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Correlation and Path Analysis Studies for Yield and its Attributes in Tomato

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A B S T R A C T

Thirty five diverse genotypes of tomato were evaluated for correlation and path analysis at Departmental Research Farm of Vegetable Science, UHF, Solan, HP during *kharif* season, 2016. The experiment was laid out in RCBD with three replications. A highly positive and significant correlation of fruit yield per plant with days to marketable maturity, plant height, fruits per cluster, average fruit weight, pericarp thickness and harvest duration was observed, however it showed negative and significant correlation with total soluble solids. Maximum positive direct effect towards fruit yield per plant was exerted by average fruit weight followed by days to 50 % flowering, number of fruits per cluster and harvest duration.

Introduction

Tomato is an important vegetable crop grown throughout the world. It is grown in tropical, subtropical and mild cold climatic regions of the world. Tomato is grown for its edible fruit, which is consumed either fresh or cooked and in the form of various processed products like juice, ketch up, sauce, puree, chutney, pickles and soup etc. Tomato being a nutritional crop, is considered as an important source of vitamin A, C and minerals like calcium, phosphorus and magnesium etc. In India, tomato is cultivated in different states like Uttar Pradesh, Karnataka, Himachal Pradesh, Maharashtra, Haryana, Punjab and Bihar. In Himachal Pradesh, tomato is grown during summer and rainy seasons, as the climatic conditions are congenial for optimum plant growth and yield. Tomato is most remunerative cash crop of the low and mid hills of Himachal Pradesh. This vegetable has been under improvement through breeding for desired traits such as faster growth, uniform maturity with higher yields, early maturing varieties, biotic and abiotic stresses. Large number of genotypes should be studied to identify the promising ones. Correlation studies are of great significance as, if significant correlation values are established between yield and other economic traits, improvement could be made through selective

plant breeding technique. Path analysis provides important information regarding direct and indirect effects of the characters contributing towards the yield of the plants.

Materials and Methods

The study was conducted at the experimental farm of the Department of Vegetable Science, UHF, Solan, Himachal Pradesh in Kharif, 2016. Experimental material comprised of thirty five genotypes. The seed sowing of all the genotypes was carried out in February, 2016 on the raised nursery beds. The experimental material was planted in a randomized complete block design with three replications in plot size of 1.8 m × 1.8 m. Twelve plants of each genotype were transplanted in each replication at spacing of 90 cm × 30 cm on 6th April, 2016. Practices recommended in the Package of Practices of Vegetable Crops were followed for growing a healthy crop (Anonymous, 2013). The characters studied during the present study were days to 50 % flowering, days to maturity, plant height, fruits per cluster, fruits per plant, fruit weight, fruit yield per plant and per hectare, fruit shape index, pericarp thickness, number of locules per fruit, total soluble solids, ascorbic acid, and harvest duration. Correlation studies were undertaken as per Al-Jibouri *et al.,* (1958) and path analysis as per Dewey and Lu (1959).

Results and Discussion

Genotypic correlation coefficients among thirteen characters (Table 1) depicted that fruit yield per plant had positive and significant association with days to marketable maturity (0.430), plant height (0.215), number of fruits per cluster (0.200), average fruit weight (0.655), pericarp thickness (0.608) and harvest duration (0.360). However, it showed significant negative correlation with total soluble solids (-0.441). Positive and significant association of fruit yield per plant with days to marketable maturity, average fruit weight, pericarp thickness and harvest duration has been reported by Khan and Samadia (2012) and Kingsley (2015). Positive and significant association of average fruit weight and pericarp thickness with fruit yield per plant was also observed by Mahapatra *et al.,* (2013) and Kumar (2014). Prashant *et al.,* (2008) noted positive and significant correlation of yield per plant with fruits per cluster and Joshi *et al.,* (2004) with harvest duration. Significant and positive correlation of number of marketable fruits per plant, plant height, average fruit weight with marketable yield per plant has been reported by Sharma *et al.,* (2019). Kumar *et al.,* (2020) observed significant and positive association of average fruit weight and number of fruits per cluster with fruit yield per plant. Jogi *et al.,* (2018) revealed significant and positive association of pericarp thickness and average fruit weight with fruit yield per plant. Significant and positive correlation of average fruit weight with yield per plant has been observed by Singh *et al.,* (2018). Negative and significant association of total soluble solids with fruit yield per plant, was in accordance with the findings of Aysh *et al.,* (2012) and Sharma *et al.,* (2019).

Days to 50% flowering exhibited positive and significant association with number of locules per fruit (0.268) and harvest duration (0.256) and had negative and significant association with number of fruits per cluster (-0.757), number of fruits per plant (-0.667), fruit shape index (-0.242), total soluble solids (-0.199) and ascorbic acid (-0.217). Positive and significant association of days to 50% flowering with number of locules per fruit and harvest duration and negative and significant correlation with number of fruits per cluster was in accordance with Kumar (2014), whereas, negative and significant correlation

of total soluble solids with days to 50% flowering was observed by Khan and Samadia (2012). Days to marketable maturity was positively and significantly correlated with average fruit weight (0.576), pericarp thickness (0.496) and ascorbic acid (0.240), while negatively and significantly with fruits per cluster (-0.225), fruits per plant (-0.315) and total soluble solids (-0.594). Kumar (2014) also reported positive and significant correlation of days to marketable maturity with average fruit weight, pericarp thickness and ascorbic acid.

Plant height exhibited positive and significant association with number of fruits per plant (0.287), total soluble solids (0.234) and harvest duration (0.832), while negative and significant association with average fruit weight (-0.235) and ascorbic acid (-0.312). Kumar (2010), Rai (2015), Joshi *et al.*, (2004) and Khan and Samadia (2012) also observed positive and significant association of plant height with harvest duration. Fruits per cluster had positive and significant association with fruits per plant (0.919) and fruit shape index (0.216) and had significant and negative association with fruit weight (-0.258), pericarp thickness (-0.254) and locules per fruit (-0.286). Positive and significant association of fruits per cluster with fruits per plant was in accordance with Kumar (2014), Kumari and Sharma (2013), Rai (2015) and Kumar *et al.*, (2020) and significant and negative correlation with fruit weight and locules per fruit was noted by Rai (2015).

Fruits per plant were positively and significantly correlated with total soluble solids (0.367) and negatively and significantly correlated with average fruit weight (-0.450), pericarp thickness (-0.362) and locules per fruit (-0.282). Negative and significant association of fruits per plant with average fruit weight and pericarp thickness has been reported by Joshi *et al.*, (2004), Manna and Paul (2012), Kumar (2014) and Rai (2015). Average fruit weight showed positive and significant association with pericarp thickness (0.778), while negative and significant correlation with total soluble solids (-0.734). Buckseth (2010), Rai (2015), Joshi *et al.*, (2004) and Sharma *et al.*, (2010) also proposed significant and positive association of average fruit weight with pericarp thickness. Singh *et al.*, (2018) also observed significant and positive association of average fruit weight with pericarp thickness and significant and negative association with total soluble solids. Fruit shape index showed negative and significant correlation with number of locules per fruit (-0.262) and total soluble solids (-0.205) which was in accordance with the findings of Kumar (2014). Pericarp thickness exhibited negative and significant correlation with total soluble solids (-0.631). Ascorbic acid had negative and significant correlation with harvest duration (-0.242). The nature of phenotypic correlation was similar to genotypic correlation. But in some cases, the magnitude of phenotypic correlation was considerably lower and was statistically non significant while they were found significant at genotypic level.

Path coefficient analysis method was devised by Dewey and Lu (1959) which helps in partitioning the correlation coefficient under direct and indirect effects which permit a critical examination of the relative importance of each trait. In order to understand such effects of different independent characters or in combination with other characters on yield, the estimates of direct and indirect effects were computed through path coefficient analysis in the present investigation. Perusal of data from table 2 indicated that maximum positive direct effect towards fruit yield per plant was contributed by average fruit weight (0.877), followed by days to 50 % flowering (0.619), number of fruits per cluster (0.611) and harvest duration (0.559).

Table.1 Genotypic and Phenotypic coefficients of correlation among different traits in tomato

Characters		Days to marketable maturity	Plant height (cm)	Numbers of fruits per cluster	Numbers of fruits per plant	Average fruit weight (g)	Fruit Shape Index	Pericarp thickness (mm)	Number of locules per fruit	Total soluble solids (^{0}B)	Ascorbic acid (mg/100 g)	Harvest duration	Fruit yield/plant (kg)
Days to 50% erings	G	-0.043	0.191	-0.757**	-0.667**	0.077	-0.242*	0.017	0.268**	-0.199*	-0.217*	0.256**	-0.141
	P	0.126	0.214*	-0.670**	-0.586**	0.100	-0.114	0.063	0.302**	-0.132	-0.155	0.303**	-0.103
Days to ketable maturity	G		-0.169	-0.225*	-0.315**	0.576**	0.029	0.496**	-0.071	-0.594**	0.240*	-0.094	0.430**
	P		-0.113	-0.179	-0.258**	0.554**	0.131	0.498**	-0.004	-0.485**	0.263**	-0.010	0.418**
Plant height)	G			0.057	0.287**	-0.235*	-0.053	-0.131	-0.057	0.234*	-0.312**	0.832**	0.215*
	P			0.063	0.291**	-0.226*	-0.025	-0.118	-0.042	0.243*	-0.297**	0.832**	0.220*
Numbers of ts per cluster	G				0.919**	-0.258**	0.216*	-0.254**	-0.286**	0.165	0.025	-0.136	0.200*
	P				0.919**	-0.252**	0.225*	-0.245*	-0.273**	0.172	0.032	-0.122	0.203*
Numbers of ts per plant	G					-0.450**	0.127	-0.362**	-0.282**	0.367**	-0.039	0.097	0.154
	P					-0.443**	0.140	-0.351**	-0.268**	0.372**	-0.031	0.107	0.157
Average fruit ght (g)	G						0.001	0.778**	0.128	-0.734**	0.134	-0.088	0.655**
	P						0.020	0.779**	0.137	-0.717**	0.141	-0.073	0.657**
Fruit shape ex	G							0.140	-0.262**	-0.205*	0.134	-0.057	0.071
	P							0.165	-0.213*	-0.164	0.157	-0.008	0.085
Pericarp kness (mm)	G								0.092	-0.631**	0.167	0.070	0.608**
	P								0.109	-0.606**	0.178	0.090	0.610**
Number of les per fruit	G									-0.114	0.057	-0.076	-0.132
	P									-0.093	0.073	-0.047	-0.120
Total soluble ds (^{0}B)	G										-0.243*	0.129	-0.441**
	P										-0.226*	0.149	-0.429**
Ascorbic acid /100 g)	G											-0.242*	0.031
	P											-0.217*	0.038
Harvest duration (days)	G												0.360**
	P												0.365**

*Significant at 5% level of significance
**Significant at 1% level of significance

Table.2 Estimates of direct and indirect effects of different traits on yield in tomato

Characters	Days to 50% flowerings	Days to marketable maturity	Plant height (cm)	Numbers of fruits per cluster	Numbers of fruits per plant	Average fruit weight (g)	Fruit Shape index	Pericarp thickness (mm)	Number of locules per fruit	Total soluble solids (^{0}B)	Ascorbic acid (mg/100 g)	Harvest duration (days)	GCCFY PP
Days to 50% flowerings	0.619	-0.015	-0.061	-0.462	-0.308	0.067	-0.020	0.004	-0.001	-0.091	-0.012	0.143	-0.141
Days to marketable maturity	-0.026	0.370	0.054	-0.137	-0.145	0.505	0.002	0.120	0.0004	-0.274	0.013	-0.052	0.430
Plant height (cm)	0.118	-0.062	-0.320	0.034	0.132	-0.206	-0.004	-0.031	0.0003	0.107	-0.018	0.465	0.215
Numbers of fruits per cluster	-0.468	-0.083	-0.018	0.611	0.424	-0.226	0.018	-0.061	0.001	0.076	0.001	-0.075	0.200
Numbers of fruits per plant	-0.413	-0.116	-0.091	0.561	0.462	-0.395	0.010	-0.087	0.001	0.169	-0.002	0.054	0.154
Average fruit weight (g)	0.047	0.213	0.075	-0.157	-0.208	0.877	0.0001	0.188	-0.0008	-0.339	0.007	-0.049	0.655
Fruit shape index	-0.149	0.010	0.016	0.132	0.058	0.001	0.083	0.034	0.001	-0.094	0.007	-0.031	0.071
Pericarp thickness (mm)	0.010	0.183	0.042	-0.155	-0.167	0.682	0.011	0.242	-0.0006	-0.291	0.009	0.039	0.608
Number of locules per fruit	0.166	-0.026	0.018	-0.174	-0.130	0.112	-0.022	0.022	-0.006	-0.052	0.003	-0.042	-0.132
Total soluble solids (^{0}B)	-0.123	-0.220	-0.075	0.100	0.169	-0.644	-0.017	-0.152	0.0007	0.461	-0.014	0.072	-0.441
Ascorbic acid (mg/100 g)	-0.134	0.089	0.100	0.015	-0.018	0.118	0.011	0.040	-0.0004	-0.112	0.057	-0.135	0.031
Harvest duration (days)	0.158	-0.034	-0.266	-0.082	0.045	-0.077	-0.004	0.017	0.0004	0.059	-0.013	0.559	0.360

At genotypic level, the residual effect was recorded to be 0.07

The other characters which showed positive direct effect were number of fruits per plant (0.462), total soluble solids (0.461), days to marketable maturity (0.370), pericarp thickness (0.242), fruit shape index (0.083) and ascorbic acid (0.057). Plant height (-0.320) and number of locules per fruit (-0.006) had negative direct effect on fruit yield per plant. Days to marketable maturity (0.213) and pericarp thickness (0.188) recorded maximum positive indirect effect via average fruit weight on fruit yield. Harvest duration (0.143) exerted maximum positive indirect effect via days to 50 % flowering. Number of fruits per plant (0.424) exerted maximum positive indirect effect via number of fruits per cluster and days to 50 % flowering (0.158) recorded maximum positive indirect effect via harvest duration. At genotypic level, the residual effect was recorded to be 0.07. Golani *et al.,* (2007), Ramana *et al.,* (2007), Tiwari and Uphadhyay (2011), Sharma and Singh (2012), Kumar *et al.,* (2013), Srivastava *et al.,* (2013), Meena & Bahadur (2015) and Prajapati *et al.,* (2015) reported highest positive direct effect of average fruit weight on fruit yield per plant. Srivastava *et al.,* (2013) and Meena and Bahadur (2015) noted positive direct effect of days to 50% flowering. Harer *et al.,* (2002) and Kumar *et al.,* (2003) also observed high positive direct effect of average fruit weight and fruits per cluster on yield per plant. Sharma *et. al.* (2019) observed positive direct effect of fruit weight, fruit shape index, number of locules and days to 50 % flowering. Singh *et al.,* (2020) observed positive direct effect of number of fruits per cluster and pericarp thickness. Ara *et al.,* (2009) proposed positive direct effect of harvest duration. Kumar (2010), Manna and Paul (2012), Kumar *et al.,* (2013), Reddy *et al.,* (2013), Khapte and Jansirani (2014), Premalakshmi *et al.,* (2014) and Menna and Bahadur (2015) also noted positive direct effect of number of fruits per plant. Harer *et al.,* (2002), Makesh *et al.,* (2006) and Ramana *et al.,* (2007) observed positive direct effect of total soluble solids. Positive direct effect of days to marketable maturity was noted by Prajapati *et al.,* (2015). Positive direct effect of pericarp thickness has been proposed by Manna and Paul (2012) and Kumar (2014). Ara *et al.,* (2009) and Saleem *et al.,* (2013) reported negative and direct effect of number of locules per fruit. Jogi *et al.,* (2018) and Singh *et al.,* (2018) revealed positive direct effect of number of fruits per plant and average fruit weight.

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