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Phenotypic Stability Analysis in Brinjal Over Environments

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ABSTRACT

The study was conducted during *rabi*-2021 (Jan, 2021–Feb, 2021) and late *kharif* (Sept, 2021–Feb, 2022) at JAU, Junagadh, Gujarat to study the G×E interaction and stable genotype over environments (Seven parents (GJB-2, GJB-3, GRB-5, JBCL-10-12, JBCL-16-12, JBCL-17-01 and Swarna Mani Black SB) were intermated in full diallel fashion to obtain 42 hybrids (including reciprocals) , and evaluated in three environments viz., normal fertilizer (E_1, 100:50:50 NPK, kg ha^{-1}), at Vegetable research station, organic condition (E_2, well rotten FYM+Vermicompost) and 25% high fertilizer dose (E_3, 125: 62.5: 62.5 NPK, kg ha^{-1}) at Instruction farm of Agronomy, JAU, Junagadh, Gujarat, India in Randomized Block Design (RBD) with three replications . The mean sum of squares due to genotype (G), environment (E), G×E interaction and E+(G×E) obtained significant for all the traits indicating that characters significantly interacted in different environments and environment created by different dose of fertilizer was justified. The environment index indicated that normal fertilizer environment was best suited for most of traits and organic environment suited for TSS content. Phenotypic stability analysis revealed that stable genotypes GRB-5 and GJB-2×GRB-5 and GRB-5×SB for days to first flowering, GJBH-4, GJB-2×SB, GJB-3×GJB-2 and SB×GJB-2 for days to first picking, SB×JBCL-16-12 for fruit girth, JBCL-17-01× GJB-2 for number of fruits plant^{-1} and GJB-3, GRB-5 and GJB-3×SB for TSS content over environments. GRB-5×JBCL-16-12 suitable for better environment for fruit yield plant^{-1}. None of the parent and cross found stable for fruit yield plant^{-1} over environments suggested that environment difference was wider and genotypes stable for other traits can be used in future breeding programme for developing stable genotypes.

KEYWORDS: Brinjal, environment index, fertilizer dose, phenotypic stability

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1. INTRODUCTION

In India, total area and production under brinjal was 7.57 lha and 13.15 mt, respectively with an average productivity of 17.36 mt ha^{-1} (Anonymous, 2020). India will surpass China as the most populous country in the world, with an estimated 1.67 billion people by 2050 (Anonymous, 2019). Brinjal had high nutritious value and most beneficial to poor consumers (Gogoi et al., 2018, Shankar et al., 2022) Tender brinjal had 92% water, 4% carbohydrates, 2% protein, dietary fiber 9%, Mg 4%, Mn 11%, P 3%, K 4% negligible fat, vitamin B complex 3-6%, ascorbic acid 3% and vitamin K 3% (Naeem and Ugur, 2019). In brinjal skin a major phenolic substance chlorogenic acid (5-O-caffeoyl-quinic acid, CGA) was found (Prohens et al., 2013) that was used to treat obesity, inflammation, diabetics and heart related problems (Plazas et al., 2013). The nutritious properties of brinjal were also observed and compared similar to tomato by Tiwari and Lal (2014), Dhaka et al. (2017), Akhtar et al. (2019) and Djidonou et al. (2020).

Many investigators (Kashyap et al., 2014, Moraditochaee et al., 2011, Suge et al., 2011) have studied the effect of organic and inorganic fertilizers on the vegetative growth, yield and quality of eggplant. Organic manures play a direct role in soil fertility, microbial population, improves plant growth by providing micro and macro nutrients in available form, which eventually increased productivity (Shahein et al., 2015) and helps to retain ammonium-nitrogen in the root zone until then (O'Neil et al., 2020). Human beings today have turned towards natural manure, which has not only increased their yield, but also improved health by using organic fertilizers fruits and vegetables in daily, B life. Concerning the organic manure, many researchers have found that addition of organic manure had a positive impact on the growth, quantitative and qualitative attributes of eggplant (Sarhan et al., 2011, Christo et al., 2011). The cultivation of brinjal in normal fertilizer was condition based on recommended dose of fertilizer, organic farming based on natural resources and high fertilizer environment based application of higher dose of fertilizer. The performance of hybrid in normal and high fertilizer conditions is good whereas, less in organic condition but, many consumers prefer the organic food to avoid residual effect of inorganic fertilizer. Thus, there is urgent need to identify the hybrids that give stable performance in normal fertilizer environment, organic environment and high fertilizer environment for fruit yield and its attributing traits in brinjal.

The progress due to selection was decline due to effect of G×E interaction and the knowledge of nature and magnitude of various types G×E interaction is useful in making decisions concerning breeding methods, selection programmes and testing procedure in crops plant. The G×E interaction was assessed by growing in different environment. The stability indices was used to identify the widely adopted genotypes over environments (Dhakre and Bhattacharya, 2013, Dia et al., 2016, Raghavendra et al., 2017a, Kumar et al., 2017, Koundinya et al., 2019, Kumari et al., 2020, Khankahdani et al., 2021, Chaitanya and Reddy, 2022). Fruit yield is quantitatively inherited character reflecting considerable interaction between genotypes and environment. A superior genotype may give good performance in one environment and poor performance in another environmental condition due G×E interaction. To overcome this problem genotypes are evaluated in normal fertilizer environment, organic environment and high fertilizer environment to find out the stable genotypes for various traits.

2. MATERIALS AND METHODS

The experiment comprise of seven parental line (GJB-2, GJB-3, GRB-5, JBCL-10-12, JBCL-16-12, JBCL-17-01 and Swarna Mani Black SB) were intermated in full diallel fashion (42 hybrids including reciprocals) in *rabi*-2021 (Jan, 2021–Feb, 2021) and 49 genotypes evaluated in late *kharif* (Sept, 2021–Feb, 2022) in three environment created by different dose of fertilizer viz., normal fertilizer (E_1, 100:50:50 NPK, kg ha^{-1}) at Vegetable research station, organic condition (E_2, well rotten FYM+Vermicompost) and 25% high fertilizer dose (E_3, 125: 62.5: 62.5 NPK, kg ha^{-1}) at Instruction farm of Agronomy, JAU, Junagadh, Gujarat, India in RBD with three replications. Geographically, Junagadh is situated at 21°N latitude and 70.5°E longitude with an altitude of 60 meters above the mean sea level. Each genotype was sown in 6 m long single row with 90×60 cm^2 row to row and plant to plant distance. All the recommended package of practices and plant protection measures except, for fruit borer infestation where unprotected condition was required were followed for raising a normal crop. The observation were recorded on days to first flowering, days to first picking, fruit length (cm), fruit girth (cm), average fruit weight (g), number of fruits plant^{-1}, days to last picking, number of pickings, fruit yield plant^{-1} and TSS content (°B) on five randomly selected brinjal plants for each of traits except, days to first flowering, days to first picking and days to last picking where, observations recorded on plot basis. The statistical analysis for genotype×environment interaction and phenotypic stability was carried out according to Eberhart and Russell (1966) for fruit yield and its components.

3. RESULTS AND DISCUSSION

Analysis of variance over environment: The sum of squares due to genotype (G), environment (E), environment (linear) G×E and E+(G×E) were found significant for all the traits. This suggested that genotypes interacting significantly in different environments for each of traits. Higher magnitude of mean sum of squares due to environment (linear) indicating higher influence of environments. This also indicated that environments created by different fertilizer dose were justified and had linear effects. The partitioning of Environments+(Geno types×Environments) mean sum of squares showed that environment (linear) differed significantly and were quite diverse with regards to their effects on the performance of the genotypes for fruit yield per plant and majority of yield components. The significance of mean sum of square due to genotype×environment (linear) was significant for all the characters except, days to first flowering and days to last picking suggested that the genotypes were diverse for their regression response to change with the environmental fluctuations for above mentioned traits. The non-linear components of G×E (pooled deviation) were significant for all the characters. This suggested that predictable components were involved in the differential response of stability for these traits. The significant sum of square due to genotype (G), environment (E), environment (linear) G×E and E+(G×E) were observed for fruit yield and its attributing traits by Mehta et al. (2011), Choudhary et al. (2015), Sivakumar et al. (2017), Akhtar et al. (2019), Kacholi et al. (2019) and Dhaka and Kasushik (2022).

3.1. Environmental index

A perusal of environmental index (Table 1) represent that E_1 environment suited for yield and majority of its

Table 1: Analysis of variance for stability over three environments and environment index for different characters in brinjal

Source	df	DFF	DFP	FL	AFW
Genotypes (G)	49	57.07$^{**\#\#++}$	62.12$^{**\#\#++}$	7.36$^{**\#\#++}$	497.56$^{**\#++}$
Environments (E)	2	745.27$^{**\#\#++}$	890.65$^{**\#\#++}$	173.99$^{**\#\#++}$	22743.03$^{**\#\#++}$
G×E	98	7.50$^{**\#\#}$	7.89**	3.27*	265.22**
E+ (G×E)	100	22.25^{**++}	25.55^{**++}	6.81$^{**\#\#++}$	714.78$^{**\#\#++}$
Environments (Linear)	1	1490.54$^{**\#}$	1781.30**	347.97$^{**\#\#++}$	45486.06$^{**\#\#++}$
G×E (Linear)	49	3.72	3.80	4.84$^{**\#\#}$	274.28**
Pooled deviation	50	11.04**	11.76**	1.66**	251.03**
Pooled error	294	0.72	5.36	0.55	25.56
Environment index					
E_1		-4.33	-4.69	1.31	21.88
E_2		3.07	3.07	-2.13	-20.73
E_3		1.26	1.26	0.81	-1.15

Table 1: Continue...

Source	df	NFP	DLP	NP	FYP	TSS
Genotypes (G)	49	24.87$^{**\#\#++}$	198.44$^{**\#\#++}$	3.99$^{**\#\#++}$	0.25$^{**\#\#++}$	0.62$^{**\#\#++}$
Environments (E)	2	590.13$^{**\#\#++}$	1001.26$^{**\#\#++}$	137.98$^{**\#\#++}$	19.94$^{**\#\#++}$	1.17$^{**\#\#++}$
G×E	98	4.98**	42.75**	1.04$^{**\#\#}$	0.13**	0.13**
E+ (G×E)	100	16.68$^{**\#\#++}$	61.92$^{**\#\#++}$	3.78$^{**\#\#}$	0.52$^{**\#\#++}$	0.15**
Environments (Linear)	1	1180.26$^{**\#\#++}$	2002.52**	275.96$^{**\#\#}$	39.87$^{**\#\#++}$	2.35$^{**\#++}$
G×E (Linear)	49	4.84**	53.50$^{**\#\#}$	0.43$^{*\#\#}$	0.14**	0.14**
Pooled deviation	50	5.02**	31.36**	1.62**	0.11**	0.12**
Pooled error	294	1.12	9.75	0.24	0.02	0.04
Environment index						
E_1		3.82	4.44	1.81	0.69	-0.04
E_2		-2.83	0.06	-1.46	-0.55	0.13
E_3		-0.99	-4.50	-0.35	-0.14	-0.17

+ and ++ Significant at (p=0.05) and (p=0.01) levels, respectively when tested against G×E; # and ## Significant at (p=0.05) and (p=0.01) levels, respectively when tested against pooled deviation; * and ** Significant at (p=0.05) and (p=0.01) levels, respectively when tested against pooled error attributing traits except for TSS content which was good in E_2 environment. The environment with positive or high value for all the traits except, days to first flowering and days to first picking where negative and lowest value was good for most favorable but TSS was good in organic condition (E_2). Thus, E_1 environment good, E_3 less poor than E_2 and E_2 was poorest environment for yield and yield attributing traits.

3.2. *Stability parameters*

According to Eberhart and Russell (1966) stable genotype has high mean ($\bar{X}$), unit regression coefficient (bi=1) and deviation from regression as small as possible ($S^2di \approx 0$) that provide stable yield over environments. The below average genotype has high mean ($\bar{X}$), regression coefficient above one (bi>1) and deviation from regression as small as possible ($S^2di \approx 0$) suitable for poor environments. The above average genotype has high mean ($\bar{X}$), regression coefficient below one (bi<1) and deviation from regression as small as possible ($S^2di \approx 0$) suitable for better environments.

The stability parameters for various traits were given in table 2, table 3 and table 4 Parent GRB-5 and crosses GJB-2×GRB-5 and GRB-5×SB were reported as stable for days to first flowering over environments. None of the genotype stable under better as well as poor environments. For days to first picking genotypes GJBH-4, GJB-2×SB, GJB-

Table 2: Mean over environment ($\bar{X}$), regression coefficient (bi) and deviation from regression (S2di) for days to first flowering, days to first pickings and fruit length

Genotypes	Days to first flowering				Days to first picking				Fruit length (cm)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
GJB-2	52.89	1.13	0.94	22.25*	64.56	1.14**	0.15	-4.53	8.93	1.17**	0.26	-0.10
GJB-3	67.33	0.85**++	0.02	-4.07	81.78	0.89**++	0.04	-5.31	10.09	1.27**	0.28	-0.01
GRB-5	56.89	0.80	0.41	1.05	71.56	1.39**++	0.02	-5.35	10.40	-0.02++	0.04	-0.54
JBCL-10-12	71.33	0.91**+	0.04	-4.02	85.44	0.81**++	0.02	-5.35	13.46	1.42**	0.49	1.14
JBCL-16-12	64.56	1.69*	0.85	17.60*	77.22	1.34**	0.32	-1.64	13.85	1.55*	0.76	3.47**
JBCL-17-01	61.22	1.23**+	0.10	-3.76	72.22	1.38	0.97	28.06*	13.43	0.81**	0.19	-0.30
Swarna Mani Black	60.33	1.39**++	0.02	-4.06	71.67	1.14	0.79	16.83*	12.36	1.17**	0.14	-0.42
GJB-2×GJB-3	59.67	1.28*	0.53	4.42	72.77	1.24*	0.56	5.66	11.42	0.07++	0.16	-0.37
GJB-2×GRB-5	54.22	0.74	0.67	9.16	68.78	0.81	1.25	50.33**	10.36	0.59	0.49	1.10
GJB-2×JBCL-10-12	60.44	1.53**	0.48	2.66	74.67	1.43**	0.30	-2.18	11.38	1.51**++	0.05	-0.54
GJB-2×JBCL -16-12	56.89	0.82	0.95	23.02*	71.11	0.74	0.99	29.23*	12.44	0.29+	0.33	0.20
GJB -2×JBCL- 17-01	57.00	0.79	0.86	17.85*	71.00	0.80	1.21	46.46**	11.44	-0.32	1.34	11.91**
GJB-2×SB	52.56	0.58	0.93	21.44*	65.89	0.60	0.70	11.86	11.06	-0.06	0.83	4.19**
GJB-3×GJB-2	55.78	0.30	0.82	15.77*	69.22	0.35	0.56	5.80	11.15	1.35**++	0.13	-0.44
GJB-3×GRB-5	65.89	1.54**++	0.20	-2.94	78.22	1.38**+	0.19	-4.07	10.72	2.35**+	0.60	1.94*
GJB-3×JBCL-10-12	68.33	1.29**++	0.09	-3.84	82.22	1.09**	0.10	-5.03	12.26	1.72**+	0.36	0.34
GJB-3×JBCL-16-12	64.78	0.99	1.08	30.96**	79.44	0.84	0.89	22.83*	11.35	1.34**++	0.03	-0.55
GJB-3×JBCL- 17-01	66.22	1.60*	0.68	9.68	80.11	1.46**	0.33	-1.46	12.41	2.14**++	0.37	0.38
GJB-3×SB	63.56	0.94	0.48	2.91	77.00	1.09**	0.35	-0.94	11.83	0.19++	0.24	-0.16
GRB-5 ×GJB-2	55.11	1.29	1.11	32.58**	68.56	1.51	0.93	25.58*	11.76	0.64**++	0.14	-0.43
GRB-5×GJB-3	64.11	0.92	0.53	4.36	78.33	0.70	0.46	2.25	12.19	0.76**++	0.09	-0.50
GRB-5×JBCL-10-12	63.00	0.90	0.75	12.66*	78.11	1.10*	0.47	2.49	11.85	0.46*++	0.18	-0.33
GRB-5×JBCL-16-12	60.89	1.25**+	0.12	-3.61	74.22	1.22**	0.13	-4.73	12.79	1.61**++	0.05	-0.54
GRB-5×JBCL-17-01	57.56	0.63	0.77	13.82*	70.56	0.56	0.73	13.52	13.85	1.12	0.92	5.34**
GRB-5×SB	55.89	0.38	0.54	4.51	70.56	0.53	1.09	36.87**	11.81	-0.76*++	0.35	0.29
JBCL-10-12×GJB-2	60.78	1.53**	0.48	2.66	74.00	1.64**+	0.28	-2.53	12.70	-0.42++	0.50	1.19
JBCL-10-12×GJB-3	67.78	1.36**	0.43	1.35	81.33	1.31**+	0.13	-4.79	13.07	1.18	0.65	2.37*

Table 2: Continue...

Genotypes	Days to first flowering				Days to first picking				Fruit length (cm)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
JBCL-10-12×GRB-5	62.89	0.92*	0.40	0.70	76.78	0.82**	0.31	-2.04	12.19	0.01	0.82	4.17**
JBCL-10-12×JBCL-16-12	65.33	0.85	0.61	6.87	79.44	0.57	0.61	7.80	11.98	0.69	0.51	1.25
JBCL-10-12×JBCL-17-01	62.89	0.78	0.81	15.48*	76.89	0.64	0.92	24.58*	15.52	1.88*	0.79	3.81**
JBCL-10-12×SB	64.44	1.30**	0.49	2.97	78.00	1.28**	0.26	-2.97	10.93	1.66**	0.42	0.69
JBCL-16-12×GJB-2	57.44	1.36**	0.43	1.35	71.22	1.44**	0.42	0.89	12.54	0.56**++	0.17	-0.36
JBCL-16-12×GJB-3	65.56	1.04**	0.28	-1.72	79.56	0.96**	0.22	-3.57	12.02	1.22**	0.29	0.05
JBCL-16-12×GRB-5	55.67	0.57	1.42	55.70**	69.44	0.71	1.20	45.59**	14.27	0.59**	0.22	-0.21
JBCL-16-12×JBCL-10-12	64.67	1.14**	0.26	-2.10	79.00	0.92**	0.24	-3.37	13.80	-1.25++	0.70	2.88*
JBCL-16-12×JBCL- 17-01	60.56	1.02	0.82	15.96*	74.22	1.09	0.68	11.17	15.05	1.58**	0.49	1.15
JBCL-16-12×SB	62.78	0.54	0.44	1.70	76.44	0.61	0.46	2.03	13.93	1.03**	0.27	-0.04
JBCL-17-01×GJB-2	57.89	1.07	0.88	19.02*	71.33	1.06	0.79	16.66*	14.58	1.25**	0.33	0.20
JBCL-17-01×GJB-3	63.56	0.69	0.52	4.08	77.33	0.55	0.56	5.95	12.88	2.04**++	0.09	-0.50
JBCL-17-01×GRB-5	58.44	0.76**	0.17	-3.20	71.78	0.73**++	0.00	-5.37	12.42	1.80**+	0.37	0.42
JBCL-17-01×JBCL-10-12	63.44	0.78*	0.37	-0.07	77.00	0.69*	0.32	-1.82	14.44	0.16	1.05	7.05**
JBCL-17-01×JBCL-16-12	63.78	1.46**+	0.22	-2.59	77.89	1.38**+	0.19	-4.07	16.13	0.80**	0.27	-0.04
JBCL-17-01×SB	62.67	1.33**	0.39	0.47	76.11	1.31**	0.29	-2.34	13.48	2.81**+	0.74	3.24**
SB ×GJB-2	53.11	0.06	0.81	15.67*	67.22	0.54	0.52	4.25	10.47	1.19	0.60	1.99*
SB ×GJB-3	62.44	0.58*	0.27	-1.87	75.78	0.59*	0.25	-3.19	9.65	0.82	0.59	1.83*
SB ×GRB-5	58.56	1.06**	0.37	-0.10	71.89	1.02**	0.17	-4.36	12.51	1.87**++	0.22	-0.23
SB ×JBCL-10-12	64.00	1.06**	0.23	-2.45	78.11	1.24**	0.27	-2.74	14.04	1.77**++	0.03	-0.55
SB ×JBCL-16-12	60.22	1.04**	0.28	-1.72	73.56	1.23**	0.15	-4.55	15.62	1.00**	0.03	-0.55
SB ×JBCL-17-01	60.33	1.12*	0.49	2.94	73.22	1.17**	0.21	-3.83	12.28	2.38**++	0.41	0.63
GJBH-4 (Standard check)	57.00	0.81**	0.16	-3.31	70.00	0.97**	0.10	-4.98	11.69	1.02**	0.19	-0.32

* and ** =Significant at (p=0.05) and (p=0.01) levels of probability, respectively when deviate from "0"; + and ++ =Significant at (p=0.05) and (p=0.01) levels of probability, respectively when deviate from "1"

3×GJB-2 and SB×GJB-2 were stable over environments. The parent GJB-2 was recorded with below average response and suitable for better environments. None of the genotype stable under poor environments. In case of fruit length cross JBCL-17-01×JBCL-16-12 showed above average response and suitable under poor environment. Cross SB×JBCL-16-12 was reported stable under average environment, while none of the genotype considered as stable under better environment.

For average fruit weight, hybrid JBCL-16-12×SB showed below average response, indicating its suitability for better environments. None of the parent and cross was observed with average and above average response. In case of number of fruits plant parent GJB-2 and crosses GRB-5×JBCL-16-12, JBCL-16-12×GJB-2, JBCL-16-12×GJB-3 and JBCL-17-01×GRB-5 showed below average response and suitable under better environment. None of the genotype considered as stable genotypes under poor environments. Cross JBCL-17-01× GJB-2 showed average response and stable genotype over environments.

In case of days to last picking, cross SB×JBCL-16-12 and GRB-5×JBCL-16-12 showed below average response and above average response, indicating their suitability under better and poor environment, respectively. For number of pickings genotypes GRB-5×JBCL-16-12 and SB×JBCL-16-12 showed below average response and were considered as stable genotypes under better environments. None of the parent and cross was considered as stable genotypes under poor environment. For Fruit yield plant^{-1} (kg) genotypes GRB-5×JBCL-16-12 showed below average response and was considered as stable genotype under better environment. None of the parent and cross was considered as stable genotype under poor environment. In case TSS content genotypes GJB-3, GRB-5, GJB-3×SB, JBCL-

Table 3: Mean over environment $(\overline{X})$, regression coefficient (bi) and deviation from regression (S2di) for average fruit weight (g), number of fruits plant-1and days to last picking

Genotypes	Average fruit weight (g)				Number of fruits plant^{-1}				Days to last picking			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
GJB-2	59.02	0.78	0.72	451.34^{**}	21.31	1.07^{**}	0.05	-1.06	136.68	0.10	1.60	92.48^{**}
GJB-3	94.57	1.12^{**}	0.33	75.84^{*}	14.32	0.64^{**++}	0.09	-0.91	159.55	1.541	1.16	44.33^{*}
GRB-5	72.36	0.91^{*}	0.40	122.79^{*}	15.76	2.18^{**++}	0.24	0.29	153.63	2.26^{**++}	0.22	-7.90
JBCL-10-12	105.39	1.40^{**++}	0.06	-22.34	11.66	0.89^{**}	0.07	-0.10	156.45	1.77^{**+}	0.37	-4.40
JBCL-16-12	104.49	1.24^{**}	0.13	-10.99	12.06	0.94^{**++}	0.01	-1.12	149.30	1.17	1.34	62.16^{**}
JBCL-17-01	68.78	0.29	0.62	318.87^{**}	15.58	1.12^{**}	0.12	-0.76	157.68	-0.42^{++}	0.44	-1.96
Swarna Mani Black	81.31	0.44	0.39	114.48^{*}	17.82	1.48^{**}	0.44	3.40^{*}	152.03	-0.01^{++}	0.29	-6.50
GJB-2×GJB-3	95.30	0.63	0.51	208.94^{**}	17.47	1.41^{**}	0.50	4.80^{*}	155.80	1.17	1.39	68.14^{**}
GJB-2×GRB-5	65.85	0.68^{**}	0.26	34.98	13.80	0.67^{*}	0.32	1.31	152.49	1.35	0.77	13.85
GJB-2×JBCL-10-12	90.54	1.22	0.71	438.85^{**}	20.19	2.25^{*}	1.12	28.45^{**}	155.39	0.53	0.27	-6.79
GJB-2×JBCL -16-12	84.06	1.01^{**}	0.34	76.93^{*}	20.38	1.30^{*}	0.63	8.11^{**}	163.25	1.50^{*}	0.64	6.44
GJB -2×JBCL- 17-01	77.90	1.00	0.63	335.21^{**}	13.82	0.79^{**}	0.15	-0.59	155.14	2.22^{**+}	0.51	0.52
GJB-2×SB	76.80	0.50	0.51	206.45^{**}	15.89	0.64^{*}	0.31	1.14	165.24	0.56^{*}	0.27	-6.79
GJB-3×GJB-2	83.80	1.91^{**+}	0.42	131.50^{*}	19.39	0.34	0.97	21.14^{**}	162.89	2.05^{**++}	0.13	-9.05
GJB-3×GRB-5	97.61	0.96^{**}	0.34	81.66^{*}	14.99	0.77^{*}	0.37	2.05	162.17	2.13^{**}	0.64	6.67
GJB-3×JBCL-10-12	82.76	1.28	0.78	521.15^{**}	13.64	1.06^{**}	0.08	-0.98	164.14	1.03	1.65	99.57^{**}
GJB-3×JBCL-16-12	78.17	1.46^{**}	0.55	253.64^{**}	14.49	0.64^{**}	0.25	0.30	168.00	0.67^{**}	0.25	-7.26
GJB-3×JBCL- 17-01	69.42	1.52^{**++}	0.11	-14.71	12.94	0.51	0.51	5.09^{*}	168.68	0.74	0.84	18.50
GJB-3×SB	83.19	0.99^{**}	0.12	-12.48	15.78	0.88^{*}	0.44	3.50^{*}	163.94	1.01	1.16	44.11^{*}
GRB-5 ×GJB-2	74.30	0.61^{**}	0.20	12.55	15.52	1.09	0.66	9.12^{**}	158.98	1.24^{*}	0.51	0.46
GRB-5×GJB-3	83.54	-0.10	0.98	846.92^{**}	13.63	0.85	0.50	4.76^{*}	169.52	0.25	1.84	125.11^{**}
GRB-5×JBCL-10-12	75.20	0.30	0.55	246.01^{**}	16.98	1.78^{*}	0.84	15.53^{**}	156.90	0.50	0.59	4.38
GRB-5×JBCL-16-12	88.89	1.77^{**++}	0.05	-23.38	20.70	1.35^{**++}	0.12	-0.79	179.88	0.91^{*}	0.41	-2.87
GRB-5×JBCL-17-01	80.33	0.99^{**}	0.28	45.60	17.48	0.42	0.70	10.57^{**}	166.41	0.77^{**}	0.21	-8.06
GRB-5×SB	86.65	0.50	0.71	438.45^{**}	13.88	0.41	0.41	2.93	158.02	2.48^{**++}	0.35	-4.75
JBCL-10-12×GJB-2	75.10	1.21^{**}	0.19	5.98	13.10	0.51^{*}	0.25	0.36	156.26	1.08	0.91	23.55
JBCL-10-12×GJB-3	83.24	1.53^{*}	0.72	448.86^{**}	15.06	0.89	0.82	14.66^{**}	157.32	2.54^{*}	1.01	30.99^{*}

Table 3: Continue...

Genotypes	Days to first flowering				Days to first picking				Fruit length (cm)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
JBCL-10-12×GRB-5	72.32	1.05	1.21	1297.06^{**}	15.76	0.82^{**}	0.21	-0.06	160.56	1.91^{*}	0.90	22.74
JBCL-10-12×JBCL-16-12	87.97	-0.21^{+}	0.50	204.23^{**}	13.09	0.97^{**}	0.12	-0.76	157.90	2.51^{**++}	0.54	1.88
JBCL-10-12×JBCL-17-01	74.60	1.72^{**+}	0.28	46.29	15.29	1.18^{**}	0.18	-0.36	157.23	3.85^{**+}	1.28	55.57^{*}
JBCL-10-12×SB	93.59	0.311^{+}	0.28	45.33	11.47	0.79	0.48	4.21^{*}	156.72	4.40^{*}	1.81	121.02^{**}
JBCL-16-12×GJB-2	82.43	0.83	0.79	536.92^{**}	20.09	1.71^{**+}	0.36	1.85	163.35	1.77	1.15	43.08^{*}

Table 3: Continue...

Genotypes	Days to first flowering				Days to first picking				Fruit length (cm)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
JBCL-16-12×GJB-3	90.48	1.59**	0.34	79.26*	22.40	1.68**++	0.19	-0.24	171.92	1.74*	0.77	14.16
JBCL-16-12×GRB-5	99.49	0.91	0.47	175.84**	18.44	0.66	0.57	6.68**	176.55	0.18	1.28	55.47*
JBCL-16-12×JBCL-10-12	89.78	1.60**+	0.29	53.12	19.55	0.40**++	0.07	-1.01	171.39	0.34	0.66	7.67
JBCL-16-12×JBCL-17-01	78.86	1.52**	0.47	176.31**	17.43	1.48**++	0.07	-0.10	169.78	-0.02	0.84	18.56
JBCL-16-12×SB	109.30	1.96**++	0.23	21.85	16.02	0.72	0.40	2.74	171.13	-0.94	1.12	40.73*
JBCL-17-01×GJB-2	75.88	1.02**	0.16	-3.63	20.55	0.96**	0.09	-0.91	164.04	0.02++	0.36	-4.53
JBCL-17-01×GJB-3	87.16	1.11	0.77	511.28**	19.94	1.12**	0.11	-0.81	173.10	-1.57*++	0.76	13.29
JBCL-17-01×GRB-5	75.58	1.86	0.95	802.57**	20.15	1.30**	0.22	0.03	168.38	-1.22*++	0.58	3.51
JBCL-17-01×JBCL-10-12	72.87	0.32	0.40	121.21*	13.64	0.67**	0.19	-0.26	169.11	0.73	0.87	20.50
JBCL-17-01×JBCL-16-12	69.94	1.31**	0.29	52.72	17.99	1.03	1.01	22.88**	169.22	0.53	0.29	-6.32
JBCL-17-01×SB	57.76	0.84**+	0.07	-21.56	19.67	0.62**++	0.03	-1.10	161.83	-0.58++	0.31	-5.80
SB ×GJB-2	88.81	1.19**	0.29	50.84	12.74	0.87**+	0.06	-1.05	156.36	0.79**++	0.08	-9.51
SB ×GJB-3	74.08	0.06++	0.31	60.79	15.67	0.53	0.65	8.86**	162.27	1.57	1.28	56.22**
SB ×GRB-5	84.69	0.75**	0.29	49.98	17.95	0.72	0.91	18.60**	167.15	0.06++	0.35	-4.77
SB ×JBCL-10-12	116.07	2.13	1.15	1174.30**	13.31	0.72**++	0.06	-1.04	167.41	0.98	0.64	6.65
SB ×JBCL-16-12	102.32	1.10*	0.54	237.34**	16.95	0.96**	0.27	0.63	175.61	1.67*	0.67	8.09
SB ×JBCL-17-01	54.67	0.22+	0.36	91.85*	17.55	1.27*	0.56	6.39*	165.82	-0.29	1.24	51.49*
GJBH-4 (Standard check)	74.25	0.68	0.47	176.82**	19.96	1.95**++	0.24	0.28	147.14	0.45	0.35	-4.72

* and ** =Significant at (p=0.05) and (p=0.01) levels of probability, respectively when deviate from "0"; + and ++ =Significant at 5% and 1% levels of probability, respectively when deviate from "1"

Table 4: Mean over environment ($\overline{X}$), regression coefficient (bi) and deviation from regression (S^2di) for number of pickings, fruit yield plant^{-1} (kg) and TSS content (°B)

Genotypes	Number of pickings				Fruit yield plant^{-1} (kg)				TSS content (°B)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
GJB-2	9.74	1.23**	0.31	0.31	1.24	0.78	0.55	0.23**	7.23	2.06**++	0.23	-0.04
GJB-3	10.60	0.75	0.46	0.91*	1.34	0.84**	0.23	0.03	8.94	0.53	0.98	0.00
GRB-5	11.28	1.47**	0.33	0.36	1.18	1.30**++	0.01	-0.02	8.90	0.64	0.97	0.00
JBCL-10-12	10.08	1.40**	0.21	-0.00	1.23	1.10**	0.08	-0.01	7.61	-0.20	0.98	0.00
JBCL-16-12	9.53	0.80	0.64	2.02**	1.25	1.05**	0.04	-0.01	7.38	-3.27+	1.89	0.13*
JBCL-17-01	11.43	0.72*	0.35	0.42	0.99	0.52**++	0.18	0.01	7.67	-0.04	2.51	0.25**
Swarna Mani Black	10.73	0.76**	0.18	-0.05	1.43	0.88*	0.35	0.09*	7.66	3.58	2.01	0.15*
GJB-2×GJB-3	11.45	1.49**	0.45	0.88*	1.64	0.98	0.51	0.20**	7.22	0.49	1.31	0.04
GJB-2×GRB-5	11.47	1.21**	0.36	0.46	0.89	0.59**++	0.03	-0.01	7.33	0.45	1.64	0.09
GJB-2×JBCL-10-12	11.08	0.94**	0.16	-0.10	1.72	1.77**++	0.26	0.04	7.70	0.12	1.56	0.07

Table 4: Continue...

Genotypes	Number of pickings				Fruit yield plant^{-1} (kg)				TSS content (°B)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
GJB-2×JBCL -16-12	12.59	0.88	0.59	1.67**	1.67	1.25^{**++}	0.07	-0.01	7.40	4.24*	2.02	0.15*
GJB -2×JBCL- 17-01	11.54	1.36*	0.66	2.14**	1.08	0.88*	0.34	0.08*	7.57	-0.06	0.78	-0.01
GJB-2×SB	13.64	0.89	0.52	1.24*	1.17	0.61^{**++}	0.14	0.00	7.38	-2.02^{+}	1.50	0.07
GJB-3×GJB-2	12.79	1.06^{**++}	0.00	-0.24	1.64	1.27	0.80	0.49**	7.53	-1.29^{+}	0.89	-0.00
GJB-3×GRB-5	11.54	1.57^{**++}	0.13	-0.14	1.47	0.95**	0.32	0.07*	7.12	2.53^{**+}	0.65	-0.02
GJB-3×JBCL-10-12	11.28	1.46**	0.33	0.35	1.15	1.00**	0.34	0.08*	8.36	-1.10^{*++}	0.48	-0.03
GJB-3×JBCL-16-12	12.12	0.80**	0.24	0.09	1.12	0.91**	0.33	0.07*	7.30	1.41*	0.67	-0.02
GJB-3×JBCL- 17-01	12.19	1.34**	0.39	0.59	0.90	0.82**	0.22	0.02	7.89	-2.13	2.61	0.28**
GJB-3×SB	11.90	0.73^{**+}	0.13	-0.15	1.31	0.92**	0.12	-0.00	8.16	0.33	0.58	-0.03
GRB-5 ×GJB-2	12.42	1.13**	0.15	-0.12	1.12	0.78^{**+}	0.09	-0.01	7.27	-0.79^{++}	0.61	-0.03
GRB-5×GJB-3	11.80	0.49	1.11	6.51**	1.06	0.40^{++}	0.21	0.02	7.01	3.09^{**+}	1.03	0.01
GRB-5×JBCL-10-12	10.78	0.71**	0.17	-0.08	1.24	0.95	0.63	0.30**	7.37	3.76^{**++}	0.58	-0.03
GRB-5×JBCL-16-12	14.50	1.26**	0.16	-0.10	1.90	1.96^{**++}	0.11	-0.01	7.12	3.41*	1.48	0.06
GRB-5×JBCL-17-01	13.12	0.88**	0.07	-0.21	1.37	0.78**	0.18	0.01	7.44	1.81*	0.72	-0.02
GRB-5×SB	11.95	1.10	0.86	3.82**	1.19	0.34	0.54	0.22**	7.48	3.77*	1.61	0.08
JBCL-10-12×GJB-2	11.27	0.97**	0.16	-0.10	0.94	0.73**	0.18	0.01	7.38	2.57	1.55	0.07
JBCL-10-12×GJB-3	10.40	1.17	0.68	2.29**	1.27	1.32	0.67	0.35**	7.42	1.20	0.97	0.00

Table 4: Continue...

Genotypes	Number of pickings				Fruit yield plant^{-1} (kg)				TSS content (°B)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
JBCL-10-12×GRB-5	11.47	0.91*	0.36	0.46	1.12	1.03	0.53	0.21**	7.67	1.19	0.43	0.78**
JBCL-10-12×JBCL-16-12	10.76	1.33*	0.54	1.35*	1.08	0.45^{*++}	0.18	0.01	7.70	-0.32^{+}	2.10	-0.03
JBCL-10-12×JBCL-17-01	10.95	1.20	1.44	11.27**	1.19	1.44**	0.29	0.05*	7.30	0.60	2.10	0.56**
JBCL-10-12×SB	10.75	1.41	1.35	9.79**	1.01	0.49^{**++}	0.18	0.01	7.44	0.19^{++}	0.95	-0.04
JBCL-16-12×GJB-2	12.61	1.06**	0.32	0.33	1.63	1.43*	0.70	0.37**	7.09	1.75^{**++}	1.30	-0.04
JBCL-16-12×GJB-3	12.64	0.98**	0.27	0.17	2.04	2.11^{**++}	0.34	0.08*	7.12	3.30	0.85	0.10
JBCL-16-12×GRB-5	14.74	1.15	1.06	5.91**	1.81	0.76	0.64	0.31**	7.47	1.10	4.17	0.01
JBCL-16-12×JBCL-10-12	12.70	1.06*	0.47	0.96*	1.68	1.14**	0.28	0.05*	7.01	0.28	0.58	0.04
JBCL-16-12×JBCL- 17-01	13.14	1.06	0.78	3.09**	1.41	1.63^{**+}	0.31	0.06*	7.60	0.52	3.58	0.15*
JBCL-16-12×SB	13.00	0.73	0.73	2.70**	1.72	1.41**	0.37	0.09**	7.06	3.01	0.17	0.16*
JBCL-17-01×GJB-2	12.71	0.90**	0.13	-0.14	1.58	1.15^{**+}	0.07	-0.01	7.59	1.75*	0.10	-0.02
JBCL-17-01×GJB-3	13.18	0.50	0.79	3.19**	1.66	1.38**	0.46	0.15**	7.69	0.63	1.77	-0.00
JBCL-17-01×GRB-5	13.26	0.50	0.85	3.76**	1.49	1.81**	0.62	0.29**	7.51	1.88	1.05	0.02
JBCL-17-01×JBCL-10-12	12.65	1.09**	0.21	0.01	0.93	0.45^{**++}	0.11	-0.05	7.92	4.16	1.35	0.37**
JBCL-17-01×JBCL-16-12	12.53	0.96**	0.16	-0.10	1.27	1.30**	0.48	0.17**	7.73	0.84	2.01	0.24**
JBCL-17-01×SB	11.78	0.80	0.64	2.02**	1.12	0.73^{**++}	0.02	-0.02	7.62	1.31**	2.09	-0.03
SB ×GJB-2	12.21	0.82^{**++}	0.06	-0.22	1.13	0.89**	0.18	0.01	7.59	1.19	0.68	0.78**
SB ×GJB-3	11.81	0.66	0.52	1.23*	1.10	0.21	0.41	0.12**	7.49	-0.32^{+}	0.90	-0.03
SB ×GRB-5	13.08	0.91	0.47	0.96*	1.44	0.71**	0.25	0.04	7.56	0.60	1.09	0.56**

Table 4: Continue...

Genotypes	Number of pickings				Fruit yield plant^{-1} (kg)				TSS content (°B)			
	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di	Mean	Bi	SE_{bi}	S^2di
SB ×JBCL-10-12	12.23	0.91**	0.02	-0.24	1.52	1.25*	0.54	0.22**	7.57	0.19++	2.97	-0.04
SB ×JBCL-16-12	13.98	1.14**	0.23	0.05	1.67	0.96*	0.47	0.16**	6.84	1.75**++	2.45	-0.04
SB ×JBCL-17-01	12.67	0.44*++	0.21	-0.00	0.91	0.52	0.36	0.09**	7.41	3.30	0.44	0.11
GJBH-4 (Standard check)	10.59	0.90**	0.21	-0.05	1.45	1.12**	0.16	0.00	9.00	0.84	0.75	-0.02

* and ** =Significant at (p=0.05) and (p=0.01) levels of probability, respectively when deviate from "0"; + and ++ =Significant at 5% and 1% levels of probability, respectively when deviate from "1"

16-12×JBCL-10-12, SB×JBCL-17-01 and GJBH-4 were considered as stable for TSS content in all the environments. None of the genotype considered as stable genotypes under better as well as poor environments.

None of the parent and hybrid reported stable for all the 13 traits studied. These are in accordance with the findings of Chaudhari et al. (2015) and Bhushan and Samnotra (2017). It was concluded from above study that environmental difference was larger and none of the genotype was found stable over environment for fruit yield plant^{-1}, although crosses GRB-5×JBCL-16-12 found stable for better environment. Some of the parents and crosses showed stability over environments for various traits can be utilized in future breeding programme.

4. CONCLUSION

The environmental difference was larger and no one parent and cross found stable over environment for fruit yield plant^{-1} although crosses GRB-5×JBCL-16-12 found stable for batter environment. There were some parents and crosses showed stability over environments for various traits may be used in future breeding programme based on stability for fruit yield and its component traits in brinjal.

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