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CORRELATION AND PATH-COEFFICIENT ANALYSIS OF SOME GROWTH CHARACTERS OF TWO IRRIGATED VARIETIES OF TOMATO (*Lycopersicum esculentum* (L.) H. Karst) IN KADAWA AREA, NIGERIA

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ABSTRACT

Two field trials were conducted in the dry season of 2015/2016 and 2016/2017 at the Irrigation Research Farm of Institute for Agricultural Research, Kadawa located in the Sudan Savannah ecological zone of Nigeria to study correlation and path-coefficient analysis of some growth characters of two irrigated variety of tomato.Treatments consisted of two tomato varieties (UC82B and Rio Grande), two organic mulch (rice straw and sugar-cane peel) at recommended rates of 5 t ha^{-1} and 10 t ha^{-1}, respectively and four nitrogen sources at recommended rate of 90 kg N ha^{-1}. Variety and nitrogen sources were assigned to the main plots while sugar-cane peel mulch was assigned to the sub plots and replicated three times. Plant height contributed the highest individual percentage contribution of 8.72% across the years while in 2015/2016 and 2016/2017. Number of leaves contributed the highest individual percentage contribution of 84.23% and 30.16% respectively. However, plant height via number of branches gave the highest combined percentage contribution of 10.30% in the mean result. The results has shown that to enhance the fresh fruit yield of tomato varieties in the Sudan Savanna characters such as plant height, number of branches and number of leaves, fruit diameter and canopy spread should be considered with plant height playing the most important role and therefore should be given prominence.

Keywords: Tomato; Nitrogen sources; Organic mulches; Sudan Savanna

INTRODUCTION

Crop productivity is influenced by the genetic characteristics of the cultivar, growing environment and management practices. However, yield is a complex character and selection for yield and yield components deserves considerable attention. A crop breeding program aimed at increasing the plant productivity requires consideration not only of yield but also of its components that have direct or indirect bearing on yield. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for improvement in yield Rajasekhar *et al,* (2013).

Path coefficient analysis measures the direct influence of one variable upon another and permits the separation of correlation coefficient into components of direct and indirect effects (Prashanth *et al.,* 2008).

Correlation and path coefficient analysis give an insight into the genetic variability present in populations. Path analysis splits the correlation coefficients into direct and indirect effects of a set of dependent variables on the independent variable thereby aids in selection of elite genotype. Rajasekhar *et al,* (2013) reported that tomato traits such as plant height, number of fruits per plant, fruit length, fruit width and ascorbic acid had high positive direct effects on fruit yield per plant. Hence, direct selection for these traits is done for improving fruit yield per plant. However, studies on correlation and path analysis were carried out using 30 tomato genotypes. Fruit yield had a positive and highly significant association with number of fruits per plant and number of branches per plant and therefore, 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 segregation. Path coefficient analysis revealed that number of flowers per cluster and number of branches per plant had the highest positive direct effect on fruit yield both at genotypic and phenotypic levels and most of the fruit related traits contributed to fruit yield mainly through number of branches. Hence, it would be essential to lay stress on these characters in selection program aiming at increasing the yield (Shashikanth and Dhotre 2012).

An improvement in yield and quality in self pollinated crop like tomato is normally achieved by selecting the genotypes with desirable character combinations existing in nature or by hybridization.

In Nigeria every year it was observed that there is always an increase scarcity and high demand for fresh tomato during the hot dry season (March-June) and this has been attributed to under production. However, tomato production is left in the hand of small and medium scale farmers and this group of farmers use minimum of the improved techniques, thus any practice to be recommended to increase yield and improve quality must be simple, affordable and applicable to small scale production.

Commercial production of tomato relies mostly on exotic introductions and production is essentially restricted to the Northern Guinea Savanna and the Sudan ecologies due to favorable climatic conditions, particularly high insulation and low relative humidity. Relative humidity of 70 % is optimal for pollination, fruit set and development. Very high humidity keeps the pollen too damp and sticky, reducing the chance of sufficient pollen transfer from anthers to stigma (Mariam, 2017).

According to United State Department of Agriculture (USDA, 2012), many tomato products are good sources of potassium and vitamins A, C, and E. Tomato products contain similar amounts of potassium and folate compared with other popular vegetables, but tomato products are superior sources of alpha-tocopherol and vitamin C. In comparison with the other regularly consumed vegetables, only carrots are better dietary source of vitamin A than tomato-based foods. The fruit of tomato is rich in lycopene which may have beneficial health effect. According to Joseph and Yoav (2004) research has demonstrated an array of health benefits clearly associated with tomato products in the diet.

In the Sudan Savanna ecology of Nigeria, observation has shown that farmer's choice of variety for increased yield of tomato depends more on such characteristics as size and firmness of fruit rather than exploring other important characteristic such as adaptation of the varieties to environmental condition.

In view of the foregoing discussions, there is need to standardize production technology under local climatic and edaphic conditions so that farmers of the area can get maximum benefit from tomato production with limited irrigation resources as well as to increase production and also maintain a safe environment under dry season condition.

Therefore this research is to investigate the correlation and path-coefficient analysis of some growth characters of two irrigated varieties of tomato.

MATERIALS AND METHODS

Two field trials were conducted in the dry season of 2015/2016 and 2016/2017 at the Irrigation Research Farm of Institute for Agricultural Research, Kadawa ($11^0$39' N 080' 027'E, 500 m above sea level) located in the Sudan Savannah ecological zone of Nigeria.

Treatments consisted of two tomato varieties (UC82B and Rio Grande), two organic mulches (rice straw and sugar-cane peel) at recommended rates of 5 t ha^{-1} and 10 t ha^{-1} respectively and three nitrogen sources at a recommended rate of 90 kg N ha^{-1}. The first nitrogen source was mineral fertilizer (N.P.K 15:15:15) which was applied to supply 45 kg ha^{-1} of nitrogen as first dose in addition to the P_2O_5 and K_2O which it supplied to meet the P and k requirements of the crop at two weeks after transplanting while urea (46% N) was used to supply the second dose of nitrogen at 45 kg ha^{-1} two weeks after the first application. Poultry manure was applied during land preparation at 90 kg N ha^{-1}. The nitrogen content of the poultry manure used was determined in the laboratory and the value obtained was used to compute the quantity of poultry manure needed to supply 90 kg N ha^{-1}. A mixture of mineral fertilizer (N.P.K-15:15:15) and poultry manure at 45 kg N ha^{-1} each was applied to supply a total of 90 N ha^{-1}. Lastly was a control treatment whose plots were left without any application of fertilizer throughout the period of experimentation. Varieties and nitrogen sources were factorially combined and assigned to the main plots while sugar-cane peels mulch was assigned to the sub plots and replicated three times. The experimental design was hence 2×4×3 factorial in split plot design replicated three times.

The experimental site was mechanically ploughed, harrowed and made into ridges 0.75 cm apart for easy marking out and later prepared manually into sunken beds (plots) of 3×3 m (9 m^2) dimension preparatory to transplanting the crop seedlings. The mean daily temperature and relative humidity in 2015/16 was 32.3 ^{0} C and 57.1 % respectively while in 2016/17 it was 36.2 ^{0} C and 36.5 % respectively. Soil samples were taken randomly at 0-15 and 15-30 cm depth and poultry manure was analyzed for physicochemical properties and chemical composition of green manure, respectively. The textural class of the soil of the experimental site was loamy with nitrogen content of 0.063 % in 2015/2016 and 0.099 % in 2016/2017.

Five plants were sampled and tagged in the net plots and mean value calculated ($plant^{-1}$) for the purpose of collecting the following morphological parameters at 5, 7 and 9 WAT, plant height, number of branches, number of leaves, canopy spread, dry weight and fruit diameter and fresh fruit yield which was determined by weighing the total number of harvested fruits per net plot with the use of a top loader balance and then converted to tones per hectare.

The phenotypic correlation coefficient and direct and indirect effects were computed by using procedure given by Deway and Lu (1959).

RESULTS AND DISCUSSION

Apart from plant height in 2015/2016, fruit diameter in 2016/2017 as well as fruit diameter and canopy spread in the combined results that showed a non significant correlation with fruit yield, all the other characters showed a strong and positive correlation with fruit yield.

The positive and significant correlations shown by almost all the characters with total fruit yield is an indication of the role played by such characters as important yield contributing factors for satisfactory growth and development of tomato in the Sudan Savannah. This is in accordance with the work of Haydar *et al.* (2007) for number of branches. The non significant correlation shown by plant height, and canopy spread does not mean that such character trait did not contribute to growth and development of the plant, however, path analysis has shown that in both years of experimentation, number of leaves of tomato gave the strongest direct contributions while in the combined data, plant height and fruit diameter simultaneously gave the strongest direct contribution to fruit yield of tomato (Table 4). In 2015/16 fruit diameter simultaneously gave the strongest direct contribution to fruit yield of tomato (Table 4). In 2015/16 fruit diameter gave a week contribution but in 2016/17 plant height gave a week direct contribution while in the combine data plant dry weight gave the least direct contribution to fruit yield. Number of leaves via number of branches in 2015/16 had the strongest indirect contribution to fruit yield but in 2016/17 dry weight via number of leaves had the strongest indirect contribution whereas in the combined results number of branches via plant height gave the highest indirect contribution as shown in Table 5).

Number of leaves gave the strongest direct percentage contribution to fresh fruit yield in both years while plant height as well as fruit diameter gave the strongest direct percentage contribution to fruit yield in the combined data. However, number of leaves via canopy spread and number of leaves via fruit diameter in both years, respectively gave the strongest indirect percentage contribution whereas in the combined results,plant height via number of branches gave the strongest indirect percentage contribution to fresh fruit yield. To increase fruit yield of tomato cultivars, good nitrogen and moisture management practices is needed to enhance phenotypic traits such as plant height, number of branches, number of leaves, canopy spread and fruit diameter which will ultimately lead to higher photosynthetic activities. The outcome of this work corroborate with the work of Shashikanth and Dhotre (2012) who observed similar traits in direct cultivar selection for improved fruit yield of tomato.

CONCLUSION

In conclusion, from the present study on correlation and path coefficient analysis in tomato, selection for such traits like plant height, number of branches, number of leaves, fruit diameter and canopy spread might be effective for the fruit yield improvement of tomato plant with height playing the most important role and therefore, should be given prominence.

Table 1: Matrix of correlation between yield, growth and yield components in 2015/2016 dry seasons at Kadawa, Kano Nigeria

	1	2	3	4	5	6	7
1	1.00000						
2	0.52077**	1.00000					
3	0.61831**	0.60202 **	1.00000				
4	0.80786**	0.66976**	0.84572*	1.00000			
5	0.46244**	0.38487*	0.31622 *	0.39230*	1.00000		
6	0.55001**	0.49396**	0.50022**	0.57276**	0.36597*	1.00000	
7	0.19474	0.28789*	0.43620*	0.38256*	0.30280*	0.32924*	1.00000

Df=n-2=70

1. Plant height
2. Number of branches
3. Number of leaves
4. Canopy spread
5. Dry weight
6. Fruit diameter
7. Fresh fruit yield

Table 2: Matrix of correlation between yield, growth and yield components in 2016/2017 dry seasons at Kadawa, Kano Nigeria

	1	2	3	4	5	6	7
1	1.00000						
2	0.27732*	1.00000					
3	0.47899**	0.41474*	1.00000				
4	0.72536**	0.27902*	0.52350**	1.00000			
5	0.29177*	0.24191*	0.35279*	0.16177	1.00000		
6	0.55001**	0.49396 **	0.50022**	0.57276**	0.36597*	1.00000	
7	0.58337**	0.38817*	0.44980**	0.55957**	0.37762**	0.65429	1.00000

Df=n-2=70

1. Plant height
2. Number of branches
3. Number of leaves
4. Canopy spread
5. Dry weight
6. Fruit diameter
7. Fresh fruit yield

Table 3: Matrix of correlation between yield, growth and yield components in the combined result in Kadawa, Kano Nigeria

	1	2	3	4	5	6	7
1	1.00						
2	0.66903**	1.00					
3	0.67135**	0.62774 **	1.00				
4	0.12672	-0.00850	0.24993*	1.00			
5	0.38929**	0.36238**	0.42626**	0.03054	1.00		
6	-0.11932	-0.08982	0.06358	0.59208**	0.00336	1.00	
7	0.62572**	0.55485**	0.57306**	0.18615	0.40195**	0.15117	1.00

Df=n-2=70

1. Plant height
2. Number of branches
3. Number of leaves
4. Canopy spread
5. Dry weight
6. Fruit diameter
7. Fresh fruit yield

Table 4: The direct and indirect contribution of growth and yield component of tomato to fruit yield in 2015/2016, 2016/2017 and combined data at Kadawa Kano Nigeria

	Pant height	Number of Branches	Number of leaves	Canopy spread	Dry weight	Fruit diameter	Totalcorrelated
2015/2016							
Pant height	-0.0791	-0.0917	0.6147	0.0685	0.0535	-0.0451	0.5208
Number of branches	-0.0476	-0.1524	0.7762	0.0563	0.0542	-0.0683	0.6183
Number of leaves	-0.0530	-0.1289	0.9178	0.0698	0.0620	-0.0600	0.8079
Canopy spread	-0.0304	-0.0482	0.3601	0.1780	0.0504	-0.0474	0.4624
Dry weight	-0.0391	-0.0762	0.5257	0.0829	0.1083	-0.0516	0.5500
Fruit diameter	-0.0228	-0.0665	0.3511	0.0539	0.0356	-0.1567	0.1947
2016/2017							
Plant height	-0.0247	0.0216	0.1532	0.0236	0.0332	0.0704	0.2773
Number of branches	-0.0103	0.0522	0.2875	0.0344	0.0336	0.0816	0.4790
Number of leaves	-0.0069	0.0273	0.5492	0.0158	0.0385	0.1015	0.7254
Canopy spread	-0.0060	0.0184	0.0889	0.0974	0.0246	0.0685	0.2918
Dry weight	-0.0122	0.0261	0.3145	0.0356	0.0672	0.1187	0.5500
Fruit diameter	-0.0096	0.02345	0.3073	0.0368	0.0440	0.1814	0.5834
Combined							
Plant height	0.2953	0.1743	-0.0012	0.0151	0.0218	0.1638	0.6690
Number of branches	0.1854	0.2778	0.0367	0.0178	-0.0154	0.1692	0.6714
Number of leaves	-0.0025	0.0694	0.1470	0.0013	-0.1435	0.0550	0.1267
Canopy spread	0.1070	0.1184	0.0045	0.0415	-0.0008	0.1187	0.3893
Dry weight	-0.0265	0.0177	0.0871	0.0001	-0.2423	0.0446	-0.1193
Fruit diameter	0.1638	0.1591	0.0274	0.0167	-0.0366	0.2953	0.6257

Table 5: Percentage contribution of different growth and yield attributes of tomato to fruit yield in 2015/2016, 2016/2017 and combined data in Kadawa, Kano Nigeria

Variable	Percent Contributions (%)		
Individual contribution	2015-16	2016-17	Mean
Plant height	0.63	0.06	8.72
Number of branches	2.32	0.27	7.71
Number leaves	84.23	30.16	2.16
Canopy spread	3.17	0.95	0.17
Dry weight	1.17	0.45	5.87
Fruit diameter	2.45	3.29	8.72
Combined Contribution			
Plant height via Number of branches	1.45	-0.12	10.30
Plant height via Number leaves	-9.72	-0.76	-0.07
Plant height via Canopy spread	-1.08	-0.12	0.89
Plant height via Dry weight	-0.85	-0.16	1.29
Plant height via Fruit diameter	0.71	-0.35	9.68
Number of branches via Number leaves	-23.66	3.00	2.04
Number of branches via Canopy spread	-1.72	0.36	0.98
Number of branches via Dry weight	-1.65	0.35	-0.86
Number of branches via Fruit diameter	2.08	0.85	9.40
Number leaves via Canopy spread	12.82	1.73	0.04
Number leaves via Dry weight	11.38	4.23	-4.22
Number leaves via Fruit diameter	-12.55	8.96	4.98
Canopy spread via Dry weight	1.80	0.48	-0.01
Canopy spread via Fruit diameter	-1.69	1.33	0.99
Dry weight via Fruit diameter	-1.12	0.60	-2.16
Residual	29.80	43.42	33.39
T0TAL	100	100	100

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