the linear component. Highly significant

Table 5 : The genotypes suitable for unfavourable environment with non-significant S^2di and less than the unity bi for various traits.

S. no.	Traits	Genotype code	Genotype	Mean
1.	Days to first flowering (days)	G8	RU 8707	34.46
		Gl3	RU 8708	34.11
		G17	**VBG 4**	**32.68**
		G 20	**COBG 653**	**33.36**
		G21	COBG 683	34.15
		G 22	**NIRMAL 7**	**33.01**
		G24	ADT-3	33.66
		G26	RU 8702	34.78
		G30	VBG 05-014	33.70
		G 31	**RU 8704**	**33.27**
		G32	RU 8703	35.63
2.	Plant height (cm)	**G 4**	**T9**	**33.77**
		G20	COBG 653	41.10
		G 24	**ADT-3**	**33.61**
3.	Number of branches per plant	G4	T9	2.68
		G 5	**IC 10703**	**3.41**
		G8	RU 8707	2.56
		G 9	**RU 8711**	**3.00**
		G 17	**VBG 4**	**3.16**
		G 19	**LBG 752**	**3.35**
		G20	COBG 653	2.48
		G 23	**TMV 1**	**3.16**
		G 24	**ADT-3**	**3.45**
4.	Number of clusters per plant	G1	COBG 662	7.60
		G 8	**RU 8707**	**13.13**
		G12	RU 8709	9.16
		G 13	**RU 8701**	**13.40**
		G18	VBN 3	9.97
		G 25	**ADT-5**	**13.26**
		G 33	**KKB 20055**	**13.16**
5.	Number of pods per cluster	G1	COBG 662	2.71
		G 19	**LBG 752**	**3.64**
		G20	COBG 653	2.62
		G26	RU 8702	2.88
		G31	RU8704	3.11
		G33	KKB 20055	2.47
		G 4	**T9**	**28.20**
		G7	IC 669	22.03
		G14	RU 8706	18.31

Table 5 continued....

Table 5 continued....

6.	Number of pods per plant	**G 22**	**NIRMAL 7**	**29.18**
		G29	COBG 647	26.11
		G32	RU 8703	26.52
		G33	KKB 20055	26.57
7.	Number of seeds per pod	**G 5**	**IC 10703**	**5.15**
		G8	RU 8707	4.78
		G11	VBG 05-02	3.91
		G12	RU 8709	4.70
		G 13	**RU 8701**	**5.02**
		G15	RU 8701	4.71
		G 16	**TAU1**	**6.02**
		G17	VBG 4	4.66
		G 18	**VBN 3**	**5.52**
		G 19	**LBG 752**	**5.06**
		G20	COBG 653	3.35
		G 24	**ADT-3**	**5.19**
		G27	VBG 05-07	4.20
		G28	VBG 05-008	4.46
		G 29	**COBG 647**	**4.96**
		G30	VBG 05-014	4.91
		G 33	**KKB 20055**	**5.61**
8.	Hundred seed weight (g)	G25	ADT-5	4.85
		G27	VBG 05-07	4.52
		G28	VBG 05-008	4.78
		G31	RU 8704	4.92
		G32	RU 8703	4.94
		G 33	**KKB 20055**	**5.33**
9.	Seed yield per plant (g)	**G 5**	**IC 10703**	**10.15**
		G 11	**VBG 05-02**	**10.71**
		G12	RU 8709	9.78
		G 13	**RU 8708**	**10.05**
		G26	RU 8702	9.08
		G28	VBG 05-008	8.36
		G29	COBG 647	9.18
		G 33	**KKB 20055**	**13.96**

Bold Values = Favourable mean.

mean squares were observed for pooled deviation for the characters plant height, number of clusters per plant, number pods per plant and seed yield per plant revealing the importance of non linear component accounting for total G × E interaction for these characters. The highly significant effect of genotype × environment for most of the characters indicated differential response of genotypes

to various environments. Therefore, the genotypes must be tested over an extensive range of environments for proper assessment, where these are to be ultimately grown for commercial purposes. Similar findings were also reported by Abbas *et al*. (2008) in black gram with different set of genotypes.

The mean performance of a genotype along with two parameters *viz*., regression coefficient (bi) and deviation from regression (S^2di) considered simultaneously representing a measure of adaptability of the genotype. A genotype with desirable mean, deviation from regression line ($S^2di = 0$) not significantly deviating from zero and unit regression coefficient (bi = 1) not significantly deviating from 1 are said to be average responsive and suitable for all the environments. The genotypes COBG 683 (10.39 g), VBG 4 (8.93 g), ADT 5 (9.27 g) and ADT 3 (8.58 g) were considered as best adapted genotypes for all the environments for seed yield per plant (table 2). The genotype VBG 4 showed non-significant deviation from regression and regression coefficient as around the unity for other character namely, number of pods per cluster. The genotypes ADT 5 and ADT 3, which showed non-significant deviation from regression and regression coefficient as around the unity for seed yield per plant, did not show for other characters. The genotype COBG 683 showed stable performance for other traits namely plant height and number of seeds per pod (table 3).

A genotype with desirable mean, deviation not significantly deviating from zero and significant unit regression coefficient value (bi > 1) is said to be highly responsive and suitable for favourable environments (table 4). The genotype RU 8711, TAU 1 and RU 8707 had significant mean value with non-significant S^2di value and significant with more than unity regression coefficient value (bi > 1). The genotype TAU 1 showed non-significant deviation from regression and regression coefficient as more than the unity for other characters namely, number of clusters per plant and number of branches per plant. The genotypes RU 8707 and RU 8711 showed non-significant deviation from regression and regression coefficient as more than the unity for the traits number of pods per plant and number of seeds per pod.

A genotype with desirable mean, deviation not significantly deviating from zero and significant unit regression coefficient value (bi < 1) is said to be low responsive suitable for unfavourable environments (table 5). The genotypes IC 10703, VBG 05-02, RU 8708 and KKB 20055 showed non-significant deviation from regression and regression coefficient as less than the unity for seed yield per plant. These genotypes were suitable for unfavourable or poor environments. The genotype KKB 20055 showed non-significant deviation from regression and regression coefficient as less than the unity for number of clusters per plant, number of seeds per pod, hundred seed weight and number of pods per cluster. The genotypes IC 10703 and VBG 05-02 showed non-significant deviation from regression and regression coefficient as less than the unity for number of seeds per pod.

The results suggested that no single genotype was stable for all the traits studied. On the basis of mean performance and stability parameters, the genotypes namely COBG 683, VBG 4, ADT 5 and ADT 3 were considered as stable one. These genotypes may be recommended for commercial cultivation or used as parent in crossing programme aimed at breeding a high yielding variety with general adaptability.

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