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TRAIT ASSOCIATION STUDIES FOR YIELD COMPONENTS IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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Abstract- Correlations and path coefficient were studied in 38 tomato (*Solanum lycopersicum* L.) genotypes for thirteen yield-contributing characters. The correlation coefficients were determined to find out the inter relationship among the characters studied. Yield plant^{-1} was found highly significant and positively with average fruit weight, fruits plant^{-1}, locule number fruit^{-1}, pericarp thickness, fruits cluster^{-1} and number of clusters plant^{-1}. Strong association of these traits revealed that the selection based on these traits would ultimately improve the fruit yield. In order to obtain a clear picture of the inter relationship between yield plant^{-1} and its components, direct and indirect effects were measured using path coefficient analysis. Analysis revealed that a highest positive direct effect on fruit yield plant^{-1} was exhibited by average fruit weight followed by fruits plant^{-1}, clusters plant^{-1}, fruits cluster^{-1} and pericarp thickness. It would be rewarding to lay stress on traits like average fruit weight and fruits plant^{-1} in selection programmes for increasing the yield because they showed positive and significant association with fruit yield plant^{-1} in both the analyses of correlation and path-coefficient. Residual effect was low which indicated that characters included in this study explained almost all variability towards yield.

Keywords- Correlation coefficient, path analysis, yields components.

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Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops in India. During 2012-2013 the total area and production of tomato in India was recorded 880'000 ha and 18227'000 MT respectively [1]. It was approximately 9.56 and 11.23 per cent of total vegetable area and production respectively. 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 neutraceutical 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. According to Comstock and Robinson [2], selection is the essential facet of 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 [3]. 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 [4], depicts the exact relationship of characters. Thus, germplasm evaluation studies would help in the identification of genetic material for improvement in crop plants. Therefore, present investigation was carried out considering 38 genotypes [Table-1] with respect to quality and important yield related traits.

Materials andMethods

The present investigation was carried out during *rabi* season of 2012-2013 at Vegetable Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (UP), India. The experimental material consist of 38 genotypes/cultivars (both exotic lines and indigenous lines) of tomato received from various sources, including Indian Institute of Vegetable Research, Varanasi and National Bureau of Plant Genetic Resources, New Delhi, at Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University. The experiment was laid out in randomized block design with three replications. Nursery was planted in second week of August and about 4 week old seedlings were transplanted during second week of September with row-to-row x plant-to-plant spacing maintained at 60 cm x 45 cm. Each plot consisted of 10 plants and represented a single entry in each replication. Standard agronomic practices were followed to ensure a good crop stand. Observations on days to first flowering and 50% fruiting were taken on plot basis. Five plants (excluding border plants) were randomly selected for recording of data on various yield traits such as days to first flowering (DFF), days to 50% flowering (D50Fl), primary branches (PB), secondary branches (SB), plant height (PH), clusters plant^{-1} (Cl/P), fruits cluster^{-1} (Fr/Cl), fruits plant^{-1} (Fr/P), pericarp thickness (PT), locule number (LN), equatorial diameter (ED), polar diameter (PD), average fruit weight (AFW), fruit yield plant^{-1} (FY/P) and their average values were used for the statistical analysis. Correlation analysis (both genotypic and phenotypic) and path coefficient analysis was done using Windostat ® ver. 8.5 software for statistical data analysis.

Results and Discussion

The phenotypic correlations along with the contributions due to genetic and environmental causes to the phenotypic correlation among the 14 traits under investigation have been presented in [Table-2]. The knowledge of the nature and magnitude of interrelationships among yield and its components is necessary for the simultaneous improvement of the characters and yield improvement. The information on correlation is quite useful in estimating the correlated response to selection and simultaneous improvement of several traits at a time. A positive and significant association of fruit yield per plant was found with average fruit weight, fruits plant^{-1}, locule number fruit^{-1}, equatorial diameter, pericarp thickness, fruits cluster^{-1}, number of clusters plant^{-1} and polar diameter. Singh et al. [5] also found strong positive correlation for number of fruits plant^{-1} and number of fruits cluster^{-1} with yield, which supports the present findings. Significant and positive correlation for yield plant^{-1} with fruits plant^{-1} and fruit weight was also reported by various scientists [6&7]. As observed in the present investigation, Golani et al. [8] also observed a significant positive correlation between yield and locule number fruit^{-1}. Mohanty [9&10] also reported significant positive correlation of yield with fruits plant^{-1} supporting present findings. In contrast to the present observation, a significant and negative correlation of fruit yield plant^{-1} with average fruit weight was reported by Mohanty [10]. In accordance to the present findings, a significant positive correlation between yield and average fruit weight was found by Joshi et al. [11] whereas, they observed a significant negative correlation for average fruit weight with number of fruits plant^{-1} and number of fruits cluster^{-1}, which was contrasting to the present observations. Al-Aysh et al. [12] also reported a significant positive interrelationship between yield and average fruit weight. A positive and significant association between fruits cluster^{-1} and fruit yield plant^{-1} was also observed by Tasisa et al. [13] which was in line with the present findings. A direct positive effects and highly significant positive correlation among fruits plant^{-1} and average fruit weight were also observed in studies of numerous researchers [14, 9, 10, 11, 15, 16, 17, 12, 7 and 18]. Golani et al. [8] reported average fruit weight that had highest positive direct effect supporting the results of present findings.

Table-1 *List of the genotypes / cultivars used in the experiment*

Sl. No.	Genotypes / Cultivars	Source	Sl. No.	Genotypes / Cultivars	Source
1.	Pusa Sadabahar	IARI, New Delhi	20.	Columbia	IIVR, Varanasi
2.	DVRT-1-2	IIVR, Varanasi	21.	Cholnak - k	IIVR, Varanasi
3.	H-88-7-4	IIVR, Varanasi	22.	T Local	IIVR, Varanasi
4.	Floradale	IIVR, Varanasi	23.	EC - 521069	NBPGR, New Delhi
5.	DT-2	IIVR, Varanasi	24.	EC-521086	NBPGR, New Delhi
6.	H-24	IIVR, Varanasi	25.	EC-521087	NBPGR, New Delhi
7.	NDT- 3	NDUAT, Faizabad	26.	EC-528374	NBPGR, New Delhi
8.	VR - 20	IIVR, Varanasi	27.	EC-531803	NBPGR, New Delhi
9.	HT - 4	IIVR, Varanasi	28.	B-S-18-7	IIVR, Varanasi
10.	Swarna Lalima	IIVR, Varanasi	29.	B-S-2-5	IIVR, Varanasi
11.	TLC - 1	IIVR, Varanasi	30.	B-S-31-3	IIVR, Varanasi
12.	GT-20	IIVR, Varanasi	31.	B-S-24-2	IIVR, Varanasi
13.	FLA - 7171	IIVR, Varanasi	32.	EC-520061	IIVR, Varanasi
14.	NDTVR - 60	NDUAT, Faizabad	33.	EC -538434	IIVR, Varanasi
15.	Flawery	IIVR, Varanasi	34.	EC -538440	IIVR, Varanasi
16.	Feb - 04	IIVR, Varanasi	35.	EC -538405	IIVR, Varanasi
17.	BT - 120	IIVR, Varanasi	36.	EC -539450	IIVR, Varanasi
18.	NF - 315	IIVR, Varanasi	37.	EC -538156	IIVR, Varanasi
19.	PS - 1	IIVR, Varanasi	38.	EC -538155	IIVR, Varanasi

Strong association of these traits revealed that the selection based on these traits would ultimately improve the fruit yield and it is also suggested that hybridization of genotypes possessing combination of above characters is most useful for obtaining desirable high yielding varieties. From the present investigation it can be concluded that fruit yield in tomato is mainly governed by fruits plant^{-1}, average fruit weight and clusters plant^{-1}. The various component of yield do not contribute to increased yield in simple additive and straight fashion. An understanding of the interdependence will be useful in evolving efficient selection and breeding strategies for minimizing the negative effects and for maximizing the synergistic effects. The interaction becomes complex with the increase of components.

The simple correlation alone, however, is not a true reflection of the nature of association of the different traits with each other when other characters are held constant. Due to mutual relationship among different characters, which may be positive or negative, these associations become more complex and do not lead to any meaningful interpretations. The path-coefficient analysis is a powerful method in analyzing the scheme of causal relationship in the development of various traits. The correlations are partitioned into direct and indirect effects to know the precise direct and indirect cause of associations. The use of path-coefficient probes into cause and effect relationships among the variables. Path-coefficient analysis at phenotypic level was carried out for 13 selected traits, with yield as dependent variable. The phenotypic path-coefficient analysis for different component characters is presented in [Table-3]. Analysis revealed that highest positive direct effects on fruit yield plant^{-1} was exhibited by average fruit weight followed by fruits plant^{-1}, clusters plant^{-1}, fruits cluster^{-1} and pericarp thickness. It would be rewarding to lay stress on traits like average fruit weight and fruits plant^{-1} in selection programmes for increasing the yield because they showed positive and significant association with fruit yield plant^{-1} in both the analyses of correlation and path-coefficient. Path-coefficient analysis resulted that the direct effect on fruit yield plant^{-1} was positive for all the traits except days to first flowering, primary branches plant^{-1}, plant height and pericarp thickness. Highest direct effect was shown by average fruit weight on fruit yield plant^{-1} followed by fruits plant^{-1}, number of secondary branches and clusters plant^{-1}. The direct effect of days to first flowering was lowest and negative too. Researches of numerous scientists also observed a direct positive effect and highly significant positive correlation among fruits plant^{-1} and average fruit weight [14, 9, 10, 11, 15, 16, 17, 12, 7, 19 and 18]. Golani et al. [8] reported average fruit weight had highest positive direct effect supporting the results of present findings. Tasisa et al. [13] reported positive direct effect exerted by days to first flowering and plant height, which was not in

Table-2 *Estimation of phenotypic correlation coefficient between yield and it's related in 38 tomato genotypes*

Trait	D50Fr	PB	SB	PH	Cl/ P	Fr/ Cl	Fr/ P	PT	LN	ED	PD	AFW	FY/ P
DFF	0.883**	-0.521**	-0.464**	-0.198	-0.221	0.177	-0.059	0.200	-0.410**	-0.301*	0.214	-0.202	-0.171
D50Fr		-0.444**	-0.407**	-0.181	-0.146	0.189	0.007	0.056	-0.393**	-0.361*	0.100	-0.322*	-0.224
PB			0.620**	0.249	0.362*	-0.102	0.247	-0.074	0.232	0.042	-0.232	0.112	0.185
SB				0.239	0.275*	-0.023	0.216	-0.146	0.379**	0.074	-0.348*	0.020	0.147
PH					0.309*	0.190	0.412**	-0.019	0.063	-0.024	-0.029	0.082	0.249
Cl/ P						-0.264	0.683**	0.119	0.078	0.016	0.060	0.037	0.354*
Fr/ Cl							0.504**	0.030	-0.048	-0.144	0.181	0.146	0.384**
Fr/ P								0.167	0.030	-0.079	0.214	0.167	0.626**
PT									0.043	0.399**	0.558**	0.443**	0.387**
LN										0.565**	-0.098	0.512**	0.416**
ED											0.383**	0.622**	0.395**
PD												0.342*	0.327*
AFW													0.833**

Significant at p<0.05, **Significant at p<0.01, ***Significant at p<0.001

Table-3 *Direct and indirect (phenotypic) effects of 13 component traits on yield per plant in tomato genotypes*

Traits	DFF	D50Fr	PB	SB	PH	Cl/ P	Fr/ Cl	Fr/ P	PT	LN	ED	PD	AFW	Correlation coefficient with FY/ P
DFF	-0.0145	-0.0128	0.0076	0.0067	0.0029	0.0032	-0.0026	0.0009	-0.0029	0.0060	0.0044	-0.0031	0.0029	-0.171
D50Fr	0.0174	0.0197	-0.0088	-0.0080	-0.0036	-0.0029	0.0037	0.0001	0.0011	-0.0078	-0.0071	0.0020	-0.0063	-0.224
PB	0.0332	0.0283	-0.0638	-0.0396	-0.0158	-0.0231	0.0065	-0.0158	0.0047	-0.0148	-0.0026	0.0148	-0.0071	0.185
SB	-0.0273	-0.0240	0.0365	0.0589	0.0140	0.0162	-0.0014	0.0127	-0.0086	0.0223	0.0043	-0.0205	0.0011	0.147
PH	0.0051	0.0047	-0.0064	-0.0062	-0.0258	-0.0080	-0.0049	-0.0106	0.0005	-0.0016	0.0006	0.0007	-0.0021	0.249
Cl/P	-0.0075	-0.0050	0.0123	0.0094	0.0105	0.0341	-0.0090	0.0233	0.0040	0.0026	0.0005	0.0020	0.0013	0.354*
Fr/Cl	0.0065	0.0069	-0.0037	-0.0008	0.0070	-0.0097	0.0368	0.0185	0.0011	-0.0018	-0.0053	0.0066	0.0054	0.384**
Fr/P	-0.0271	0.0030	0.1144	0.1000	0.1905	0.3163	0.2333	0.4632	0.0772	0.0136	-0.0363	0.0987	0.0773	0.626**
PT	-0.0022	-0.0006	0.0008	0.0016	0.0002	-0.0013	-0.0003	-0.0018	-0.0108	-0.0005	-0.0043	-0.0060	-0.0048	0.387**
LN	-0.0094	-0.0090	0.0053	0.0086	0.0014	0.0018	-0.0011	0.0007	0.0010	0.0228	0.0129	-0.0022	0.0117	0.416**
ED	0.0187	0.0224	-0.0026	-0.0046	0.0015	-0.0010	0.0089	0.0049	-0.0248	-0.0350	-0.0621	-0.0238	-0.0386	0.395**
PD	-0.0032	-0.0015	0.0035	0.0052	0.0004	-0.0009	-0.0027	-0.0032	-0.0084	0.0015	-0.0058	-0.0150	-0.0051	0.327*
AFW	-0.1606	-0.2560	0.0890	0.0152	0.0649	0.0292	0.1163	0.1329	0.3529	0.4078	0.4948	0.2720	0.7966	0.833**

agreement with present findings.

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 average fruit weight, is the most important component character followed by fruits plant^{-1}. Other important component character is, clusters plant^{-1} and number of secondary branches. Thus in selection programmes, more emphasis should be given on the above mentioned characters.

Conflict of Interest: None declared

References

[1] Anonymous (2014) *Handbook on Horticultural Statistics, Government of India*.
[2] Comstock R. E. and Robinson H. F. (1952) *Heterosis, Ames., Lowa, Lowa State College Press*, 494-516.
[3] Mahapatra S. A., Singh A. K., Vani V. M., Mishra R., Kumar H. and Rajkumar B. V. (2013) *Int. J. Curr. Microbiol. App. Sci.*, 2(9), 147-152.
[4] Wright S. (1921) *J. Agric. Res.*, 20, 557-585.
[5] Singh D. N., Sahu A. and Parida A. K. (1997) *Environ. Ecol.*, 15(1), 117-121.
[6] Das B., Hazarika M. H. and Das P. K. (1998) *Ann. Agric. Res.*, 19(1), 77-80.
[7] Manna, M. and Paul, A. (2012) *Horti Flora Res. Spectrum*, 1(2), 110-116.
[8] Golani I. J., Mehta D. R., Purohit V. L., Pandya H. M. and Kanzariya, M. V. (2007) *Indian J. Agric. Res.*, 41(2), 146-149.
[9] Mohanty, B. K. (2002) *Ann. Agric. Res.*, 2(1), 65-69.
[10] Mohanty, B. K. (2002) *Haryana J. Horti. Sci.*, 31, 230-233.
[11] Joshi A., Vikram A. and Thakur M. C. (2004) *Progr. Hort.*, 36(1), 51-58.
[12] Al-Aysh F., Kutma H., Serhan M., Al-Zoubai A. and Al-Naseer M. A. (2012) *New York Sci. J.*, 5(10), 142-145.
[13] Tasisa J., Belew D. and Bantte, K. (2012) *Int. J. Genet. Pl. Breeding*, 6(3), 129-139.
[14] Vikram A. and Kohli U. K. (1998) *J. Hill Sci.*, 11(1), 107-111.
[15] Asati B. S., Rai N. and Singh A. K. (2008) *Asian J. Hort.*, 3(2), 222-225.
[16] Ara A., Narayan R., Ahmed N. and Khan S. H. (2009) *Indian J. Hort.*, 66(1), 73-78.
[17] Ghosh K. P., Islam A., Mak M. and Hossain M. M. (2010) *Journal of Applied Science and Environmental Managemen*t, 14, 91-95
[18] Meena P. O. and Bahadur V. (2015) *Journal of Agricultural Science*, 7(3), 66-69.
[19] Nwosu D. J., Onakoya O. A., Okere A. U., Babatunde A. O. and Popoola A. F. (2014) *Greener J. Ag. Sci.*, 4 (5), 211-219.