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Genetic Association and path coefficient analysis among yield and yield related traits in Tomato (*Solanum lycopersicon* MILL.)

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Abstract

The proposed research study was conducted at the experimental field of Department of Horticultural Research and Development, National Agricultural Research Centre, Islamabad. The aim of this study was ˈ ˈGenetic association and path coefficients analysis among yield and yield related traits in Tomato (*Solanumlycopersicon* MILL)ˈ.Total eight parents and 15 F_1s were evaluated in proposed experiment. Correlation analysis showed that plant height, number of branches plant^{-1}, number of clusters plant^{-1}, number of flowers cluster^{-1}, number of fruits cluster^{-1}, single fruit weight and fruits setting percentage cluster^{-1}exhibited significant correlation with yield plant^{-1} at genotypic level and highly significant at phenotypic level and these traits could be used as selection criteria for improvement of yield plant^{-1}.Path analysis revealed that plant height, number of branches plant^{-1}, number of clusters plant^{-1}, number of flowers cluster^{-1}, single fruit weight and fruits setting percentage cluster^{-1} were directly contributing to yield improvement.

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Introduction

Tomato (*Solanumlycopersicon* MILL.) is most important vegetable crop and belongs to the family Solanaceae and it has a chromosome number of (2n=24). Its Centre of origin is country South Mexico. It is ranked on second number after potato in world. Tomato is consumed regularly and it mixed with other cooking products like potato, bringel and cabbage. This crop is grown on about fifty two thousand hectares (52.30) area with estimated annual production of about 10.10 tons/hectare (Ramzan *et al.,* 2014). In Pakistan yearly production of tomato crop reaches to 0.3 million tons (MFAL, 2015).Pakistan lack enough tomato seed for local cultivation and therefore imported 85.5 metric tons of quality seed amounting to US$ 2.45 million during the year 2013-2014 to full fill the space (MNFSR, 2015). Total production of tomato in world during 2015 was 166 million tons produced on 4.7 million hectares (FAO, 2015).

Genetic association studies provide significant facts for hereditary breeding since they aid to detect and define the percentage of phenotypic association that is linked with hereditary causes to authenticate whether the selection of one parameter effects another character to increase indirect gain due to the selection on associated traits, and also to find out the complexity of the traits (Tiwari and Upadhyay, 2011). If two traitsare genetically linked than it is conceivable to achievegain in any of them through secondary selection of the other character.

Phenotypic and genotypic path coefficient analysis revealed the direct and indirect impact of one trait on another trait and allows the partitioning of link coefficients into components of straight and secondary effects as described by (Prashanth *et al.*, 2008). Many yield components having their influence on yield of tomato have been recognized. These components of yield are, number of clusters plant^{-1}, fruit weight and fruits setting percentage cluster^{-1}(Rashidi *et al.*, 2009) and (Monamodi *et al.*, 2013).The aim of current study was to worked out genetic relationship among yield as well as direct and indirect influence of yield related traits on yield in tomato.

Materials and methods

The proposed research study was conducted at the experimental field of Department of Horticultural Research and Development,NARC, Islamabad during 2016. The aim of study was Genetic Association and Path Coefficient Analysis among Yield and Yield Related Traits in Tomato.

Experimental Design

The experimental design used was Randomized Complete Block Design with three replications. Size of plot was 1.25cm x 4cm (L x W).For Experimental material the seed of parents and F_1s was placed in incubator for one week at 30˚C. After one week the germinated seed was sown in trays. These trays were placed in tunnels so that required temperature can be provided. Plant to and row to row distance was (50 cm, 75cm). Five plants sample was used to collect data. Eight parents and their 15 F_1s crosses were used in experiment.

Parameters Studied

Data was recorded for following yield and yield related traits. plant height (cm), days to flowering (50%), days to fruit maturity (50%), number of locules fruit-1, number of branches plant-1 , number of clusters plant-1, number of flowers cluster-1, number of fruits cluster-1, single fruit weight (g) ,fruit setting percentage cluster1 and yield plant-1 (kg).

Statistical analysis

Phenotypic and genotypic correlation coefficients of variation were estimated using the formulae of (Johanson *et al.*,1955). The path analysis was calculated according to method of (Dewey and Lu, 1959).

Results and discussion

Correlation coefficient analysis in tomato

In current study for most of parameters genotypic correlation coefficients were found to be higher in magnitude than corresponding phenotypic correlation coefficients. Different yield components showed significant correlation at genotypic level and highly significant positive correlation at genotypic level *viz*, plant height (0.727*, 0.717**), number of branches plant^{-1}, (0.540*,0.534**), number of clusters plant^{-1} (0.335*,0.330**), number of flowers cluster^{-1} (0.724*, 0.720**), number of fruits cluster^{-1} (0.717*,0.711**), single fruit weight (0.678*,0.673**) and fruits setting percentage cluster^{-1} (0.451*,0.433**) respectively.

Table 1. List of genotypes used in study.

Parents	Hybrids	Hybrids
17905	Nagina x 17905	Riogrande x BSX-935
Riogrande	Nagina x BS-X935	Riogrande x Continental
Pakit	Nagina x Continental	Pakit x 17905
BSX-935	Roma x 17905	Pakit x BSX-935
Roma	Roma x BSX-935	Pakit x Continental
VCT-01	Roma x Continental	VCT-01 x 17905
Continental	Riogrande x 17905	VCT-01 x BSX-935
Nagina	Nagina x 17905	

These characters offered much scope for selection towards yield improvement and could be given due importance for further breeding program. Days to 50% flowering (0.403*, 0.401**) showed negative significant correlation with yield at genotypic level and highly significant negative correlation at phenotypic showed greater influence of environment where as days to 50% fruits maturity (-0.007,-0.006) and number of locules fruit^{-1} (-0.031,-0.033) showed non-significant negative correlation with yield because they are not important yield. Days to 50% flowering and days to 50% fruits maturity indicated earliness in genotypes which is desire able for early supply of product in market.

Table 2. Estimates of genotypic and phenotypic correlation coefficients among yield and yield related traits in 23 tomato genotypes.

		PH	DF	NB	NC	NF	NFC	DM	SFW	NL	FSP	YP
PH	G	1.00	-0.622*	0.360*	0.356*	0.799*	0.810*	-0.149*	0.512*	-0.037	0.630*	0.727*
	P		-0.608**	0.352**	0.349**	0.793**	0.799**	-0.146	0.507**	-0.034	0.591**	0.717**
DF	G		1.00	-0.331*	-0.127*	-0.417*	-0.366*	0.123*	-0.119*	0.120	-0.146*	-0.403*
	P			0.331**	-0.118	-0.411**	-0.361**	0.123	-0.116	0.116	-0.137	-0.401**
NB	G			1.00	0.158	0.460*	0.437*	-0.091	0.468*	-0.087	0.168*	0.540*
	P				0.154	0.456**	0.427**	-0.087	0.465**	-0.088	0.147	0.534**
NC	G				1.00	0.421*	0.360*	-0.150*	0.108*	0.253*	0.159*	0.335*
	P					0.416**	0.351**	-0.149	0.106	0.242*	0.142	0.330**
NFC	G					1.00	0.976	0.023	0.721	-0.014	0.649	0.724*
	P						0.967**	0.024	0.719**	-0.015	0.610**	0.720**
NFRC	G						1.00	-0.004	0.764*	0.021	0.796*	0.717*
	P							-0.002	0.757**	0.018	0.784**	0.711**
DM	G							1.00	0.167*	-0.083	-0.068*	-0.007
	P								0.166	-0.081	-0.053	-0.006
SFW	G							1.00	1.00	-0.105*	0.605*	0.678*
	P									-0.101	0.572**	0.673**
NL	G									1.00	0.181*	-0.031
	P										0.164	-0.033
FSP	G										1.00	0.451*
	P											0.433**

PH= Plant height (cm), DF= Days to 50% flowering, NB= Number of branches plant^{-1}, NC= Number of clusters plant^{-1}, NF= Number of flowers cluster^{-1}, NFR= Number of fruits cluster^{-1}, DM= Days to 50% fruits maturity, SFW= Single fruit weight (g), NL= Number of locules fruit^{-1}, FSP= Fruits setting percentage cluster^{-1}, YP=Yield plant^{-1} (kg).Highly significant ($p \le 0.1$**), significant ($p \le 0.5$*).

Numbers of locules fruit^{-1} are important for fruits processing. Number of flowers had highly significant correlation with number of fruits cluster^{-1} (0.976, 0966**) and single fruit weight (0.721,0.721**) at phenotypic level and positive non-significant at genotypic level indicated stronger environmental influence than genotypic factors. Significant positive correlation of number of fruits cluster^{-1} at genotypic level and highly significant at phenotypic level was (0.764*, 0.757**) and observed with (0.796*, 0.784**) which showed weak influence of genetic factors on expression of these traits than environmental factors. Single fruit weight had significant positive association with percent fruit set (0.605*, 0.572**) at genotypic level and highly significant correlation at phenotypic level. These associations indicated that due to positive correlation between these important yield components yield could be significantly improved through targeted selection upon these yield components.

Table 3. Direct and indirect effects of yield related traits on yield plant^{-1} (kg) in 23 tomato genotypes.

	PH	DF	NB	NC	NFC	NFRC	DM	SFW	NL	FSP	Gen.cor
PH	0.654	-0.058	0.102	0.005	2.672	-3.563	0.003	0.301	-0.001	0.611	0.727*
DF	-0.407	0.094	-0.095	-0.002	-1.393	1.611	-0.002	-0.069	0.003	-0.142	-0.403*
NB	0.235	-0.031	0.283	0.002	1.536	-1.924	0.001	0.275	-0.002	0.163	0.540*
NC	0.232	-0.012	0.044	0.016	1.408	-1.585	0.003	0.063	0.008	0.154	0.335*
NFC	0.523	-0.039	0.130	0.006	3.340	-4.291	-0.0005	0.424	-0.0004	0.630	0.723*
NFRC	0.530	-0.034	0.124	0.005	3.262	-4.394	0.0001	0.449	0.0006	0.772	0.717*
DM	-0.098	0.011	-0.026	-0.002	0.078	0.020	-0.021	0.098	-0.002	-0.066	-0.007*
SFW	0.335	-0.011	0.132	0.001	2.409	-3.359	-0.003	0.588	-0.003	0.587	0.678*
NLF	-0.024	0.011	-0.024	0.004	0.049	-0.094	0.001	-0.061	0.031	0.175	-0.031
FSP	0.412	-0.013	0.047	0.002	2.169	-3.500	0.001	0.356	0.005	0.970	0.451*

PH = Plant height (cm), DF=Days to 50% flowering, NB=Number of branches plant^{-1}, NC=Number of clusters plant^{-1}, NFC = Number of flowers cluster^{-1}, NFRC =Number of fruits cluster^{-1}, DM= Days to 50% fruits maturity, SFW=Single fruit weight (g), NL= Number of locules fruit^{-1},= FSP = Fruits setting percentage cluster^{-1}, YP= Yield plant^{-1} (kg). Highly significant (p≤0.1**), significant (p≤0.5*).

Results were strongly supported by earlier researchers *viz*, (Sivaprasad *et al.*, 2008) for plant height,(Islam *et al.*, 2010)for number of flowers cluster^{-1},(Moya *et al.*, 1996) for number of fruits cluster^{-1}, (Prasad and Rai, 1999) and (Mohanthy *et al.*, 2002)for single fruit weight and (Gogogi and Ghotum, 2003) for fruits setting percentage cluster^{-1} etc.

Path coefficient analysis in tomato

Highly positive direct effect on yield plant^{-1} was contributed by plant height (0.654), number of flowers cluster^{-1} (3.340), single fruit weight (0.588) and fruits setting percentage cluster^{-1} (0.970) which indicated scope of selection on these traits for yield improvement. Days to 50% flowering (0.094), number of branches plant^{-1} (0.283), number of cluster plant^{-1} (0.016) and number of locules fruit^{-1} (0.031) showed positive indirect effect on yield which showed medium scope of selection for improvement. Negative direct effect on yield was exerted by days to 50% fruits maturity. Number of flowers cluster^{-1} exhibited high positive indirect effect on yield via, plant height (0.523) and fruits setting percentage cluster^{-1} (0.630) while it had high negative indirect effect via number of fruits cluster^{-1} (-4.291). Number of flowers cluster^{-1} had positive direct effect on yield via, number of branches plant^{-1} (0.130),number of cluster plant^{-1} (0.006) and single fruit weight (0.424) respectively. High direct indirect effect on yield was contributed by number of fruits cluster^{-1} via, plant height (0.530), number of flowers cluster^{-1} (3.262) and fruits setting percentage cluster^{-1} (0.772) which showed that by improving these characters yield could be indirectly improved through selection. Number of fruits cluster^{-1} contributed highly negative indirect effect on yield which indicated the strong environmental influence. Number of fruits cluster^{-1} contributed indirect positive effect on yield via, number of branches plant^{-1} (0.124), number of cluster plant^{-1} (0.005), days to 50% fruits maturity (0.0001), single fruit weight (0.449) and number of locules fruit^{-1} (0.0006) which showed that number of fruits cluster^{-1} coupled with these traits could be selected for yield improvement. Single fruit weight along with number of flowers cluster^{-1} (2.409) and fruits setting percentage cluster^{-1} (0.587) contributed indirect high positive effect on yield while high negative indirect effect via number of fruits cluster^{-1} (-3.359). Positive indirect effect on yield was shown by single fruit weight via, plant height (0.335), number of branches plant^{-1} (0.132) and number of cluster plant^{-1} (0.001) which indicated little scope of selection for yield improvement with these traits. Percent fruit set cluster^{-1} had high positive direct effect on yield plant^{-1} with number of flowers cluster^{-1} (2.169) while positive indirect effect via, plant height (0.412), number of branches plant^{-1}, (0.047) number of cluster plant^{-1} (0.002), days to 50% fruits maturity (0.001), single fruit weight (0.356) and number of locules fruit^{-1} (0.005) hence suggested smaller scope of indirect selection with these traits. Percent fruit set cluster^{-1} showed indirect high negative effect on yield plant^{-1} via number of fruits cluster^{-1} (-3.500) presented zero significance of selection. Some earlier scientists reported results on same pattern viz, (Asati *et al.*, 2008) for plant height, (Rani *et al.*,2008) for number of flowers cluster^{-1}, (Singh *et al.*,1989) and (Mohanty, 2003) for single fruit weight and (Meena and Bahadur,2015) for percent fruits sett cluster^{-1}.

These researchers reported high positive direct effect of these yield components on yield plant^{-1}.

Conclusion

Plant height, number of branches plant^{-1}, number of cluster plant^{-1}, number of flowers cluster^{-1}, number of fruits cluster^{-1}, single fruit weight and fruits setting percentage cluster^{-1} were strongly favored by environmental factors as they showed highly significant correlation with yield plant^{-1} at phenotypic levels and significant correlation at genotypic level. Results of path analysis showed that plant height, number of flowers cluster^{-1}, single fruit weight and % fruit set cluster^{-1} directly contributing to yield enhancement due to their high positive direct effect on yield plant^{-1}

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