Middle East Journal of Agriculture Research, 3(3): 694-700, 2014
ISSN 2077-4605

Enhancing the Efficiency of Irrigation Water Use by Using Some Antitranspirants in Wounderful Pomegranate Orchards

[1]El-Khawaga A.S. and [2] Mansour A.E.M.

[1]Hort. Dept., Fac. of Agric., South Valley Univ. Qena. Egypt.
[2]Pomology Dept., National Res. Centre., Dokki, Egypt.

ABSTRACT

During 2013 & 2014 seasons, Wounderful pomegranate trees received irrigation water at three levels namely 4 , 6 and 8 m3/ tree season with or without spraying three antitranspirants namely silica gel at 2% , Kaolin at 3% or Chitosan at 2% . The counteractive effects of antitranspirants on the adverse effects of water deficit on growth and fruiting of Wounderful pomegranate trees were investigated

Reducing irrigation water regimes from 8 to 4 m^3/ tree/ season had a announced promotive effect on hard leaf water , leaf succulence grade, leaf osmotic pressure , total phenols, proline, total soluble tannins % and anthocyanins in the fruit peels and juice. A remarkable reduction was appeared in shoot length, leaf area leaf relative turgidity %, total chlorophylls, total indoles , wood total carbohydrates %, percentages, of N, P and K , initial fruit setting, fruit retention %, number of fruits/ tree, yield , fruit weight , percentage of juice and grain and edible to non edible portions . Using anyone of the three antitranspirants namely silica gel at 2%, kaolin at 3% and Chitosan at 2% under water deficit conditions materially enhanced growth characters, leaf relative turgidity %, total chlorophylls , total indoles, wood total carbohydrates %, percentages of N, P and K, initial fruit setting, fruit retention , yield , fruit weight , percentages of grains and juice , edible to nonedible portions , T.S.S., reducing and total sugars and total anthocyanins in the fruit peel and juice. The best antitranspirants in this connection were silica gel, kaolin and chitosan, in ascending order.

For enhancing water use efficiency and reducing the adverse effects of water deficit on Wounderful pomegranate, it is advised to irrigate the trees with water at 6 m3/ tree / season plus supplying the trees three times with chitosan at 2%

Key words: Water deficit, pomegranate, antitranspirants, yield.

Introduction

The lack of water is the major restricting factor to cultivation in arid and semi arid regions. Water deficit occurs whenever the loss of water in transpiration exceeds the rate of absorption. It is characterized by the reduction in water content accompanied with the loss of turgor, closure of stomata and inhibit growth and photosynthesis process (Boyer, 1995 and Hassan, 1998).

There is a critical need to balance water availability, water requirements and water consumption thus water conserving is becoming a decisive consideration for agriculture, particularly in arid and semi-arid regions where water is the main limiting factor for plant growth. Moreover, plants are prodigal in the water use because only roughly 5% of water uptake is used for its growth and development while the remaining 95% is lost for transpiration (Prakash and Ramachandran, 2000). Actively growing plants would transpire a weight of water equal to their leaf fresh weight each hour under conditions of arid and semi-arid regions if water is supplied adequately.

Certain chemicals with some biological activities could be used to reduce the transpiration rate and mitigate plant water stress by increasing the leaf resistance to the diffusion of water vapor. Based on their mechanism of action, such antitranspirants were grouped into three categories namely film-forming types (which coat leaf surface with films that are impervious to water vapor), reflecting materials (which reflect back a portion of the incident radiation falling on the upper surface of the leaves) and stomatal closing types (which affect the metabolic processes in leaf tissues). Film forming and reflecting antitranspirants were found to be non- toxic and have longer period of effectiveness than metabolic types. Moreover, in contrast to most film-forming antitranspirants which are impermeable to CO_2 exchange and thus may reduce the rate of photosynthesis, the pinolene-base Vapor gard has not been reported to reduce the photosynthetic rate. It dries on plants to form a clear, glossy film which retards normal moisture loss without interfering with plant growth or normal respiration. It is also safe for human use as well as it has been used on various fruit crops. In addition, a reflective Kaolin spray was found to decrease leaf temperature by increasing leaf reflectance and to reduce transpiration rate more than photosynthesis in many plant species grown at high solar radiation levels. (Bergovis *et al.,* 2001; Cheng *et al.,* 2008 and Peter, 2008)

Corresponding Author: El-Khawaga, A.S. , Hort. Dept., Fac. of Agric., South Valley Univ. Qena. Egypt.

Using antitranspirants will lower the surface tension of water, which increases the efficiency of water penetration but reduces the build-up of water droplets on the plant. This can lead to a reduction in the incidence of scorch during bright weather conditions and the time available for any fungal spores to try and germinate on the leaf surface. Some products coat the leaf surface with a thin plastic film which prevents water loss. When it is applied to plant tissue it forms a very thin, transparent layer over the leaves and stems. Application is recommended early in the morning or late afternoon. Once dry, the coating allows gases to permeate but not liquids, which allows normal plant respiration but reduces transpiration by up to 80%. They have also been used effectively at reducing foliage damage to roadside trees during periods of salt applications. (Bose *et al.,* 2001; Gindaba and Wand, 2005 and Lolicato, 2011).

Previous studies showed that water deficit has negative effect on growth and fruiting of fruit crops (Abd El- Moteleb, 1991; Hassan, 1998, Gupta *et al.,* 1999; Gowda, 2002 and Khattab- Magda *et al.,* 2012).

Application of antitranspirants has beneficial effects on growth and fruiting of fruit crops (Kerns and Wright , 2000; Wunsche *et al.,* 2002 ; Yazici *et al.,* 2005 ; Morsy *et al.,* 2008 and Glenn, 2009).

Chitosan is one of the most common natural polymers that can be obtained from species especially from the exoskeletons of crustance . It is also found in cuiticles of insects and used as a coating materials (Photochanachai *et al.,* 2006)

The target of this study was examining the effect of some antitranspirants on alleviating the adverse effects of water deficit on growth and fruiting of Wounderful pomegranate trees. Also, the effect of these antitranspirants on saving irrigation water regimes was investigated.

Materials and Methods

This study was carried out during 2013 & 2014 seasons on thirty- six uniform in vigour 6-years old Wounderful pomegranate trees grown in a private orchards situated at El- Hawarta village, Minia district, Minia Governorate. The trees are planted in heavy clay soil (Table1) at 4x4 meters apart. Surface irrigation system using Nile water (according to the three irrigation regimes) was adopted. Regular horticultural practices were applied to all the experimental trees as recommended. Soil analysis was done using the procedure that outlined by Wilde *et al.,* (1985).

Table 1. Analysis of the tested soil

Constituents	**Values**
Sand %	6.1
Silt %	13.9
Clay %	80.0
Texture	Clay
O.M. %	2.79
pH (1 : 2.5 extract)	7.49
EC (1 : 2.5 extract) mmhos / cm/ 25ºC)	0.91
$CaCO_3$ %	1.09
Total N %	0.11
Available P (ppm)	4.2
Available K (ppm)	447

This experiment involved the following twelve treatments from water irrigation regime and antitranspirant treatments arranged as follows:

1- Irrigation with 4 m^3 water/ tree/ season.
2- Irrigation with 4 m3 water/ tree/ season + Silica gel at 2%.
3- Irrigation with 4 m3 water/ tree/ season + Kaolin at 3%
4- Irrigation with 4 m3 water/ tree/ season + Chitosan at 2%
5- Irrigation with 6 m3 water/ tree/ season.
6- Irrigation with 6m3 water/ tree/ season + Silica gel at 2%.
7- Irrigation with 6m3 water/ tree/ season + Kaolin at 3%
8- Irrigation with 6 m3 water/ tree/ season + Chitosan at 2%
9- Irrigation with 8 m3 water/ tree/ season.
10- Irrigation with 8 m3 water/ tree/ season + Silica gel at 2%.
11- Irrigation with 8m3 water/ tree/ season + Kaolin at 3%
12- Irrigation with 8 m3 water/ tree/ season + Chitosan at 2%

Each treatment was replicated three times, one tree per each. The monthly amount of irrigation water as litres/ tree for each regime in both seasons are shown in Table (2).

Table 2. Distribution of the irrigation water (L/ month) during both seasons.

Water regime	Mar.	Apr.	May	June	July	Aug/	Sept.	Oct.	Nov.
$4m^3$ / tree/ season	100(2)	150(2)	300(3)	900(3)	900(4)	900(4)	500(3)	150(2)	100(2)
$6m^3$ / tree/ sea season	150	250	500	1300	1300	1300	800	250	150
$8m^3$ / tree/ sea season	200	300	600	1800	1800	1800	1000	300	200

Each antitranspirant was sprayed three times just after fruit setting (mid. of Apr.) and at one month intervals (mid. of May and June). Triton B as a wetting agent was used at 0.05 % . All antitranspirant spray applications must be applied for full coverage. Randomized complete block design (RCBD) was adopted.

During both seasons the following parameters were carried out:

1-Shoot length (cm.) and leaf area(cm^2) (Mofeed, 2009).

2-Physiological aspects of leaves such as leaf relative turgidity % of leaves (Ahmed – Safaa, 1994); leaf succulence grade (g H_2O/ dec^2 of leaf) according to Hassan, (1998), hard leaf character (g dry matter / dec^2 of leaf) according to Hassan, (1998) and leaf osmotic pressure (bar) according to Gusov, (1960).

3-Chemical characters namely total chlorophylls (as mg/ 1.0 g F.W.) according to Von- Westtstein, (1987), proline content (mg/ g. F.W.) according to Draz, (1986), total phenols (as mg/ 1.0 g F.W.) according to A.O.A.C, (2000), total indoles (mg g / g F.W.) according to Larson *et al.,* (1962) wood total carbohydrates % (Smith *et al.,* 1956) and N, P and K (as percentages) according to Chapman and Pratt (1975).

4- Initial fruit setting percentage was estimated by dividing number of fruits just after fruit setting by total number of flowers and multiplying the product by 100.

5- Yield expressed in weight (kg.) and number of fruits/ tree (the mid of Sept.)

6-Fruit weight (g.) as well as percentage of fruit peel weight, grains and juice, edible to non – edible portions.

7- Percentages of total soluble solids, total and reducing sugars (A.O.A.C. 2000) and total soluble tannins (Balbaa, 1981), juice pH and anthocyanins (mg/ g F.W.) in the fruit peel and juice

Statistical analysis was done using new L.S.D. at 5% (Mead *et al.,* 1995).

Results

1- Growth characters:

It is clear from the data in Table (3) that increasing water deficit from 8 to 4 m^3 water / tree / seasons resulted in a gradual significant inhibition on the shoot length and leaf area. Irrigation the trees with water at 4 to 8 m^3/ tree/ season significantly reduced such two growth characters relative to irrigation plus application of any antitranspirants (silica gel, kaolin or chitosan). Using any antitranspirants significantly enhanced shoot length and leaf area rather than irrigation alone. The stimulation on growth character was significantly associated with using silica gel at 2% , kaolin at 3% and chitosan at 2%, in ascending order. Irrigating the trees with water at $6m^3$ / tree/ season without any antitranspirants. Using water at any transplants significantly reduced shoot length and leaf area rather than using 4 m^3 water/ tree regime with any transplants. Increasing water using from 6 to 8 m^3/ tree/ sea in most had no significant promotion on growth characters.

Using $4m^3$ water/ tree with any antitreansplants was significantly preferable than using $6m^3$ water without any antitranspirants. Also, Using 6 m^3 water with any antitransplants was significantly preferable than using water at 8 m^3/ tree alone. The maximum values were recorded on the trees that irrigated with 6 m^3 water + spraying chitosan at 2% . The minimum values were recorded on the trees that irrigated with $4m^3$ water/ tree alone (without any anitranspirants). These results were true during both seasons.

2- Physiological aspects:

All physiological aspects (hard leaf character, leaf succulence grade and leaf osmotic pressure) except leaf, relative turgidity significant increased with reducing irrigation water from 8 to 4 m^3/ tree/ season (water stress). Using any antitranspirant (silica gel at 2% , kaolin at 3% or chitosan at 2%) under water stress conditions significantly reduced hard leaf character, leaf succulence and leaf osmotic pressure and increased leaf relative turgidity %, compared to the neglection of using any antityrans plants under water stress conditions. Irrigation with water at 4& 6 m^3/ tree/ season with any antitransporants was significantly preferable than using 6 or $8m^3$ water alone in reducing hard leaf character, leaf pressure and increasing leaf relative turgidity %. Using chitosan at 2% under water irrigation at 4 to 8 m^3/ tree gave the best results with regard to the reduction on all physiological aspects except leaf relative turgidity %. Irrigation with water at 4 m^3 water/ tree (water stress conditions) resulted in the maximum hard leaf character, leaf succulence and leaf osmotic pressure and the minimum leaf relative turgidity.

Table 3: Effect of different irrigation water regime and antitranspirant treatments on shoot length, leaf area and some physiological aspects in the leaves of Wounderful pomegranate trees during 2013 & 2014 seasons.

Treatments	Main shoot length (cm.)		Leaf area (cm^2)		Hard leaf character (g/ Dec^2)		Leaf succulence (gH_2O/Dec^2)		Leaf relative turgidity %		Leaf osmotic pressure (bar)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
4 m3 water/ tree/ season	71.3	73.0	8.0	7.0	0.17	0.14	0.25	0.27	20.5	19.8	16.9	17.2
4m3 +silica gel at 2%	77.7	85.4	9.9	8.7	0.12	0.09	0.20	0.22	23.5	22.8	15.3	15.5
4m3 +kaolin at 3 %	81.3	83.0	10.9	9.8	0.10	0.07	0.17	0.20	25.0	24.2	14.5	14.8
4m3 +chitosan at 2%	84.2	85.9	11.9	10.9	0.07	0.05	0.15	0.17	27.0	26.2	13.7	14.0
6 m3 water/ tree/ season	74.0	75.8	8.9	7.9	0.14	0.11	0.22	0.24	22.0	21.2	16.1	16.4
6m3 +silica gel at 2%	90.0	91.6	13.6	12.3	0.05	0.02	0.11	0.13	30.9	30.2	12.2	12.5
6m3 +kaolin at 3 %	92.7	94.3	14.2	13.2	0.04	0.02	0.10	0.12	33.0	32.3	11.2	11.5
6m3 +chitosan at 2%	95.3	97.0	14.8	13.7	0.03	0.01	0.08	0.10	34.9	34.2	10.4	10.7
8 m3 water/ tree/ season	87.0	88.6	12.9	11.8	0.06	0.03	0.13	0.15	28.9	28.2	13.0	13.3
8m3 +silica gel at 2%	90.5	92.0	13.7	12.6	0.05	0.02	0.09	0.11	31.0	30.3	12.1	12.4
8m3 +kaolin at 3 %	93.0	94.7	14.3	13.3	0.04	0.02	0.08	0.10	33.1	32.3	11.1	11.4
8m3 +chitosan at 2%	95.7	97.3	14.9	13.8	0.03	0.01	0.12	0.14	35.0	34.4	10.3	10.7
New L.S.D. at 5%	1.4	1.5	0.6	0.8	0.02	0.02	0.02	0.02	1.1	1.3	0.7	0.6

3- Leaf and shoot chemical composition:

It is clear from the data in Table (4) that water stress conditions (4 & 6 m^3 water / tree/ season) significantly inhibited total chlorophylls, total indoles, wood total carbohydrates % as well as percentages of N, P and K and promoted both total phenols and proline in the leaves. Irrigation water at 4 to 8 m^3/ tree/ season significantly reduced all characters except proline and total phenols over the irrigation combined with using any one of the three antitranspiants. Using the three antitranspirants namely silica gel at 2% kaolin at 3% and chitosan at 2%, in ascending order was significantly very effective in enhancing all characters except total phenols and proline comparing with irrigation alone. Irrigation with water at 4 m^3/ tree/ season plus any antitranspirants was significantly superior than irrigation with 6m^3/ tree. This means that using any antitranspirants with irrigation water significantly saved irrigation water. Increasing irrigation water from 6 to 8m^3/ tree failed significantly to show any promotion on all characters except total phenols and proline. The maximum total chlorophylls, total indoles, wood total carbohydrates as well as leaf N, P and K and the lowest total phenols and proline were observed on the trees that irrigated with water at 6m^3/ tree/ season along with spraying chitosan at 2% four times. The trees irrigated with 4m^3 water/ tree/ season without any antitranspirant gave the lowest values of total chlorophylls, total indoles, wood total carbohydrates, P and K and the highest values of total phenols and proline. These results were true during both seasons.

Table 4: Effect of different irrigation water regime and antitranspirant treatments on total chlorophylls, total indoles , total phenols, proline , wood total carbohydrates and N % in the leaves of Wounderful pomegranate trees during 2013 & 2014 seasons.

Treatments	Total chlorophylls (mg/ g F.W.)		Total indoles (mg/ g F.W.)		Total phenoles (mg/ g F.W.)		Proline (mg/ g F.W.)		Wood total carbohydrates %		Leaf N %	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
4 m3 water/ tree/ season	1.29	1.36	6.1	6.5	8.1	9.0	0.79	0.76	8.1	9.0	1.64	1.71
4m3 +silica gel at 2%	1.50	1.58	7.1	7.5	7.0	7.8	0.70	0.68	9.0	9.8	1.82	1.89
4m3 +kaolin at 3 %	1.59	1.66	7.7	8.1	6.6	7.5	0.66	0.62	9.5	10.4	1.90	1.98
4m3 +chitosan at 2%	1.70	1.75	8.5	9.0	6.2	7.1	0.61	0.58	10.0	10.9	1.97	2.04
6 m3 water/ tree/ season	1.39	1.44	6.6	7.1	7.6	8.5	0.74	0.71	8.5	9.5	1.74	1.81
6m3 +silica gel at 2%	1.90	1.97	9.4	9.9	5.0	5.9	0.49	0.46	10.9	12.0	2.15	2.22
6m3 +kaolin at 3 %	1.97	2.04	9.9	10.4	4.5	5.4	0.41	0.38	11.4	12.3	2.25	2.32
6m3 +chitosan at 2%	2.09	2.16	10.6	11.1	4.0	4.9	0.36	0.33	12.0	12.9	2.41	2.48
8 m3 water/ tree/ season	1.79	1.87	9.0	9.5	5.5	6.4	0.55	0.52	10.4	11.4	2.05	2.12
8m3 +silica gel at 2%	1.91	1.99	9.5	10.0	4.9	5.8	0.48	0.44	11.0	12.0	2.16	2.23
8m3 +kaolin at 3 %	1.98	2.06	10.0	10.4	4.4	5.3	0.40	0.37	11.5	12.5	2.26	2.33
8m3 +chitosan at 2%	2.11	2.18	10.7	11.2	3.8	4.7	0.35	0.32	12.1	13.0	2.42	2.49
New L.S.D. at 5%	0.06	0.05	0.4	0.5	0.3	0.3	0.04	0.04	0.3	0.3	0.06	0.07

3- Fruit setting and yield

Data in Table (5) clearly show that reducing irrigation water regimes from 8 to 4 m^3/ tree/ year had significant reduction on the percentages of initial fruit setting, fruit retention , yield and number of fruits per tree. The promotion on these parameters due to increasing water regimes from 6 to 8 m3/ tree was slight. Using anyone of the three antitranspirants with irrigation water at 4 to 8 m^3 was significantly preferable than carrying out irrigation alone. The best nutrients in this respect was chitosan at 2% followed by kaolin. Silica gel at 2% occupied the last position in this respect. Irrigation with water at 4m^3/ tree plus spraying anyone of the three antitranspirants significantly surpassed the irrigation with water at 6m^3/ tree without using antitranspiration . Also, irrigation with water at 6m^3 without using any antitranspirants was superior than irrigation with water at 8 m^3/ tree alone. The maximum yield was presented on the trees that irrigated with water at 6m^3/ tree plus spraying chitosan at 2% four times. The lowest values were recorded on the trees that irrigated with water at 4m^3 without spraying any antitranspirants. Similar results were announced during both seasons.

Table 5: Effect of different irrigation water regime and antitranspirant treatments on the percentages of P and K in the leaves, initial fruit setitng and fruit retention and yield of Wounderful pomegranate trees during 2013 & 2014 seasons.

Treatments	Leaf P %		Leaf K %		Initial fruit setting %		Fruit retention %		No. of fruits / tree		Yield / tree (kg.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
4 m3 water/ tree/ season	0.13	0.15	1.22	1.31	38.1	39.0	24.1	25.0	48.9	50.0	16.7	17.5
4m3 +silica gel at 2%	0.18	0.20	1.35	1.44	40.5	41.5	25.8	26.7	52.5	54.0	19.3	21.1
4m3 +kaolin at 3 %	0.20	0.21	1.42	1.51	41.8	42.8	26.6	27.5	55.0	56.6	21.0	22.1
4m3 +chitosan at 2%	0.22	0.24	1.51	1.60	43.0	44.0	27.4	28.3	57.0	58.5	22.5	23.7
6 m3 water/ tree/ season	0.15	0.17	1.28	1.37	39.3	40.3	25.0	25.8	50.0	51.6	17.8	18.8
6m3 +silica gel at 2%	0.27	0.30	1.66	1.75	45.3	46.4	29.9	30.8	61.5	63.0	26.0	27.3
6m3 +kaolin at 3 %	0.30	0.33	1.72	1.81	46.5	47.5	30.7	31.6	64.0	65.5	27.9	29.3
6m3 +chitosan at 2%	0.33	0.36	1.80	1.89	48.0	49.1	31.8	32.7	69.5	70.0	31.3	32.3
8 m3 water/ tree/ season	0.24	0.29	1.60	1.70	44.1	45.1	28.5	29.4	59.0	60.5	24.1	25.4
8m3 +silica gel at 2%	0.28	0.31	1.67	1.76	45.4	46.5	30.0	30.9	62.0	63.5	26.3	27.6
8m3 +kaolin at 3 %	0.31	0.34	1.73	1.82	46.6	47.7	30.8	31.8	65.0	66.0	28.4	29.6
8m3 +chitosan at 2%	0.34	0.37	1.81	1.90	48.1	49.2	31.9	33.0	70.0	70.5	31.6	32.6
New L.S.D. at 5%	0.02	0.02	0.05	0.05	1.0	9.0	0.7	0.8	1.2	1.2		

Table 6: Effect of different irrigation water regime and antitranspirant treatments on some physical and chemical characters of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

Treatments	Fruit weight (g.)		Fruit peel %		Grain %		Juice %		Edible to non edible portions		T.S.S.%	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
4 m3 water/ tree/ season	341.0	350.0	47.1	47.5	52.9	52.5	34.1	33.5	1.12	1.11	15.6	15.6
4m3 +silica gel at 2%	367.0	376.0	43.1	43.5	56.9	56.4	36.5	36.0	1.32	1.29	15.9	15.9
4m3 +kaolin at 3 %	381.0	390.0	42.4	42.8	57.6	57.2	37.1	37.1	1.36	1.34	16.5	16.5
4m3 +chitosan at 2%	395.0	405.0	41.2	41.6	58.8	58.4	38.1	38.1	1.43	1.10	16.6	16.6
6 m3 water/ tree/ season	355.0	365.0	47.0	47.5	53.0	52.5	34.8	34.8	1.13	1.11	15.9	15.0
6m3 +silica gel at 2%	423.0	434.0	38.0	38.5	62.0	61.5	40.6	40.6	1.63	1.60	15.0	15.0
6m3 +kaolin at 3 %	436.0	447.0	37.1	37.5	62.9	62.5	41.7	41.7	1.70	1.67	15.6	15.7
6m3 +chitosan at 2%	450.0	461.0	36.2	36.6	63.8	63.4	42.9	42.9	1.76	1.73	16.0	16.0
8 m3 water/ tree/ season	409.0	420.0	46.0	46.5	54.0	53.5	39.0	39.0	1.17	1.15	14.7	14.7
8m3 +silica gel at 2%	424.0	435.0	37.9	38.4	62.1	61.6	40.7	70.7	1.64	1.60	14.8	14.8
8m3 +kaolin at 3 %	437.0	448.0	37.0	37.4	53.0	62.6	41.8	41.8	1.43	1.67	15.2	15.2
8m3 +chitosan at 2%	451.0	462.0	36.0	36.5	64.0	63.5	43.0	43.0	1.78	1.74	15.5	15.7
New L.S.D. at 5%	11.5	12.0	0.6	0.6	0.6	0.6	0.9	0.9	0.05	0.05	0.3	0.3

4- Fruit quality:

Data in Tables (6 & 7) clearly show that reducing water irrigation levels from 8 to 4 m^3/ tree / season caused a significant reduction on fruit weight, percentages of juice and grains , juice pH and total anthocyanins in the peels and juice and edible to non edible portions frit peel weight, T.S.S., total and reducing sugars. Using any antitranspirants significantly alleviated the adverse effects of water stress on fruit quality. Using antitranspirants besides irrigation water at 4 to 8 m^3/ tree significantly succeeded in improving fruit quality rather than carrying out irrigation alone. The best antitranspirants in this respect was chitosan following by kaolin at 3% . A slight and unsignificant promotion on fruit quality was observed due to increasing water from 6 to 8 m^3/ tree. These results were true during both seasons. The best results with regard to fruit quality were obtained due to carrying out irrigation at 6 m^3/ tree besides foliar application of chitosan at 2% . These results were true during both seasons.

Table 7: Effect of different irrigation water regime and antitranspirant treatments on some chemical characteristics of the fruits of Wounderful pomegranate trees during 2013 & 2014 seasons.

Treatments	Juice pH		Total sugars %		Reducing sugars %		Total soluble tannins %		Anthocyanins in the peel (mg/ g F.W.)		Anthiocynanins in the juice (mg/ g F.W.)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
4 m3 water/ tree/ season	2.55	2.55	11.1	11.2	10.1	10.2	0.92	0.90	92.3	93.0	50.2	51.0
4m3 +silica gel at 2%	2.71	2.80	11.5	11.5	10.5	10.6	0.87	0.82	93.0	93.7	49.3	50.1
4m3 +kaolin at 3 %	2.60	2.68	12.0	12.0	11.5	11.6	0.80	0.78	94.0	94.8	50.5	51.4
4m3 +chitosan at 2%	2.55	2.63	12.6	12.5	12.4	12.5	0.77	0.75	95.7	96.8	51.7	52.5
6 m3 water/ tree/ season	2.81	2.90	11.0	10.9	10.0	10.1	0.88	0.86	91.0	91.0	48.2	49.0
6m3 +silica gel at 2%	2.73	2.81	11.4	11.1	10.2	10.3	0.64	0.62	91.1	91.0	45.2	46.0
6m3 +kaolin at 3 %	2.93	3.01	11.9	11.5	11.1	11.2	0.60	0.57	98.1	92.0	48.0	48.9
6m3 +chitosan at 2%	2.80	2.90	12.5	11.8	12.0	12.0	0.55	0.53	96.2	93.0	50.0	51.0
8 m3 water/ tree/ season	3.01	3.10	10.9	10.8	9.7	9.8	0.70	0.64	90.0	90.0	46.0	47.0
8m3 +silica gel at 2%	3.11	3.20	10.8	11.0	10.1	10.2	0.63	0.47	90.0	90.0	43.9	45.0
8m3 +kaolin at 3 %	2.98	3.11	11.7	11.2	11.0	11.1	0.56	0.40	91.0	91.2	46.0	47.0
8m3 +chitosan at 2%	2.86	3.04	12.4	11.7	11.9	12.0	0.50	0.38	92.0	92.3	49.0	49.7
New L.S.D. at 5%	0.06	0.07	0.03	0.3	0.3	0.3	0.03	0.03	1.0	1.0	0.9	0.9.

Discussion

The previous adverse and inferior effects of water stress on growth, leaf chemical composition, yield and quality of Wounderful fruits might be attributed to the negative impact of water deficit on cell division and elongation, plastides, IAA biosynthesis, building of organic foods, plant pigments, photosynthesis, nutrient uptake, root development as well as collapsing all plant metabolism and enzymes (Boyer, 1995 and Hassan, 1998).

However, the beneficial effects of antitranspirants on counteracting the adverse effects of water deficient on growth and fruiting are mainly ascribed to the important role of these materials on blocking stomata without causing any inferiors effects on photosynthesis. Antitranspirants coat leaf surface with films that are imprevious to water vapour, reflect back a portion of the incident radiation falling on the upper surface of the leaves. Some antitranspirants dried on plants to form a clear glossy film which retards normal moisture loss without interfering with plant growth or normal respiration (Cheng *et al.*, 2008 and Peter, 2008).

These results regarding the adverse effects of water stress on growth and fruiting of pomegranate are in agreement with those obtained by Abd El- Moteleb (1991); Hassan (1998); Gupta *et al.,* (1999) and Gowda (2002).

The beneficial effects of antritranspirants on growth and fruiting of Wounderful pomegranate trees are in harmony with those obtained by Kerns and Wright, (2000); Morsy *et al.,* (2008); Phitchanachai (2006); Glenn (2009); Ahmed *et al.,* (2011) and Ebrahiem – Asmaa (2012).

Conclusion:

For alleviating the adverse effects of water stress and at the same time saving irrigation water, it is advised to use any antitranspirant under the conditions of this study. Irrigating Wounderful pomegranate trees with water at $6m^3$ / tree / year certainly required three sprays of chitosan at 2%. This means that using water at 6 m^3/ tree/ year instead of using 8 m^3/ tree/ year surely required three sprays of chitosan at 2% for saving $2m^3$/ tree/ year. This means that it is possible for saving 500 m^3 / fed/ year (in basis of each feddan contains 250 trees, 4x4 m). The total saving water for the fruiting area that cultivated with pomegranate (700 fed.) reached 3.5 million m^3/ tree.

References

Abd El- Moteleb, M.M.M.,1991. Physiological and anatomical studies on grapevine transplants as affected by different irrigation treatments. M. Sc. Thesis Fac. of Agric. Ain Shams Univ. Egypt.

Ahmed- Safaa, N., 1994. Physiological studies on Kaki (Diospras Kaki L.) Ph. D. Thesis Fac. of Agric. Zagazig Univ. Egypt.

Association of Official Agricultural Chemists,1995. Official Methods of Analysis 14th Ed. A.O.A.C, Washington, D.C, U.S.A. pp 490-510.

Balbaa, S.I.,1981. Chemistry of Crude drugs (Lab. Manual) Cairo Uni. Chapter 6 pp. 127-137.

Bergovis, J., N. Dokoozlian N. Ebisuda, 2001. Sunlight exposure and temperature effects on berry growth and composition of Cabernet Sauvignon and Grenache grapevines. The Central San Jonquin Valley of California. Am. J. Enol. Vitic. 52, 1 -7.

Bose, T. K., S. K. Mitra and D. Sanyal, 2001. Fruits-Tropical and Sub-Tropical. Naya Udyog. Pp. 100-105.

Boyer, J.S. (1995): Advances in drought tolerance in plants. Acad. Press advance in Agronomy. Vol. 56 : 187-218.

Chapman, H.P., and P.E. Pratt, 1975. Methods of Analysis for soils, plants and water. California Univ. Division o Agric. Sci. pp. 172- 173.

Cheng, L. S., P. Li, and L. Cheng, 2008. Effects of high temperature coupled with high light on the balance between photooxidation and photoprotection in the sun-exposed peel of apple. Planta 228, 745 - 756.

Draz, M.Y., 1986. Response of bitter almond seedling to different water regimes. Ph. D. Thesis Fac. of Agric. Cairo Univ., Egypt.

Gindaba, J. and S. J. E. Wand, 2005. Sunburn in apples and effectiveness of control measures. Combined Congress, 10-13 January 2005, Potchefstroom, South Africa, Abstract pp 43.

Glenn, D. M., 2009. Particle film mechanisms of action that reduce the effect of environmental stress in "Empire" apple. J. Amer. Soc. Hort. Sci. 134 (3): 314 - 321.

Gowda, A.M., 2002. Physiological studies on the drought tolerance of some fruit transplants. Ph. D. Thesis Fac. of Agric. Minia Univ. Egypt.

Gupta, R.S., R.N.S. Banafar, and R.A. Sharma, 1999. Effect of straw much and irrigation on root distribution pattern and yield of pomegranate (*Punica granatum*) group. Res. Hisar 17 (1) : 100- 103.

Gusov, N.A., 1960. Some methods in studying plant water relations. Leningrad A cod. of Sci. MUSSR pp. 100-105.

Hassan, A.A.A., 1998. Effect of drought on fruit seedlings , M. Sc. Thesis Fac. of Agric. Al- Azhar Univ. Cairo. Egypt.

Kerns, D.L. and G. C. Wright, 2000. Protective and yield enhancement qualities of kaolin on lemons. Citrus and Deciduous Fruit and Nut Research Repot, College Agric. And Life Sciences, Arizona Univ., Tucson, Arizona, 85721.

Khattab- Magda, M. Shaban, A.E., A.H. El- Shrif, and A.S.E. Mohamed, 2012. Effect of humic acid and amino acids on pomegranate trees under deficit irrigation 1- Growth flowering and fruiting. J. of Hort. Sci. & ornamental plants 4(3) 253-259.

Larson, P., A. Harbo, S. Klungsan, and L. Ashein, 1962. On the biogenesis of some indole compounds in Acetobacter xylinum – physiol plant , 15 pp. 552- 565.

Lolicato, S., 2011. Sunburn Protection for Fruit - a practical manual for orchardists in northern Victoria. Department of Primary Industries, Victoria.

Mead, R., R. N. Currnow, and A. M. Harted, 1993. Statistical Methods in Agricultural and Experimental Biology. 2nd Ed. Chapman and Hall, London pp. 10-44.

Mofeed, A.S., 2009. Effect of conversion to organic farming on yield, fruits and soil quality of olive. Ph. D. Thesis, Fac. of Agric. Ain Shams Univ., Egypt.

Morsy, M., A. M. K. Abd El- Aal, and H. A. Abd El- Aal, 2008. Attempts to find the best preharvest treatment required for obtaining the optimum marketable fruits and its effect on storage life of "Manfalouty" pomegranates. I. Evaluating of some soil and foliar treatments on splitting, sunburn, yield and fruit quality. Minia J. of Agric. Res. & Develop. 28 (2): 263 - 283.

Peter, K. V., 2008.Basics of Horticulture. New India Publ. Age Pp50-60.

Photochanachai , S. , J. Singkaew and J. Thomthong, 2006. Effect of chiosan seed treatment on collectorichum sp. and seedling growth of Chili cv. Jinda Acta Hort. 712: 585-590.

Prakash, M., K. Ramachandran, 2000. Effects of moisture stress and anti-transpirants on leaf chlorophyll. J. Agron. Crop sci. 184: 153- 156.

Smith, F., M.A. Gilles, J.K. Hamilton, and P.A. Godness, 1956. Colormetric method for determination of Sugar related substances: Ann Cehm. 28: 530.

Von-Wettstein, D. V. C., 1957. Clatale und der Sumbmikro Skopisne Formwechsel de Plastids. Experimental Cell Research, 12:427.

Wilde, S. A., R. J. B. Corey, I. G. Lyer, and G. K. Voigt, 1985. Soil and Plant Analysis for Tree Culture. 3rd Oxford & IBH publishing Co., New Delhi, pp. 1 - 218.

Wunsche, J.N., L. Lombardini, D. H. Greer, J.W. Palmer, and A.B. Woolf, 2002. Surround particle film applications- effect on whole canopy physiology of apple XXVIth international Horticulture Congress & Exhibition, August 11-1 2 p. 565-571, Toronto.

Yazici, K., I. Karasahin, G. Sahin, M. Erkan, and I. Kaynak, 2005.Effects of kaolin applications and modified atmosphere conditions on protection in pomegranate. (*Punica granatum* L. cv. Hicaznar). Ill International Horticultural Crop Protection Congress, September 6-9, Antakya, Turkey.