TROPENTAG 2014

''Bridging the gap between increasing knowledge and decreasing resources''
17 - 19 September 2014, Czech University of Life Sciences, Prague

Correlation and Path Coefficients in Tomato (*Solanum lycopersicon* Mill) under Fruit Worm (*Helicoverpa zea* Buddie) Infestation in Line × Tester Breeding

By

Adamu Usman Izge*[1] and Yusuf Garba[2]

[1] Department of Crop Science, Faculty of Agriculture, Federal University Dutse, Ibrahim Aliyu Bye Pass, P.M.B. 7156, Dutse, Jigawa State, Nigeria.
Mobile +2348030636782, E: mail: bamsyizge@yahoo.com

[2] Department of Agricultural Education, School of Vocational and Technical Education, College of Education Hong, P. M. B. 2237, Yola, Adamawa State, Nigeria.

ABSTRACT

Field experiments were conducted under irrigation during 2010 to 2011 at Lake Allau, Borno State (11º 6′ N, 13º 17′ E) and Hong, Adamawa State (10º 15′ N, 13º 20′ E) in Nigeria to evaluate the parents F1 hybrids of tomato developed through line × tester for fruit yield and resistance to *Helicovarpa zea*. The study determined the association between fruit yield and other yield components. It also determined path coefficients between fruit yield and other traits. Correlation revealed that relationship between numbers of trichomes was negative and significant genotypically and phenotypically associated with damaged fruits. The higher the number of trichomes the less damage was observed due to worm infestation in tomato. Further result indicated that association between numbers of leaves/plant, and percentage damaged fruits was significant negative. Number of fruits/plant was positively and significantly genotypically correlated with fruit yield and percentage damaged fruits. Genotypic correlation values were higher in magnitude than the corresponding phenotypic values, thus establishing a strong genetic relationship among the traits. Path coefficient analysis revealed that, number of flower clusters/plant exhibited highest direct effect on fruit yield. Even though correlation between number of flower clusters and fruit yield was positive, it was not statistically significant. It is suggestive from the result of this study that the direct effect of trichome count, number of flower clusters/plant and days to final harvest and indirect effects of trichome count, number of leaves/plant and plant height could be considered concurrently for amenability fruit yield. This investigation is not unmindful that more agronomic traits and their relationship with yield need to be investigated while selecting for better fruit yield under worm infestation in parts of Nigeria. Further evaluation is recommended in that respect.

Keywords: Correlation, fruit yield, line × tester, northeastern Nigeria, path analysis, trichome

INTRODUCTION

Tomato (*Solanum lycopersicon* L. Karst) is an important vegetable crops in many parts of the world and annual production is put at 153 million tonnes (FAO, 2009). Among the top 15 countries producing tomato in the world, Nigeria is in the 13th position, with 1.7 million tonnes on average annually and most of it comes from northern Nigeria. Tomato plants have been reported to be severely affected by several plant insects, among which are the fruit worm. The yield loss in tomato due to this insect has been tremendous and as such the use of tolerant varieties are the most economically and ecologically friendly means of their control.

Correlation provide information that selection for one trait results in progress for all positively correlated traits. The importance of correlation in selection programmes therefore becomes appreciable when highly heritable traits are associated with the important trait like yield. Yield is a complex trait with polygenic inheritance. By the use of regression analysis, each trait can be assigned appropriate weight to bring out rational improvement in yield. Premalakshmi (2001) reported that number of fruits per plant was positively correlated with yield in tomato. In another development, fruit weight was found to be positively correlated with yield per plant according to Yadav and Singh (1998).

Path coefficient analysis is helpful in partitioning the correlation into components due to direct and indirect effects and also permits critical examination of specific factors that provide a given correlation. In a path coefficient analysis Sristava *et al*., (1973), reported that, fruit weight had negative direct effect on yield, while the number of fruits/plant had the highest positive direct effect on yield, followed by fruit diameter. Flower clusters and fruit weight in early pickings had high positive direct effect on total yield Singh *et al*., (1976). But fruit length, fruits/plant and fruit weight in total pickings had high negative direct effect on early yields. Total number of fruits/plant showed a negative direct effect with yield/plant.

The highest contribution to yield per plant according to Kalloo (1997) was by number of fruits/plant through direct effect, followed by the indirect contribution of average mean fruit weight. Most characters influenced fruit yield through number of fruits/plant. Sharma (1990) reported that plant height had the direct effect on fruit yield. The objective of the study was to find out the relationship and association between yield and yield traits and Path coefficient analysis of yield attributes on yield/plant in F_1 hybrids of tomato.

MATERIALS AND METHODS

Experiments were undertaken during dry season of 2010 to 2011 on 8 parents of tomato and 12 hybrids derived through line × tester. The experiments were conducted at 2 locations: Lake Alau near Maiduguri, Borno State (11° 6′ N; 13° 17′ E) and Hong in Adamawa State (10° 15′ N; 13° 20′ E), all in north eastern Nigeria. Land was prepared manually using hoe and a 2m x 2m sunken beds were made and watered to field capacity. Plants were later transplanted from nursery and spaced 75 cm on row to row and 50 cm on stand to stand. The treatments were laid out in Randomized Complete Block Design (RCBD), replicated three times.

Irrigation water was applied into the beds at 2 to 4 days intervals as required from transplanting to final harvest. NPK (15:15:15) fertilizer at the rate of 80 kg/ha was applied into the field 15 days after transplanting. Weeding was done as and when required according to the Nigerian Crop Production Guide. The field was artificially infested by tomato fruit worm in order to see the reactions of the parental lines and hybrids to this insect.

Data were collected on 5 randomly selected plants/plot on the following yield and yield traits: trichome count, number of flower clusters/plant, number of leaves/plant, plant height and number of fruits/plant. Other traits on which data were recorded included, weight of fruits/plant, percentage damaged fruits and days to final harvest. All data collected were subjected to correlation and path coefficient analysis and the correlation coefficient among all the traits at phenotypic (r_p) and genotypic (r_g) level were estimated employing the formulae of Al-Jibourie *et al.* (1958). While the estimates of direct and indirect effect of component traits on fruit yield were computed using the formula suggested by Wright (1921) and elaborated by Dewey and Lu (1959).

RESULTS AND DISCUSSION

Genotypic and Phenotypic Correlations

The estimates of genotypic and phenotypic correlations are presented in **Table 1**. The results indicated that genotypic correlation was positive and highly significant between numbers of fruits/plant with flower clusters (0.99), number of leaves/plant (0.99) and plant height (0.95). The results also indicated that number of fruits/plant were phenotypically and positively correlated with flower clusters/plant, leaves/plant and plant height and as well as with trichome count. The phenotypic correlation between fruit yield and days to final harvest were negative and not significant (-0.07). There was negative and significant genotypic correlation between fruit yield and number of flower clusters (-0.91) and number of leaves/plant (-0.91). This then suggests that selection for such traits will invariably lead to lower fruit yield. Positive and significant genotypic correlation existed between fruit yield and number of fruits/plant (0.92).

The results indicated that trichome count was highly and positively genotypically correlated with flower clusters/plant (0.90), leaves/plant (0.90) and percentage damaged fruits. The phenotypic correlation indicated that the trichome count was positively and significantly correlated with number of flower clusters (0.90), leaves/plant (0.90), plant height (0.71), fruits/plant (0.91) and days to final harvest (0.90). However, the phenotypic correlation between trichome count and % fruit damage was significant and negative (-0.90). The phenotypic correlation between % damaged fruits with, flower clusters and leaves/plant were also significant and negative. The phenotypic relationship between % damaged fruit with number of fruits/plant (-0.92), leaves/plant (-0.90) and flower clusters (-0.90) were negative and significant.

Yield is associated with a number of component traits that is controlled by a multi-facetted factor. It is the concern of the plant breeder and the ultimate factor on which selection programmes are to be envisaged. All changes in crop yield must be accompanied by a shift in one or more traits (Graffius, 1964). All the shift in the traits need not however, be expressed by changes in yield. This could be due to varying levels of positive or negative correlations between yield and its component traits and among the components themselves. The study of association between traits helps in the selection of genotypes and also proffers a way forward for a simultaneous selection scheme in more than one trait. The significant and positive genotypic correlations between fruits/plant with flower clusters, leaves/plant, plant height and days to final harvest implies that these traits could be improved concurrently. Similar findings were reported by Kumar *et al*. (1979). It also means that

a high level of heritability existed between the traits. Hannan *et al* (2007) and Hayder *et al.* (2007) also reported high and significant positive association between fruit yield and flower clusters/plant, leaves/plant and plant height in tomato. Hayder *et al.* (2007) affirmed that these traits are synonymous to yield increase.
The high and significant positive correlation with trichome count actually signifies the importance of trichome as a resistance strategy in the control of fruit worm in tomato. Kennedy and Sorenson (1985) had reported a direct relationship between the preponderant levels of trichome with resistance to insects on tomato plant.

Table 1: Genotypic and phenotypic correlation coefficients between yield and yield traits in tomato

Traits	**Trichome Count**	**No. Flower Cluster**	**No. Leaves /Plant**	**Plant Height**	**Fruits/ Plant**	**Yield/ Plant**	**% Dam. Fruits**	**Days to Harvest**
Trichome Count	**1.00**	0.90**	0.90**	0.69	0.04	0.16	0.92**	0.02
No. Flower Cluster	0.90**	**1.00**	0.92**	0.91**	0.99**	-0.91**	-0.92**	0.92**
No. Leaves/Plant	0.90**	0.90**	**1.00**	0.91**	0.99**	-0.91**	-0.92**	-0.91**
Plant Height	0.71**	0.81**	0.99**	**1.00**	0.95**	0.56	0.91**	0.91**
No. Fruits/Plant	0.91**	0.91**	0.91**	0.90**	**1.00**	0.92**	0.97**	0.99**
Yield/Plant	0.22	0.22	0.29	-0.10	0.91**	**1.00**	-0.91**	-0.90**
% Damaged Fruits	-0.90**	-0.90**	-0.90**	0.66	0.92**	-0.32	**1.00**	-0.92**
Days to Harvest	0.90**	-0.81**	-0.91**	0.57	0.92**	-0.07	-0.77**	**1.00**

**** Significant at 1 % level of probability**
Genotypic correlation values: upper right diagonal (Green)
Phenotypic correlation values: lower left diagonal (Yellow).

Path Coefficient Analysis

Path coefficient analysis provides an effective means of partitioning direct or indirect causes of relationships. Since crop yield is affected by many factors, selection based on correlation alone may be misleading because it measures only the mutual association between two variables. In order to find out the direct and indirect effects and to measure the relative importance of causal factors, path coefficient analysis is useful and it permits critical examination of the specific forces acting to produce a given correlation (Bhatt, 1973)
The estimates of direct and indirect effects of yield components on fruit yield of tomato are presented in **Table 2**. It revealed that the highest direct contributions towards fruit yield was evident through % damaged fruits (0.977) followed by flower clusters (0.651), days to final harvest (0.478) and leaves/plant (0.346). Improving these traits that bears direct effects on fruit yield would therefore elevate the yield in tomato.
High positive indirect effect towards fruit yield through % damaged fruits via trichome count (0.991) and days to final harvest (0.829) were observed. Number of flower cluster's indirect effect on fruit yield via trichome count (0.631), leaves/plant (0.586), plant height (0.527) and fruits/plant (0.592) were high and positive. Number of flower clusters (-0.991), number of leaves at 60 days (-0.991), plant height (-0.980) number of fruit (-0.945) had high negative indirect effects on fruit yield via % damage fruit. Highest direct contribution towards fruit yield was evident through % damaged fruits followed by flower clusters and days to final harvest. It therefore means that yield had direct bearing on the % of damaged fruit/plant, flower clusters and days to final harvest. The indirect effect of % damaged fruits to yield via trichome count and days to final harvest were high. This was also the case with days to final harvest via number of flower clusters, plant height, number of fruits/plant and % damaged fruits. It therefore means that % damaged fruits, flower clusters and days to final harvest contributed immensely to fruit yield. Hayder *et al* (2007) and Bhardwaj and Sharma (2005) reported similar results and found a significant contributions to yield through plant height, flower clusters, leaves/plant and fruits/plant.
The important yield contributing traits could therefore be circumvented for fruit yield in tomato. This result is in agreement with that of Golani *et al*. (2007) and Indu Rani *et al*. (2008). This finding confirms the reliability of these traits in selecting a superior tomato type for yield.

Table 2: Path coefficients of component traits on fruit yield in tomato.

Traits	Trichome Count	Flower Clusters	Leaves/ Plant	Plant Height	Fruits /Plant	% Damaged Fruits	Days to Final Harvest	**Correlation Coefficients**
Trichome Count	**0.092**	0.631	0.239	-0.001	0.047	0.991	0.010	0.16
No. Flower Clusters	0.087	**0.651**	0.315	-0.030	0.267	-0.991	0.440	-0.91
No. Leaves/Plant	0.087	0.586	**0.346**	-0.027	-0.290	-0.991	-0.435	-0.91
Plant Height	0.069	0.527	-0.030	**-0.030**	-0.279	-0.980	0.435	0.56
No. Fruits/Plant	0.088	0.592	0.315	0.027	**-0.293**	-0.945	0.473	0.92
% Damaged Fruits	-0.087	-0.586	-0.311	0.020	0.270	**0.977**	0.440	-0.91
Days to Final Harvest	0.087	-0.527	-0.315	-0.017	0.270	0.829	**0.478**	-0.90

SUMMARY AND CONCLUSION

The yield traits e.g. flower clusters/plant, leaves/plant and plant height were having positive and significant genotypic and phenotypic correlations with fruits/plant. The resistance trait i.e. trichome count was genotypically correlated with flower clusters/plant, leaves/plant and % damaged fruits. Number of fruits/plant were phenotypically positively correlated with flower clusters/plant, leaves/plant, plant height and days to final harvest. Trichome count was significantly and negatively phenotypically correlated with number of fruits/plant.
The % damaged fruit exhibited the highest positive direct effect (0.977) on fruit yield. The direct effects of flower clusters/plant, days to final harvest, and leaves/plant were positive upon fruit yield. These traits could be exploited when selecting for high fruit yields in tomato and could be considered concurrently for amenability in fruit yield.

REFEREE

Al-Jibourie, H. A., Miller, P. A. and Robinson, H. F. (1958), Genotypic and environmental variance in an upland cotton cross of inter-specific origin. *Agronomy Journal*, 50: 663-637.

Bhardwaj N. V. and Sharma M. K. (2005). Genetic parameters in tomato. *Bangladesh Journal of Agricultural Research*, 30: (1) 49-56.

Bhatt, G.H. (1973). Significance of path coefficient analysis in determining the nature of character association. *Euphytica*, 22: 338-343.

Dewey, D.R. and Lu, K.H. (1959). A correlation and path coefficient analysis of components of wheat grass seed production. *Agronomy Journal*, 51: 515-518.

Golani I. J., Mehta D. R., Purohit V. L., Pandya H. M. and Kanzariya M. V. (2007). Genetic variability, correlation and path coefficient studies in tomato. *Indian Journal of Agricultural Research*, 41 (2): 146 - 149

Graffius, R. (1964). A geometry for plant breeding. *Crop Science*, 4: 241-246.

Hannan, M. M., Ahmed, M. B., Razuy M. A., Karim, R., Khatun, M., Hayda A., Hossaine, M and Roy, U. K. **(2007).** Heterosis and correlation of yield components in tomato *(Lycopersicon esculentum* Mill.*). American – Eurasian Journal of Scientific Research* **2** (2).

Haydar A., Mandal M. A, Ahmed M. B. K., Hannan M M., Karim R. Razuy M. A., Roy I. K. and Salahin I. N. (2007). *Studies on genetic variability and interrelationship among the different traits in tomato (Lycopersicon esculentum* Mill.*), Middle-East Journal of Scientific Research*, 2: 139-142

Indu Rani C., D. Veeraragavathatham and Sanjutha, S. (2008). Studies on correlation and path coefficient analysis on yield attributes in root knot nematode resistant F_1 hybrids of tomato. *Journal of Applied Sciences Research*, 4(3): 287-295.

Kalloo, G. (1997). Solanaceous vegetables. In 50 years of crop science research in India. ICAR Publication, Ministry of Agriculture, Government of India, New Delhi.

Kennedy, G. G and Sorenson, C. F. (1985). Role of glandular trichomes in the resistance of *Lycopersicon hirsutum* f. *glabratum* to Colorado potato beetle (Coleoptera: chrysomelidae), *Journal of Economic Entomology*, 78 (3): 547-551

Premalakshmi, V. (2001). Breeding for yield and post harvest qualities in tomato (*Lycopersicon esculentum* Mill.). Ph.D. Thesis, Tamil Nadu Agricultural University, Coimbatore.

Sharma, D.C. (1990). Discriminate function selection in tomato (*Lycopersicon esculentum* Mill.) *Thesis Abstract*, 16(3): 227.

Singh, H. N. and Mital, R. K. (1976). Genotypic association and path analysis in tomato. Indian *Journal of Agricultural Research*, 10(2): 83-90.

Singh, R.K. and Chaudhary, B. D. (1977). *Biometrical Methods in Quantitative Genetic Analysis*. Kalyani Publishers, New Delhi.

Srivastava, L. S. and Sachan, S. C. P. (1973). Genetic parameters, correlation coefficient and path coefficient analysis in tomato (*Lycopersicon esculentum* Mill.). *Indian Journal of Agricultural Science*, 43(6): 604-607.

Wright, S., (1921). Correlation and causation. *Journal of Agricultural Research*, 20: 557-587.

Yadav, D. S. and Singh, S. P. (1998). Correlation and path analysis in tomato. *Journal of Hill Research*, 11(2): 207-211.