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Stability Analysis for Fruit Yield and its Components in Tomato (*Solanum lycopersicum* L.) under Acidic Soils of Manipur Valley

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A B S T R A C T

Twenty nine promising genotypes of Tomato were grown in five different environments to study phenotypic stability for fruit yield and its components. The study revealed that the genotype BRH-2 followed by the genotype Arka Vikas can be utilized to develop promising lines having wider adaptability in future breeding programmes. Among the environments it was found that the pre- winter sowing ,that is, sowing in September was favourable for the characters like days to 50% flowering, days to maturity, plant height, number of primary branches per plant and fruit weight. However, sowing of tomato in November favoured characters like number of fruits per plant, size of fruit and fruit yield per plant.

Introduction

High yielding varieties that have inherent stability in performance over different agro-ecological conditions are of great significance in countries like India towards sustainable production and productivity. The phenotypic performance of a genotype is not necessarily the same under diverse agro-ecological conditions. Some genotypes may perform well in some environments but not so well in others. Such genotype and environment (Gx E) interactions have assumed greater importance in Plant Breeding as they affect stability of genotypes under diverse environments. Once the G x E interactions were found to be significant, the next task is to identify stable genotypes. The stable genotypes are one which interact less with the environments giving a near consistent performance across different environments (Finlay and Wilkinson, 1963). A variety is said to be stable when regression coefficient (b) is equal to one and deviation from regression (S^2d) as close to zero as possible with high mean performance (Eberhart and Russell, 1966). Allard and Bradshaw (1964) suggested selection of stable genotypes that interact less with environments in which they are to be grown with a view to reduce the genotype x environment interaction to a considerable extent. The above three

measures of assessing the stability of genotype viz, mean, regression coefficient (b) and the mean square deviation (S^2d) were employed in assessing the stability of genotypes included in the present study.

In the present investigation, an attempt has been made to study the stability of some promising genotypes of tomato (*Solanum lycopersicum* L.) under acidic soils of Manipur.

Materials and Methods

The materials of the present investigation comprised 29 genotypes of tomato possessing different morphological and productive attributes. The genotypes were studied for stability parameters under five different environments *viz*., September 2017 (E1), November 2017 (E2), February 2018 (E3), September 2018 (E4) and November 2018 (E5). The experiment was laid out in Randomised Block Design with three replications at experimental farm of College of Agriculture, CAU, Imphal. The 25 days old seedlings were transplanted in 6 rows of 2m length maintaining plant to plant and row to row distances of 40 cm and 60 cm respectively in each replication. All the recommended package of practices was followed to raise the crop. Observations were recorded on 10 randomly chosen plants in each replication for plant height, number of primary branches per plant, number of fruits per plant, length of the fruit, fruit diameter, fruit weight, fruit yield per plant, while for days to 50% flowering and days to maturity, data were recorded on plot basis. Stability parameters were estimated using the model proposed by Eberhart and Russel (1966).

Results and Discussion

Pooled analysis of variance revealed significant differences among the genotypes for most of the characters under study. Further, significant variances due to environment (linear) indicated that performance of the genotypes could be predicted. The variance due to G x E was significant for all the characters except numbers of primary branches per plant, fruit length; fruit weight and fruit yield per plant (Table 1). Stability parameters for different characters are summarised in table 2.

Most stable genotype among all the studied genotypes for days to 50% flowering was TWC-3 with unit regression coefficient and non- significant deviation from regression.

For days to maturity the genotype Pusa Ruby was the only genotype, which was stable having mean value lower than the population mean with unit regression and non-significant deviation from regression.

Among the genotypes studied for plant height at maturity, most stable genotypes were CAU-M-4, CAU-TS-2, CAU-TS-4 and TWC-2. These genotypes expressed lower plant height from the population mean with unit regression coefficient and non- significant deviations from the regression.

For the character number of primary branches per plant mean sum of squares for [Environment + Genotype x environment] as well as Environment (linear) and Genotype x Environment (linear) were non-significant. This clearly showed that the genotypes did not respond significantly to varying degrees of environment i.e. over different sowing dates and year. Among the genotypes, most stable were Pusa Ruby and Money Maker with unit regression coefficient and non-significant deviation from regression. In the study of the most important yield contributing character *viz*., number of fruits per plant, the most stable genotypes were BRH-2, Sutton Roma, Marglobe Supreme and CAU-TS-5.

Table.1 Pooled analysis of variance over all environments for different characters in tomato (Eberhart and Russell, 1966)

Source of variation	d.f	Mean sum of squares								
		Days to 50% flowering	Days to maturity	Plant height	Number of primary branches per plant	Number of fruits per plant	Fruit length	Fruit diameter	Fruit weight	**Fruit yield per plant**
Genotype (G)	**28**	**303.12****	**454.62****	**38.53**	**0.73**	**51.97****	**1.12***	**0.93****	**303.14****	**31650.30****
Environment (E)+	**116**	**16.90**	**20.98**	**54.15**	**0.13**	**2.67**	**0.24**	**0.22**	**41.24**	**2807.44**
(G x E)	**1**	**17.84**	**75.40**	**594.24****	**1.07**	**26.79****	**1.39****	**3.28****	**16.34**	**8654.60**
E (Linear)	**28**	**48.83***	**68.57****	**173.45****	**0.14**	**8.83***	**0.52**	**0.76****	**35.26**	**4129.13**
G x E (Linear)	**87**	**84.30****	**58.95****	**163.03****	**1.31****	**7.14**	**1.49****	**0.50**	**436.24****	**2413.35**
Pooled deviation	**280**	**28.78**	**37.29**	**76.23**	**0.60**	**5.61**	**0.45**	**0.34**	**86.97**	**9774.95**
Pooled error										

*, ** Significant at P=0.05 and P= 0.01 level respectively

Table.2 Stability parameters for different characters in tomato

	Days to 50% flowering			**Days to maturity**			**Plant height (cm)**		
Genotype	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
TWC-1	71.27	0.4857	-9.07	38.73	3.195	-12.51	71.47	3.5060	-21.01
TWC-2	64.95	1.3273	-6.92	95.87	0.491	-9.78	70.22	-2.6850	-11.45
TWC-3	61.44	0.807	1.16	91.93	3.698	-12.03	65.32	0.2860	-24.53
TWC-4	68.32	-1.1267	5.3	94.20	-5.788	-0.16	61.97	-1.5520	-19.46
TWC-8	77.67	-1.1059	-0.37	99.33	0.428	-8.37	60.79	0.9930	-21.2
TWC-9	84.17	-0.1134	-3.68	97.73	1.102	-8.34	63.96	-0.5830	-1.62
TWC-10	82.26	0.4516	-0.94	97.33	0.324	-2.37	74.46	4.7150	-23.84
TWC-11	76.75	1.2078	-8.5	90.87	4.732	-4.09	72.26	4.5690	-52.09
A.ALOK	69.99	-0.1151	21.48	89.80	0.004	-0.09	75.32	4.4610	-20.87
A.VIKAS	81.75	-2.5612	63.73	106.00	-19.196	16.51	71.45	-4.3330	34.93
BRH-1	92.26	0.2047	-8.93	120.67	1.095	-9.9	56.93	-1.1150	-13.13

BRH-2	90.20	0.65	-9.01	117.53	3.318	18.22	52.86	-0.0999	-7.26
PED	84.33	0.7921	-0.93	105.73	7.723	-6.02	66.61	5.3120	8.03
PR	74.05	1.5931	24.34	98.00	2.005	-11.84	72.94	-2.2470	-22.79
SR	68.29	0.2849	-0.24	96.60	1.019	-11.74	72.87	2.0160	-23.4
OR	68.00	0.5919	-1.67	92.20	4.261	-11.83	69.98	-2.6850	-21.6
SL-22	66.52	-0.4955	-7.61	92.07	-3.204	-5.23	78.81	4.9020	3.17
NS-101	71.16	-0.2907	3.87	99.53	4.694	-9.04	82.02	-2.3530	36.6
MM	75.14	-0.905	-6.56	102.20	0.198	0.62	63.94	-4.1000	-9.47
CAU-M-4	81.00	-0.3995	-6.52	106.80	3.007	-6.44	60.12	1.9850	-22.61
MS	83.08	0.0535	-8.6	112.73	-5.491	-10.6	62.96	-0.0512	-19.59
CAU-TS-2	82.53	-0.065	-8.23	115.20	2.286	-11.58	68.85	1.4300	-18.05
CAU-TS-5	83.93	-0.0576	-6.96	115.87	-2.076	-11.97	78.42	1.2970	25.71
CAU-TS-1-3	83.40	0.1799	-7.69	117.60	0.088	-11.74	90.97	3.1730	-25.05
CAU-TS-2-3	83.40	-0.1251	-8.53	117.00	6.600	-9.62	90.35	-2.0660	6.14
CAU-TS-3-3	81.78	0.7914	-4.49	112.93	4.271	-12.73	75.73	-2.8900	11.65
CAU-TS-4-3	74.48	0.862	2.63	111.07	1.380	-5.39	66.01	-1.4920	-20.3
CAU-TS-4-3	72.07	-0.1784	-7.31	103.07	9.593	-9.94	70.53	2.1280	-8.04
CAU-TS-1	71.82	0.3788	-9.06	96.47	0.331	-11.52	74.87	0.0566	-10
Mean+SE	75.66 +1.34			100.64+1.58			68+2.25		

	Number of primary branches per plant			**Fruit length (cm)**			**Fruit diameter (cm)**		
Genotype	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
TWC-1	3.29	3.669	-0.1	4.97	-2.071	0.04	3.14	2.111	-0.08
TWC-2	2.87	0.624	-0.16	4.72	5.697	-0.08	2.93	-0.0302	-0.06
TWC-3	3.02	-0.615	-0.09	3.25	5.919	0.25	2.55	2.017	-0.11
TWC-4	3.07	-1.180	-0.12	2.70	-2.620	-0.14	2.50	1.469	-0.04
TWC-8	3.11	0.692	-0.17	3.64	-5.026	0.03	3.46	3.930	-0.11
TWC-9	2.67	1.742	-0.01	4.27	-0.302	-0.15	3.83	1.450	-0.08
TWC-10	3.31	-5.936	0.71	4.13	2.622	-0.09	3.24	1.775	-0.1
TWC-11	4.13	2.827	-0.12	3.40	2.453	0.13	3.86	0.0649	-0.08

A.ALOK	3.61	-1.605	-0.1	3.93	-6.305	0.09	3.40	3.441	-0.08
A.VIKAS	3.32	2.706	-0.11	4.44	1.828	-0.11	3.99	0.054	-0.08
BRH-1	2.87	-0.056	-0.16	4.11	1.810	-0.14	3.67	1.249	-0.03
BRH-2	3.13	-2.699	-0.11	3.42	3.509	0.1	2.82	3.509	-0.08
PED	3.69	0.075	-0.15	3.83	-5.189	0.36	2.99	3.668	-0.07
PR	3.80	1.111	-0.19	3.53	5.825	0.39	2.67	4.920	-0.08
SR	3.38	1.861	-0.07	3.16	-3.621	-0.14	2.63	4.054	-0.05
OR	3.56	-2.404	0.06	3.96	-2.446	0.05	3.65	2.213	-0.09
SL-22	3.95	-0.832	-0.15	3.81	1.976	0.12	3.26	3.767	-0.05
NS-101	4.04	0.836	-0.16	4.12	-2.843	0.22	2.50	0.828	-0.05
MM	3.82	1.523	-0.12	4.28	0.784	0.02	2.71	1.377	-0.1
CAU-M-4	3.42	1.314	-0.11	4.34	-0.053	-0.11	3.12	1.416	0
MS	3.11	-1.375	-0.12	3.99	2.409	-0.09	3.51	0.021	0.04
CAU-TS-2	3.49	-0.211	-0.03	3.75	-0.586	-0.14	2.80	2.741	-0.08
CAU-TS-5	3.69	-0.271	-0.2	3.92	-1.313	-0.09	2.34	0.445	-0.03
CAU-TS-1-3	3.84	-1.176	-0.18	4.14	0.982	-0.1	3.11	3.916	-0.06
CAU-TS-2-3	4.02	0.409	-0.19	3.90	-0.770	-0.08	3.60	-0.154	-0.11
CAU-TS-3-3	3.47	1.809	-0.09	4.34	-2.915	-0.07	3.18	2.498	-0.05
CAU-TS-4-3	3.42	-0.758	0.02	4.21	3.085	-0.11	2.82	-0.044	-0.06
CAU-TS-4-3	3.22	-0.693	0.14	3.99	-1.449	-0.04	3.37	2.926	-0.09
CAU-TS-1	3.29	1.589	-0.08	4.21	0.0514	-0.03	3.25	3.755	-0.04
Mean+SE	3.72+0.20			3.99+0.17			3.37+0.15		

	Number of fruits per plant			**Fruit weight (g)**			**Fruit yield per plant (g)**		
Genotype	Mean	bi	S^2di	Mean	bi	S^2di	Mean	bi	S^2di
TWC-1	11.38	5.376	-1.54	39.36	2.997	-27.05	220.60	6.210	-1388.61
TWC-2	9.46	-1.90	-1.21	27.92	4.331	152.18	352.51	5.453	2760.79
TWC-3	13.42	-6.782	-0.85	18.14	0.543	-24.65	426.65	0.254	-2544.48
TWC-4	15.09	2.79	-1.36	22.92	1.190	-2.78	363.92	-3.237	3668.74
TWC-8	14.31	-1.30	-1.63	30.28	1.302	-21.7	333.19	1.878	1251.07
TWC-9	16.54	-3.16	-1.39	29.27	0.807	-11.17	317.49	0.426	-57.52

TWC-10	18.13	-1.88	-0.87	24.17	0.646	-25.12	339.11	4.120	-929.21
TWC-11	14.63	6.49	-0.69	29.19	0.894	51.93	388.49	1.819	-14.94
A.ALOK	11.80	-0.36	-0.49	44.37	2.499	45.11	395.53	2.279	-1019.86
A.VIKAS	15.75	-6.48	-0.12	51.15	0.361	-23.91	372.01	-3.851	-716.51
BRH-1	20.41	-3.15	-0.15	44.63	0.045	31.3	377.61	6.181	-1510.23
BRH-2	20.98	1.77	0.36	31.82	1.995	23	457.34	1.546	-721.96
PED	20.55	-1.32	-0.97	30.87	1.350	-22.27	530.03	1.802	-885.38
PR	21.33	0.16	-1.63	29.39	0.622	-16.7	517.65	-4.272	-2167.97
SR	19.96	2.29	-1.54	23.00	4.545	-23	406.13	-5.964	173.76
OR	18.36	0.94	-1.83	30.19	5.035	79.5	325.53	0.442	-2595.73
SL-22	18.41	-1.13	-1.63	28.69	2.566	52.33	270.57	-3.149	-1570.51
NS-101	17.21	3.47	-1.72	29.55	1.566	78.57	249.59	1.514	-2897.93
MM	17.18	-2.91	-1.19	45.71	4.309	9.84	300.03	1.016	-615.11
CAU-M-4	19.66	-1.93	-1.75	39.08	4.239	102.1	283.19	3.016	1430.5
MS	21.47	-1.91	-1.57	29.84	2.068	-23.83	297.46	0.5464	352.73
CAU-TS-2	21.83	1.09	-0.56	31.72	2.429	-11.73	340.04	1.393	-3002.79
CAU-TS-5	19.61	2.81	-1.67	31.26	1.669	-9.75	326.21	2.856	-2961.4
CAU-TS-1-3	18.33	0.65	-1.76	36.48	1.331	6.56	263.59	-2.016	-1247.7
CAU-TS-2-3	18.24	-0.71	-1.85	39.77	2.196	-25.47	292.22	6.532	-1472.61
CAU-TS-3-3	18.06	0.77	-1.72	30.97	2.666	72.2	364.36	0.309	-144.08
CAU-TS-4-3	18.62	-1.38	-0.51	21.28	1.371	-26.54	276.73	7.454	921.1
CAU-TS-4-3	17.18	3.36	-1.42	28.05	1.340	36.73	219.18	1.493	-2741.32
CAU-TS-1	13.85	3.91	-0.32	37.62	2.838	-21.26	226.92	2.680	-2551.95
Mean+SE	17.32+0.28			3.99+0.17			32.30+2.41		

The stable genotypes for other important yield contributing characters were TWC-1, Arka Vikas and BRH-1 for fruit length; TWC-9 for fruit diameter and Arka Alok, CAU-TS-2-3 and CAU-TS-1 for fruit weight, respectively.

In the present study, highly stable performance for mean fruit yield per plant was shown by the genotypes Arka Vikas, TWC-8, TWC-11, BRH-2, Pusa Early Dwarf and CAU-TS-2 with mean yield more than the population mean with unit regression coefficient and non-significant deviation from the regression. Good performing variety Pusa Ruby came out to be quite unstable as the regression coefficient was significantly deviated from unity though deviation from regression was non-significant implying that this variety could be recommended for poor environment. Likewise, Sutton Roma could also be recommended for poor environment. Similar observations were observed by Shalini (2016), Shankar *et al.*, (2017) and Sonam *et al.*, (2017).

From the above discussion, it could be concluded that no single genotype was stable for all the characters under study. This is in consonance with studies of Ummyiah et.al. (2015), Ravindra Kumar *et al.*, (2019) and Krupal and Acharya (2019) as they observed that no single genotype showed stability for all the traits under different environments.

It can be concluded that variety BRH-2, which was stable for the characters fruit yield per plant and number of fruits per plant and Arka Vikas which was stable for fruit length and fruit yield per plant can be utilized to develop stable strains having wider adaptability in future breeding programmes. It can also be concluded that November sowing showed better performance in yield while September sowing favoured for earliness, better growth, and can be suitable for growing genotypes for seed production purpose.

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