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RESEARCH PAPER

Analysis of genotype-by-environment interaction for growth and earliness traits of eggplant in Rajasthan

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Abstract : Numerous common eggplant varieties have been developed in India, which when grown under variable environments, the magnitude of the growth and flowering is influenced by them. In order to determine the reasons for such variations the effect of the growing conditions on growth and flowering from the eggplant cultivars with the region specific in production were investigated. The cultivars were investigated during four successive environments at two different locations in Rajasthan with contrasting environmental components such as soil and climate. The phenotypic response of the genotypes was followed with a focus on the size of the growth and the direction of flowering within the group of genotypes as a result of each factor: season, location of growing, genotype and their complex interactions. The collected data were analyzed and provided sufficient information on the genotype x environment interaction. Significant differences were found among the investigated genotypes by growth and earliness traits regardless of their specific response to the year conditions and the location. The genotype x environment interaction was significantly high and non-linear. This means that under changeable environments the different cultivars react differently and can, therefore, be grouped according to the growth and earliness stability. This is very clear from the environmental mean scores, environments E_1 was more stable with a lowest mean value for earliness traits and highest mean value had the highest genotypic response for growth traits. Seven genotypes were found to be stable across the environments for days to anthesis of first flower, eight genotypes were found stable for days to 50 per cent flowering and ten genotypes were also found stable for days to first fruit picking. Among the stable genotypes for earliness the Pusa Upkar and Punjab Sadabahar x Pusa Upkar were found to be stable for all the earliness traits. They earliness below the average mean days of all the genotypes under test, with a slope of unity and the mean square due to deviation from regression equal to zero. The five genotypes were identified for leaf area, four genotypes for plant height, three genotypes for plant spread and two genotypes for number of branches per plant as most widely adapted genotypes for growth parameters based on stability analysis. Thus, these stable genotypes can be recommended for commercial cultivation over wide range of environments or can be used in further breeding programmes.

Key Words : Eggplant, Environment, Genotype, Interaction

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INTRODUCTION

Genotype-environment interaction in crops such as the eggplant (*Solanum melongena* L.) is the differential response of genotypes to changing environmental conditions. Such interactions complicate testing and selection in plant breeding programmes and result in reduced overall genetic gain. The literature on genotype-environment interaction in eggplant is not extensive. Its effects have been recognized in India by Chadha and Singh (1982); Vadivel and Bapu (1989); Mohanty and Prusti (2000); Sharma *et al*. (2000); Mohanty (2002) and Vadodaria *et al*. (2009) and more recently in Andhra Pradesh (Sivakumar *et al*., 2015). In eggplant, productivity performance is represented mainly by growth and yield stability. Breeders search for genotypes that show stability vigour and early high yield over the years and locations. Therefore, there is a need for identifying eggplant genotype with stable traits of growth and earliness. A genotype or cultivar that shows consistent performance across different environments and years for a given trait is considered stable. Although, the earliness characteristic is affected by genotype and environmental factors, cultivar has a major effect. Therefore, it is possible to select widely adapted stable genotype for earliness. Plant breeders can selectively develop cultivars with certain ranges of early harvest. Partitioning of growing environments to reduce genotype x environment (G x E) interaction is challenging especially in regions where climatic variation is large. Therefore, evaluation of cultivars by stability parameters across multi-environments is important to identify the consistent performing and high yielding cultivars. There are several methods developed to assess stability of cultivars across environments. However, each method has its advantages and limitations. Combined analysis of variance (ANOVA) has been used to detect G x E interactions and their magnitude. However, this analysis does not provide the measurement of response by individual genotype to environments. Regression technique was proposed by Finlay and Wilkinson (1963) and was improved by Eberhart and Russell (1966). This is a popular method in stability analysis and has been applied in many crops. Given the limitation of information on the stability of growth traits in eggplant, this study was conducted across four environments to understand the responses and to identify varietal stability on earliness.

MATERIAL AND METHODS

Plant materials and field experiments :

The experimental materials comprised of ten open-pollinated varieties *viz*., Pusa Purple long, Pusa Uttam, Punjab Sadabahar, Selection-2, Mukta Shree, Type-3, Pusa Upkar, BR-112, Azad-331 and Udaipur Local and their possible 45 F_1s. These 45 F_1s were obtained by crossing 10 genotypes in diallel fashion (without reciprocal) during the autumn-winter season, 2010-11. Field experiments were conducted across four environments, each two in Udaipur and Chittorgarh. In Udaipur, the early growing season or rainy season experiments were conducted from 25 June–November 2011 and late season was done from 25 July 2011–January 2012 at Maharana Pratap University of Agriculture and Technology farm (24^{0}35'N and 73^{0}42'E, at 582.17 m a.s.l). In Chittorgarh, experiments were conducted during eggplant growing season *i.e.* 10 July 2011-January 2012 and very late growing season 10 August 2011-February 2012 at the Krishi Vigyan Kendra (KVK), Saethi (23^{0}32/25^{0}13'N and 74^{0}12/75^{0}49'E, at 394m a.s.l). A Randomized Complete Block Design with three replications was used in all experiments. The plants were spaced 60 cm between plants, and 75 cm between rows. Standard crop management practices, through

Table A : Descriptions of environments where trials were conducted during 2011–2012

Environments	Planting date	Geographial co-ordinates	Altitude (masl)	Temperature (C) Max	Temperature (C) Min	Relative humidity (%) Max	Relative humidity (%) Min	Rainfall (mm)	Soil type	Soil PH
Udaipur (E_1)	25 June, 2011	24^{0}35'N 73^{0}42'E	582.17	33.4	23.3	95.5	69.7	88.7	Sandy clay loam	8.2
Chittorgarh (E_2)	10 July, 2011	23^{0}32/25^{0}13'N 74^{0}12/75^{0}49'E	394	36.4	24.5	91.4	56.1	111.5	Sandy clay loam	8.3
Udaipur (E_3)	25 July, 2011	24^{0}35'N 73^{0}42'E	582.17	31.6	24.2	91.4	78.9	56.6	Sandy clay loam	8.2
Chittorgarh (E_4)	10August, 2011	23^{0}32/25^{0}13'N 74^{0}12/75^{0}49'E	394	33.1	24.0	93.7	78.7	121.5	Sandy clay loam	8.3

nursery to harvest, were followed in all locations. Irrigation system was laid out in all the experiments so that soil moisture was not limiting. Environment data such as soil properties, temperature, relative humidity and rainfall were recorded (Table A). The observations were recorded on five competitive plants for different characters *viz*., days to anthesis of first flower, days to 50 per cent flowering, days to first fruit picking, leaf area (cm^2), plant height (cm), plant spread (m^2) and number of branches per plant.

Statistical analysis :

Growth and earliness traits were statistically analyzed for each environment. Error variances were tested for homogeneity with Bartlett's test as described by Gomez and Gomez (1984) and the data on growth and earliness traits of the genotypes tested averaged over four environments were homogenous before the data was pooled. The stability model proposed by Eberhart and Russell (1966) was used to estimate stability parameters for growth and earliness traits. This model provides regression indices (bi values) and mean square for deviation from regression minus pooled error (S^2di) as indices of a stable genotype. The stable genotype will be those having mean value higher than the average value of all the genotypes under test, regression co-efficient of unity and deviation from regression equal to zero. Pooled error was obtained by averaging the error mean squares from the analysis of variance of individual environments and dividing by the number of replications. The significance of mean squares were tested against the pooled error. For testing significance of mean values; least significant difference (LSD) was computed by using the pooled error. The t-test based on the standard error of regression value was used to test significant deviation from 1.0. To determine whether deviation from regression were significantly different from zero, the F-test was employed *i.e.* comparing the mean square due to deviation from regression with pooled error.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Analysis of variance :

The results of combined analysis of variance for growth and flowering traits are presented in Table 1. There were significant differences among genotypes, environments and for genotypes by environment interactions for all traits. A high and significant variances due to environment and genotype x environment for all the traits indicates that, genotypes were significantly different from each other. These results are in agreement with the earlier findings of Mohanty and Prusti (2000), Sharma *et al*. (2000); Rai *et al*. (2000) and Krishna Prasad *et al*. (2002). The joint regression analysis of variance for different characters indicated that the components genotype x environment interaction was highly significant for all the characters, indicating that the genotypes had the divergent linear response to environmental changes, while significant pooled deviation except for leaf area and plant spread suggests, deviation from linear regression also contributed substantially towards the differences in stability of genotypes. Thus, it can be concluded that, both predictable (linear) and unpredictable (non-linear) components contributed significantly to the differences in stability among the

Table 1 : Combined analysis of variance for growth and earliness traits of 55 eggplant genotypes evaluated in four environments during 2011–2012

Source of variation	D.f.	Days to anthesis of first flower	Days to 50 per cent flowering	Days to first fruit picking	Leaf area (cm^2)	Plant height (cm)	Plant spread (m^2)	Number of branches per plant
Genotypes (G)	54	104.71**	89.6**	119.09**	255**	332.51**	0.0173**	7.18**
Environment (E)	3	963.11**	925.54**	1221.67**	6423.22**	2370.26**	0.0653**	42.86**
Genotypes x environment	162	6.29**	6.61**	6.88**	24.41**	15.55**	0.0003**	0.32**
Environments + (G x E)	165	23.69**++	23.31**++	28.97**++	140.75**++	58.36**++	0.0015**++	1.09**++
Environments (linear)	1	2889.15**++	2776.4**++	3665.2**++	19269.8**++	7110.95**++	0.198**++	128.7**++
G x E (linear)	54	5.97*	6.07*	6.95*	39.12**++	24.91**++	0.0004**++	0.63**++
Pooled deviation	110	6.33**	6.75**	6.72*	16.74	10.67**	0.0002	0.16**
Pooled error	432	4.28	3.92	5.08	15.45	5.95	0.0002	0.09

* and ** indicate significance of values at P=0.05 and 0.01, respectively, +, ++ Significant at 1 and 1 per cent against pooled deviation, respectively

genotypes tested. However, significant G x E interactions against pooled deviation for all the characters indicating that the interactions was linear in nature and prediction over the environments for these characters is not possible. Many studies reported that eggplant growth and earliness traits is affected by environment conditions (Mohanty and Prusti, 2000; Rao, 2003; Suneetha *et al.*, 2006; Kumar *et al.*, 2008 and Vadodaria *et al.*, 2009).

Environment evaluation :

The G × E study is especially important in countries with various agro-ecologies (Fasahat *et al.*, 2015). Significant G × E interaction is a consequence of variations in the extent of differences among genotypes in diverse environments or variations in the comparative ranking of the genotypes (Falconer, 1952 and Fernandez, 1991). Basford and Cooper (1998) indicated that

Table 2 : Minimum, maximum and mean of growth and earliness traits in four environments during the 2011–2012 cropping seasons

Characters	Environment	Parents			Hybrids			S.E.±	CV (%)
		Minimum	Maximum	Mean	Minimum	Maximum	Mean		
Days to anthesis of first flower	E_1	61.13	87.84	74.99	53.74	79.86	73.10	2.02	4.76
	E_2	60.23	86.23	77.34	58.63	89.43	79.15	1.98	4.36
	E_3	60.22	87.63	77.62	57.96	83.21	75.27	2.10	4.81
	E_4	73.20	97.66	85.41	61.00	91.32	82.59	2.12	4.41
	Mean	63.70	86.07	78.84	57.83	84.72	77.53	1.03	4.58
Days to 50 per cent flowering	E_1	70.47	96.97	84.21	61.36	88.01	80.81	1.84	3.92
	E_2	72.36	90.23	84.84	68.60	98.96	86.89	2.22	4.44
	E_3	70.36	90.96	84.58	67.23	89.65	83.17	2.01	4.17
	E_4	81.23	103.70	92.98	71.67	97.44	90.37	1.77	3.38
	Mean	73.61	95.27	86.65	67.22	91.26	85.31	0.98	3.98
Days to first fruit picking	E_1	83.10	112.20	99.38	78.23	105.95	95.90	2.21	3.96
	E_2	90.36	118.75	104.18	81.40	115.32	102.29	2.34	3.94
	E_3	90.20	110.20	101.34	84.30	108.65	99.10	2.48	4.32
	E_4	95.23	116.50	108.88	85.96	116.45	107.27	1.95	3.14
	Mean	89.72	112.12	103.45	82.47	109.84	101.14	1.13	3.84
Leaf area (cm^2)	E_1	106.89	145.64	120.09	96.34	140.72	124.49	4.19	5.87
	E_2	91.52	135.65	104.96	96.36	128.92	110.09	3.94	6.25
	E_3	103.52	141.65	115.15	107.87	132.58	117.84	4.06	5.99
	E_4	90.25	137.38	101.94	83.55	115.71	97.97	3.37	5.91
	Mean	99.28	140.08	110.53	98.26	125.78	112.60	1.95	6.03
Plant height (cm)	E_1	56.33	90.77	67.37	49.11	93.31	70.62	2.60	6.44
	E_2	50.57	74.75	60.98	39.64	80.29	58.81	2.24	6.54
	E_3	53.37	86.71	63.52	45.45	85.25	67.10	2.64	6.88
	E_4	45.11	74.61	54.27	41.60	70.82	55.99	2.18	6.77
	Mean	51.83	81.71	61.54	45.04	81.16	63.13	1.21	6.67
Plant spread (m^2)	E_1	0.1516	0.4975	0.2983	0.1831	0.4513	0.3248	0.0137	7.43
	E_2	0.1466	0.4530	0.2662	0.1545	0.3953	0.2800	0.0137	8.55
	E_3	0.1599	0.4760	0.2897	0.1798	0.4428	0.3087	0.0148	8.37
	E_4	0.1255	0.3848	0.2350	0.1229	0.3612	0.2432	0.0105	7.53
	Mean	0.1459	0.4528	0.2723	0.1601	0.4113	0.2892	0.0066	8.02
Number of branches per plant	E_1	6.67	12.23	8.90	7.27	14.73	9.64	0.34	6.20
	E_2	5.63	10.65	7.93	6.26	13.20	8.25	0.29	6.22
	E_3	6.10	11.50	8.63	6.97	14.20	9.09	0.30	5.72
	E_4	5.23	10.10	7.33	5.66	10.98	7.55	0.23	5.39
	Mean	5.91	11.12	8.20	6.66	12.78	8.63	0.15	5.94

genotype is the genetic makeup of an organism while, environment refers to biophysical factors that have an effect on the growth and development of a genotype. Thus, it is important to study in depth the vigor levels, adaptation patterns and stability of genotypes in multi-location trials. Freeman (1985) also indicated that, most breeding programmes, appearance of different genotypes is especially in the comparison of genotypes in different environments. Due to highly significant differences among genotypes by environment interactions, the mean of genotypes for growth and earliness traits from each environment was used to rank (Min.and Max.) the environmental effects on each trait as suggested by Finlay and Wilkinson (1963) are presented in Table 2. Across different environment, days to first flower opening for parents at individual environments ranged from 60.23 days in E_3 to 97.66 days in E_4 and in hybrids the lowest value days to anthesis of first flower of 53.74 days was obtained from E_1, while the highest was from (91.32) at E_4. The days to 50 per cent flowering varied from 70.36 days in E_3 to 103.70 days in E_4 and lowest at 61.36 days in E_1 to the highest at 98.96 days in E_2 for parents and hybrids, respectively. The average environmental days to first fruit picking ranged from earliest at 83.10 days in E_1 to the highest at 118.75 days in E_2 for parents and across hybrids ranged from lowest at 78.27 days in E_1 to the highest at 116.45 days in E_4. According to environmental mean scores, environments E_1 was more stable and had surpassed all other environments with a lowest mean value for earliness traits, whereas the highest environmental mean scores belonged to E_4. According to mean, environments E_1 and E_3 were ideal environments for selecting genotypes with specific adaptation to high input conditions, because these two environments situated at similar geographical location. Among the genotypes, Pusa Purple Long and Pusa Purple Long x Pusa Uttam recorded earliness for all the flowering traits in all the environments, indicating its earliness and good adaptability to the eggplant-growing environment of Rajasthan.

The mean leaf area for parents ranged from 90.25 cm^2 (E_4) to 145.64 cm^2 (E_1) across four environments. The values for plant height varied from 45.11 cm (E_4) to 90.77 cm (E_1), for plant spread ranged from 0.1255 m^2 (E_4) to 0.4975 m^2 (E_1), for number of branches per plant was varied from 5.23 (E_4) to 12.23 (E_1) across four environments. The smallest growth amplitude for hybrids was obtained from E_4 (83.55) for leaf area, in E_2 (39.64) for plant height, in E_4 (0.1229) for plant spread and in E_4 (5.66) for number of branches per plant revealing their consistent performance across the test environments, whereas the highest growth amplitude was recorded form E_1, (140.72, 93.31, 0.4513 and 14.73) for leaf area, plant height, plant spread and number of branches per plant, respectively. The mean values of parents and hybrids across the environments were found lowest in E_4 and highest in E_1 (Table 2). By using this environmental evaluation, environment E_1 had the highest stability with the highest mean value, whereas environment E_4 with the lowest mean value had the lowest genotypic response. Test of environments based on co-efficient of variation (CV) showed with the lowest CV as having the least variability for genotypic responses.

Stability for earliness :

Stability parameters for earliness traits are shown in Table 3. Stability measures are very important to identify both linear (bi) and non-linear (S^2di) components of G × E interaction for judging the stability of a genotype (Eberhart and Russell, 1966). Linear regression for days to anthesis of first flower a single genotype on average of all genotypes in each environment resulted in regression co-efficients (bi values) ranged from 0.27 to 1.93. This variation in regression co-efficients indicated varied responses of genotypes to environmental changes (Table 3). On perusal of results, it is revealed that 48 genotypes recorded stableness for days to anthesis of first flower over the environments. The regression co-efficient of genotypes *i.e.* Pusa Upkar (1.07), Pusa Purple Long x Punjab Sadabahar (0.94), Pusa Purple Long x Pusa Upkar (0.94), Pusa Uttam x Punjab Sadabahar (0.93), Pusa Uttam x BR-112 (0.92), Punjab Sadabahar x Pusa Upkar (0.95) and BR-112 x Udaipur Local (1.03) for days to anthesis of first flower was near (bi = 1.0) and has a small deviation from regression (S^2di) and with below average days to anthesis of first flower (location mean = 77.77 days) indicated general adaptability for days to anthesis of first flower. Although, Type-3, Pusa Uttam x Azad-331, Punjab Sadabahar x Type-3, Punjab Sadabahar x BR-112, Selection-2 x Pusa Upkar, Type-3x Pusa Upkar and BR-112 x Azad-331 had regression co-efficient for days to anthesis of first flower of bi >1 and their average days to anthesis of first flower was low, therefore, more stable in better environments but in general early days to anthesis of first flower. Punjab Sadabahar, Selection-2, Azad-331, Udaipur Local, Pusa

Table 3 : Stability analyses for growth and earliness traits of 55 eggplant genotypes grown at four environments during 2011-2012

Genotypes	Days to anthesis of first flower			Days to 50 per cent flowering			Days to first fruit picking		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
P_1	63.70	1.24	15.68*	73.61	1.17	1.60	89.72	0.99	-0.37
P_2	75.57	1.22	5.12	82.02	1.76	16.85*	98.33	1.46	-1.21
P_3	78.00	0.75	-3.16	86.69	0.87	-2.57	101.11	0.95	-1.48
P_4	79.01	0.71	-2.38	86.54	0.52	0.68	106.48	0.51*	-3.65
P_5	86.07	1.80	29.49**	95.27	0.86	40.07**	112.12	0.57	48.23**
P_6	85.19	1.16	5.79	92.23	1.11	2.54	107.71	0.80	-1.07
P_7	76.57	1.07	0.01	84.34	1.01	-0.80	99.81	1.00	-2.53
P_8	77.31	0.87	-1.79	84.91	0.76	-2.00	100.58	0.95	5.14
P_9	81.17	0.85	-1.95	88.74	0.97	-0.28	107.05	0.67*	-4.52
P_{10}	85.84	0.34	8.86	92.18	0.13	1.91	111.58	0.82**	-5.01
P_1 x P_2	57.83	0.67	-2.35	67.22	0.97	0.33	82.47	0.56	1.78
P_1 x P_3	70.23	0.94	-1.03	77.31	1.32	2.30	92.64	0.95	-3.28
P_1 x P_4	79.44	1.38**	-3.86	86.95	1.48*	-2.98	99.79	1.47	-2.54
P_1 x P_5	78.00	0.89	4.94	87.03	0.38	0.80	103.67	0.45	3.11
P_1 x P_6	79.84	0.87	-3.25	87.65	0.86	-2.35	102.38	1.60	8.72
P_1 x P_7	75.56	0.94	-2.92	82.96	0.85	-2.54	98.66	0.84	1.40
P_1 x P_8	77.62	0.66	-3.06	81.05	1.01	34.75**	98.11	1.14	40.52**
P_1 x P_9	79.80	1.36	-2.07	87.69	1.38*	-3.38	101.84	1.20	-4.18
P_1 x P_{10}	80.61	1.18	2.58	88.70	1.06	-1.31	106.77	1.22	2.26
P_2 x P_3	76.36	0.93	-4.32	83.82	0.96	-0.18	99.21	0.90*	-5.02
P_2 x P_4	70.01	0.27**	-4.08	77.62	0.83	-2.44	91.30	1.08	-0.59
P_2 x P_5	81.57	1.93	5.60	88.73	1.99	7.23	103.51	1.82	2.21
P_2 x P_6	83.40	1.34	-0.64	90.73	1.44	6.93	105.04	1.32	13.33
P_2 x P_7	76.93	0.85	-0.76	84.50	0.61	1.74	101.12	0.74	9.28
P_2 x P_8	76.41	0.92	-1.84	84.66	1.07	-3.27	98.67	1.38	-0.64
P_2 x P_9	76.89	1.11	-2.18	85.09	0.98	1.67	102.20	1.21**	-5.13
P_2 x P_{10}	77.92	1.09	-4.16	85.15	1.33	-1.09	103.01	1.01	8.28
P_3 x P_4	78.63	0.79	-2.26	85.37	0.53	-1.06	101.09	0.75	-3.23
P_3 x P_5	81.27	0.93	-1.50	87.74	0.89	-1.89	103.56	0.74	-2.89
P_3 x P_6	76.69	1.14	-2.39	84.68	1.13	-0.67	101.49	0.86	1.03
P_3 x P_7	77.68	0.95	-3.49	84.41	0.96	-1.64	99.92	0.91	-4.80
P_3 x P_8	77.19	1.20	-0.97	83.89	1.39	0.39	99.20	1.44	-0.53
P_3 x P_9	79.73	0.91	-3.27	86.52	0.88	-3.29	100.18	1.07	-3.02
P_3 x P_{10}	74.77	0.39**	-3.87	82.27	1.02	-3.05	95.61	1.11	-2.45
P_4 x P_5	80.41	1.82	18.40*	88.01	1.60	13.02*	105.39	1.86**	-3.72
P_4 x P_6	81.72	0.69	4.36	87.63	0.74	-1.26	104.48	0.68	-2.69
P_4 x P_7	75.58	1.13	-0.59	83.85	0.89	-2.74	101.74	1.12*	-5.21
P_4 x P_8	78.32	1.00	-2.59	87.06	1.29	15.53*	102.69	0.86	-4.43
P_4 x P_9	79.97	0.90	-2.22	88.06	0.65*	-3.33	103.11	0.62	-3.65
P_4 x P_{10}	82.11	0.48	2.17	90.79	0.82	0.28	109.84	0.93	-1.73
P_5 x P_6	84.72	1.17	-3.88	91.26	1.07	-3.15	106.00	0.79	-1.05
P_5 x P_7	78.54	0.42	1.55	88.29	0.97	0.21	102.62	1.18	6.35
P_5 x P_8	77.38	0.86	-1.27	85.23	0.55**	-3.73	98.02	0.37*	-2.60
P_5 x P_9	78.74	0.82	-3.95	86.86	0.94	-3.38	105.58	0.58	1.55
P_5 x P_{10}	81.00	1.03	1.37	89.28	0.78	0.53	107.27	1.32	-0.77
P_6 x P_7	75.38	1.58	4.13	85.64	1.44**	-3.54	101.43	1.11	-3.56

Table 3: Contd…………

Table 3 : Contd…………

P_6 x P_8	69.30	0.87	-0.51	78.63	0.27	7.47	92.23	0.61**	-4.76
P_6 x P_9	81.87	1.19	-3.32	87.32	1.06	5.08	102.20	1.16	9.96
P_6 x P_{10}	80.88	1.09	27.44**	88.39	0.81	7.91	105.45	1.23	-3.12
P_7 x P_8	75.50	0.81	12.69*	84.39	1.04	13.07*	98.51	1.21	-1.80
P_7 x P_9	66.15	1.00	16.95*	77.46	0.96	-0.18	91.96	0.92	-4.89
P_7 x P_{10}	81.48	1.32	3.15	88.95	1.11	8.74	103.74	1.00	-2.64
P_8 x P_9	76.20	1.28	-0.61	84.25	1.03	-3.27	103.60	1.21	20.85*
P_8 x P_{10}	77.37	1.03	-1.17	84.76	1.44*	-2.70	104.60	0.99	-5.06
P_9 x P_{10}	81.87	0.84	26.30**	91.21	1.12	28.00**	109.44	0.77	15.99*
Mean	77.77	1.00	2.05	85.55	1.00	2.83	101.56	1.00	1.64
S.E. (bi)		0.41			0.44			0.37	

* and ** indicate significance of values at P=0.05 and 0.01, respectively

Purple Long x Pusa Uttam, Pusa Purple Long x BR-112, Pusa Uttam x Selection-2, Pusa Uttam x Pusa Upkar, Punjab Sadabahar x Udaipur Local, Mukta Shree x BR-112, Type-3 x BR-112, Pusa Upkar x BR-112 gave early flowering but had a lower regression co-efficient of bi < 1 indicating that this genotypes performed well under poor environmental conditions (Table 5). Pusa Purple Long, Mukta Shree, Selection-2 x Mukta Shree, Type-3 x Udaipur Local, Pusa Upkar x BR-112, Pusa Upkar x Azad-331 and Azad-331 x Udaipur Local produced early and late flowering and showed stability (bi = 1.24, 1.80, 1.82, 1.09, 0.81, 1.00, 0.84), but significantly different from 1.0 and 5.0 and high deviation from regression (Table 3). This showed that these, genotypes is very sensitive to changes in environment.

Fourty eight genotypes showed stability for days to 50 per cent flowering and regression co-efficients (bi values) ranged from 0.27 to 1.99. The regression co-efficient of genotypes *i.e.* Pusa Upkar (1.01), Pusa Purple Long x Pusa Uttam (0.97), Pusa Uttam x BR-112 (1.07), Pusa Uttam x Azad-331 (0.98), Punjab Sadabahar x Pusa Upkar (0.96), Punjab Sadabahar x Udaipur Local (1.02), Pusa Upkar x Azad-331 (0.96) and BR-112 x Azad-331 (1.03) for days to 50 per cent flowering was near (bi = 1.0) and has a small deviation from regression (S^2di) and with below average days to 50 per cent flowering (location mean = 85.55 days) indicated general adaptability for days to 50 per cent flowering. The genotypes Pusa Purple Long, Pusa Purple Long x Punjab Sadabahar, Pusa Uttam x Udaipur Local, Punjab Sadabahar x Type-3, Punjab Sadabahar x BR-112, BR-112 x Udaipur Local had regression co-efficient for days to 50 per cent flowering of more than unity (bi>1) and their average days to 50 per cent flowering was low, therefore, more stable in better environments. BR-112, Pusa Purple Long x Pusa Upkar, Pusa Uttam x Selection-2, Pusa Uttam x Pusa Upkar, Punjab Sadabahar x Selection-2, Selection-2 x Pusa Upkar, Mukta Shree x BR-112 and Type-3 x BR-112 gave early days to 50 per cent flowering but had a lower regression co-efficient of bi < 1 indicating that these genotypes performed well under poor environmental conditions. The seven genotypes showed significantly different from 1.0 and 5.0 and high deviation from regression (S^2di), indicating high fluctuation in days to 50 per cent flowering across environments.

For days to first fruit picking fifty one genotypes showed low deviation from regression (S^2di), indicating stableness across environments. All the genotypes in each environment resulted in regression co-efficients (bi values) ranged from 0.37 to 1.86. Pusa Purple Long (0.99), Punjab Sadabahar (0.95), Pusa Upkar (1.00), BR-112 (0.95), Pusa Purple Long x Punjab Sadabahar (0.95), Pusa Uttam x Punjab Sadabahar (0.90), Pusa Uttam x Selection-2 (1.04), Punjab Sadabahar x Pusa Upkar (0.91), Punjab Sadabahar x Azad-331 (1.07) and Pusa Upkar x Azad-331(0.92) showed unit regression coefficient (bi=1) for days to first fruit picking and has a non-significant deviation from regression (S^2di) and with below average first fruit picking (location mean = 101.56 days) indicated general adaptability for days to first fruit picking. In Pusa Uttam, Pusa Purple Long x Selection-2, Pusa Uttam x BR-112, Punjab Sadabahar x BR-112, Punjab Sadabahar x Udaipur Local, Type-3 x Pusa Upkar and Pusa Upkar x BR-112, days to first fruit picking were stable *i.e.* bi>1. Therefore, these genotypes are considered to be good only for better environment. Pusa Purple Long x Pusa Uttam, Pusa Purple Long x Pusa Upkar, Pusa Uttam x Pusa Upkar, Punjab Sadabahar x Selection-2, Punjab Sadabahar x Type-3, Mukta Shree x

Table 4 : Stability analyses for growth and earliness traits of 55 eggplant genotypes grown at four environments during 2011-2012

Genotypes	Leaf area (cm^2)			Plant height (cm)			Plant spread (m^2)			Number of branches per plant		
	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
P_1	101.30	0.49	36.49	66.74	0.55**	-5.74	0.29	0.83**	-0.0002	11.12	1.06	-0.08
P_2	112.91	1.15	108.48**	62.97	0.74	1.96	0.32	0.61	0.0002	8.52	0.84*	-0.09
P_3	104.06	0.36**	-6.95	54.94	0.72**	-5.46	0.23	0.53	0.0001	7.75	0.88	-0.05
P_4	114.80	1.24	6.60	54.84	0.28	38.21**	0.27	0.94**	-0.0002	6.86	0.81**	-0.08
P_5	140.08	0.35**	-6.64	81.71	1.23	-0.99	0.45	1.39	-0.0001	8.34	0.08	0.85**
P_6	115.66	1.00	-14.93	60.22	1.28	8.99	0.25	0.92	0.0000	7.19	0.69*	-0.07
P_7	105.41	0.67	4.36	65.39	1.17	7.82	0.34	1.17	0.0011**	5.91	0.69**	-0.07
P_8	103.26	0.69	-1.57	51.83	0.75	-3.06	0.20	0.47*	-0.0001	7.65	0.93	-0.05
P_9	99.28	0.73*	-13.41	57.99	0.72	2.55	0.15	0.39**	-0.0001	9.38	1.38	0.05
P_{10}	108.59	0.93	-14.26	58.73	0.53	4.70	0.22	0.89	0.0002	9.27	0.62*	-0.06
P_1 x P_2	125.78	0.54	1.73	72.57	0.76	-4.33	0.36	0.19**	-0.0001	12.53	1.28	0.01
P_1 x P_3	103.51	0.95	-0.47	64.56	1.20**	-5.82	0.26	1.06	0.0000	9.90	1.27	0.05
P_1 x P_4	109.19	0.80	-8.57	59.02	0.59	21.66*	0.28	0.97	-0.0001	10.19	0.76	0.07
P_1 x P_5	120.48	0.99	-8.68	77.76	1.46*	-3.55	0.41	1.22	-0.0001	12.78	2.70	1.60**
P_1 x P_6	116.07	1.01	-10.98	69.27	1.17	9.69	0.28	0.92	-0.0001	9.50	1.42	0.03
P_1 x P_7	105.61	1.00	-15.20	65.89	0.63	2.60	0.34	0.78	-0.0001	9.90	2.62	1.46**
P_1 x P_8	104.09	1.39**	-13.36	56.10	1.14	-4.59	0.24	0.86	0.0001	8.73	0.91	-0.05
P_1 x P_9	103.02	1.04	-14.77	60.54	1.03	-4.00	0.23	1.03	0.0002	9.73	2.29**	-0.01
P_1 x P_{10}	112.02	0.72*	-13.02	63.42	0.98	-5.10	0.27	0.69	-0.0001	10.08	1.54*	0.00
P_2 x P_3	112.63	1.28**	-15.92	67.09	0.80	-4.23	0.28	0.75	0.0000	8.88	1.31	0.00
P_2 x P_4	122.94	0.42	20.06	76.13	0.93	-1.30	0.36	0.69	-0.0001	9.60	1.50	0.17
P_2 x P_5	123.51	0.96	-14.44	79.62	1.19	-4.36	0.38	1.08	-0.0001	8.77	1.56*	-0.03
P_2 x P_6	117.98	1.21**	-14.35	62.33	0.44**	-5.48	0.30	0.69	0.0001	8.12	0.61	-0.04
P_2 x P_7	113.19	1.45	-3.92	58.54	1.97**	-4.86	0.31	1.25	0.0002	8.52	0.80	-0.04
P_2 x P_8	110.79	0.72*	-13.42	54.17	1.25	6.58	0.25	1.14	-0.0001	7.99	0.69*	-0.07
P_2 x P_9	105.53	1.06	-13.78	64.52	0.68**	-5.38	0.23	1.28	0.0001	9.03	1.10	-0.04
P_2 x P_{10}	107.18	1.45	19.77	61.41	0.83	0.29	0.27	1.14**	-0.0002	8.85	0.57*	-0.04
P_3 x P_4	105.70	1.03	-1.58	53.88	1.30	-3.72	0.27	0.92	-0.0001	7.28	0.65**	-0.08
P_3 x P_5	120.36	1.10	8.09	71.95	1.73**	-1.91	0.36	1.11**	-0.0002	7.94	0.54**	-0.09
P_3 x P_6	113.32	0.52	10.27	60.69	1.01	0.46	0.23	1.19	0.0003	7.59	1.27	0.23
P_3 x P_7	106.22	0.95	-11.11	55.84	1.44	-1.80	0.34	0.86	-0.0001	7.20	1.06	0.19
P_3 x P_8	110.37	0.88	0.79	50.32	0.62	38.56**	0.22	0.83	-0.0001	7.82	0.77*	-0.08
P_3 x P_9	104.89	0.54*	-8.42	56.96	0.53*	-2.95	0.23	1.08**	-0.0002	8.36	1.17	-0.08
P_3 x P_{10}	122.01	1.06	-12.36	70.32	1.05	-3.08	0.29	0.89	-0.0001	10.00	0.35**	-0.03
P_4 x P_5	123.46	1.28**	-15.06	78.75	1.05	-5.12	0.38	1.53	0.0001	7.89	0.46**	-0.06
P_4 x P_6	111.13	1.57*	-2.70	57.50	0.08	20.74*	0.28	0.92	0.0001	6.66	0.62**	-0.08
P_4 x P_7	109.46	1.34	-4.36	70.02	1.16	28.19*	0.32	1.14	-0.0001	8.04	1.49	0.13
P_4 x P_8	111.90	0.68	25.68	50.68	0.18*	0.74	0.25	1.14**	-0.0002	6.91	0.50**	-0.05
P_4 x P_9	109.43	1.45*	-9.97	53.01	1.22	7.07	0.22	1.03	-0.0001	7.95	0.67*	-0.06
P_4 x P_{10}	111.18	1.24	-7.73	54.68	0.29	4.59	0.24	1.50**	-0.0001	8.05	0.75	-0.01
P_5 x P_6	124.39	1.50**	-14.78	57.38	1.24	7.03	0.36	1.33**	-0.0002	7.92	1.01	-0.01
P_5 x P_7	116.51	1.60**	-6.01	81.16	1.67	14.76	0.38	1.53	0.0001	8.21	0.76	-0.06
P_5 x P_8	116.28	1.53	-0.73	72.70	1.58*	-1.19	0.33	1.28	-0.0001	7.20	0.49**	-0.06

Table 4: Contd…….

Table 4 : Contd………..

P_5 x P_9	114.98	1.67	20.84	76.00	1.85*	2.24	0.29	1.78**	0.0000	9.19	1.18	0.11
P_5 x P_{10}	120.91	1.16	-6.87	66.21	1.44**	-5.56	0.34	1.33	0.0001	9.09	0.39**	-0.05
P_6 x P_7	120.72	0.88	-0.20	63.42	1.32	2.28	0.30	1.14	-0.0001	7.31	1.75**	0.01
P_6 x P_8	120.56	0.84	-12.77	67.23	0.87	-3.39	0.30	1.42	0.0000	8.23	1.09	0.05
P_6 x P_9	111.18	1.04	35.64	48.71	0.31*	-1.16	0.23	1.44	0.0005*	8.75	0.79	0.00
P_6 x P_{10}	107.44	1.14	1.86	45.04	0.44**	-4.69	0.23	1.25	-0.0001	8.48	0.36**	-0.07
P_7 x P_8	109.45	1.26	29.12	61.97	1.43	17.37*	0.29	0.94	0.0000	7.93	0.92	0.02
P_7 x P_9	117.49	0.70	32.98	79.07	1.36	-2.83	0.41	1.06	-0.0001	10.50	0.74**	-0.08
P_7 x P_{10}	106.69	0.94	-13.25	61.63	1.69	4.18	0.29	-0.25	0.0018**	7.84	0.62	-0.03
P_8 x P_9	106.48	0.84	-7.99	58.32	1.06	47.60**	0.16	0.81**	-0.0002	6.93	1.13	0.09
P_8 x P_{10}	102.73	1.08	-13.49	52.98	1.24	7.72	0.19	0.53**	-0.0002	7.13	0.92	0.25*
P_9 x P_{10}	98.26	0.54	76.53*	51.49	0.79	56.79**	0.19	0.81	0.001**	8.99	1.56	0.36*
Mean	112.22	1.00	1.30	62.84	1.00	4.72	0.29	0.99	0.0000	8.55	1.00	0.07
S.E. (bi)		0.26			0.34			0.27			0.28	

*and ** indicate significance of values at P=0.05 and 0.01, respectively

BR-112 and Type-3 x BR-112 showed low regression values for days to first fruit picking (b<1). These indicate less responsiveness to changes in environments for days to first fruit picking and suitable for poor environmental condition. Mukta Shree and Azad-331 x Udaipur Local showed low co-efficient of regression (bi<1) value and high deviation from regression for days to first fruit picking. Similarly, Pusa Purple Long x BR-112 and BR-112 x Azad-331showed high regression (bi>1) values and high deviation from regression for days to first fruit picking, indicating high fluctuation across environments. Earlier studies by Mehta *et al*. (2011) on eggplant assessed across different environments and reported that only one character for earliness. Although direct comparisons of results are considered irrelevant as the environments and characters are different, our results are comparable on stability.

Stability for growth traits :

The joint regression of the mean genotypic performance on the environmental index showed that results from the two stability parameters bi and S^2di were not consistent in assessing the reaction of genotypes to varying environmental conditions. The genotypes showed regression co-efficient (bi) values that were significantly and nonsignificantly different from unity (Table 4) but, in contrast, some genotypes showed significant deviation from regression (S^2di) values of greater than zero (Table 4). Thus, based on the regression co-efficients, all genotypes had different response in all test environments. According to Becker and Leon (1988) genotypes with bi values of unity showed an average response to changing environmental conditions. Eberhart and Russell (1966) and Finlay and Wilkinson (1963) found that genotypes with high mean performance, a regression co-efficient of unity (bi = 1), and deviation from regression of zero (S^2di = 0) showed better general adaptability across environments. Thus, five genotypes, namely Type-3, Pusa Purple Long x Mukta Shree, Pusa Purple Long x Type-3, Pusa Uttam x Mukta Shree and Punjab Sadabahar x Udaipur Local, with above-average leaf area performances, regression co-efficient (bi) values non significantly different from unity, and deviation from regression (S^2di) values non-significantly different from zero, were found to be more stable than the other genotypes. Eleven other genotypes, namely Selection-2, Pusa Uttam x Punjab Sadabahar, Pusa Uttam x Type-3, Pusa Uttam x Pusa Upkar, Punjab Sadabahar x Mukta Shree, Selection-2 x Mukta Shree, Mukta Shree x Type-3, Mukta Shree x Pusa Upkar, Mukta Shree x BR-112, Mukta Shree x Azad-331 and Mukta Shree x Udaipur Local, not only were found to bi value more than unity, but also showed specific adaptation to the better environments. Other genotypes, Mukta Shree, Pusa Purple Long x Pusa Uttam, Pusa Uttam x Selection-2, Punjab Sadabahar x Type-3, Type-3 x Pusa Upkar, Type-3 x BR-112 and Pusa Upkar x Azad-331, had a deviation from regression (S^2di) of zero and bi value lower than unity, indicating that these genotypes are poor adaptation to the test environments.However, two others, genotypes, including Pusa Uttam and Azad-331 x Udaipur Local with higher values of S^2di showed unstability performances (Table 4).

According to linear (bi) and non-linear (S^2di) components of genotype by environment interaction, a general adaptability genotype for plant height matches with Pusa Purple Long x Udaipur Local, Pusa Uttam x Selection-2, Punjab Sadabahar x Udaipur Local and Selection-2 x Mukta Shree, with regression co-efficients of almost close to unity (0.98, 0.93, 1.05 and 1.05), respectively and with above average plant height (location mean = 62.84 cm) indicated general adaptability for plant height. The genotypes Mukta Shree, Pusa Upkar, Pusa Purple Long x Punjab Sadabahar, Pusa Purple Long x Mukta Shree, Pusa Purple Long x Type-3, Pusa Uttam x Mukta Shree, Punjab Sadabahar x Mukta Shree, Mukta Shree x Pusa Upkar, Mukta Shree x BR-112, Mukta Shree x Azad-331, Mukta Shree x Udaipur Local, Type-3 x Pusa Upkar and Pusa Upkar x Azad-331 in better environment and genotypes Pusa Purple Long, Pusa Uttam, Pusa Purple Long x Pusa Uttam, Pusa Purple Long x Pusa Upkar, Pusa Uttam x Punjab Sadabahar, Pusa Uttam x Azad-331 and Type-3 x BR-112 in poor environments can provide better plant height, whereas eight other genotypes, namely Selection-2, Pusa Purple long x Selection-2, Punjab Sadabahar x BR-112, Selection-2 x Type-3, Selection-2 x Pusa Upkar, Pusa Upkar x BR-112, BR-112 x Azad-331 and Azad-331 x Udaipur Local, showed high deviation from regression for plant height.

In this study values for the regression co-efficient (bi) ranged from 0.19 (Pusa Purple Long x Pusa Uttam) to 1.78 (Mukta Shree x Azad-331) for plant spread. A fifty one genotypes recorded high stability as one with S^2di = 0. The regression co-efficient of genotypes Pusa Uttam x Mukta Shree, Pusa Upkar x BR-112 and Pusa Upkar x Azad-331 for plant spread was non-significantly different from the unity (bi = 1) and had a small deviation from regression (S^2di) and high mean, thus, possessed fair stability. Specific adaptability (Table 5) stated that

Table 5 : Classification of eggplant genotypes for their stability and adaptability

Characters	Genotypes identified for				Specific adaptability for			
	(Group-**A**) Stableness (S^2di=0)		(Group-**B**) General adaptability (S^2di=0, Mean > General mean and bi=1)		(Group-**C**) Better environment (S^2di=0, Mean > General mean and bi >1)		(Group-**D**) Poor environment (S^2di=0, Mean > General mean and bi<1)	
	Parents	Hybrids	Parents	Hybrids	Parents	Hybrids	Parents	Hybrids
Days to anthesis of first flower	8	40	P_7	P_1 x P_3, P_1 x P_7, P_2 x P_3, P_2 x P_8, P_3 x P_7, P_8 x P_{10}	P_6	P_2 x P_9, P_3 x P_6, P_3 x P_8, P_4 x P_7, P_6 x P_7, P_8 x P_9	P_3, P_4, P_9, P_{10}	P_1 x P_2, P_1 x P_8, P_2 x P_4, P_2 x P_7, P_3 x P_{10}, P_5 x P_8, P_6 x P_8, P_7 x P_8
Days to 50 per cent flowering	8	40	P_7	P_1 x P_2, P_2 x P_8, P_2 x P_9, P_3 x P_7, P_3 x P_{10}, P_7 x P_9, P_8 x P_9	P_1	P_1 x P_3, P_2 x P_{10}, P_3 x P_6, P_3 x P_8, P_8 x P_{10}	P_8	P_1 x P_7, P_2 x P_4, P_2 x P_7, P_3 x P_4, P_4 x P_7, P_5 x P_8, P_6 x P_8
Days to first fruit picking	9	42	P_1, P_3, P_7, P_8	P_1 x P_3, P_2 x P_3, P_2 x P_4, P_3 x P_7, P_3 x P_9, P_7 x P_9	P_2	P_1 x P_4, P_2 x P_8, P_3 x P_8, P_3 x P_{10}, P_6 x P_7, P_7 x P_8	NF	P_1 x P_2, P_1 x P_7, P_2 x P_7, P_3 x P_4, P_3 x P_6, P_5 x P_8, P_6 x P_8
Leaf area (cm^2)	9	44	P_6	P_1 x P_5, P_1 x P_6, P_2 x P_5, P_3 x P_{10},	P_4	P_2 x P_3, P_2 x P_6, P_2 x P_7, P_3 x P_5, P_4 x P_5, P_5 x P_6, P_5 x P_7, P_5 x P_8, P_5 x P_9, P_5 x P_{10}	P_5	P_1 x P_2, P_2 x P_4, P_3 x P_6, P_6 x P_7, P_6 x P_8, P_7 x P_9
Plant height (cm)	9	38	NF	P_1 x P_{10}, P_2 x P_4, P_3 x P_{10}, P_4 x P_5	P_5, P_7	P_1 x P_3, P_1 x P_5, P_1 x P_6, P_2 x P_5, P_3 x P_5, P_5 x P_7, P_5 x P_8, P_5 x P_9, P_5 x P_{10}, P_6 x P_7, P_7 x P_9,	P_1, P_2	P_1 x P_2, P_1 x P_7, P_2 x P_3, P_2 x P_9, P_6 x P_8
Plant spread (m^2)	9	42	NF	P_2 x P_5, P_7 x P_8, P_7 x P_9	P_5	P_1 x P_5, P_2 x P_7, P_3 x P_5, P_4 x P_5, P_4 x P_7, P_5 x P_6, P_5 x P_7, P_5 x P_8, P_5 x P_9, P_5 x P_{10}, P_6 x P_7, P_6 x P_8	P_1	P_1 x P_2, P_1 x P_7, P_2 x P_4, P_2 x P_6, P_3 x P_7, P_3 x P_{10}
Number of branches per plant	9	41	P_1	P_1 x P_8	P_9	P_1 x P_2, P_1 x P_3, P_1 x P_6, P_1 x P_9, P_1 x P_{10}, P_2 x P_3, P_2 x P_4, P_2 x P_5, P_2 x P_9, P_5 x P_9	P_{10}	P_1 x P_4, P_2 x P_{10}, P_3 x P_{10}, P_5 x P_{10}, P_6 x P_9, P_7 x P_9

NF- Not found suitable genotypes P_1-Pusa Purple Long, P_2-Pusa Uttam, P_3-Punjab Sadabahar, P_4-Selection-2, P_5-Mukta Shree, P_6-Type-3, P_7-Pusa Upkar, P_8-BR-112, P_9-Azad-331, P_{10}-Udaipur local genotypes with high mean plant spread, regression co-efficient more than unity (bi>1) and deviation from regression as small as possible (S^2di = 0) are considered stable for better environment. Accordingly, Mukta Shree, Pusa Purple Long x Mukta Shree, Pusa Uttam x Pusa Upkar, Punjab Sadabahar x Mukta Shree, Selection-2 x Mukta Shree, Selection-2 x Pusa Upkar, Mukta Shree x Type-3, Mukta Shree x Pusa Upkar, Mukta Shree x BR-112, Mukta Shree x Azad-331, Mukta Shree x Udaipur Local, Type-3 x Pusa Upkar and Type-3 x BR-112 for plant spread, with regression co-efficients greater than one, were regarded as sensitive to environmental changes, so it may be characterized as suitable for specific adaptation in favourable (Better) environments. The genotypes Pusa Purple Long, Pusa Purple Long x Pusa Uttam, Pusa Purple Long x Pusa Upkar, Pusa Uttam x Selection-2, Pusa Uttam x Type-3, Punjab Sadabahar x Pusa Upkar and Punjab Sadabahar x Udaipur Local that had regression co-efficients of less than unity and above average plant spread, indicating that they offer a greater resistance to environmental change and are specially adapted to poor environments.

For number of branches per plant the fifty genotypes showed high stability as one with S^2di = 0. The regression co-efficients bi for the genotypes ranked from 0.08 to 2.70. Genotypes Pusa Purple Long (1.06) and Pusa Purple Long x BR-112 (0.91) with co-efficient of regression bi values equal to 1.0 and has a small deviation from regression (S^2di) and with above average number of branches (8.55) indicated general adaptability. The genotypes with the highest bi; Azad-331, Pusa Purple Long x Pusa Uttam, Pusa Purple Long x Punjab Sadabahar, Pusa Purple Long x Type-3, Pusa Purple Long x azad-331, Pusa Purple Long x Udaipur Local, Pusa Uttam x Punjab Sadabahar, Pusa Uttam x Selection-2, Pusa Uttam x Mukta Shree, Pusa Uttam x Azad-331 and Mukta Shree x Azad-331 were more adapted to better environments whereas genotypes Udaipur Local, Pusa Purple Long x Selection-2, Pusa Uttam x Udaipur Local, Punjab Sadabahar x Udaipur Local, Mukta Shree x Udaipur Local, Type-3 x Azad-331 and Pusa Upkar x Azad-331showed lowest regression (bi>1) values and adapted to poor environments. The predictability of genotypes for the number of branches per plant ranged from 5.91 for Pusa Upkar, to 12.78 for Pusa Purple Long x Mukta shree. The undesirable genotypes identified were Mukta Shree, Pusa Purple Long x Mukta shree, Pusa Purple Long x Pusa Upkar, BR-112 x Udaipur Local and Azad-331 x Udaipur Local with the highest S^2di (Table 4). Considering our results on growth, four groups of stability was observed for growth which corresponds to the earliness traits.

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