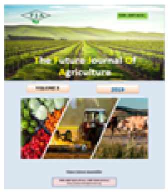
FSA

Available online free at www.futurejornals.org

The Future Journal of Agriculture

Print ISSN: 2687-8151 Online ISSN: 2687-8216

Future Science Association



Future J. Agric., 3 (2019) 9-19 **OPEN ACCES**

EFFECT OF IRRIGATION LEVELS AND SPRAYING MEPIQUAT CHLORIDE ON GROWTH AND PRODUCTIVITY OF PEACH TREES

Zaen El-Daen, E.M.A

Plant Production Department, Desert Research Center, Cairo, **Egypt**

***Corresponding author:** Zaeneldeeneid@yahoo.com **Received:** 15 August 2019 **; Accepted:** 16 Sept. 2019

ABESTRACT: To study the effect of rationalizing irrigation and mepiquat chloride foliar application on growth, productivity and fruit quality of Florida Brines peach trees grafted on Nimagard root stock and grown in sandy soil at a private orchard in El- Tahadi road, EL-Behara Governorate, Egypt. A trial in a split plot design has carried out through two successive seasons of 2018 and 2019. Three drip irrigation levels (100, 80 and 60 % of ETc) were in the main plot and mepiquat chloride foliar application by three levels (without, 150 and 300 ppm) in sub plot and all trees had fertilized by recommended doses. Results indicated that shoot length (cm) and number of leaves/ shoot was not significantly affect by the three irrigation levels in both seasons. Reducing irrigation increased acidity of peach fruits and led to a significant reduction on leaf area $(cm)^2$, total chlorophyll contents, yield, fruit weight, flesh weight, seed weight, TSS and total sugars but no significant difference between irrigation by 80 or 60 % from calculated ETc except with yield and seed weight in both studied seasons. Number of leaves/ shoot, yield either kg/tree or ton/feddan and fruit flesh thickness (cm) were not significantly affected by mepiquat chloride foliar application at all concentrations in both seasons. The highest fruit TSS and the lowest shoot length (cm), leaf length and width (cm), leaf area (cm^2) and total fruit acidity were obtained from peach trees treated by mepiquat chloride foliar application at 300 ppm but by mepiquat chloride foliar application at150ppm achieved the highest increase in fruit weight (gr), flesh weight (gr) and fruit total sugars in both seasons. Additionally, the obtained data from the interaction between irrigation levels and mepiquat chloride foliar application showed that mepiquat chloride foliar application made the decrease in irrigation level gave no significantly reduction in shoot length, leaf length and width (cm), leaf area (cm^2) especially with concentration 150 ppm and with 300 ppm on leaf total chlorophyll contents. However, this interaction failed to show a clear trend on others studied parameters in both seasons. In addition, peach leaf anatomy has affected by foliar application with mepiquat chloride at 150 ppm and 300 ppm where a prominent increase in thickness of lamina of leaf blade more than those of unsprayed ones (control) has found. Finally, irrigated peach trees by 60% of calculated ETc led to the highest water saving and gave the highest productivity of irrigation water where every used m^3 water gave (4.83 & 5.33 kg peach fruits).

Key words: Rationalizing irrigation, mepiquat chloride, Florida Brines cv., water use efficiency, leaf anatomy, leaf blade lamina.

INTRODUCTION

Water availability is a considerable constraint for agriculture and the improvement of water use efficiency (units of product per unit of water) in agricultural sector is an importance issue, with environmental and economic implications. Extensive irrigation from farmers and limited water resources in addition, to the requirements of expansion in the agricultural area to meet the population increase make this problem more difficult. Irrigation is an important limiting factor of crop yield, because it participates with others plant environment factors, which effect on plant growth. The availability of sufficient amount of ground moisture helps facilitate the nutrients necessary for growth and productivity. Consequently, any degree of water stress may produce deleterious effects on growth and yield of the crop **(Saif *et al.*, 2003)**.

To address this problem, many researchers have sought to study the effect of irrigation rationalization on the growth and productivity of many fruit trees. **Johnson *et al.*, (1992)** studied the possibility of reducing the amount of irrigation water without affecting the tree performance in California. The greatest irrigation water saving in treatment regulated deficit irrigation (RDI), irrigated at 100% of ETc only during stage III of fruit growth and 25% the rest of the growing season caused the higher water use efficiency values in this treatment (**Abrisqueta *et al.*, 2010**). **Pliakoni and Nanos (2010)** studied the effect of deficit irrigation with 50% of Etc on "Royal Glory" peach and "Caldesi 2000" nectarine trees and the results showed an increase in total soluble solid (TSS) with higher acidity than fruit from control trees. Moreover, **Rufat *et al.*, (2010)** whose study irrigation restriction of 28% Etc during stage III of peach trees, which led to a clear yield reduction in comparison with T1 (100%Etc). They revealed that this results may be due to a direct effect on fruit weight but gave an increase in total soluble solids and soluble sugar with 30% Etc. Additionally, decreased water amount applied by using irrigation regime from75% up to 25% of field capacity led to significantly decreased in average leaf area (cm^2) of Ne plus Ultra almond as compared with control which was irrigated with 100% of field capacity (**Mohy, 2011**). Besides, **Khattab *et al*., (2011)** indicated that chlorophyll a, b and carotenoids of pomegranate trees increased with high irrigation rate. **Omima and El-Hagarey (2014**) studied the effect of irrigation by three levels (60, 80, 100% of calculated ETc) on yield, fruit quality and some leaf parameters of peach trees. They indicated that irrigation by 80% of ETc under surface ultra-low drip 1.0 l/h irrigation system gave the best results on tree yield and fruit quality, except fruit volume, fruit length, T.S.S. and total acidity percentage where the highest significant values had obtained with this treatment under Gr surface drip 4 l/h. irrigation systems. **Sheren *et al.*, (2017**) were found that the best number of leaves per shoot, leaf area, total chlorophyll content, total yield, cluster weigh , cluster length and width, berry dimensions, weight and volume of 100 berries, soluble solids content (SSC), sugar contents in berries Juice obtained from irrigation vineyard trees at 100% of calculated ETc by sub surface drip irrigation system. On the other side, 80% water amount under a sub-surface drip irrigation system gave the lowest total acidity in both seasons.

Control of tree growth limits exposed surface of the plant it may reduce water loss. This can be obtaining by over-pruning but it may be effect on flowering by reducing number of remaining flower buds. This can be achieved by using foliar application with one of growth retardant from their substances PIX (Mepiquat chloride). PIX (Mepiquat chloride) is a systemic plant growth regulator, extensively used in cotton production for the last two decades (**Hake *et al.*, 1991 & Reddy *et al*., 1993**). PIX treated cotton plants tended to be shorter and narrower with thick and smaller leaves (**Gausman *et al.*, 1979)**. A study on five years old 'Le Conte' pear trees had carried in two types of soil. some plant growth retardants such as, Paclobutrazol (Cultar) sprayed at 200 and 300 ppm, Mepiquat chloride at 150 and 250 ppm, Succinic acid at 150 and 300 ppm and control. Results indicated that Mepiquat chloride in both concentrations increased chlorophyll content and reduced the rate of vegetative growth by decreasing shoot length, leaf area besides and improved fruit quality (**Hanaa and samia, 2014**).

The aim of this work is study the effect of rationalizing irrigation and mepiquat chloride foliar application on growth, productivity and fruit quality of Florida Brines cv. peach trees grafted on Nimagard rootstock and grown in sandy soil.

MATERALS AND METHODS

This study was conducted during two successive seasons 2018 and 2019 in a private orchard in El-Tahadi road, EL-Behara Governorate, Egypt to study the effect of rationalizing irrigation and mepiquat chloride foliar application on growth, productivity and fruit quality of Florida Brines cv. peach trees grafted on Nimagard root stock and grown in sandy soil. Fifty four trees were 5-years old uniform in vigor, planted at 3 x 5 meters were received all requirements from essential elements as the recommendation of the ministry of agriculture and all pests and diseases were controlled. Initial some physical and chemical properties were determined according to **A.O.A.C. (2005)** and recorded as in Table (1).

Table 1. Some physical and chemical properties of the experimental orchard soil

Particle size distribution %			Texture soil	Ec/dsm	PH	Soluble cation meq/L				Soluble Anions meq/L			
Sand	Silt	Clay				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3	Hco_3	CL^{-}	SO_4
90.98	5.85	2.22	Sandy	1.26	7.75	1.54	1.45	8.98	0.63	-	1.56	8.25	2.79

A spilt plot design with two factors and three replicates had used for each treatment and every replicate has represented by two as follow:

- The main factor were the three irrigation water levels (100, 80 and 60 %) of the calculated applied water.

- Sub main factor is three levels of mepiquat chloride as a foliar application (control, 150 and 300 ppm).

Water irrigation sample were determined before the beginning of experiment according to **A.O.A.C. (2005)** and all data had tabulated in Table (2).

Table 2. Some chemical analysis of irrigation water

Characteristics	Ec/dsm	PH	Soluble cation meq/L				Soluble Anions meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co_3	Hco_3	CL^{-}	SO_4
values	1.23	6.77	3.54	3.65	6.98	0.35	-	2.85	6.55	2.90

Irrigation requirements:

Irrigation water requirements for peach trees had calculated according to the local weather station data at El-Beharia Governorate, belonged to the Central Laboratory for Agricultural Climate **(C.L.A.C.),** Ministry of Agriculture and Land Reclamation.

Crop water use was calculated through the evapotranspiration method (ETc = ETo x Kc x Kr (**Allen *et al*, 1998**), where Kc is a coefficient to adjust for the difference between the orchard and ETo and Kr adjusts for ground cover. ETo was obtained from local weather station data at El-Beharia Governorate.

Water requirements (WR) of the peach orchard were calculated on daily basis through the relationship of the simplified water budget WR = ETc – Er, where Er stands for effective rainfall **(Dastane, 1974**).

From calculated water requirements the amount of irrigation water as treatments (100, 80 and 60% calculated as in (Table 3).

Table 3. Amount of irrigation water m^3/tree and m^3/ feddan as treatments (100, 80 and 60%)

Irrigation levels	irrigation water m^3/tree/season		irrigation water m^3/feddan/season	
	2018	2019	2018	2019
100% of calculated ETc	11.20345	11.06001	3136.966	3096.803
80% of calculated ETc	8.962759	8.848008	2509.573	2477.442
60% of calculated ETc	6.722069	6.636006	1882.179	1858.082

The following parameters had recorded:

Vegetative growth measurements: In the first June of the two seasons, shoot length (cm), number of leaves per shoot, leaf length (L) and width (W) were measured and leaf area (cm^2) was calculated LA = 0.70 (L × W) - 1.06 according to **(Ahmed and Morsy 1999)**. Average total chlorophyll content has measured using a chlorophyll meter SPAD 502. Leaf samples had collected from the middle portion of the current season growth and fresh weight was record. Washed by distilled water and dried in oven at 70 ºC until constant weight. Dry weight was record and the percentage of dry matter has calculated as follows:

$$\text{Dry matter \%} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

Yield: At harvesting time in early May in two seasons fruit yield as Weight in (kg) per tree has recorded.

Fruit quality:

- Fruit physical characteristics: Samples of twenty fruits had taken from each replicate for measuring fruit weight (g), flesh weight (g), seed weight (g) and flesh thickness (cm).

- Fruit chemical characteristics: Total soluble solids percentage (TSS) has measured in fruit juice by hand refractometer. Total acidity percentage in fruit juice as malice acid, total and reducing sugar contents were determined according to **A.O.A.C (2005)** and non-reducing sugars was calculated.

Anatomical study: The anatomical studies had carried out only in the second season (2018) to follow the changes occurring in peach leaf tissues as affected by foliar application with mepiquat chloride treatments. Samples of all treatments had taken from the third leaf of the chosen shoots after 15 days from the second date of foliar application. Microtechnique procedures given by **Nassar and El- Sahhar (1998).** Specimens had killed and fixed for at least 48 h in FAA (10 ml formalin, 5 ml glacial acetic acid and 85 ml ethyl alcohol 70%). The selected materials were washed in 50% ethyl alcohol, dehydrated in normal butyl alcohol series, embedded in paraffin wax of 56 ºC melting point, Sectioned to a thickness of 20 microns, double stained with safranin and light green, cleared in xylene and mounted in canada balsam. Sections were examined to detect histological manifestations of the chosen treatments and photomicrographed. To studies the effect of treatments on peach leaf structure some measurements i.e. (midvein thick., lamina thick., upper epidermis thick., lower epidermis thick., palisade tissue thick., spongy tissue thick, midvein bundle length, midvein bundle width, number of xylem vessels/bundle and diameter of xylem vessels/bundle) were estimated.

Productivity of irrigation water (PIW, kg/m^3). Productivity of irrigation water (PIW) was calculated by the following equation according to **(Ali *et al.*, 2007). PIW=Y/Wa Where:** PIW: Productivity of irrigation water (kg fruits /m^3 of water), Y: fruit yield (kg/fed.) and Wa: Water applied to the field (m^3)

Statistical analysis: The obtained data of all seasons has subjected to analysis of variance according to **Snedecor and Cochran (1980).** The means had differentiated using Duncan multiple range test at 5% level (**Duncan, 1955).**

RESULTS AND DISCUITIONS

Vegetative growth parameters

It is clear from data in Table (4) that shoot length (cm) and number of leaves per shoot was not significantly affected by the three irrigation levels applied in both seasons.

Regarding to mepiquat chloride foliar application effect on shoot length (cm) number of leaves was affected significantly by different concentrations in both seasons. In addition, mepiquat chloride foliar application at 300 ppm produced the lowest shoot length (cm) comparing with the second concentration 150 ppm or without mepiquat chloride foliar application. But, number of leaves per shoot was not significantly affected by mepiquat chloride foliar application in both seasons.

Table 4. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on shoot length (cm) and number of leaves per shoot of peach trees during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	Shoot length (cm)				Number of leaves pre shoot			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		24.00 a	19.33 b	18.0 bc	20.44 A	25.67 a	24.00 a	23.33 a	24.33 A
80 ETC		23.67 a	18.67 b	17.6 bc	20.00 A	24.67 a	23.33 a	23.00 a	23.67 A
60 ETC		23.67 a	19.33 b	16.67 c	19.89 A	24.33 a	23.33 a	23.00 a	23.56 A
Mean		23.78 A	19.11 B	17.44 C		24.89 A	23.55 A	23.11 A	
2019									
100 ETC		23.64 a	18.97b	17.6bc	20.08A	25.94a	24.27a	23.60a	24.60A
80 ETC		23.31a	18.31b	17.3bc	19.64A	24.94a	23.60a	23.27a	23.94A
60 ETC		23.31a	18.97b	16.31c	19.53A	24.60a	23.60a	23.27a	23.83A
Mean		23.42A	18.75B	17.08C		25.16A	23.8A	23.4A	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

Additionally, the obtained data from the interaction between irrigation levels and mepequat chloride foliar application showed that mepequat chloride foliar application made the decrease in irrigation level gave no significantly reduction in shoot length especially with concentration 150 ppm. However, number of leaves per shoot was not significantly affected by the interaction between irrigation levels and mepequat chloride foliar application in both seasons.

Data in Table (5) revealed that leaf length and width (cm) significantly affected by the three irrigation levels applied but no significant difference between irrigation by 80 or 60 % from calculated ETc in both seasons in this respect.

Furthermore, mepiquat chloride foliar application effect on leaf length and width (cm) significantly affected by different concentrations in both seasons. Mepiquat chloride foliar application at 300 ppm produced the lowest leaf length and width (7.5, 7.74 and 2.51, 2.06 cm) comparing with the highest values (12.17, 12.41 and 2.30, 2.85 cm) obtained from without mepiquat chloride foliar application (control) in 2018 and 2019 seasons, respectively.

Although, the highest values of peach leaf length and width obtained from trees irrigated with 100% of calculated ETc without mepiquat chloride foliar application but mepiquat chloride foliar application made the decrease in irrigation level gave no significantly reduction in leaf length and width in both seasons.

On the contrary, data in Table (6) indicated that leaf area (cm^2) and total chlorophyll contents significantly affected by the three irrigation levels applied but no significant difference between irrigation by 80 or 60 % from calculated ETc in both seasons in this respect.

Table 5. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on width and length of peach leaves during 2018 and 2019 seasons

Irrigation treatments	Leaf width (cm)				Leaf length (cm)			
Mepequat chloride treatments	Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018								
100 ETC	3.33a	2.93b	2.77b	3.01A	13.00a	9.00c	8.00d	10.00A
80 ETC	3.30a	2.53c	2.40c	2.75B	12.00b	8.00d	7.50de	9.17B
60 ETC	3.28a	2.51c	2.37c	2.72B	11.50b	8.00d	7.00e	8.83B
Mean	3.30A	2.66B	2.51C		12.17A	8.33B	7.50C	
2019								
100 ETC	2.88a	2.48b	2.32b	2.56A	13.24a	9.24c	8.24d	10.24A
80 ETC	2.85a	2.08c	1.95c	2.30B	12.24b	8.24d	7.74de	9.41B
60 ETC	2.83a	2.06c	1.92c	2.27B	11.74b	8.24d	7.24e	9.07B
Mean	2.85A	2.21B	2.06C		12.41A	8.57B	7.74C	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

Regarding to leaf area (cm^2) and total chlorophyll contents as affected by mepiquat chloride foliar application we found significant differences between the three using concentrations in both seasons in this respect. Mepiquat chloride foliar application at 300 ppm produced the lowest leaf area (12.18 and 10.16 cm^2) comparing with the highest leaf area (27.10 and 23.73 cm^2) obtained from without mepiquat chloride foliar application (control) in 2018 & 2019 seasons respectively. Another trend was found in total chlorophyll contents where we found that mepiquat chloride foliar application at 300 ppm produced the highest total chlorophyll contents (45.19 and 47.00 SPAD value) comparing with the lowest total chlorophyll contents (36.24 and 38.04 SPAD value) obtained from without mepiquat chloride foliar application (control) in 2018 and 2019 seasons respectively.

Table 6. Effect of irrigation levels, foliar application of mepquat chloride and their interaction on leaf area $(cm)^2$ and Total chlorophyll of peach leavess during 2018 and 2019 seasons

Irrigation treatments	Leaf area				Total chlorophyll			
Mepequat chloride treatments	Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018								
100 ETC	29.33a	17.44c	14.47d	20.42A	36.80de	39.17c	48.23a	41.40A
80 ETC	26.65b	13.1de	11.55e	17.10B	36.40de	37.8cd	44.13b	39.46B
60 ETC	25.31b	13.0de	10.53e	16.29B	35.53e	37.0de	43.50b	38.67B
Mean	27.10A	14.52B	12.18C		36.24C	37.99B	45.29A	
2019								
100 ETC	25.71a	15.01c	12.34d	17.69A	38.60de	40.97c	50.03a	43.20A
80 ETC	23.34ab	10.9de	9.51e	14.59B	38.20de	39.6cd	45.93b	41.26B
60 ETC	22.15b	10.9de	8.64e	13.88B	37.33e	38.8de	45.30b	40.47B
Mean	23.73A	12.26B	10.16C		38.04C	39.79B	47.0A	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

On the other hand, the highest values of peach leaf area (29.33 and 25.71 cm^2) obtained from trees irrigated with 100% of calculated ETc without mepiquat chloride foliar application but mepiquat chloride foliar application at 300 ppm with irrigation level 100 % of calculated ETc achieved the highest total chlorophyll contents (48.23 and 50.03 SPAD value) in the first and second seasons respectively. Besides, mepiquat chloride foliar application made decrease irrigation level gave no significantly reduction in leaf area in both seasons.

The reduction in some vegetative growth by decreasing water amount may be due to the effect of disability in irrigation on plant biological processes as solving nutrients. These data are agree with the findings by (**Mohy, 2011**) who reported that decreased water amount applied by using irrigation regime from 75% up to 25% of field capacity led to significantly decreased in average leaf area (cm^2) of Ne plus Ultra almond as compared with control which was irrigated with 100% of field capacity. **Khattab *et al*., (2011)** indicated that chlorophyll a, b and carotenoids of pomegranate trees increased with high irrigation rate. **Sheren *et al*., (2017**) were found that the best number of leaves per shoot, leaf area and total chlorophyll content of grape trees obtained from irrigation vineyard trees at 100% of calculated ETc by sub surface drip irrigation system.

Besides, reduction of some vegetative growth parameters of peach trees treated by mepiquat chloride foliar application due to mepiquat chloride mode of action as a growth retardants in inhibiting growth. These results in same way of the findings by leaves (**Gausman *et al.*, 1979)** whose reported that PIX treated cotton plants tended to be shorter and narrower with thick and smaller. Moreover, a study on five years old 'Le Conte' pear trees was carried in two types of soil. some plant growth retardants such as, Paclobutrazol (Cultar) sprayed at 200 and 300 ppm, Mepiquat chloride at 150 and 250 ppm, Succinic acid at 150 and300 ppm and control. Results indicated that Mepiquat chloride in both concentrations increased chlorophyll content and reduced the rate of vegetative growth by decreasing shoot length and leaf area besides (**Hanaa and samia, 2014**).

Yield (kg/ tree) and (ton/ feddan)

Regarding to data in Table (7) irrigated peach trees by three levels significantly affected on yield (kg/ tree) and (ton/ feddan) in both studied seasons. In addition, the lowest yield (32.49, 35.39 kg/ tree and 9.10, 9.91 ton/ feddan) obtained from peach trees irrigated by 60% of calculated ETc comparing with the highest yield (45.20, 48.10 kg/ tree and 12.66, 13.47 ton/ feddan) obtained from peach trees irrigated by 100% of calculated ETc in 2018 and 2019 seasons respectively.

It is clear from data in the same table that yield either kg/ tree or ton/ feddan was not significantly affected by mepiquat chloride foliar application at all concentrations in both seasons.

Table 7. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on yield kg/tree and ton/feddan of peach trees during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	Yield kg/tree				Yield ton/feddan			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		44.53a	46.20a	44.87a	45.20A	12.47a	12.94a	12.56a	12.66A
80 ETC		37.78b	43.82c	39.03b	37.21B	10.58b	9.75c	10.93b	10.42B
60 ETC		31.40d	33.7cd	32.3cd	32.49C	8.79d	9.44cd	9.05cd	9.10C
Mean		37.90A	41.25A	38.74A		10.61A	10.71A	10.85A	
2019									
100 ETC		47.43a	49.10a	47.77a	48.10A	13.28a	13.75a	13.38a	13.47A
80 ETC		40.68b	37.72c	41.93b	40.11B	11.39b	10.56c	11.74b	11.23B
60 ETC		34.30d	36.6cd	35.2cd	35.39C	9.60d	10.3cd	9.86cd	9.91C
Mean		40.80A	41.1A	41.6A		11.43A	11.5A	11.6A	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

On the other hand, the highest values of yield (44.53, 47.43 kg/tree and 12.94, 13.28 ton/feddan) obtained from trees irrigated with 100% of calculated ETc without mepiquat chloride foliar application in the first and second seasons respectively. Besides, mepiquat chloride foliar applications failed in decrease the effect of reduce irrigation level on peach trees yield in both seasons.

On my opinion the reduction in yield due to the effect of reducing irrigation which led to less vegetative growth and its effect on reducing photothynsis and carbohydrate accumulation. As the findings by **Rufat *et al.*, (2010)** whose study irrigation restriction of 28% Etc during stage III of peach trees which led to a clear yield reduction in comparison with T1 (100%Etc). **Omima and El-Hagarey (2014**) they were indicated that irrigation by 80% of ETc under surface ultra-low drip 1.0 l/h irrigation system gave the best results on tree yield. **Sheren *et al.*, (2017**) were found that the best total yield obtained from irrigation vineyard trees at 100% of calculated ETc by sub surface drip irrigation system.

I think that non-significant differences between mepequat chloride foliar applications at two using concentrations and control on yield may be due to the role of this treatment in increasing leaf chlorophyll contents which led to an increase in photothynsis and carbohydrate accumulation. This opinion is agree with the results by **Hanaa and samia, 2014** whose indicated that mepiquat chloride in both concentrations increased chlorophyll content.

Fruit physical properties

Peach fruit physical properties (fruit weight, flesh weight, thickness and seed weight “g”) as affected by irrigation levels, mepiquat chloride foliar application and the interaction between them recorded in Tables (8 and 9).

Data in Table (8) indicated that fruit weight significantly affected by the three irrigation levels applied but no significant difference between irrigation by 80 or 60 % from calculated ETc. Nevertheless, data of flesh thickness did not show any significant differences between the three irrigation levels in both seasons in this respect.

Regarding to fruit weight as affected by mepiquat chloride foliar application we found significant differences between the three using concentrations in both seasons in this respect. Mepiquat chloride foliar application at 150 ppm produced the highest fruit weight (84.74 and 85.9 g) but no significant differences between data obtained from without mepiquat chloride foliar application (control) or mepiquat chloride foliar application at 300 ppm 2018 and 2019 seasons respectively. No significant differences between without mepiquat chloride foliar application (control) and mepiquat chloride foliar application either at 150 or at 300 ppm in both studied seasons.

Table 8. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on fruit weight and flesh thickness of peach during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	Fruit weight (g)				Flesh thickness (cm)			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		82.13bc	91.67a	87.0ab	86.93A	1.56a	1.49a	1.46a	1.50A
80 ETC		76.7cde	82.5bc	76.8cde	78.64B	1.41a	1.58a	1.49a	1.49A
60 ETC		72.70e	80.1cd	74.6de	75.80B	1.38a	1.40a	1.41a	1.40A
Mean		77.18B	84.74A	79.46B		1.45A	1.49A	1.45A	
2019									
100 ETC		83.27bc	92.81a	88.1ab	88.07A	1.58a	1.51a	1.48a	1.52A
80 ETC		77.8cde	83.6bc	77.9cde	79.78B	1.43a	1.60a	1.51a	1.51A
60 ETC		73.87e	81.2cd	75.7de	76.94B	1.40a	1.43a	1.43a	1.42A
Mean		78.32B	85.9A	80.60B		1.47A	1.51A	1.47A	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

However, the highest values of peach fruit weight (91.67 and 92.81 g) obtained from trees irrigated with 100% of calculated ETc with mepiquat chloride foliar application at 150 ppm in the first and second season respectively. Besides, the interaction between mepiquat chloride foliar application at (without, 150 and 300 ppm) and irrigate peach trees by the three studied levels (100, 80 and 60% of calculated ETc) failed to achieve any significant in fruit flesh thickness in both studied seasons.

In addition to, data in Table (9) revealed that although fruit flesh weight significantly affected by the three irrigation levels applied but no significant difference between irrigation by 80 or 60 % from calculated ETc. Besides, data of seed weight significantly affected by the three irrigation levels and seed weight decreased by decrease irrigation where the highest seed weight (5.13 and 4.83 g) obtained from trees irrigated by 100% of calculated ETc in 2018 and 2019 seasons respectively.

Peach trees treated by mepiquat chloride foliar application resulted fruits with significant differences in flesh and seed weight as affected by the three using concentrations in both seasons in this respect. Mepiquat chloride foliar application at 150 ppm produced the highest flesh weight (80.33 and 81.8 g) in the first and second season respectively. But seed weight of peach fruits significant decreased by mepiquat chloride foliar application comparing with the highest seed weight (4.68 and 4.38 g) which obtained from without mepiquat chloride foliar application (control) in 2018 and 2019 seasons respectively. No significant differences between mepiquat chloride foliar application either at 150 or 300 ppm in both studied seasons in this respect.

Table 9. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on flesh and seed weight of peach fruits during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	Fruit flesh weight (g)				Seed weight (g)			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		67.80bc	86.70a	81.9ab	81.80A	5.33a	5.00ab	5.07a	5.13A
80 ETC		72.1cde	78.3bc	72.4cde	74.24B	4.58bc	4.23cd	4.40cd	4.40B
60 ETC		68.60e	76.1bcd	70.3de	71.67B	4.13d	4.00d	4.27cd	4.13C
Mean		72.49B	80.33A	74.88B		4.68A	4.41B	4.58AB	
2019									
100 ETC		78.24bc	88.11a	83.4ab	83.24A	5.03a	4.70ab	4.77a	4.83A
80 ETC		73.5cde	79.7bc	73.8cde	75.68B	4.28bc	3.93cd	4.10cd	4.11B
60 ETC		70.04e	77.5bcd	71.8de	73.11B	3.83d	3.70d	3.97cd	3.83C
Mean		73.93B	81.8A	76.32B		4.38A	4.11B	4.3AB	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

However, the highest values of peach fruit flesh weight (86.70 and 88.11 g) obtained from trees irrigated with 100% of calculated ETc with mepiquat chloride foliar application at 150 ppm in the first and second season respectively. Besides, seed weight significantly decreased by the interaction between mepiquat chloride foliar application at (150 and 300 ppm) and irrigate peach trees by the three studied levels (100, 80 and 60% of calculated ETc) where the lowest seed weight (4.00 and 3.70 g) obtained from trees irrigated by 60% of calculated ETc and treated with 150 ppm mepiquat chloride foliar application comparing the highest seed weight obtained from trees irrigated by 100% of calculated ETc without mepiquat chloride foliar application in the first and 2018 and 2019 seasons, respectively.

The results were in some line with several reports as **Rufat *et al.* (2010)** who reported that deficit irrigation during stage III reduced fruit size and weight of peach fruit which are major attributes to fruit quality. **Omima and El-Hagarey (2014**) they were indicated that irrigation by 80% of ETc under surface ultra-low drip 1.0 l/h irrigation system gave the best results of fruit quality. **Sheren *et al.*, (2017**) were found that the best cluster weigh, cluster length and width, berry dimensions, weight.

Hanaa and samia (2014) studied the effect of mepiquat chloride at 150 and 250 ppm on five years old 'Le Conte' pear trees. Results indicated that mepiquat chloride in both concentrations increased chlorophyll content and improved fruit quality.

Fruit chemical properties

Some chemical properties of peach fruits i.e., total soluble solids percentage (TSS), TSS/ acid ratio, total acidity percentage and total sugars as affected by three irrigation levels, mepiquat chloride foliar application and its interaction recorded in Table (10 and 11).

Data in Table (10) revealed that although TSS & TSS/ acid ratio significantly affected by the three irrigation levels applied but less significant difference between irrigation by 80 or 60 % from calculated ETc in TSS and no significant differences between them in TSS/ acid ratio. Besides, the highest TSS (8.73 and 9.83%) and the highest TSS/ acid ratio (23.17 and 18.58) obtained from trees irrigated by 100% of calculated ETc in 2018 and 2019 seasons respectively.

Regarding to the effect of mepiquat chloride foliar application on TSS and TSS/ acid ratio of peach fruits we found significant differences between the three using concentrations in both seasons in this respect. Mepiquat chloride foliar application at 300 ppm produced the highest TSS (8.58 and 9.68%) and the highest TSS/acid ratio (20.83 and 17.2%) in the first and second season respectively. However, no significant difference between mepiquat chloride foliar application at 150 ppm and without mepiquat chloride foliar application (control) on TSS in both studied seasons in this respect.

TSS and TSS/ acid ratio significantly affected by the interaction between the two studied factors where, the highest values of TSS and TSS/ acid ratio (10.30 and 11.40 % in TSS and 30.62 and 23.46 in TSS/ acid ratio) obtained from trees irrigated with 100 % of calculated ETc with mepiquat chloride foliar application at 150 ppm in the first and second seasons, respectively.

Table 10. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on TSS and TSS/ acid ratio of peach fruits during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	TSS				TSS/ acid ratio			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		7.17cd	10.30a	8.73b	8.73A	15.87cd	30.68a	22.97b	23.17A
80 ETC		7.47cd	7.05d	9.13b	7.88AB	16.14cd	17.6cd	21.22b	18.33B
60 ETC		7.67cd	7.11d	7.87c	7.54B	15.65d	17.2cd	18.31c	17.05B
Mean		7.43B	8.15AB	8.58A		15.89B	21.83A	20.83A	
2019									
100 ETC		8.27cd	11.40a	9.83b	9.83A	13.73d	23.46a	18.55b	18.58A
80 ETC		8.57cd	8.15d	10.23b	9.0AB	13.98cd	14.8cd	17.63b	15.48B
60 ETC		8.77cd	8.21d	8.97c	8.65B	13.70d	14.6cd	15.47c	14.57B
Mean		8.53B	9.3AB	9.68A		13.80B	17.6A	17.2A	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

Data in Table (11) revealed that acidity and total sugars percentage significantly affected by the three irrigation levels applied but no significant difference between irrigation by 80 or 60 % from calculated ETc in both seasons. Besides, the lowest acidity (0.39 and 0.54%) and the highest total sugars (7.18 and 6.68%) obtained from trees irrigated by 100 % of calculated ETc in 2018 and 2019 seasons respectively.

The acidity and total sugars of peach fruits significantly affected by of mepequat chloride foliar application by the three using concentrations in both seasons in this respect. Mepiquat chloride foliar application at 300 ppm produced the lowest values of acidity (0.41 and 0.56 %) but the highest values of total sugars (7.52 and 7.03 %) has obtained from trees treated by mepiquat chloride foliar application at 150 ppm in the first and second season respectively. But no significant difference between mepiquat chloride foliar application at 300 ppm and control on total sugars in both studied seasons in this respect.

Table 11. Effect of irrigation levels, foliar application of mepiquat chloride and their interaction on acidity and Total sugars of peach fruits during 2018 and 2019 seasons

Irrigation treatments	Mepiquat chloride treatments	Acidity				Total sugars			
		Control	150 ppm	300 ppm	Mean	Control	150 ppm	300 ppm	Mean
2018									
100 ETC		0.45bc	0.34g	0.38f	0.39B	6.80de	7.73a	7.00cd	7.18A
80 ETC		0.46ab	0.40ef	0.43cd	0.43A	6.76de	7.60ab	6.85de	7.07AB
60 ETC		0.49a	0.42de	0.43cd	0.45A	6.62e	7.25bc	6.78de	6.88B
Mean		0.47A	0.38B	0.41C		6.73B	7.53A	6.88B	
2019									
100 ETC		0.60bc	0.53f	0.53f	0.54B	6.30de	7.23a	6.50cd	6.68A
80 ETC		0.61ab	0.55de	0.58cd	0.58A	6.26de	7.10ab	6.35de	6.6AB
60 ETC		0.64a	0.57de	0.58cd	0.60A	6.12e	6.75bc	6.28de	6.38B
Mean		0.62A	0.53B	0.56C		6.23B	7.03A	6.37B	

Means with the same letter (s) in each column or row are not significantly different at 5% level.

Finally, total acidity and total sugars significantly affected by the interaction between the two studied factors where, the lowest values of total acidity (0.34 and 0.53%) obtained from trees irrigated with 100% of calculated ETc with mepiquat chloride foliar application at 150 ppm but this treatment produced peach fruits with the highest total sugars (7.73 and 7.23%) in the first and second season respectively.

These results were agree with the obtained by **Pliakoni and Nanos (2010)** studied the effect of deficit irrigation with 50% of Etc on “Royal Glory” peach and “Caldesi 2000” nectarine trees and the results showed an increase in total soluble solid (TSS) with higher acidity than fruit from control trees. **Rufat *et al.*, (2010)** whose study irrigation restriction of 28% Etc during stage III of peach trees which led to a clear yield reduction in comparison with T1 (100%Etc). They were revealed that this result gave an increase in total soluble solids and soluble sugar with 30% Etc. **Omima and El-Hagarey (2014**) indicated that TSS and total acidity % where the highest significant values were obtained with irrigation by 80% of calculated ETc under Gr surface drip 4 l/h. irrigation systems. **Sheren *et al.*, (2017**) were found that the best soluble solids content (SSC) and sugar contents in berries Juice obtained from irrigation vineyard trees at 100% of calculated ETc by sub surface drip irrigation system. On the other side, 80% water amount under by sub surface drip irrigation system gave the lowest total acidity in both seasons.

Hanaa and samia, 2014 studied mepiquat chloride at 150 and 250 ppm on five years old 'Le Conte' pear trees. Results indicated that mepiquat chloride in both concentrations increased chlorophyll content improved fruit quality.

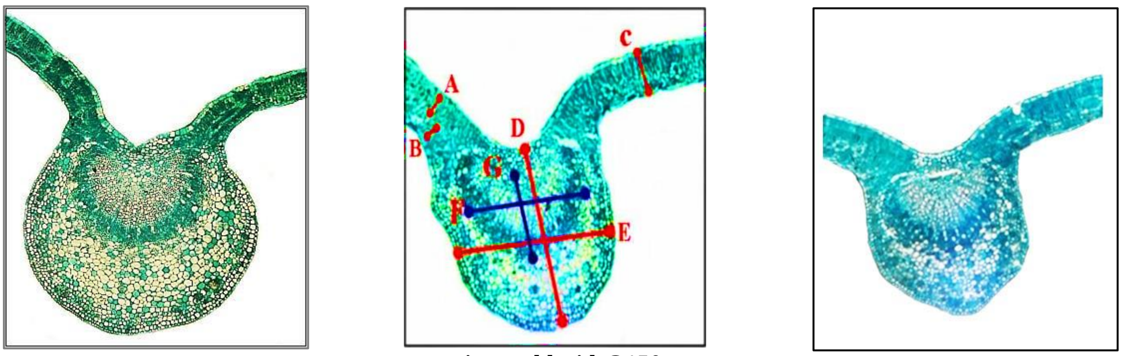
Leaf Anatomy

Microscopical counts and measurements of certain histological characters in transverse section through the blade of peach trees leaf sprayed with mepiquat chloride at 150 ppm and 300 ppm in Table (12) and fig. (1). It is obvious, the foliar application with mepiquat chloride at 150 ppm and 300 ppm on peach trees a prominent increase in thickness of lamina of leaf blade more than those of unsprayed ones (control). It is clear that the increase in lamina thickness increments in thickness of upper epidermis, lower epidermis, palisade tissue and spongy tissue compared with unsprayed ones. Bundle length, Midvein thick., Midvein width, midvein bundle length and xylem vessels/ midvein row number decreased in response to spraying mepiquat chloride at 150 ppm and 300 ppm this decrease was accompanied by increasing in leaf thickness and numbers of xylem row and vessels, yet all the recorded values were still higher than the control treatment.

Table 12. Effect of spraying with mepiquat chloride at 150 ppm and 300 ppm on leaf anatomical traits of peach trees in successive growing season of 2018

Characters of leaf anatomy	Control	Mepiquat chloride concentrations	
		300 ppm	150 ppm
Midvein thick. **(µ)**	990	623.4	534.6
Midvein width **(µ)**	970.2	643.5	613.8
Midvein bundle length **(µ)**	623.7	485.1	465.3
Midvein bundle width **(µ)**	297	247.5	207.9
Palisade mesophyll **(µ)**	69.3	89.1	79.2
Spongy mesophyll **(µ)**	39.6	59.4	49.5
Lamina thick. **(µ)**	138.6	178.2	158.4
Xylem vessels/midvein row number	31	25	23

All enhanced leaf anatomical parameters (palisade cell length, spongy tissue thickness, blade thickness, midrib vascular bundle width, midrib vascular bundle length and midvein thickness) due to spraying with mepiquat chloride at 150 ppm and 300 ppm on peach trees reflected on a good translocation of the observed water and nutrients into cell to be used in different metabolic process which positively affected fresh weight of leaves and shoot on photosynthesis process activity and accumulation of photo-assimilates, Therefore, helping in better retention of flowers and fruits and this in turn increased yield.



Control **mepiquat chlorid @150ppm** **mepiquat chlorid @ 300ppm**

A- Palisade tissue thick.; B- Spongy tissue thick.; C- Blade thick.; D- Midvein thick.; E- Midvein width; F- Midrib V.B. Width.; G- Midrib V.B. length.

Fig. 1. Transverse sections through the blade of leaf developed on shoots of peach trees. Effect of sprayed with mepiquat chlorid on leaf anatomy at 15 days after spray at the season of 2018. (×100)

Water saving: It is clear from data in Table (13) that irrigated peach trees by 60% of calculated ETc led to the highest water saving (4.48 and 4.42 m^3/tree/season) and (1254.787 and 1238.721 m^3/feddan/season) but irrigated peach trees by 80% of calculated ETc only save (2.24 and 2.21 m^3/tree/season) and (627.39 and 619.36 m^3/feddan/season) compared with used water when peach trees irrigated by 100% of calculated ETc in 2018 and 2019 seasons, respectively.

Table 13. Effect of irrigation levels applied to peach trees on water saving (m^3/tree/season and m^3/feddan/season) during 2018 and 2019 seasons

Irrigation treatments	Water saving m^3/tree/season		Water saving m^3/feddan/season	
	2018	2019	2018	2019
100 ETC	0	0	0	0.0002
80 ETC	2.240691	2.212002	627.3934	619.3608
60 ETC	4.481381	4.424004	1254.787	1238.721

Productivity of irrigation water: Additionally data in Table (14) showed that irrigated peach trees by 60% of calculated ETc gave the highest productivity of irrigation water where every used m^3 water gave (4.83 and 5.33 kg peach fruits) followed by (4.15 and 4.53 kg peach fruits) obtained from each m^3 water when peach trees irrigated by 80% of calculated ETc compared with (4.04 and 4.35 kg peach fruits) obtained from each m^3 water when peach trees irrigated by 100% of calculated ETc in 2018 and 2019 seasons, respectively.

Table 14. Effect of irrigation levels applied to peach trees on productivity of irrigation water (kg fruits /m^3 of water) during 2018 and 2019 seasons

Irrigation treatments	2018	2019
100 ETC	4.04	4.35
80 ETC	4.15	4.53
60 ETC	4.83	5.33

REFRENCES

A.O.A.C. (2005). Association of Official Analytical Chemists, Official Methods of Analysis, 26th edition. Washington D.C., USA.

Abrisqueta, I.; Tapia, L. M.; Conejero1, W.; Sanchez-Toribio, M. I.; Abrisqueta, J. M.; Vera, J. and Ruiz-Sanchez, M. C. (2010). Response of early-peach *Prunus persica* (L.) trees to deficit irrigation. Spanish Journal of Agricultural Research, 8 (S2), S30-S39ISSN: 1695-971-X.

Ahmed, F.F. and Morsy, M.H. (1999). A new method for measuring leaf area in different fruit species. Minia Agric. Res. & Develop., (19): 97-105.

Ali, M. H.; Hoque, M. R.; Hassan, A. A. and Khair, A. (2007). Effects of deficit irrigation on yield, water productivity, and economic returns of wheat Agricultural Water Management, 92 (3): 151-161.

Allen, R. G.; Pereira, L. S.; Raes. D. and Smith, M. (1998). Crop evapotranspiration. Guidelines for computing crop requirements. Irrigation and drainage paper No.56 FAO, Rome, Italy.

Dastane, N. G. (1974). Effective rainfall in irrigated agriculture, FAO Irrigation and Drainage Paper 25, Food and Agric. Organization of the United Nations, Rome.

Duncan, D.B. (1955). Multiple F test. Biometrics, 11:1-24.

Gausman H.W.; Walter, H.; Stein, E.; Rittig, F.R.; Learner, R.W.; Escobar, D.E. and Rodrignez, (1979). Leaf CO_2 uptake and chlorophyll ratios of PIX-treated cotton. In: Proc 6th Ann Meeting of Plant Growth Regulators Working Group, CO Las Vegas, pp 117-12.5. USA: PGRWG, Longmount.

Hake, K.; Kerby, T.; MCarty, W.O.; Neal, D. and Supak, J. (1991) Physiology of PIX. In: Physiology Today, Vol. 2, No. 6. Mem phis, USA: National Cotton Council of America.

Hanaa M. S. and Samia, A. A. (2014). Effect of Some Plant Growth Retardants on Vegetative Growth, Spurs and Fruiting of 'Le - Conte' Pear Trees. British J. Appl. Sci. & Technol. 4 (26): 3785-3804.

Johnson, R.S.; Handley, D.F. and DeJong. T.M. (1992). Long-term response of early maturing peach trees to postharvest water deficit. J. Amer. Soc. Hort. Sci., 117: 881-886.

Khattab, M.M.; Shaban, A.E.; El-Shrief, A.H. and Mohamed, A.S.E. (2011). Growth and Productivity of Pomegranate Trees under Different Irrigation Levels. III: Leaf Pigments, Proline and Mineral Content. J. Hort. Sci. & Ornamental Plants, 3 (3): 265-269.

Mohy, A.A. (2011). Effect of some water treatments on growth and chemical composition of almond transplants. M.Sc. thesis, Fac. Agric, Benha Univ., Egypt, 126p.

Nassar, M.A. and El-Sahhar, K.F. (1998). Botanical Preparations and Microscopy (Microtechnique). Academic Bookshop, Dokki, Giza, Egypt, 219 pp. (In Arabic).

Omima, M. El-sayed and El-Hagarey, M. E. (2014). Evaluation of Ultra-low Drip Irrigation and Relationship between Moisture and Salts in Soil and Peach (*pruns perssica*) Yield. J. Amer. Sci., 10 (8). http://www.jofamericanscience.org.

Pliakoni, E.D. and Nanos, G.D. (2010). Deficit irrigation and reflective mulch effects on peach and nectarine fruit quality and storage ability. Acta Horticulture, 877: 215-222.

Reddy, K.R.; Hodges H.F. and McKinion, J.M. (1993). A tempera true model for cotton phenology. Biotronics, 22: 47-59.

Rufat, J.; Arbones, A.; Villar, P.; Domingo, X.; Pascual, M. and Villar, J. M. (2010). Effects of irrigation and nitrogen fertilization on growth, yield and fruit quality parameters of peaches for processing. Acta Horticulture, 868: 87-94.

Saif, U.; Maqsood, M.; Farooq, M.; Hussain S. and Habib. A. (2003). Effect of planting patterns and different irrigation levels on yield and yield component of maize (*Zea mays*, L). Intern. J. Agric. and Biol., 1: 64–66.

Sheren, A. Abed EL-Hamied; Zaen El-Deen, E. M. A. and El-Hagarey, M. E. (2017). Management of Irrigation Systems to Improve Productivity and Quality of Grapevine under Desert Conditions. IOSR J. Agric. and Veterinary Sci., 10 (10): 77-90. www.iosrjournals.org.

Snedecor, G.W. and Cochran, G.W. (1989). Statistical Methods, 8th edition. Iowa State University Press, Iowa, USA.