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Stability of yield and its component characters in tomato (*Lycopersicon esculentum* Mill.)

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Abstract

Eleven tomato (*Lycopersicon esculentum* Mill.) genotypes were evaluated for yield and its components under eight environments. Variance due to genotypes, environments, genotype × environment and G × E (linear) components were highly significant for average fruit weight, fruit polar diameter, fruit equatorial diameter, number of fruits per plant, yield per plant, early yield per plot and total yield per plot. The genotypes F_1-124, Shivaji and BSS-211 were found to be desirable and stable for total yield per plot, while genotypes S-72 and Rashmi were suited for favourable environments. The genotype Megha was found stable for early yield. The F_1 hybrids had greater stability for yield across environment compared to open pollinated varieties.

Key words: Tomato, adaptation, cultivars, stability, yield

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important solanaceous vegetable crops grown all over the world. Phenotypically stable genotypes are of great importance, because the environmental conditions vary from season to season and year to year. Wide adaptation to the particular environment and consistent performance of recommended varieties/hybrids are very important for successful cultivation of tomatoes. Although number of varieties/hybrids are recommended for the cultivation, the information on the stability is lacking. Therefore, the present study was aimed to evaluate and screen the commercial varieties/hybrids over environments and to select the varieties/hybrids on the basis of stability parameters for important yield and its component characters.

Materials and Methods

The materials of the present investigation comprised of eleven genotypes of tomato including five OP varieties *viz.*, Arka Meghali, Arka Vikas, Arka Ashish, Pusa Ruby and Megha and six F_1 hybrids *viz.*, Rashmi, S-72, NS-815, Shivaji, F_1-124 and BSS-211. The experiment was carried out in randomized block design with three replications during *kharif* and *rabi* 2000-2001 over eight environments *viz.*, E_1 (*kharif* 2000-2001, package of practices with recommended dose of fertilizer i.e. 250:250:250 kg NPK/ha), E_2 (*kharif* 2000-2001, package of practices with half recommended dose of fertilizer), E_3 (*kharif* 2000-2001, package of practices without fertilizer application), E_4 (*kharif* 2000-2001, package of practices without plant protection measures), E_5 (*Rabi* 2000-2001 with package of practices with recommended dose of fertilizer i.e. 250:250:250 kg NPK/ha), E_6 (*Rabi* 2000-2001 package of practices with half recommended dose of fertilizer), E_7 (*Rabi* 2000-2001 package of practices without fertilizer application) and E_8 (*Rabi* 2000-2001 package of practices without plant protection measure). Each plot comprised with ten plants in a row with 4.5 square meter net plot size at 75 cm × 60 cm distance. The data were analysed for stability parameters using the model proposed by Eberhart and Russell [4] for average fruit weight, fruit polar diameter, fruit equatorial diameter, number of fruits per plant, yield per plant, early yield per plot and total yield per plot.

Results and Discussion

The analysis of variance (Table 1) showed highly significant mean squares for genotypes and environments for almost all the traits. This reveals significant difference among genotypes and diversity of environments. Genotypes also interacted significantly with environments for all the traits (2, 3, 5). The G × E (linear) as well as pooled deviation mean squares were found significant for average fruit weight, number of fruits per plant and yield per plant indicating the presence of both predictable and non predictable components. The importance of both linear and non-linear sensitivity for the expression of these traits was thus evident. However, linear component was significantly higher than the non-linear portion of the G × E interaction supporting the earlier findings [1, 8].

Stability of all the genotypes for average fruit weight can be predicted except Arka Vikas, which possessed highly significant deviation from regression.

Table 1. Pooled analysis of variance (mean square) for different characters in tomato

Source of variation	df	MS						
		Average fruit weight(g)	Fruit polar diameter (cm)	Fruit equatorial diameter (cm)	No. of fruits per plant	Yield per plant (kg)	Early yield per plot (kg)	Total yield per plot (kg)
Genotypes	10	1214.17**	4.55**	0.80**	407.48**	0.25**	1.02**	13.51**
Environments	7	2263.94**	2.30**	0.49**	4238.10**	17.53**	1.70**	1293.60**
Genotype × environment	70	83.74**	0.07**	0.06**	55.91**	0.06**	0.33**	2.58**
Environment+ (Genotype × environment)	77	281.94**	0.27**	0.10**	436.11**	1.64**	0.46**	119.95**
Environment (linear)	1	15847.53**	16.10**	0.34**	29666.77**	122.71**	11.88**	9055.19**
Genotype × environment (linear)	10	235.45**	0.23**	0.07	320.56**	0.20**	0.34	10.82**
Pooled deviation	66	53.14**	0.04	0.05**	10.73**	0.03**	0.30**	1.1
Pooled error	160	106.95	0.14	0.11	24.77	0.09	0.62	5.05

**Significant at P = 0.01

The genotypes NS-815 (80.38 g) and BSS-211 (78.53g) were found stable with non significant regression coefficients approaching one, having lower mean values (Table 2), which are in commercially acceptable range. The genotypes Arka Meghali, Rashmi, Shivaji and F_1-124 possessed higher mean values and non significant regression coefficients and hence, are stable and suited to favourable environments. The genotype Arka Ashish possessed higher mean value and non significant regression coefficient and hence, was stable and suited to unfavourable environment. The genotype S-72 possessed higher mean value and regression coefficient significantly exceeding unity and non significant deviation from regression, indicating its unstability and suitability to favourable environments with predictable performance.

All the genotypes were linearly predictable in terms of fruit polar diameter because of non significant deviations from regression (Table 2). The genotype NS-815 (5.28 cm) was found most stable with higher mean values and regression coefficient exactly one, while the genotype BSS-211 (5.13 cm) with higher mean value was also found stable as indicated by its around unit regression coefficient and non significant deviation from regression. The genotypes Shivaji (5.52cm) and F_1-124 (5.56 cm) had higher mean values and non significant regression coefficients greater than one, indicating their stability up to some extent and their suitability for favourable environments. The genotypes S-72, Arka Ashish and Rashmi possessed higher mean values and the regression coefficients significantly exceeding unity, indicating their unstability and suitability to favourable environments.

The genotypes Arka vikas (5.65 cm), Arka Meghali (5.60 cm) and F_1-124 (5.05 cm) possessed high mean values for fruit equatorial diameter and non significant regression coefficients approaching unity and non significant deviations from regression and hence, were

Table 2. Stability parameters for average fruit weight and fruit polar and equatorial diameter in tomato

Sl.No.	Varieties/ hybrids	Average fruit weight (g)			Fruit polar diameter (cm)			Fruit equatorial diameter (cm)		
		Mean	b_i	$S^2_{d_i}$	Mean	b_i	$S^2_{d_i}$	Mean	b_i	$S^2_{d_i}$
1	Arka Meghali	88.68	1.13	18.28	4.40	0.88	-0.01	5.60	0.85	0.03
2	Arka Vikas	90.60	1.27	173.34**	4.21	0.68*	-0.03	5.65	1.05	0.03
3	Arka Ashish	82.08	0.72	29.99	5.48	1.45**	0.02	4.89	0.48	0.05*
4	Pusa Ruby	48.44	0.18**	-11.25	3.24	0.36**	-0.03	4.65	0.47	0.01
5	Megha	69.22	0.44**	-2.91	4.65	0.43**	-0.01	4.85	0.46	0.05*
6	Rashmi	83.06	1.25	-7.96	5.24	1.37*	-0.03	5.07	1.96*	-0.03
7	S-72	89.05	1.57**	27.02	5.74	1.50**	-0.04	5.05	1.57	-0.03
8	NS-815	80.38	0.96	-4.19	5.28	1.00	0.01	4.85	0.98	0.00
9	Shivaji	87.32	1.17	14.77	5.52	1.26	0.02	4.98	0.90	0.02
10	F1-124	88.32	1.22	-20.62	5.56	1.15	0.01	5.05	1.10	-0.03
11	BSS-211	78.53	1.09	29.94	5.13	0.91	-0.01	4.80	1.17	0.04*
Population mean		80.52			4.95			5.04		
S.E. (mean)		2.76			0.072			0.085		
S.E. of bi			0.192			0.158			0.40	

b_i **, *: Regression coefficient significantly different from unity at P = 0.01 and P = 0.05, respectively

$S^2_{d_i}$ **, *: Deviation from regression significantly different from zero at P = 0.01 and P = 0.05, respectively

most stable across the environments. The genotype S-72 (5.05 cm) had high mean values with non significant regression coefficient greater than unity (b_i = 1.57) and non significant deviation from regression indicating their stability. The genotype Rashmi even though had high mean values for fruit equatorial diameter, bi was significantly greater than unity (b_i = 1.96) and hence, it was unstable and suited to favourable environment.

The genotypes F_1-124 (32.90) and S-72 (32.15) were found stable with higher value for number of fruits/plant and non significant regression coefficient approaching unity (Table 3). The genotype Megha (35.76) had higher mean value but was not stable as indicated by its significantly higher regression coefficient than unity (b_i = 1.21) and was suited to favourable environments [1].

environments, with predictable performance. Pandey [6] also reported that suitability of the genotype Pusa Ruby for favourable environments. The genotypes NS-815 and BSS-211 also found stable with higher mean values for early yield but, were unpredictable with respect to their stability due to their significant deviations from regression.

The genotypes F_1-124 (17.27 kg), Shivaji (17.19kg) and BSS-211 (16.52 kg) were found to be stable with higher mean values for total yield per plot and non significant regression coefficients around unity and non significant deviations from regression (Table 3). Stoffella *et al.* [9] observed that high yielding fresh market tomato genotypes had good phenotypic stability for fruit yield. The genotype F_1-124 was also found stable with higher mean values and predictable performance

Table 3. Estimates of stability parameters for number of fruits and early and total yield in tomato genotypes

S.No.	Varieties/ hybrids	Number of fruits per plant			Yield per plant (kg)			Early yield per plot (kg)			Total yield per plot (kg)		
		Mean	b_i	$S^2_{d_i}$	Mean	b_i	$S^2_{d_i}$	Mean	b_i	$S^2_{d_i}$	Mean	b_i	$S^2_{d_i}$
1	Arka Meghali	23.49	0.60**	-4.37	1.75	0.86**	0.01	1.58	1.21	0.07	14.26	0.86**	–0.73
2	Arka Vikas	23.92	0.62**	0.46	1.80	0.89**	0.00	1.51	0.55	0.08	15.24	0.93	–0.13
3	Arka Ashish	30.28	0.89	-6.84	1.83	0.90	–0.02	1.69	0.45	-0.07	15.58	0.94	–1.02
4	Pusa Ruby	50.72	1.89**	37.84**	1.89	1.17**	0.04*	2.66	2.33*	0.07	16.08	1.14**	0.64
5	Megha	35.76	1.21**	–4.14	1.67	0.80**	–0.01	2.05	1.12	0.13	14.45	0.85**	–0.49
6	Rashmi	30.07	1.07	2.68	2.04	1.18**	–0.02	1.71	1.22	–0.13	16.95	1.17**	–0.17
7	S-72	32.15	0.91	–6.81	2.21	1.13*	–0.02	1.51	0.60	–0.04	18.56	1.15**	–0.57
8	NS-815	30.33	0.92	7.28	1.86	0.93	–0.01	2.24	1.49	0.47**	15.57	0.92*	–0.99
9	Shivaji	31.86	0.91	–7.37	2.09	1.01	–0.01	1.57	0.71	0.09	17.19	0.97	–0.80
10	F_1-124	32.90	0.92	–4.89	2.14	1.03	–0.01	1.77	0.79	0.01	17.27	1.01	–1.30
11	BSS-211	33.61	1.07	9.40*	2.05	1.09	0.09**	1.90	0.53	0.37**	16.52	1.06	0.09
Population mean		32.46			1.94			1.84			16.15		
S.E. (mean)		1.238			0.066			0.208			0.396		
S.E. of b_i			0.063			0.052			0.529			0.036	

b_i **, *: Regression coefficient significantly different from unity at P = 0.01 and P = 0.05, respectively

$S^2_{d_i}$, **,*: Deviation from regression significantly different from zero at P = 0.01 and P = 0.05, respectively

The genotypes F_1-124 (2.14kg) and Shivaji (2.09kg) with higher mean values for yield per plant were found highly stable due to their non significant regression coefficients approaching unity with predictable performance (Table 3). The genotypes Rashmi (2.04 kg) and S-72 (2.21 kg) were suited for favourable environments as indicated by $b_i > 1$ and $S^2_{d_i} \approx 0$.

The genotype Megha (2.05 kg) had high mean values for early yield per plot and was found stable due to its insignificant regression coefficient (Table 3). This is an open pollinated variety which can be used for further breeding programmes to develop hybrids or varieties with stability for early yield. The genotype Pusa Ruby had high mean values and was unstable due to its significantly greater regression coefficient than unity (b_i = 2.33) and hence, suited to favourable

for yield per plant, number of fruits per plant, fruit equatorial diameter, fruit polar diameter and average fruit weight. The genotype Shivaji was also found stable with high mean values and predictable performance for yield per plant, fruit polar diameter and average fruit weight.

The genotypes S-72 (18.56 kg) and Rashmi (16.95 kg) although had high mean values for total yield per plot were found unstable with significantly greater regression coefficients than unity indicting their suitability to favourable environments.

The present study brought out the fact that, advantage of F_1 population may not only be in the area of increased yield, but also for greater stability in production across environments [6, 7]. The outstanding genotypes for yield *per se* performance and stability

parameters were hybrids *viz.*, F_1-124, Shivaji, BSS 211, S-72 and Rashmi. These hybrids were far superior than open pollinated varieties (Arka Meghali, Arka Vikas, Arka Ashish, Pusa Ruby and Megha) for *per se* performance and stability parameters.

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