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Effect of Number of Different Stems on some Fruit Quality Characteristics and Yield in Tomatoes (*Lycopersicon lycopersicum* L.)

Ali ECE Nilay DARAKCI

Gaziosmanpasa University, Faculty of Agriculture Department of Horticulture Tokat, Turkey

***Corresponding Author**
e-mail: aliece@gop.edu.tr

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ABSTRACT

In this study, it was aimed to determine the relations between number of stem and some fruit quality parameters of tomato. Two different stem applications (single and double stem) and 34 tomato varieties were used in this research. Randomized block-split plot design with 3 replications was used in experiments. Stem applications were placed in main plots and varieties were placed in sub-plots. Marketable total yield (t ha^{-1}), marketable average fruit weight (g), water-soluble dry matter content (%), ascorbic acid content (mg 100 g^{-1}) and pH values were taken into consideration. Marketable yield averages of varieties varied between 152.75 – 109.98 t ha^{-1} and marketable fruit weights between 144.38 – 95.24 g. statistically significant differences were not observed between stem applications. Although stem applications have not affected the water-soluble dry matter, ascorbic acid contents and pH values, statistically significant differences were observed among varieties.

Key Words: Tomatoes, yield,quality, stem number

INTRODUCTION

Fruits and vegetables are the main vitamin sources for human beings. Therefore, they should definitely consume a certain amounts of fruit and vegetable in their daily nutrition. Vegetables cannot be produced in their natural habitats during the entire year and it is impossible to consume them fresh all year long. Their fresh periods are limited with couple months depending on growing seasons and environmental conditions. While under-cover production provides all-year long fresh production, various preservation methods were developed for the regions where under-cover production is not possible or is not preferred. Vegetables and fruits are preserved as canned food, dried, deep freeze, tomato paste, pickle or concentrated fruit juice during the periods with abundant productions and they are served to consumers for later periods. Some fruit characteristics affect their marketability and methods of preservation. For instance, ascorbic acid and water-soluble dry matter content, pH, fruit weight and color are the significant fruit quality parameters for tomato [1].

During the recent years, under-cover tomato varieties have also been produced over open fields. Conditions required for under-cover production are not able to be provided in open fields most of the time.

However, they are able to provide a high performance in yield and fruit quality [2,3,4].

Tomato has a direct response to production techniques. Fruit size, yield per plant and earliness increase with increasing land area per plant [5]. Following the studies carried out in various regions, researchers have found changes in yield with changing number of plant per unit area. Beside the yield, a proper fertilization program also affects the fruit quality [6,7,8].

There is a positive relation between ascorbic acid content and lighting of tomato fruits. Method of production, fertilization, climate and soil conditions also affect ascorbic acid contents of tomato fruits. Ascorbic acid contents of tomato fruits vary between 12.0-35.7 mg 100 g^{-1} [1,9,10,11,12].

Sugar constitutes the largest part of soluble dry matter contents of fruit juices. These sugars are mainly glucose, fructose and saccharose. Factors like climate, soil conditions and plant nutrition affect the soluble dry matter content. Water-soluble dry matter content of tomato fruits is between 3.71-8.10% [9,10,12].

pH values of tomato fruits are between 4.00-4.50 [10,12].

Objectives of this study are to evaluate some quality parameters of commercial tomato varieties used in Turkey and to investigate the relations between these parameters and different stem applications.

MATERIALS AND METHODS

This study was carried out in the year 2004 under Tokat-Turkey conditions. Hybrid tomato varietis of Memory F1, Astona F1 , Menhir F1 , FA 198 F1, Petek F1, Konak F1, Volare F1, Sidera F1, Sümela F1-RN , Töre F1 , Helena F1-RN , Etna F1-RN , BT 131 Gülle F1, BT Gülle-55 F1, BT Gülle-50 F1, BT 134 F1, Yeni Talya F1, Cemile F1 , Y-22-16, 73-14 Beril RZ, Barbados F1, Veglia F1, Selin F1, Tülin F1, Gökçe 191 F1, Elif 190 F1, Duygu F1, Alida F1, Diyansa F1, Nemo-Netta F1, Netta F1, Polaris F1, Newton F1 and Zorro F1 constituted the plant materials of the study.

Soils of experimental site were clay-loam with neutral and light alkaline reaction, medium organic material content and without any salinity problem. During the experiments, the lowest average temperature (11.3 °C) was observed in April and the highest in August (21.9 °C). While the highest precipitation (48 mm) was observed in May, zero precipitation was observed in September. The highest relative humidity (78.6 %) was seen in June and the lowest (65.2 %) in April (Table 1).

Table 1 Climate data for experimental period

Climate Parameter		Months					
		April	May	June	July	August	September
Temperature (°C)	Minimum	-8.3	0.7	6.5	7.0	9.9	1.1
	Maximum	30.5	30.1	32.4	36.2	36.4	33.3
	Average	11.3	14.9	18.7	20.6	21.9	16.8
Total Precipitation (mm)		32.0	48.0	27.2	0.4	4.8	0.0
Relative Humidity (%)		65.2	74.2	78.6	68.0	73.6	72.8

Field experiments were carried out in randomized blocks - split plots experimental design with 3 replications. Stem applications (single and double stem) were placed in main plots and varieties were placed in sub-plots. Sowing was performed in 10 April 2004. Seedlings reaching the planting maturity were planted in field at 75 x 40 cm spacing in single-stem application and at 75 x 60 cm in double-stem application. There were 10 plants in each plot of both applications. Drip irrigation was used to meet the water demands of the plants. Fertilization was also carried out through drip irritation system.

Marketable yield (t ha^{-1}), marketable average fruit weight (g), water-soluble dry matter content (%) [13], ascorbic acid content (vitamin C, mg 100 g^{-1}) [14] and pH [15] were taken into consideration as fruit quality parameters. Marketable yield and marketable average fruit weights were determined in accordance with Bas and Sevgican [16]. Analysis of variance was performed by using proper statistical analysis methods and Duncan significance test was applied to statistically significant averages [17].

RESULTS AND DISCUSSION

While the marketable yield parameter was not affected by stem applications and stem application x variety interactions at statistically significant level, it showed a change with variety at 0.01 level of significance. Although it did not exhibit a statistical significance, marketable yield values were slightly higher in single-stem application (129.71 t ha^{-1}) than double-stem application (128.13 t ha^{-1}). Marketable yield averages of varieties were between 152.75–109.98 t ha^{-1}.

While the highest value (152.75 t ha^{-1}) was obtained from Newton F_1, the variety Volare F_1 with 152.46 t ha^{-1} was placed in the same statistical group with. The lowest yield was obtained from Duygu F1 with 109.98 t ha^{-1} (Table 2).

As seen in Table 2, a similar pattern was observed in marketable average fruit weights. While this parameter was also not affected by stem applications and stem application x variety interactions at statistically significant level, it also showed a change with variety at 0.01 level of significance. Marketable average fruit weights were 128.95 g at single-stem application and 122.47 at double-stem. Increase in land area per plant and number of plant per unit area changes the yields and fruit sizes [5,6,7,8]. When the variety averages were evaluated, it can be seen that the highest value was obtained from BT Gülle 55 F1 with 144.38 g and respectively the varieties of Newton F1, Alida F1 and Duygu F1 has followed it. The lowest value was obtained from Barbados F1 with 95.24 g (Table 2).

Table 2. Marketable yield and marketable average fruit weight values of tomato varieties at different stem applications

Variety	Marketable total yield (t ha^{-1})			Marketable average fruit weight (g)		
	Single Stem	Double Stem	Average	Single Stem	Double Stem	Average
Memory F1	133.62	134.85	134.24 a-e	117.78	115.46	116.62 g-ı
Astona F1	144.83	127.53	136.18 a-d	123.49	121.84	122.67 d-ı
Menhir F1	137.98	119.37	128.68 a-e	114.97	112.35	113.66 hı
FA 198 F1	141.28	145.36	143.32 a-c	120.62	123.24	121.93 d-ı
Petek F1	143.96	148.50	146.23 a-c	130.22	127.24	128.73 b-h
Konak F1	112.32	115.93	114.12 de	122.14	120.84	121.49 e-ı
Volare F1	149.95	154.97	152.46 a	121.66	119.57	120.62 e-ı
Sidera F1	134.03	126.98	130.50 a-e	130.08	122.73	126.41 c-h
Sümela F1-RN	141.38	129.21	135.29 a-d	134.91	127.24	131.08 a-g
Töre F1	129.83	119.89	124.86 b-e	123.22	111.55	117.39 f-ı
Helena F1-RN	130.54	131.43	130.99 a-e	133.69	123.94	128.82 b-h
Etna F1-RN	128.38	108.51	118.45 de	117.13	102.79	109.96 h-i
BT 131Gülle F1	120.64	126.39	123.52 b-e	138.82	127.80	133.31 a-f
BT Gülle- 55 F1	118.93	127.80	123.37 c-e	147.12	141.64	144.38 a
BT Gülle-50 F1	129.35	131.48	130.42 a-e	133.82	134.99	134.41 a-e
BT 134 F1	114.77	112.92	113.84 de	122.58	120.32	121.45 e-ı
Yeni Talya F1	143.57	152.68	148.13 ab	126.97	108.85	117.91 f-ı
Cemile F1	118.96	128.75	123.85 b-e	129.28	113.20	121.24 e-ı
Y-22-16	108.40	121.85	115.12 de	115.58	117.87	116.27 g-ı
73-14 Beril Rz	141.55	125.79	133.67 a-e	132.85	114.49	123.67 d-ı
Barbados F1	138.99	151.59	145.29 a-c	92.92	97.55	95.24 i
Veglia F1	110.31	120.92	115.61 de	126.73	137.80	132.27 a-g
Selin F1	115.01	113.03	114.04 de	122.29	120.78	121.54 e-ı
Tülin F1	125.61	128.19	126.91 b-e	136.87	129.03	132.95 a-f
Gökçe 191 F1	116.90	115.19	116.05 de	127.92	118.54	123.23 d-ı
Elif 190 F1	114.73	120.20	117.47 de	137.55	131.01	134.28 a-e
Duygu F1	112.89	107.06	109.98 e	141.35	133.66	137.50 a-d
Alida F1	126.55	123.38	124.96 b-e	145.90	135.93	140.92 a-c
Diyansa F1	126.63	139.80	133.20 a-c	132.71	132.73	132.71 a-f
Nemo-Netta F1	135.83	124.29	130.06 a-e	131.87	116.34	124.10 d-ı
Netta F1	148.08	139.65	143.87 a-c	131.16	121.14	126.15 c-h
Polaris F1	128.59	114.94	121.77 c-e	128.23	116.76	122.50 d-ı
Newton F1	153.10	152.40	152.75 a	147.07	137.72	142.39 ab
Zorro F1	152.54	115.24	123.89 b-e	144.61	126.81	135.71 a-e
Average	**129.71**	**128.13**		**128.95**	**122.46**	
LSD	**Stem: ns**	**Variety : 19,88** SxV : ns**		**Stem: ns**	**Variety: 12,865****	**SxV : ns**

ns: Not significant, S=Stem, V=Variety

a,b: Means in the same column with different superscript are significantly different ** : P<0,01

While the parameter of water-soluble dry matter content also did not exhibit statistically significant change with stem applications, it showed highly significant changes with variety, stem application x variety interactions. Water-soluble dry matter content averages of single-stem applications (3.41%) were slightly higher than double-stem applications (3.30 %).

The highest value was obtained from Cemile F1 with 3.83% and respectively the varieties of BT 131 Gülle F1, Etna F1 RN, Veglia F1 and Polaris F1 has followed it. The lowest value was obtained from 73-14 Beril Rz with 2.88 %. Water-soluble dry matter contents of tomato fruits have exhibited statistically significant changes with stem application x variety interactions. While the variety of Zorro F1 provided the highest value at double-stem application, it was placed in the same statistical group with FA 198 F1 providing the lowest value at single-stem application (Table 3).

Table 3. Water-soluble dry matter, ascorbic acid contents and ph values of tomato varieties at different stem applications

Variety	Water-soluble dry matter content (%)			Ascorbic Acid (Vitamin C mg $100g^{-1}$)			pH		
	Single Stem	Double Stem	Average	Single Stem	Double Stem	Average	Single Stem	Double Stem	Average
Memory F1	3.23 a-d	3.08 c-f	3.16 a-d	20.93	24.72	22.82	4.52	4.36	4.44 a-e
Astona F1	3.58 a-d	3.33 a-f	3.46 a-d	22.46	19.33	20.90	4.56	4.37	4.46 a-e
Menhir F1	3.17 b-d	3.42 a-f	3.30 a-d	20.72	20.97	20.85	4.44	4.44	4.44 a-e
FA 198 F1	2.75 d	3.17 b-f	2.96 c-d	21.99	23.28	22.63	4.16	4.39	4.27 e
Petek F1	3.33 a-d	3.00 d-f	3.17 a-d	15.13	21.55	18.34	4.65	4.56	4.61 a
Konak F1	3.58 a-d	3.58 a-d	3.58 a-d	17.58	22.26	19.92	4.48	4.54	4.51 a-c
Volare F1	3.17 b-d	2.83 d-f	3.00 b-d	19.48	18.75	19.12	4.58	4.49	4.54 a-c
Sidera F1	3.08 c-d	2.67 e-f	2.88 d	21.43	18.24	19.83	4.63	4.48	4.56 a b
SümelaF1-RN	3.80 a-c	3.08 c-f	3.44 a-d	17.08	18.61	17.85	4.54	4.46	4.50 a-d
Töre F1	3.38 a-d	3.50 a-e	3.44 a-d	19.46	23.85	21.65	4.52	4.37	4.44 a-e
HelenaF1-RN	3.25 a-d	3.50 a-e	3.38 a-d	22.88	23.12	23.00	4.42	4.35	4.39 b-e
Etna F1-RN	4.00 a b	3.50 a-e	3.75 a-c	23.00	23.58	23.29	4.40	4.36	4.38 b-e
BT 131Gülle F1	4.00 a b	3.58 a-d	3.79 a b	23.77	23.82	23.80	4.40	4.40	4.40 b-e
BT Gülle-55 F1	3.33 a-d	3.42 a-f	3.38 a-d	22.01	23.77	22.89	4.45	4.37	4.41 b-e
BT Gülle-50 F1	3.20 b-d	2.92 c-f	3.06 a-d	20.77	21.75	21.26	4.55	4.41	4.48 a-d
BT 134 F1	3.58 a-d	3.08 c-f	3.33 a-d	22.28	25.15	23.71	4.44	4.38	4.41 b-e
Yeni Talya F1	3.33 a-d	2.92 d-f	3.13 a-d	20.39	23.10	21.75	4.47	4.36	4.41 b-e
Cemile F1	4.08 a	3.58 a-d	3.83 a	19.99	21.80	20.89	4.51	4.36	4.43 a-e
Y-22-16	3.17 b-d	3.33 a-f	3.25 a-d	17.23	22.64	19.93	4.66	4.47	4.57 a b
73-14 Beril Rz	3.17 b-d	2.58 f	2.88 d	21.31	19.35	20.33	4.37	4.32	4.35 c-e
Barbados F1	3.75 a-c	3.00 d-f	3.37 a-d	22.34	24.91	23.62	4.36	4.33	4.35 c-e
Veglia F1	3.58 a-d	3.92 a-c	3.75 a-c	24.36	25.08	24.72	4.53	4.33	4.43 a-e
Selin F1	3.00 c-d	3.08 c-f	3.04 a-d	21.92	21.57	21.74	4.30	4.33	4.31 d e
Tülin F1	2.92 c-d	3.92 a-c	3.42 a-d	19.84	23.68	21.76	4.41	4.39	4.40 b-e
Gökçe 191 F1	3.50 a-d	3.58 a-d	3.54 a-d	18.87	21.92	20.39	4.43	4.34	4.39 b-e
Elif 190 F1	3.58 a-d	3.33 a-f	3.46 a-d	18.48	16.89	17.69	4.48	4.43	4.45 a-e
Duygu F1	3.33 a-d	4.00 a b	3.67 a-d	20.42	21.48	20.95	4.44	4.38	4.41 b-e
Alida F1	3.50 a-d	3.17 b-f	3.33 a-d	23.12	20.08	21.60	4.40	4.35	4.38 b-e
Diyansa F1	3.33 a-d	3.17 b-f	3.25 a-d	26.62	17.81	22.21	4.50	4.45	4.47 a-d
Nemo-Netta F1	3.33 a-d	3.33 a-f	3.33 a-d	22.89	22.20	22.54	4.44	4.46	4.45 a-e
Netta F1	3.58 a-d	3.33 a-f	3.45 a-d	17.87	21.79	19.83	4.49	4.45	4.47 a-d
Polaris F1	4.08 a	3.25 a-f	3.67 a-d	20.77	19.60	20.18	4.51	4.47	4.49 a-d
Newton F1	3.25 a-d	2.92 d-f	3.08 a-d	20.25	19.76	20.00	4.47	4.42	4.45 a-e
Zorro F1	3.08 c-d	4.08 a	3.58 a-d	17.42	19.77	18.59	4.47	4.52	4.50 a-d
Average	3.41	3.30		20.74	21.65		4.47	4.41	
LSD	Stem: ns Variety: 0.670** SxV : 0.947**			Stem: ns Variety: ns SxV : ns			Stem: ns Variety: 0.156** SxV : ns		

ns: Not significant, S=Stem, V=Variety

a,b: Means in the same column with different superscript are significantly different ** : p<0,01

Ascorbic acid contents of tomato varieties investigated in this study did not exhibit statistically significant changes with factors taken into consideration.

Ascorbic acid contents were higher in double-stem application (21.65 mg $100g^{-1}$) than single-stem application (20.74 mg $100g^{-1}$). While the variety averages were between 17.69-23.80 mg100 g^{-1}, numerically Veglia F1 yielded the highest and Elif 190 F1 the lowest value (Table 3).

While the pH values of fruits did not show statistically significant changes with stem-applications, stem application x variety interactions, they exhibited highly significant changes with variety.

Although there were not statistically significant differences between single and double-stem applications, pH values of single-stem fruits (4.47) were slightly higher than double-stem fruits (4.41). When the variety averages were evaluated, it can be seen that Petek F_1 yielded the highest value with 4.61 and it was followed by Y-22-16, Sidera F1, Volare F1 and Konak F1. The variety FA 198 F1 yielded the lowest value with 4.27 (Table 3).

CONCLUSIONS

Following results were obtained from this study carried out with 34 tomato varieties to determine the relations between some fruit quality parameters and number of stem:

- While the number stem was not effective on marketable total yield at statistically significant level, numerically single-stem application yielded higher values. However, statistically significant changes were observed between varieties.

- Number of stem did not have statistically significant effects on marketable average fruit weights but the differences between varieties were statistically significant.

- Number of stem did not have an effect on water-soluble dry matter, ascorbic acid contents and pH values. Statistically significant differences were observed between the varieties in water-soluble dry matter content and pH values.

Based on the above mentioned results, it can be said that number of stem did not have effects on fruit quality parameters, but varieties played a significant role on these parameters.

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