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Research Article

Stability analysis in black gram (*Vigna mungo* L.) genotypes

Rajmohan Sharma and S.K. Rao
Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) 482004
E-mail : sharma.rajmohan@gmail.com

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Abstract
The present study was carried out to investigate the extent of genetic diversity and identify promising genotypes for future utilization. The experiment comprising of thirty five genotypes of urd bean was laid out with three replications in four environments in a randomized complete block design at Ganjbasoda, district Vidisha (Madhya Pradesh). Stability analysis revealed that JU 8-6 appeared as promising genotype for seed yield per plant. It could be recommended for general cultivation to improve the urd bean production in Madhya Pradesh. BARC Urd -1, a high yielding genotype, can be recommended for stress conditions. Other high yielding genotypes namely T-9, TU 92-3 and IU 83-4 were found suitable for favourable condition of crop growth.

Key words
Vigna mungo, stability analysis.

Introduction

Black gram (*Vigna mungo* L.) or urdbean is an important short duration pulse crop grown in India. Although black gram has been identified as a high yielding crop in many Asian countries, but due to its sensitivity to environmental fluctuation, high yielding and stable genotypes are yet to be explored for particular environment. Various biometrical and taxonomic techniques have been successfully used to classify and measure the pattern of genetic diversity in legumes (Shanmugam and Sreerangaswamy, 1982; Dasgupta and Das, 1984, 1985). In India, it is grown in an area of about 3.29 m ha. with a total production of 1.6 MT with an average productivity of 485 kg/ha (Annual Report of AICRP MULLaRP, 2010). Andhra Pradesh ranks first in area and production followed by Madhya Pradesh, Orissa and Maharashtra, while Karnataka leads in productivity followed by Andhra Pradesh.

The productivity of urdbean is very low as compared to other pulses. Hence, efforts should be concentrated in increasing the yield potential by developing high yielding stable varieties having resistance to diseases and insect pests. The yield of urdbean can be further substantiated by incorporating the genes for non shattering, synchronous maturity and infusing seed dormancy. Blackgram have narrow genetic base offering limited scope of adequate variability in the existing gene pool thus restricting creation of new traits desired for developing varieties with high yield and tolerance to biotic and abiotic stresses. Conventional breeding needs to be focused on development of high yielding varieties with wider adaptation. In the present study, an effort was made to identify suitable parents having stability and wider adaptability for different environments.

Materials and methods

The experimental material used in present study comprised of thirty five genotypes of urdbean collected from the genetic stock maintained at Department of Genetics and Plant Breeding, JNKVV, Jabalpur. The present experiment was conducted in Randomized Complete Block Design with three replications in four environments namely *zaid* 2011, *kharif* 2011, *zaid* 2012 and *kharif* 2012 with row to row distance 30 cm. and plant to plant distance 15 cm. The full package of practices, recommended for urdbean cultivation in Madhya Pradesh was strictly adopted for optimum crop growth. The agronomical operations were timely carried out.

Five competitive plants were randomly tagged in each genotype, in each replication and each environment for recording observations for days to 50 % flowering, number of branches per plant, number of pods per plant, YMV incidence, days to maturity, plant height (cm), biological yield per plant, 100 seed weight (g), harvest Index (%) and seed yield per plant (g). The data was analyzed to estimate the stability parameters for varieties under different environments as per model of Eberhart and Russell (1966).

Results and discussion

Stability analysis of variance revealed highly significant variation among the genotypes for days to 50 % flowering, days to maturity and 100 seed weight (Table 1). The mean sum of squares due to environment (linear) were highly significant for characters *viz.* number of branches per plant, number of pods per plant, plant height, biological yield per plant, 100 seed weight, harvest index and seed yield per plant. Genotype x environment interaction (linear) was also significant for number of pods per plant, 100 seed weight, biological yield per plant and seed yield per plant. It revealed that prediction of performance of the genotypes based on stability analysis may be reliable but the significant estimates of mean sum of squares due to pooled deviation from regression for all the characters showed the existence of unpredictable components of genotype x environment interaction. Hence care should be taken in the selection of genotypes based on stability analysis from the present material. The existence of linear and non linear components of genotype x environment interaction for different characters in urd bean has also been emphasized by Ghulam *et al*. (2008), Cholin *et al*. (2009) Konda *et al*. (2009), Singh *et al*. (2009) and Revanappa *et al*. (2012).

Finlay and Wilkinson (1963) considered the linear regression as a measure of stability. Eberhart and Russel (1966) suggested that linear regression is a measure of response and emphasized the need of considering both linear and non linear components of genotype x environment interaction in determining the stability. In the present study mean performance, regression coefficient and deviation from the regression were estimated for the stability of urd bean genotypes.

IU 94-3 recorded the highest mean seed yield per plant over the environment followed by IU 88-10 and T-9 T (Table 4). JU 8-6 was found responsive and stable for seed yield per plant having regression coefficient close to unity and zero deviation from regression coefficient. It is also responsive during stress condition for days to maturity. IU 94-3, IU 88-10, T-9 and KU 301 were identified as high yielder and responsive to favourable conditions. Co-5, TU 65-1, TPU-4 and IU 62-219 were suitable for stress conditions having negative estimate of regression coefficient. TU 31-13 and TU 92-3 were found stable and suitable for favourable condition having regression coefficient greater than one and deviation from regression coefficient around zero and above average seed yield per plant. These genotypes can be recommended for general cultivation in Madhya Pradesh in order to stabilize seed yield per plant in urd bean.

Magnitude of regression coefficient and deviation from regression varied from -5.64 to 5.25 and 0.36 to 1.32 for days to 50 % flowering, 0.36 to 1.32 and 0.07 to 0.81 for number of branches per plant, -1.79 to 3.61 and -2.85 to 48.23 for number of pods per plant, -45.5 to 80.5 and -0.15 to 6.18 for yellow vein mosaic incidence, 6.82 to 12 and -0.19 to 11.27 for days to maturity, 0.01 to 1.73 and -5.58 to 73.88 for plant height, -0.47 to 2.65 and -3.57 to 33.33 for biological yield per plant, -1.0 to 3.19 and 0.04 to 0.51 for 100 seed weight, 0.14 to 2.46 and - 9.39 to 619.76 for harvest index and -0.76 to 3.34 and 0.35 to 5.22 for seed yield per plant respectively (Tables 2 to 4). It revealed that response of genotypes to changing environmental conditions and their stability mechanism are the genetic property of an individual genotype and thus varies from genotype to genotype.

BARC urd 1, IU 65-2, Pant urd – 19 and TU 98-14 were the average yielders, responsive to stress condition and found stable for seed yield per plant. These genotypes may be utilized as parents in hybridization programme to develop varieties suitable for stress condition. IU 83-4, T-9, TU 31-13, TU 92-3 and Azad urd-1 are above average yielder responsive to favourable conditions and showed stability for yield per plant. Therefore, these can serve as donors for genetic amelioration programme. Responsiveness and stability in seed yield was found associated with stability and responsiveness in yield attributes. Stability in high yielding and average responsive genotype T-9 was attributed due to stability in 100 seed weight. Similarly, stability in high yielding genotype TVM -1 was attributed due to stability for number of pods per plant and biological yield per plant. Number of pods per plant attributed stability for favourable condition in BARC urd-1, IU 65-2, TU 92-3 and IU 83-4.

In general, responsive to favourable condition and stability in both high and low yielding genotypes was reflected due to stability and responsiveness in number of pods per plant, days to maturity, yellow vein mosaic incidence and 100 seed weight. More or less similar findings were noted for responsiveness in favourable conditions and stability of genotypes by Naidu and Satyanarayan (1991 b) and Gupta *et al*. (2009). Perkins and Jinks (1968) have also emphasized that parameters of stability were governed by independent genetic systems which are in agreement with the results of the present study.

An overall observation of stability analysis revealed that JU 8-6 appeared as promising stable genotype for seed yield per plant. It can be recommended for general cultivation to stabilize the urdbean production in Madhya Pradesh. BARC urd -1 a high yielding genotype could be recommended for stress conditions. Other high yielding genotypes like T-9, TU 92-3 and IU 83-4 were found suitable for favourable conditions of crop growth.

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Table 1. Pooled analysis of variance for seed yield per plant and its components in urdbean

Source of variation	d.f.	Mean sum of squares									
		Days to 50 % Flowering	No. of branches/ plant	No. of pods/ plant	YMV incidence	Days to maturity	Plant height	Biological yield/ Plant	100 seed weight	Harvest Index	Seed yield/ plant
Total	139	5.295	1.848	18.566	1.761	5.271	76.807	95.511	0.289	118.142	4.530
Genotypes	34	19.293***	0.293	21.132	1.652	16.578***	32.094	48.591	0.435***	58.863	3.252
Environments	3	0.935	72.909***	134.396***	0.021	0.733	2267.551***	2164.715***	2.085***	2149.751***	73.267***
Env. + (Var * Env)	105	0.762	2.351***	17.735*	1.797	1.609	91.285***	110.705***	0.242*	137.337*	4.944
Environments (Linear)	1	2.805	218.726***	403.188***	0.063	2.198	6802.653***	6494.144***	6.256***	6449.254***	219.802***
Var. x Env. (Linear)	34	0.535	0.354	19.697*	1.840	0.861	31.088	128.205***	0.256*	53.812	5.973***
Pooled deviation	70	0.843***	0.230***	11.276***	1.801***	1.964***	24.647***	11.013***	0.149***	87.735***	1.375***
Pooled error	272	0.377	0.076	3.002	0.224	0.197	5.720	3.789	0.039	11.842	0.356

* at 5 % probability, ** at 1 % probability and *** at 0.1 % Probability

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Table 2. Stability parameters for Days to 50 % flowering, No. of branches per plant, No. of pods per plant and YMV incidence in urdbean

S. No.	Genotypes	Days to 50 % flowering			No. of branches per plant			No. of pods per plant			YMV incidence		
		Mean	Bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1	Pant Urd 19	42.83	3.48	-0.37	2.93	0.65	-0.02	16.22	-0.12	2.13	6.00	-7.00	6.18
2	Narendra - 1	40.75	-0.63	0.65	2.52	0.98	0.64	15.46	-0.02	5.94	5.33	21.00	4.05
3	TVM1	41.50	-1.72	0.00	2.38	1.21	0.01	14.57	1.05	0.04	5.17	59.50	0.29
4	BARC Urd1	44.42	4.85	-0.29	2.98	0.78	0.11	18.47	1.86	14.21	4.83	-38.50	1.27
5	PU -13	42.08	-3.26	1.12	2.46	1.15	0.81	14.30	0.89	0.14	5.67	-14.00	0.49
6	U-10	41.90	1.59	-0.22	2.03	1.08	-0.07	12.47	0.15	-0.89	6.17	24.50	0.29
7	ADT 5	39.85	2.84	2.54	2.40	0.75	0.35	14.20	0.64	-2.61	5.83	-31.50	0.38
8	KU 301	43.57	1.10	0.07	2.93	0.90	0.40	19.65	2.43	-1.84	5.83	-10.50	1.18
9	Mash404	44.20	3.20	0.40	2.38	0.72	0.22	12.02	-0.41	4.78	5.17	24.50	2.07
10	LBG 623	39.96	1.34	1.69	1.99	0.91	-0.06	13.57	0.88	1.98	4.83	10.50	0.74
11	Co-5	44.73	-2.69	-0.12	2.72	0.57	0.07	13.97	0.92	18.90	5.17	24.50	1.18
12	T-91	46.03	2.60	0.21	1.96	0.36	0.42	15.79	0.34	5.90	5.67	-28.00	2.18
13	T-9	44.76	4.39	0.27	2.46	1.20	-0.05	18.42	3.61	-0.35	6.00	-21.00	0.49
14	TAU-1	43.80	-1.28	-0.07	2.67	1.32	0.29	15.95	1.56	1.39	6.17	-3.50	0.83
15	LBG-20	44.28	5.25	-0.32	2.22	1.22	-0.05	15.97	1.54	0.84	5.83	24.50	0.74
16	TU 92-14	41.20	3.44	-0.31	2.55	1.26	0.07	16.77	2.31	19.47	5.00	-28.00	0.85
17	TU-65-1	41.03	0.07	-0.15	2.30	1.31	-0.05	17.48	1.98	-1.15	4.83	24.50	1.18
18	TU31-13	42.53	0.77	-0.33	2.38	1.28	0.22	18.46	2.73	-2.32	4.00	14.00	0.71
19	IU86-1	44.00	2.16	-0.14	2.24	0.95	-0.07	16.24	3.16	48.23	4.00	0.00	0.89
20	IU98-843	38.82	1.58	-0.19	3.04	1.05	0.01	19.62	3.58	18.08	4.17	17.50	0.56
21	IU-65-2	38.33	-5.64	1.31	2.38	1.23	0.10	16.38	1.55	12.75	4.67	-21.00	2.27
22	TAU-1-1	43.64	1.56	0.04	2.68	0.97	0.19	17.50	-0.43	0.03	5.67	14.00	1.83
23	TU-92-3	44.50	1.07	-0.10	2.53	1.31	-0.05	19.57	2.82	7.89	5.67	-42.00	0.40
24	TPU-4	42.19	-2.14	-0.26	2.63	0.67	0.25	13.91	-0.05	-2.11	5.50	-17.50	2.78
25	TAU-4	41.83	1.32	-0.30	2.02	0.90	-0.01	13.75	0.03	-1.12	5.17	38.50	1.27
26	TU98-14	38.87	1.94	0.32	2.34	1.08	0.21	15.48	1.43	1.63	5.33	35.00	2.89
27	JU-2	41.72	0.52	-0.23	2.27	0.79	0.05	19.93	-0.12	28.69	4.83	-45.00	4.29
28	JU-8-6	41.20	3.44	-0.31	2.63	1.17	-0.01	20.16	0.11	18.93	5.17	-31.50	4.38
29	IU 83-5	38.93	1.37	-0.10	2.39	0.81	0.19	13.77	-1.79	-1.86	5.50	80.50	-0.15
30	IU62-219	43.31	2.27	3.25	2.53	1.23	0.12	18.45	-0.08	3.45	4.50	-45.50	1.18
31	IU83-4	46.60	0.88	-0.06	2.62	1.19	0.06	18.43	1.16	4.69	4.83	-17.50	1.45
32	IU94-3	41.59	2.42	2.38	2.26	0.92	0.50	13.28	-1.13	11.62	5.33	56.00	0.71
33	IU88-10	44.09	-0.80	0.24	2.49	1.02	0.31	18.00	0.15	38.86	5.17	-17.50	2.78
34	PDU-1	40.36	2.09	4.63	2.40	1.10	-0.03	17.72	1.89	-2.85	6.17	-31.50	2.16
35	Azad Urd 1	38.38	-5.08	1.09	2.22	0.96	0.15	15.40	0.38	30.68	6.83	17.50	0.56
	Mean	42.22			2.45			16.32			5.31		

SE ±	0.53	0.28	1.94	0.77

Table 3. Stability parameters for days to maturity, plant height and Biological yield/plant (g) in urdbean

S. No.	Genotypes	Days to maturity			Plant height (cm.)			Biological yield/plant (g)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1	Pant Urd 19	76.12	3.01	0.07	26.67	1.30	31.41	14.58	0.55	-2.96
2	Narendra - 1	73.38	0.16	0.28	27.40	1.37	23.64	15.55	0.79	6.63
3	TVM1	75.58	1.64	0.24	30.73	1.07	24.40	19.06	1.74	12.08
4	BARC Urd1	79.66	12.00	-0.15	23.04	0.01	18.56	18.67	0.57	6.07
5	PU -13	72.62	-4.39	0.24	24.00	1.16	39.05	16.87	2.16	-0.95
6	U-10	76.07	2.12	0.46	25.33	1.17	73.88	15.50	1.80	-1.25
7	ADT 5	76.19	0.22	0.20	22.67	1.29	63.87	16.32	2.03	-3.57
8	KU 301	73.90	1.56	3.29	28.28	1.54	37.39	19.10	0.57	6.21
9	Mash404	72.45	-1.22	-0.14	25.05	1.47	32.89	10.95	0.46	4.03
10	LBG 623	72.33	3.61	-0.02	25.72	0.63	-0.81	23.67	2.36	33.33
11	Co-5	73.53	-0.60	-0.04	29.97	0.80	7.83	11.66	-0.47	12.28
12	T-91	74.74	0.35	0.70	31.92	1.70	37.60	19.47	1.63	6.32
13	T-9	72.81	1.62	0.44	32.55	0.74	26.61	17.25	0.89	1.56
14	TAU-1	73.43	3.66	0.45	29.85	0.96	65.04	14.10	0.16	3.51
15	LBG-20	72.08	3.35	1.48	28.52	0.87	6.99	16.18	0.90	-2.92
16	TU 92-14	72.62	0.93	1.01	27.05	0.73	3.12	23.75	2.65	31.98
17	TU-65-1	69.72	4.13	2.88	28.87	0.57	20.60	15.57	0.73	10.97
18	TU31-13	73.69	-6.82	11.27	27.12	0.78	-3.03	17.27	1.22	10.59
19	IU86-1	76.87	-3.04	0.16	28.61	0.94	17.09	14.07	0.09	30.66
20	IU98-843	73.21	5.93	6.76	29.03	0.76	3.06	21.85	1.95	-0.33
21	IU-65-2	73.93	-0.95	0.96	28.50	1.08	-1.44	12.47	0.38	-3.06
22	TAU-1-1	72.82	2.41	1.62	29.87	1.17	-5.58	13.45	0.29	4.04
23	TU-92-3	76.12	-5.09	7.66	30.68	0.98	10.77	22.90	2.42	17.33
24	TPU-4	76.50	0.30	0.96	25.66	0.77	-3.26	10.93	0.06	15.80
25	TAU-4	76.28	-0.10	-0.06	27.73	1.46	-1.86	11.27	0.11	-0.30
26	TU98-14	72.42	7.38	7.56	35.76	1.73	10.55	16.38	1.27	-3.56
27	JU-2	73.88	-6.77	6.25	29.30	0.98	2.46	13.62	0.35	-0.58
28	JU-8-6	75.27	-1.56	0.27	29.70	1.28	-4.50	17.57	1.30	11.08
29	IU 83-5	75.56	0.84	-0.19	25.47	1.34	56.81	14.35	1.10	8.52
30	IU62-219	73.53	3.00	1.08	29.00	1.08	-2.74	11.77	-0.32	3.07
31	IU83-4	74.06	-2.37	1.32	30.12	1.27	-4.41	16.85	0.79	-3.10
32	IU94-3	74.07	2.44	0.69	27.09	0.64	14.42	18.38	0.73	17.02
33	IU88-10	73.72	1.86	-0.16	23.37	0.03	-4.02	19.80	2.42	-1.23
34	PDU-1	71.74	3.55	3.07	31.22	0.81	9.45	14.93	0.51	13.72
35	Azad Urd 1	69.46	2.67	1.18	28.60	0.53	31.98	14.90	0.82	7.45

	Mean	74.01	28.13	16.31
	SE ±	0.81	2.87	1.92

Table 4. Stability parameters for days to maturity, plant height and Biological yield/plant (g) in urdbean

S. No.	Genotypes	100 seed weight (g)			Harvest Index			Seed yield per plant (g)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
1	Pant Urd 19	3.93	0.98	0.18	32.17	0.79	1.36	4.48	0.15	-0.34
2	Narendra - 1	3.93	1.32	0.12	38.95	0.91	103.82	5.61	0.89	1.33
3	TVM1	3.93	2.20	0.20	32.08	1.04	90.21	5.67	2.63	0.18
4	BARC Urd1	3.89	0.86	0.16	31.27	0.30	90.39	5.53	0.16	-0.24
5	PU -13	3.46	1.81	0.12	39.73	2.15	124.24	4.59	1.13	0.47
6	U-10	4.18	1.47	-0.04	33.51	0.83	279.84	4.02	1.56	0.93
7	ADT 5	3.85	2.63	0.30	44.45	1.48	619.76	4.98	1.20	1.26
8	KU 301	4.04	3.16	-0.03	33.74	1.11	-5.67	6.16	0.59	1.28
9	Mash404	4.36	-0.48	0.05	37.56	1.44	40.52	3.72	0.22	-0.20
10	LBG 623	4.26	1.69	0.04	32.57	1.42	181.99	5.48	0.82	1.33
11	Co-5	3.93	1.75	0.10	35.86	1.05	42.96	3.93	-0.76	1.00
12	T-91	4.04	-1.00	0.31	31.12	0.79	-0.13	5.63	1.92	2.90
13	T-9	4.79	1.07	0.16	36.53	0.53	58.52	6.42	2.23	-0.29
14	TAU-1	4.05	2.03	-0.04	28.31	1.02	-7.43	3.97	0.14	2.33
15	LBG-20	4.26	3.19	0.11	29.83	1.19	-6.26	4.43	0.51	0.32
16	TU 92-14	4.17	0.50	-0.02	27.74	0.27	91.64	5.68	2.29	0.32
17	TU-65-1	4.09	1.39	0.51	35.08	1.65	143.57	4.75	-0.56	4.95
18	TU31-13	4.31	1.44	0.01	32.54	0.76	-7.36	5.48	1.87	0.09
19	IU86-1	4.44	2.94	0.05	33.66	0.47	-8.46	4.78	0.39	5.22
20	IU98-843	4.22	1.43	0.20	27.95	1.58	6.18	4.87	0.60	1.58
21	IU-65-2	4.74	0.34	0.17	33.68	0.59	-4.90	4.1	0.40	-0.09
22	TAU-1-1	4.48	-0.82	-0.02	30.58	1.04	12.10	3.93	0.06	-0.21
23	TU-92-3	4.27	-0.02	0.18	28.97	0.43	38.83	5.76	2.25	0.07
24	TPU-4	4.10	1.04	0.04	32.45	1.50	66.62	3.29	-0.01	0.42
25	TAU-4	4.69	-0.24	0.21	34.25	0.28	63.14	3.76	0.50	-0.35
26	TU98-14	4.63	-0.66	-0.04	31.50	1.52	-3.26	4.38	0.74	-0.26
27	JU-2	4.67	-0.15	0.04	36.05	0.52	54.18	4.81	0.49	0.37
28	JU-8-6	4.72	0.81	0.12	33.20	1.16	202.03	4.96	1.16	0.01
29	IU 83-5	4.41	0.06	0.26	40.94	2.46	117.37	4.94	1.48	0.29
30	IU62-219	4.25	-0.90	0.11	33.95	0.96	-9.39	4.00	-0.54	2.93
31	IU83-4	4.55	0.05	0.20	32.96	0.56	95.44	5.65	2.09	-0.14
32	IU94-3	4.68	-0.07	0.10	39.07	0.39	77.04	7.13	1.91	4.32
33	IU88-10	4.13	1.70	-0.02	37.32	1.22	-7.44	6.55	3.34	2.51
34	PDU-1	4.70	2.50	0.02	34.34	0.14	9.62	5.25	1.52	0.59

35	Azad Urd 1	4.84	1.45	0.01	38.55	1.44	93.49	5.42	1.64	0.21
	Mean	4.29			34.07			4.98		
	SE ±	0.22			5.41			0.68		

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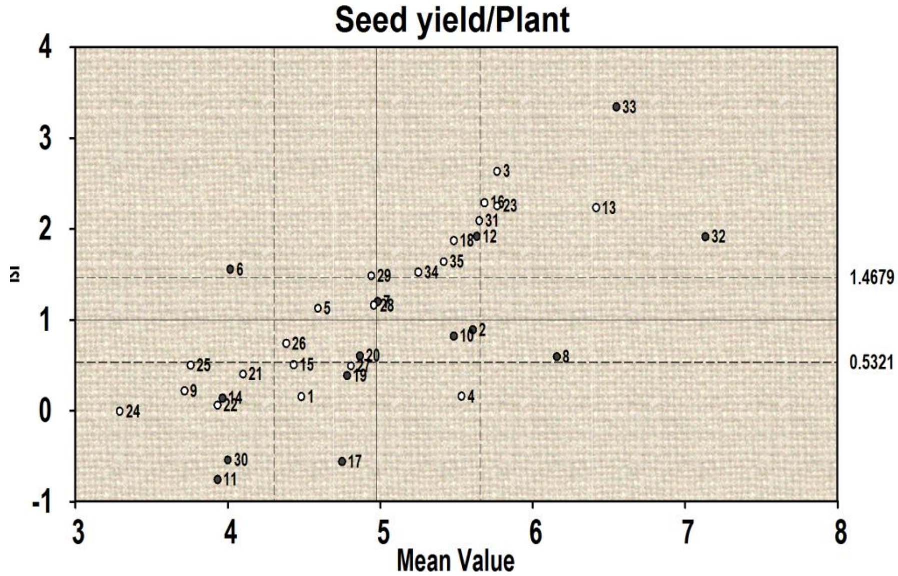

Figure 1. Stability behavior of genotypes seed yield/plant