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

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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.


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I. Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most economically important vegetables 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 4,848,384 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...
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 whereas number 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 by number 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 and non-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 with number 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 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 where pericarp 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 fruits showed 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 was obtained by Rani et al. (2010) contrariwise fruit yield per plant showed non-significant positive relationship but number of seeds per fruit 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).
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 (-0.23), 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 Pummoelo. 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 (0.004), 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

<table>
<thead>
<tr>
<th>Characters</th>
<th>PH</th>
<th>DF</th>
<th>NFIN</th>
<th>NFPRC</th>
<th>IFW</th>
<th>FL</th>
<th>FD</th>
<th>PT</th>
<th>NL</th>
<th>NFPP</th>
<th>NSPP</th>
<th>TSS</th>
<th>FYPP</th>
<th>YTH</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>0.013</td>
<td>0.005</td>
<td>0.074</td>
<td>-0.072</td>
<td>-0.003</td>
<td>0.005</td>
<td>0.025</td>
<td>-0.04</td>
<td>0.001</td>
<td>0.012</td>
<td>0.377</td>
<td>0.38</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DF</td>
<td>-0.004</td>
<td>-0.016</td>
<td>-0.051</td>
<td>0.060</td>
<td>0.036</td>
<td>-0.006</td>
<td>0.059</td>
<td>0.040</td>
<td>0.007</td>
<td>0.028</td>
<td>0.011</td>
<td>0.001</td>
<td>-0.142</td>
<td>-0.11</td>
</tr>
<tr>
<td>NFIN</td>
<td>0.005</td>
<td>0.004</td>
<td>0.212</td>
<td>-0.026</td>
<td>-0.085</td>
<td>0.065</td>
<td>0.151</td>
<td>-0.087</td>
<td>0.007</td>
<td>-0.048</td>
<td>0.015</td>
<td>0.020</td>
<td>-0.092</td>
<td>-0.09</td>
</tr>
<tr>
<td>NFPRC</td>
<td>0.004</td>
<td>0.004</td>
<td>0.193</td>
<td>-0.048</td>
<td>-0.106</td>
<td>0.075</td>
<td>0.201</td>
<td>-0.111</td>
<td>0.012</td>
<td>-0.049</td>
<td>0.014</td>
<td>0.023</td>
<td>-0.173</td>
<td>-0.19</td>
</tr>
<tr>
<td>IFW</td>
<td>0.000</td>
<td>-0.004</td>
<td>-0.119</td>
<td>0.174</td>
<td>0.151</td>
<td>-0.073</td>
<td>-0.259</td>
<td>0.125</td>
<td>-0.026</td>
<td>0.035</td>
<td>0.021</td>
<td>-0.018</td>
<td>0.712</td>
<td>0.72 **</td>
</tr>
<tr>
<td>FL</td>
<td>-0.004</td>
<td>-0.001</td>
<td>-0.132</td>
<td>0.179</td>
<td>0.106</td>
<td>-0.104</td>
<td>-0.212</td>
<td>0.125</td>
<td>-0.014</td>
<td>0.031</td>
<td>0.017</td>
<td>-0.021</td>
<td>0.560</td>
<td>0.53 **</td>
</tr>
<tr>
<td>FD</td>
<td>0.000</td>
<td>-0.003</td>
<td>-0.115</td>
<td>0.179</td>
<td>0.141</td>
<td>-0.079</td>
<td>-0.279</td>
<td>0.132</td>
<td>-0.027</td>
<td>0.035</td>
<td>0.023</td>
<td>-0.018</td>
<td>0.682</td>
<td>0.67 **</td>
</tr>
<tr>
<td>PT</td>
<td>-0.002</td>
<td>-0.004</td>
<td>-0.119</td>
<td>0.179</td>
<td>0.123</td>
<td>-0.085</td>
<td>-0.237</td>
<td>0.155</td>
<td>-0.020</td>
<td>0.035</td>
<td>0.014</td>
<td>-0.021</td>
<td>0.641</td>
<td>0.66 **</td>
</tr>
<tr>
<td>NL</td>
<td>0.004</td>
<td>-0.003</td>
<td>-0.042</td>
<td>0.087</td>
<td>0.115</td>
<td>-0.043</td>
<td>-0.226</td>
<td>0.090</td>
<td>-0.034</td>
<td>0.022</td>
<td>0.017</td>
<td>-0.008</td>
<td>0.692</td>
<td>0.67 **</td>
</tr>
<tr>
<td>NFPP</td>
<td>0.006</td>
<td>0.007</td>
<td>0.159</td>
<td>-0.189</td>
<td>-0.082</td>
<td>0.051</td>
<td>0.153</td>
<td>-0.085</td>
<td>0.012</td>
<td>-0.064</td>
<td>0.013</td>
<td>0.015</td>
<td>0.010</td>
<td>-0.02</td>
</tr>
<tr>
<td>NSPP</td>
<td>0.000</td>
<td>-0.005</td>
<td>-0.085</td>
<td>0.092</td>
<td>0.083</td>
<td>-0.046</td>
<td>-0.164</td>
<td>0.056</td>
<td>-0.015</td>
<td>0.022</td>
<td>0.039</td>
<td>-0.003</td>
<td>0.356</td>
<td>0.33</td>
</tr>
<tr>
<td>TSS</td>
<td>0.006</td>
<td>0.000</td>
<td>0.147</td>
<td>-0.201</td>
<td>-0.094</td>
<td>0.077</td>
<td>0.173</td>
<td>-0.111</td>
<td>0.009</td>
<td>-0.034</td>
<td>0.005</td>
<td>0.029</td>
<td>-0.254</td>
<td>-0.26</td>
</tr>
<tr>
<td>YPP</td>
<td>0.005</td>
<td>0.002</td>
<td>-0.019</td>
<td>0.042</td>
<td>0.106</td>
<td>-0.057</td>
<td>-0.187</td>
<td>0.098</td>
<td>-0.023</td>
<td>-0.001</td>
<td>-0.003</td>
<td>-0.087</td>
<td>1.018</td>
<td>0.99 **</td>
</tr>
</tbody>
</table>

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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 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.

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V. References


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