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Stability analysis in French bean genotypes for different traits under temperate conditions of Kashmir valley

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Abstract
In the present study 31 genotypes were evaluated for stability performance across four diverse locations using Eberhert and Russel model. Analysis of variance revealed that all genotypes possessed significant difference for various yield related traits. Estimation of genetic parameters over locations revealed that the environments were significant. Mean squares due to G X E interaction were significant for all the traits. The component analysis of environment (G X E) revealed significant mean squares for all the traits. Mean squares of linear and non-linear components revealed that environments (linear) were significant for all the traits and the significant mean squares for environment + (G x E) for all the traits arose due to environments (Linear) and linear response of the regression of the cultivars to environment. The good performance of different traits and their stability across the environment indicated that the genotype WB-416, WB-195, WB-1139, WB-360, WB-30 and WB-1136 were stable for many traits. These genotypes would be useful for commercial exploitation or can be exploited as elite gene pool for future breeding programmes.

Keywords: Stability analysis, French bean, genotypes, varieties

Introduction
French bean (*Phaseolus vulgaris* L.) is the most important vegetable-cum-pulse crop of the world covering about half of the global pulse acreage. It is globally cultivated over an area of 26 million ha with a production of 21 million tons. In India, it is cultivated in Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Uttar Pradesh and North-eastern States as an important warm season vegetable-cum-pulse crop. In India common bean is grown over an area of about 6 Mha with a production of about 2.5 million tonnes (Anonymous, 2010) [1]. In J&K, it is cultivated over an area of about 2000 hectares with production of about 1600 tonnes and yield of about 0.8 t ha^{-1} (Anonymous, 2012) [2]. However actual figures of French bean are not known.

Common bean offers an alternative for diversification of agricultural system but inherent low yielding ability of pulses, relegation to harsh environments; lack of major technological breakthrough and the lack of encouraging market and price support from the government renders them poor competitors of cereals, oilseeds and other cash crops. Therefore, in order to make pulse cultivation a lucrative endeavour, there is an urgent need to augment the yielding ability of bean cultivars. A major factor that limits large scale adoption of varieties is the significant variations in performances under different agro-climatic niches. This situation emerges out of differential response and adaptability of genotypes in varied environments which is stability measured as G x E interaction. The term "stability of genotypes" is central to all types of analyses of G x E interactions especially with reference to plant breeding. Stability has been described in many different ways over the years and there have also been different concepts of stability (Lin *et al.*, 1986) [10].

Stability model proposed by Eberhart and Russel (1966) [5] is a powerful tool which enables to measure the phenotypic stability related to performance of genotypes. Eberhart and Russel (1966) [5] recommended growing of varieties in adequate number of environments so that useful information is available regarding stability. The stability of varieties was defined by high mean yield, regression coefficient (bi = 1.0) and deviations from regression as small as possible (s2 di = 0). In the present investigation, an attempt has been made to study the stability of 31 genotypes over 4 environments in common bean.

Materials and Methods

Selection of area

In the present study two districts namely Budgam and Ganderbal were selected during 2013-14.In each district two locations were selected for undertaking the study namely Rangar (E_1) and Daetmuribagh (E_2) in District Budgam and Yarmuqam (E_3) and Arhama (E_4) in District Ganderbal. Both the districts were selected on the basis of their strategic importance. Ten genotypes were evaluated in a randomised block design with two replications at each location using four local varieties provided by farmers as check. Each genotype was represented by 2 x 3 metre length with spacing of 15 x 30 cm.

Analysis of variance for stability

The phenotypic stability of ten genotypes studied across the enviroments was worked out following the linear model proposed by Eberhart and Russel (1966) [5]. The estimated parameters were mean of the trait (X), linear regression (bi) and mean square deviation from regression (S^2di), where X provides a measure of the performance of a variety as compared to other entries, the bi and S^2di values are the measure of the G x E interaction. In general, if G x E interactions are non-significant or where this G x E interaction is either linear or predominantly linear as compared to its non-linear component, the prediction of stability of a genotype over environments becomes more reliable.

Results and Discussion

Analysis of variance for stability

Analysis of variance for stability in the performance of different genotypes across four random environments (Table-1) revealed that the mean squares due to genotypes were highly significant for all the traits *viz*., days to 50 per cent flowering, days to maturity, plant height, pods plant^{-1}, pod length, number of seeds pod^{-1}, pod density, pod yield plant^{-1}, seed yield plot^{-1} and 100 seed weight. The material selected were thus, divergent and possessed significant genetic variation for all traits. The mean squares due to environments were also significant for all the traits indicating the environments selected were random and were different in agro-climatic conditions. Interaction of genotypes with the environment (G x E) were observed to be significant for all the traits indicating thereby that the genotypes were having, by and large, significant differential response to the changing environments. The environment + (genotype × environment) mean were significant for all the traits. However, partitioning this variance into components like environments, environments (linear), genotype × environment (linear) and pooled deviation (non linear) revealed that mean squares due to environment (linear) were highly significant for all the traits. The significant mean squares confirmed that the environment were random and different, and they exercised influence on the expression of a trait having significant mean squares and this variation could be attributed to have arisen due to linear response of the expression of the genotypes to the environment. The mean squares due to G × E (linear) were significant for all the traits revealing that the behaviour of the genotypes could be predicted for environments more precisely for most of the traits and the G × E interaction was the outcome of the linear function of the environmental components. Mean squares due to environment were also found to be significant by Park (1987) [14], Harer (2000) [7] and Corte *et al.* (2002) [3]. GxE interaction were reported to be significant by other workers (Ramalho,1993; Guv, 1998; Rafi *et al.*, 2004; Dar *et al.*, 2009 and Mwale *et al.*, 2009) [16, 6, 15, 4, 11]. The variance due to genotypes x environments (linear) was found significant for various traits by Singh *et al.* (2007) [17]. The non-linear component arising due to heterogeneity, measured as mean squares due to pooled deviation, was significant for days to 50% flowering, days to maturity, plant height, pod length, number of pods plant plant^{-1}, number of pods plot^{-1}, number of seeds pod^{-1}, seed yield plot^{-1}, pod yield plot^{-1}, pod density and 100-seed weight. These significant mean squares revealed presence of non-linear response of the genotypes to the changing environments (stability performance). The significant mean squares for the pooled deviation confirmjed contribution of non-linear component to total G × E interaction. The genotypes differed with respect to the stability for these traits making its prediction more difficult.

Table 1: Analysis of variance for stability of different traits in selected French bean genotypes across 4 environments

Source of variation	d.f.	Days to 50% flowering	Days to Maturity	Plant height	No. of pods per plant	Pod length	Pod Yield per plant	Seed yield per plot	Pod density	Seeds per pod	100 seed weight
Genotypes	29	215.63***	121.42**	2452.13***	75.94***	12.08**	343.53***	1883673.00**	0.02***	3.12***	343.53***
Environment + (Genotypes × Environment)	90	2.029*	3.851**	11.71***	2.587***	1.29**	3.17***	6838.55**	0.01**	0.04	3.17**
Environment	3	3.85*	4.56**	97.90***	25.86***	11.46**	18.68***	8845.99***	0.01**	0.04	18.68***
Genotypes × Environment	87	1.88**	3.77**	8.73*	1.785***	0.84**	2.64*	6769.32***	0.01**	0.04	2.64*
Environment (linear)	1	20.54***	22.80**	293.71***	77.58***	34.40**	56.04***	26537.95**	0.03**	0.12	56.04***
Genotype × Environment (linear)	29	10.81**	10.88**	15.25***	2.99***	1.42**	1.77***	16728.07***	0.03**	0.04	4.77***
Pooled deviation (non linear)	60	1.82*	1.80**	5.16**	1.15**	0.66**	1.52*	1730.29**	0.01**	0.036	1.52
Pooled error	120	0.91	0.58	9.64	1.924	0.64	0.02	2591.37	0.01	0.033	2.48

* Significant at p=0.05; ** Significant at p=0.01

Stability in performance is one of the most important properties of a genotype for acceptability for commercial cultivation. The breeders aim is to develop cultivars that are stable across range of environments. An ideal genotype is defined as the one possessing high mean performance, with regression coefficient around unity (b_i=1) and deviation from regression (S^2d_i) close to zero. The linear regression is regarded as the measure of linear response of a particular genotype to the changing environment. If the regression coefficient (b_i) is greater than unity, the genotype is said to be highly sensitive to environmental fluctuations but adapted to all environments. If the regression coefficient (b_i) is equal to unity, nit indicates average sensitivity to environmental changes and adaptable to all environments. If the regression coefficient (b_i) is less than unity, it indicates less sensitivity to environmental fluctuations and if this is accomplished by a high mean value, then the genotype is said to be better adapted to poor conditions. The non-significant linear (b_i) and non-linear (S^2d_i) estimates indicate average stability of genotype across different environments, whereas significant b_i and non-significant S^2d_i values indicate stability to specific environments. However the significance of S^2d_i estimate, irrespective of whether the corresponding b_i estimate is significant or non-significant would suggest that that the behaviour of genotype is unpredictable.

In present investigation, estimation of stability parameters for thirty one French bean genotypes revealed non-significant estimates of deviation from regression (S^2d_i) for all traits, some genotypes revealed significant mean square deviation from regression (S^2d_i) such as WB-481 WB-160 and WB-1136 for days to flowering and days to maturity respectively, WB-492, for seeds pod^{-1}(Table-2). The genotype showing non-significant mean square deviation (S^2d_i) from the regression indicated that non-linear component (heterogeneity from regression) was equal to zero. Hence, the performance of these genotypes for a given environment could be predicted. Accordingly, a genotype whose performance could be predicted (i.e., $S^2d_i = 0$) was classified to be stable. Similar results were found by Jhonson (1955) [8], Lin *et al.* (1986) [10] and Sheikh *et al*., (2017) [18].

The significant linear regression was reported in various traits with respect to genotype WB-160, W-1128, WB-249, WB-30, WB-467 (plant height); WB-249, WB-30 (Pods plant^{-1}); WB-492,WB-481, WB-651 (Pod length); WB-940 (pod yield plant^{-1}); WB-160,b WB-941, WB-335, WB-492, WB-223, WB-416, WB-322, WB-147, WB-345,WB-481, WB-411 (pod density); WB-160, WB-492, WB-1128, WB-360 (100-seed weight); WB-479, WB-429, WB-940, WB-1538, WB-249, WB-569 (pod yield plot^{-1}) (Table-2, 3 and 4). Similar results with respect to linear regression component were found by Krishna Prasad *et al.* (1993) and Pan (2006) [9, 12] in French bean genotypes.

Table 2: Stability parameters for days to 50% flowering, days to maturity, Plant height and number of pods plant^{-1} in selected French bean genotypes evaluated across 4 random environments

Genotypes	Days to 50% flowering			Days taken to maturity			Plant height (cm)			Number of pods plant^{-1}		
	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i
WB-195	41.87	0.43	-0.73	49.62	-0.21	-4.05	53.75	0.55	-9.49	24.31	1.07	-0.96
WB-1186	43.12	0.64	0.19	52.50	-0.67*	-6.09	51.37	0.23	-9.05	25.50	0.95	-0.58
WB-479	42.25	-0.26	1.84	50.75	0.72	-4.24	48.50	2.36	-5.18	19.00	0.37	-1.85
WB-160	44.87	-1.47	5.58*	53.37	0.98	-3.98	48.62	2.08*	-9.41	21.69	1.43	-1.47
WB-252	49.12	1.19	-0.91	62.51	0.41	9.55	62.25	0.54	-5.45	16.50	0.07	-1.18
WB-941	58.75	3.21	-0.42	64.87	2.28	0.76	89.00	-1.83	23.45*	19.00	0.88	-1.17
WB-335	55.50	-1.37	1.09	63.12	2.58	-5.18	90.50	0.99	-8.52	15.25	-0.68	-1.39
WB -940	63.00	1.56	2.91	66.00	1.98	5.03	131.87	1.04	8.85	16.75	1.48	-1.39
WB-492	62.25	5.43	1.02	71.50	0.63	-5.56	47.25	-1.42**	-9.33	8.69	1.78	0.49
WB-429	57.00	0.23	0.22	64.37	0.73	-2.031	132.12	0.76	18.11	10.87	-0.92*	-1.42
WB-1538	45.37	-0.89	1.31	54.25	0.27	-3.53	57.00	2.16	-7.84	14.81	3.45*	-1.48
WB-416	51.50	0.56	-0.62	62.62	-0.38	-4.84	86.87	-1.87*	-8.74	16.12	1.99	0.01
WB-223	41.50	-0.28	-1.29	49.87	0.06	-3.03	45.87	1.68	-9.36	9.37	-0.16	-1.36
W B-322	52.50	0.56	-0.62	63.62	2.05	-5.52	45.37	1.85	-6.98	11.62	0.39	-1.77
WB-1128	46.25	3.49	0.94	54.50	1.72	-1.27	56.87	1.73*	-9.54	13.75	1.94	-1.69
WB-147	40.50	-0.02	-0.76	48.25	-3.37	1.13	57.12	0.71	-8.25	12.87	1.32	-0.09
WB-249	46.25	-0.84	-0.63	54.87	2.60	-3.73	50.75	1.36*	-9.58	17.00	-0.37*	-1.85
WB-1136	53.87	2.06	-0.13	52.62	8.41	44.56***	44.75	0.30	-8.72	16.25	1.60	-1.11
WB-360	47.12	1.22	-1.43	60.25	-0.61	0.33	44.12	0.59	-3.04	22.12	1.26	-0.40
WB-1139	41.62	0.97	-0.74	51.75	-0.19	-6.01	46.12	2.26	-6.37	19.75	2.72	-1.39
WB-30	59.75	0.84	-0.63	67.87	2.78	-4.42	60.87	-0.09**	-9.59	13.75	2.70*	-1.75
WB-345	63.25	-0.02	-0.39	70.00	0.18	-3.38	96.87	2.07	-7.75	14.94	-0.15	-1.55
WB-648	41.75	-0.81	-0.36	50.87	-0.29	-4.31	41.00	-0.01	-1.39	22.12	-0.17	-0.36
WB-1181	42.50	3.52	-0.99	51.62	2.29	3.49	47.75	2.25	-4.01	13.81	1.53	-0.86
WB-46	45.37	1.53	2.78	54.25	3.85	7.49	46.75	2.36	4.49	11.80	1.45	2.65
WB-569	44.87	3.08	-0.68	55.00	-0.07	-5.87	37.62	1.82	-6.99	14.57	1.25	1.57
WB-467	44.37	2.04	-1.09	54.87	0.07	-0.53	53.62	3.33**	-9.63	12.18	1.23	2.45
WB-411	58.12	0.97	-0.74	66.62	1.59	-0.23	56.87	0.98	1.18	10.37	-0.82	-0.95
WB-481	48.12	-0.10	3.33*	55.25	1.04	2.99	42.62	1.29	-8.55	15.62	1.33	-1.36
WB-651	42.87	2.55	1.36	52.37	-1.45	-5.03	43.25	-1.29	-7.60	12.25	1.07	-1.02
Population mean	49.17			57.67			60.58			m15.76		
SE(m)	0.78			1.39			1.3118			0.m6189		
SE(b_i)	1.63			2.49			0.7262			0.6665		

Table 3: Stability parameters for pod length, seeds pod^{-1}, pod yield plant^{-1} and pod density in selected French bean genotypes evaluated across 4 random environments

Genotypes	pod length			seeds pod^{-1}			pod yield plant^{-1}			pod density		
	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i
WB-195	16.03	0.33	-0.61	6.24	2.67	0.01	158.20	1.14	-48.15	0.39	-0.34	-0.0006
WB-1186	16.48	0.56	-0.50	7.17	-0.91	-0.03	144.00	-0.28	-27.77	0.43	0.61	-0.0007
WB-479	13.02	0.97	-0.53	5.21	-0.34	-0.03	100.40	1.41	83.19	0.39	0.84	-0.0006
WB-160	15.0o	1.68	-0.54	6.67	3.59	0.04	84.60	3.01	-66.28	0.45	0.37**	-0.0008
WB-252	11.44	0.47	0.01	5.40	0.51	0.06	97.70	-2.77	7.82	0.49	2.65	-0.0005

WB-941	12.55	0.61	-0.59	5.16	1.29	0.00	144.80	1.97	-19.96	0.41	-0.13**	-0.0008
WB-335	10.69	1.52	-0.63	6.12	-3.49	-0.02	70.90	0.70	70.15	0.57	2.24**	-0.0008
WB -940	9.81	-0.53	1.53	4.25	1.09	-0.01	97.60	4.06*	-18.10	0.47	1.79	-0.0005
WB-492	8.75	3.27**	-0.63	5.64	3.25	0.08*	62.00	-3.33	-71.49	0.67	6.03*	-0.0004
WB-429	13.44	1.59	-0.31	6.27	3.60	-0.01	97.00	-4.11	265.05*	0.47	1.67	-0.0004
WB-1538	13.62	-0.07	-0.61	7.30	-8.09*	-0.02	154.30	0.63	8.66	0.53	0.35	-0.0007
WB-416	11.71	1.14	-0.48	5.16	-1.30	0.02	102.00	0.35	-2.12	0.43	1.37*	-0.0008
WB-223	11.40	2.15	-0.16	6.16	1.02	-0.02	67.30	0.12	-58.59	0.54	3.47**	-0.0007
W B-322	12.44	0.79	-0.59	5.25	0.74	-0.03	68.00	0.89	-35.47	0.41	0.38*	-0.0007
WB-1128	13.30	1.65	-0.24	5.42	1.16	0.02	70.30	0.59	-1.74	0.39	1.09	-0.0007
WB-147	13.78	1.48	-0.59	5.32	0.35	-0.03	80.30	1.36	24.02	0.47	1.63*	-0.0007
WB-249	9.59	0.67	1.68	6.41	4.22	-0.01	73.10	-1.05	-9.38	0.42	1.12	-0.0008
WB-1136	13.41	1.59	-0.46	6.39	1.63	-0.02	104.30	5.99	183.15*	0.48	1.19	-0.0003
WB-360	13.012	-0.19	-0.48	4.4o	2.33	-0.03	136.80	1.46	84.09	0.40	-0.66	-0.0005
WB-1139	10.96	0.54	-0.11	7.12	0.79	-0.01	155.60	2.05	25.45	0.59	0.81	-0.0002
WB-30	12.17	1.39	-0.41	6.21	1.22	-0.02	94.40	-1.63	56.26	0.41	0.89	-0.0007
WB-345	14.82	1.40	-0.05	5.26	5.43	0.01	86.80	0.19	-51.29	0.44	1.98*	-0.0007
WB-648	12.89	0.59	-0.57	4.37	1.41	-0.02	154.90	1.45*	-66.38	0.34	0.28	-0.0006
WB-1181	10.19	0.49	-0.32	4.81	-5.61	0.05	74.00	3.88	-74.49	0.49	1.26	-0.0007
WB-46	`13.00	0.46	-0.57	5.35	-2.42	0.08*	152.50	5.20	-5.77	0.40	0.37**	-0.0008
WB-569	10.95	1.64	-0.53	6.37	-1.03	-0.02	136.50	2.25	76.81	0.58	2.206	-0.0006
WB-467	10.41	0.92	-0.26	4.47	6.55	0.00	52.80	0.72	-29.34	0.42	-0.30	-0.0004
WB-411	11.72	-1.75	0.301	4.41	4.68	-0.01	46.30	2.99	-57.05	0.38	-3.28*	0.0001
WB-481	12.06	0.18**	-0.64	6.66	1.87	0.01	83.70	0.24	-51.58	0.54	-1.00**	-0.0007
WB-651	11.92	0.69*	-0.64	5.38	3.77	0.04	66.80	0.78	-26.55	0.46	1.11	-0.007
Population mean	12.34			5.68			100.60			0.46		
SE(m)	0.47			0.11			5.2			0.0072		
SE(b_i)	0.76			3.03			1.9			0.3803		

Table 4: Stability parameters for 100-seed weight (g), pod yield $plot^{-1}$ and seed yield $plot^{-1}$ in selected French bean genotypes evaluated across 4 random environments

Genotypes	100-seed weight			Pod yield $plot^{-1}$			Seed yield per plot		
	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i	Mean ($\bar{X}$)	b_i	S^2d_i
WB-195	31.87	0.98	0.47	7182.10	0.40	-938.07	2582.30	0.74	2454.55
WB-1186	27.55	-0.38	-1.56	6761.90	0.01	384.15	2434.80	-13.36	7470.67*
WB-479	30.87	-1.08	-1.74	4266.30	0.17*	-977.66	1224.80	-0.84	2301.79
WB-160	21.12	-1.35*	-2.33	3948.00	0.10	-711.88	1557.40	0.29	1813.78
WB-252	34.96	1.60	-0.74	5169.60	0.29	67.24	1314.40	0.17	2389.16
WB-941	61.67	2.40	-2.02	7634.60	0.15	-323.41	3457.50	-0.10	2241.14
WB-335	43.89	-1.64	-1.51	4369.70	-0.06	-27.78	1868.90	1.14	1247.86
WB -940	49.92	3.46	-1.24	4071.00	0.15*	-867.20	1889.90	0.45	1899.26
WB-492	42.05	3.35*	-1.99	2753.80	0.89	-989.66	1652.60	3.05*	2500.68
WB-429	42.75	-0.27	-0.93	4163.10	0.09**	-1051.97	1457.50	0.41	2006.59
WB-1538	30.44	1.77	-2.39	7231.60	10.22**	1293.35	2195.90	1.83	971.94
WB-416	31.20	1.42	-0.27	4830.30	1.32	2151.75	1762.00	1.59	2235.29
WB-223	33.28	1.83	-2.01	3205.90	0.92	-753.02	908.10	1.16	2413.43
W B-322	31.23	1.54	-2.24	3464.10	0.61	2323.85*	845.40	0.58	2086.47
WB-1128	17.70	-0.58**	-2.46	3020.90	-0.08	3047.52*	551.10	0.39	2061.77
WB-147	27.37	1.39	-0.95	3546.90	-0.56	827.61	1059.90	-0.59	838.44
WB-249	27.16	1.21	4.90	3246.40	0.49*	1040.50	1125.60	0.54	2426.59
WB-1136	30.25	0.31	-1.44	4450.10	0.42	2563.94*	1159.60	0.07	2401.71
WB-360	31.76	-2.3*	-2.15	7113.80	1.19	-700.88	1363.90	1.24	2555.54
WB-1139	25.33	-0.24	2.71	7566.10	1.25	-1049.09	1900.80	2.26	3396.31
WB-30	47.62	1.25	0.39	4471.80	4.57*	1073.33	2295.50	1.57	2409.67
WB-345	33.30	-0.74	1.44	3567.40	0.71	2276.27*	977.80	1.07	1699.88
WB-648	30.11	3.73*	-2.05	6825.80	0.65	647.61	1348.90	1.09	1412.03
WB-1181	28.87	3.47**	-2.39	3390.00	0.38	-769.58	1091.60	0.79	1995.76
WB-46	31.48	0.88	-2.42	7280.00	0.24	-863.52	1084.00	1.22	2121.32
WB-569	34.44	2.05	-0.73	5563.40	1.91**	-1067.93	1323.00	18.97	12933.72**
WB-467	21.12	2.48	-1.15	2792.90	1.29	-835.72	674.00	1.35	2240.75
WB-411	24.53	2.34	1.56	2020.30	1.05	436.19	639.60	0.71	1481.98
WB-481	31.44	0.51	-1.30	4089.40	0.90	193.15	1664.50	1.79	1626.89
WB-651	41.27	0.65	-2.27	3272.40	0.28	3762.32*	1105.30	0.45	2202.85
Population mean	33.22			4709.00			1483.90		
SE(m)	0.7122			21.30			24.00		
SE(b_i)	0.9025			0.50			1.4		

The genotypes not deviating from unit regression for a particular trait revealed that they were average in stability with high prediction across environments and as such were either poorly or well adapted to all the environments depending upon the mean performance. However, the non significant linear regression coefficient (bi) was valid only for genotypes with non significant deviation from regression (S^2di). Genotypes that showed average stability and were well adapted to all the environments included WB-360, WB-1139, WB-46
for days to 50% flowering; WB-479, WB-160, WB-252, WB-1128, WB-481 for days to maturity; WB-335, WB-940, WB-429 for plant height; WB-195, WB-1186, WB-160, WB-941, WB-940, WB-1136, WB-360 for pods plant^{-1}; WB-479, WB-160, WB-429, WB-1128, WB-147, WB-1136, WB-345 for pod length; WB-223, WB-1136, WB-1139, WB-30 for seeds pod^{-1}; WB-195, WB-360 for pod yield plant^{-1}; WB-940, WB-429, WB-249, WB-1136, WB-1139, WB-36, WB-1181, WB-651 for pod density; WB-252, WB-30, WB-651 for 100 seed weight; WB-416,WB-360, WB-1139, WB-648 for pod yield plot^{-1}; WB-195, WB-335, WB-416, WB-30 for seed yield plot^{-1} (Table-2, 3 and 4).
None of the genotypes was well adapted to all the environments. On the basis of mean performance and average stability, it could be derived that WB-195 and WB-416 exhibited stable performance to all the environments for most of the yield and related traits.

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