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Response of Cherry Tomato (*Solanum lycopersicum* var. *cerasiforme*) to Pruning Systems and Irrigation Rates under Greenhouse Conditions

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ABSTRACT

Prober agricultural practices such as irrigation and pruning have been reported to enhance yield quality and quantity of vegetables. This study aims to determine the most efficient pruning system and optimum irrigation rate on cherry tomato to achieve the maximum production and high fruit quality in protected agriculture. Two pruning systems, one and two branches and four irrigation rates, 100% (T1, full water), 80% (T2), 60% (T3) and 40% (T4) of crop evapotranspiration (ETc) were compared. The highest productivity in plants pruned to two branches was related to the increase in fruit cluster than that detected in plants pruned to one branch. Whereas, the plants pruned to one branch exhibited improved fruit quality (dry matter, titratable acidity, vitamin C, total soluble solids and total sugars). The highest irrigation rates, T1 and T2, produced the highest fruit yield, although the increased water stress treatment (T4) enhanced the fruit quality traits. Water-use efficiency increased with two branches pruning system and under water stress conditions. Irrigation treatment T2 was considered more appropriate for optimizing water-use efficiency without any significant reduction in the total fruit yield. This study demonstrated that the best results of interaction effects for increasing fruit production and conserving water were obtained by pruning cherry tomato plants to two branches under the T2 irrigation rate. Fruit weight and size were increased by pruning the plants to one branch under the T2 irrigation rate. On the other hand, pruning the plants to one branch under the lowest irrigation rate (T4) resulted in high fruit quality levels. This trend is relatively important under semi-arid environmental conditions, where water shortage and thus water costs are continuously increasing.

Key words: Cherry tomato, pruning systems, water stress, vitamin C, water-use efficiency

INTRODUCTION

Cherry tomato (*Solanum lycopersicum* var. *cerasiforme*) is a popular type of table tomato with small fruits (1.5-3.5 cm in diameter) on long panicles and the demand for cherry tomato has increased in the market, chiefly due to the recognition of their high quality and good taste (Kobryn and Hallmann, 2005). The cherry tomato is also beneficial to human health because of its high content of antioxidant and phytochemical compounds, including lycopene, β-carotene, flavonoids, vitamin C and many essential nutrients (Rosales *et al.*, 2011).

Pruning systems are normally used in protected cultivation and the choice of a proper pruning system is an important factor for achieving a profitable balance between labour costs and crop yield without the loss of fruit quality (Franco *et al.*, 2009). The pruning of side shoots plays a key role in the efficient use of the planting area in protected cultivation (Mantur and Patil, 2008) and shoot pruning maintains a proper balance between vegetative growth and the fruit load (Utobo *et al.*, 2010).

Irrigation is a vital agricultural practice that affects both the yield and fruit quality under greenhouse conditions. Indeed, the irrigation schedule has a great impact on the growth, yield and fruit quality of tomato depending on the amount of water applied (Kere *et al.*, 2003).

Although sufficient water is a prerequisite for good plant growth and fruit development, over-watering reduces quality and increases the production costs (Amundson, 2012). Under a low water supply in arid and semi-arid areas, maximizing water productivity may be more valuable to the farmer than maximizing crop yield (Patane *et al.*, 2011). Therefore, optimal irrigation management and scheduling are essential to increase water-use efficiency (WUE) in agricultural production.

The aim of this study was to elucidate the effects of different pruning systems and irrigation rates upon vegetative growth traits, fruit yield and quality in addition to the water-use efficiency of cherry tomato plants cultivated under greenhouse conditions.

MATERIALS AND METHODS

Plant material and growth conditions: Cherry tomato (*Solanum lycopersicum* cv. Dulcito RZ, RIJK ZWAAN; Netherlands) was grown in a fibreglass greenhouse at the Agricultural Research and Experimental Station, Dirab region, near Riyadh, Saudi Arabia (24°39 N, 46°44 E), during the 2010/2011 and 2011/2012 growing seasons. The seeds were germinated in Jiffy 7 pellets (one seed per pellet) on 1 Sep., 2010 and 3 Sep., 2011 in a controlled environment (25±1°C day/18±1°C night temperatures). At the two true-leaf stage, the seedlings were transplanted into soil and grown in a greenhouse. The soil structure was 82% sand, 9% silt and 9% clay. The daytime temperature in the greenhouse was set to 26±2°C and the night-time temperature was 18±2°C; the relative humidity was set to 70±2% during the growing season.

Experimental layout: The experimental design was split-plot in a randomized complete block. Two pruning systems were assigned to the main plots and four irrigation rate treatments were allocated to the subplots, with four replicates. The sub-plot area was 8 m^2, which comprised 16 plants. The plants were placed in rows 1.0 m apart and the space between the plants within a row was 0.50 m.

Pruning systems: The apical bud of all the plants was removed (10 days from transplanting) to encourage the simultaneous growth of the selected branches. To shape the cherry tomato plants to one central branch or two main lateral branches, all the new side branches were pruned at 10-day intervals during the growth period. Hence, the plants were either trained to two branches to form the 'V' trellising shape or to a single branch (the nearest one to the soil surface). For supporting plants, they were trained with strings fixed to transversal wires at 2.5 m above the ground surface.

Irrigation rate treatments: At transplanting, water was uniformly and simultaneously distributed using a drip irrigation system. The irrigation treatments started 7 days after transplanting and included four rates based on the crop evapotranspiration (ETc) of tomato, as follows: T1 control treatment (full water) receiving 100% of ETc and three reduced irrigation rate treatments receiving 80% (T2), 60% (T3) and 40% (T4) of ETc.

The irrigation scheduling method was based on pan evaporation because it is simple to use and easily available in the greenhouse (Harmanto *et al.*, 2005). The crop evapotranspiration (ETc) was determined as follows:

$$ETc = Eo\ Kp\ Kc$$

Where:

ETc = The maximum daily crop evapotranspiration, in mm
Eo = The evaporation from class A, pan in mm
Kp = The pan coefficient (range between 0.7 and 0.9)
Kc = The crop coefficient (range between 0.4 and 1.1, depending on the growth stage). Kp and Kc were calculated according to the equations of Allen *et al.* (1998)

The total period of the irrigation treatments was 180 days and the amount of water applied was 3000, 2400, 1800 and 1200 $m^3\ ha^{-1}$ for irrigation treatments T1, T2, T3 and T4, respectively.

Agricultural practices: Fertilization and pest and disease control were managed following standard practices under greenhouse conditions. Harvest-ripe fruits were manually collected and weighed twice a week, starting at 60 days after transplanting and continuing throughout the season.

Data recorded: At 50 days after transplanting, five plants $plot^{-1}$ were collected and the aboveground organs were separated into stems, leaves and green fruits to estimate the plant fresh biomass. Their tissues were then oven dried at 70°C for 72 h to determine the dry biomass. Both the aboveground fresh and dry biomass were expressed in ton ha^{-1}. In addition, certain traits, such as plant height and leaf area $plant^{-1}$, were measured.

The fruit yield traits (early and total yield) were determined by weighing all the collected fruits during the harvests. The early yield (the first five harvests) and the total yield were expressed in ton ha^{-1}. Number of clusters and fruit weight $plant^{-1}$ were also determined.

Fifty representative fruits $treatment^{-1}$ were randomly selected, weighed and analyzed for fruit quality traits. Portions of the fruits were sliced and dried at 70°C for 72 h to measure their dry matter content. Other parts were homogenized using a fruit blender to determine the fruit chemical composition. Total Soluble Solids (TSS,%) content were determined using a portable digital refractometer (PR-101, ATAGO, Japan). Titratable acidity (g 100 g^{-1} fresh weight, as citric acid) was determined by potentiometric titration with 0.1 N NaOH against 9:1 dilution of fruit homogenate juice samples with distilled water. Vitamin C (mg 100 g^{-1} fresh weight, as ascorbic acid) content was measured by titration of homogenate fruit juice samples using 2,6 dichlorophenol-indophenol solution standardized in a solution of ascorbic acid with an identified concentration (Patane *et al.*, 2011). Total sugars (%) content was also determined following AOAC (1995) procedure.

Water-use efficiency: Water-use efficiency (WUE) was calculated by dividing the total fruit yield (kg ha^{-1}) by the seasonal irrigation water (m^3 ha^{-1}) applied in the various irrigation treatments, as described by Kirda *et al*. (2004):

$$WUE = Y/I$$

Where:
Y = Yield (kg ha^{-1})
I = The irrigation water applied (m^3 ha^{-1})

Statistical analysis: The collected data were analyzed using an Analysis of Variance (ANOVA) in the SAS version 8.1 computer programme (SAS, 2008). The means were compared via a revised Least Significant Difference (LSD) test at the 0.05 level (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Vegetative growth traits: Pruning the cherry tomato plants significantly affected the vegetative growth traits. One-branch pruning produced the tallest plants (195.3 and 190.1 cm) in the first and second seasons, respectively. This result was in agreement with the findings of Ara *et al*. (2007) for tomato plants. However, the highest leaf area and the heaviest aboveground fresh and dry biomass were found in the plants pruned to two branches (Table 1). The significant difference between the pruning systems for leaf area and either the aboveground fresh or dry biomass indicates that the foliar structure in the plants pruned to two branches was sufficiently large to allow for superior vegetative growth when compared to the plants pruned to one branch.

Significant differences in the vegetative growth traits were found among the irrigation rate treatments: T1 (100% of ETc, full water) showed the highest values, followed by T2 (80% of ETc), T3 (60% of ETc) and T4 (40% of ETc) (Table 1). It is well-known that plant growth is decreased when soil water availability is limited (Kirnak *et al*., 2001). In addition, insignificant differences were detected between the T1 and T2 irrigation rate treatments with regard to the leaf area in the first season, aboveground fresh biomass in the second season and aboveground dry biomass in both seasons (Table 1). These results indicate that either 100 or 80% of ETc generated the maximum plant growth.

Table 1: Vegetative growth traits of cherry tomato plants as affected by different pruning systems and irrigation rate treatments during two growing seasons of 2010/2011 and 2011/2012

	Plant height (cm)		Leaf area plant^{-1} (cm^2)		Above ground fresh biomass (ton ha^{-1})		Above ground dry biomass (ton ha^{-1})	
Treatments	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
Pruning systems								
One branch	195.3^a	190.1^a	5610.75^b	5440.00^b	1011.38^b	994.89^b	165.03^b	158.96^b
Two branches	181.5^b	173.1^b	8884.81^a	8811.44^a	1615.77^a	1597.63^a	207.11^a	211.97^a
Irrigation rates								
T1 (100% ETc)	205.75^a	200.25^a	8226.75^a	8142.50^a	1449.550^a	1433.413^a	200.425^a	200.413^a
T2 (80% ETc)	199.00^b	189.62^b	8221.38^a	8046.25^b	1432.288^b	1428.625^a	199.400^a	199.200^a
T3 (60% ETc)	179.63^c	172.75^c	7149.13^b	7028.13^c	1284.338^c	1252.713^b	183.200^b	184.288^b
T4 (40% ETc)	169.00^d	163.63^d	5393.88^c	5286.00^d	1088.113^d	1070.300^c	161.250^c	157.950^c

For each treatment, values within a season in each column followed by the same letter are not significantly different using revised LSD at 0.05 level

Fruit yield and its components: A significant increase in the early and total fruit yield was found for the plants pruned to two branches compared to plants pruned to one branch (Table 2); however, this response was accompanied with decreased fruit weight. These results are in agreement with those obtained by Maboko and Du Plooy (2009) and Maboko *et al.* (2011), who reported that tomato plants pruned to two stems produced a higher total fruit yield. However, competition for assimilate between the growing fruits can lead to reduced fruit size, thus a high fruit load causes a reduction in the source (assimilate availability) to sink (assimilate demand) ratio, causing a decrease in fruit size and weight (Maboko and Du Plooy, 2009; Matsuda *et al.*, 2011). The plants pruned to double branches exhibited a 35.6% increase in total fruit yield compared to the plants pruned to a single branch in the first season and a 40.3% increase for the second season, due to the large number of clusters (17 clusters plant^{-1}) in two branches versus 12 clusters plant^{-1} in one branch (Table 2). This finding agrees with De Azevedo *et al.* (2010), who also found a larger number of fruits plant^{-1} with the increment in the number of pruned cherry tomato branches plant^{-1}. The result of increased fruit weight after pruning plants to a single branch was in accordance with the results of Mantur and Patil (2008) and De Pinho *et al.* (2011), who recorded fewer and heavier fruits derived from fewer branches plant^{-1} because the fruits contained higher levels of carbohydrates and other soluble compounds.

The Irrigation rate treatments positively influenced the productivity of the cherry tomato plants. The highest performance for fruit weight and, early and total fruit yield was found in the T1 (100% of ETc, control treatment) and T2 (80% of ETc) treatments (Table 2). Conversely, fruit yield reductions occurred with the lower irrigation rates and the lowest reduction was 34.08 and 35.65% under stress water (T4, 40% of ETc), in both seasons compared with full water (T1, 100% of ETc). On the other hand, the heaviest fruit weight (>20 g) was obtained from plants of T1 and T2 treatments. As expected, fruit weight was significantly reduced to the half (<11 g) in plants where lower irrigation rate (T4) was applied (Table 2). If irrigation water rate is reduced, water absorption by plant roots is lower than that of crop transpiration. This case encourages an internal water deficit which affects photosynthesis and results in small leaf area, cell size and intercellular volume. The result is reduced fruit water accumulation and consequently decreased fruit weight (Madrid *et al.*, 2009). A similar tendency concerning the effects of water restriction on tomato fruit development has also been reported (Savic *et al.*, 2008). The potential size of tomato fruits depends on the rate of water accumulation because water represents 94-95% of the total fruit fresh weight (Savic *et al.*, 2008), with the remaining fruit weight (5-6%) consisting of organic compounds (solids) of which approximately 1% relates to the skin and seeds (Turhan and Seniz, 2009).

Table 2: Fruit yield components of cherry tomato plants as affected by different pruning systems and irrigation rate treatments during two growing seasons of 2010/2011 and 2011/2012

	No. of clusters plant^{-1}		Fruit weight plant^{-1} (g)		Early fruit yield (ton ha^{-1})		Total fruit yield (ton ha^{-1})	
Treatments	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
Pruning systems								
One branch	11.63^{b}	11.56^{b}	19.19^{a}	18.63^{a}	12.547^{b}	12.435^{b}	51.453^{b}	50.301^{b}
Two branches	17.13^{a}	16.88^{a}	14.00^{b}	14.56^{b}	17.808^{a}	17.654^{a}	69.755^{a}	70.611^{a}
Irrigation rates								
T1 (100% ETc)	17.38^{a}	17.13^{a}	20.90^{a}	21.25^{a}	17.316^{a}	16.993^{a}	70.106^{a}	70.384^{a}
T2 (80% ETc)	15.25^{b}	15.50^{b}	20.65^{a}	20.63^{a}	17.046^{a}	16.962^{a}	69.186^{a}	70.281^{a}
T3 (60% ETc)	13.75^{c}	13.63^{c}	14.13^{b}	14.00^{b}	14.278^{b}	14.234^{b}	56.928^{b}	55.865^{b}
T4 (40% ETc)	11.13^{d}	10.63^{d}	10.75^{c}	10.50^{c}	12.071^{b}	11.998^{c}	46.215^{c}	45.293^{c}

For each treatment, values within a season in each column followed by the same letter are not significantly different using revised LSD at 0.05 level

Fruit quality: There were significant differences between the single-and double-branched pruning systems with regard to the chemical composition of the cherry tomato fruits. The fruit dry matter, titratable acidity, vitamin C, TSS and total sugars contents were higher in the one-branch pruning system versus that of the two-branched pruning system (Table 3). These results could be attributed to the high assimilate supply associated with the good light conditions for the plants pruned more intensively to a single branch (Ambroszczyk *et al*., 2008) when the canopy is not very dense, light can easily penetrate and be distributed within it. Similar findings were reported by Ece and Darakci (2009), who found a positive relationship between the vitamin C content of tomato fruits and the amount of incident light. Fruits exposed to maximum sunlight in a one-branch pruning system have a higher amount of vitamin C than shaded fruits in a two-branched pruning system, whereas an increase of plant foliage reduces the light intensity and accumulation of vitamin C in the shaded parts. In general, the lower the light intensity during growth, the lower the vitamin C content of plant tissues (Lee and Kader, 2000).

Among the fruit quality traits affected by water stress were those that are mainly important for consumer approval, i.e., dry matter, titratable acidity, vitamin C, TSS and total sugars. Lower irrigation rates improved all the fruit quality characters related to composition (Table 3). The attained results were, in general, in agreement with Rouphael *et al*. (2008), who illustrated that water stress reduces the yield of vegetable crops, but can improve quality in many cases. When tomato plants are irrigated with less water, the plants regulate certain metabolic activities, such as osmotic adjustment in sink organs, to increase the sucrose and organic acid transformation rate and amount; consequently, more assimilate shifts to the fruits, thus improving the TSS and soluble sugar contents (Hong-yan *et al*., 2003). The titratable acidity and vitamin C were significantly increased under the water stress (T4, 40% of ETc) treatment (Table 3), results that agree with Patane *et al*. (2011) reporting that the titratable acidity and vitamin C contents were enhanced under water stress (50% of ETc) compared to a full irrigation water treatment (100% of ETc). Cherry tomatoes are generally characterized by their superior dry matter and soluble solid levels compared to normal-sized fresh market tomatoes (Sgherri *et al*., 2007, 2008). As reported by Sgherri *et al*. (2008), the dry matter (10 to 12%) and soluble solids (9 to 11%) detected in the cherry tomato "Dulcito RZ" cultivar were higher than in the cherry tomato "Naomi" cultivar (7.5 to 10% and 5.5 to 8%). However, lower values of dry matter (4 to 7%) and soluble solids (3.4 to 5.5%) were also detected in 33 genotypes of normal-sized tomato (Turhan and Seniz, 2009).

Table 3: Fruit quality traits of cherry tomato plants as affected by different pruning systems and irrigation rate treatments during two growing seasons of 2010/2011 and 2011/2012

	Dry matter (%)		Titratable acidity (g 100 g^{-1} f.w.)		Vitamin C (mg 100 g^{-1} f.w.)		TSS (%)		Total sugars (%)	
Treatments	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012	2010-2011	2011-2012
Pruning systems										
One branch	11.77^a	11.67^a	0.59^a	0.60^a	22.50^a	23.75^a	10.05^a	10.47^a	9.33^a	9.64^a
Two branches	10.42^b	10.55^b	0.55^b	0.54^b	20.44^b	20.69^b	9.15^b	9.40^b	7.85^b	7.81^b
Irrigation rates										
T1 (100% ETc)	10.20^d	10.35^d	0.55^d	0.54^d	19.13^d	18.75^d	8.69^d	9.10^d	7.88^d	7.94^d
T2 (80% ETc)	10.85^c	10.65^c	0.56^c	0.56^c	20.38^c	21.63^c	9.45^c	9.49^c	8.53^c	8.42^c
T3 (60% ETc)	11.30^b	11.50^b	0.58^b	0.58^b	21.75^b	23.30^b	9.80^b	10.05^b	8.89^b	8.90^b
T4 (40% ETc)	12.05^a	11.95^a	0.59^a	0.60^a	24.63^a	25.30^a	10.45^a	11.10^a	9.11^a	9.71^a

For each treatment, values within a season in each column followed by the same letter are not significantly different using revised LSD at 0.05 level

Water-use efficiency: Water-use Efficiency (WUE) is defined as the ratio of fruit yield to its seasonal cumulative irrigation water. The WUE in the cherry tomato plants pruned to two branches increased by 27.34 and 29.62% in the first and second seasons, respectively compared with those pruned to one branch (Fig. 1), resulting in increased total fruit yield for the plants with two branches compared with one-branched plants, even though the plants in both pruning systems were supplied with the same amount of water.

The plants pruned to two branches showed increased rates of canopy expansion, as illustrated by the leaf area and, aboveground fresh and dry biomass traits (Table 1) and consequently, had increased total fruit yield (Table 2) and improved WUE in comparison to the plants pruned to a single-branch (Fig. 1).

The one-branch pruning system resulted in a lower leaf area (Table 1), which represents the main factor for detecting reduction in water uptake and transpiration, compared with the plants pruned to two branches. This result agrees with Omami *et al.* (2006), who reported that reduced leaf number and leaf area could be the main reason for reduced water uptake and transpiration in amaranth (*Amaranthus* spp.).

To clarify the effects of different irrigation rates on WUE, a regression analysis was performed and a strong relationship between WUE and the irrigation rate treatments ($R^2 = 0.97$) was found (Fig. 2). In general, WUE increased linearly in response to each increase in the irrigation rate and

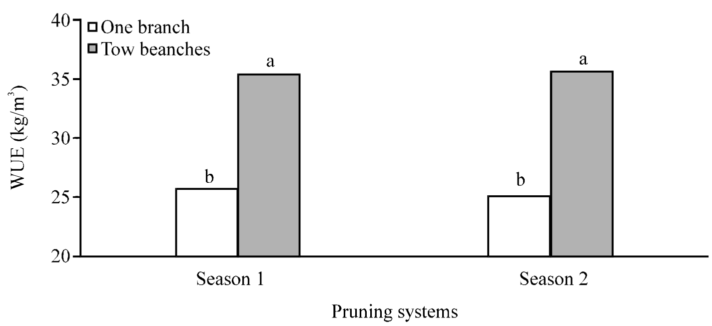

Fig. 1: Effect of pruning systems on water use efficiency for cherry tomato plants during two growing seasons of 2010/2011 and 2011/2012

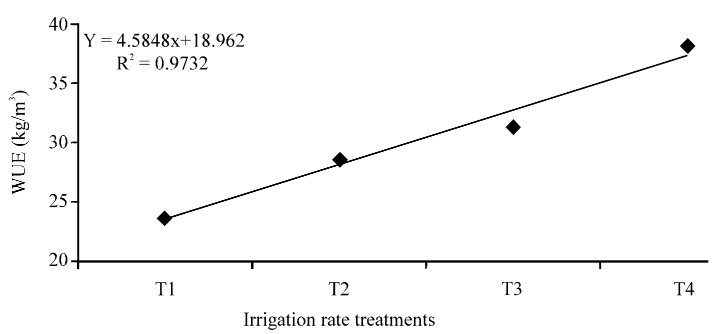

Fig. 2: Relationship between WUE and irrigation rate treatments for cherry tomato (pooled data of the two seasons, 2010/2011 and 2011/2012), T1: 100%, T2: 80%, T3: 60% and T4, 40% of crop evapotranspiration (ETc)

such a linear relationship between ET and WUE was previously recorded in tomato (Wahb-Allah *et al.*, 2011). In both seasons, WUE increased at the lowest water rate (T4; 40% of ETc) by 37.64 and 37.88% more than T1 control treatment (100% of ETc). Indeed, Howell (2006) reported that WUE varied considerably among water irrigation treatments and generally tended to increase with a decrease in irrigation level.

Interaction effect: The interaction of branch pruning x irrigation rates was significant for the fruit fresh weight and total fruit yield in addition to the fruit quality (vitamin C, TSS and total sugar). Results presented in Table 4 indicated that the fruit weight increased significantly with the single-branch pruning system with the T1 (100% of ETc, full water) and T2 (80% of Etc) treatments. This finding was due to the increase in fruit size plant^{-1} as the irrigation rate increased. However, the total fruit yield increased significantly with double-branched pruning system under the same irrigation rates, i.e., T1 and T2 compared to T3 (60% of ETc) and T4 (40% of ETc) treatments with either pruning systems. In terms of the soil water availability, the two branches pruning system may provide more vegetative growth because the soil remains wetter, thus allowing for more water uptake, which is reflected in a higher fruit yield (Zotarelli *et al.*, 2009).

Regarding fruit quality aspects, the interaction effect of the pruning system and irrigation rates on the vitamin C, TSS and total sugar contents showed maximum values when pruning the plants to one-branch under the water-stress of T4 (40% of ETc), followed by pruning the plants to one-branch plus the water-stress of T3 (60% of ETc) as shown in Table 4. In general, such cultural practices as pruning and irrigation determine the crop load and fruit size, which can influence the nutritional composition of fruits (Lee and Kader, 2000).

The total sugars content is a vital feature of the taste of tomatoes (Turhan and Seniz, 2009). Cherry tomatoes detect higher sugars content than full-sized tomatoes and, therefore, taste sweeter. The highest content of total sugars was noted in the plants pruned to one branch at the lowest irrigation rate (T4, 40% of ETc) in comparison to the other pruning system and irrigation treatments. The total sugars content detected in this study was high, ranging from 7.2 to 10.7% (Table 4). In comparison to other tomato types, the largest sugars content was 6.02% in cherry tomato, 3.86% in standard tomato and 4.03% in cluster tomato (Kobryn and Hallmann, 2005) and a low total sugar content (1.67 to 3.73%) was also observed in 33 genotypes of normal-sized tomato

Table 4: Interaction effect of different pruning systems and irrigation rate treatments on fruit fresh weight, fruit yield and quality traits of cherry tomato plants during the growing seasons of 2010/2011 and 2011/2012

		Fruit weight plant^{-1} (g)		Total fruit yield (ton ha^{-1})		Vitamin C (mg 100 g^{-1} f.w.)		TSS (%)		Total sugars (%)	
Pruning systems	Irrigation rate treatments	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12	2010/11	2011/12
One branch	T1 (100% ETc)	25.3^{a}	24.5^{a}	61.670^{c}	59.813^{c}	20.3^{f}	20.0^{e}	9.0^{e}	9.7^{d}	8.2^{d}	8.6^{d}
	T2 (80% ETc)	25.0^{a}	24.3^{a}	60.669^{c}	59.731^{c}	21.8^{d}	23.3^{c}	9.8^{c}	9.9^{c}	9.2^{c}	9.3^{c}
	T3 (60% ETc)	14.8^{c}	14.3^{c}	45.231^{e}	44.900^{e}	22.5^{c}	24.8^{b}	10.2^{b}	10.7^{b}	9.8^{b}	10.0^{b}
	T4 (40% ETc)	11.8^{e}	11.5^{d}	38.244^{f}	36.763^{f}	25.5^{a}	27.0^{a}	11.2^{a}	11.6^{a}	10.2^{a}	10.7^{a}
Two branches	T1 (100% ETc)	16.5^{b}	18.0^{b}	78.544^{a}	80.956^{a}	18.0^{h}	17.5^{f}	8.4^{f}	8.5^{g}	7.5^{f}	7.2^{h}
	T2 (80% ETc)	16.3^{b}	17.0^{b}	77.762^{a}	80.831^{a}	19.0^{g}	20.0^{e}	9.1^{e}	9.1^{f}	7.9^{e}	7.5^{g}
	T3 (60% ETc)	13.5^{d}	13.8^{c}	68.625^{b}	66.831^{b}	21.0^{e}	21.8^{d}	9.4^{d}	9.4^{e}	8.0^{e}	7.8^{f}
	T4 (40% ETc)	9.8^{f}	9.5^{e}	54.187^{d}	53.825^{d}	23.8^{b}	23.5^{c}	9.7^{c}	10.6^{b}	8.0^{e}	8.1^{e}

For each treatment, values within a season in each column followed by the same letter are not significantly different nsing revised LSD at 0.05 level

(Turhan and Seniz, 2009). These results are in harmony with the results of Hobson and Bedford (1989), who reported that cherry-type fruits contain more sugars, which positively affects their sweet taste and attractiveness to be eaten as a snack. Thus, the obtained results indicate that cherry tomato "Dulcito RZ" cv. should be desirable for either local or export markets in which consumers prefer sweet tasting fruits as a snack.

CONCLUSION

Water conservation is a fundamental concern in irrigation strategies for sustainable agriculture. Insignificant differences were detected between T2 (80% of ETc) and T1 (100% of ETc, full water) for most of the plant vegetative growth traits and fruit yield. Therefore, the T2 treatment could be considered more applicable and helpful for farmers to optimize WUE by saving water without any significant reduction in the total fruit yield. Moreover, pruning cherry tomato plants to two branches permits the early ripening of fruits and produces a higher fruit yield. Hence, the two-branched pruning system combined with the T2 irrigation rate (80% of ETc) is recommended for production cherry tomato under greenhouse conditions to obtain a higher fruit yield and conserve water.

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