

USE OF MAGNETIZED WATER AND COMPOST TEA TO IMPROVE PEACH PRODUCTIVITY UNDER SALINITY STRESS OF NORTH SINAI CONDITIONS, EGYPT

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This study was conducted during two successive seasons (2015 and 2016) at El-Sheikh Zuwayid, North Sinai Governorate, Egypt. The aim of this research was to investigate the effect of electromagnetic device and compost tea with or without some natural growth stimulants on growth and productivity of Sweet Sheikh Zuwayid peach cultivar (*Prunus persica* L.) under salinity stress. In this experiment, there was two irrigation water types (i.e., magnetized water (MW), and non-magnetized water (NMW)). Besides spraying with compost tea (as a natural growth stimulants), as follows: T₁: spraying with water + molasses as a control treatment, T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, and T₅: compost tea + algae extract + molasses. Investigated trees sprayed with 1.5 L four times along each season (at full bloom, fruit set, after one month later from fruit set and after two months later from fruit set). The obtained results revealed that all treatments were very effective in stimulating growth parameters, mineral contents, yield, physical and chemical characteristics of the fruits, water properties and soil properties. Generally, magnetized water (MW) was better than non-magnetized water (NMW) in all parameters. In addition, T₃ under MW increased shoot length, number of leaves/shoot, leaf area, leaf mineral contents (N, P, K, Fe, Zn, Cu and Mg), fruit length, fruit diameter, fruit volume, fruit weight, flesh weight, fruit flesh ratio, yield, total soluble solids and total sugar content, and decreased total acidity content. Furthermore, there was a slight change in water-soluble salts, pH, micronutrients and salts composition when irrigation water conducted to magnetic field. Generally, it clearly appears that EC, pH, Ca, Mg, K and Na in the soil decreased, when irrigated with

magnetized water, while Fe, Zn, Cu and Mn in the soil increased.

Keywords: peach, salinity stress, magnetized water, compost tea, licorice extract, moringa extract, algae extract, North Sinai

Peach (*Prunus persica* L.) belonging to the family Rosaceae is an important stone fruit grown in temperate and subtropical regions of the world. In Egypt, North Sinai is one of the focus points of peach production.

The increase of the groundwater salinity at several regions resulted in big chronic problems in the availability of irrigation water suitable for agriculture in the Egyptian deserts. Therefore, the importance of physical treatment of saline water using magnetic devices becomes feasible. Magnetically treated water (MTW) is considered as environmentally friendly technique (Nimmi and Medhu, 2009). MTW is produced when water passes through the magnetic field of the permanent electromagnetic device, installed on feed pipeline, where all water and salt molecules have the internal vibration (Babu, 2010). The irrigation with magnetized water significantly increased the plant characteristics, chemical composition and availability of nutrients in the soil, as well as the increments of total yield. However, the mechanism of action of magnetic field treatment in the plants is still unknown until now, but several theories have been proposed to explain this action, i.e.;

1. The mechanism of magnetic field is associated with the activation of phytohormone such as gibberellic acid-equivalents, indole-3-acetic acid and trans-zeatin as well as activation of the bio-enzyme systems (Maheshwari and Grewal, 2009 and Hozayn and Abdul Qados, 2010).
2. The modification of rate of ion transport across the plasma membrane or otherwise affect the structure of cell membrane lipid protein dynamics may cause the alteration in the permeability of the plasma membrane of plant roots (Stange et al., 2002).
3. In the same manner, the variations induced by magnetic fields in the ionic currents across the cellular membrane leads to change in the osmotic pressure and significant increase in the rate of water absorption (Taia et al., 2007). MTW removes the excess of the soluble salts; reduces pH values, due to that MTW solves soil salts and leaches them away from the roots zone (Hilal et al., 2012). In addition, Selim (2008) stated that MTW has induced changes in the mobility of nutrient elements in root zone, which differences from one element to another according to the element magnetic susceptibility. Using MTW improved the crop yield and increases the productivity of water unit and save water supply, especially with the future water scarcity as mentioned by Hilal et al. (2012) and Fanous et al.(2017).

Compost tea is becoming increasingly popular amendment in organic agriculture, which is simply liquid solution form compost that has been

soaked in water. Researches had documented that compost tea suppresses diseases in the organic systems, thought to increase aggregate stability, produces convert organic matters partially or into available nutrients, plant hormones, mineralize plant available nutrients, fixes nitrogen and providing useful microorganisms. Many investigators reported similar promotion effect of compost fertilizer on different plants such as El-Sherbeny et al. (2007) on *Ruta graveolens* and Hendawy (2008) on *Plantago arenaria*.

Licorice (*Glycyrrhiza glabra*) family Leguminosae, is a plant which grows in Egypt and some other countries of the world. Its roots possess some nutritive value and medicinal properties, so, it is widely used as a cold beverage and in preparing some pharmaceutical agents (Fenwick et al., 1990). The licorice extract contains more than 100 various compounds, which some of them accumulate in large amounts. The most important of the compounds are triterpene saponins (including glycyrrhizin) and phenolic compounds (Shibata, 2000 and Shabani et al., 2009). In addition, licorice extract contain protein and amino acid (Asparagin), monosaccharide (glucose, fructose, sucrose and maltose), lignins, tannins, starch, choline, phytosterols, different types of vitamins such as B1, B2, B3, B6, C, E, biotin, folic acid, pantothenic acid, many mineral compounds (aluminum, calcium, iron, magnesium, cobalt, zinc, phosphorus, sodium, silicone, potassium and stannous) and bitter principles (Fukai et al., 1998 and Arystanova et al., 2001). Moreover, Qaraghoul and Jalal (2005) found that spraying apple with licorice and garlic extracts gave the highest value in yield and fruit quality in addition to improve all growth parameters. Hussein (2008) found that spraying date palm with licorice extract at 5 g/L increased the fruit quality.

Moringa oleifera (family: Moringaceae) is one of such alternatives, being investigated to ascertain its effect on growth and yield of crops and thus can be promoted among farmers as a possible supplement or substitute to inorganic fertilizers (Phiri, 2010). Fresh *Moringa oleifera* content of proteins, vitamins (such as A, B1, B2, B3, ascorbic acid and E), β carotene, amino acids, phenolic compounds, sugars and minerals (such as calcium, magnesium, sodium, iron, phosphorus, and potassium) (Fuglie, 2000; Foidl et al., 2001 and Nagar et al., 2006). Moringa leaf extract that sprayed onto leaves (25 ml) of onions, bell pepper, soya beans, sorghum, coffee, tea, chili, melon, and maize was shown to increase yields of these crops (Fuglie, 2000).

Algae extract has a positive effect on plant growth, yield and fruit quality (Jaswant et al., 1994 and Hegab et al., 2005). Algae extract (as a new bio-fertilizer), containing N, P, K, Ca, Mg, and S as well as Zn, Fe, Mn, Cu, Mo, and Co, some growth regulators, polyamines and vitamins is applied to improve nutritional status, vegetative growth in different orchard such as vineyards (Eman and Abd-Allah, 2008 and Elham et al., 2010). Chouliaras et al. (2009) recommended the combination of NH_4NO_3 + borax + seaweed

extract in order to improve growth and nutrition status of the Koroneiki cultivar olive (*Olea europaea* L.). Mansour et al. (2006) investigated the impact of algae extract application to Anna apple trees and found that it was very effective in stimulating the leaf mineral content.

The aim of this study was to investigate the effect of irrigation with water subjected to electromagnetic fields, irrigation with normal water and with or without some natural growth stimulants; on growth and productivity of Sweet Sheikh Zuwayid peach cultivar (*Prunus persica* L.) under salinity stress, in addition to their effect on the soil properties.

MATERIALS AND METHODS

This study was conducted during the two successive seasons of 2015 and 2016 at El-Sheikh Zuwayid, North Sinai Governorate, Egypt, on 60 trees of the Sweet Sheikh Zuwayid peach cultivar (*Prunus persica* L.) grafted on almond rootstock. The trees were 10 years old, planted at 5 X 5 m apart, and grown in sandy soil under drip irrigation system. All trees are almost uniform in shape and received the common horticultural practices. The soil and irrigation water analysis data are given in table (1). The magnetized irrigation water was obtained by passing irrigation water through the electromagnetic device installed on the main irrigation pipes of the experimental area of the orchard (EWN Sharaf-1 device, from ITEN Company, Egypt; 220V. 50 CIS or 12 V.D.C. and power consumption 2.4 W/unit)

Table (1). Some physical and chemical properties of the experimental soil and irrigation water.

Characteristics	Soil	Water	Characteristics	Soil	Water
Particle size distribution (%)			Soluble anions (meq/L)		
sand	93.30				
silt	4.90				
clay	2.10				
Texture class	sandy soil				
SP	19.50	6.60	CO ₃ ⁻²	---	--
EC (dsm ⁻¹)	4.29	2.13	HCO ₃ ⁻	3.1	1.6
pH	8.00	8.00	Cl ⁻	25.6	16.3
SP%	19.50	6.60	SO ₄ ⁻²	14.2	3.4
Soluble cations (meq/L)			Available micronutrients in soil (ppm)		
Ca ⁺²	20.00	6.00	Fe	2.8	1.4
Mg ⁺²	7.80	1.30	Zn	3.6	1.4
Na ⁺	14.10	13.60	Cu	0.7	0.2
K ⁺	1.00	0.40	Mn	5.4	0.1

Preparing the compost tea of different sources, and all of the other extracts (i.e., licorice, moringa and algae) was carried out prior the begging of each spraying time (at full bloom, fruit set, one month later from fruit set and after two months later from fruit set). The procedure of preparing the mentioned materials (compost tea and the other extracts) could be described as follow:

1. El Nile Compost Tea

Compost tea (Table 2) was prepared by soaking compost in water (1: 4 w/w) according to Said et al. (2010). Compost was mixed in a large plastic barrel to ensure a homogeneous mix. The compost was kept in a refrigerated condition to maintain consistent tea production by slowing microbial activity with the help of molasses substance as 100 ml/L. Prior to brewing, the compost was put through a 0.64 cm sieve to remove any unnecessary large fragments. The compost tea was brewing for 48 hours.

Table (2). The physicochemical properties and microbial population of organic compost tea.

Bacterial plate count (CFU/ml)	7.2×10^7	EC dsm^{-1}	0.812	Ca (ppm)	85.0
Bacterial direct count (Cell/ml)	6.5×10^8	pH	6.550	Mg (ppm)	119.0
Spore-forming bacteria (CFU/ml)	8×10^4	N (ppm)	251.000	Fe (ppm)	64.0
Total fungi (CFU/ml)	2.9×10^5	P (ppm)	7.500	Zn (ppm)	7.1
		K (ppm)	212.000		

2. Licorice Roots Extract

The aqueous extract of licorice roots (*Glycyrrhiza glabra*) (Table 3) was prepared by boiling 2 g in one liter of distilled water for 15 minutes. The solution filtered using a cotton cloth, and re-filtered through Whatman filter paper No. 2 and completed by distilled water to one liter.

Table (3). The physicochemical properties of Licorice extracted (in dry matter).

Reducing sugar (%)	3.23	Humidity (%)	5.88	Ca (mg/g)	560.0
Non-reducing sugar (%)	10.27	GA₃ (%)	0.63	Mg (mg/g)	280.0
Starch (%)	4.76	P (mg/g)	540.00	Fe (mg/g)	33.0
Ash (%)	10.55	K (mg/g)	1235.00	Zn (mg/g)	3.6
Glycyrrhizic acid (%)	26.00				

3. Moringa Extract

The moringa extract (Table 4) was prepared by blending 2 g of young moringa leaves with 675 ml of 80% ethanol as suggested by Makkar and Becker (1996). The obtained suspension homogenized and filtered using a cotton cloth. Finally, the solution re-filtered using Whatman filter paper No. 2 and rose to one liter.

Table (4). Chemical components and amino acid composition of moringa leaves extracted according to Mona (2013).

Chemical components extracted	(g/100 g. d. wt.)	Chemical components extracted	(g/100 g. d. wt.)
Water	5.9	Ca	2.000
Protein	27.2	Mg	0.370
Lipids	17.1	K	0.013
Total sugars	38.6	Fe	0.028
Fiber	19.2	P	0.200

4. Algae Extract

Algae extract physicochemical properties are shown in table (5). It was used as 2 g/L concentration (as recommended by the producing company). Triton B at 0.1% was used as wetting agents with all treatments, except with *Glycyrrhiza glabra* extract that contains saponin triterpenes.

Table (5). The physicochemical properties of algae.

Oligosaccharide (%)	Alginic acid (%)	Phytin (%)	Menthol (%)	Natural growth regulators		
				Cytokinin (%)	Indol acetic acid (%)	Pepsin (%)
3	5	0.003	0.001	0.001	0.0002	0.02
Minerals	K oxide (%)	P oxide (%)	N (%)	Zn (%)	Fe (%)	Mn (%)
	12	0.5	1	0.3	0.2	0.2

The ratio of mixing the spraying solutions was four volumes of compost tea plus one volume of the other extracts in addition to molasses (100 ml/L). The experiments work arrangement in factorial design with two irrigation water types (i.e., magnetized water (MW), and non-magnetized water (NMW) and the sub-main factor was spraying with different sources of compost tea, as follows: T₁: control treatment (spraying with water + molasses (100 ml/L)), T₂: El Nile compost tea + molasses (100 ml/L), T₃: El Nile compost tea + licorice extract (4:1, v: v) + molasses (100 ml/L), T₄: El Nile compost tea + moringa extract (4:1, v: v) + molasses (100 ml/L) and T₅: El Nile compost tea + algae extract (4:1, v: v) + molasses (100 ml/L). Each tree was sprayed with 1.5 L.

The following parameters were measured for both seasons:

a. Shoot length and number of leaves/shoot: at the end of each season (first week of October).

b. Leaf area (cm²): was determined by using the leaf area meter CL203.

c. Macro and micronutrients: Leaves samples were collected at the end of June 2015 and then dried at 70°C in a hot air oven. The dried samples were ground and then digested for nitrogen, phosphorus and potassium analyses. Nitrogen was determined by micro-Kjeldahl method, Phosphorus was estimated colorimetrically using ascorbic acid and ammonium molybdate using spectrophotometer and potassium was measured using flame photometer according to Page et al. (1982). Total iron, zinc, copper and manganese contents were determined by using Atomic Absorption Spectrophotometer, Pye unican SP1900, according to Brandifeld and Spincer (1965).

d. The tree yield (kg/tree) was recorded

e. Fruit parameters (fruit physical characteristics): Fruits sample were taken at the harvest time to be used for determining the physical properties (i.e., fruit length (cm), fruit diameter (cm) and fruit weight (g), fruit volume (cm³), flesh weight and fruit flesh ratio% (flesh weight/fruit weight).

f. Fruit quality (fruit chemical characteristics): a sample of 10 mature fruits of each tree was taken at the harvest time to be used for determining the chemical properties i.e., the total soluble solids percentage (T.S.S.%) was measured by using a hand refractometer and the acidity % as citric acid content using fresh juice with titration against 0.1 NaOH. The total sugars % according to A.O.A.C (1985) was determined.

g. Soil and water nutrient contents: Before applying the treatments and at the end of experiment of work, soil samples were taken from each treatment at major root zone (0–60 cm depth). Soil samples were prepared for analysis according to Jackson (1967). These soil samples were dried, sieved (through 2 mm) and analyzed for soluble cations, soluble anions and available micronutrients in soil. In addition, water samples were taken from MW and NMW to be examined as discussed by Page et al. (1982).

5. Statistical Analysis

The obtained data were subjected to analysis of variance according to Clarke and Kempson (1997). Means were differentiated using Range test at the 0.05 level (Duncan, 1955).

RESULTS AND DISCUSSION

1. Shoot Length, Number of Leaves/Shoot and Leaf Area

Data in table (6), clear that shoot length, the number of leaves/shoot and leaf area were significantly affected by all treatments in both seasons. However, MW gave the best shoot length (26.27 cm in the 1st and 27.83 cm

in the 2nd season), number of leaves/shoot (20.00 in the 1st and 21.13 in the 2nd season) and leaf area (19.88 cm² in the 1st and 20.24 cm² in the 2nd season) comparing with NMW.

Table (6). Effect of magnetized water and compost tea on some peach growth parameters during 2015 and 2016 seasons.

		Shoot length (cm)		Number of leaves/shoot		Leaf area (cm ²)	
		Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016
Effect of water							
MW		26.27a	27.83a	20.00 a	21.13a	19.88a	20.24a
NMW		20.71b	22.13b	15.73b	15.93b	15.79b	15.16b
Effect of compost tea with or without some growth stimulants							
T ₁		21.21e	22.62e	16.00e	16.33e	16.35d	15.40e
T ₂		22.30d	23.82d	16.66d	17.50d	16.72cd	16.77d
T ₃		25.84a	27.23a	19.83a	20.66a	19.27a	19.79a
T ₄		24.85b	26.09b	19.00b	19.66b	18.97ab	18.81b
T ₅		23.25c	25.13c	17.83c	18.50c	17.85bc	17.74c
Effect of interaction between water and compost tea treatments							
Water	Compost tea	Shoot length (cm)		Number of leaves/shoot		Leaf area (cm ²)	
		Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016
MW	T ₁	24.29d	25.18e	18.66cd	19.33d	19.06bc	18.14d
	T ₂	25.39c	26.44d	19.00c	20.00cd	19.12abc	19.44c
	T ₃	28.18a	30.33a	21.66a	23.33a	20.69a	22.18a
	T ₄	27.41b	29.03b	20.66b	22.33b	20.52ab	21.06b
	T ₅	26.07c	28.15c	20.00b	20.66c	20.00ab	20.37b
NMW	T ₁	18.13i	20.07j	13.33h	13.33h	13.65e	12.66h
	T ₂	19.22h	21.20i	14.33g	15.00g	14.33de	14.11g
	T ₃	23.51e	24.14f	18.00de	18.00e	17.85c	17.40de
	T ₄	22.30f	23.15g	17.33e	17.00f	17.43c	16.56e
	T ₅	20.43g	22.10h	15.66f	16.33f	15.71d	15.10f

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

Regarding compost tea with or without other growth stimulants, shoot length, the number of leaves/shoot and leaf area was affected significantly in both seasons. Whatever, T₃ produced the highest shoot length, number of leaves/shoot in both seasons and leaf area in the second season, while there was insignificant difference between T₃ and T₄ in leaf area in the first season compared with other compost tea used. On the other

side, T₁ was the lowest in shoot length, number of leaves/shoot and leaf area in both seasons.

The data of the interaction between MW and compost tea with or without other growth stimulants treatments showed that, T₃ under MW recorded the highest shoot length, number of leaves/shoot in both seasons and leaf area in the second season, while, there was insignificant affect among T₂, T₃, T₄ and T₅ in leaf area in the first season as compared with the other compost tea treatments. In addition, T₁ under NMW recorded the lowest shoot length, the number of leaves/shoot and leaf area in both seasons.

These results may be due to the mechanism of magnetic field that enhance the activation of phytohormone, such as gibberellic acid-equivalents, indole-3-acetic acid and trans-zeatin as well as activation of the bio-enzyme systems, which leads to the growth improvement and increased the yield (Maheshwari and Grewal, 2009 and Hozayn and Abdul Qados, 2010). It is also could be due to the magnetic water's ability to the direct effect on chemical and physical properties of the soil and then its indirect effect on the plant uptake of available nutrients as stated by Selim (2008) and Abou El- Yazied et al. (2012). Compost tea contains an abundance of micronutrients, which are absorbed through the foliar surface of plants. In addition, improving vegetative growth could be going to that behavior of licorice extract that containing mevalonic acid is similar to gibberellin. Furthermore, it could be due to that licorice extract contain protein and amino acid (Asparagin), monosaccharide (glucose, fructose, sucrose and maltose), lignins, tannins, starch, choline, phytosterols, different types of vitamins such as B1, B2, B3, B6, C, E, biotin, folic acid, pantothenic acid, many mineral compounds (aluminum, calcium, iron, magnesium, cobalt, zinc, phosphorus, sodium, silicone, potassium and stannous) and bitter principles (Fukai et al., 1998 and Arystanova et al., 2001).

The obtained results are in agreement with those of Bilalis et al. (2012), who stated that the electromagnetic fields could replace and activate hormones in vegetative growth of oregano as found by Podlesny et al. (2005), who recorded that magnetic treatment improved emergence and growth of two pea varieties. Also, Zuhair (2010) showed that spraying strawberry with licorice extract (2 g/L) gave a significant increase in average leaf area, and Qaraghoul and Jalal (2005) found that spraying apple with licorice extract improved all growth parameters and Sheren and Eman (2015) proved that licorice extracts improved growth of Le-Conte "pear".

2. Nitrogen, Phosphorus and Potassium Content in Leaves

Data presented in table (7), show that all treatments were significantly effective on the peach content of leaf nitrogen, phosphorus and potassium in both seasons. However, MW gave higher significant leaf nitrogen, phosphorus and potassium content in both seasons comparing with

NMW.

Table (7). Effect of magnetized water and compost tea on peach leaves content of nitrogen, phosphorus and potassium during 2015 and 2016 seasons.

Treatments	N (%)		P (%)		K (%)		
	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	
Effect of water							
MW	2.94a	2.98a	0.25a	0.27a	1.67a	1.72a	
NMW	2.50b	2.57b	0.15b	0.16b	1.15b	1.17b	
Effect of compost tea with or without some growth stimulants							
T ₁	2.53c	2.61e	0.17e	0.19e	1.27d	1.29e	
T ₂	2.65b	2.7d	0.19d	0.21d	1.34c	1.38d	
T ₃	2.90a	2.94a	0.23a	0.25a	1.58a	1.61a	
T ₄	2.81a	2.84b	0.22b	0.23b	1.47b	1.51b	
T ₅	2.71b	2.78c	0.21c	0.22c	1.41c	1.44c	
Effect of interaction between water and compost tea treatments							
Water	Compost tea	N (%)		P (%)		K (%)	
		Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016
MW	T ₁	2.76cd	2.80d	0.21e	0.24d	1.54c	1.56d
	T ₂	2.86bc	2.90c	0.23d	0.26c	1.60bc	1.67c
	T ₃	3.10a	3.16a	0.29a	0.31a	1.83a	1.86a
	T ₄	3.06a	3.06b	0.27b	0.28b	1.75a	1.80ab
	T ₅	2.93b	3.00b	0.26c	0.27b	1.65b	1.73bc
NMW	T ₁	2.30g	2.43g	0.13i	0.14h	1.01g	1.03h
	T ₂	2.45f	2.50f	0.15h	0.16g	1.08f	1.10g
	T ₃	2.70d	2.73d	0.18f	0.19e	1.34d	1.36e
	T ₄	2.56e	2.63e	0.17fg	0.18f	1.20e	1.23f
	T ₅	2.50ef	2.56ef	0.16g	0.17fg	1.15ef	1.16fg

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

In addition, leaf nitrogen, phosphorus and potassium content were affected significantly by compost tea with or without some growth stimulants in both seasons. T₃ and T₄ produced the highest leaf nitrogen content in the first season, While, T₃ gave the highest leaf nitrogen content in the second season and the highest leaf phosphorus and potassium content in both seasons comparing with other used compost tea. While, T₁ gave the lowest leaf nitrogen, phosphorus and potassium content in both seasons.

The interaction between magnetized water and compost tea treatments indicated that, T₃ and T₄ under MW recorded the highest leaf

nitrogen content in the first season and leaf potassium content in both seasons. While, T₃ under MW recorded the highest value of leaf nitrogen content in the second season and leaf phosphorus content in both seasons. In addition, T₁ under NMW recorded the lowest leaf nitrogen phosphorus and potassium content in both seasons.

The obtained results are in agreement with those of Aly et al. (2015), who found that magnetic water caused an increase in nitrogen, phosphorus, potassium, calcium, and magnesium in Valencia orange leaves. Also, Fayek et al. (2014) showed that foliar application of compost tea recorded the highest N, P and K contents in pear leaves. In addition, Al-Hadethi et al. (2012), Sheren and Eman (2015) and Shakir and Rawi (2017), found that spraying licorice extract on pear increased leaves nitrogen, potassium, iron and zinc content.

3. Iron, Zinc, Copper and Manganese Content in Leaves

It is evident from the data in table (8), that iron, zinc, copper and manganese content in leaves was significantly affected by all treatments in both seasons. However, MW gave the higher significant leaf iron (54.83 ppm in the 1st and 58.85 ppm in the 2nd season), zinc (20.73 ppm in the 1st and 22.56 ppm in the 2nd season), copper (6.05 ppm in the 1st and 6.54 ppm in the 2nd season) and manganese (20.37 ppm in the 1st and 22.54 ppm in the 2nd season) contents comparing with NMW in both seasons.

Leaf iron, zinc, copper and manganese content were affected significantly by compost tea treatments in both seasons. The treatment “T₃” produced the highest iron, zinc, copper and manganese content in leaves in both seasons. While, T₁ gave the lowest leaf iron, zinc, copper and manganese content in both seasons.

The data obtained from the interaction between of MW and compost tea treatments pointed that T₃ under MW recorded the highest leaf iron, zinc, copper and manganese content in both seasons. In addition, T₁ under NMW recorded the lowest leaf iron, zinc, copper and manganese content in both seasons.

The positive influence of these results in the tables (7 and 8) may be due to that electromagnetic fields modify the rate of ion transport across the plasma membrane or otherwise affect the structure of cell membrane lipid protein dynamics. This may cause the alteration in the permeability of the plasma membrane of plant roots (Stange et al., 2002). It could be due to the significant increase in the rate of water absorption (Taia et al., 2007). Noran et al. (1996) and Maheshwari and Grewal (2009) mentioned that plants absorb more water of MTW than non-treated, consequently they uptake more nutrients as a result of water molecules of MTW that are minute and small, which reflected on the yield and water productivity. These results exhibited that MTW played an important role in improving the availability of these elements to plants. Selim (2008) indicated that MTW has induced

changes in the mobility of nutrient elements in root zone, which is different from one element to another according to element magnetic susceptibility. In addition, the treatment of magnetic water affected the absorption of calcium and phosphorus in soil and the plants can easily absorb them and consequently increased their growth (Maheshwari and Grewal, 2009).

Table (8). Effect of magnetized water and compost tea on peach leaves content of iron, zinc, copper and manganese during 2015 and 2016 seasons.

		Fe (ppm)		Zn (ppm)		Cu (ppm)		Mn (ppm)	
		Season 2015	Season 2016						
Effect of water									
MW		54.83a	58.85a	20.73a	22.56a	6.05a	6.54a	20.37a	22.54a
NMW		43.75b	46.26b	14.70b	16.87b	2.60b	3.97b	16.00b	17.05b
Effect of compost tea with or without some growth stimulants									
T ₁		45.24e	48.61e	15.76e	17.8e	3.45d	4.20d	16.58e	17.72e
T ₂		46.75d	50.75d	16.86d	18.80d	3.70d	4.78c	17.33d	19.07d
T ₃		53.68a	56.76a	19.78a	21.57a	5.28a	6.45a	19.98a	21.87a
T ₄		51.77b	54.56b	18.59b	20.58b	4.77b	5.78b	18.92b	20.46b
T ₅		49.02c	52.10c	17.59c	19.81c	4.42c	5.09c	18.13c	19.86c
Effect of interaction between water and compost tea treatments									
Water	Compost tea	Fe (ppm)		Zn (ppm)		Cu (ppm)		Mn (ppm)	
		Season 2015	Season 2016						
MW	T ₁	49.85e	55.13d	18.99d	20.55d	4.95d	5.41de	18.61d	20.20 e
	T ₂	51.18d	57.26c	19.83c	21.86c	5.37c	5.93cd	19.29d	21.77d
	T ₃	60.63a	62.64a	22.82a	24.26a	7.26a	7.95 a	22.48a	25.16a
	T ₄	57.96b	61.01b	21.73b	23.40b	6.47b	7.13b	21.27b	23.21b
	T ₅	54.55c	58.21c	20.30c	22.73b	6.18b	6.30c	20.23c	22.39c
NMW	T ₁	40.63j	42.10i	12.54h	15.07h	1.95g	3.00i	14.55h	15.25i
	T ₂	42.31i	44.23h	13.90g	15.73h	2.04g	3.62h	15.38g	16.38h
	T ₃	46.74f	50.89e	16.74e	18.88e	3.30e	4.95ef	17.48e	18.59f
	T ₄	45.59g	48.11f	15.45f	17.77f	3.07e	4.42fg	16.57f	17.70g
	T ₅	43.50h	45.99g	14.88f	16.89g	2.66f	3.88gh	16.03f	17.33g

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

4. Fruit Length and Diameter

Data presented in table (9) show that fruit length and diameter was significantly affected by all treatments in both seasons. However, MW gave a higher fruit length, diameter comparing with NMW in both seasons.

Table (9). Effect of magnetized water and compost tea on fruit length and fruit diameter of peach during 2015 and 2016 seasons.

Treatments	Fruit length (cm)		Fruit diameter (cm)		
	Season 2015	Season 2016	Season 2015	Season 2016	
Effect of water					
MW	5.66a	5.80a	4.48a	4.64a	
NMW	4.62b	4.71b	3.90b	4.07b	
Effect of compost tea with or without some growth stimulants					
T ₁	4.78 e	4.90d	3.98 e	4.11e	
T ₂	4.98d	5.03c	4.10d	4.26d	
T ₃	5.51a	5.71a	4.40a	4.58a	
T ₄	5.28 b	5.36b	4.28 b	4.48b	
T ₅	5.15c	5.26 b	4.20 c	4.33c	
Effect of interaction between of water and compost tea treatments					
Water	Compost tea	Fruit length (cm)		Fruit diameter (cm)	
		Season 2015	Season 2016	Season 2015	Season 2016
MW	T ₁	5.10e	5.23e	4.16e	4.43d
	T ₂	5.40d	5.46d	4.36d	4.53c
	T ₃	6.20a	6.50a	4.76a	4.86a
	T ₄	5.90b	6.00b	4.60b	4.76b
	T ₅	5.70c	5.80c	4.50c	4.60c
NMW	T ₁	4.46h	4.56h	3.80i	3.80h
	T ₂	4.56gh	4.60gh	3.83hi	4.00g
	T ₃	4.83f	4.93f	4.03ef	4.30e
	T ₄	4.66fg	4.73g	3.96fg	4.20f
	T ₅	4.60gh	4.73g	3.90gg	4.06g

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

Furthermore, fruit length and diameter were affected significantly by compost tea treatments in both seasons. T₃ produced the highest fruit length (5.51 cm in the 1st and 5.71 cm in the 2nd season) and diameter (4.40 cm in the 1st and 4.58 cm in the 2nd season). On the other side, T₁ gave the lowest fruit length (4.78 cm in the 1st and 4.90 cm in the 2nd season) and diameter (3.98 cm in the 1st and 4.11cm in the 2nd season).

The obtained data from the interaction between the MW and compost tea treatments cleared that, T₃ under MW recorded the highest fruit length and diameter in both seasons. In addition, T₁ and T₂ under NMW recorded the lowest fruit length and diameter in both seasons.

5. Fruit Volume, Weight, Flesh Weight and Fruit Flesh Ratio

The results in tables (10) show that fruit volume, weight, flesh weight and fruit flesh ratio (pulp weight/fruit weight) were significantly affected by all treatments in both seasons. However, MW gave the best fruit volume (54.38 cm in the 1st and 58.00 cm in the 2nd season), weight (52.86 g in the 1st and 56.48 g in the 2nd season), flesh weight (48.17 g in the 1st and 52.81g in the 2nd season) and fruit flesh ratio (90.80% in the 1st and 93.26% in the 2nd season).

On the other hand, fruit volume, weight, flesh weight and fruit flesh ratio (pulp weight/fruit weight) were affected significantly by different sources of compost tea in both seasons. T₃ produced the highest fruit volume, fruit weight, flesh weight and fruit flesh ratio in both seasons. On the other side, T₁ gave the lowest fruit volume, fruit weight, flesh weight and fruit flesh ratio in both seasons.

Moreover, the interactions between MW and different sources of compost tea cleared that T₃ under MW recorded the highest fruit volume, fruit weight, flesh weight and fruit flesh ratio in both seasons. In addition, T₁ under NMW recorded the lowest fruit volume, fruit weight, flesh weight and fruit flesh ratio in both seasons.

6. Yield, Total Soluble Solids, Total Sugar and Total Acidity Content

Data in table (11) indicated that yield, total soluble solids, total sugar and total acidity content were significantly affected by all treatments in both seasons. However, MW gave the best yield (29.82 kg in the 1st and 32.35 kg in the 2nd season), total soluble solids (14.48% in the 1st and 14.84% in the 2nd season), total sugar (12.53% in the 1st and 12.69% in the 2nd season) and decreased total acidity (0.23% in the 1st and 0.22% in the 2nd season).

On the other hand, yield, total soluble solids, total sugar and total acidity content were affected significantly by compost tea with or without some growth stimulants in both seasons. T₃ produced the highest yield, total soluble solids, total sugar and decreased total acidity in both seasons. On the other side, T₁ decreased yield, total soluble solids, total sugar and increased total acidity in both seasons.

Table (10). Effect of magnetized water and compost tea on fruit volume, weight, flesh weight and fruit flesh ratio of peach during 2015 and 2016 seasons.

Treatments	Fruit volume (cm ³)		Fruit weight (g)		Flesh weight (g)		Fruit flesh ratio		
	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	
Effect of water									
MW	54.38a	58.00a	52.86a	56.48a	48.17a	52.81a	90.80a	93.26a	
NMW	36.14b	38.20b	34.87b	36.46b	27.27b	30.26b	77.58b	82.44b	
Effect of compost tea with or without some growth stimulants									
T1	37.93e	40.66e	36.37e	38.90e	29.03e	32.73e	77.98e	82.45d	
T2	42.04d	44.33d	40.60d	42.74d	33.94d	37.24d	82.19d	85.89c	
T3	52.35a	55.66a	51.04a	54.17a	46.15a	50.50a	89.29a	92.38a	
T4	49.40b	51.16b	47.61b	49.56b	41.94b	45.06b	86.98b	89.93b	
T5	44.60c	48.66c	43.71c	46.97c	37.54c	42.14c	84.51c	88.61b	
Effect of interaction between of water and compost tea treatments									
Water	Compost tea	Fruit volume (cm ³)		Fruit weight (g)		Flesh weight (g)		Fruit flesh ratio	
		Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016
MW	T1	45.74e	49.66e	44.26e	47.49e	38.26e	42.82e	86.43d	90.17de
	T2	50.48d	53.66d	48.75d	52.00d	43.41d	47.66d	89.06c	91.68cd
	T3	62.80a	66.66a	61.26a	65.45a	58.14a	63.11a	94.91a	96.43a
	T4	59.17b	61.33b	57.32b	60.19b	52.99b	56.86b	92.45b	94.45ab
	T5	53.71c	58.66c	52.71c	57.27c	48.04c	53.61c	91.15b	93.59bc
NMW	T1	30.12j	31.66j	28.48j	30.31j	19.81j	22.65j	69.52h	74.72h
	T2	33.60i	35.00i	32.46i	33.49i	24.46i	26.82i	75.32g	80.10g
	T3	41.89f	44.66f	40.83f	42.89f	34.17f	37.89f	83.67d	88.33e
	T4	39.62g	41.00g	37.89g	38.93g	30.89g	33.26g	81.52e	85.41f
	T5	35.50h	38.66h	34.71h	36.67h	27.04h	30.67h	77.87f	83.63f

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

The obtained data from the interaction between MW and compost tea treatments indicated that T₃ under MW recorded the highest yield, total soluble solids and total sugar, followed by T₄, T₅ and T₂, respectively, and decreased total acidity in both seasons. In addition, T₁ under NMW was decreased yield, total soluble solids, total sugar and increased total acidity content in both seasons.

The positive effect in tables (9, 10 and 11) may be due to that the application of magnetized irrigation water significantly increased the plant characteristics, chemical composition and availability of nutrients in the soil and increasing fruit quality and yield. The mechanism of magnetic field

associated with the activation of phytohormone, such as gibberellic acid-equivalents, indole-3-acetic acid and trans-zeatin as well as activation of the bio-enzyme systems, which play an important role in control the fruit drop and to improve the quality of fruit (Maheshwari and Grewal, 2009 and Hozayn and Abdul Qados, 2010). In addition, the enhancement of fruit quality and yield could be due to the effective components of licorice extract (i.e., nutritive, minerals and phytohormone) (Fukai et al., 1998 and Arystanova et al., 2001).

Table (11). Effect of magnetized water and compost tea on yield, total soluble solids, total sugar, total acidity content of peach during 2015 and 2016 seasons.

Treatments	Yield (kg/tree)		T.S.S. (%)		Total sugar (%)		Acidity (%)		
	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	
Effect of water									
MW	29.82a	32.35a	14.48a	14.84a	12.53a	12.69a	0.23b	0.22 b	
NMW	19.60b	23.31b	11.00b	11.49b	8.98b	9.45b	0.27a	0.29a	
Effect of compost tea with or without some growth stimulants									
T ₁	20.74e	23.91e	11.40e	12.20d	9.40e	9.97d	0.30a	0.28a	
T ₂	22.92d	25.80d	11.82d	12.54cd	9.80d	10.43 d	0.25b	0.27b	
T ₃	28.84a	31.58 a	14.18a	14.42a	12.20 a	12.43a	0.22e	0.23e	
T ₄	26.54b	30.06 b	13.79b	13.85b	11.61b	11.58b	0.23d	0.25d	
T ₅	24.52c	27.78c	12.51c	12.82c	10.75c	10.96c	0.24c	0.26c	
Effect of interaction between of water and compost tea treatments									
Water	Compost tea	Yield (kg/tree)		T.S.S (%)		Total sugar (%)		Acidity (%)	
		Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016	Season 2015	Season 2016
MW	T ₁	25.49e	28.20e	12.96 d	13.95 c	10.96 d	11.44cd	0.24d	0.25 cd
	T ₂	27.59 d	30.25d	13.44 d	14.04c	11.29 d	11.86 c	0.22e	0.24d
	T ₃	34.56 a	36.47 a	16.32 a	16.33 a	14.34 a	14.26 a	0.20f	0.19g
	T ₄	32.22 b	34.76 b	15.66b	15.37 b	13.55 b	13.20 b	0.21f	0.21f
	T ₅	29.26 c	32.08 c	14.03 c	14.50 c	12.51 c	12.70 b	0.22e	0.23e
NMW	T ₁	16.00 i	19.63 j	9.85 g	10.45f	7.85g	8.50 g	0.31a	0.32a
	T ₂	18.25 h	21.36i	10.21g	11.03ef	8.32 g	9.00 fg	0.30b	0.31 a
	T ₃	23.12f	26.70 f	12.03e	12.51d	10.07e	10.60de	0.25d	0.26c
	T ₄	20.85 g	25.36g	11.92e	12.33d	9.66e	9.96e	0.27c	0.28b
	T ₅	19.77g	23.49h	11.00f	11.15e	9.00 f	9.22f	0.28c	0.29b

Means having the same letter(s) in each column, row or interaction are not significantly different at 5% level. MW: magnetic water, NMW: non-magnetized water. *T₁: control treatment (spraying with water + molasses), T₂: compost tea + molasses, T₃: compost tea + licorice extract + molasses, T₄: compost tea + moringa extract + molasses, T₅: compost tea + algae extract + molasses.

The obtained results are in agreement with Esitken and Turan (2004) on cheery, *Lepidium Sativum* L. and tomato and Aly et al. (2015) on orange.

They clearly showed a gradual increase in fruits quality and yield by using magnetic irrigation water. In addition, Fayek et al. (2014) showed that foliar compost tea on pear recorded the highest yield and better fruit quality. In addition, Qaraghoul and Jalal (2005) on apple and Hussein (2008) on date palm found that spraying with licorice extracts increased the fruit quality and yield.

7. Effect of Magnetic Water Treatment on Water Properties

Fig. (1) clears that there were slight changes in water-soluble salts, pH, micronutrients and salts composition under the irrigation with MW treatment as compared with NMW. Also, there is no evidence for the change in the content of microelements (Fe, Zn, Cu and Mn) before and after magnetized treatment. In spite of the ability in magnetic treatment of irrigation water to slightly decrease of salinity than in untreated water, however, the salinity categories of water in magnetic treatment still located at the same classes of untreated water. The reason of using magnetic devices is not for causing chemical change of the salts in the magnetic of water (only about 10% decrease) (Hozien, 2014 and Stephen, 2013), but to enhance water's ability to affect directly the chemical and physical properties of the soil, then its indirectly effect on plant uptake of available nutrients (Selim, 2008 and Abou El-Yazied et al., 2012). The main properties of magnetized treated water are the reduction of water molecules stores within the water. When that water passes through the soil, it leads to positive charges in the chemical and physical properties i.e. reduces soil EC and pH; improves the soil permeability, fastness water movement to dissolve soil salts and entails a better assimilation of nutrients, which become available to plant uptake (Grewal and Maheshwari, 2011).

8. Effect of Magnetic Water Treatment on Soil Chemical Properties

Fig. (2) indicates that there was a decrease in EC and pH in soil paste extract after using magnetic treatment. In respect of the essential elements for plants, i.e. Ca, Mg, K and Na, the results revealed that magnetized treatment affected the solubility of these elements in the soil and decreased using magnetic water as compared to without magnetic water. It appears that water magnetizing treatment leads to the intensive reduction of soluble Na salts, meanwhile, the decrease of other elements (Ca, Mg and K) is less than the decrease of Na. In addition, Fe, Zn, Cu and Mn in soil were increased under water magnetic treatments.

These results could be due to that the dissolving properties of water increase when started with the magnetic field as the magnetic water has small molecules, less viscosity, faster water movement and permeability at soil pore (Amiri and Dadkhah, 2006 and Al-Khazan et al., 2011). In addition, Hilal et al. (2012) mentioned that total salts removal from the soil with magnetic treatment was greater by 24.39% compared with normal

water. Furthermore, magnetic treatment removes the excess of soluble salts and leaches the salts far away from root zone (Hilal et al., 2012 and Abou El-Yazied et al., 2012). In addition, Al Khazan et al. (2011) and Abou El-Yazied et al. (2012) showed that reduction in soil pH is due to the effect of magnetic field on organic matter in the soil, where it releases relatively greater of organic acids in the rhizosphere. In addition, magnetic treatments lead to an increase in all elements content, except sodium. This is because Na is paramagnetic elements, which have a small positive susceptibility to magnetic fields, while other elements are diamagnetic, which are slightly repelled by a magnetic field (Nave, 2008). Moreover, Maheshwari and Grewal (2009) and Hilal et al. (2012) recorded that there was an increase of Ca, Mg, K concentration in the plants. Selim (2008) indicated that magnetic treatment has induced changes in the mobility of nutrient elements in root zone, which there are differences from one element to another according to element magnetic susceptibility.

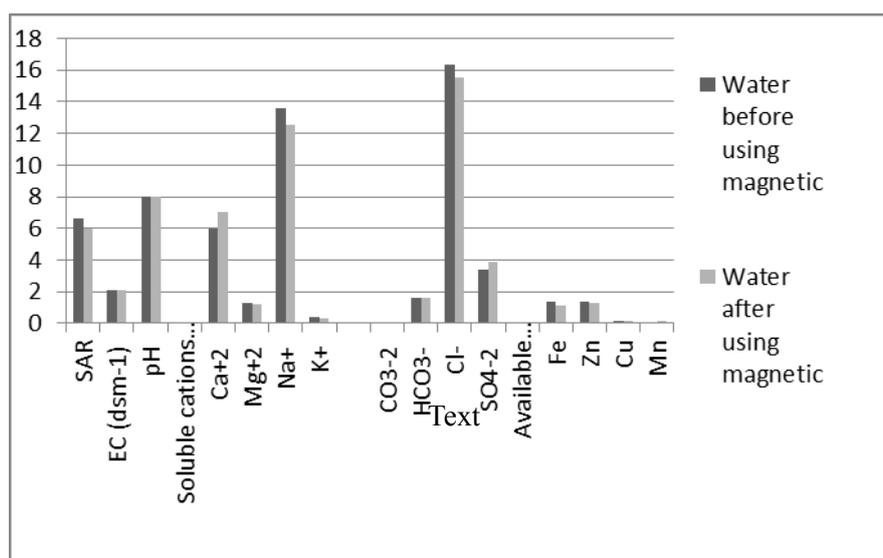


Fig. (1). Effect of magnetized treatment of the irrigation water on irrigation groundwater properties.

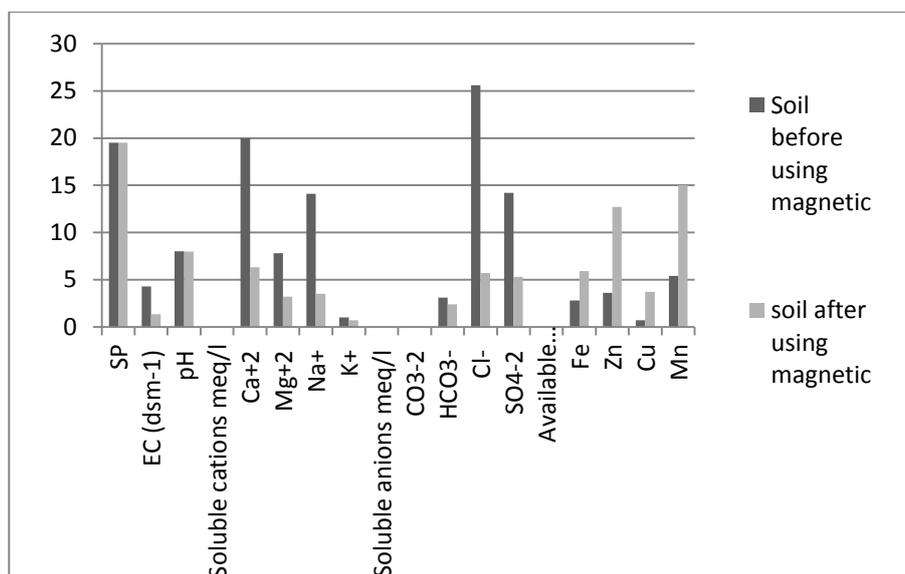


Fig. (2). Effect of magnetized treatment of the irrigation water on soil chemical properties.

CONCLUSION

All things considered, it seems pertinent to indicate that under salinity stress, irrigation with magnetized water, coupled with the application of “compost tea + licorice extract (4:1, v: v) + molasses” can be recommended as an environmentally friendly treatment. Furthermore, this treatment can be used for various crops due to its high potentiality as well as its nutritive value.

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إستخدام الماء الممغنط وشاي الكمبوست لتحسين إنتاجية الخوخ تحت ظروف الإجهاد الملحي بشمال سيناء، مصر

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أجريت هذه الدراسة خلال الموسمين المتتاليين ٢٠١٥ و ٢٠١٦ في أحد المزارع بمنطقة الشيخ زويد، بمحافظة شمال سيناء، مصر. وكان الهدف من هذا البحث هو دراسة تأثير إستخدام الماء الممغنط وشاي الكمبوست مع وبدون بعض محفزات النمو الطبيعية على صنف خوخ الشيخ زويد الحلو، تحت ظروف الإجهاد الملحي. وفي هذه التجربة تم تنفيذ عدد من المعاملات، إستخدام فيها نوعين من مياه الري هما الماء الممغنط والماء غير الممغنط بالإضافة إلى شاي الكمبوست مع وبدون بعض محفزات النمو الطبيعية، يمكن إجمالها كما يلي: المعاملة الأولى: رش بالماء + المولاس وهي معاملة المقارنة، المعاملة الثانية: شاي الكمبوست + المولاس والمعاملة الثالثة: شاي الكمبوست + مستخلص جذور العرق سوس + المولاس والمعاملة الرابعة: شاي الكمبوست + مستخلص المورينجا + المولاس، والمعاملة الخامسة: شاي الكمبوست + مستخلص الطحالب البنية + المولاس. وقد تم رش الأشجار بمعدل ١,٥ لتر/شجرة/رشة على أربع مرات على طول كل موسم (عند تمام الإزهار، عند تمام العقد، بعد شهر واحد من العقد ثم بعد شهرين من العقد). أظهرت النتائج أن جميع المعاملات كانت فعالة جداً في تحفيز النمو ومحتوى الأوراق من العناصر المعدنية والمحصول والخصائص الفيزيائية والكيميائية للثمار وكذا خصائص التربة. عموماً، كان الماء الممغنط أفضل من المياه غير الممغنطة في جميع المعاملات. وبالإضافة إلى ذلك، أدت المعاملة الثالثة (شاي الكمبوست + مستخلص جذور العرق سوس + المولاس) بإستخدام الماء المغناطيسي إلى زيادة في طول النموات الجديدة، ونسبة عدد الأوراق / فرع، مساحة الورقة، ومحتوى الأوراق من العناصر المعدنية (النيتروجين، الفوسفور، البوتاسيوم، الحديد، الزنك، النحاس والمغنيسيوم)، طول الثمرة وقطر الثمرة وحجم الثمرة، ووزن الثمرة، ووزن اللحم، والنسبة المئوية للحم، والإنتاجية، والمواد الصلبة الكلية، والمحتوى الكلي من السكريات، بالإضافة إلى إنخفاض في المحتوى الكلي للحموضة في الثمرة. علاوة على ذلك، كان هناك تغير طفيف في الأملاح القابلة للذوبان في الماء، ودرجة الحموضة والمغذيات الدقيقة والأملاح تحت الري الممغنط. أيضاً أدى إستخدام الماء الممغنط إلى إنخفاض في ملوحة التربة، ودرجة الحموضة، ومحتواها من عناصر الكالسيوم، والمغنسيوم، والبوتاسيوم والصوديوم. وكذلك، زاد محتواها من الحديد، والزنك، والنحاس والمنجنيز.