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YIELD AND FRUIT TRAITS OF SELECTED TOMATO GENOTYPES UNDER SAINT CATHERINE CONDITIONS, SOUTH SINAI

K.E.M. Bayomi

Plant Breeding Unit, Genetic Resources Dept., DRC, Cairo, Egypt.

ABSTRACT

Performance of genotypes under Egyptian desert conditions comes in the first order for Plant Breeding and Conservation Program of Desert Research Center (DRC). Yield and fruit traits parameters are important criteria for selection of appropriate genotypes for hybrid production. Evaluation was carried out for fifteen selected genotypes of tomato at a local community farm, Saint Catherine, South Sinai during 2020 and 2021 seasons. The experimental design was randomized complete block design with three replicates. The results indicated that tomato genotypes mean squares were highly significant for all studied traits at the two growing seasons. Based on the results obtained, the most productive tomato genotypes and those best adapted to the climatic conditions of the location were identified. All traits were similar in the two growing seasons; therefore reflecting the stability of genotypes. This is considered as necessary for hybrid production in future. Through the two season's data, SGE12031 genotype was the best for all traits under Saint Catherine conditions. Yield per plant showed a positive and significant correlation with all studied traits, except fruit set percentage and TSS%, which had a significant negative correlation with yield.

Key words: ***Tomato genotypes, Solanum lycopersicum L., plant yield, Saint Catherine, South Sinai.***

INTRODUCTION

Today, tomato is a premier vegetable and is one of the most popular and globally grown crops all over the year. It belongs to the family *Solanaceae*. It is originated from Peru-Ecuador Bolivia region of the Andes in South America. It is recognized as an important commercial and dietary vegetable crop and occupies a prominent position among vegetables, due to its export value (Singh *et al* 2014).

Tomato is a good source of minerals, vitamins A, B1, B2, B3, B6, C, E, niacin, folic acid, biotin, and other compounds, including lycopene that has antioxidant activity and is associated with reduced risk of cancer (Soares and Farias 2012) and development of risk reduction of other chronic diseases (Moritz and Tramonte 2006).

Mishra and Lal (1998) studied the performance of 39 varieties of tomato and found that variety Pusa Ruby was found to have maximum fruit yield per plant (2.7 kg). Gustavo *et al* (2006) evaluated seventeen tomato recombinant inbred lines for plant traits (internodes length between third and fourth node, number of flowers per inflorescence, stem perimeter at the basal, middle, and apical part) and fruit traits (soluble solid content, pH, acidity, diameter, height, shape, weight and shelf life). They found that number of flowers per inflorescence was between 5.2 and 12.1. Soluble solid content was between 3.7 and 5.8. Fruit diameter was between 1 and 7.2cm. Fruit height was between 0.9 and 5.4cm and fruit weight between 0.9

and 98.5g. Ahmad *et al* (2007) reported that fruit weight per plant was between 0.83 and 3.03 kg. Golani *et al* (2007) in evaluating tomato genotypes with path analysis confirmed that fruit weight had the highest positive direct effect followed by number of carpels per fruit.

Alam *et al* (2010) studied eight hybrid tomato lines bred for heat tolerance to observe their fruit setting ability and yield performance under the hot, humid conditions. They found that fruit set percentage was between32.96 and 52.85. Fruit weight was between33.97 and 56.02 g. TSS % was between 3.71 and 4.39. The total fruit yield per plant was between 1.20 and 1.73 k g. Yesmin *et al* (2014) found that the total fruit yield per plant was between 2.03 and 2.94 kg. No. of locales per fruit was between 2.2 and 5.06.

Kumar *et al* (2015) evaluated tomato lines for quantitative traits such as plant height, fruit yield, single fruit weight, total soluble solids, fruit weight loss and fruit shelf-life in greenhouse as well as in the field conditions. They found that, in field conditions, the total fruit yield per plant was between 420 and 1805 g. Fruit weight was between 53.0 and 149 g. No. of locales per fruit was between 2.0 and 5.0.

Bayomi *et al* (2019) evaluated fifty one tomato genotypes in two locations. They found that Edkawy, SD174-5-2, SH174-7, SK1743 and SY174-1 were the best genotypes for yield per plant at two locations. Fruit set percentage was between 48.83 and 90.9%. Fruit weight was between 52.5 and 152.7 g. Locules per fruit was between 3.57 and 7.37. TSS % was between 3.1 and 4. 9. The total fruit yield per plant was between 1223.83 and 2054.30g . Yield per plant showed a positive and significant correlation with all studied traits, except TSS%, which had a significant and negative correlation with yield.

The genotypes made available to tomato breeders from Plant Breeding and Conservation Program of Desert Research Center include crosses, selections and inbred lines, also included both determinate and indeterminate lines. The genotypes are designated by a combination of letters and numbers. The first letter “S” refers to Sinai. The second letter and numbers refers to description of breeding lines. The objective of this study

was the evaluation of fifteen genotypes of determinate tomato at Saint Catherine, South Sinai for the selection of appropriate parents for hybrid production.

MATERIALS AND METHODS

The trial was set up during 2020 and 2021 seasons. Evaluation was carried out for fifteen selected genotypes of tomato at a local community farm, Saint Catherine, South Sinai. Study area; Saint Catherine Protectorate was established in 1996, under the support of the Egyptian Environmental Affairs Agency (EEAA). It extends over virtually the entire mountain massif of southern Sinai, an area of 4350 km^2. It lies between 33° 55′ to 34° 30′E and 28° 30′ to 28° 35′N with an elevation range of 1300–2641 m above sea level. Tomato genotypes (inbred lines) obtained from Plant Breeding and conservation Program of Desert Research Center (DRC) were SGE12031, SGE3203R, SGE4203R, STEL176, SA1174, SA4175, SC1-0175, SD5-3176, SR2175, SS5-1176, SAL2167, SAL4167, SAR215, SR71166 and SR72166.

Tomato genotypes were evaluated in a randomized complete blocks design with three replications. Each replicate contained 15 experimental plots. Each experimental plot contained two rows of 3.5 meter long and 1 meter wide. Plants were transplanted on the 15th of May in the two seasons and the distance between plants was 50 cm in the row. Drip irrigation system was used; fertigation was carried out according to the recommendations. Routine cultural practices were done as needed similar to those used in tomato production at the two seasons.

The observation of eight important traits was recorded from five randomly selected plants from each plot. Measurements were recorded on number of flowers/cluster, fruit set(%), average fruit weight(g), fruit length(cm), fruit diameter (cm), number of locules/fruit, total soluble solids (T.S.S.%) and total yield /plant(kg).

Statistical Analysis: statistical analysis was performed using analysis of variance technique by means of "MSTAT" computer software package. The treatment means were compared using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Analyses of variance for genotypes in the two growing seasons are presented in Table (1). Tomato genotypes mean squares were highly significant for all traits at the two seasons, indicating that the genotypes different significant and behaved differently from year to another. Differences among genotypes are necessary to continue to study the genetic behavior of these traits to improve them. These results are in the same line with those obtained by Gustavo *et al* (2006), Alam *et al* (2010), Yesmin *et al* (2014), Kumar *et al* (2015) and Bayomi *et al* (2019).

Table 1. Analysis of variance (ANOVA) for number of flowers/cluster, fruit set%, fruit weight, fruit length, fruit diameter, number of locules/fruit, T.S.S% and yield/plant of fifteen tomato genotypes under Saint Catherine conditions in the two growing seasons.

SOV	df	No. of flowers/ cluster	Fruit set (%)	Fruit weight (g)	Fruit length (cm)	Fruit diameter (cm)	No. of locules/ fruit	T.S.S (%)	Yield/ plant (kg)
2020 Season									
Rep.	**2**	**0.68**	**2.69**	**88.41**	**0.01**	**0.06**	**0.82**	**0.01**	**0.08**
Genotype	**14**	**13.59****	**310.05****	**1986.72****	**2.42****	**1.16****	**4.17****	**1.62****	**0.59****
Error	**28**	**1.02**	**14.25**	**367.73**	**0.04**	**0.06**	**0.47**	**0.05**	**0.03**
2021 Season									
Rep.	**2**	**0.87**	**4.45**	**53.69**	**0.02**	**0.06**	**0.15**	**0.09**	**0.01**
Genotype	**14**	**17.19****	**397.96****	**2579.82****	**2.84****	**1.42****	**5.61****	**1.47****	**0.73****
Error	**28**	**0.84**	**21.89**	**153.20**	**0.06**	**0.12**	**0.29**	**0.07**	**0.03**

*** and **: significant at 0.05 and 0.01 levels of probability, respectively.**

The results presented in Table (2) indicate clearly that, significant differences were recorded among the different tomato genotypes in number of flowers/cluster. The average number of flowers/cluster was 5.36 and 5.33 in the first and second seasons, respectively. SGE12031 genotype gave the highest value of number of flower/cluster (12.67 and 13.67) in the first and second seasons, respectively. While, SR72166 genotype recorded the lowest value of number of flowers/cluster trait at the two growing seasons. Gustavo

et al (2006) found that number of flowers per cluster was between 5.2 and 12.1

The average fruit set percentage was 56.9 and 63.8% in the first and second seasons, respectively. The highest value of fruit set percentage was recorded for SGE12031 genotype (79.6 and 78.7 % in the first and second seasons, respectively). While, SR72166 genotype gave the lowest values of fruit set percentage (43.7 and 36.8%) in the first and second seasons, respectively. Generally, five genotypes (SGE12031, SGE3203R, SGE4203R, STEL176 and SA1174) were the best with respect to fruit set percentage in the two growing seasons. Alam *et al* (2010) found that fruit set percentage was between32.96 and 52.85. Bayomi *et al* (2019) found that fruit set percentage was between 48.83 and 90.9%.

Table 2. Average performance for number of flowers/cluster, fruit set%, fruit weight, fruit length, fruit diameter, number of locules/fruit, T.S.S% and yield/plant of fifteen tomato genotypes under Saint Catherine conditions in the two growing seasons.

Genotype	No.of flowers/cluster		Fruit set (%)		Fruit weight (g)		Fruit length (cm)	
	2020	2021	2020	2021	2020	2021	2020	2021
SGE12031	12.67 a	13.67 a	79.6 a	78.7 a	158.1 a	158.7 a	7.97 a	8.20 a
SGE3203R	6.00 b	6.00 b	78.5 a	74.7 ab	127.6 ab	158.4 a	7.07 b	6.83 b
SGE4203R	5.67 bc	5.67 bc	76.2 ab	72.1 abc	123.6 bc	135.2 b	6.17 c	6.17 c
STEL176	5.67bc	5.33 bcd	74.4 ab	71.5 abc	119.1 bc	122.6 bc	5.97 c	6.10 c
SA1174	5.33 bcd	5.00 bcde	73.4 abc	70.6 bc	110.6 bcd	112.5 cd	5.93 cd	6.07 c
SA4175	5.33 bcd	5.00 bcde	70.4 bcd	69.6 bc	106.9 bcd	110.9 cd	5.63 de	5.87 cd
SC1-0175	5.00 bcd	5.00 bcde	67.4 cde	68.3 bcd	103.5 bcde	105.3 cde	5.53 e	5.57 de
SD5-3176	4.67 bcd	5.00 bcde	66.8 def	67.9 bcd	101.9 bcde	99.7 def	5.53 e	5.47 def
SR2175	4.67 bcd	4.67 bcde	65.9 def	66.3 cd	92.4 cdef	97.6 def	5.40 ef	5.23 efg
SS5-1176	4.67 bcd	4.33 cde	63.1 efg	64.8 cde	86.1 def	94.5 def	5.37 ef	5.07 fgh
SAL2167	4.33 bcd	4.33 cde	60.9 fgh	60.9 de	83.4 def	87.6 efg	5.20 fg	5.07 fgh
SAL4167	4.33 bcd	4.33 cde	59.4 gh	58.4 ef	80.9 def	84.4 fgh	5.00 gh	5.00 ghi
SAR215	4.33 bcd	4.00 de	65.0 hi	52.6 f	72.2 ef	70.2 gh	4.80 hi	4.70 hij
SR71166	4.00 cd	4.00 de	52.6 i	44.6 g	66.6 f	70.0 gh	4.7 hi	4.63 ij
SR72166	3.67 d	3.67 e	43.7 j	36.8 g	64.4 f	64.6 h	4.63 i	4.46 j
Average	5.36	5.33	56.9	63.8	99.8	104.8	5.66	5.63

Table 2. Cont.

Genotype	Fruit diameter (cm)		No. of locules/fruit		T.S.S (%)		Yield /plant (kg)	
	2020	2021	2020	2021	2020	2021	2020	2021
SGE12031	6.67 a	6.70 a	5.67 a	6.33 a	6.3 a	6.3 a	2.79 a	3.01 a
SGE3203R	6.30 ab	6.57 ab	5.33 a	5.67 ab	6.3 a	6.0 a	2.77 a	2.83 ab
SGE4203R	6.30 ab	6.43 ab	5.00 a	5.00 bc	5.3 b	5. 3 b	2.55 a	2.55 bc
STEL176	6.13 bd	6.23 ab	5.00 a	4.67 c	5.1 b	5.١ b	2.25 b	2.37 c
SA1174	6.10 bc	6.23 ab	3.33 b	4.33 c	5.1 b	5. 3 b	2.06 bc	2.35 c
SA4175	5.87 cd	6.03 bc	3.00 bc	3.00 d	5. 3 b	5. 3 b	2.05 cbd	2.03 d
SC1-0175	5.80 cde	6.03 bc	3.00 bc	3.00 d	5. 3 b	5. 3 b	1.94 cd	2.03 d
SD5-3176	5.57 de	5.63 cd	3.00 bc	3.00 d	5. 1 b	5. 1 b	1.92 cd	1.99 de
SR2175	5.67 de	5.63 cd	3.00 bc	3.00 d	4. 3 c	5.0 b	1.91 cd	1.97 de
SS5-1176	5.63 de	5.57 cd	3.00 bc	3.00 d	4. 1 cd	4.7 bc	1.88 cde	1.84 def
SAL2167	5.43 ef	5.37 de	2.67 bc	2.67 de	4. 1 cd	4.3 cd	1.79 de	1.76 def
SAL4167	5.17 fg	5.13 def	2.67 bc	2.33 de	4. 1 cd	4.0 d	1.63 ef	1.72 efg
SAR215	4.93 gh	4.87 efg	2.67 bc	2.33 de	4. 1 cd	4.0 d	1.62 ef	1.60 fg
SR71166	4.70 hi	4.73 fg	2.33 bc	2.00 e	4. 1cd	4.0 d	1.40 fg	1.47 gh
SR72166	4.50 i	4.50 g	2.00 c	2.00 e	3.67 d	4.0 d	1.34 g	1.27 h
Average	5.65	5.71	3.33	3.49	4.٨	4.٩	1.99	2.05

The average fruit weight was 99.9 and 104.8g in the first and second seasons, respectively. The highest value of fruit weight was recorded for SGE12031 genotype (158.1 and 158.7g) in the first and second seasons, respectively). While, SR71166 and SR72166 genotypes gave the lowest values of fruit weight in the two growing seasons. Generally, all genotypes had good average fruit weight in the two growing seasons, except SAR215, SR71166 and SR72166 genotypes. Gustavo *et al* (2006) found that fruit weight was between 0.9 and 98.5g. Alam *et al* (2010) found that fruit weight was between 33.97 and 56.02 g. Kumar *et al* (2015) found that fruit

weight was between 53.0 and 149 g. Bayomi *et al* (2019) found that fruit weight was between 52.5 and 152.7 g.

The average fruit length was 5.66 and 5.63cm in the first and second seasons, respectively. The highest value of fruit length was recorded for SGE12031 genotype (7.97 and 8.20cm) in the first and second seasons, respectively). While, SR71166 genotype gave the lowest value of fruit length (4.63 and 4.46cm in the first and second seasons, respectively). Gustavo *et al.* (2006) found that fruit height was between 0.9 and 5.4 cm.

The average fruit diameter was 5.65 and 5.71cm in the first and second seasons, respectively. The highest value of fruit diameter was recorded for SGE12031 genotype (6.67 and 6.70cm in the first and second seasons, respectively). While, SR72166 genotype gave the lowest values of fruit diameter 4.50cm in the two growing seasons. Generally, SGE12031, SGE3203R and SGE4203R genotypes recorded the best fruit diameter in the two growing seasons. Gustavo *et al.* (2006) found that fruit diameter was between 1 and 7.2 cm.

The average number of locules per fruit was 3.33 and 3.49 in the first and second seasons, respectively. The highest value of number of locules/fruit was recorded for SGE12031 genotype (5.67 and 6.33) in the first and second seasons, respectively). While, SR71166 genotype gave the lowest values of number of locules/fruit (2.00) in the two growing seasons. SA4175, SC1-0175, SD5-3176, SR2175 and SS5-1176 genotypes recorded (3.00) locules/fruit in the two growing seasons. Yesmin *et al* (2014) found that the number of locales per fruit was between 2.2 and 5.06. Kumar *et al* (2015) found that the number of locules per fruit was between 2.0 and 5.0. Bayomi *et al* (2019) found that number of locules per fruit was between 3.57 and 7.37.

The average total soluble solids (T.S.S.%) was 4.8 and 4.9 in the first and second seasons, respectively. The highest value of total soluble solids was recorded for SGE12031and SGE3203R genotypes in the two growing seasons. While, SR72166 genotype gave the lowest value of total soluble solids in the two growing seasons. Gustavo *et al* (2006) found that soluble solid content was between 3.7 and 5.8. Alam *et al* (2010) found that

total soluble solids was between3.71 and 4.39. Bayomi *et al* (2019) found that total soluble solids was between 3.1 and 4. 9.

The average yield per plant was 1.99 and 2.05 kg in the first and second seasons, respectively. SGE12031, SGE3203R and SGE4203R genotypes gave the highest value of yield per plant of 2.79, 2.77 and 2.55 kg in the first season, respectively. SGE12031 and SGE3203R genotypes gave the highest value of yield per plant of 3.01 and 2.83 kg in the second season, respectively. While, SR72166 genotype gave the lowest values of yield per plant of 1.34 and 1.27 kg in the first and second seasons, respectively. Alam *et al* (2010) found that the total fruit yield per plant was between 1.20 and 1.73 k g. Yesmin *et al* (2014) found that the total fruit yield per plant was between 2.03 and 2.94 kg.. Kumar *et al* (2015) found that the total fruit yield per plant was between 420 and 1805 g. Bayomi *et al* (2019) found that the total fruit yield per plant was between 1223.83 and 2054.30g.

The knowledge of degree and direction of correlation among different traits of tomato are of great importance for selection programs in the future. The results presented in Table (3) revealed that the combination between eight important traits of tomato genotypes under Saint Catherine conditions at the two growing seasons. In that context, number of flowers/cluster had highly significant and positive correlation with each of fruit weight, fruit length and yield per plant. In the contrary, negative correlation with number of locules fruit. Fruit set percentage had highly significant negative correlation with number of flowers/cluster, fruit weight, fruit length, fruit diameter and yield per plant. Yield per plant had highly significant positive correlation with number of flowers/cluster, fruit weight, fruit length and fruit diameter. On the other hand, yield per plant showed negative correlation with T.S.S. percentage. Ghosh *et al* (1995) found that total yield had positive correlation with fruit weight. On the other hand, Khalaf-Allah *et al* (1996) found that negative correlation was detected between total yield and T.S.S. percentage. Bayomi *et al* (2019) found that total yield had positive correlation with each of plant height, number of branches per plant, fruit weight and number of locules/ fruit, and negative correlation with T.S.S. percentage.

Table 3. Simple correlation coefficients among the traits at the two growing seasons.

Traits	season	1	2	3	4	5	6	7	8
1- No.of flowers/cluster	2020	1.000	-0.509**	0.415**	0.622**	0.258*	-0.253*	0.045	0.375*
	2021	1.000	-0.450**	0.338*	0.623**	0.239	-0.271	-0.004	0.431**
2- Fruit set	2020		1.000	-0.419**	-0.617**	-0.471**	0.028	-0.223	-0.364*
	2021		1.000	-.0592**	-0.545**	-0.517**	-0.087	-0.432**	-0.445**
3- Fruit weight	2020			1.000	0.553**	0.725**	0.025	-0.117	0.488**
	2021			1.000	0.617**	0.883**	0.184	0.198	0.695**
4- Fruit length	2020				1.000	0.266	-0.318*	0.263	0.436**
	2021				1.000	0.266	-0.436**	0.226	0.596**
5- Fruit diameter	2020					1.000	0.376*	0.093	0.458**
	2021					1.000	0.451**	0.147	0.512**
6- No. of Locules/ fruit	2020						1.000	0.231	-0.078
	2021						1.000	0.155	0.014
7- T.S.S.	2020							1.000	-0.311*
	2021							1.000	-0.121
8- Yield /plant	2020								1.000
	2021								1.000

CONCLUSION

This study is an important step for Plant Breeding and Conservation Program of Desert Research Center to identify the best genotypes for hybrids production in future and suitable for agriculture under Egyptian desert conditions. Rather all traits were similar in the two growing seasons; thus this reflecting the stability of genotypes. This is necessary for hybrid production in the future. SGE12031 genotype was the best for all traits in the two growing seasons under Saint Catherine conditions. Yield per plant had highly significant positive correlation with number of flowers/cluster, fruit weight, fruit length and fruit diameter.

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المحصول وخصائص الثمار للتراكيب الوراثية المنتخبة من الطماطم تحت ظروف سانت كاترين بجنوب سيناء

خالد السيد مجاهد بيومى

وحدة تربية النبات– قسم الأصول الوراثية– مركز بحوث الصحراء

تقييم أداء التراكيب الوراثية من الطماطم تحت ظروف الصحراء المصرية يأتي في المرتبة الأولى لبرنامج تربية وصون النباتات بمركز بحوث الصحراء. المحصول وخصائص الثمار للتراكيب الوراثية المنتخبة من الطماطم مهمة لانتاج الهجن. تم زراعة خمسة عشر تركيب وراثى من الطماطم بمزارع المجتمع المحلى بسانت كاترين جنوب سيناء خلال موسمى النمو ٢٠٢٠ و ٢٠٢١. التصميم الاحصائي المستخدم هو القطاعات الكاملة العشوائية مع استخدام ثلاث مكررات. وكانت النتائج تشير إلى وجود اختلافات معنوية بين التراكيب الوراثية لجميع الصفات ، واستنادًا إلى النتائج المتحصل عليها فى الموسمين، تم تحديد أكثر التراكيب الوراثية للطماطم إنتاجيةً وتكيفًا مع ظروف المنطقة. تقارب نتائج الصفات للموسمين يعكس مدى ثبات التراكيب الوراثية وأهميته لانتاج الهجن فى المستقبل. التركيب الوراثى SGE12031 كان الافضل لجميع الصفات تحت ظروف سانت كاترين. وجد ارتباط موجب بين محصول النبات وجميع الصفات ماعدا صفتى نسبة عقد الثمار و نسبة المواد الصلبة الذائبة الكلية حيث كان الارتباط سالباً.

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