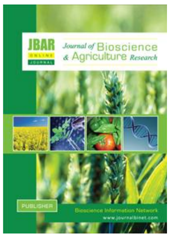
Journal BiNET
Scientific Publication

Published with Open Access at Journal BiNET
Vol. 22, Issue 01: 1815-1822
Journal of Bioscience and Agriculture Research

Journal Home: www.journalbinet.com/jbar-journal.html



Character association and path analysis of tomato (*Solanum lycopersicum* L.)

Md. Sarowar Alam[1 & 2], Md. Nurul Huda[2 & 3], Md. Sadiqur Rahman[1], A.K.M. Azad[4], Md. Mizanur Rahman[1] and Mohammad Mainuddin Molla[1]

[1]Regional Agricultural Research Station (RARS), BARI, Akbarpur, Moulvibazar, Bangladesh
[2]Department of Arid land Agriculture, King Abdulaziz University, Jeddah, Kingdom of Saudi Arabia
[3]Department of Genetics and Plant Breeding, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh
[4]Bangladesh Forest Research Institute, Moulvibazar, Bangladesh

✉For any information: ask.author@journalbinet.com
Article received: 08.05.19; Revised: 04.09.19; First published online: 01 October 2019.

ABSTRACT

The study was conducted at the vegetables research field and laboratory of the Regional Agricultural Research Station, Akbarpur, Moulvibazar, Bangladesh to find out the inter-relationship among the characters studied. Correlation and path analysis was executed in twenty-three tomato genotypes for thirteen yield contributing characters. The correlation coefficients were ascertained to detect the studied character interrelationships. Yield (t/ha) was showed positive and highly significant correlated with yield per plant(r =0.99) followed by individual fruit weight (r =0.72), fruit breadth (r =0.67), number of locules per fruit (r =0.67) and pericarp thickness (r =0.66) which indicated that yield could be enhanced by improving these traits. Path coefficient analysis indicated the cause and effect relationship among yield (t/ha) and its components. Yield per plant exhibited the highest positive direct effect (1.018) on yield (t/ha) followed by the number of flowers per inflorescence (0.212) and pericarp thickness (0.155). Fruit breadth (-0.279) showed the highest negative direct effect on yield (t/ha) but it had a highly significant positive correlation with Yield (t/ha) (r=0.67). High direct effect on yield (t/ha) was revealed by the characters that indicated direct selection in favor of these traits might be feasible. Selection based on these characters has great potential for improving yield (t/ha). The studied characters explained almost all variability towards yield signified by considerably very low residual effect (0.004606).

Key words: *Tomato, Correlation analysis, Path-coefficients analysis, Traits and Direct effect.*

Cite Article: Alam, M. S., Huda, M. N., Rahman, M. S., Azad, A. K. M., Rahman, M. M. and Molla, M. M. (2019). Character association and path analysis of tomato (*Solanum lycopersicum* L.). Journal of Bioscience and Agriculture Research, 22(01), 1815-1822.
Crossref: https://doi.org/10.18801/jbar.220119.223

EISSN: 2312-7945,

I. Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetable in all over the world. Tomato species are diploid with twelve pairs of chromosomes (2n = 24) and is a self-pollinated annual crop which belongs to the family Solanaceae (Jenkins, 1948). It is the most frequently consumed vegetable in many countries becoming the main supplier of several plant nutrients and providing an important nutritional value of human diet (Willcox et al., 2003). The world dedicated 4,848384 hectares cultivable land in 2017 for tomato cultivation and the total production was about 182,301,395 metric tons (FAO, 2017). In Bangladesh, at present 8.59% cultivable land area (68,366 acres) is under tomato cultivation both in winter and summer (BBS, 2017). It is a good source of an antioxidant (lycopene), ascorbic acid, Vitamin A and Vitamin B. These vitamins and beta-carotene work as antioxidants to neutralize harmful free radicals in the blood. Free radicals in the blood stream are dangerous because it may lead to cell damage. Recent epidemiological studies have found that consumption of tomato and its products suppress the risk of developing digestive tract and prostate cancers (Khapte and Jansirani, 2014). Tomato is mainly consumed as salad, cooked or processed into several products like ketchup, juice, puree, sauce and whole canned fruit (Yadav et al., 2013). The degree of relationship between two or more traits as indicated by the correlation coefficients has always been a helpful tool for the selection of desirable characters under a breeding program. Like other crops, tomato yield is the final product attributed by the direct and indirect interrelating effects of different characters (Singh et al., 1989; Islam and Khan, 1991). So it is important to make a relative study among vital characters to select desirable ones. Correlation coefficient alone cannot give a complete picture of the causal basis of relationship and that cases, path coefficient analysis is a feasible instrument (Islam and Khan, 1991). Thus, keeping above considerations in view; present research work has been conducted to study the correlation and path coefficient analysis to estimate associations among desired traits and their direct and indirect contributions toward yield.

II. Materials and Methods

The experiment was conducted at the vegetables research field and laboratory of the Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Akbarpur, Moulvibazar, Bangladesh during October 2014 to April 2015. Twenty three tomato genotypes were used in the present study and the experiment was laid out in randomized complete design with 3 replications. The unit plot size was 4.8m × 1.0m. Seeds were sown on 25 October 2014 and 31 days old seedlings were transplanted in the main field on 25 November, 2014 maintaining 60 cm × 40 cm plant spacing. Manure and Fertilizers were applied @ 10 ton well decomposed cow dung, 550 kg Urea, 450 kg TSP and 250 kg MP, Gypsum 121 kg, Zinc sulphate 15 kg and Boric acid 12 kg per hectare. Half of the quantity of cow dung, half amount of TSP and entire amount of gypsum and boric acid were applied during land preparation. The remaining half of cow dung and TSP was applied during pit preparation before a week of planting. The entire urea and MP were applied in 3 equal installments at 21, 35 and 50 days after transplanting. Irrigation, intercultural operation and pest management were done as and when necessary. Data on plant height (cm), days for 50% flowering, number of flowers per inflorescence, number of fruits per cluster, individual fruit weight (g), fruit length (cm) and diameter (cm), pericarp thickness (cm), number of locules per fruit, number of fruits per plant, number of seeds per fruit, % Brix (TSS), yield per plant (kg.) and yield (t/ha) were recorded. The correlation coefficients were calculated as per Snedecor (1957). Path coefficients were estimated according to Dewey and Lu (1959), where yield (t/ha) was kept as resultant variable and other contributing characters as causal variables. Correlation and Path analysis were conducted by using R (version 3.1.2) computer software (R Core Team, 2014).

III. Results and Discussion

Fruits yield is a complex product being influenced by different quantitative characters. The analysis of the relationship among those characters and their association with fruit yield is very much essential for selection criteria. Breeders always seek for genetic variation among characters to select desirable type. Correlation co-efficient between fruit yield and its 13 component characters in all possible combinations are shown in (Table 01). Plant height showed positive and non-significant correlation with number of flowers per inflorescence, number of fruits per cluster, fruit diameter, number of

Published with open access atjournalbinet.com
EISSN: 2312-7945,

locules per fruit, number of fruits per plant, number of seeds per fruit, TSS, fruit yield per plant and yield (t/ha) while days for first flowering, individual fruit weight, fruit length and pericarp thickness presented negative and non-significant correlation. Alam et al. (2016) reported positive significant correlation of plant height and number of fruits per plant with yield in pummelo. Days for first flowering presented positive and non-significant correlation with individual fruit weight, fruit length, fruit diameter, pericarp thickness, number of locules per fruit, number of seeds per fruit and TSS whereasnumber of flowers per inflorescence, number of fruits per cluster, number of fruits per plant, and fruit yield per plant demonstrated negative and non-significant correlation. Islam et al. (2010) reported non-significant correlation between days to first flowering with all other characters.

Number of flowers per inflorescence exhibited highly significant positive interrelation with number of fruits per cluster (0.91) followed bynumber of fruits per plant (0.75) and TSS (0.69) respectively, but negative and highly significant correlation with fruit length (-0.62), individual fruit weight (-0.56), and pericarp thickness (-0.56). Negative significant interrelation was observed in case of fruit diameter (-0.54) on the other hand, negative andnon-significant values was recorded for number of locules per fruit, number of seeds per fruit, fruit yield per plant and yield (t/ha). Number of fruits per cluster presented positive and highly significant correlation with TSS (0.81) followed by number of fruits per plant (0.76) whereas fruit length (-0.72), fruit diameter (-0.72) and pericarp thickness (-0.72) showed highly significant negative relationship. All the other characters namely individual fruit weight, number of locules per fruit, number of seeds per fruit, fruit yield per plant and yield (t/ha) demonstrated non-significant and negative relationship.Individual fruit weight showed positive and highly significant relationship with fruit diameter (0.93), pericarp thickness (0.81), number of locules per fruit (0.76), yield (t/ha) (0.72), fruit length (0.70) and number of seeds per fruit (0.55) respectively. It revealed negative and highly significant correlation with TSS (-0.62) which is corroboration with Kumar et al. (2013) but negative significant relationship withnumber of fruits per plant (-0.54). Individual fruit weight showed positive and non-significant relationship with fruit yield per plant (0.70). Prasad and Rai (1999); Mohanthy 2002a, b) and Harer et al. (2003) reported very highly significant correlation coefficient between yield and fruit weight.

Fruit length exhibited highly significant positive correlation with pericarp thickness (0.81), fruit diameter (0.76) and fruit yield per plant (0.55) which is corroboration with Rajolli et al. (2017) whereas TSS (-0.74) showed highly negative significant relationship. Positive significant interrelation was observed in case of yield (t/ha) (0.53) and number of seeds per fruit (0.44), on the other hand number of fruits per plant showed significant negative correlation, but number of locules per fruit presented non-significant positive relationship. Fruit diameter presented highly significant relationship with all the characters wherepericarp thickness (0.85), number of locules per fruit (0.81), fruit yield per plant (0.67), yield (t/ha) (0.67), number of seeds per fruit (0.59) were positive and TSS (-0.62), number of fruits per plant (-0.55) were in negative correlation. Prasad and Rai (1999) and Agong et al. (2008) reported very highly significant correlation coefficient between yield and fruit length and fruit diameter.Pericarp thickness showed highly positive correlation with yield (t/ha) (0.66), fruit yield per plant (0.63) and number of locules per fruit (0.58) whereas TSS (-0.72) and number of fruits per plant (-0.55) showed highly negative correlation. On the other hand number of seeds per fruit presented non-significant positive relationship.

Number of locules per fruit exhibited positive and highly significant correlation with fruit yield per plant (0.68) and yield (t/ha) (0.67) while number of seeds per fruitshowed significant positive correlation. Number of fruits per plant and TSS showed non-significant negative relationship with Number of locules per fruit. These results are in consonance with the finding of Madhurina and Paul (2012); Maurya et al. (2011); Ara et al. (2009) and Singh (1997). Number of fruits per plant presented highly significant positive correlation with TSS (0.53) Similar observation wasobtained by Rani et al. (2010) contrariwise fruit yield per plantshowed non-significant positive relationship but number of seeds per fruit and yield (t/ha) had non-significant negative correlation. Number of seeds per fruits demonstrated non-significant positive relationship with fruit yield per plant (0.35) and yield (t/ha) (0.33) whereas TSS showed non-significant negative correlation. Singh et al. (1997); Harer et al. (2003) and Haydar et al. (2007) observed that yield had a strong positive correlation with fruits per plant. Brix percentage had non-significant negative correlation with fruit yield per plant and yield (t/ha).

Table 01. Correlation co-efficient between yield and yield contributing characters in 21 tomato genotype

Characters	DFFL	NFIN	NFRPC	IFW	FL	FD	PT	NL	NFPP	NSPF	TSS	FYPP	YTH
PH	-0.28	0.35	0.29	-0.02	-0.34	0.02	-0.13	0.27	0.43	0.03	0.43	0.37	0.38
DFFL		-0.24	-0.24	0.24	0.06	0.21	0.26	0.21	-0.43	0.29	0.02	-0.14	-0.11
NFIN			0.91**	-0.56**	-0.62**	-0.54*	-0.56**	-0.2	0.75**	-0.4	0.69**	-0.09	-0.09
NFRPC				-0.7	-0.72**	-0.72**	-0.72**	-0.35	0.76**	-0.37	0.81**	-0.17	-0.19
IFW					0.7**	0.93**	0.81**	0.76**	-0.54*	0.55**	-0.62**	0.7	0.72**
FL						0.76**	0.81**	0.41	-0.49*	0.44*	-0.74**	0.55**	0.53*
FD							0.85**	0.81**	-0.55**	0.59**	-0.62**	0.67**	0.67**
PT								0.58**	-0.55**	0.36	-0.72**	0.63**	0.66**
NL									-0.34	0.44*	-0.27	0.68**	0.67**
NFPP										-0.35	0.53**	0.01	-0.02
NSPF											-0.12	0.35	0.33
TSS												-0.25	-0.26
YPP													0.99**

df = 21-2 = 19; r0.05 = 0.433, r0.01 = 0.549, ** Significant at 1% level * Significant at 5% level. PH=Plant Height (cm), DFFL=Days for first flowering (days), NFIN=Number of flowers per inflorescence (m), NFRPC=Number of fruits per cluster, IFW=Individual fruit weight (g), FL=Fruit length (cm), FD=Fruit diameter (cm), PT=Pericarp thickness(cm), NL=Number of locules per fruit, NFPP=Number of fruits per plant, NSPF=Number of seeds per fruit , TSS=% Brix, FYPP=Fruit yield per plant (kg.), YTH= Yield (t/ha).

Path co-efficient analysis for yield and yield contributing characters: Path co-efficient analysis (Table 02) estimate the direct and indirect effects of yield and its 13 component characters. Fruit yield per plant (1.018) had maximum positive direct effect on yield (t/ha). This character exhibited positive indirect effect via individual fruit weight (0.106) followed by pericarp thickness (0.098), number of fruits per cluster (0.042), number of seeds per fruit (0.013), plant height (0.005) and days for first flowering (0.002). Negative indirect effect were found on fruit diameter (-0.187), fruit length (-0.057), number of locules per fruit (-0.023), number of flower per inflorescence (-0.019), TSS (-0.007) and number of fruits per plant (-0.001). Finally it showed positive and highly significant correlation (0.99) between fruit yield per plant and yield (t/ha) was the cumulative contribution of these direct and indirect effects. Dhankar et al. (2001); Verma and Sarnaik (2000); Mageswari et al. (1999) and Yadav and Singh (1998) found that fruits yield per plant had the highest positive direct effect on yield and Alam et al. (2016) also found similar trends in case of Pummelo. Number of flowers per inflorescence (0.212) had positive direct effect on yield (t/ha). This character showed positive indirect effect via fruit diameter (0.151) followed by fruit length (0.065), TSS (0.020), number of locules per fruit (0.007), plant height (0.005), days for first flowering (0.004) and negative indirect effect were found on number of fruits per cluster (-0.226), fruit yield per plant (-0.092), pericarp thickness (-0.087), individual fruit weight (-0.085), number of fruits per plant (-0.048) and number of seeds per fruit (-0.015). Finally it showed negative non-significant correlation with yield (t/ha) (-0.09).

Table 02. Genotypic path coefficient analysis showing direct (diagonal bold) and indirect (non-diagonal) effect of 13 characters on yield of tomato

Characters	PH	DFFL	NFIN	NFRPC	IFW	FL	FD	PT	NL	NFPP	NSPF	TSS	FYPP	YTH
PH	**0.013**	0.005	0.074	-0.072	-0.003	0.036	-0.006	-0.020	-0.009	-0.028	0.001	0.012	0.377	0.38
DFFL	-0.004	**-0.016**	-0.051	0.060	0.036	-0.006	-0.059	0.040	-0.007	0.028	0.011	0.001	-0.142	-0.11
NFIN	0.005	0.004	**0.212**	-0.226	-0.085	0.065	0.151	-0.087	0.007	-0.048	-0.015	0.020	-0.092	-0.09
NFRPC	0.004	0.004	0.193	**-0.248**	-0.106	0.075	0.201	-0.111	0.012	-0.049	-0.014	0.023	-0.173	-0.19
IFW	0.000	-0.004	-0.119	0.174	**0.151**	-0.073	-0.259	0.125	-0.026	0.035	0.021	-0.018	0.712	0.72 **
FL	-0.004	-0.001	-0.132	0.179	0.106	**-0.104**	-0.212	0.125	-0.014	0.031	0.017	-0.021	0.560	0.53 *
FD	0.000	-0.003	-0.115	0.179	0.141	-0.079	**-0.279**	0.132	-0.027	0.035	0.023	-0.018	0.682	0.67 **
PT	-0.002	-0.004	-0.119	0.179	0.123	-0.085	-0.237	**0.155**	-0.020	0.035	0.014	-0.021	0.641	0.66 **
NL	0.004	-0.003	-0.042	0.087	0.115	-0.043	-0.226	0.090	**-0.034**	0.022	0.017	-0.008	0.692	0.67 **
NFPP	0.006	0.007	0.159	-0.189	-0.082	0.051	0.153	-0.085	0.012	**-0.064**	-0.013	0.015	0.010	-0.02
NSPF	0.000	-0.005	-0.085	0.092	0.083	-0.046	-0.164	0.056	-0.015	0.022	**0.039**	-0.003	0.356	0.33
TSS	0.006	0.000	0.147	-0.201	-0.094	0.077	0.173	-0.111	0.009	-0.034	-0.005	**0.029**	-0.254	-0.26
YPP	0.005	0.002	-0.019	0.042	0.106	-0.057	-0.187	0.098	-0.023	-0.001	0.013	-0.007	**1.018**	0.99 **

Residual Effect: 0.004606; PH=Plant Height (cm), DFFL=Days for first flowering (days), NFIN=Number of flowers per inflorescence (m), NFRPC=Number of fruits per cluster, IFW=Individual fruit weight (g), FL=Fruit length (cm), FD=Fruit diameter (cm), PT=Pericarp thickness(cm), NL=Number of locules per fruit, NFPP=Number of fruits per plant, NSPF=Number of seeds per fruit, TSS=% Brix, FYPP=Fruit yield per plant (kg.), YTH= Yield (t/ha).

Published with open access atjournalbinet.com
EISSN: 2312-7945,

Pericarp thickness (0.155) showed positive direct effect on yield (t/ha). Positive indirect effects were found via fruit yield per plant, number of fruits per cluster, individual fruit weight, number of fruits per plant and number of seeds per fruit and negative indirect effects via fruit diameter, number of flowers per inflorescence, fruit length, TSS and number of locules per fruit. Indirect effect via days for first flowering and plant height were very poor. Positive highly significant correlation (0.67) between pericarp thickness and yield (t/ha) was the cumulative contribution of these direct and indirect effects. Islam et al. (2010) also observed that Pericarp thickness showed positive direct effect on yield per plant. Individual fruit weight (0.151) had positive direct effect on yield (t/ha). Positive indirect effect were presented via fruit yield per plant, followed by number of fruits per cluster, pericarp thickness, number of fruits per plant, number of seeds per fruit and negative indirect effect were found via fruit diameter, number of flowers per inflorescence, fruit length, number of locules per fruit, TSS and days for first flowering and there was no indirect effect via plant height. Positive and highly significant correlation (0.72) between individual fruit weight and yield (t/ha) was the cumulative contribution of these direct and indirect effects. Similar finding were observed by Meena et al. (2014); Nagariya et al. (2015) and Sudesh and Anita (2016). Gorbtenko and Gorbtenko (1985) also observed that single fruit weight had considerable direct effect on yield per plant. Fruit diameter (-0.279) had negative direct effect on yield (t/ha). Positive indirect effect were showed via fruit yield per plant, followed by number of fruits per cluster, individual fruit weight, pericarp thickness, number of fruits per plant, number of seeds per fruit, and negative indirect effect were exhibited via number of flowers per inflorescence, fruit length, number of locules per fruit, TSS and days for first flowering. There was no indirect effect via plant height. Positive and highly significant correlation (0.67) between individual fruit weight and yield (t/ha) was the cumulative contribution of these direct and indirect effects. Islam et al. (2010) reported that Fruit diameter showed positive direct effect on yield per plant. Number of fruits per cluster (-0.248) had negative direct effect on yield (t/ha). Positive indirect effect were presented via fruit diameter followed by number of flowers per inflorescence, fruit length, TSS, number of locules per fruit, days for first flowering and plant height. Negative indirect effect were exhibited via fruit yield per plant, pericarp thickness, individual fruit weight, number of fruits per plant and number of seeds per fruit. Finally it showed negative non-significant correlation with yield (t/ha) (-0.19). Similar result was reported by Prashanth et al. (2008).

Fruit length (-0.104) had negative direct effect on yield (t/ha) similar results were recorded by Saleem et al. (2013) and Rahman et al. (2015). Positive indirect effects were found via fruit yield per plant, followed by number of fruits per cluster, pericarp thickness, individual fruit weight, number of fruits per plant and number of seeds per fruit. Negative indirect effects were exhibited via fruit diameter, number of flowers per inflorescence, TSS, number of locules per fruit, plant height and days for first flowering and there was very little indirect effect via plant height. Positive and significant correlation (0.53) between individual fruit weight and yield (t/ha) was the cumulative contribution of these direct and indirect effects. The residual effects appeared to be considerably very low (0.004606) which indicated that the characters under this study explained almost all variability towards yield.

IV. Conclusion

Fruits yield per plant, number of flowers per inflorescence, pericarp thickness and individual fruit weight were the most important contributors to yield (t/ha) in tomato. Thus, emphasis should be given for the selection of these characters for the development of high yielding with quality rich tomato varieties.

Acknowledgement

Authors are highly thankful to the Regional Agricultural Research Station (RARS), BARI, Akbarpur, Moulvibazar, Bangladesh for conducting and supporting this research.

V. References

[1]. Agong, S. G., Schittenhelm, S. and Friedt, W. (2008). Genotypic variation of Kenyan tomato (*Lycopersicon esculentum* L.) germplasm. PGR Newsletter, FAO Biodiversity, 123, 61–67.

Published with open access atjournalbinet.com

[2]. Alam, M. S., Rahman, M. S., Rahman, M. G., Rahman, M. M., Yesmin, S. and Uddin, M. Z. (2016). Correlation and path-coefficient analysis of pummelo. Journal of Bioscience and Agriculture Research, 08(01), 718–725. https://doi.org/10.18801/jbar.080116.85

[3]. Ara, A., Narayan, R., Ahmed, N. and Khan, S. H. (2009). Genetic variability and selection parameters for yield and quality attributes in tomato. Indian Journal of Horticulture. 66(1), 73–78.

[4]. BBS (2017). Yearbook of Agricultural Statistics of Bangladesh 2011. Bangladesh Bureau of Statistics, Statistics and Informatics Division, Ministry of Planning, Government of the People's Republic of Bangladesh. http://www.bbs.gov.bd

[5]. Dewey, D. K. and Lu, L. H. (1959). A correlation and path co-efficient analysis of components of creased wheat grass and production. Agronomy Journal, 51(2), 515–518. https://doi.org/10.2134/agronj1959.00021962005100090002x

[6]. Dhankar, S. K., Dhankhar, B. S. and Sharma, N. K. (2001). Correlation and path analysis in tomato under normal and high temperature conditions. Haryana Journal of Horticultural Science, 30(1-2), 89–92.

[7]. FAO, (2017). FAOSTAT. Food and Agriculture Organization of the United Nations, Rome, Italy. http://www.fao.org/faostat/en/#data

[8]. Gorbtenko, E. M. and Gorbtenko, I. Y. U. (1985). Path analysis of economically useful characters in tomato. Tsitologiya Genetika, 19(3), 206–210.

[9]. Harer, P. N., Lad, D. B. and Bhor, T. J. (2003). Correlation and path analysis studies in tomato. Journal of Maharashtra Agricultural University, 27(3), 302–303.

[10]. Haydar, A., Mandal, M. A., Ahmed, M. B., Hannan, M. M., Karim, R., Razvy, M. A., Roy, U. K. and Salahin, M. (2007). Studies on genetic variability and interrelationship among the different traits in tomato (*L. esculentum* Mill.). Middle-East Journal of Scientific Research, 2(3-4), 139–142.

[11]. Islam, B. M. R., Ivy, N. A., Rasul, M. G. and Zakaria, M. (2010). Character association and path analysis of exotic tomato (*Solanum lycopersicum* l.) Genotypes. Bangladesh Journal of Plant Breeding and Genetics, 23(1), 13–18. https://doi.org/10.3329/bjpbg.v23i1.9313

[12]. Islam, M. S. and Khan, S. (1991). Variability and character association in tomato (*Lycopersicon esculentum* Mill). Bangladesh Journal of Plant Breeding and Genetics, 4(1-2), 49–53.

[13]. Jenkins, J. A., (1948). The origin of the cultivated tomato. Econ. Bot. 2, 379–392. https://doi.org/10.1007/BF02859492

[14]. Khapte, P. S. and Jansirani, P. (2014). Genetic variability and performance studies of tomato (*Solanum lycopersicum* L.) genotypes for fruit quality and yield. Trends in Biosciences, 7(12): 1246-1248.

[15]. Kumar, D., Kumar, R., Bhardwaj, L. M., Thakur, C. M., Thakur, S. K., Dogra, S. B., Vikram, A., Thakur, A. and Kumar, P. (2013). Genetic Variability, Correlation and Path Coefficient Analysis in Tomato. International Journal of Vegetable Science, 19(4), 313–323. https://doi.org/10.1080/19315260.2012.726701

[16]. Madhurina, M. and Paul, A. (2012). Studies on genetic variability and character association of fruit quality parameters in tomato. Horticultural Flora Research Spectrum, 1(2), 110–116.

[17]. Mageswari, K., Natarajan, S. and Thamburaj, S. (1999). Causal influence of component traits on yield in hybrids of tomato. South Indian Hort. 47(1-6), 179–181.

[18]. Maurya, V., Singh, A. K., Rai, V. K. and Mishra, R. (2011). Genetic variability, correlation and path coefficient analysis of tomato (*Lycopersicon esculentum* Mill.). Raman and Mishra Environment and Ecology, 29(3), 1076–1081.

[19]. Meena, O. P. and Bahadur, V. (2014). Assessment of correlation and path coefficient analysis for yield and yield contributing traits among tomato (*Solanum lycopersicum* L.) germplasm. Agricultural Science Digest, 34(4), 245-250. https://doi.org/10.5958/0976-0547.2014.01013.1

[20]. Mohanty, B. K. (2002a). Variability, heritability, correlation and path coefficient studies in tomato. Haryana Journal of Horticultural Science, 31(3-4), 230–233.

[21]. Mohanty, B. K. (2002b). Studies on variability, heritability, interrelationship and path analysis in tomato. Annals of Agricultural Research, 23(1), 65–69.

[22]. Nagariya, N. K., Bhardwaj, R., Sharma, N., Mukherjee, S. and Umesh (2015). Correlation and path analysis in tomato (*Solanum lycopersicon* L.). International Journal of Farm Sciences, 5(4), 111–117.

Published with open access atjournalbinet.com
EISSN: 2312-7945, © 2019 The Authors, Research paper

[23]. Prasad, V. S. R. K. and Rai, M. (1999). Genetic variation, component association and direct and indirect selections in some exotic tomato germplasm. Indian Journal of Horticulture. 56(3), 262–266.

[24]. Prashanth, S. J., Jaiprakashnarayan, R. P., Mulge, R. and Madalageri, M. B. (2008). Correlation and path analysis in tomato (*Lycopersicon esculentum* Mill.). The Asian Journal of Horticulture, 3(2), 403–408.

[25]. R Core Team (2014). R: A language and environment for statistical computing, Vienna, Austria. URL http://www.R-project.org/

[26]. Rahman, M. S., Parveen, S., Rashid, M. H., Akter, R., Hossain, A. Y. and Robbani, M. G. (2015). Correlation and path coefficient analysis of tomato germplasms. International Journal of Applied Science and Biotechnology, 3(2), 223–226. https://doi.org/10.3126/ijasbt.v3i2.12421

[27]. Rajolli, M. G., Lingaiah, H. B., Ishwaree, R. M., Bhat, A. S. and Aravindkumar, J. S. (2017). Correlation and Path Co-Efficient Studies in Tomato (*Solanum lycopersicum* L.). International Journal of Pure Applied Bioscience, 5(6), 913–917. https://doi.org/10.18782/2320-7051.6096

[28]. Rani, C. I., Muthuvel, I. and Veer, D. (2010). Correlation and path analysis of yield components and quality traits in tomato (*Lycopersicon esculentum* Mill.). Agricultural Science Digest, 30(1), 11–14.

[29]. Saleem, M. Y., Iqbal, Q. and Asghar, M. (2013). Genetic variability, heritability, character association and path analysis in F1 hybrid of tomato. Pakistan Journal of Agricultural Science, 50(4), 649–653.

[30]. Singh, D. N., Sahu, A. and Parida, A. K. (1997). Genetic variability and correlation studies in tomato (*Lycopersicon esculentum* Mill.). Environment and Ecology, 15(1), 117–121.

[31]. Snedecor, G. W. (1957). Statistical methods (5^{th} Ed.). Iowa State University Press., Ames. USA, p.534.

[32]. Sudesh, K. and Anita, S. (2016). Assessment of genetic variability, character association and path analysis in tomato (*S. lycopersicum* L.) under tarai condition of Uttarakhand. International Journal of Agriculture Sciences, 34(8), 1706–1709.

[33]. Verma, S. K. and Sarnaik, D. A. (2000). Path analysis of yield components in tomato (*Lycopersicon esculentum* Mill). Journal of Applied Biology, 10(2), 136–138.

[34]. Willcox, J. K., Catignani, G. L. and Lazarus, S. (2003). Tomatoes and cardiovascular health. Critical Reviews in Food Science and Nutrition, 43, 1–18. https://doi.org/10.1080/10408690390826437

[35]. Yadav, D. S. and Singh, S. P. (1998). Correlation and path analysis in tomato. Journal of Hill Research, 11(2), 207–211.

HOW TO CITE THIS ARTICLE?

Crossref: https://doi.org/10.18801/jbar.220119.223

MLA

Alam, M. S. et al. "Character association and path analysis of tomato (*Solanum lycopersicum* L.)." Journal of Bioscience and Agriculture Research 22(01) (2019): 1815-1822.

APA

Alam, M. S., Huda, M. N., Rahman, M. S., Azad, A. K. M., Rahman, M. M. and Molla, M. M. (2019). Character association and path analysis of tomato (*Solanum lycopersicum* L.). Journal of Bioscience and Agriculture Research, 22(01), 1815-1822.

Chicago

Alam, M. S., Huda, M. N., Rahman, M. S., Azad, A. K. M., Rahman, M. M. and Molla, M. M. "Character association and path analysis of tomato (*Solanum lycopersicum* L.)". Journal of Bioscience and Agriculture Research 22(01) (2019): 1815-1822.

Harvard

Alam, M. S., Huda, M. N., Rahman, M. S., Azad, A. K. M., Rahman, M. M. and Molla, M. M. 2019. Character association and path analysis of tomato (*Solanum lycopersicum* L.). Journal of Bioscience and Agriculture Research, 22(01), pp. 1815-1822.

Vancouver

Alam, MS, Huda, MN, Rahman, MS, Azad, AKM, Rahman, MM and Molla, MM. Character association and path analysis of tomato (*Solanum lycopersicum* L.). Journal of Bioscience and Agriculture Research. 2019 October 22(01): 1815-1822.

EISSN: 2312-7945,