J. Plant Production, Mansoura Univ., Vol. 10 (6): 469 - 475, 2019

Impact of Magnetization and Organic Acids on the Growth and Productivity of 'Washington Navel Orange' Trees under Irrigation with Salty Water

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ABSTRACT

The current investigation was executed to assess the effects of magnetization, which combines magnetized water (MW) and magnetic iron (150g tree^{-1}), and organic acids (Humic acid at 150cm tree^{-1}) As anti-salinity factors in mitigating the negative effects of salinity on growth, leaf mineral contents, yield and fruit properties of Washington Navel orange trees planted in sandy soil and watered with drip irrigation method (ECw of irrigation water = 4ds/m) in 2014 and 2015 under El-Behera governorate conditions. The results indicated that the trees subjected to combination treatment involved (MW) and humic acid as soil application or magnetic iron gave the best vegetative growth parameters (tree height, canopy volume, No. of shoots per branch, shoot length, No. of leaves shoot and leaf area compared to comparative treatment (the control). Soil application of humic acid under irrigation with MW(MW+ Humic acid) increased mineral contents for leaves (N, P, K, and Mg) meanwhile, the sequence of MW+ magnetic iron gave the highest Ca content. The highest leaf Na content (0.48 and 0.52%) obtained by the control meanwhile, the lowest leaf proline content (10.0 and 9.2mg g^{-1}) was obtained by combination treatment (MW + humic acid) compared to the highest values (12.4 and 12.7mg g^{-1}) recorded with the control (WW). Yield and fruit quality attributes were increased with soil application of humic acid or magnetic iron following irrigation with magnetized water.

Keywords: Salinity, Navel orange, magnetized water, magnetic iron, humic acid, growth and yield

INTRODUCTION

Orang (Navel orange; *Citrus sinensis* L. Osbeck) belongs citrus family one and it the most widely produced fruit tree crops in global and local markets. It occupies significant economic incomes compared with other fruit crops regarding the cultivated and production areas. Recently, the harvested area developed quickly from year to another, it was 541,723 fed. from the total fruit crops area that estimated to be 1,624,250 feds. (Ministry of Agriculture and Land Reclamation, 2015). The fruiting area production of citrus occupies about 439,024 feds. and produced about 4,098,590 tons with an average of 9.34 tons fed^{-1}. It is a popular fruit in Egypt, because it is seedless, low price, nutritive value and large sized, It is also a major source of early-season income for citrus farmers in all citrus commercial areas in Egypt. Occupies an area of 35% of the total area of cultivated citrus, with an area of about 185892 fed. produced about 1531952 tons per year (Ministry of Agriculture and Land Reclamation, 2015).

Despite the loss of water, such as losses in sanitary, agricultural and industrial drainage, as well as salinity of irrigation water, which requires the use of water magnetization technology. The study of reclamation depends on other sources of irrigation water such as wells, sanitary drainage, seawater, etc. Generally, the salinity problem and saline water used for irrigation are considered as limiting factors for the success of such a project. Due to the extinction in the cultivated area in arid and semi-arid areas is becoming more vital by using water magnetization technology under salinity condition. Considering, the water salinity is the main problem in the cultivation of citrus fruits, especially orange which affect negatively on the grow the and yield of different citrus trees. Also, it is admitted more sensitive to water salinity especially orange tree during growth (Prior *et al.*, 2007). The impacts of salinity on growth and yield of orange trees drives to dysfunction in osmotic property of root cells so, its effects on water uptake by roots. Additionally, the imbalance in the nutritional elements, the increases in ion (toxicity), and accumulation both Na+ and Cl- minimized fruit yield (Al-Yassin, 2005). Therefore, finding new strategies to minimize salinity stress on citrus trees (Orange trees) is very essential to demand sustainable productivity from orange trees.

Newly, great attention has been paid to technology role e.g. MWand soil application of some organic materials like humic acid and magnetic iron to minimize salinity effects harmful. (MW) technology one of the ways by which we can reduce the harmful effects of salinity water. The treated water by crossing into a magnetic device called water treated magnetically(MW) which has three positive effects i.e. depressing soil alkalinity, increasing the leaking of dissoluble salts and dissolving partially soluble salts (phosphates, sulfates and carbonates,) (Hilal and Hilal, 2000a, b). MW improves mineral uptake, growth characters and yield in the citrus tree (Mostafa *et al.*, 2016). Humic materials (HM) like as humic acid (HA) and fulvic acid (FA) as bio-stimulants have different positive effects on soil and plant traits. Whereas they improve the soil properties, enhancement plant growth parameters and minimize the damaging influences of salinity and increase salt tolerance (Ennab and El-Sayed, 2016) on citrus trees. Magnetic iron (magnetite ore) is an ordinary rock with a very high percentage of iron, and it has a black, one of the two natural rocks in the world, that is naturally magnetic (Mansour, 2007). Application of magnetic iron increased the growth, mineral content of leaves and fruit yield of trees under saline irrigation conditions (Abobatta, 2014).The purpose of the existing investigation is to find an effective treatment to decrease the deleterious impacts of salinity on citrus trees. Therefore, the present study aimed to evaluate the effect of water treated magnetically, magnetic iron as well as humic acid, alone or in combinations, on reducing salinity harms in relative to the growth traits, fruit yield, and fruit properties of Navel orange trees planted under soil salinity.

MATERIALS AND METHODS

This research was carried out throughout 2014 & 2015 grown seasons on trees six years old of Washington Navel orange trees (*Citrus sinensis* L. Osbeck. Trees were spaced at 5 × 4 m in apart in a commercial farm settled at El-

Behera provinces, Egypt. The trees were planted in sandy soil and watered with drip irrigation method (ECw of irrigation water = 4ds/m). Trees were also received a common horticultural practice based on the recommended of the Agriculture Ministry. Mechanical and chemical analysis of experiential soil features are exhibited in Table (1).

Table 1. Mechanical and chemical properties of experiential soil

Characters	Particle size distribution (%)			Textural class	PH	Ec	O.M (%)	$CaCO_3$	Available (%)		
	Sand	Silt	Clay		7.6	2.02	0.45	0.68	N	P	K
	88.2	9.5	2.3	Sandy					8.1	5.1	11.5
Soluble cations (meq/L)					Soluble anions (meq/L)						
Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	Co_3		Hco_3	Cl		So_4		
5.60	5.20	8.15	1.30	---		4.70	7.20		8.35		

The fifty-four trees symmetrical in growth and yield were defined and divided into six groups (treatments). The orange trees were characterized into 6-treatments × 3 replicates × 3 trees replicate^{-1}. The actual research was analyzed by using A Complete Randomized Block Design (CRBD).

1- The Control = (Water pumped from a well, EC_w = 4ds/m)
2- Control (WW) + Humic acid
3- Control (WW) + Magnetic iron
4- magnetized water (MW)
5- (MW) + Humic acid
6- (MW) + Magnetic iron

Humic acid: Arranged for marketing as a liquid nature growth regulation commercially termed "Rich Humic" having 40% humic acid. Humic acid at 150cm /tree was added three times 50cm/tree in March, April and May in double ditches as length at 100 cm, width at 20 cm and 30 cm for depth were done on the both sides of the chosen trees in both seasons.

Magnetic iron (48.8% Fe_3O_4, 17.3% FeO, 26.7% Fe_2O_3)**:** produced by EL-Ahram Company, EL-Giza Governorate, Egypt. It was added at 750 g/tree divided in three equal times in March, April and May.

Magnetized water: It was obtained by passing the water through a magnetic device 14000 gauss magnetron unit, 4inch diameter brought by Delta water Company, Alexandria, Egypt (Photo, 1) and (Table 2).

Photo 1. Magnetized water device.

Table 2. chemical analysis of irrigation water before and after the magnetization

Variables	Magnetized water	Water Well (control)
pH	7.85	7.65
EC (dSm^{-1})	4.15	4.17
Ca^{+2} ($meql^{-1}$)	79.20	83.60
Mg^{+2}($meql^{-1}$)	13.92	20.88
Na^{+} ($meql^{-1}$)	832.92	819.70
K^{+} ($meql^{-1}$)	79.20	83.60
HCO^{-3} ($meql^{-1}$)	4.00	5.60
Cl^{-} ($meql^{-1}$)	273.63	280.31
SO_4^{-2} ($meql^{-1}$)	1536.77	1516.03

Throughout 2014 and 2105 seasons, the subsequent determinants and measurements were conducted.

1. Characteristics of vegetable growth

Four branches approximately 2" in diameter on each tree in four directions were selected and tagged. Forty new emergence shoots were selected and tagged for computing the growth parameters (number of shoots/branch, shoot length and number of leaves/ shoot), also leaf area was calculated according to the equation of Chou, (1966). Total leaf area/shoot was calculated by multiplying the No. of leaves / shoot x leaf area. However, leaf fresh and dry weight (g) was measured .Also, canopy size of tree was calculated according to Castle (1983).

2. Leaf mineral and proline contents

September 1st in 2015 and 2016 seasons, 50 healthy leaves from spring cycle were collected from each replicate from non-bearing shoots. Sample leaves were washed with distilled water to remove any deposits, and then dried in an oven at 70°C to constant weight. The dried leaves were ground and digested. In the blend of processed leaves, N, P, K, Mg, and Na was resolved. N (%) was estimated by the Kjeldahl technique depicted by Chapman and Pratt (1978). P% was determined calorimetrically utilizing spectrophotometer as per the strategy depicted by Murphy and Riely (1962). In the interim, the level of both K and Na were dictated by Flame photometer as indicated by Jackson (1967). In any case, Mg substance was controlled by Perking Elmer Atomic Absorption Spectrophotometer Model 2380 A1, as indicated by Jackson and Ulrich (1959) and Yoshida *et al*., (1972). Furthermore, proline content in leaves was proposed by Bates *et al.*, (1973).

3. Fruit set (%) and yield

An introductory natural product set % was assessed by counting the number of fruitlets during the second week of April) isolated on the all-out the number of blossoms at the full flowering phase (the second week of March) × 100. At reap time December 10th and 15th in 2014 and 2015 seasons, individually yield as the number of products of the soil/tree was recorded, at that point yield (tons/encouraged.) was determined.

4. Fruit quality

Ten fruit orange were randomly picked at the ripening phase from each repeat to determine fruit weight (g), fruit volume (cm3), organic product shape profile (length/distance (cm) and juice weight %. Additionally, in similar fruit tests, TSS% was controlled by utilizing a hand-held refractometer "ATAGO, Japan" and titratable acidity ratio (TA%) based on citric acid was estimated by titration with 0.1N blending of NaOH, at that point the TSS/TA ratio was calculated by dividing TSS % on the

relating estimation of titratable acidity %. Ascorbic acid quantity (V.C) in fruit juice was introduced as appeared by Ranganna, (1979).

5. Statistical Analysis

The obtained data were analyzed as completely randomized design using SPSS program. According to Duncan (1955) the variances between treatments were compared at 5% level.

RESULTS AND DISCUSSION

1. Vegetative growth

Results in Table 3 showed that all treatments significantly increased canopy size (CS) comparing with control. The best treatments in this aspect were both Control (WW) + Magnetic iron and MW+ humic acid without significant variations between them in the first season, while the treatment of MW+ humic acid has the highest values compared with the other treatments in the second season..

Table 3. Impact of magnetization and organic acids on vegetative growth parameters of Washington Navel orange tree two seasons 2014 and 2015

Treatments	Canopy size (m^3)		No. of shoots/branch		Shoot length (cm)	
	2014	2015	2014	2015	2014	2015
Control (WW*)	6.2c	7.6e	17.7c	17.1c	7.9c	9.2c
Control + Humic acid	9.0ab	11.3d	18.0bc	19.7ab	9.2b	10.1bc
Control + Magnetic iron	9.6a	13.7c	16.4d	18.8b	9.5b	9.8bc
MW	7.9ab	10.7d	18.6abc	19.5ab	9.0b	9.2c
M W + Humic acid	8.4ab	18.3a	19.1a	20.5a	10.4a	11.5a
M W + Magnetic iron	7.6bc	16.6b	18.1ab	19.8ab	9.0b	10.1b

***, WW = Water pumped from a well (ECw = 4ds/m).**

This finding is in concurrence with those of Aly *et al*. (2015) on 'Valencia' oranges trees, Mostafa *et al*., (2016) and Ghaffar (2016) on 'Navel' orange trees who found that, under saltiness stress, MW improved the vegetative development parameters than un-treated trees. Likewise, Abobatta, (2014) on 'Washington', 'Navel' and 'Valencia' orange trees, revealed that oil treatment of magnetite completely improved trees growth. In the interim, Sayed, *et al*., (2007) on 'Valencia' orange and Abd El-Hamied (2014) on 'Washington', 'Navel', and 'Valencia' orange trees exhibited that treated trees with humic acid improved vegetative and development trees. Similar outcomes were acquired by Barakat, *et al*., (2012) and Ennab (2016) on lime trees.

The data obtained in Table 4 showed leaf parameters (number of leaves / shoot, leaf area, fresh and dry weight of leaf) as influenced by magnetization and organic acids treatments in 2014 and 2015 seasons. As for, number of leaves/shoot, trees irrigated with MW and treated with magnetic iron significantly increased number of leaves. The largest area per leaf (cm2) was recorded with MW(MW) treatment followed by control (WW) + Magnetic iron, MW + humic and MW+ Magnetic iron treatments without significant differences among them in the first season, while in the second one MW and MW+ humic treatments without significant differences among them gave the highest values in this respect. MW + humic acid and MW+ magnetic iron treatments significantly increased leaf fresh, dry weight and leaf specific weight (Fig. 1) compared to the other treatments in both seasons.

Table 4. Impact of magnetization and organic acids on vegetative growth variables of 'Washington Navel orange' tree during two seasons 2014 and 2015.

Treatments	Total leaves area/shoot (cm^2)		Leaf fresh weight (g)		Leaf dry weight (g)	
	2014	2015	2014	2015	2014	2015
Control (WW*)	185.8e	169.5f	0.86c	0.61b	0.23c	0.26b
Control + Humic acid	189.2d	171.1e	0.89c	0.74a	0.24c	0.30a
Control + Magnetic iron	204.0b	195.8d	0.92bc	0.77a	0.24c	0.30a
Magnetized water (MW)	197.1c	197.1b	1.0b	0.72a	0.29b	0.29a
M W + Humic acid	197.2c	215.5a	1.1a	0.75a	0.35a	0.31a
M W + Magnetic iron	233.9a	196.8c	1.1a	0.71a	0.33ab	0.30a

***, WW = Water pumped from a well (EC_w = 4ds/m).**

These outcomes are in concurrence with those of Abd El-Hamied and Ghieth (2017) who found that, applying MW increased the number of leaves/shoot and leaf area on peach trees under saltiness problem than non-polarized water (control). Likewise, Mohamed *et al*., (2013) on 'Valencia orange' trees, found that water system by utilizing magnate-iron was successful in encouraging growth parameters as complete leaf area this might be because of attractive MW-treatment may influence phytohormone creation prompting improve cell activities and plant development growth (Maheshwari, 2009). Additionally, Mostafa *et al*., (2016) and Ghaffar (2016) suggested that irrigation 'Washington Navel' orange trees with MW gave the best outcomes on leaf development parameters compared with un-MW treatment. Nevertheless, Ibrahim, (2011) and Abobatta, (2014) on citrus trees, who detailed that the magnetite application is essential to, improved leaf parameters. In the meantime, Abd El-Hamied (2014) and Ennab (2016) who found that treated citrus trees with humic acid improved leaf area.

Therefore, bring the water with energy, vitality and-flowing than it was. Later, these changes will effect on the qualities of the material that enters the structure through its effect on the qualities physical or in chemical or physiological processes and biochemical which reflect on the growth of trees (Al-Jubouri and Hamza, 2006). Likewise, MW was presented to have three primary effects like as, increasing the filtering of extra solvent salts, bringing down soil alkalinity and dissolving solvent salts, for example, phosphates, carbonates, and sulfates.

However, the level of capacity of MW on soil saltiness and ionic equalization in soil solution depended extraordinarily on the removing/separating of MW along the drip irrigation system lines (Hilal and Hilal, 2000b; Ahmed and Bassem, 2013). However, Magnetizing water in drip irrigation system showed a 7.5% increase in soil moisture distribution compared to normal water in the root zone depth and caused higher soil moisture for different irrigation water salinity (Behrouz *et al.*, 2011). In addition, humic acid influence plant growth by increasing soil organic matter, improved the availability and uptake of macro and micronutrients (Cavalcante *et al.*, 2013). Also, humate applications increase the permeability of plant membranes which improving growth of various groups of beneficial microorganisms, accelerate cell division, increased root growth and all plant organs for different fruit trees (Ferrara and Brunetti, 2010). Also application of magnetite increased the growth this may be due to it plays

an important role in cation uptake capacity and has a positive effect on immobile nutrients plant uptake (Esitkea and Turan, 2003). Magnetic treatments may affect phytohormone production leading to improve cell activity and plant growth (Maheshwari, 2009).

2. Leaf mineral and proline contents

Results in Table 5 showed that soil application of humic acid under irrigation with Magnetized water (MW) (MW + Humic acid) treatment had statistically the greatest N, P, K and Mg contents of leaf compared to the control (WW) and other treatments in both experimental seasons. The data illustrated in Fig. 1 demonstrate that there are significant differences among all treatments in leaf Na^+ content in both seasons. The highest accumulation of Na^+ in leaf (0.48 and 0.52%) was obtained by control treatment compared to the other treatments in both seasons (Fig.1). This means that applying the magnetization technique or humic acid alone or in combination works to reduce the absorption and accumulation of sodium ions in the leaves of treated orange tree. The data graphed in Fig. 2 showed that the lowest leaf proline content (10.0 and 9.2mg/g) was obtained by MW + humic acid treatment compared to the highest values (12.4 and 12.7mg/g) recorded with the control (WW) in both seasons, respectively.

MW caused an increase leaf mineral contents (N, P, K and Mg). This increase may be due to improved solubility of fertilizers in the soil irrigated with MWand changes in ionic currents generated by magnetic fields across the cellular membrane with a change in osmotic pressure, increasing the absorption rate of water and mineral elements and thus increasing their percentages in leaves (Aly *et al*., 2015).

Table 5. Effect of magnetization and organic acids on leaf mineral contents of 'Washington Navel orange' trees during two seasons 2014 and 2015

Treatments	N(%)		P(%)		K(%)		Mg(%)	
	2014	2015	2014	2015	2014	2015	2014	2015
Control (WW*)	1.8e	1.9d	0.12e	0.14c	0.95e	1.0e	0.47e	0.39d
Control + Humic acid	2.2b	2.2b	0.15b	0.16b	1.1b	1.3b	0.57d	0.52c
Control + Magnetic iron	1.9d	2.0c	0.13d	0.15bc	1.0d	1.1d	0.76b	0.71b
Magnetized water (MW)	1.9d	2.0c	0.13d	0.15bc	1.1c	1.1d	0.72b	0.66b
MW + Humic acid	2.3a	2.3a	0.17a	0.19a	1.3a	1.5a	0.83a	0.79a
MW + Magnetic iron	2.1c	2.1b	0.14c	0.16b	1.1b	1.2c	0.65c	0.56c

***, WW = Water pumped from a well (EC_w = 4ds/m).**

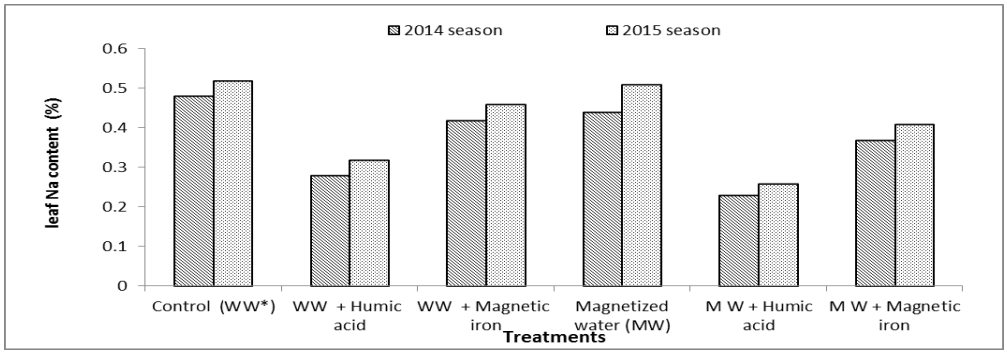

Figure 1. Effect of magnetization and organic acids on leaf Na content % 'Washington Navel orange' tree during two seasons 2014 and 2015.

***, WW = Water pumped from a well (EC_w = 4ds/m).**

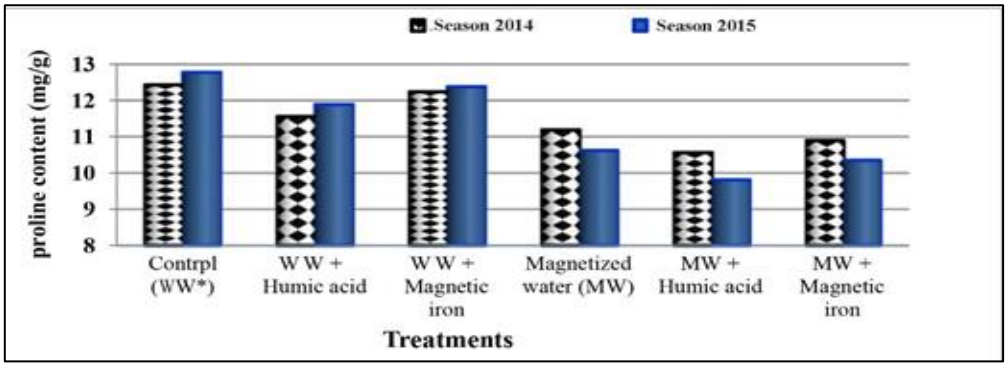

Figure 2. Effect of magnetization and organic acids on leaf proline content (mg/g) of Washington Navel orange tree during 2014 and 2015.

***, WW = Water pumped from a well (EC_w = 4ds/m).**

The present findings were in accordance with those obtained by Ghaffar (2016) who recommended that irrigation of Washington Navel orange trees with MWincreased leaf mineral contents when compared with trees irrigated with non-magnetized water. However, humic acid improve soil structure and change physical properties, promote the chelation of many elements and make these available to plants, also improving plant nutrition by humic acid which enhances the absorption of mineral elements through stimulating root growth and increases the rate of absorption of mineral ions on root surfaces and their penetration into the cells of the plant tissue, so plants show more active metabolism and increase respiratory activity (Cavalcante *et al.*, 2013). In the same line, Cerdán *et al*., (2007) on lemon trees, Perez-lopez, *et al*., (2007) on Clemenules mandarin, Sayed, *et al*., (2007) and Abobatta (2014) on Valencia orange trees indicated that, application of humic acid increased leaf mineral contents (N, P, K, Mg, Fe,

Zn and Mn). In spite of, Magnetic iron applications was positively effectiveness in N, P, K and Mg element uptake without any disorders phenomena on orange trees for both seasons this may be due to elements accumulation property. These results are harmony with those obtained by Turker *et al.,* (2007) who indicated that there are many benefits to tree growth resulted from addition natural mineral product like magnetic iron ore, which include improve soil structure, increase soil organic matter, and improve properties of the water that become more energy and this known as "Magneto biology', improving water holding capacity and cation exchange capacity, and thus improve tree nutrition of macro and micro elements.

3. Fruit set percentage and yield components

Applying Magnetized water (MW)or magnetic iron caused a significant increase in the fruit set % as compared to control (water pumped) which recorded the lowest values in this respect in both study seasons (Table 6). On the other side, in the second season, MW, MW + Humic acid (HA) and MW + magnetic iron treatments without significant differences among them gave the highest percentage of fruit set and they had a significant superiority over the single treatment with humic acid or magnetic iron. Similar results were mentioned by both Mohamed *et al*. (2013) and Abobatta (2014) on Valencia orange trees and Mohamed *et al*., (2017) on mandarin trees.

Table 6. Effect of magnetization and organic acids on fruit set % and yield (Ton) 'Washington Navel orange' tree during two seasons 2014 and 2015.

Treatments	Initial fruit set (%)		Yield/tree (Kg)		Yield/fed. (ton)	
	2014	2015	2014	2015	2014	2015
Control (WW*)	12.3b	13.2c	56.6c	64.9b	9.5c	10.9b
Control + Humic acid	16.8a	14.6bc	62.2bc	65.0b	10.4bc	10.9b
Control + Magnetic iron	15.4a	15.7b	58.8c	77.6a	9.8c	13.0a
Magnetized water (MW)	16.3a	17.8a	76.5a	84.3a	12.8a	14.1a
M W + Humic acid	15.1a	18.1a	67.6b	84.1a	11.3a	14.1a
M W + Magnetic iron	16.4a	18.6a	75.9a	83.3a	12.7a	14.0a

***, WW = Water pumped from a well (EC_w = 4ds/m).**

The use of Magnetized water treatment alone (MW) or in combination with humic acid (MW+HA) or magnetic iron (MW+ magnetic iron) resulted in an increase in tree yield (kg) and yield per fed. (ton) significantly compared to single-humic acid treatment or to control (WW) which recorded the lowest values in both seasons (Table 6). The treatments of MW and MW+ magnetic iron recorded the highest yield (kg/tree) in the first season which recorded 76.5 and 75.9 kg/tree, respectively. The increasing in yield as kg/tree could be attributed to increase in fruit set (%) and improved nutritional status and subsequent appropriate vegetative growth of the treated trees. This conclusion finds support in data presented in Tables 3 up to 5. The maximum yield (ton/fed.) was produced with MW, MW+ Humic acid and MW+ magnetic iron treatments without significant differences among them in both seasons.

Generally, improving yield of Navel orange trees by using MW may be due to that magnetic water may be induced a resonance-like phenomena which increase the internal energy of the tree that become highly effective in enhancing growth characteristics and thus getting higher fruit yield (Shabrangi and Majd, 2009). The stimulatory effect of magnetic water treatment on fruit yield also reported by Aly *et al*. (2015) on Valencia orange trees, Hamdy *et al.,* (2015) on mandarin varieties and Ghaffar (2016) on Washington Navel orange. They found that, trees irrigated with MWgave higher yield than trees irrigated with normal water. In this respect, Sayed, *et al*., (2007) and Abobatta (2014) on Valencia orange trees noticed that, application of humic acid increased total yield per trees compared with control.

4. Fruit quality

1. Fruit physical properties

The results in Table 7 cleared that the treatments of control + Humic acid, MW (magnetized water), MW + Humic and magnetic iron were significantly increased fruit weight without significant differences among them when compared with control (WW) in both seasons. Moreover, all tested treatments gave significant higher values of fruit shape index compared to the control fruits (Table 7). Regarding of fruit volume, combination treatment of control (WW) + Magnetic iron in the first season and M W + Humic acid in the second season increased fruit volume comparison with the other treatments. The best treatment of juice weight % were control and MW + Humic acid in the first season, meanwhile, in the second one control (WW) + Humic acid, MW(MW) and MW + Humic acid gave the highest juice weight (%) compared other treatments (Table 8). The present results are in agreement with those found by Ghaffar (2016) on Washington Navel orange trees, Sayed, *et al*., (2007) on Valencia orange trees, Ennab (2016) and Mohamed, *et al*., (2017) on mandarin trees.

Table 7. Influence of magnetization and organic acids on physical properties 'Washington Navel orange' tree during two seasons 2014 and 2015.

Treatments	Fruit weigh(g)		Fruit shape index (L/D)		Fruit volume(cm^3)	
	2014	2015	2014	2015	2014	2015
Control (WW*)	293.1bc	225.3d	1.0b	0.98b	330.5b	287.9c
Control + Humic acid	318.1ab	330.1a	1.07a	1.04a	381.1a	269.9c
Control + Magnetic iron	278.4c	286.6c	0.99b	1.06a	272.5c	278.c
Magnetized water (MW)	328.1a	330.3a	1.10a	1.03a	322.6b	318.6ab
M W + Humic acid	302.3abc	321.1ab	1.08a	1.04a	289.1c	329.4a
M W + Magnetic iron	313.3ab	322.7ab	1.09a	1.06a	308.3bc	286.1c

***, WW = Water pumped from a well (EC_w = 4ds/m).**

Table 8. Impact of magnetization and organic acids on juice weight % and vitamin C content 'Washington Navel orange' tree during two seasons 2014 and 2015.

Treatments	Juice weigh (%)		Vitamin C content (mg/100 ml juice)	
	2014	2015	2014	2015
Control (WW*)	30.7a	33.4ab	38.9c	44.6b
Control + Humic acid	25.0c	30.25ab	45.0b	46.8b
Control + Magnetic iron	29.3ab	28.7b	52.6a	50.7a
Magnetized water (MW)	25.6bc	34.3a	43.9b	40.8c
M W + Humic acid	31.3a	35.1a	43.4b	41.4c
M W + Magnetic iron	7.6abc	32.7ab	42.9b	46.4b

***, WW = Water pumped from a well (EC_w = 4ds/m).**

2. Fruit chemical properties

The present results of fruits TSS (%) in Table 9 showed that application of Magnetized water treatment alone (MW) or in combination with humic acid (MW+HA) or magnetic iron (MW+ magnetic iron)

resulted in a significant increase in TSS% compared to single-humic acid treatment or to control which recorded the lowest values in both seasons. The combination treatment of the control + magnetic iron gave the highest values of TSS / acid ratio in the first season, while, in the second one the combination treatments of the control + Humic acid and MW + Magnetic iron resulted the highest values in this respect compared with the other treatments. The fruits from trees irrigated with the control + magnetic iron gave the highest level of vitamin C (52.6 and 50.7 mg/100 ml juice) content as compared with the other treatments (Table 8). These results are in line with those of Aly *et al*., (2015), Ghaffar (2016) and Mohamed, *et al*., (2017) on citrus trees

Table 9. Effect of magnetization and organic acids on chemical fruit quality 'Washington Navel orange' tree during two seasons 2014 and 2015.

Treatments	TSS (%)		Acidity (%)		TSS / Acid ratio	
	2014	2015	2014	2015	2014	2015
Control (WW*)	11.3b	10.7c	0.81b	0.95ab	13.9a	11.2c
Control + Humic acid	11.2b	10.87c	0.80b	0.82c	14.0a	13.2a
Control + Magnetic iron	12.1a	11.1abc	0.86b	1.0a	14.1a	10.8c
Magnetized water (MW)	12.2a	11.2abc	0.98a	1.0a	12.5b	11.1c
M W + Humic acid	11.9ab	11.2ab	0.94a	0.99a	12.7b	11.3b
M W + Magnetic iron	12.0a	11.4a	0.94a	0.91ab	12.8b	12.5b

***, WW = Water pumped from a well (EC_w = 4ds/m)l**

CONCLUSION

Depending on the previous results from this work and in order to alleviate the harmful effect of salinity water stress and improvement the growth, yield and fruit properties of Navel orange trees grown in sandy soil under drip irrigation system it can be irrigated citrus trees with Magnetized water (MW) with add 150g $tree^{-1}$ humic acid or magnetic iron.

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تأثير المغنطة والأحماض العضوية على نمو وإنتاجية البرتقال ابو سرة ' صنف واشنطن 'تحت ظروف الري بمياه مالحة

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اجريت هذه الدراسة لتقييم تأثير المغنطة (الماء الممغنط (MW) والحديد المغناطيسي بمعدل 150 جم / شجرة) والأحماض العضوية (حمض الهيومك بمعدل 150 سم / شجرة) كعوامل مضادة للملوحة للتخفيف من الآثار الضارة للملوحة على النمو الخضري والمحتوى المعدني ، المحصول وجودة الثمار لأشجار ا لبرتقال ابو سرة المنزرعة في تربة رملية تحت نظام الري بالتنقيط (EC_W = 4ds/m) خلال عامي 2014 و 2015 تحت ظروف محافظة البحيرة. أوضحت النتائج ان أعلى القيم لقياسات النمو الخضري (حجم مظلة الشجرة طول وسمك الفرع وعدد الاوراق/الفرع ومساحة سطح الورقة) والمحتوى المعدني للأوراق ر(نتروجين وفسفور وبوتاسيوم ومغنسيوم) قد سجلت عند ري الاشجار بالماء الممغنط مع الاضافة الارضية للهيومك او الحديد المغناطيسي في حين سجلت معاملة الكنترول اعلى محتوى من الصوديوم فى الاوراق (0.48 و 0.52 %), سجلت معاملة الرى بالماء الممغنط + الهيومك اقل محتوى للاوراق من البرولين (10.06 و 9.26 ملجم / جم) مقارنة بأعلى القيم سجلت عن طريق معاملة الكنترول (12.43 و12.78 ملجم / جم). تم الحصول على أقصى إنتاجية وجودة للثمار عند ري الاشجار بالماء الممغنط مع اضافة الهيومك أو الحديد المغناطيسي.