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Genotype – Environment Interaction and Stability Analysis in Tomato (*Solanum lycopersicum* L.)

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ABSTRACT

Twenty five genotypes of tomato were evaluated in RBD with three replications under four environments to study the stability behavior of genotypes under the four environmental conditions created with different doses of plant bioregulators viz. NAA 50ppm (E1), GA + PCPA (combined) each 50ppm (E2), 2,4-D 5ppm (E3) and control (E4). Pooled analysis of variance exhibited significant mean squares due to genotypes for all the traits. There was enough variability due to environments for all the traits except plant height. Significant variation due to G x E interaction was observed for all the traits except fruit weight. Pant T-5 and ARTH-3 were found to be only desirable stable genotypes for fruit yield per plant. They can be used as parents in hybridization programme or could be suggested for planting under varying type of environments as specified in the present investigation.

Key Words : Solanum lycopersicum; Genotype; Environment; Stability.

INTRODUCTION

The major objective of any plant breeding and selection programme is to develop genotypes, which could perform consistently superior in many variables environment . Phenotypically suitable genotypes are usually sought after for the commercial production of crop plants. However, one of the main constraints to the fulfillment of this objective is the genotype-environment interactions (GXE interaction) which make it difficult to correctly identify genotypes that could exhibit stable performance over different environments and are widely adapted so that these may be commercially grown in larger area. Therefore, one of the significant steps in identifying stable genotypes is to subject the population of potential genotypes to multi – environments testing and thereby to generate basic information with respect to likely magnitude of GXE interactions. Such a breeding objective requires the basic information on the nature and extent of GXE interaction in respect of yield and its component characters.

It was, therefore, felt necessary to study the stability behavior of newly developed tomato varieties/ hybrids (referred as genotypes in this investigation) and their performance under varying plant bio-regulator regimes.

MATERIALS AND METHODS

The present investigation was conducted during summer season , at the VRC, patharchatta, Govind Ballabh Pant University of agriculture and technology, pantnagar. The experimental material comprised of 25 promising determinate and indeterminate tomato genotypes including varieties and hybrids obtained from diverse sources and being maintained at V.R.C of the university. The experiment was conducted in Randomized Block Design with three replications under four created environments as given below during summer season.

E1 = Napthalene Acetic Acid (NAA) 50 ppm
E2 = Gibberellic acid + Parachlorophenoxy Acetic Acid combine 50 ppm each (GA + PCPA)
E3 = 2,4- DIchlorophenoxy acetic acid (2,4-D) 5ppm
E4 = Control (No growth regulator)

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Each plot consisted of four rows, having 5 plants in each row. The seedlings were planted at a spacing of 60cm row to row and 60cm plant to plant. First row subjected to E_1 environment, second row to E_2 environment, third row to E_3 environment and fourth row to E_4 environment. First plants per row were used to record observations on plant height, number of primary branches per plant, days to 50% fruit set , Fruit weight (g), number of fruits per plant and fruit yield per plant. Data was analysed statistically as per technique proposed by Eberhart and Russell (1969) to estimate the stability parameters and G x E interactions with respect to different characters.

RESULT AND DISCUSSION

The pooled analysis of variance for different characters is presented in table 1. The mean squares due to genotype were significant for all the characters viz. plant height, number of primary branches per plant, days to 50% fruit set, fruit weight (g), number of fruits per plant and fruit yield per plant (g). The significant variation due to environments was noticed for all the characters except plant height. The presence of environmental variability is a pre requisite to any useful regression response analysis (Pfahler and linskens, 1979). Among the four environments, comprising different growth regulators, the environment GA + PCPA (combined) 50 ppm each (E_2) was found to be significantly superior to other environments for all the traits. Significant mean squares due to G x E interaction was observed for all the traits except fruit weight (g) indicating differential response of the genotypes to four different growth regulators. This suggested that tomato genotypes must be evaluated over different growth regulators regimes to obtain the precise estimates for different traits. The linear component of GxE interaction was significant for days to 50% fruit set, fruit weight and number of fruits per plant denoting significant differences among regression coefficients pertaining to various genotypes on the environmental indices.

The non linear response of genotypes as measured from linear regression were significant for most of the charactetrs except fruit weight (g). These results suggested that Eberhart and Russell"s model (1966) could be used to identify stable genotypes.

Finally, it is usually considered necessary to identify genotypes performing consistently good under high, medium and low yielding environments. For getting such information so vital to the breeding programmes Eberhart and Russell (1966) suggested that an ideally adaptable genotypes would be one having high mean value, unit regression coefficients (bi = 1.0) and a deviation from regression as small as possible ($S^2di = 0$). Based on the Eberhart and Russell"s model (1966), the genotypes could be catego rized as suitable for favourable, moderately favourable and unfavourable environment (control) for the character fruit yield / plant in our study. It was found that, the genotypes BSS-40, BSS-99, ARTH- 128 and Arka Vikas had bi values less than unity, so that these were considered suitable for unfavourable environments i.e E_4 (control) while BSS-20, SC-3, Krishna, Avinash and ARTH- 164 had bi values greater than one considered suitable for favourable environments that GA+PCPA 50 ppm each (E_2).

Table 1 : Pooled analysis of variance for different characters in tomato (Eberhart and Russell, 1966)

Source of variation	D.f.	Plant height (cm)	No. of primary branches / plant	No. of days to 50% fruit set	Average fruit weight (g)	No. of fruits / plant	Fruit yield /plant (g)
Genotypes	24	835.51**	5.30**	63.87**	88.36**	145.04**	127133.0**
Environment	3	163.61 ns	3.32**	128.45**	361.47**	439.06**	10383.67**
G X E	72	106.34**	2.00**	4.36**	11.69 ns	18.37**	23063.10**
Environment (G X E)	75	108.63	0.80	9.32	25.68	35.20	63674.50
Environment (Linear)	1	490.73*	9.97**	385.37**	1084.42**	1317.20**	31150.44**
G X E (linear)	24	117.39 ns	0.47 ns	6.14*	9.30 ns	37.45**	54612.59**
Pooled Deviation	50	96.79**	0.77**	3.32**	12.38**	8.48**	6997.10**
Pooled Error	200	9.63	0.37	0.30	3.04	3.18	2134.75

*, ** Significance at 5% and 1% level

Pant T -5 and ARTH-3 exhibiting significantly higher means than the general mean (X_i) having regression coefficient close to one and S^2di values approaching zero indicated that they fulfilled the criteria of desirable and stable genotypes as per the requirements of Eberhart and Russell's (1966).

The information about stability and contribution of different characters of interest will be useful in selecting parents for hybridization. Hybridization may be initiated to generate wide spectrum of variability so that breeder can manipulate the material. At the same time, the promising genotype can be evaluated in larger plots and recommended for release.

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