Pak. J. Bot., 40(2): 627-635, 2008.

PATH COEFFICIENT ANALYSIS OF YIELD COMPONENT IN TOMATO (*LYCOPERSICON ESCULENTUM*)

HIDAYATULLAH*, SHAKEEL AHMAD JATOI, ABDUL GHAFOOR AND TARIQ MAHMOOD

National Agricultural Research Center, Islamabad, Pakistan.

Abstract

Thirty six tomato genotypes, including cultivar, were evaluated at National Agricultural Research Centre, Islamabad, during summer, 2002 and 2003 to estimate the nature and magnitude of genetic variability based on days to first harvest, number of pickings, plant height, number of fruit plant^{-1}, fruit weight plant^{-1}, fruit size, single fruit weight, number of locules, pericarp thickness, TSS, fruit pH, seeds fruit^{-1} and 1000 seed weight. A wide range of variation was observed among the characters studied which have a great interest for tomato breeders. Heritability for (broad sense) ranged from 51.8 to 99.8 % in 2002 and from 86.0 to 99.9 % in 2003. Single fruit weight gave the highest heritability during 2002, however, it was at maximum for days to first harvest during 2003. Fruit weight plant^{-1}showed high and positive genotypic and phenotypic correlation with number of picking and with number of fruits plant^{-1}, thus indicating that these traits were the most important yield components. On the basis of performance and keeping in view the selection criteria observed in the present study, 14 genotypes were identified for future testing under wide range of environments.

Introduction

Tomato (2n=24) belonging the family Solanaceae is an important vegetable crop of the world with a yield potential of up to 42.1 t/ha (Yamaguchi, 1983). It is grown all over Pakistan in different seasons according to their environments with main crop during spring season, whereas the autumn crop is being planted in the Soan Valley (Punjab) and Durgai (NWFP) where it yields from November till middle of December (Chaudhary *et al.,* 1995). Its cultivated area is 38,959 hectares and production is 4, 12,786 tones with per unit area yield 10.6 t ha^{-1} that is less than half of its potential yield (Anon., 2004; Ashraf & Ahmad, 2001).

Systematic study and evaluation of tomato germplasm is of great importance for current and future agronomic and genetic improvement of the crop. Furthermore, if an improvement programme is to be carried out, evaluation of germplasm is imperative, in order to understand the genetic background and the breeding value of the available germplasm (Agong *et al.,* 2000). Singh *et al.,* (2002) observed high genetic variation for plant height, number of days to fruit set, number of fruit clusters plant^{-1}, number of fruits plant^{-1}, fruit weight plant^{-1}and fruit yield plant^{-1}. Yield being a complex trait, it is difficult to exploit various yield contributing characters through the knowledge of correlation, therefore it is important to carry out other analysis including path coefficient that provides a clear indication for selection criterion (Mc Giffens *et al.,* 1994). The coefficients generated by path analysis measure the direct and the indirect influence of a variable upon another (Dewey & Lu, 1959). Present study was conducted to evaluate tomato germplasm received from various sources both exotic and local.

*E-mail: hidayatu_2003@yahoo.co.uk

Materials and Methods

The experimental material comprised of 36 genotypes including one check (Roma) and out of these 28 were exotic i.e., from North Korea (11), India (5), Bangladesh (3), Sri Lanka (2), Japan (1), Italy (1) and AVRDC, Taiwan (5). Seven genotypes were local, one each obtained from Punjab (Nagina) and Baluchistan (Sariab Long), whereas other 5 were collected from different parts of the country. Seeds were sown on third week of January and transplanting under field conditions at NARC (longitude 73° 08 east and latitude 33° 42 north with an altitude of 510 meters above sea level) during third week of March both the years in Randomized Complete Block Design with three replications. Two rows of 3 meter for each genotype were planted with 75 cm inter row spacing, whereas plant distance were kept at 50 cm. All cultural practices were done according to the need of plant (Choudhury & Shahid, 2000). Data on days to first harvest, plant height, number and weight of fruits plant^{-1}, single fruit weight, fruit size and other fruit characteristics (TSS, pH, pericarp thickness, number of locules) and total yield were recorded from all the plants at approximately similar physiological maturity (bright red ripe).

Variance and covariance analyses were carried out along with phenotypic, genotypic and environmental correlations with the help of computer software following the techniques described by Singh & Chaudhry (1979). Heritability was estimated as a ratio between genotypic and phenotypic variability. Path analysis was also carried out to determine the relationship among the yield components (Dewey & Lu, 1959).

Results and Discussion

Analysis of variance for yield and its components presented in the Table 1 revealed significant differences among genotypes for all the characters during both the years. Similar observations have been reported by Shravan *et al.,* (2004) on 14 characters in tomato. Singh & Raj (2004) and Barman *et al.,* (1995) also had similar findings that **t**he genotypes showed significant differences for all the traits. The effect of year for various characters (days to first harvest, number of pickings, number of fruits plant^{-1}, fruit weight plant^{-1} and fruit size) indicated the influence of environmental changes over the years that was expected under field conditions in a crop like tomato. These differences were mainly attributed towards climatic data during two years (Table 2). Similarly genotypes-years interaction was significant for most of the characters which revealed that the evaluation experiments under field condition should be conducted over the years or locations to minimize errors (Goncalves *et al.,* 2003).

Mean data, range, genotypic and phenotypic coefficient of variation and heritability revealed high range for most of traits studied (Table 3). High heritability for days to first harvest, number of fruits plant^{-1}, single fruit weight and number of locules indicated less influence of environments within specific year that could be exploited through simple selection from this material to improve yield as suggested by Mohanty, (2003). Low to medium heritability for TSS and seeds fruit^{-1} suggested a careful selection from the material for enhancing the genetic portion of variation that can also be attained through addition of superior Germplasm (Johnson *et al.,* 1955).

Table 1. Analysis of variance for yield and its components of 36 genotypes of tomato (*Lycopersicon esculentum*).

Characters	Years	Replication – year	Genotypes	Genotype – years	Error
Days to First harvest	23541.8**	250.6	116.6**	65.7**	0.1
No. of Pickings	394.7**	4.5	5.1**	3.7**	0.4
Plant height	232.3 NS	249.7	4608.0**	36.9 NS	38.7
Fruits per plant	3458.4**	22.6	1633.3**	149.2**	23.3
Fruit weight/ plant	1.3*	0.1	0.3**	0.03**	0.02
Fruit length	278.8*	29.1	799.9**	0.5NS	20.2
Fruit diameter	263.8*	22.5	715.7**	0.4 NS	18.5
Single fruit weight	62.6 NS	193.9	3028.7**	103.2**	5.02
No. of locules	0.2 NS	0.4	8.8**	0.1**	0.03
Pericarp thickness	0.03 NS	1.4	11.9**	0.1 NS	0.2
TSS	1.5 NS	1.4	1.9**	0.3**	0.1
PH	6.0 NS	1.6	11.6**	0.5*	0.3
Seeds/ fruit	48.7 NS	279.6	3691.5**	33.5 NS	131.2
1000 seed weight	0.6 NS	0.4	0.8**	0.02 NS	0.02

*****Significant at 1% level
**Significant at 5% level

The genotypic and phenotypic correlations among all the characters are presented in Table 4 and 5. In most of the cases genotypic and phenotypic correlation coefficients were of the same directions but the former were slightly higher in magnitude indicating low influence of environments that enhanced the acceptance of these findings (Shravan *et al.,* 2004; Nakawuka & Adipala, 1999). Out of total 91 combinations for correlation, 73 showed similarity during both years for genotypic association, whereas 79 combinations were similar for phenotypic correlations. Although year effects were observed for most of the characters for basic statistics but about two third combinations for correlation were of same magnitude over the years that enhanced the acceptance of the results. Due to high similarity in results for correlation at both genotypic and phenotypic levels, we discussed only genotypic correlations onward. Days to first harvest showed negative correlation with number of pickings that could be exploited for developing determinate cultivars which are not available at present, although these types of cultivars are more acceptable by growers. Number of pickings had positive correlation with fruit weight plant^{-1}and 1000 seed weight. Number of fruits plant^{-1} showed positive association with fruit weight plant^{-1} and seeds fruit^{-1}. Similar results were reported by Joshi *et al.,* (1998), Moya *et al.,* (1996), Singh *et al.,* (1997) and Das *et al.,* (1998). Number of fruits plant^{-1} had negative correlation with fruit size, single fruit weight as already mentioned by Mohanty (2002), whereas in our findings in addition it was also negative with number of locules and pericarp thickness. Fruit length had positive correlation with fruit diameter, single fruit weight, pericarp thickness and 1000 seed weight, whereas negative with seed fruit^{-1}.

Because of significant association of fruit weight plant^{-1} with other characters, genotypic correlations were partitioned into direct and indirect effects (Table 6). All the characters exhibited direct effect on fruit weight plant^{-1}, however, based on two years results, it was concluded that fruit diameter that exhibited the highest direct effect could be the selection criteria for improving fruit yield plant^{-1}, whereas other important characters (plant height, fruit length, single fruit weight, TSS and seeds per fruit) those exhibited negative direct effect are suggested to be exploited through high indirect effects. The undesirable negative association as of fruit length with other yield contributing traits could be broken through selective diallel mating or mutation to broaden the genetic base for selection to improve fruit yield (Arshad *et al*., 2005).

Overall 14 genotypes showed more fruit yield plant^{-1} as compared to control (Table 7). Maximum fruit yield plant^{-1} was recorded from 10584 acquired from North korea, through PGRP gene bank. Maximum number of fruits plant^{-1} was recorded in a variety Pant Bahar from India. However due to smaller fruit size of variety Pant Bahar it was at no.4 in fruit yield plant^{-1}. Pericarp thickness and average fruit weight were highest in Avinash-2 as compared to control. All the selected genotypes exhibited higher fruit yield along with other desirable traits, hence these are suggested to test under potential areas for identification of best cultivar for general cultivation.

Table 2. Monthly mean maximum/minimum air temperatures during crop growth period.

Months	Maximum (°C)		Minimum (°C)	
	2002	2003	2002	2003
March	26.9	23.0	9.5	9.6
April	32.6	30.9	15.1	14.2
May	39.1	35.0	19.7	16.8
June	38.4	38.8	23.2	22.2

Table 3. Genetic parameters for various quantitative characteristics in tomato grown at NARC during 2002-03.

Character	Year	Mean	Range	GCV	PCV	h^2 (BS)
Days to first harvest	2002	120.31 ± 0.215	114-128	3.84	3.85	99.4
	2003	141.19 ± 0.112	131-160	4.44	4.45	99.9
Number of pickings	2002	6.15 ± 0.403	3.33-7.67	16.69	20.19	68.4
	2003	3.44 ± 0.291	2-6	37.35	40.11	86.7
Plant height	2002	74.58 ± 5.013	42.33-134.33	37.15	38.93	91.1
	2003	72.51 ± 0.818	34-132	37.89	37.94	99.7
Number of fruits/plant	2002	24.97 ± 3.92	4.8-88.5	80.41	84.88	89.7
	2003	16.97 ± 0.384	1.8-45.1	78.07	78.17	99.7
Fruit weight/plant	2002	0.67 ± 0.072	0.14-1.41	37.95	42.24	80.7
	2003	0.52 ± 0.015	0.09-0.98	49.03	49.29	99.0
Fruit length	2002	45.22 ± 2.528	23.03-67.1	24.27	26.13	86.3
	2003	47.49 ± 2.654	24.17-70.47	24.27	26.13	86.3
Fruit diameter	2002	43.94 ± 2.423	23.17-65.3	23.61	25.47	85.9
	2003	46.15 ± 2.542	24.33-68.57	23.61	25.46	86.0
Single fruit weight	2002	41.26 ± 0.706	5.3-87.7	59.23	59.3	99.8
	2003	42.62 ± 0.614	7.7-88.3	50.04	50.11	99.8
Number of locules	2002	2.99 ± 0.14	2.0-6.2	40.07	40.88	96.1
	2003	3.05 ± 0.039	2.0-6.3	39.78	39.84	99.7
Pericarp thickness	2002	4.42 ± 0.399	2.33-7.13	31.04	34.76	79.8
	2003	4.44 ± 0.044	2.4-7.2	31.51	31.55	99.7
TSS	2002	5.23 ± 0.304	4.37-6.63	10.43	14.49	51.8
	2003	5.40 ± 0.026	4.1-6.5	10.53	10.56	99.4
Fruit Ph	2002	4.63 ± 0.439	2.1-9.73	29.85	34.07	76.8
	2003	4.97 ± 0.046	2.5-9.8	27.80	27.84	99.7
Seeds/fruit	2002	43.77 ± 9.227	2.23-108.37	53.65	64.90	68.3
	2003	43.00 ± 0.721	2.3-112.4	57.86	57.93	99.7
1000 seed weight	2002	2.14 ± 0.112	1.46-3.07	16.29	18.65	76.3
	2003	2.04 ± 0.013	1.11- 2.94	18.65	18.68	99.6

h^2 (BS) = heritability for broad sense

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(Received for publication 5 August 2006)