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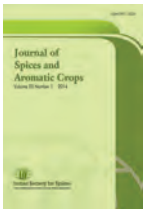

Studies on stability of chilli genotypes at different fertility levels under terai zone of West Bengal[1]

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Abstract

An experiment was carried out to study the stability of 15 chilli genotypes at five fertility levels (0%, 50%, 100%, 150% and 200% of recommended dose of fertilizer) during *rabi* season of 2006–07 and *kharif* season of 2007. Pooled analysis of variance showed the presence of significant genetic variability among the genotypes for all the characters studied. Among the different early flowering genotypes, 'CA-29' and 'CA-30' were specifically adapted to the unfavourable environment and 'Diamond F_1' and 'Pusa Sadabahar' were adapted to the favourable environment. None of the genotypes showed absolute stability with respect to fruit length under different environments. With respect to number of fruits, 'Pusa Sadabahar' was stable under different environments. With respect to yield, 12 genotypes showed S^2d_i value significantly greater than zero which indicated the unstability for this trait. Among the high yielding genotypes, 'Ulka 686 F_1', 'Jwalan', 'CA-29', 'CA-48' and 'CA-47' and low yielder genotype had regression value of > 1 which indicated that they showed better response under favourable environment. However, deviation from regression value (S^2d_i) was significant which indicated that their performance among the environment was unpredictable. 'Chilli Philhal' and 'Pusa Jwala' produced lower yield but these genotypes were adapted to unfavourable environment. The *rabi* crop showed its superiority over *kharif* crop with respect to yield and its attributing characters.

Keywords: chilli, season, soil fertility, stability, yield

Introduction

In West Bengal, chilli (*Capsicum annum*) is cultivated in an area of about 65,930 ha with a production of about 6,43,677 tonnes. Productivity of this crop is low (0.98 t ha^{-1}) as compared to national level (1.12 t ha^{-1}). This yield gap can be minimized by growing suitable cultivars with appropriate package of practices. Chilli being sensitive to environmental variations exhibits large fluctuations in yield. Phenotypically stable genotypes (varieties/ hybrids) are of great importance, because environmental condition varies from season to season. Wide adaptation to a particular environment and consistent performance of

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recommended genotypes is one of the main objectives in breeding programme. The differential response of chilli genotypes when grown under different environments in the same season has been reported by Lohithaswa *et al.* (2000) and under different growing seasons by Mini & Vahab (2000). A large number of studies regarding the stability of chilli under *rabi* season has been carried out in different parts of the country (Sooch *et al.* 1981; Zewdiel & Poulos 1996; Singh *et al.* 1999; Senapati & Sarkar 2002; Reddy & Sadashiva 2003). Although a number of high yielding varieties and F_1 hybrids have been recommended for cultivation, the information on stability is lacking for the agroclimatic condition of the region under study. Keeping this in view, the present investigation was undertaken to determine the genotype × environmental interaction on stability parameters and to identify the stable and responsive genotypes for yield and quality characters.

Materials and methods

The experiment was undertaken during *rabi* 2006–07 and *kharif* 2007 at the Experimental Farm (26°19'86" N latitude and 89°23'53" E longitude) of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The experimental soil was sandy clay loam having pH 5.5, 0.91% organic carbon, 133.81 kg ha^{-1} available nitrogen, 45.62 kg ha^{-1} available phosphorus and 59.43 kg ha^{-1} potassium. The climatic condition of this region is sub-tropical humid in nature. The experiment was laid out in Factorial Randomized Block Design with three replications. Fifteen chilli genotypes (five) genotypes each from local genotypes *viz*., 'CA-29', 'CA-30', 'CA-39', 'CA-47' and 'CA-48', improved varieties *viz*., 'Chilli Philhal', 'Pusa Sadabahar', 'DKC-8', 'Pusa Jwala' and 'G-4' and hybrids *viz*., 'Diamond F_1', 'Tejaswini', 'NS-1701', 'Jwalan', and 'Ulka 686 F_1' were evaluated at five fertility levels created artificially by applying 0%, 50%, 100%, 150% and 200% of recommended dose of fertilizers (RDF) of 100:50:50 kg N, P_2O_5 and K_2O ha^{-1} during *rabi* season of 2006–07 and *kharif* season of 2007. Healthy and uniform seedlings were transplanted in plots of 3.60 m × 3.0 m size with a spacing of 30 cm × 45 cm during Middle of November for *rabi* season and third week of April for *kharif* season in both the years. Well rotten farm yard manure @ 15 t ha^{-1} was applied as basal irrespective of the doses of inorganic fertilizer application. Full dose of P_2O_5, one third of N and half of K was given as basal at the time of land preparation. After 45 days of transplanting, top dressing was done with one third of N and rest of K. Second top dressing was done with the remaining 1/3rd of N at 75 days after transplanting. Irrigation, weeding, spraying of plant protection chemicals were carried out as and when required. Observations on different morphological and yield attributing characters were recorded from 10 randomly selected plants from each replication. Ascorbic acid in green chilli was determined by colorimetric method as described by Ranganna (2001). Capsaicin content of green fruits was measured as described by Sadasivam & Manickam (1996). Stability analysis was done as per the method suggested by Eberhat & Russell (1966).

Results and discussion

Pooled analysis of variance (Tables 1 & 2) showed the presence of significant genetic variability among the genotypes for all the characters namely, plant height, primary branches, days to first harvest, fruit length, fruit number, individual fruit weight, yield per ha, ascorbic acid and capsaicin content in green fruit. Significant environment mean square indicated that the differential effect of environment affected the performance of the genotypes. Highly significant mean squares due to environment and G × E interaction revealed that the phenotypic expressions of all genotypes varied in different environments. Similar results were reported by Patil (1994) in tomato. Partitioning of mean squares due to G × E interaction into linear and non-linear compounds revealed that major portion of interactions in all the parameters was attributable to linear component. This indicated that the prediction of performance in different environments was possible for all the growth, yield and quality characters.

Table 1. Genotype × environment interaction and regression analysis for different growth and fruit characters of chilli

Source	df	Plant height (cm)	Primary branches	Days taken for 50% flowering (days)	Days taken for 1st harvest (days)	Fruit length (cm)
Genotype (G)	14	1235.91**	2.73**	1020.23**	3823.01**	12.35**
Environment (E)	9	1606.76**	28.86**	435.10**	1509.75**	0.69**
G × E interaction	126	33.22**	0.20**	15.30**	27.87**	0.02**
Environment + (G × E)	135	138.13**	2.11**	43.29**	126.66**	0.07**
Environment (linear)	1	14461.03**	259.78**	3915.90**	13588.15**	6.24**
(G × E) linear	14	57.41*	0.55**	6.94	124.53**	0.07**
Pooled deviation	120	28.19**	0.14	15.26	14.73	0.01**
Pooled error	300	1.74	0.05	1.01	2.33	0.01

*Significant at P<0.05; **Significant at P<0.01

Table 2. Genotype × environment interaction and regression analysis for different fruit characters, yield and quality characters of chilli

Source	Leaf chlorophyll (SPAD-502)	Fruit number	Individual fruit weight (g)	Fruit yield (t ha^{-1})	Ascorbic acid (mg 100 g $fresh^{-1}$)	Capsaicin content in green fruit (%)
Genotype (G)	101.11**	9007.28**	1.87**	73.30**	2096.1**	0.35**
Environment (E)	1272.12**	23647.12**	0.18**	273.50**	254.80**	0.01**
G × E interaction	7.84**	627.09**	0.002**	3.59**	25.59**	0.001**
Environment + (G × E)	91.79**	2161.75**	0.01**	17.05**	40.87**	0.001**
Environment (linear)	11449.1**	212823**	1.64**	1849.5**	2292.8**	0.13**
(G × E) linear	35.70**	4124.04**	0.01**	23.91**	11.85	0.001**
Pooled deviation	3.69	177.31**	0.002**	0.98**	25.49	0.002**
Pooled error	1.75	2.78	0.001	0.04	3.58	0.0002

*Significant at P<0.05; **Significant at P<0.01

Plant height varied from 51.58 cm to 88.09 cm with an average value of 65.53 cm (Table 3). Out of 15 genotypes, only one genotype namely 'Ulka 686 F_1' showed non significant S^2d_i value and was specifically adapted to favourable environment. Instability in plant height of most of the genotypes in different environments might be due to huge variation in the existing environment. Among the different genotypes, 'CA-39' produced less number of branches but was stable in all the environments. 'Jwalan', 'CA-29', 'NS-1701' and 'Diamond F_1' recorded higher number of branches but their S^2d_i value was significant and their performance was unpredictable.

Early flowering and fruiting as well as early harvesting of fruit is desirable in chilli as it would enable the crop to fit in intensive cropping systems. 'CA-48' having lower mean value and 'Pusa Sadabahar' and 'Ulka-686 F_1' having higher mean value were stable over the environments. 'Pusa Jwala' took relatively more time for harvest and was specifically adapted to favourable environment.

In this experiment, none of the genotypes showed absolute stability with respect to fruit number under different environments (Table 4). Genotypes 'CA-29', 'DKC-8', 'Pusa Sadabahar' and 'NS-1701' were specifically adapted to adverse environment and 'CA-30',

Table 3. Stability parameters for plant height, primary branches and days taken for first harvest of chilli

Genotypes	Plant height (cm)			Primary branches			Days taken for 1st harvest		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
CA-29	51.58	0.78	85.84**	6.97	1.09	0.14**	77.37	0.68	1.12
CA-30	57.90	0.99	42.89**	6.48	1.15	0.05	83.67	0.88	0.36
CA-39	62.03	1.51	14.51**	5.67	0.98	-0.01	98.83	1.33	20.69**
CA-47	65.66	0.78	67.61**	6.33	1.10	0.03	94.43	1.22	4.59**
CA-48	54.27	0.77	7.91**	6.05	1.18	0.15**	100.13	1.01	0.45
DKC-8	70.77	1.22	35.19**	6.43	0.95	-0.04	132.10	1.57	23.14**
Chilli Philhal	58.58	0.62	4.28**	5.85	1.11	0.21**	100.47	0.80	3.39*
Pusa Sadabahar	71.42	0.97	46.69**	6.57	0.77	0.22**	123.80	1.00	-0.39
Pusa Jwala	58.00	0.78	13.55**	5.78	1.08	0.16**	128.63	1.07	-1.66
G-4	88.09	1.29	30.62**	6.34	0.95	-0.04	139.53	1.53	19.88**
Diamond F1	56.55	0.99	5.11**	6.49	0.82	0.11*	118.70	0.72	4.30**
Tejaswini	86.79	1.15	10.74**	6.97	0.87	0.03	134.33	1.26	2.35**
NS-1701	60.41	0.84	14.64**	6.72	0.58	0.37**	115.43	0.14	108.33**
Jwalan	65.15	1.16	16.33**	7.24	1.22*	-0.03	124.67	0.71	0.90**
Ulka 686 F1	75.71	1.17	0.91	7.44	1.15	-0.01	130.27	1.01	-1.33
Mean	65.53			6.49			113.49		

*Significant at P<0.05; **Significant at P<0.01

Table 4. Stability parameters for fruit length, individual fruit weight and fruit number of chilli

Genotypes	Fruit length (cm)			Individual fruit weight (g)			Fruit number		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
CA-29	6.29	1.64	0.21**	2.80	1.13	0.001	133.12	1.38	65.92**
CA-30	6.17	1.28	-0.003	2.06	0.87	0.00	83.25	0.86	125.58**
CA-39	4.96	0.88	-0.01	2.27	1.07	-0.001*	93.87	1.25	194.83**
CA-47	5.73	1.34	0.004	2.27	0.79	0.00	112.18	1.73	245.97**
CA-48	6.05	1.56	0.01	2.57	0.72	0.001**	108.89	1.52	154.48**
DKC-8	5.57	0.36	0.01	2.08	0.88	0.001**	94.23	0.91	61.42**
Chilli Philhal	5.23	0.23	0.02*	1.75	0.56	0.004**	91.54	0.92	35.69
Pusa Sadabahar	6.34	0.61	-0.01	2.35	1.03	0.00	115.95	0.44	376.35**
Pusa Jwala	7.89	1.29	-0.004**	2.36	1.07	0.001	63.05	0.43	49.31
G-4	6.81	0.87	0.03*	2.30	1.01	0.00	60.51	0.28	23.98**
Diamond F1	7.57	0.95	-0.01**	2.74	1.30	0.002**	99.68	0.94	37.00**
Tejaswini	6.67	1.05	0.01**	2.25	1.48	0.01**	120.29	0.68	185.24**
NS-1701	8.85	0.84	-0.003	3.24	1.08	0.001**	95.84	0.19	643.89**
Jwalan	4.75	1.19	0.01	1.89	0.90	0.00	164.82	1.73	145.09**
Ulka 686 F1	6.29	0.90	-0.01	3.21	1.13	0.00	160.78	1.75	273.52**
Mean	6.34			2.39			106.53		

*Significant at P<0.05; **Significant at P<0.01

'CA-47', 'CA-48', 'Pusa Jwala' and 'Jwalan' were specifically stable under favourable environment. Higher fruit weight was recorded in 'NS-1701', 'Ulka 686 F_1', 'Diamond F_1' and 'CA-29' (Table 4). Genotype 'Pusa Sadabahar' and 'G-4' were stable over the environments and genotype. The genotypes, 'Ulka 686 F_1', 'CA-29' and 'Pusa Jwala' were found to be stable under favourable condition.

With respect to fruit number, 13 genotypes showed significant S^2d_i value. This indicated that under different environments these genotypes produced variable number of fruits. Therefore, these genotypes showed low predictability over the environment. None of the genotype exhibited absolute stability in all the environments.

With respect to yield (Table 5), out of 15 genotypes, 12 genotypes showed S^2d_i value significantly greater than zero which indicated the unstability for this trait. Among the high yielders 'Ulka 686 F_1', 'Jwalan', 'CA-29', 'CA-48' and 'CA-47' and low yielder genotype had regression value (b_i) of > 1 which indicated that they showed better response under favourable environment. But deviation from regression value (S^2d_i) was significant, which indicated that their performance over the environment was unpredictable. 'Diamond F_1' also produced higher yield as its mean values was very close to the average value and was specifically adapted to favourable condition. 'Chilli Philhal' and 'Pusa Jwala' produced lower yield but these genotypes were adapted to unfavourable environment. The possible reason for unstability of the genotypes would be due to large gap between yield under different environments, different fertility levels and growing seasons (Figs.1 & 2). Considering the stability analysis and *per se* performance, genotype 'Ulka 686 F_1' and 'Jwalan' were suitable for both favourable and unfavourable conditions. The *rabi* crop showed its superiority over kharif crop with respect to yield and its attributing characters. With respect to ascorbic acid content, only six genotypes exhibited non significant S^2d_i value, which suggested that

Table 5. Stability parameters for yield, ascorbic acid and capsaicin content of chilli

Genotypes	Fresh green fruit yield (t ha^{-1})			Ascorbic acid (mg 100 g^{-1} fresh)			Capsaicin content in green fruit (%)		
	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i	Mean	b_i	S^2d_i
CA-29	10.93	1.40	0.47**	141.67	1.30	34.74**	0.51	0.82	0.00
CA-30	6.86	0.96	1.20**	133.46	1.17	1.75	0.36	0.62	0.00
CA-39	7.81	1.32	1.66**	132.71	1.05	2.59	0.45	1.19	0.00
CA-47	9.21	1.59	1.51**	128.19	0.75	7.06**	0.33	1.17	0.00
CA-48	9.43	1.50	0.98**	113.42	0.60	4.83*	0.56	1.62	0.00**
DKC-8	6.99	0.85	0.49**	123.65	0.88	-2.72	0.34	0.79	0.00
Chilli Philhal	6.68	0.77	0.06	126.51	1.57	98.96**	0.51	1.74	0.00**
Pusa Sadabahar	8.80	0.38	2.11**	138.67	0.43	158.06**	0.49	0.75	0.00
Pusa Jwala	4.73	0.41	0.31	142.67	1.04	1.48	0.53	0.54	0.00
G-4	4.60	0.43	0.45**	150.81	1.11	-2.73	0.83	0.70	0.00
Diamond F1	8.47	1.07	0.13	138.35	1.02	-2.94*	0.44	0.92	0.00*
Tejaswini	8.86	0.66	0.93**	105.84	1.08	13.74**	0.97	1.24	0.00
NS-1701	8.76	0.52	1.44**	100.56	1.09	4.00*	0.62	0.66	0.00**
Jwalan	12.76	1.29	0.98**	129.92	1.11	1.11	0.70	0.83	0.00
Ulka 686 F1	14.17	1.87	3.12**	111.95	0.81	8.75**	0.77	1.42	0.00**
Mean	8.60			127.89			0.56		

*Significant at P<0.05; **Significant at P<0.01

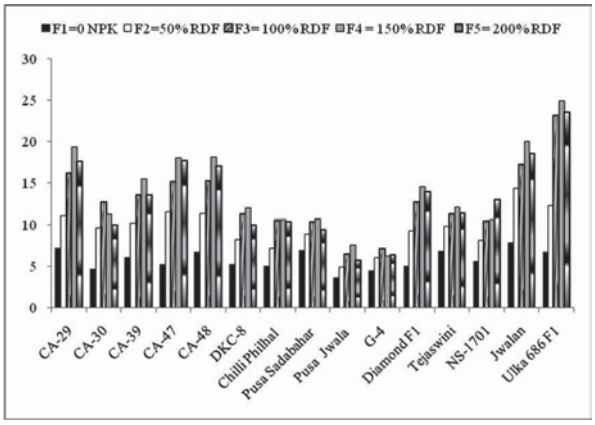

Fig. 1. Green yield of chilli genotypes at different fertility levels in *rabi* season

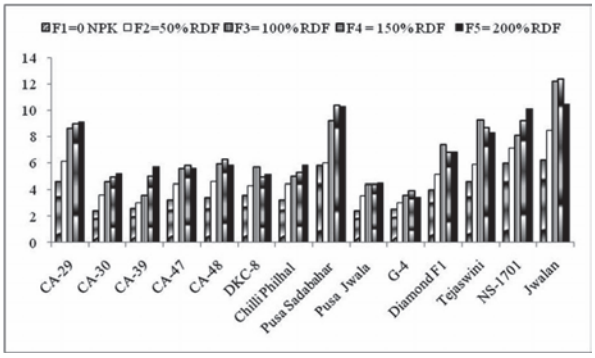

Fig. 2. Green yield of chilli genotypes at different fertility levels in *kharif* season

these genotypes were adapted to various environments. The genotype 'Pusa Jwala' possessed high ascorbic acid and was stable in nature under different environment as b_i value was close to 1 with low non significant S^2d_i value. Chaubey *et al.* (2000) also found that out of 23 cabbage genotypes, only one genotype showed absolute stability over different fertilizer levels and seasons. The highest capsaicin content in green fruit was recorded in 'Jwalan' which was specifically adapted to favourable environment. Low capsaicin containing genotypes 'CA-39' and 'CA-47' were also stable under favourable condition. 'Pusa Sadabahar' and 'Pusa Jwala' also had low capsaicin content as compared to population mean and were adapted to unfavourable environment. G-4 having higher capsaicin content was also specifically adapted to unfavourable environment.

Considering the stability analysis and *per se* performance, genotype 'Ulka 686 F_1' and 'Jwalan' were suitable to both favourable and unfavourable conditions and 'CA-29' was suitable for cultivation under favourable condition and genotypes 'Pusa Sadabahar', 'Chilli Philhal' and 'Pusa Jwala' were adapted to unfavourable environment.

References

Chaubey T, Srivastava B K & Singh M 2000 Stability analysis yield and quality contributing characters in cabbage. Veg. Sci. 27: 45–50.

Eberhat S A &. Russel W L 1966 Stability parameters for comparing varieties. Crop Sci. 6: 36–40.

Lohithaswa H C, Kulkarni R S & Manjunath A 2000 Combining ability analysis for fruit yield, capsaicin and other quantitative traits in chillies (*Capsicum annuum* L.) over environments. Indian J. Genet. Plant Br. 60: 511–518.

Mini C & Vahab A 2000 Evaluation of *Capsicum* genotypes for olerosin recovery with respect to season and harvest maturity. Vegetable Sci. 27: 67–71.

Patil G S 1994 Stability studies in tomato. M. Sc. Thesis, University of Agricultural Sciences, Dharwad.

Ranganna S 2001 Analysis and quality control for fruits and vegetable products. Tata McGraw Hill Publication, 2nd Edition, New Delhi, India, pp.110–112.

Reddy K M & Sadashiva A T 2003 Studies on yield stability in chilli (*Capsicum annuum* L.). Indian J. Hort. 60: 183–187.

Sadasivam S & Manickam A 1996 Ascorbic Acid. In: Biochemical Methods. New Age International Publishers, 2nd Edition, New Delhi, India, pp.185–186.

Senapati B K & Sarkar G 2002 Genotype-environment interaction and stability for yield and yield components in chilli (*Capsicum annuum* L.). Veg. Sci. 29: 146–148.

Singh G P, Maurya K R & Prasad B 1999 Stabilty analysis in chilli (*Capsicum annuum* L.). J. Applied Biol. 9: 1–4.

Sooch B S, Thakur M R & Gupta V P 1981 Stability analysis for some characters in chilli (*Capsicum annuum* L.). Indian J. Hort. 39: 83–88.

Zewdiel Y & Poulos J M 1996 Stability analysis in hot pepper. *Capsicum* & Eggplant Newslett. 14: 39–42.