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Correlation and path analysis for yield and quality traits in tomato (*Solanum lycopersicum* L.)

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Abstract

Forty two genotypes of tomato including four check cultivar (GT-2, GT-6, JT-3, Pusa Ruby) were planted in Randomized Block Design, during *rabi*, 2018 and were assessed to study correlation and path analysis for yield and quality traits in tomato. Genotypic correlation coefficients were generally similar in nature and higher in magnitude than the corresponding phenotypic correlation coefficients. Fruit yield per plant had exhibited highly significant and positive association with fruit length and shelf life of fruits while significant and positive correlation showed by fruit girth and fruit borer damage. Plant height, no. of branches per plant and no. of locules per fruit showed negative and significant association with yield per plant. Path analysis revealed that highest positive direct effects on fruit yield per plant was exhibited by fruit length, no. of fruits per plant, shelf life of fruits and fruit borer damage.

Keywords: Correlation coefficient, path analysis, yields components

Introduction

Tomato (*Solanum lycopersicum* L., $2n=24$) is a member of solanaceae family, grown throughout the year in all over the world. It has wider adaptability, high yielding potential and multipurpose uses in fresh as well as processed food industries. It is an important source of vitamin A, vitamin C and minerals. Tomato stands unique among vegetables because of its high nutritive value, medicinal values and other myriad uses. The nutraceutical effect of tomato is attributed to 'Lycopene', a major carotenoid present in tomatoes. Keeping in view the nutritional importance of this crop, there is a need for breeding programmes in order to develop cultivars with high quality of fruit as well as yield. The success of a systematic breeding programme depends mainly on judicious selection of promising parents from the gene pool. Selection is the essential facet for most of the breeding programmes and new population is developed from the selected material. The direct selection for fruit yield is not sufficiently effective, as yield is polygenetically controlled and associated with number of related traits. Therefore, indirect selection is desirable for improvement of yield. However, correlation alone does not provide information on the direct and indirect contribution of component characters, which necessitates the study of cause and effect relationship of different characters among themselves. Therefore, the path coefficient analysis developed by Wright, depicts the exact relationship of characters. Thus, germplasm evaluation studies would help in identification of genetic material for improvement in crop plants. Therefore, present investigation was carried out considering 42 genotypes with respect to quality and important yield related traits.

Materials and Methods

The present experiment was conducted at NMCA college farm, Navsari Agricultural University, Navsari, during *Rabi* 2018-19. The soil of the experimental plot was black cotton soil with pH 7.4. Navsari is situated at $72^{\circ} 54'$ East longitude and $20^{\circ} 57'$ North latitude and at an altitude of 11.89 m above the mean sea level. This region falls under "South Gujarat Heavy Rainfall Zone, AES -III". The climate of this zone is typically tropical and monsoonic. The average rainfall of the zone is about 1500 mm and is normally received by second fortnight of June and ceases by September end. Winter starts from November and ends by the middle of February. The experimental materials comprised of 42 genotypes of tomato (NTL-7, NTL-10, NTL-19, NTL-22, NTL-24, NTL-25, NTL-26, NTL-28, NTL-31, NTL-38, NTL-41, NTL-45,

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NTL-50, NTL-52, NTL-57, NTL-58, NTL-63, NTL-64, NTL-65, NTL-66, NTL-68, NTL-71, NTL-72, NTL-73, NTL-77, NTL-81, NTL-84, NTL-85, NTL-87, NTL-89, NTL-91, NTL-96, NTL-99, NTL-105, NTL-17, NTL-21, NTL-48, NTL-53, GT-2, GT-6, JT-3, Pusa Ruby) collected from different indigenous and exotic sources. The experiment was laid out in Randomized Block Design at a spacing of 90 cm × 45 cm in the plots with 3 replications. The standard agronomic practices were followed to maintain healthy crop stand. Except days to 50 % flowering, fruit borer damage, tomato leaf curl virus damage, all other characters *viz.*, plant height, branches per plant, no. of fruits per plant, fruit length, fruit girth, no. of locules per plant, shelf life of fruits, average fruit weight and fruit yield per plant observations were recorded on five randomly selected plants per plot excluding border plants. The data were analyzed as per methods suggested for correlation coefficient [1] and for path coefficient analysis [2].

Results and Discussion

The knowledge of nature and magnitude of association between yield and its component traits is necessary for effective selection in advance generations. Correlations between pairs of characters are either due to linkage of genes or due to pleiotropic gene action. In the present study correlations between twelve characters were worked out in all possible combinations at phenotypic and genotypic levels which are presented in Table 1. In general, the magnitudes of genotypic correlation coefficients were higher than the corresponding values of the phenotypic correlation coefficients. This indicates the presence of an inherent relationship between the variables. The present study also suggested that both genotypic and phenotypic correlations were similar in direction. Fruit yield per plant had recorded highly significant and positive correlation exhibited by fruit length and shelf life of fruits, while significant and positive correlation showed by fruit girth and fruit borer damage. This character showed non significant and positive correlation with days to 50 per cent flowering, average fruit weight and tomato leaf curl virus incidence. This character showed non significant but negative correlation with number of fruits per plant. It showed highly significant and negative correlation with plant height and number of branches per plant, while significant and negative correlation with number of locules per fruit. Days to 50 per cent flowering showed highly

significant and positive genotypic correlation for number of fruits per plant. Plant height showed highly significant and positive correlation for number of branches per plant, number of fruits per plant and tomato leaf curl damage. Number of branches per plant showed highly significant and positive correlation with number of fruits per plant. Fruit length exhibited highly significant and positive correlation with average fruit weight, fruit girth, shelf life of tomato, number of locules per fruit, fruit borer damage and fruit yield per plant. Fruit girth exhibited highly significant and positive correlation with shelf life of fruits, average fruit weight and fruit borer damage. Number of locules per fruit showed highly significant and positive correlation with shelf life of fruits, average fruit weight and fruit borer damage. Shelf life of fruit showed highly significant and positive correlation with fruit yield per plant, average fruit weight, fruit borer damage and tomato leaf curl virus incidence. Average fruit weight exhibited highly significant and positive correlation with fruit borer damage. These results are in accordance with the findings of [3-11].

Path coefficient analysis is a tool to partition the observed correlation coefficient of yield components on yield into direct and indirect effects to provide clearer picture of character associations for formulating effective selection strategy. Path-coefficient analysis at genotypic level was carried out for twelve selected traits by keeping yield as dependent variable. The genotypic path-coefficient analysis for different component characters is presented in Table 2. Analysis revealed that highest positive direct effects on fruit yield per plant was exhibited by fruit length, no. of fruits per plant, shelf life of fruits and fruit borer damage. It would be rewarding to lay stress on traits like fruit length and no. of fruits per plant in selection programmes for increasing the yield because they showed positive and significant association with fruit yield per plant. Path-coefficient analysis resulted that the direct effect on fruit yield per plant was positive for all the traits except average fruit weight, no. of locules per fruit, fruit girth, branches per plant, days to 50% flowering, plant height and tomato leaf curl virus incidence. Highest direct effect was shown by fruit length on fruit yield per plant followed by no. of fruits per plant. These results are in accordance with the findings of [9, 10, 12-17].

Table 1: Genotypic (r_g) and phenotypic (r_p) correlation coefficients among twelve characters in tomato

Characters		Days to 50 % flowering	Plant height (cm)	Branches per plant	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	No. of locules per fruit	Shelf life of fruits (days)	Average fruit weight (g)	Fruit borer damage (%)	Tomato leaf curl virus incidence (%)
Days to 50 per cent flowering	r_g	1.000										
	r_p	1.000										
Plant height (cm)	r_g	0.153 ^{NS}	1.000									
	r_p	0.140	1.000									
Branches per plant	r_g	-0.025 ^{NS}	0.567 ^{**}	1.000								
	r_p	-0.005	0.356	1.000								
No. of fruits per plant	r_g	0.364 ^{**}	0.713 ^{**}	0.541 ^{**}	1.000							
	r_p	0.261 ^{**}	0.662	0.384	1.000							
Fruit length (cm)	r_g	-0.112 ^{NS}	-0.564 ^{**}	-0.648 ^{**}	-0.762 ^{**}	1.000						
	r_p	-0.118	-0.479	-0.484	-0.682	1.000						
Fruit girth (cm)	r_g	-0.221 [*]	-0.656 ^{**}	-0.613 ^{**}	-0.789 ^{**}	0.756 ^{**}	1.000					
	r_p	-0.157	-0.582	-0.431	-0.707	0.712	1.000					
No. of locules per fruit	r_g	0.064 ^{NS}	-0.307 ^{**}	-0.504 ^{**}	-0.347 ^{**}	0.689 ^{**}	0.169 ^{NS}	1.000				
	r_p	-0.021	-0.249	-0.272	-0.287	0.593	0.157	1.000				
Shelf life of fruits (days)	r_g	-0.128 ^{NS}	-0.202 [*]	-0.465 ^{**}	-0.532 ^{**}	0.716 ^{**}	0.651 ^{**}	0.270 ^{**}	1.000			
	r_p	-0.107	-0.152	-0.326	-0.459	0.596	0.549	0.187	1.000			

Average fruit weight (g)	r_g	-0.123 ^{NS}	-0.451 ^{**}	-0.570 ^{**}	-0.671 ^{**}	0.966 ^{**}	0.782 ^{**}	0.569 ^{**}	0.771 ^{**}	1.000		
	r_p	-0.119	-0.402	-0.402	-0.579	0.922	0.747	0.494	0.600	1.000		
Fruit borer damage (%)	r_g	-0.271 ^{**}	-0.513 ^{**}	-0.521 ^{**}	-0.642 ^{**}	0.681 ^{**}	0.690 ^{**}	0.299 ^{**}	0.499 ^{**}	0.691 ^{**}	1.000	
	r_p	-0.195	-0.364	-0.311	-0.521	0.561	0.559	0.201	0.424	0.544	1.000	
Tomato leaf curl virus incidence (%)	r_g	-0.088 ^{NS}	0.230 ^{**}	0.205 [*]	0.146 ^{NS}	-0.206 [*]	-0.120 ^{NS}	-0.361 ^{**}	0.172 ^{NS}	-0.137 ^{NS}	-0.145 ^{NS}	1.000
	r_p	-0.104	0.146	0.170	0.123	-0.124	-0.066	-0.238	0.133	-0.047	-0.150	1.000
Fruit yield per plant (kg)	r_g	0.153 ^{NS}	-0.450 ^{**}	-0.753 ^{**}	-0.080 ^{NS}	0.243 ^{**}	0.202 [*]	-0.199 [*]	0.320 ^{**}	0.156 ^{NS}	0.223 [*]	0.075 ^{NS}
	r_p	-0.073	-0.139	-0.212	-0.023	0.079	0.066	0.007	0.110	0.068	0.149	-0.007

*, ** Significant at 5 % and 1% levels, respectively.

Table 2: Direct and indirect effects of eleven causal variables on fruit yield per plant in tomato

Character	Days to 50 % flowering	Plant height (cm)	Branches per plant	No. of fruits per plant	Fruit length (cm)	Fruit girth (cm)	No. of locules per fruit	Shelf life of fruits (days)	Average fruit weight (g)	Fruit borer damage (%)	Tomato leaf curl virus incidence (%)
Days to 50 % flowering	-0.522	-0.080	0.013	-0.190	0.059	0.116	-0.033	0.067	0.064	0.142	0.046
Plant height (cm)	-0.054	-0.350	-0.199	-0.250	0.198	0.230	0.107	0.071	0.158	0.180	-0.081
Branches per plant	0.034	-0.773	-1.363	-0.738	0.883	0.836	0.687	0.633	0.777	0.709	-0.279
No. of fruits per plant	1.063	2.081	1.579	2.917	-2.223	-2.302	-1.011	-1.553	-1.958	-1.874	0.425
Fruit length (cm)	-1.387	-6.982	-8.022	-9.436	12.381	9.357	8.530	8.868	11.957	8.434	-2.552
Fruit girth (cm)	0.422	1.251	1.170	1.505	-1.442	-1.908	-0.322	-1.242	-1.492	-1.317	0.228
No. of locules per fruit	-0.272	1.310	2.156	1.481	-2.944	-0.721	-4.273	-1.156	-2.430	-1.279	1.543
Shelf life of fruits (days)	-0.011	-0.017	-0.039	-0.045	0.060	0.055	0.023	0.084	0.065	0.042	0.015
Average fruit weight (g)	0.861	3.164	4.000	4.711	-6.777	-5.490	-3.991	-5.414	-7.018	-4.850	0.960
Fruit borer damage (%)	-0.001	-0.001	-0.001	-0.001	0.002	0.002	0.001	0.001	0.002	0.002	-0.0003
Tomato leaf curl virus incidence (%)	0.020	-0.053	-0.047	-0.034	0.048	0.028	0.083	-0.040	0.032	0.034	-0.231
Correlation Coefficient with Fruit yield plant-1 (kg)	0.153 ^{NS}	-0.450 ^{**}	-0.753 ^{**}	-0.080 ^{NS}	0.243 ^{**}	0.202 [*]	-0.199 [*]	0.320 ^{**}	0.156 ^{NS}	0.223 [*]	0.075

Bold values indicate the direct effect of different characters on fruit yield per plant. * and ** indicate significance at 5 % and 1 %, respectively.

Conclusion

Insight in to the magnitude and adequate knowledge about and degree and the direction of association of yield with its attributing characters is of great significance to the breeders as yield is a complex trait, for which inter relationship studies among various characters is necessary. From the above results, it emerged that fruit length is the most important component character followed by no. of fruits per plant, shelf life of tomato and fruit borer damage. Thus, in selection programmes, more emphasis should be given on these characters.

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