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STABILITY STUDIES IN CLUSTER BEAN UNDER WESTERN VIDARBHA REGION

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ABSTRACT

Stability was studied for seed yield and their component characters in fifty five genotypes of cluster bean under four environmental conditions during summer and *kharif* at two locations of western Vidarbha region. The variance due to genotype × environment (linear) was found to be highly significant against pooled deviation for four traits viz., days to first flower, ten dry pod weight, seed yield plant^{-1} and endosperm percentage in seed and the non linear component (pooled deviation) was also highly significant for all the traits. The environment + (genotypes X environment) was highly significant for all the characters against pooled error indicating distinct nature of environments and the effects due to environments (linear) was highly significant for all the characters. Based on stability parameters and over all mean, six genotypes *viz.*, IC-298638, IC-421834, IC-421839, IC-421815, IC-324032, and IC-421798 were stable in performance for seed yield plant^{-1}. The genotype IC-421822 was most stable for the endosperm percentage in seed.

(Key words: Deviation from regression, genotypes, GXE interactions, regression coefficient)

INTRODUCTION

Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] [2n=14], is commonly known as guar, chavli kayi, guari, khutti. It is one of the most important and potential vegetable cum industrial crop grown for its tender pods for vegetable purpose and endospermic gum [30-35%]. The endosperm fraction of cluster bean seed is rich in galactomannan (16.80 to 30.90 %), while the germ and hull portion termed as guar meal obtained after the extraction of gum is rich in protein (28.90–46.00 %) and used as animal and poultry feed. The seed also contain 30-35% protein, 26.8-32.2% gum, 6.1-7.7% oil and 2.99-3.75% minerals.

In India, cluster bean for seed production (Guar seed) occupies an area of 42.15 lakh hectares with a production of 18.96 lakh tones during the year 2016-17 (Baldodiya and Awasthi, 2018). In Indian states like Rajasthan, Haryana, Gujarat and Punjab, guar is mainly cultivated for guar gum production and for forage. Major quantities of guar products were exported to three countries i.e. USA, Germany and china pertaining to an export growth over the years of 16.22, 3.38 and 9.68 per cent per annum, respectively. Guar gum has emerged as India's top farm export due to increasing demand from USA and other countries oil and gas industry (Baldodiya and Awasthi, 2018).

Considering the importance of cluster bean gum for industrial and medical purpose, there is a prime need for its improvement. Breeding for varieties suited to specific agro-ecological conditions for seed purpose is urgently needed for Western Vidarbha region of Maharashtra state.

Therefore, there is a need for identification or development of cluster bean genotypes suited for seed purpose for Western Vidarbha. Hence, evaluation of local or related genotypes study was undertaken to identify the superior genotypes on the basis of phenotypic stability for seed yield in cluster bean genotypes.

MATERIALS AND METHODS

The experimental material for the present investigation comprised of 55 cluster bean genotypes were grown in a randomized block design with two replications over four different environments at University Department of Horticulture, Dr.PDKV, Akola and Regional Research Centre, Dr.PDKV, Amravati, Maharashtra during summer and *kharif* 2014. Each plot consisted of two rows of 1 m length with a spacing of 60 cm X 10 cm. All the recommended package of practices for guar was followed. The experimental season showed different temperature regimes, humidity, rain fall and sunshine hours during the crop durations. Observations were recorded on five competitive plants in respect of 5 characters *viz.*, ten dry pod weight, dry pod

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yield plant^{-1} (g), seed yield plant^{-1} and endosperm (%), whereas days to first flower were recorded on plot basis. The stability parameters estimated were mean of the trait (X), linear regression (bi) and mean square deviation from the regression (S2di) line. As per the Eberhart and Russel model of stability, components S2di measures the predictability, whereas bi measures the stability. Stability of a genotype can be predicted more precisely if G X E interaction is present but S2di values are non significant. According to them, a genotype which possess high mean (x), unit regression coefficient (bi=1) with the deviation from regression line approaching zero (S2di=0) is considered to be stable one i.e. possessing average stability, whereas a variety with regression coefficient lower than one has above average stability and is specially adapted to unfavourable (poor) environments. They hardly express response to improved environmental conditions. A variety with regression coefficient greater than one (bi>1) has below average stability and is suitable for favourable/rich environments. In the present study, the G x E interaction and stability analysis of different genotypes across the four environments were worked out as per the model given by Eberhart and Russel (1966). Endosperm percentage in seed was estimated by procedure given by Pathak (2008) and Pathak et al. (2009).

RESULTS AND DISCUSSION

Pooled analysis of variance for stability

Pooled analysis of variance for stability of all traits across four different environments revealed that there were highly significant differences among the genotypes tested for the days to first flower, ten dry pod weight, dry pod yield plant^{-1} (g), seed yield plant^{-1} and endosperm percentage in seed characters studied. Jain and Patel *(*2012) reported similar result in cluster bean. They reported highly significant differences among genotypes of guar for days to 50 per cent flowering, days to 75 per cent maturity, pods plant^{-1}, plant height and seed yield characters. Significant differences were observed among varieties for grain and fodder yield characters studied in sorghum reported by Jain and Patel (2019) and number of pods plant^{-1} and grain yield characters in pigeonpea by Puttawar and Patel (2018).

The environment in which these experiments were conducted showed highly significant differences in all the observations indicating the validity of conduct of experiment in these environments (Table 1). Significant differences were observed among environments for grain and fodder yield characters reported by Jain and Patel (2019) in sorghum.

The differences due to G × E interactions were found to be highly significant for all the characters against pooled error indicating considerable amount of interaction between the genotypes and environments. The G × E interactions differed significantly high for the traits *viz.*, days to first flower, ten dry pod weight and endosperm percentage in seed. The results obtained are in agreement with the findings of earlier worker Jain and Patel (2012). They reported that G X E interactions for days to 50 per cent flowering, days to 75 per cent maturity, pods plant^{-1}, plant height and seed yield were significant in cluster bean. The G x E interactions for grain and fodder yield characters were significant in sorghum reported by Jain and Patel (2019) and number of pods plant^{-1} and grain yield characters in pigeonpea by Puttawar *et al*. (2018).

The environment + (genotypes X environment) were also highly significant for all the characters against pooled error (Table 1).

The effects due to environments (linear) were highly significant for the days to first flower, ten dry pod weight, dry pod yield plant^{-1} (g), seed yield plant^{-1} and endosperm percentage in seed characters indicating that environmental effects are additive (Table 1). The results obtained are in agreement with the findings of earlier workers Jain and Patel (2012), Jain and Patel (2019) and Puttawar *et al*. (2018). The significant mean square due to environment (linear) indicated the existence of the real genotypic differences in the characters (days to 50 per cent flowering, days to 75 per cent maturity, pods plant^{-1}, plant height and seed yield) for regression over the environmental mean observed by Jain and Patel (2012) in cluster bean. Significant mean squares due to environments (linear) indicated the existence of real varietal differences in grain and fodder yield characters for regression over the environmental mean reported by Jain and Patel (2019) in sorghum and number of pods plant^{-1} and grain yield characters in pigeonpea by Puttawar *et al.* (2018).

The variance due to G × E (linear) was found to be highly significant against pooled deviation for four traits *viz.*, days to first flower, ten dry pods weight, seed yield plant^{-1} and endosperm percentage in seed (Table 1) revealing that the behavior of genotypes could be predicted over the environments more precisely and accurately as G x E interaction was the outcome of the linear function of the environmental components. Similar results reported by Pawan kumar *et al*. (2016) in cluster bean that the genotype × environment (linear) components were significant for the characters viz., days to 50 per cent flowering, pod length, 100-seed weight and seed yield plant^{-1} indicating that genotypes are predictable based on such characters.

The G x E (linear) was found to be non-significant for dry pod yield plant^{-1} traits against pooled deviation. The mean sum of squares due to pooled deviation was also found highly significant for days to first flower, ten dry pods weight, dry pod yield plant^{-1} (g), seed yield plant^{-1} and endosperm percentage in seed which indicates the non linear or unpredictable portion of G × E interaction was predominant when tested against pooled error. Similar result reported by Pawan kumar *et al*. (2016) in cluster bean that the mean sum of squares due to pooled deviation (non-linear) were also significant for days to 50 per cent flowering and 100 seed weight characters except seed yield plant^{-1} indicating role of the characters studied.

Stability analysis for different characters

The results pertaining to these stability parameters are discussed character-wise as suggested by Eberhart and Russell (1966).

Days to first flower

According to the Eberhart and Russell model one genotype IC-369861 (49) was found to be the most stable genotypes for days to first flower as it had high mean, regression coefficient one and non significant deviation from regression line and genotypes IC-421816 (13), IC-421825 (17), IC-421843 (29), IC-329036 (39), IC-325811(40), RGC-1031(46), IC-373480 (48) and IC-369831 (49) were the other stable genotypes which had high mean, regression coefficient nearer to one and non significant deviation from regression line. The genotypes IC-421811(12), IC421822 (16), IC- 415140(44), IC-402296(47) and IC-421798(51) were well adapted to favourable environment as far as days to first flowers is concerned, as indicated by stability parameters. The genotypes viz., IC-421815 (32), RGC-936 (45) and IC-421812 (50) were adapted to unfavourable environment as these genotypes exhibited mean values high, regression coefficient less than unity and non significant deviation from regression line (Table 2). The genotypes *viz*., GAUG-0309 and GAUG-0511 found suitable for favourable and unfavourable environment for 50 per cent flowering reported by Jain and Patel (2012) in cluster bean.

Ten dry pod weight (g)

Stability performance revealed that, no one genotype showed stable performance in four environmental conditions. The genotypes IC-370742 (02), IC-415102 (03), IC-415165 (07), IC-421821 (15), IC-421828 (19), IC-421831 (21), IC-421839 (25), IC-421843 (29), IC-329639 (31), IC-324032 (34) and IC-311441 (43) recorded more ten dry pod weight and bi value more than one with non significant S2di, explaining its suitability in favourable environments (below stability). The 13 genotypes *viz*., IC-298638(01),IC-415163 (06), IC-421801 (09), IC-421816 (13), IC-421840 (26), IC-369789 (30), IC-421815 (32), IC-329036 (39), IC-373427 (41), RGC-936 (45), IC-402296 (47), IC-373480 (48) and HG-3-100 (54) recorded more ten dry pod weight and bi value less than one with non significant S2di, explaining its suitability in poor environments (unfavourable) with above average stability (Table 2).

Dry pod yield plant^{-1} (g)

Three genotypes namely IC-421839 (25), IC-324032 (34) and IC-329036 (39) recorded average stability as it had higher dry pod yield plant^{-1} with regression coefficient near to unity and non significant deviation from regression line with predictable performance across the environments for this yield component trait i.e. stable genotypes. Seven genotypes recorded below average stability *viz*., IC-298638 (01), IC-421797 (08), IC-421830 (20), IC-248087 (33), IC-370478 (36), IC-373480 (48) and IC-369861 (49) had recorded higher dry pod yield plant^{-1} with bi value greater than one with non significant S2di indicating suitability of these genotypes under favourable environmental situations with predictable performance.

The genotypes *viz*., IC-421831 (21), IC-421837 (24) and IC-421798 (51) recorded above average stability as it had more dry pod yield plant^{-1} and bi value less than one with non significant S2di, explaining its suitability in poor environments (unfavourable) with predictable performance (Table 2). The genotypes *viz*., GAUG-0309 and GAUG-0511 found suitable for favourable and unfavourable environment for pods plant^{-1} reported by Jain and Patel (2012) in cluster bean.

Seed yield plant^{-1} (g)

The genotypes namely IC-298638 (01) , IC-421834 (23), IC-421839 (25), IC-421815 (32), IC-324032 (34) and IC-421798 (51) recorded higher seed yield plant^{-1} with regression coefficient near to unity and non significant deviation from regression line indicating its average stability with predictable performance across the environments for this yield component trait i.e. stable genotypes. The genotypes *viz*., IC-415163 (06), IC-421797 (08), IC-248087 (33), IC-370478 (36), IC-329036 (39), RGC-1031 (46), IC-373480 (48) and IC-369861 (49) had recorded higher seed yield plant^{-1} with bi value greater than one with non significant S2di indicating suitability of these genotypes under favorable environmental situations with predictable performance with below average stability. Three genotypes *viz*., IC-421816 (13), IC-421831 (21) and IC-421837 (24) recorded more seed yield plant^{-1} and bi value less than one with non significant S2di, explaining its suitability in poor environments (unfavourable) with predictable performance with above average stability (Table 2 and Fig. 1). The result obtained is in agreement with the findings of earlier workers in cluster bean Henry and Kackar (2001) D'almeida and Tikka (2003) and Jain and Patel (2012). Henry and Kackar (2001) observed genotype 2470/12 was found to be the best among all the genotypes tested as it had high grain yield and average stability in cluster bean. D'almeida and Tikka (2003) observed genotypes HGS-843, RGC-1022, RGC-1017, GAUG-8832 and GG-1 gave stable performance for seed yield, whereas genotype GAUG-9003 was found to be highly responsive to unfavourable environments in cluster bean. Jain and Patel (2012) observed the genotypes *viz.*, GAUG-0309 and GAUG-0511 were the most stable under rainfed situation for improvement of seed yield in cluster bean.

Endosperm (%)

The genotype IC-421822 (16) recorded average stability due to higher endosperm percentage in seed and regression coefficient around unity with non significant deviation from regression line indicating well adopted to all environments. Fifteen genotypes (IC-415102 (03), IC-415160 (05), IC-415163 (06), IC-421797 (08), IC-421801(09), IC-421803 (10), IC-421821 (15), IC-421830 (20), IC-421831 (21), IC-421840 (26), IC-324032 (34), IC-415109 (37), IC-329036 (39), IC-373480 (48) and IC-421812 (50)) recorded below average stability as it had regression coefficient more than unity and non significant deviation from regression line indicating its suitability for specially desirable to favourable environments. The genotypes IC-421820 (14), IC-421825 (17), IC-421828(19), PLG-85 (38), IC-325811 (40), IC-311441 (43), IC-402296 (47) and IC-369861 (49) showed above average stability due to bi value less than one and non significant deviation from regression line were found suitable under unfavourable environmental situations (Table 2).

Considering overall performance of the genotypes, one genotype IC-421822 (16) was most stable for the endosperm percentage in seed and six genotypes namely IC-298638 (01), IC-421834 (23), IC-421839 (25), IC-421815 (32), IC-324032 (34) and IC-421798 (51) found stable for seed yield plant^{-1}. Considering above facts there is better chances of utilizing these genotypes in breeding programme to develop superior genotypes having stable performance than existing ones.

Table 1. Analysis of variance for stability of different characters over four environment (two summer and two kharif, 2014)

Sr. No.	Source of variation	d.f.	Mean sum of square				
			Days to first flower	Ten dry pod weight (g)	Dry pod yield plant^{-1} (g)	Seed yield plant^{-1} (g)	Endosperm (%)
1	Rep within Env.	4	0.21	0.009	0.43	0.24	0.74
2	Genotypes	54	7.23**++	0.60**++	55.30**++	19.00**++	4.52**++
3	Environments	3	54.48**++	9.91**++	624.97**++	264.68**++	28.37**++
4	Genotype x Environment	162	0.80++	0.19**++	12.35++	4.58++	1.11**++
5	Total	219	3.12	0.43	31.33	11.70	2.32
6	Pooled error	216	0.14	0.0020	2.5900	1.00	0.29
7	Environment +(Genotype x Environment)	165	1.77**++	0.37**++	23.48**++	9.31**++	1.61**++
8	Environment (Linear)	1	163.43**+	29.76**++	1874.91**++	794.03**++	85.10**++
9	Genotype x Environment (Linear)	54	1.17**++	0.56**++	13.86++	5.76*++	1.91**++
10	Pooled deviation	110	0.60++	0.005++	11.38++	3.91++	0.70++

Table 2. Estimates of stability parameters for days to first flower, ten dry pod weight, dry pod yield plant^{-1} (g), seed yield plant^{-1} (g) and endosperm (%) in cluster bean genotypes

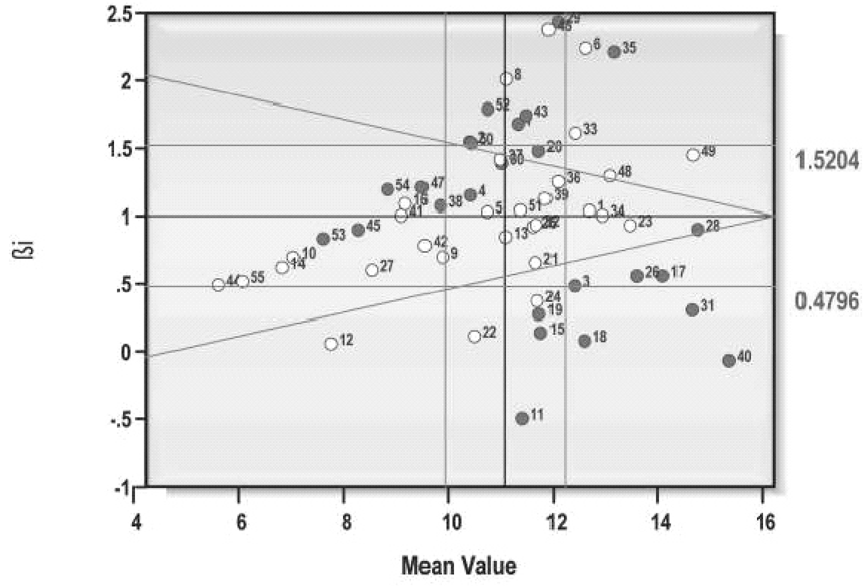
Sr.	Genotype	Days to first flower			Ten dry pod weight (g)			Dry pod yield plant^{-1} (g)			Seed yield plant^{-1} (g)			Endosperm (%)		
No.		Mean	bi	S²di	Mean	bi	S²di	Mean	bi	S²di	Mean	bi	S²di	Mean	bi	S²di
1	IC-298638	30.54	0.14*	-0.03	4.25	-0.47**	-0.002	22.01	1.36	-2.01	12.45	1.04	0.10	35.78	1.93	0.29
2	IC-370742	29.53	-0.08*	0.01	4.51	1.80**	0.001	16.86	1.42	14.63**	10.17	1.55	6.41**	35.54	1.41	-0.15
3	IC-415102	30.61	0.42	0.46*	4.45	1.62**	-0.001	20.34	0.37	17.88**	12.18	0.48	3.44*	36.29	2.99**	-0.29
4	IC-415157	29.25	-0.36*	-0.14	3.90	2.22**	0.001	16.77	1.09	8.68*	10.19	1.15	3.29*	37.14	2.21	0.71*
5	IC-415160	30.49	0.22	0.14	4.05	0.34**	-0.001	16.93	1.13	8.98*	10.51	1.03	1.55	37.26	1.63	-0.13
6	IC-415163	30.95	0.12	0.82**	4.47	-0.40**	-0.001	20.32	2.26	4.78	12.38	2.24	1.53	36.89	4.24*	0.46
7	IC-415165	29.87	1.23	-0.10	4.13	1.65**	-0.001	18.08	1.66	9.37*	11.11	1.68	2.94*	35.91	3.18*	-0.08
8	IC-421797	29.37	0.92	0.18	3.78	1.56**	-0.001	18.90	2.02	2.48	10.88	2.01	0.24	36.15	2.12	0.34
9	IC-421801	30.20	0.88	0.01	4.88	0.55**	-0.002	16.24	0.72	-2.11	9.66	0.70	-0.84	37.19	2.44	-0.12
10	IC-421803	33.22	1.56	1.81**	4.00	0.00**	-0.002	10.49	0.67	3.07	6.81	0.69	0.92	37.16	1.19	-0.12
11	IC-421806	32.99	2.47	1.40**	3.97	0.42**	-0.001	18.65	-0.56	68.77**	11.19	-0.50	19.29**	35.21	-0.51	2.51**
12	IC-421811	31.69	1.91**	-0.13	3.52	1.65**	0.000	12.61	-0.01	2.70	7.52	0.06	0.14	35.09	-0.79*	-0.18
13	IC-421816	31.54	0.93	-0.12	4.68	0.50**	-0.001	17.91	0.87	-2.34	10.87	0.84	-0.86	37.26	0.67	1.06*
14	IC-421820	29.93	0.70	0.06	3.68	-0.93**	0.007*	11.34	0.61	3.91	6.61	0.62	0.81	36.88	0.20**	-0.29
15	IC-421821	28.21	0.76	0.18	4.40	1.68**	-0.002	19.51	0.17	20.91**	11.54	0.14	6.33**	36.99	2.06	0.33
16	IC-421822	31.16	1.84	0.11	3.84	1.47**	-0.001	14.86	1.15	-1.66	8.95	1.09	-0.82	36.39	1.03	0.05
17	IC-421825	30.77	1.03	-0.10	4.06	-0.20**	0.004	22.46	0.67	12.53**	13.86	0.56	5.65**	36.02	-0.16	0.51
18	IC-421826	30.68	1.04	0.08	4.04	0.90*	-0.002	19.99	-0.06	16.87**	12.36	0.08	3.79**	35.34	0.19	-0.19
19	IC-421828	30.32	0.53	0.01	4.26	1.96**	-0.001	18.32	0.30	16.86**	11.51	0.27	6.57**	36.13	-0.35	0.58
20	IC-421830	27.05	1.16	1.04**	4.00	0.61**	-0.002	18.54	1.76	0.39	11.50	1.48	2.53*	37.84	2.95	0.22
21	IC-421831	29.59	0.99	-0.08	4.16	2.77**	0.001	18.67	0.70	-1.95	11.44	0.65	-0.77	36.82	1.57	0.00
22	IC-421832	31.27	1.52	7.11**	3.87	1.56**	-0.001	16.54	0.11	3.34	10.26	0.11	1.07	36.13	0.96	0.82*
23	IC-421834	31.74	1.80	1.13**	3.61	0.41**	-0.001	22.78	0.83	1.34	13.24	0.93	-0.47	34.88	0.26	0.48
24	IC-421837	28.77	0.41	1.50**	3.98	0.79	0.187**	19.26	0.53	1.03	11.48	0.37	0.05	35.22	0.36	2.96**
25	IC-421839	29.70	0.92	-0.09	4.22	1.86**	-0.001	18.38	1.02	0.68	11.40	0.92	0.92	34.15	-0.87*	-0.18
26	IC-421840	31.61	2.48	2.77**	4.27	0.84*	-0.002	21.62	0.52	18.74**	13.38	0.55	5.73**	37.00	1.23	-0.16
27	IC-421841	32.41	1.79	1.16**	3.90	1.79**	-0.002	12.92	0.52	3.36	8.31	0.60	1.49	35.36	0.92	-0.01
28	IC-421842	28.92	0.14	0.01**	3.93	0.61*	0.000	24.03	0.84	40.67**	14.52	0.90	12.13**	34.34	2.28	-0.12
29	IC-421843	31.31	1.04	-0.12	4.60	2.38**	0.000	20.30	2.36	8.63*	11.85	2.43	2.42*	33.16	-0.24	-0.02

Sr. No.	Genotype	Days to first flower			Ten dry pod weight (g)			Dry pod yield plant^{-1} (g)			Seed yield plant^{-1} (g)			Endosperm (%)		
		Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
30	IC-369789	29.53	0.62	-0.10	4.14	0.86*	-0.002	17.76	1.31	6.34*	10.79	1.39	2.67*	36.55	1.04	2.79**
31	IC-329639	29.54	0.76	-0.04	4.12	2.04**	-0.001	23.22	0.45	17.51**	14.41	0.30	8.29**	34.55	0.91	-0.01
32	IC-421815	30.78	0.79	0.18	4.09	0.54**	-0.002	18.72	0.86	-1.85	11.46	0.93	-0.90	34.48	-0.35*	-0.26
33	IC-248087	30.79	0.88	0.76**	4.05	1.69**	-0.002	19.85	1.53	-1.47	12.18	1.61	-0.59	33.61	-1.24**	-0.25
34	IC-324032	29.46	0.87	-0.11	4.56	1.67**	-0.001	20.29	0.98	-0.53	12.71	1.00	-0.23	37.21	2.26	0.24
35	PLG-354	28.61	0.44	0.06	3.36	-0.14**	-0.002	21.43	2.40	3.64	12.93	2.21	2.34**	34.55	0.89	2.86**
36	IC-370478	30.40	1.01	-0.12	3.66	-1.34**	0.004	19.89	1.26	-0.28	11.86	1.25	-0.38	34.24	0.76	-0.25
37	IC-415109	31.95	1.83	2.49**	4.07	1.15	-0.001	17.43	1.50	0.38	10.77	1.41	-0.35	37.46	1.45	0.42
38	PLG-85	29.97	0.88	0.33*	3.89	2.65**	0.000	17.24	0.96	11.27**	9.61	1.07	5.10**	36.82	0.59	0.05
39	IC-329036	31.49	0.95	0.19	4.22	0.65*	-0.001	21.02	0.99	1.03	11.62	1.12	-0.92	37.07	1.78	-0.16
40	IC-325811	32.31	0.96	-0.01	3.39	0.73*	-0.001	25.70	0.29	38.40**	15.13	-0.07	21.15**	36.12	0.10	0.32
41	IC-373427	30.70	0.08	0.33*	4.84	0.44*	0.000	13.63	0.95	-0.42	8.88	1.00	-0.38	36.16	-0.14	-0.15
42	IC-415159	30.24	0.93	-0.07	3.78	3.03**	0.005*	14.61	0.70	2.22	9.32	0.78	1.11	35.53	0.89	0.06
43	IC-311441	30.74	1.12	0.69**	4.18	3.58**	0.008**	18.34	1.77	12.92**	11.26	1.74	2.85*	36.42	0.78	-0.09
44	IC-415140	32.71	1.63*	-0.11	2.76	-0.02**	0.000	9.47	0.52	-2.05	5.38	0.49*	-0.86	36.81	0.70	0.68*
45	RGC-936	31.15	0.61	-0.11	4.51	0.05**	-0.001	12.10	0.79	16.60**	8.05	0.90	6.47**	35.62	0.56	1.64**
46	RGC-1031	30.74	1.01	-0.09	4.05	2.73**	0.002	20.46	2.30	7.84*	11.68	2.38	1.64	34.76	-1.09	0.20
47	IC-402296	30.88	1.15	0.07	4.74	0.41**	-0.002	15.45	0.96	12.79**	9.26	1.21	7.93**	36.51	0.74	-0.18
48	IC-373480	30.87	1.02	0.07	4.28	0.68**	-0.002	20.49	1.14	-1.53	12.85	1.29*	-0.93	36.19	1.36	-0.15
49	IC-369861	31.05	1.00	0.18	3.90	1.08	-0.002	23.19	1.54	0.99	14.43	1.45	1.17	36.18	0.75	0.29
50	IC-421812	31.05	0.83	0.05	3.73	1.02	0.003	17.94	1.72	31.03**	10.20	1.53	6.16**	36.78	1.68	0.05
51	IC-421798	33.01	1.74	0.00	3.95	1.12*	-0.002	19.79	0.80	-0.09	11.15	1.04	-0.96	35.22	0.78	-0.22
52	IC-369868	30.32	0.37	0.01	3.89	0.32**	0.000	16.73	1.79	22.46**	10.52	1.79	6.14**	37.09	1.69	2.13**
53	RGC-986	33.98	2.14	1.08**	4.02	-0.01**	0.000	11.99	0.81	11.06**	7.37	0.83	3.26*	36.01	0.72	0.58
54	HG-3-100	33.50	2.17	0.33*	4.44	0.07**	-0.002	13.27	1.10	16.99**	8.61	1.19	5.96**	36.41	0.66	1.08*
55	AVT-GR-11	30.66	0.70	-0.01	3.57	0.03**	-0.001	9.67	0.52	-0.59	5.84	0.51	-0.48	36.73	1.62	1.03*
	Mean	**30.73**			**4.07**			**17.91**			**10.84**			**36.01**		
	SE(m)±	0.33	0.45		0.14	0.10		1.30	0.58		0.80	0.52		0.40	0.67	
	CD 5%	0.90			0.40			3.62			2.21			1.12		
	CD 1%	1.19			0.53			4.76			2.91			1.47		

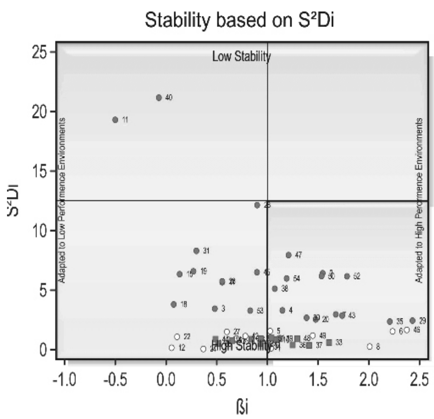
*,**- significant at 5 % and 1 % level and b_i= regression coefficient , $\mathbf{S^2d_i}$ = deviation from regression line

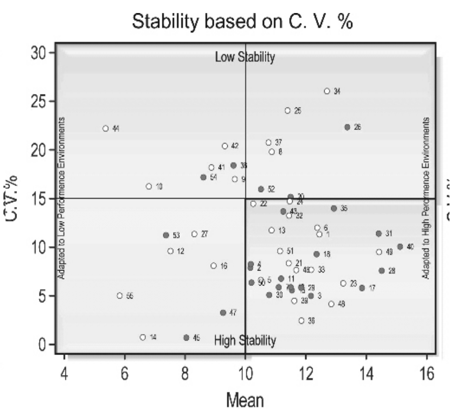
	Legend:
S.N.	Genotypes
1	IC-298638
2	IC-370742
3	IC-415102
4	IC-415157
5	IC-415160
6	IC-415163
7	IC-415165
8	IC-421797
9	IC-421801
10	IC-421803
11	IC-421806
12	IC-421811
13	IC-421816
14	IC-421820
15	IC-421821
16	IC-421822
17	IC-421825
18	IC-421826
19	IC-421828
20	IC-421830
21	IC-421831
22	IC-421832
23	IC-421834
24	IC-421837
25	IC-421839
26	IC-421840
27	IC-421841
28	IC-421842
29	IC-421843
30	IC-369789
31	IC-329639
32	IC-421815
33	IC-248087
34	IC-324032
35	PLG-354
36	IC-370478
37	IC-415109
38	PLG-85
39	IC-329036
40	IC-325811
41	IC-373427
42	IC-415159
43	IC-311441
44	IC-415140
45	RGC-936
46	RGC-1031
47	IC-402296
48	IC-373480
49	IC-369861
50	IC-421812
51	IC-421798
52	IC-369868
53	RGC-986
54	HG-3-100
55	AVT-GR-11

Seed yield plant^{-1} (g)



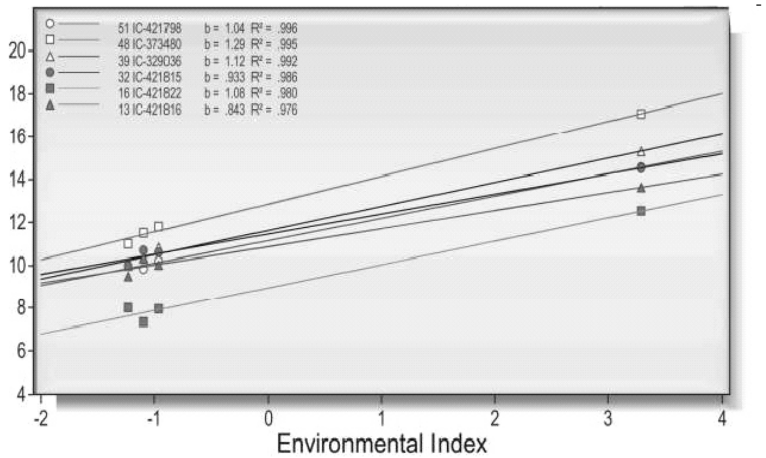
(a) Plotting of genotypes on mean and bi





(b) Plotting genotypes on bi and S^{2}di (c) Plotting of genotypes with mean and C.V

Seed yield plant^{-1} (g)



Plotted numbers of genotypes correspond to their serial number shown above

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Rec. on 14.07.2021 & Acc. on 20.07.2021