VARIABILITY AND CORRELATION AMONG AGRONOMIC AND PHYTOCHEMICAL TRAITS OF TOMATO INBRED LINES

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Abstract— The phytochemical and agronomical features of 15 tomato inbred lines were studied for two successive years under local environmental conditions of Oman. The objectives of this experiment were to; (1) determine the correlation between the variables to explain variation among tomato inbred lines, (2) estimate the relationship and divergence among tomato inbred lines using principal component analysis (PCA) and cluster analysis. The experiments were conducted in randomized complete block design with three replications in Tawoos Agricultural farm in Barka in 2013- 2014. Data collected were 1) Agronomical data: fruit yield, marketable fruit yield, single fruit weight, fruit number and 2) Phytochemical data: PH, TSS, TA and Color. In both years 2013 and 2014, the first three components of PCA showed 76.3 and 77.5% respectively, of the total variation among traits. Agronomical data contributed more in total variation than phytochemical data among different tomato inbred lines. The resulting dendrogram from cluster analysis using ward method revealed 3 groups. The first and second groups show close relationship among inbred lines while the third group with two lines (3022E and GS 12) showed no similarity with other two groups. In 2014, 3125F-19 with the highest fruit size (140 g) grouped alone . This method of grouping inbred lines was completely consistent with the results of principal component analysis. In general, these inbred lines performed well and produced good fruit yield.

Index Terms— TYLCV, virus, resistance, tomato, disease, whitefly, Solanum lycopersicum.

1 INTRODUCTION

Tomato crop (*Solanum lycopersicum* L.) is considered one of the most important vegetable crops cultivated in Oman. Tomato market targets the best fruit yield and quality. In 2016, A total of 110,072 tons of tomatoes were produced in Oman [1]. Tomato fruit is known to have high nutritional value with vitamin C contents [2]. Lycopene and beta-carotene along with other components have attracted the consumer attention due to their efficacy in decreasing the risk of esophagus, stomach, and respiratory tract cancers [3] , [4]. Environmental variability and different crop practices used by farmers make tomato plant breeding more difficult, because different fruit yield and quality responses are obtained among tomato lines and crop environments [5]. Data are available in the literature about tomato yield and fruit quality but few studies correlate between them [6]. Selection of yield based on several characteristics is usually better than based on the yield alone because yield is considered as a quantitative trait that is expressed by multiple genes [7], [8]. Therefore, having adequate knowledge about the degree of association between yield and its components is very important to the breeders. By correlating these components, breeders will be able to understand the strength of correlated traits that would help in decision making process to choose for improvement of more than one character. Some components, such as titratable acidity and PH, are considered as important characteristics of tomato fruit [9]. Organic acids give the fruits sour taste and they have an effect on the flavor of the fruit [10]. Lower pH eliminates the risk of pathogen growth (*Bacillus coagulans*) in tomato fruits [11]. Titratable acidity has no effect on tomato flavor unless pH is low. Therefore, PH bellow 4.5 and citric acid above 0.35 g/100g of fresh weight is desirable. Tomatoes have the advantage of providing adequate proportion of antioxidants in the diet.; lycopene is mainly responsible for red color of tomato fruit [12]. Recently with the availability of more tomato varieties, external fruit characters such as color, size and shape have become as important as phytochemical and nutritional values in some markets. Having enough knowledge about the genetic diversity among different varieties is very important when crossing between distant groups since they will lead to desirable characteristics and segregation for their progenies. Several authors have studied the genetic diversity of different tomato genotypes from different countries [13], [14], [15], [16]. Little information is available regarding the relatedness and variation among tomato genotypes cultivated under dry conditions of Oman. Therefore, the current study was conducted to examine the performance of tomato inbred lines under local conditions and to estimate the pattern of variation and relatedness that are present among different tomato lines.

2. MATERIALS AND METHODS

2.1. Experimental site design

The experiment was carried out successively in fall season for the years 2012 and 2013 from September to February at Tawoos Agricultural Systems, South Al Batinah Governorate, Barka, Oman. A randomized block design was used in both experiments, with three replicates and fourteen tomato inbred lines: 3149A, 3150A-5, 3126A-7, 31250-19, 3136D, 3166E, 3167B, 3078L, 3079E, 3109F, 2819B, 3125E-19, 2498D, and 3022E that have different *Ty* begomovirus resistant genes from the Agricultural Vegetable Research and Development Centre (AVRDC) at Taiwan and one local variety GS 12 from Oman (Table 1). The plant spacing used between and in-row was 1.5 m and 0.5 m, respectively. Tomato plants were adjusted vertically with one stem and pruned after the sixth flower cluster. Each experimental plot consisted of ten plants. The field experiment was carried out under natural conditions without any protection. The seedlings were produced and maintained in 72 cell seedling trays for 35 days after sowing on the 15th of August, then transplanted to soil on the 27th of September each year. Drip irrigation system was used in the two experiments with fertigation being as explained previously [17]. Diseases were controlled periodically as required by the crop. The most important disease was tomato yellow leaf curl disease, caused by begomoviruses. The disease was managed by covering the crop for seven weeks using Agryl cover to reduce the chance of virus transmission via whiteflies.

2.2. Fruit measurements

Fruits were harvested when they reached the complete ripening stage. After each harvest, the fruits were classified and weighed. The fruit quality characteristics were evaluated by using three plants in each plot. In this experiment, only the marketable fruits of high standard were evaluated as marketable yield, isolating fruits that have cracks or that are attacked by fungal or bacterial diseases. Fruits smaller than 40 mm in diameter for oblong and smaller than 50 mm for round fruits were not counted. The following fruit characteristics were evaluated: a) Titratable acidity (TA, % of citric acid) was determined by titrating 5-ml of fruit juice with 0.1 N sodium hydroxide, using phenolphthalein as an indicator; b) pH was determined using pH meter; c) Total soluble solids (TSS, ºBrix) were measured with a refractometer, the juice of fruit was prepared by blending the flesh in blender, then a few drops were put on prism of refractometer and reading was taken by reading the scale in meter; d) the Color (a/b), the a/b ratio increases to zero and above as the fruits ripen toward a dark red, values > 2.0 indicting superior color quality; Hunter L [18] , [19].

2.3. Statistical analysis

Statistical analysis was performed using analysis of variance (ANOVA), and Duncan range multiple test (comparing sets of means). Differences between all treatments means were analyzed by Duncan's least significant difference (LSD) tests. To assess the relationships between characteristics involved in tomato fruit among all the traits pearson's correlation was done and the significance was tested with t-test at a significance level of 0.05 and 0.01. To test variations among the studied tomato inbred lines, component analysis was applied, while Ward's method of cluster analysis was used to group lines. Measured components analysis was done based on the mean of the raw data.

3. RESULTS

3.1. Comparison among traits in the years 2013 and 2014

Comparison between different tomato lines by average of all traits in 2013 and 2014 is presented in Tables 1 and 2. Higher value in TSS content (4.4° Brix) was found in line 3136D. The lowest value was recorded in 3125E-19 line (2.03° Brix). Higher value in TA (0.7 % citric acid) was observed in 2819B while the lowest value (0.283%) was recorded in 3125A-5. The PH showed ideal range, ranging from 3.86 (3109F) to 4.33 (3149A). Three lines (3126A-7, 31250-19, and 3079E) produced deep red internal fruit color clarified by a/b values ≥ 2.0. Mean fruit weight of four lines (3136D, 3166E, 3167B, and 3125E-19) exceeded 100 g. Fruit characters such as fruit number, total yield and marketable yield had higher range of variation between the lines as showed in Table 2. In 2014, higher value in TSS content (4.1° Brix) was found in the local variety GS 12. The lowest value was recorded in 31250-19 line (2.02° Brix). A higher value in TA (0.489 % citric acid) was observed in 3136D while the lowest value (0.217%) was recorded in 3166E. The pH showed data ranging from 3.88 (GS 12) to 4.83 (3125E-19). Five lines (3126A-7, 31250-19, 3166E, 3079E and 3022E) produced deep red internal fruit color clarified by a/b values ≥ 2.0. Mean fruit weight of four lines (31250-19, 3166E, 3167B, and 3125E-19) exceeded 100 g. Fruit characters such as fruit number, total yield and marketable yield had higher range of variation between the lines (Table 2).

Table 1: Mean value of physiochemical parameters evaluated in tomato fruits of tomato inbred line

	pH		Color(a/b)		TSS (Brix)		TA (%)	
Line	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
3149A	4.330a	4.790ab	1.556a	1.377bc	2.066f	2.430cde	0.317de	0.397a
3150A-5	4.160abcd	4.140cde	1.717a	1.737abc	2.33ef	3.230abcd	0.283e	0.347a
3126A-7	3.996def	4.170bcde	2.055a	2.080ab	3.500abc	3.630ab	0.4533bcde	0.287a
31250-19	4.266abc	4.440abcde	2.027a	2.040abc	2.600cdef	1.767e	0.570abc	0.370a
3136D	3.936ef	3.967e	1.907a	1.86abc	4.400a	3.667ab	0.527abcd	0.487a
3166E	3.923ef	4.220abcde	1.520a	2.170a	3.330bcd	2.43cde	0.507abcde	0.217a
3167B	3.986def	4.767abc	1.637a	1.687abc	2.730cdef	2.73bcd	0.667ab	0.477a
3078L	4.076cdef	4.730abcd	1.63a	1.697abc	3.400bc	2.330de	0.600abc	0.340a
3079E	4.133abcde	4.400abcde	2.023a	2.130a	2.667cdef	2.630de	0.467abcde	0.350a
3109F	3.860f	4.767ab	1.7033a	1.910abc	3.866ab	3.300abc	0.317de	0.453a
2819B	4.100bcde	4.300abcde	1.750a	1.350c	2.400def	2.600cde	0.700a	0.403a
3.13E-16	4.310ab	4.830a	1.513a	1.707abc	2.030f	2.800bcd	0.420cde	0.223a
2498D	4.186abcd	4.500abcde	1.530a	1.590abc	2.066f	3.130bcd	0.660ab	0.360a
3022E	4.066cdef	4.100de	1.950a	2.110a	3.200bcde	2.367cde	0.497abcde	0.440a
GS 12	3.970def	3.880e	1.780a	1.480abc	3.966ab	4.100a	0.420cde	0.363a

Columns with the same letter are not significantly different from each other at P< 0.05 (Duncan multiple range test, SAS). *Data were transformed prior to analysis of variance and mean separation. Non-transformed means are shown. **Values for a and b were measured with a chromometer using a red standard surface. Immature green tomatoes have an a/b ratio less than 0. The a/b ratio increases to zero and above as the fruits ripen toward a dark red. Values > 2.0 have superior color.

Table 2: Mean value of agronomic parameters evaluated in tomato fruits of tomato inbred line

	Fruit weight(g)		Fruit number/Plant		Total yield(t/ha)		Marketable yield(t/ha)	
Line	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**	**2013**	**2014**
3149A	105.0ab	96.3bc	31.3c	28.0cde	40.3de	34.7bc	31.0de	24.0ef

3150A-5	94.0ab	93.7bc	39.3b	32.3bc	33.0efg	39.7abc	22.3f	30.7bcde
3126A-7	75.3b	85.3bc	47.0a	43.7a	42.7cd	49.0a	33.0cd	39.3a
31250-19	99.0ab	100.7ab	29.0cd	27.7cde	42.7cd	35.7bc	33.3cd	28.7cde
3136D	100.3ab	95.0bc	24.0de	25.7def	31.0fg	32.3cd	22.3f	25.3ef
3166E	105.0ab	101.7ab	20.0ef	23.0efg	39.7de	35.0bc	29.0de	28.0de
3167B	104.7ab	100.0ab	20.0ef	18.3gh	49.3abc	40.0abc	37.3bc	30.0cde
3078L	91.0ab	85.3bc	24.0de	31.3bcd	51.7ab	45.0ab	43.0ab	32.0abcde
3079E	77.0b	80.7bc	27.0cd	26.7cdef	52.0ab	40.7abc	40.3b	26.7e
3109F	78.7b	79.0bc	31.7c	32.3bc	57.0a	48.0a	47.7a	36.7abc
2819B	77.0b	76.3bc	28.7cd	34.3b	50.0abc	44.0ab	39.0bc	35.3abcd
3.13E-16	140.3a	138.0a	18.0fg	21.3fg	48.7bc	45.0ab	40.0b	38.7ab
2498D	88.0ab	88.0bc	20.3ef	18.7gh	38.0def	31.7cd	26.7ef	17.7fg
3022E	70.3b	68.7bc	4.5h	5.6h	21.3g	22.0de	10.0g	8.0g
GS 12	57.3b	57.3c	5.0gh	6.0h	20.3g	20.0e	5.0g	7.0g

Columns with the same letter are not significantly different from each other at P< 0.05 (Duncan multiple range test, SAS). *Data were transformed prior to analysis of variance and mean separation. Non-transformed means are shown.

3.2 Correlation between traits in 2013 and 2014

Results of correlation analysis between different traits in 2013 and 2014 are summarized in Table 3. The strongest positive correlation was observed between total yield and marketable yield (0.99, P<0.01) followed by the correlation between fruit number and marketable yield (0.5148, P<0.05). TSS , TA and red color showed negative insignificant correlation with most of the other traits (Table 3). In 2014, fruit weight and total yield were positively correlated with pH (0.51445 and 0.57259, respectively) at P<0.05. The strongest positive correlation was observed between total yield and marketable yield (0.976, P<0.01) followed by the correlation between fruit number and total yield (0.855, P<0.01). Red color intensity was negatively correlated with TSS and TA (Table 3).

3.3 Principal component analysis (PCA)

This analysis was based on 8 traits in 15 tomato inbred lines. In 2013, the first three components justified a total of 76.3% of variation between the data according to Joliffe cut off (0.6) (Table 4). The first component was contributing in 37.4% of the total variation and 51.50% of the variation by the other 3 components. In the first component, the color and TSS have negative contribution and other 6 traits had positive contribution (Table 4). The highest negative values for PC1 indicated inbred lines that had lower Y and fruit number, fruit yield and marketable yield (Fig. 1). Positive values for PC1 corresponded to inbred lines 3149A and 3125E-19. The second component contributed 22.98% of the total variance. In this component, positive values for PC2 corresponded to inbred lines 3126A-7 and 3109F. The negative significant coefficients belonged to pH and fruit weight, others are positive to the PC 2. The third component includes pH, color and fruit number which contributed positively to PC3; others have a negative role. Inbred lines that positively contributed to PC3 are 3150A-5 and 3126A-7 (Fig. 1). In 2014, the PCA showed that more than 77.5% of the variability observed was explained by the first 3 components. PC1, PC2 and PC3 accounted for 44.195%, 17.21% and 16.086%, respectively. Correlation between fruit trait components and the first three principal components for tomato inbred lines is shown in Table 1. The highest positive values for PC1 indicated that inbred lines 3126A-7 and 3125F-19 had more fruit weight, fruit number, total yield, marketable yield and PH whereas, 3022E and GS 12 inbred lines represented the highest negative values (Fig. 1). PC2 indicated the highest positive values for TSS which include inbred lines 3126A-7 and 3136D and negatively correlated to inbred lines 3125F-19 and 3022E (Fig. 1). The highest positive PC3 value belongs to the inbred line that had the highest percentage of TA (3149A) (Fig. 1). Negative values for PC3 indicated the inbred lines that had higher color index. This group included inbred lines 3166E and 3126A-7(Fig. 1).

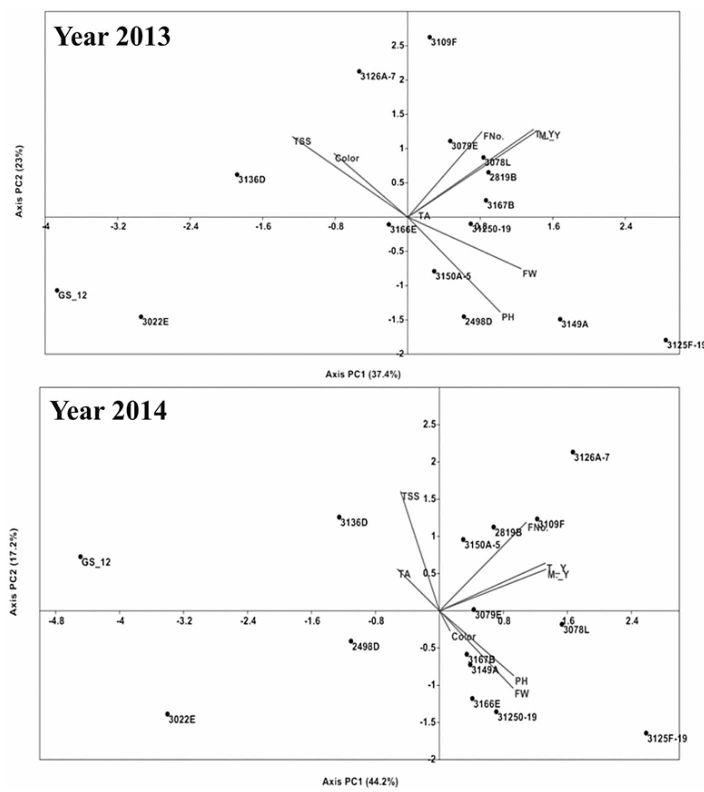

Fig. 1. Segregation of 15 tomato inbred lines according to their fruit quality determined by principal component analysis (PCA). Vectors represent the loadings of quality traits data along with the principal component scores. Abbreviations in biplot are: TSS: Total soluble solids content; T-Y: Total yield; M-Y: Marketable yield; FNo: fruit number;: pH: pH value; FW: Fruit weight; TA: Titratable acidity.

3.4 Cluster analysis

The relationship among 15 tomato inbred lines revealed by cluster analysis in 2013 is presented in Fig. 2. There are three clusters that can be framed from cluster analysis. Out of 15 inbred lines, 3022E and GS12 formed cluster I. 3126A-7, 3109F, 3079E and 2819B formed cluster II whereas, all other lines formed cluster III (Fig. 2). In 2014, the dendrogram generated from the cluster analysis based on UPGA distance classified 15 inbred lines into 4 main groups (Fig. 2). The first group included two inbred lines: 3022E and GS 12. The second group was made up of one inbred line: 3125E-19. The third group comprised of five inbred lines: 3126A-7, 3109F, 2819B, 3078L and 3079E. The fourth group consisted of 2498D, 31250A-5, 3167B, 3149A, 3136D, 31250-19 and 3166E (Fig. 2).

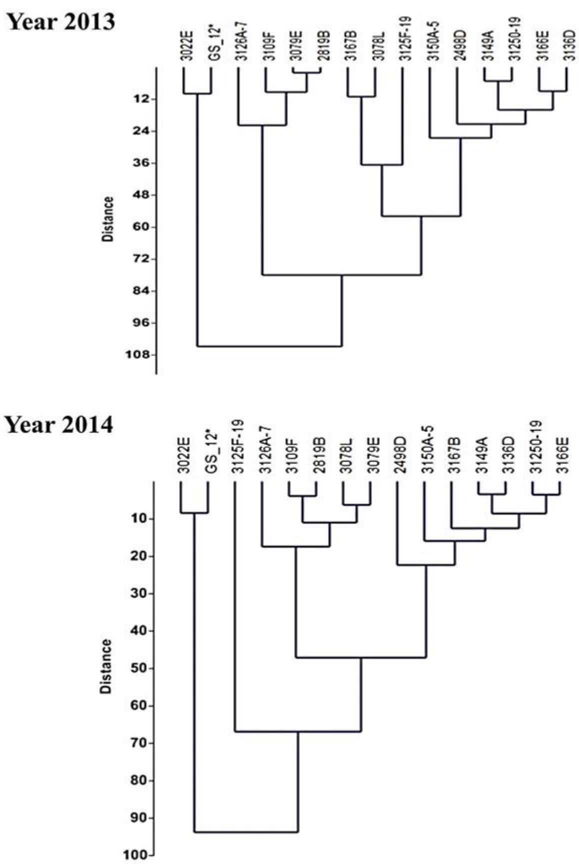

Fig. 2. Dendrogram of 15 tomato inbred lines obtained by ward method cluster analysis based on 8 fruit quality traits for years 2013 and 2014. (* is the local cultivar 'GS 12).

4. DISCUSSION

Tomato crop production targets to help the markets and provide high quality fresh fruit for human consumption. Getting higher fruit quality cultivars has been obstacled by negative correlation between fruit quality and plant yield. Environmental changes and different crop practices used by farmers make the breeding of tomato more difficult [5]. The data of two successive years obtained in this study displayed same pattern based on the data with slight differences in yield and other traits. A negative correlation between pH and yield has been found in this study which is consistent with the results presented by Stevens and Rudich [20]. Most inbred lines produced excellent internal red color and low solids. Most lines have more than 0.35% of citric acid. Palop, Raso [11] reported that low pH eliminates the risk of pathogen growth (*Bacillus coagulans*) in tomato products. Titratable acidity has no significant effect on tomato flavor unless pH is low. For this reason, a pH below 4.5 and citric acid of more than 0.35 % of fruit are desirable. Hence, by correlation studies, it is easy to assume the relationship between groups of traits or which trait is directly associated with other trait. The total yield is strongly correlated to marketable yield and fruit weight as well as fruit number. This strong correlation is reasonable due to the direct effect of each of these traits on others. In few cases, there is no correlation between total yield and fruit number or sometimes with fruit weight. The negative correlation observed between fruit number and fruit weight can be explained in that if there are more fruits in plant, the tomato fruit weight will tend to be smaller as fruits will compete for nutrients. [21] found that average fruit weight is the most important yield contributing character after fruit number per plant. [22] reported that the number of fruits per plant is the most important yield attributing traits. Some statistics such as Principal component analysis |(PCA) and cluster analysis play an important role in the study of parental selection that has good characteristics, genetic variation among different cultivars, and the interaction effects of tomato inbred lines and environment. In plant breeding programs, the lines that have more genetic distances are used for crosses. The distance between different lines is determined based on cluster analysis. [23] have used the principal component analysis to determine the effects of interaction among different sunflower cultivars and environments and to look for the possibility of improving the yield component in such environments. [24] have used this method to faster the choice of cultivar for traits such as yield and to reduce the costs, being very useful in choosing new cultivars in early stages. In this study, the PCA showed slight differences between the two years in some parameters, which is mainly related to phytochemical parameters not to the agronomic traits. This is because such parameters are more changing (increase or decrease) due to fruit stage, temperature, solar radiation and irrigation regime. [25] reported that traits with higher values in the first principal component are more close to unity than those which are close to zero. [26] stated that 57% of total variation was explained in the first 3 principal components when evaluating 143 tomato lines in North America. In 2013 The dendrogram obtained from the cluster analysis grouped the 15 tomato lines into 3 groups, 2 groups are close to each other and they are distinguished from the third group which includes (3022E and GS 12) in their better agronomic traits such as total yield, marketable yield, fruit weight and fruit number. In 2014 one line (3125E-19) grouped separately and this is due to its highest fruit weight as compared with other lines. For breeder, this shows the possibility to cross any line of low fruit character to others of high quality in other groups. The best recombination and segregation of progenies is expected to come from cluster having 3022E and GS 12 with any line in other groups. Therefore, the integration between inbred lines that are in different groups could present more variations and lead to increase yield or other agronomic traits depending on the object. [27] used cluster analysis to study the genetic diversity among different tomato genotypes in Ethiopia. It was applied for other crops as well such as squash [28] and rice [29]. [30] stated that determining the degree of relationship and divergence among tomato genotypes is considered to be one of the most essential steps for successful selection process in plant breeding programs**.**

5. CONCLUSIONS

Performance among tomato lines was found to be more variable in terms of agronomic traits than phytochemical traits. The existence of this variability is crucial because the success of any crop development relies on variability and to the character which is heritable. Except 3022E and GS 12, most inbred lines came up with a better characteristic in terms of yield and most of the measured components. PC analysis revealed that the total yield, marketable yield, fruit weight and fruit number contributed in the highest variation compared with the other traits. The cluster analysis showed clear relatedness among tomato lines and complement the results that obtained by PCA. From the present findings it is suggested that 3022E and GS 12 can be considered for yield improvement by crossing with other lines having higher performance. 3125F-19, which has the highest fruit size compared with others, can be considered for fruit size improvement by crossing with some lines of low size fruits. The breeders are more interested in the lines that are distantly related as they could have different characteristics [31]. They can cross 3022E and GS 12 lines with lines in the other two groups which have high agronomic features or even cross other lines of small fruit size with 3125F-19. However, results of this study come out from 15 tomato inbred lines and their general performance in terms of yield is well under local conditions of Oman.

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Table 3 Pearson's correlation coefficients and level of significance among traits analysed in fruits of tomato inbred lines.

Year 2013	PH	Color (a/b)	TSS (Brix %)	TA (%)	Fruit weight (g)	Fruit number/Plant	Total yield (t/ha)	Marketable yield (t/ha)
PH	1							
Color (a/b)	-0.15383	1						
TSS (Brix %)	**-0.839****	0.362477	1					
TA (%)	-0.06873	-0.00335	-0.0876417	1				
Fruit weight (g)	0.458411	-0.51871	-0.4333402	-0.02904	1			
Fruit number/Plant	0.10121	0.191702	-0.153331	-0.25242	0.086706	1		
Total yield (t/ha)	0.060299	-0.1929	-0.2564995	0.160081	0.316855	0.4774706	1	
Marketable yield (t/ha)	0.090894	-0.19149	-0.2483892	0.133305	0.3799	**0.514866***	**0.991228****	1

Year 2014	PH	Color (a/b)	TSS (Brix%)	TA (%)	Fruit weight (g)	Fruit number/Plant	Total yield (t/ha)	Marketable yield (t/ha)
PH	1							
Color (a/b)	-0.222	1						
TSS (Brix%)	-0.463	-0.18287	1					
TA (%)	-0.038523	-0.21104	0.104247	1				
Fruit weight (g)	**0.5144512***	0.058742	-0.30664	-0.4321	1			
Fruit number/Plant	0.2230631	0.067618	-0.03596	-0.1649	0.1988095	1		
Total yield (t/ha)	**0.5725978***	0.058254	-0.14166	-0.2211	0.4341127	**0.855****	1	
Marketable yield (t/ha)	0.4947921	0.110705	-0.15846	-0.2824	**0.5167730***	**0.839****	**0.976****	1

*The correlation is significant at level P < 0.05 (2-tailed). **The correlation is significant at level P < 0.01 (2-tailed)

Table 4
Correlation coefficients, Eigen value, relative and cumulative variance of 3 main components of essential components analysis of the yield components of tomato inbred lines and component loadings for 15 tomato inbred lines in the years 2013 and 2014

	2013			2014		
Traits	**PC 1**	**PC 2**	**PC 3**	**PC 1**	**PC 2**	**PC 3**
PH	0.5719	**-0.6086**	0.3638	**0.6617**	-0.3872	0.5255
Color(a/b)	-0.456	0.4085	0.4202	0.09602	-0.1216	**-0.8054**
TSS(Brix)	**-0.7125**	0.5164	-0.1527	-0.3476	**0.715**	-0.05802
TA (%)	0.05733	0.03889	**-0.7429**	-0.3773	0.251	0.5886

Fruit wt(g)	**0.7007**	-0.3309	-0.1091	**0.6573**	-0.4628	-0.05695
Fruit Number	0.4591	0.5486	0.5644	**0.774**	0.5297	-0.06467
Total yield(t/ha)	**0.7766**	0.5623	-0.1864	**0.9437**	0.2853	0.05828
Marketable yield(t/ha)	**0.8006**	0.5538	-0.1506	**0.9506**	0.2485	-0.03789
Eigenvalue	**2.99166**	**1.83887**	**1.27189**	**3.5356**	**1.37681**	**1.28689**
% variance	**37.396**	**22.986**	**15.899**	**44.195**	**17.21**	**16.086**
Cumulated % variance	**37.396**	**60.382**	**76.281**	**44.195**	**61.405**	**77.491**
Tomato lines	**PC1**	**PC2**	**PC3**	**PC1**	**PC2**	**PC3**
3149A	1.6812	-1.4905	1.4487	0.38461	-0.72236	1.8447
3150A-5	0.29197	-0.78968	2.1526	0.29727	0.95819	-0.42811
3126A-7	-0.53509	2.1276	1.5277	1.6681	2.1329	-1.6833
31250-19	0.69477	-0.0981	0.72254	0.71028	-1.3553	-0.51681
3136D	-1.8819	0.62068	-0.29327	-1.2543	1.2588	-0.11808
3166E	-0.20852	-0.10672	-1.1977	0.41067	-1.1777	-2.1737
3167B	0.86334	0.24502	-1.7469	0.34084	-0.58312	1.5731
3078L	0.83579	0.87078	-1.1871	1.5315	-0.17993	0.58261
3079E	0.46894	1.1111	0.68577	0.42759	0.017915	-0.93978
3109F	0.24272	2.6263	0.055669	1.2214	1.2344	0.74093
2819B	0.89032	0.65391	-0.88938	0.67687	1.1252	1.2273
3125F-19	2.8465	-1.7943	-0.18242	2.5843	-1.6426	-0.20229
2498D	0.61977	-1.452	-0.96015	-1.107	-0.40698	0.64582
3022E	-2.9419	-1.455	-0.00543	-3.4019	-1.3865	-0.61362
GS_12	-3.8679	-1.0692	-0.13061	-4.4902	0.72711	0.061189