



Comparison of Different Stability Parameters in Blackgram [*Vigna mungo* (L.) Hepper]

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ABSTRACT

The study of different stability parameters in blackgram genotypes in six environments indicated that stability parameters like Wricke's (1962) ecovalence, mean variance due to genotypes-environment interaction of Plaisted and Peterson (1959), variance or information of ranks over environments and Shukla's stability variance gave similar results to that of the deviation from regression (S^2_d) of Eberhart and Russell (1966), whose calculation is cumbersome. All these methods indicated more stable genotypes like 1 (AKU-7), 6 (PBG-1), 7 (PBG-107) for plant height; 1 (AKU-7), 3 (T-9), 8 (MBG-162) for number of primary branches per plant; 2 (LBG-752), 5 (LBG-17), 11 (LBG-623) for number of pods per plant; 2 (LBG-752), 5 (LBG-17), 4 (LBG-20) for 1000 seed weight; 2 (LBG-752), 4 (LBG-20), 12 (LBG-645) for seed yield per plant; 5 (LBG-17), 10 (LBG-648), 11 (LBG-623) for yield kg/plot over environments.

Key words : Blackgram, Stability.

Blackgram is an important pulse crop cultivated round the year in almost all parts of India. In Andhra Pradesh, it is grown in 4.21 lakh hectares with an annual production of 2.50 metric tonnes, with a productivity of 695 kg/ha. When varieties are evaluated over a series of environments the relative ranking usually differ. Varieties are known to differ genetically for their stability across environments. Knowledge on the genotype – environment interactions is the basic requirement to a plant breeder for successful crop improvement (Manikannan *et al.* 2002). The present study was undertaken to evaluate different stability parameters for the stability of yield and its components in some blackgram genotypes.

MATERIAL AND METHODS

Twelve genotypes namely AKU-7, LBG-752, T-9, LBG-20, LBG-17, PBG-1, PBG-107, MBG-162, MBG-207, LBG-648, LBG-623 and LBG-645 were sown during *rabi*, 2006 (six environments) three sowing dates i.e 15-09-2006, 30-09-2006 & 15-10-2006; with two fertility levels i.e 20kg N: 50kg P per ha (only basal) and 20kg N: 50kg P per ha (basal) + 20kg N per ha (top dressing) in each date of sowing thus providing six environments for study in Agricultural Research Station (ARS) Madhira, Khammam (District) in Andhra Pradesh. Material was grown in randomized block design with three replications with 4m long plots of 4 rows per genotype per replication. An inter- and intra-row spacing of 30cm and 10 cm was practiced. The observations on plant height, number of primary

branches per plant, number of pods per plant, 1000 seed weight, seed yield per plant and yield kg/plot were taken. Statistical analysis was carried out using regression model (Eberhart and Russell, 1966), stability factor (Lewis, 1954), ecovalence (Wricke, 1962) method, pair wise analysis (Plaisted and Peterson, 1959), genotypic stability (Hanson, 1970) and stability random (Shukla, 1972) variance of each genotype over environments, mean of ranks of each genotype over environments. Rank correlation coefficients among different stability parameters were worked out as per Spearman (1904).

The mean values of genotypes over environments were ranked in order of superiority such that the genotype with 1st rank was the one with maximum mean and the one with 12th rank with minimum mean. Similarly another parameter mean of ranks over environments was calculated. Genotypes in each environment were ranked and mean and variance or information of ranks over environments for a genotype was calculated. The means of ranks were ranked such that the genotypes with 1st and 12th rank were the one with greater and least desirability respectively. The variance values of the ranks over environments were ranked such that the genotype with 1st rank or least variance may prove desirable compared to the one with 12th rank and with maximum variance.

Thomson and Cunningham (1979) ranked cotton cultivar yields in individual environments and calculated standard deviation of these ranks for each cultivar as a measure of consistency of performance denoted by CI (consistency index). This provides a

Table 1. Rank correlation coefficients between pairs of different stability parameters in blackgram [*Vigna mungo* (L.) Hepper]

	variance	Mean rank	Var.rank	SF	Mean GxE	Ecovalence	S ² di	bi	Hanson's genotypic stability	Shukla's variance
Mean	-0.042	0.897**	-0.512	-0.021	-0.126	-0.203	-0.308	-0.497	-0.265	-0.279
	-0.497	0.979**	0.014	-0.273	-0.056	0.455	-0.021	0.133	-0.188	-0.489
variance		0.026	0.026	0.608*	0.105	-0.238	0.133	-0.028	0.409	-0.171
		-0.545	0.675*	0.231	0.573	0.762**	-0.154	0.343	0.412	0.734*
Mean of rank			-0.573	0.061	-0.131	-0.229	-0.145	-0.439	-0.236	-0.267
			-0.038	-0.301	-0.133	-0.497	0.049	0.070	-0.160	-0.517
Variance of rank				0.264	0.418	0.544	-0.110	0.505	0.169	0.617
				-0.189	0.703*	0.636	0.220	0.322	0.038	0.594
Stability factor					0.322	0.294	-0.350	-0.014	0.328	0.370
					0.259	0.217	-0.140	-0.112	0.069	0.258
Mean variance due to GxE(+)						0.776**	-0.133	0.762	-0.272	0.818**
Ecovalence						0.762**	0.182	0.301	-0.188	0.734*
							-0.524	0.678	-0.027	0.958**
							0.126	0.441	0.020	0.979**
S ² Deviation from regression								0.147	-0.377	-0.328
bi								0.000	-0.741**	0.076
									0.104	0.727*
									0.027	0.349
Hanson's genotypic stability										-0.153
										0.118

Thin: Number of pods per plant

Bold: yield kg/plot

measure of consistency resulting from changes in the ordering of the genotypes from one environment to the next. Huhn and Leon (1985) worked out "mean rank difference" (according to Huhn, 1979) for judging the stability of genotypes of *Brassica napus*. Variance of genotype over environments may indicate the stability of a genotype. A genotype with least variance over environment may show less fluctuation to the frequent changes in the environments.

Wricke's ecovalence over environments and variety – environment interaction variance of a genotype proposed by Plaisted and Peterson (1959) also indicate a genotype's contribution to the total interaction variance of genotype and environment. However, these differ from the earlier parameter variance genotype over environments such that these two models take care of the replication and error effects.

Other workers Luthra and Singh (1974) in wheat, Kang and Miller (1984) in sugarcane and Huhn and Leon (1985) in winter rape also used these models for study of genotype – environment interaction. The high mean (\bar{x}), unit regression coefficient (b) and non-significant deviation from regression (S²d) proposed by Eberhart and Russell (1966) define a stable genotype.

Huhn and Leon (1985) reported numerically low or intermediate rank correlation coefficients between mean of the lines and different stability parameters like variance, ecovalence, genotypic stability, regression coefficient, sum of squared deviations from the regression and mean rank difference.

According to Shukla's (s_i²) stability variance the genotype with 12th rank or least variance and non-significant may prove stable to fluctuations in environments compared to the genotype with first rank or maximum variance and significant. Hanson (D_i²) genotypic stability is a measure which combines the information from equivalence and regression into a simple useful measure of yield stability. In this model the genotypes with least variance over environments were considered to be stable and were ranked as 12th and vice versa.

RESULTS AND DISCUSSION

A comparison of different stability parameters was made based on rank correlation coefficients between pairs of these parameters (Table 1, 2 & 3) and by empirically comparing the stable or desirable genotypes under each of these parameters (Table 4).

Table 2. Rank correlation coefficients between pairs of different stability parameters in blackgram [*Vigna mungo* (L.) Hepper]

	variance	Mean rank	Var.rank	SF	Mean GxE	Ecovalence	S ² di	bi	Hanson's genotypic stability	Shukla's variance
Mean	-0.580	0.993**	0.145	-0.196	0.033	-0.091	-0.252	-0.070	-0.580	-0.152
variance	0.224	0.986**	-0.360	0.224	0.238	0.063	0.091	-0.322	0.223	0.062
Mean of rank		0	0.215	-0.140	0.110	-0.038	-0.196	-0.007	-0.552	-0.101
Variance of rank			-0.357	0.231	0.206	0.066	0.066	-0.325	0.229	0.082
Stability factor				0.715**	0.934**	0.862	0.498	0.481	0.501	0.838**
Mean variance due to GxE(+)				0.269	0.108	0.143	-0.413	-0.374	0.192	0.143
Ecovalence					0.851**	0.867	0.455	0.476	0.804**	0.843**
S ² - Devation from regression					0.881**	0.888	-0.140	-0.042	0.986**	0.888**
bi						0.865	0.624	0.575	0.543	0.852**
Hanson's genotypic stability						0.930	-0.028	0.266	0.881**	0.951**
							0.427	0.594	0.748**	0.871**
							0.203	-0.063	0.888**	1.000**
								0.105	0.272	0.667*
								0.231	-0.104	-0.062
									0.230	0.486
									-0.041	0.202
										0.850**
										0.888**

Normal font: Number of pods per plant

Bold font: yield kg/plot

In the present study the mean and mean of ranks were significantly and positively correlated for all characters considered in the study as they are similar calculations and have same criteria for defining a stable genotype. The genotypes classified as more or less stable are the same in both these cases (Table 4).

The variance over environments and stability factor showed close association among stable or unstable genotypes for different characters. This was confirmed by the genotypes ranked as stable under these two parameters. For example for protein content genotypes 8,12,4 ranked as high stable and genotypes 6,7,11 ranked as less stable according to these two parameters.

Variance positively associated with mean variance due to GXE according to Plaisted and Peterson (1959) for number of pods per plant, with ecovalence per plant height, yield kg/plot, number of pods per plant and seed yield per plant, with Hanson (D^2_i) genotypic stability for number of pods per plant, yield kg/plot, number of primary branches

per plant and plant height, with Shukla's (σ^2_i) stability variance for number of pods per plant, plant height, seed yield per plant and yield kg/plot.

Variance of ranks and mean variance due to genotype environment interaction (Plaisted and Peterson, 1959) were positively significant for plant height, number of primary branches per plant, yield kg/plot and seed yield per plant. Variance of ranks was also associated with ecovalence for number of primary branches per plant, yield kg/plot and seed yield per plant, with Shukla's (σ^2_i) stability variance for number of primary branches per plant, yield kg/plot, with deviation from regression significant for all the characters under study.

Stability factor had positive association with mean variance due to genotype environment interaction and ecovalence for number of pods per plant and yield kg/plot, with Hanson (D^2_i) genotypic stability for number of pods per plant, yield kg/plot, number of primary branches per plant and plant height, with Shukla's (σ^2_i) stability variance for number of pods per plant, yield kg/plot and plant height.

Table 3. Rank correlation coefficients between pairs of different stability parameters in blackgram [*Vigna mungo* (L.) Hepper]

	variance	Mean rank	Var.rank	SF	Mean GxE	Ecovalence	S ² di	bi	Hanson's genotypic stability	Shukla's variance
Mean	-0.462	0.988**	0.166	-0.077	0.070	-0.042	-0.657*	0.168	-0.454	-0.0416
variance	-0.357	0.993**	-0.624	-0.259	-0.734**	-0.720	-0.329	-0.091	-0.314	-0.720**
Mean of rank		-0.407	0.309	0.881**	0.266	0.650*	0.231	-0.042	0.944**	0.650*
Variance of rank		-0.392	0.509	0.979**	0.462	0.524	0.503	0.056	0.993**	0.524
Stability factor			0.192	-0.016	0.040	-0.054	-0.666*	0.173	-0.402	-0.059
Mean variance due to GxE(+)			-0.167	-0.287	-0.699*	-0.685	-0.301	-0.049	-0.349	-0.685*
Ecovalence				0.467	0.624*	0.474	-0.142	0.288	0.246	0.473
S ² Deviation from regression				0.418	0.935**	0.897	0.449	0.456	0.449	0.896**
bi					0.413	0.650	-0.035	0.105	0.860**	0.650*
Hanson's genotypic stability					0.399	0.469	0.524	0.000	0.986**	0.468
						0.678	0.294	0.650*	0.237	0.678*
						0.951	0.559	0.406	0.412	0.951**
							0.098	0.329	0.475	1.000**
							0.469	0.531	0.468	1.000**
								-0.056	0.293	0.097
								0.042	0.552	0.531
									-0.069	0.328
									0.013	0.468
										0.475
										0.468

Normal font: Number of primary branches per plant

Bold font: plant height

Mean variance due to genotype - environment interaction had significant positive association with ecovalence and with Shukla's (σ^2_i) stability variance for all the characters under study, with deviation from regression for yield kg/plot and with regression coefficient for plant height and 1000 seed weight, with Hanson (D^2_i) genotypic stability for number of pods per plant.

Ecovalence showed significant positive association with regression coefficient for yield kg/plot and 1000 seed weight, with Shukla's (σ^2_i) stability variance for all the characters under study, with Hanson (D^2_i) genotypic stability for number of pods per plant and yield kg/plot.

The study indicates similarity of results for spotting stable genotypes according to ecovalence, variance due to genotype - environment interaction of Plaisted and Peterson, b and S²d of Eberhart and Russell, σ^2_i , D^2_i and variance or information of ranks. The study also indicated as far as the spotting of stable genotypes simple methods like ecovalence

and variance of ranks shall give similar results like S²d whose calculation is cumbersome. The above simpler techniques may be applied as per suitability of experiment and convenience of the experimenter.

Luthra and Singh (1974) observed low rank correlation coefficient between ecovalence and deviation due to regression of Eberhart and Russell (1966). They however, observed that the most stable varieties could be detected by using any of these methods. In the present study the significant rank correlation between ecovalence and deviation due to regression of Eberhart and Russell (1966) was noticed because the genotype classified as more and less stable are almost same under both these methods. Whereas, in the experiment of Luthra and Singh (1974) though, the stable genotypes were same according to both methods the two methods differed in spotting less stable genotypes resulting in low rank correlation coefficients between the rankings of genotypes.

Table 4 More (HS)and less (LS) stable genotypes according to different stability parameters of blackgram [Vigna mungo (L.) Hepper]

Character	Mean		Variance		Mena of ranks		Variance of Stability factor ranks		Mean variance due to GxE(+)		Ecovalence		S ² di		bi		Hanson's genotypic stability		Shukla's Variance		
	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	HS	LS	
Days to 50% flowering	3,1,4	5,10,2	3,5,10	9,11,12	3,1,4	5,10,12	1,3,5	9,7,11	3,5,9,11,12	12,11,4	9,8,7	3,5,1	9,11,2,7,4	9,11,8	3,5,4	12,9,2	10,2,3	9,11,12	3,5,1	9,11,8	
Days to maturity	4,6,1,	10,12,7,3,8,1	10,6,4	4,6,1	10,12,7	11,3,4	9,7,10	3,2,8	6,10,4	8,5,3	10,6,4	1,2,8	10,6,4,10,9,5	6,1,2	8,12,3	10,4,11	4,11,7	10,6,9	1,2,8	10,6,4	
Plant height	6,7,12	3,1,9	9,5,4	8,12,11	6,7,12	3,1,9	3,6,7	8,11,2	9,5,4	8,11,12	7,1,6	8,11,12	6,5,10	8,12,1,2,3	8,12,6	1,7,8	11,12,2	9,4,2	8,11,12	6,5,10	8,12,11
No. of primary branches /plant	6,10,5	1,3,8	4,5,3	11,10,6	10,5	3,8,1	11,10,2	5,4,2	11,10,6	3,8,1	10,11,6	3,1,7	10,11,6,2,9,7	10,6,11	6,1,3	11,12,4	4,5,2	11,10,12	3,1,7	10,11,6	
No. of pods / plant	9,10,6	3,7,1	11,9,12	3,10,6	9,6,10	3,7,9	6,8,2	11,9,12	3,10,6	11,5,2	3,6,10	5,11,1	3,6,10,4,10,8	3,6,11	2,5,8	10,9,12	11,9,12	3,10,6	5,11,1	3,6,10	
No. of pod / plant	6,5,4	10,11,9,6,4,9	3,12,1	6,4,5	2,5,9	6,11,10	3,12,1	6,4,9	3,12,1	6,4,7	3,12,2	10,8,4	3,12,11,7,12	3,10,6	7,5,10	3,12,6	6,4,9	12,3,1	10,8,4	3,12,1	
1000 seed weight (gm)	6,7,4	2,9,10	8,1,6	4,12,2	6,7,12,1,9,8	6,10,2	4,8,12	8,6,1	4,2,3	5,10,11	4,7,2	5,10,1	4,7,9	7,2,12	4,1,8	9,5,11	4,7,8	7,8,6	4,12,2	5,10,1	4,7,9
Seed yield / plant (g)	10,7,6	1,8,9	7,8,1	3,9,10	10,7,1,3,8	9,1,2	6,11,4	7,8,2	10,6,1	2,5,4	6,8,10	9,2,5	10,8,10,1,11	6,2,7	1,9,4	6,8,10	8,6,7	10,11,2	9,2,5	6,10,8	
Yield Kg/plot	6,11,10	1,3,8	4,5,1	9,10,8	6,10,1,3,2	6,1,4	9,8,11	7,8,2	10,6,1	12,2,4	9,11,8	2,1,7	9,11,6,8,10	11,9,2	11,7,6	9,8,10	9,5,4	8,10,12	2,1,7	11,10,9	
Protein content	6,9,10	1,3,2	1,4,11	6,9,8	6,10,9,3,2,11	12,10,4	9,8,7	11,5,10	6,9,8	10,5,11	9,6,8	4,11,2	9,6,8	3,5,7	9,8,6	8,10,11	6,9,1	1,2,4	6,9,8	1,2,3	9,6,8
	4,5,10	2,3,11	10,9,4	6,7,1	4,5,10	4,3,10	1,6,7	10,9,4	6,7,11	2,5,3	7,6,8	5,10,4	7,6,1	12,3,4	7,1,8	8,12,4	6,7,11	10,9,4	6,11,7	5,4,10	7,6,1

(+) = Mean variance due to genotype × environment (Plaisted and Peterson, 1959)

Note = The figures in the table are serial no.of the genotypes.

The other parameters like mean, stability factor, mean of ranks and variance over environments may not specify the same genotypes as in case of other parameters like b and S^2d and may not be very useful due to the fact that, the first three parameters employ the mean which is a first order statistics and the partitioning of treatment and error effects was not there in calculation of these parameters.

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