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Improving of Hayany Date Palm Production by Using K-Humate as Soil Application and Magnetic Water Irrigation at South Sinai Governorate Egypt

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THE present investigation was carried out during 2018 and 2019 seasons to investigate the consequences of K - Humate with and without magnetic water irrigation on yield, fruit quality and some mineral composition of Hayany date palm cultivar cultivated in South Sinai Research Station (Ras Sudr), Desert Research Center, South Sinai Governorate, Egypt. Results showed that there was significantly effect by using K – Humate as a soil application and magnetic water irrigation in both seasons. Treatment K – Humate at 300 g/tree with magnetic water irrigation produced higher yield and bunch weight. The same treatment gave the highest fruit weight, flesh weight, fruit size and fruit dimensions in both seasons. Also, data showed that the total soluble solids, reducing sugars and nonreducing sugars content in fruits increased significantly by application of K – Humate and magnetic water irrigation. However results indicated that such treatment gave the highest values of N, P, K, Ca and Mg contents in pinnae of Hayany date palm cultivar in the first and second seasons compared with the control and other treatments.

Keywords: K - Humate, Yield, Fruit quality, Pinnae, Leaf mineral content, Hayany Date palm, Soil salinity, Soil properties, Relative yield

Introduction

Date palm tree (*Phoenix dactylifera* L.) is an important fruit crop in the old land as well as new reclaimed regions. Date palm is one of the most important fruit species grown in Egypt and can grow well under drastic environmental conditions, which may be not suitable for many fruit species. Such drastic conditions are prevailing in desert regions. The number of fruitful female palms in Egypt was 14,379,648 produced (1770603 million tons and planted in approximately 134126 feddan according to (Ministry of Agriculture statistic in 2020).

The nutritional value of dates for human being is high. Dates are rich in many minerals, such as potassium, calcium and contain a moderate amount of copper, magnesium, phosphorus and sulpher (Nixon and Carpenter 1978) Amino acids, vitamins, dietary fibre, and phenolics are also present so dates have a wide range of bioactivity potentials, including antibacterial, antioxidant, anticancer, and antidiabetic properties also Hytochemicals such as carotenoids, phenolic acid, flavonoids, and tocopherols improve these bioactivities. (Idowu et al., 2020).

Magnetically treated water is water that has been prepared by exposing it to a magnetic field of a specific intensity, flow rate, and duration (Alattar et al., 2019) Agricultural production, despite issues such as water scarcity, desertification,

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salinity, and low yield, is one of the most essential factors that contribute to economic income and food security. These issues can be solved comparatively employing a water magnetic treatment technology. This technique has been the concentrate of researchers compared ways physical and other chemicals, as provided by the pureness of the ecological and health safety and simple to use. The state of water molecules under a magnetic field causes hydrogen bonds between molecules to alter or break. This causes changes in water properties such as electrical systems, increased oxygen dissolved in water, increased ability to dissolve salts and acids, polymerization, surface tension, change in the speed of chemical reactions, evaporation, moisture, elasticity, electrical insulation, and increased permeability. As a result, infuse the water with more vitality, energy and flow than it previously had. Later, these modifications will have an effect on the quality of the material that enters the structure by affecting physical, chemical, physiological, and metabolic processes (Al-Jubouri et al., 2006).

(Aly et al., 2015) recorded that, Valencia orange treated with magnetic irrigation water revealed an increase in all growth characteristics investigated, vegetative growth, components of yield, fruit quality and leaves contents of elements compared with nonmagnetic irrigation water during their two seasons of investigation. (Alattar et al., 2021) revealed that, corn plants that were watered with magnetized water had longer shoots than those that were watered with regular tap water. When compared to non-magnetized plants, magnetized water considerably enhanced the dry weight of maize plants. There are three essential watched influences of magnetic water in soil: 1- the removal of excess soluble salts, 2- bringing down of pH esteems, and 3- the dissolving of slightly soluble components such as phosphates, carbonates, and sulphates (Mohamed and Sherif, 2020). Moreover, the attractive strategy of magnetic method for saline water is allegedly a successful technique for soil desalinization and it leads to modifications of its properties. So, it becomes more energetic and more-able to flow which can be considered as a birth of new science called Magneto biology (Fanous et al., 2017). However, Magnetic fields may assume a significant action in cation take-up and positively effects on immobile plant nutrient uptake (Mohamed and Sherif 2020).

In aquatic systems, humic acid (polymeric polyhydroxy acid) is the most important component of organic compounds. Humic acid is extremely useful to both plant and soil; it is important for enhancing microbial activity, it is considered as a plant growth bio-stimulate, an efficient soil enhancer; it enhances nutrient uptake as chelating agent and promotes vegetative characteristics, nutritional state and leaf tinctures (Eissa et al., 2007). Potassium humate increases production and quality of a crop, plant tolerance to drought stress, salinity, heat, cold, disease and pests (Jalilm et al., 2013).

Picual olive trees sprayed with humic acid as foliar application at (0.5 %) at the begging of fruit set gained the highest yield (kg/tree) whereas average fruit size, weight, and pulp/pit ratio also fruit oil percentage rather than low concentration of humic acid. (Hagagg et al., 2013). Humic acid treatments (foliar and soil applications) markedly increased the growth parameters (shoot length, number of leaves / shoot and leaf area), yield and fruit physical as well as chemical properties (fruit firmness, juice SSC and SSC / acid ratio) of 'Canino' apricot (Fathy et al., 2010).

(Rahi et al., 2021) cleared that, increasing the level of K-humate significantly improved the yield, total biomass and harvesting index of tomato. Some researchers reported that Potassium humate (K.H) could improve soil structure, organic matter, cations exchange capacity, water properties and consequently affecting on plant growth. K.H is very concentrated form of humus in the naturally occurring lignite which is the brown coal that accompanies coal deposits as reported by (Kumar et al., 2013) and (Abo Gabien et al., 2020).

Therefore, this investigation aims to study the effect of using K- Humate as a soil application with and without magnetic water irrigation of Hayany date palm cultivar and study its effects on yield, fruit physical and chemical properties under saline conditions at South Sinai, Egypt.

Materials and Methods

This work was preforming in the two successive seasons 2018 and 2019 at Ras Sudr Experimental Station, in South Saini Governorate, Egypt in order to study the effect of using K – Humate as a soil application with and without magnetic water irrigation on production and fruit quality of Hayany date palm cultivar. The Hayany date palm trees were selected on the basis of similarity in age (about 14 years) normal growth vigor, healthy in their fruiting and flowering behaviors, all date palm trees of Hayany received

the same cultural practices and planted at 8 × 8 meters apart in sandy soil, and they were irrigated by drip irrigation system. Only 8 bunches were left on each experimental tree.

The study was involved four levels of K-Humate and two kinds of water irrigation. The experimental treatments were arranged in a randomized complete block design with three replicates and each replicate was represented by one tree. The yield of experimental palm trees was harvested through the first half of September in each season. K- Humate were applied to trees as a soil application at four different rates, i.e. (0, 100, 200 and 300 g/tree with and without magnetic water irrigation. Different K- Humate levels were added once in the winter (January) around the trees in the two seasons.

Irrigation water was trickle through the irrigation system from well. Irrigation water source was magnetized by passing magnetic field Magnolith (EWL umelttechnick GMBH, German) permanent magnets with north and south poles 88 cascaded magnetic field. The strength of this magnetic field ranged between 2000-4000 Gauss. The device consists of two parts, attached to an irrigation pipe with its internal diameter of 3inches. Soil and magnetic irrigation water used for irrigation were analyzed according to the method of (Chapman and Pratt, 1961) and the data are presented in Tables (1 and 2).

The effect of K- Humate addition as a soil application with and without magnetic water irrigation on yield and fruit quality, leaf minerals content of Hayany date palm cultivar in the two studied seasons was investigated as follows:

*The averages yield and bunch weight (kg)***:** at harvest time in the first half of September in each season, average bunch weight was recorded and palm yield were calculated.

Fruit physical properties: Samples of 80 fruits per tree (10 fruits / bunch) were taken for the determination of fruit, flesh and seed weight (g), fruit length (cm), fruit diameter (cm), fruit size (cm^3), pulp percentage and finally seed/fruit ratio were determined according to (A.O.A.C., 1984).

Fruit chemical properties: Ten date fruits from each treatment were divided into pieces and seeds were omitted. Fifty grams of pieces were mixed with 100 ml. distilled water using special electric mixer for extraction, then filtered and the filtrate was used for determinations:

Moisture, total soluble solids (TSS) and acidity as a percentage were recorded by using hand refractometer, acidity (%) as malic acid was determined by titration according to (A. O. A. C., 1984), TSS/acid ratio was calculated, total, reducing and non-reducing sugars (%) were determined according to (Miller, 1959).

Leaf mineral content: For leaf mineral analysis, newly emerged leaf was selected from each palm and composted for three palms of Hayany cultivar. Leaflets samples were taken during the first half of October and washed with tap water and then with distilled water to remove the dust and any chemical spray residues. After washing, they were dried in an electric oven at 70 °C *till constant weight*. The dried material was ground in an electric mill to be stored in paper bags for analysis. *Dry leaves were digested using* hydrogen peroxide and sulfuric acid as recommended by (Parkinson and Allen, 1975).

Total nitrogen was determined in ground material by semi-micro Kjeldahl methods as recommended by (Bremner, 1965). *Phosphorus* was calorimetrically determined using the molybdenum blow method according to (Chapman and Pratt, 1961). Potassium was determined by the flame photometer as described by (Irri, 1976). *Calcium and magnesium percentage* according to (Wilde *et al*., 1985). *Proline* was determined according to (Bates et al., 1973).

Soil sampling and analysis

Soil samples were collected at triplicate at 0-30 cm depth from selected trees by soil auger. These disturbed soil samples were air dried, crushed and passed through 2 mm sieve and prepared for soil analysis. The undisturbed and disturbed soil samples were collected to determine chemical and physical properties were determined using the relevant standard methods described by (Klute 1986) and (Page et al., 1982). These properties included particle size distribution; Soil bulk density (BD), total calcium carbonate ($CaCO_3$), soil pH, soil salinity (ECe), soluble cations and anions as well as calculated sodium adsorption ratio SAR, organic matter (SOC), total nitrogen (TN), available phosphorus (P) and available potassium (Av.K). Otherwise, the available nutrient of micronutrients were Zn, Mn, Fe and Cu were extracted according to the method of (Soltanpour, 1991). pH, ECe, soluble cations and anions was measured in soil extract 1:2. Some physical properties of initial soil were shown in Table 1. The soil is sandy loam in texture and highly calcium carbonate.

TABLE 1. Some physical properties of soil surface (0-30) at Ras Sudr district, South Sinai. Eygpt.

Soil depth	Particle Size distribution			Texture Class	$CaCO_3$ (%)	BD* (g/cm³)
	Sand (%)	Silt (%)	Clay (%)			
0 – 30	73.3	14.8	11.9	Sandy loam	47.8	1.51

BD: Bulk Density.

TABLE 2. Some water chemical properties of the studied water

Magnetic Treatments	PH	EC	Cations (meq./L)				Anions (meq./L)				SAR*
			Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	
Nonmagnetic Water	7.4	9.19	16.65	10.25	82.14	2.3	0	2.24	90.32	19.12	2.16
Magnetic Water	7.0	8.12	14.20	11.3	70.02	3.1	0	1.23	87.24	1.23	1.94

SAR: Sodium adsorption ratio.

Statistical Analysis

The obtained data of both seasons were subjected to analysis of variance as reported by (Snedecor and Cochran, 1989) and statistically analyzed using the Computer Program, (SAS 2003) and the means were differentiated using Duncan multiple range test at 5% level (Duncan, 1955).

Results and Dissuasion

Bunch and yield weight (Kg)

The results in Table 3 indicated that soil application of K – Humate at 300 g/tree in both seasons gave the highest bunch weight and yield of Hayany date palm cultivar as compared with untreated trees and other treatments. Regardless of water irrigation magnetic water gave the highest bunch weight and yield (Kg/palm) in the two seasons. As for the interaction it is quite clear that, trees received K – Humate soil application at 300 g/tree and irrigated by magnetic water gained the highest bunch weight (17.20 and 17.73 Kg/palm) opposite to those irrigated by Non-magnetic water (15.35 and 14.31 Kg/palm) in the first and second seasons, respectively. The same treatment exhibited the highest yield (137.56 and 141.87 Kg/palm) in the first and second seasons, respectively. When compared with those irrigated by Non-magnetic water (122.78 and 114.45 Kg/palm) in the first and second seasons, respectively.

Improving plant nutrition by humic acid which activating the absorption of mineral elements through promoting root growth and enhance the rate of absorption of mineral ions on root surfaces and their permeationinto the cells of the plant tissue, so plants display more energetic metabolism and promote respiratory activity. These results are harmony with those acquired by Eissa et al. (2007), Ismail et al. (2010), Fathy et al. (2010), Taha et al. (2011), Jalilm et al. (2013) Hoda et al. (2013) on Valencia orange trees (Citrus Sinensis L.) and Rahi et al. (2021) on tomato. Furthermore, Mohammed et al. (2010) and Abd El-Monem et al. (2011).

Also, the gained results are obvious that, magnetic water irrigation improves moisture retention in the soil, which has an impact on all plant characteristics. i.e. yield and fruit quality Magnetically treated water has a promoting effect on the photosynthetic tinctures content in comparison to the control. Magnetic water lead up to raise of essential elements helped treated water plants to excess their chlorophyll content, which lead out to raise carbohydrate product in plant which produces power for fruit properties. These findings were in line with those obtained by Hozayn et al. (2011). And Alattar et al. (2019) recorded that use of magnetically treated water can lead to improving the quantity and of pepper fruits.

Effect of K - Humate soil application and magnetic water irrigation on some fruit physical properties
Fruit, flesh and seed weight (g)

Results in Table 4 showed that K - Humate and magnetic water irrigation treatments significantly increased fruit and flesh weight (g) of Hayany data palm cultivar, when compared to other treatment and the control in the two seasons,. Maximum value of fruit and flesh weight (g) were recorded in K - Humate at 300 g/palm compared to other treatment and the control in the two studied seasons, regardless of magnetic

TABLE 3. Effect of K-humate soil application and magnetic water irrigation on bunch weight and yield of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Bunch weight (Kg)			Yield (Kg/tree)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
			2018 season			
0	13.75 b	11.66 c	12.71 C	110.10 b	93.30 c	101.34 D
100	14.44 b	12.02 c	13.23 BC	115.53 b	96.12 c	105.83 BC
200	15.55 b	11.92 c	13.74 B	124.43 b	95.35 c	109.89 B
300	17.20 a	15.35 b	16.27 A	137.56 a	122.78 b	130.17 A
Mean	15.24 A	12.74 B		121.91 A	101.89 B	
			2019 season			
0	14.04 b-d	11.29 d	12.67 D	112.33 b-d	90.35 d	101.34 D
100	15.29 bc	11.88 d	13.58 C	122.32 bc	95.00 d	108.66 C
200	16.50 bc	13.17 cd	14.83 B	132.00 ab	105.33 cd	118.67 B
300	17.73 a	14.31 b-d	16.02 A	141.87 a	114.45 b-d	128.16 A
Mean	15.89 A	12.66 B		127.13 A	101.28 B	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

TABLE 4. Effect of K-humate soil application and magnetic water irrigation on fruit, flesh and seed weight of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Fruit weight (g)			Flesh weight (g)			Seed weight (g)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
				2018 season					
0	16.81 cd	15.45 d	16.13 D	14.68 cd	13.72 d	14.20 D	2.13 a	1.73 bc	1.93 A
100	18.47 c	16.84 cd	17.66 C	16.27 c	15.39 c	15.83 C	2.20 a	1.45 c	1.83 AB
200	20.29 b	17.29 c	18.79 B	18.37 b	15.65 c	17.01 B	1.92 ab	1.64 bc	1.78 B
300	21.66 a	17.89 c	19.78 A	19.70 a	16.22 c	17.96 A	1.96 ab	1.67 bc	1.82 AB
Mean	19.31 A	16.87 B		17.26 A	15.25 B		2.05 A	1.62 B	
				2019 season					
0	17.84 de	16.89 e	17.37 D	15.18 d	15.26 e	15.22 D	2.65 a	1.63 b	2.14 B
100	19.17 bc	17.21 e	18.19 C	17.28 c	15.75 e	16.52 C	1.88 b	1.46 b	1.67 D
200	21.55 a	18.49 cd	20.02 B	18.88 b	16.55 d	17.71 B	2.67 a	1.95 b	2.31 A
300	22.25 a	19.67 b	20.96 A	20.29 a	17.70 c	19.00 A	1.96 b	1.97 b	1.96 C
Mean	20.20 A	18.07 B		17.91 A	16.31 B		2.29 A	1.75 B	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

water irrigation. On the other hand, magnetic water irrigation gave the highest fruit and flesh weight (g) opposite to those without magnetic water irrigation in both seasons, regardless of K – Humate. As for the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest fruit weight (21.66 and 22.25 g) opposite to those without magnetic water irrigation (17.89 and 19.67 g) and flesh weight (19.70 and 20.29 g) opposite to those without magnetic water irrigation (16.22 and 17.70 g) compared with the untreated trees and other treatments in the first and second seasons, respectively. As for seed

weight, magnetic water irrigation gave the lowest seed weight (g) in the two seasons, regardless of K – Humate application. However, K - Humate at 200 g/tree gave the lowest seed weight (g) in the first season, but in the second season, treatment K – Humate at 100g/palm gave the lowest seed weight (g) regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K - Humate at 200 g/tree with magnetic water irrigation had the lowest seed weight (1.92 g) in the first season, while in the second season K - Humate at 100 g/tree with magnetic water irrigation gave the lowest seed weight (1.88 g) opposite to those without magnetic water irrigation with 100 g/tree (1.45 and 1.46 g) compared with the control and other treatments in the first and second seasons respectively.

Fruit dimension (length & width) and volume

The results in (Table 5) cleared that K - Humate and magnetic water irrigation significantly increased fruit dimension (length and width) and volume of Hayany date palm cultivar, when compared with untreated trees and other treatments in both seasons. Treatment K - Humate at 300 g/tree gave the highest dimension (length and width) in the first and second seasons, regardless of magnetic water irrigation. Whereas, magnetic water irrigation proved to give the best dimension (length and width) opposite to those without magnetic water irrigation in both seasons, regardless of K– Humate treatments. Regarding the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation had the highest fruit length (5.23 and 5.32 cm) opposite to those without magnetic water irrigation (4.52 and 4.63 cm) compared with the control and other treatments in the first and second seasons respectively. As for the fruit width, K – Humate at 300 g/tree with magnetic water irrigation had the highest fruit width (2.58 and 2.68 cm) opposite to those without magnetic water irrigation (2.44 and 2.44 cm) compared with the control and other treatments in the first and second seasons respectively. Concerning to fruit volume, treatment K - Humate at 300 g/tree gave the highest fruit volume in both seasons, regardless of magnetic water irrigation. Whereas, magnetic water irrigation gave the highest fruit volume opposite to those without magnetic water irrigation in the two seasons, regardless of K – Humate application. As for the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation had the highest fruit size (19.98 and 21.03 cm3) opposite to those without magnetic water irrigation (16.33 and 18.19 cm3) compared with the untreated trees and other treatments in the first and second seasons, respectively. The increase in fruit flesh weight, fruit size, fruit length, and fruit diameter

TABLE 5. Effect of K-humate soil application and magnetic water irrigation on fruit length, fruit diameter and fruit size of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Fruit dimensions (cm)						Fruit size		
	Fruit length (cm)			Fruit diameter (cm)					
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
						2018 season			
0	4.17 d	4.13 d	4.15 D	2.38 a	2.35 a	2.37 C	15.77 b	14.11 c	14.94 D
100	4.44 bc	4.14 d	4.29 C	2.45 a	2.34 a	2.39 BC	17.03 b	15.44 b	16.24 C
200	5.22 a	4.32 cd	4.77 B	2.51 a	2.40 a	2.46 AB	18.90 a	15.90 b	17.40 B
300	5.23 a	4.52 b	4.88 A	2.58 a	2.44 a	2.51 A	19.98 a	16.33 b	18.15 A
Mean	4.77 A	4.28 B		2.48 A	2.38 B		17.92 A	15.44 B	
						2019 season			
0	4.17 de	4.09 e	4.13 D	2.36 c	2.17 d	2.26 D	16.43 de	15.45 e	15.94 D
100	4.34 de	4.20 de	4.27 C	2.40 c	2.34 c	2.37 C	17.65 cd	15.51 e	16.58 C
200	5.10 b	4.41 d	4.76 B	2.61 b	2.37 c	2.49 B	20.03 b	16.93 c-e	18.48 B
300	5.32 a	4.63 c	4.98 A	2.68 a	2.44 c	2.56 A	21.03 a	18.19 c	19.61 A
Mean	4.73 A	4.33 B		2.51 A	2.33 B		18.78 A	16.52 B	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

may be due to the influence of magnetic water on growth characteristics of Hayany date palm trees, the magnetic water irrigation promoting the vegetative growth which displays this trait. the outcomes are in line with Alattar et al., (2021) on corn. There are some amendments occurred in the chemical and physical characteristics of water according to magnetism, mainly hydrogen bonding, polarity, surface tension, conductivity, pH and salt solubility, and these modifications in water characteristics may be able for affecting the plants growth. In this concern, many research workers presupposed that the decrease in water pH and increase in EC in magnetic water may be due to increased mobility of ions and changes in hydrogen bonding. Similar outcomes were obvious by Grewal and Maheshwari, (2011). These findings are in line with earlier results by Rahemi and Atahosseini, (2004) on pomegranate. Jalilm et al. (2013) recorded that potassium humate increased production and quality of a crop, plant tolerance to drought stress, salinity, heat, cold, disease and pests. Also Rahi et al. (2021) reported that, increasing the level of K-humate significantly improved total biomass of tomato plants.

Effect of K - Humate and magnetic water irrigation on some fruit chemical properties

Moisture content, total soluble solids and total acidity percentage

Results in Table 6 clearly show that K – Humate addition and magnetic water irrigation treatments significantly increased moisture content and total soluble solids of Hayany data palm cultivar, as compared with the control and other treatments in the two seasons. The highest value of moisture content and total soluble solids recorded in K - Humate at 300 g/palm compared with the control and other treatments in the two studied seasons, regardless of magnetic water used in irrigation. However, magnetic water irrigation gave the highest moisture content and total soluble solids opposite to those without magnetic water irrigation in both seasons, regardless of K – Humate treatments. As for the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation had the highest moisture content of Hayany fruits (68.09 and 69.94 %) opposite to those without magnetic water irrigation (64.51 and 65.03 %), but total soluble solids percentage, K – Humate at 300 g/tree with magnetic water irrigation had the highest total soluble solids percentage (36.59 and 34.65 cm) opposite to those without magnetic water irrigation (31.60 and 31.51 cm) compared with the control and other treatments in the first and second seasons respectively. As for the total acidity, no significant effect was found due to with and without magnetic water irrigation in both seasons. Meanwhile, the total acidity percentage was not significantly affected by K – Humate application in the first season only, but in the second one there was significant differences between K – Humate treatments. Treatment K – Humate at 300 g/tree gave the lowest total acidity percentage (0.080 %) in the second season, regardless of magnetic water irrigation. Regarding the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation gave the lowest total acidity percentage (0.080 and 0.079 %) opposite to those without magnetic water irrigation (0.081 and 0.081 %) compared with the control and other treatments in the first and second seasons, respectively.

Total sugars, reducing sugars and non-reducing sugars percentage

The results in (Table 7**)** cleared that K - Humate and magnetic water irrigation treatments significantly increased total, reducing and non-reducing sugars of Hayany data palm cultivar, when compared with the control and other treatments in the two seasons. Magnetic water irrigation gave the highest total sugars percentage opposite to those without magnetic water irrigation in the two seasons, regardless of K – Humate treatments. On the other hand, K – Humate at 300 g/tree gave the highest total sugars percentage in both seasons, regardless of magnetic water irrigation treatments. As for the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation had the highest total sugars percentage of Hayany fruits (32.11 and 31.44 %) in the first and second seasons, respectively. As for the reducing sugars, no significant effect was found on reducing sugars percentage due to K – Humate and magnetic water irrigation treatments and their interaction for Hayany cultivar in the two seasons. In regard to the non-reducing sugars, the results indicated that the non-reducing sugars percentage was significantly affected by magnetic water irrigation for Hayany cultivar in the first season only. Magnetic water irrigation gave the highest non-reducing sugars percentage (12.01 %) opposite to those without magnetic water irrigation (9.77 %) in the first season regardless of K – Humate.

TABLE 6. Effect of K-humate soil application and magnetic water irrigation on Moisture content (%), Total soluble solids and Total acidity of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Moisture content (%)			Total soluble solids (%)			Total acidity (%)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
					2018 season				
0	64.57 ab	57.85 d	61.21 D	35.32 ab	31.59 c	33.46 AB	0.082 a	0.083 a	0.083 A
100	67.00 a	60.33 c	63.66 C	34.88 ab	32.42 c	33.65 A	0.082 a	0.082 a	0.082 A
200	67.60 a	62.29 bc	64.94 B	34.35 b	31.23 c	32.79 B	0.081 a	0.082 a	0.082 A
300	68.09 a	64.51 ab	66.30 A	36.59 a	31.60 c	34.09 A	0.080 a	0.081 a	0.081 A
Mean	66.82 A	61.24 B		35.29 A	31.71 B		0.081 A	0.082 A	
					2019 season				
0	66.57 bc	60.39 d	63.48 D	32.42 b	30.68 b	31.55 C	0.082 a	0.082 a	0.082 A
100	67.27 a-c	61.92 d	64.60 C	32.01 b	31.97 b	31.99 BC	0.082 a	0.083 a	0.083 A
200	68.66 ab	62.49 d	65.58 B	33.66 a	31.27 b	32.46 B	0.082 a	0.082 a	0.082 A
300	69.94 a	65.03 c	67.49 A	34.65 a	31.51 b	33.08 A	0.079 b	0.081 a	0.080 B
Mean	69.11 A	62.46 B		33.18 A	31.36 B		0.081 A	0.082 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

TABLE 7. Effect of K-humate soil application and magnetic water irrigation on total sugar (%), reducing sugar (%) and non-reducing (%) of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Total sugars (%)			Reducing sugars (%)			Non-reducing sugars (%)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
					2018 season				
0	30.60 ab	28.72 ab	29.66 A	18.96 a	18.59 a	18.78 A	11.64 a	10.13 a	10.88 A
100	30.91 ab	27.50 b	29.21 A	18.91 a	18.82 a	18.86 A	12.00 a	8.68 a	10.34 A
200	31.27 ab	28.74 ab	30.01 A	19.85 a	18.47 a	19.16 A	11.42 a	10.27 a	10.84 A
300	32.11 a	28.17 ab	30.14 A	19.13 a	18.17 a	18.65 A	12.98 a	10.00 a	11.49 A
Mean	31.22 A	28.28 B		19.21 A	18.51 A		12.01 A	9.77 B	
					2019 season				
0	28.88 b	26.70 b	27.79 C	19.12 a	17.59 a	18.36 A	9.76 a	9.11 a	9.44 A
100	28.10 b	28.80 b	28.45 BC	19.19 a	18.97 a	19.08 A	8.91 a	9.83 a	9.37 A
200	29.87 ab	28.53 b	29.20 AB	20.15 a	18.56 a	19.36 A	9.71 a	9.97 a	9.84 A
300	31.44 a	27.87 b	29.66 A	20.80 a	18.57 a	19.69 A	10.64 a	9.30 a	9.97 A
Mean	29.57 A	27.98 B		19.81 A	18.43 A		9.76 A	9.55 A	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

Effect of K - Humate and magnetic water irrigation treatments on leaflet mineral contents

Pinnae nitrogen, phosphorus and potassium contents

Significant effect was found in nitrogen, phosphorus and potassium contents in leaflet of Hayany date palm cultivar due to the K – Humate and magnetic water irrigation treatments in the two seasons. Magnetic water irrigation gave the highest pinnae nitrogen content opposite to those without magnetic water irrigation in the second season only regardless of K – Humate use. On the other side, K – Humate at 300 g/tree gave the highest pinnae nitrogen content in the two seasons, regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K – Humate at 300 g/tree with magnetic water irrigation had the highest pinnae nitrogen content (2.23 and 2.24 %) opposite to those without magnetic water irrigation (2.21 and 2.17 %) in the first and second seasons, respectively compared with the control and other treatments. In respect to the phosphorus content, magnetic water irrigation gave the highest values of phosphorus concentration opposite to those without magnetic water irrigation in the two seasons, regardless of K – Humate application but K - Humate at 300 g/tree gave the highest phosphorus concentration in pinnae in both seasons, regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest phosphorus concentration (0.27 and 0.26 %) opposite to those without magnetic water irrigation (0.23 and 0.23 %) compared with the control and other treatments in the first and second seasons, respectively. Concerning potassium content, magnetic water irrigation gave the highest potassium concentration opposite to those without magnetic water irrigation in the two seasons, regardless of K – Humate. On the other hand, K – Humate at 300 g/tree gave the highest potassium concentration in both seasons, regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest potassium concentration (0.85 and 0.89 %) opposite to those without magnetic water irrigation (0.70 and 0.71 %) compared with the control and other treatments in the first and second seasons respectively, (Table 8).

Pinnae calcium, magnesium and proline contents

Results in Table 9 clearly showed that K - Humate and magnetic water irrigation treatments significantly increased calcium, magnesium and proline contents of Hayany data palm cultivar, as compared with the control and other treatments in the two seasons. Regarding calcium content,

TABLE 8. Effect of K-humate soil application and magnetic water irrigation on nitrogen, phosphorus and potassium percentage of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
2018 season									
0	1.90 b	1.85 b	1.87 C	0.22 b	0.18 c	0.20 D	0.63 b	0.61 b	0.62 C
100	2.04 a	2.08 a	2.06 B	0.23 b	0.20 bc	0.22 C	0.67 b	0.63 b	0.65 C
200	2.17 a	2.19 a	2.18 A	0.24 b	0.22 b	0.23 B	0.74 b	0.66 b	0.70 B
300	2.23 a	2.21 a	2.22 A	0.27 a	0.23 b	0.25 A	0.85 a	0.70 b	0.78 A
Mean	2.09 A	2.08 A		0.24 A	0.21 B		0.72 A	0.65 B	
2019 season									
0	1.98 ab	1.87 b	1.93 C	0.21 a-c	0.18 c	0.20 C	0.64 b	0.63 b	0.64 C
100	2.10 ab	2.13 ab	2.12 B	0.23 a-c	0.20 bc	0.22 B	0.68 b	0.63 b	0.66 C
200	2.23 a	2.06 ab	2.15 AB	0.24 ab	0.23 a-c	0.24 A	0.73 b	0.67 b	0.70 B
300	2.24 a	2.18 ab	2.21 A	0.26 a	0.23 a-c	0.25 A	0.89 a	0.71 b	0.80 A
Mean	2.14 A	2.06 B		0.24 A	0.21 B		0.74 A	0.66 B	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

magnetic water irrigation gave the highest calcium content opposite to those without magnetic water irrigation in both seasons regardless of K – Humate treatment. While, K – Humate at 300 g/tree gave the highest calcium content in the two seasons, regardless of using magnetic water irrigation. With respect to the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest calcium content (1.70 and 1.72 %) opposite to those without magnetic water irrigation (1.46 and 1.50 %) compared with the control and other treatments in the first and second seasons, respectively. Concerning magnesium content, magnetic water irrigation gave the highest magnesium content in the two seasons, opposite to those without magnetic water irrigation in both seasons, regardless of K – Humate treatments. On the other side, K – Humate at 300 g/tree gave the highest magnesium content in the first and second seasons, regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest magnesium content (0.48 and 0.49 %) opposite to those without magnetic water irrigation (0.43 and 0.44 %) compared with the control and other treatments in the first and second seasons respectively. In respect to the proline content, magnetic water irrigation gave the highest proline content, opposite to those without magnetic water irrigation in the two seasons, regardless of K – Humate application. While, K – Humate at 300 g/tree gave the highest proline content in both seasons, regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received K - Humate at 300 g/tree with magnetic water irrigation had the highest proline content (2.19 and 2.36 %) opposite to those without magnetic water irrigation (1.82 and 1.89 %) compared with the control and other treatments in the first and second seasons respectively.

These results are harmony with those obtained by, Eissa et al. (2007), Ismail et al., (2010). Fathy et al. (2010). Taha et al. (2011); Hoda et al. (2013) on Valencia orange trees (Citrus Sinensis L.). In addition Jalilm. et al. (2013) they recorded that Potassium humate increases production and quality of a crop, plant tolerance to drought stress, salinity, heat, cold, disease and pests. Likewise Rahi et al., (2021) reported that, increasing the level of K-humate significantly improved the harvesting index of tomato.

Furthermore, Mohammed et al. (2010) and Abd El-Monem et al., (2011) indicated that there are many benefits to crop growth resulted from addition natural mineral product like magnetic iron ore including improved soil structure, increased soil organic matter, improved water

TABLE 9. Effect of K-humate soil application and magnetic water irrigation on calcium, magnesium and proline of Hayany date palm during 2018 and 2019 seasons.

K-Humate (g/tree)	Calcium (%)			Magnesium (%)			Proline (ppm)		
	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean	Magnetic water	Non Magnetic water	Mean
2018 season									
0	1.42 b	1.20 c	1.31 C	0.42 cd	0.40 d	0.41 C	1.50 ab	1.45 b	1.47 C
100	1.50 b	1.40 b	1.45 B	0.45 bc	0.42 cd	0.43 B	1.77 ab	1.60 ab	1.69 B
200	1.57 b	1.43 b	1.50 B	0.47 ab	0.42 cd	0.44 B	1.88 ab	1.71 ab	1.80 B
300	1.70 a	1.46 b	1.58 A	0.48 a	0.43 cd	0.45 A	2.19 a	1.82 ab	2.01 A
Mean	1.55 A	1.37 B		0.45 A	0.42 B		1.84 A	1.65 B	
2019 season									
0	1.43 c	1.21 d	1.32 D	0.43 bc	0.40 c	0.42 C	1.57 bc	1.48 c	1.53 D
100	1.51 bc	1.39 c	1.45 C	0.45 a-c	0.42 bc	0.44 B	1.84 bc	1.64 bc	1.74 C
200	1.57 b	1.42 c	1.50 B	0.48 ab	0.43 bc	0.45 AB	2.01 b	1.75 bc	1.88 B
300	1.72 a	1.50 bc	1.61 A	0.49 a	0.44 a-c	0.47 A	1.36 a	1.89 bc	2.13 A
Mean	1.56 A	1.38 B		0.46 A	0.42 B		1.95 A	1.69 B	

Means followed by the same letter (s) within each row, column or interaction are not significantly different at 5% level.

properties and become more energy and vigor and this known as "Magneto biology" improving water holding capacity and cation exchange capacity. Improved crop nutrition from macro and micro elements. Moreover, the magnetic process separates all chlorine, toxic and harmful gases from soil, increased salt movement and solubility of nutrients increasing water retention by soil and this help on plant growth, moderation of soil temperature. Improving plant nutrition by humic acid which stimulating 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.

Magnetic treatment of irrigation water has effect on some chemical and physical characteristics of water and soil. So it is an acknowledged technique for attaining high water use efficiencies. These modifications leaded to an increment ability of soil to get rid of salts and subsequently better absorption of fertilizers and nutrients in plants during the vegetative time. These results are in line with those reported by Abobatta, (2015) on Valencia orange and Shaimaa et al. (2016) on mango.

Soil salinity (ECe) and soil sodicity:

The application of magnetic water under trickle irrigation system and potassium humate alone or in combination with each other, revealed highly significant effect on decreasing soil salinity indicated by electrical conductivity (ECe) dS/m and soil sodicity by sodium adsorption ratio (SAR) after harvesting of plants during the two growing seasons as shown in fig. 1 and 2. Soil salinity and sodicity as affected by treatments can be arranged in a descending order as control > 100 > 200 >300 gm /tree. It has good potential to reduce soil salinity and sodicity due to the magnetic water increase soil salt leaching and reduce soil salt concentration reported by Fanous et al. (2017). Moreover, it may cause by the effect of solubility of NaCl and Na_2CO_3 salts in magnetized water and the latter can use for leaching the salts away from roots zone as proposed by Hilal et al. (2012). On the other hand, the effect of potassium humate caused more reduction in soil salinity due to well-balanced K^+: Na^+ ratio is deceived for the proper adjustment of stomatal function, activation of enzymes, protein synthesis, cell osmoregulation and oxidants metabolism as reported by Abo-Gabien et al., (2020). On the other hand, oxygen concentration was increased that is through its influenced-on hydrogen bonds as reported by Abobatta, (2015) and Abo Gabien et al. (2020).

Soil pH and soil cation exchange capacity (CEC):

The results of Soil pH as shows in Fig. (3) was highly significant decreased with treatments. The best treatment was 300 gm /tree K humate with magnetic water which decreased pH with about 40%. This result is in agreement with Fanous et al., (2017), Abdeen, (2020) and Mohamed and Sherif, (2020).

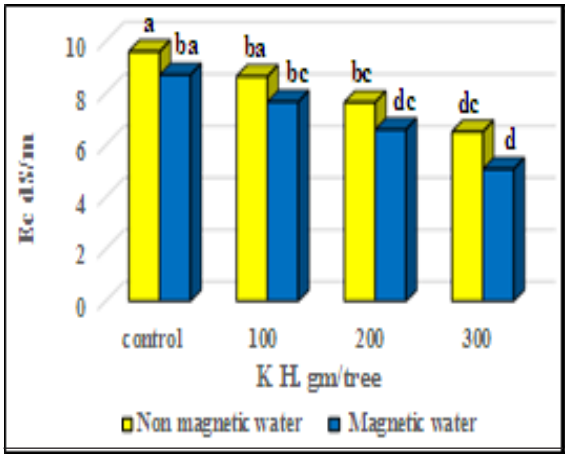

Fig. 1. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on EC dS/m, values followed by different letters are significantly at p < 0.05.

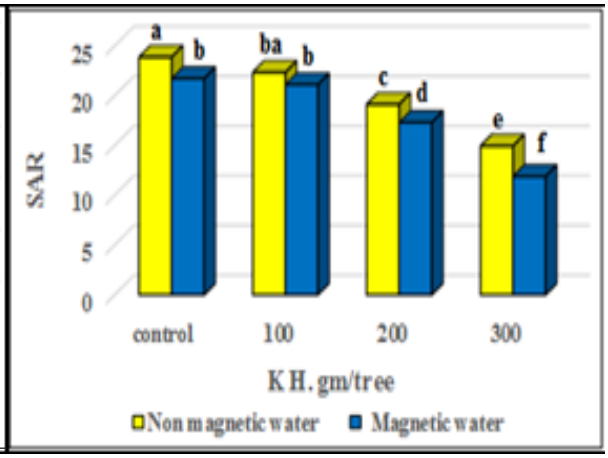

Fig. 2. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on SAR, values followed by different letters are significantly at p < 0.05.

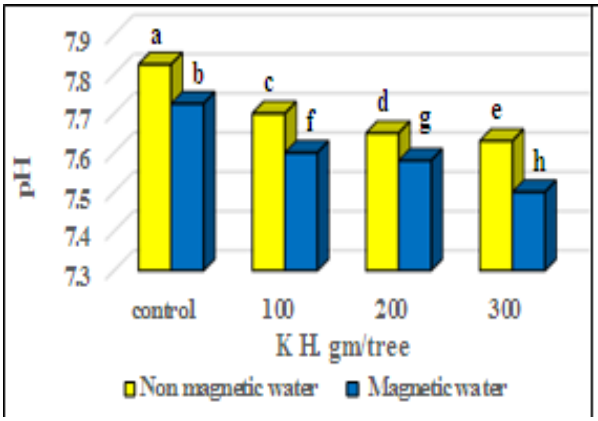

Fig. 3. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on pH, values followed by different letters are significantly at p < 0.05.

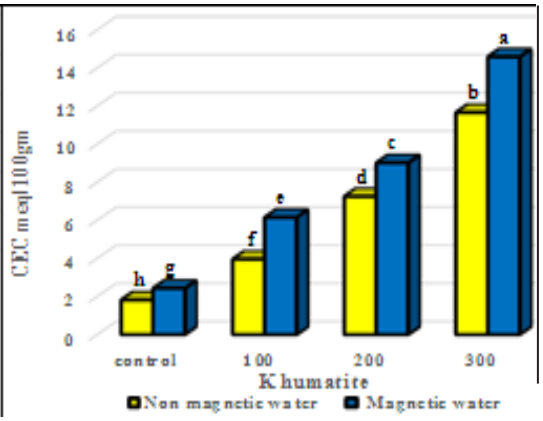

Fig. 4. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on CEC meq/100gm, values followed by different letters are significantly at p < 0.05.

This result cause by increase the effect of magnetic field K humate on organic matter in the soil. While the humate exchanges H^+ ions with soil Na^+ to lower the Na content and increase H^+ levels, resulting in lower soil pH. So, where it releases relatively greater of organic acids in rhizosphere reported by Fanous et al. (2017) and Abdeen, (2020). Regarding the effect of treatments on soil CEC after harvesting of Hayane date palm, data pointed out that soil CEC values were highly significant increased due to individual application of K humate, magnetic water, or combination with each other (Fig. 4). With respect to the effect of treatments on soil CEC, it could be arranged in the following descending order 300>200>100>control gm/tree. The cause of CEC results was due to decreasing pH as the variable charge surfaces become more positively charged due to protonation of functional groups as reported by Sparks, (2003). Thus, CEC acts to buffer the acidity of many temperate soils. When H+ is added to the soil solution, it exchanges for cations, on clay minerals and organic matter as reported by William et al. (2020).

Organic matter and soil macronutrients

The results of effect of treatment on soil organic matter (SOM) and soil macronutrients (N, P and K) are shown in Fig. 5, 6, 7 and 8. Soil organic matter and macronutrients increased by increasing the addition rates of K humate. The values were increased by 5, 8 and 18 % respectively in 100, 200 and 300 g k. H /tree respectively when compared with control. The result's ordering was 300>200>100>control with the highest rates of K-humate treatment, respectively.

Soil organic matter significantly increased by addition of potassium humate acts as organic matter which promote of soil. It is agreement with Abdeen (2020). Furthermore, the effect of magnetic water has effect to increase soil organic matter. These results caused by increased oxygen concentration. That is through magnetic field influenced-on hydrogen bonds and van der waals forces, which lead to defect in the hydrogen and non-hydrogen bonds. This leads to the tightening and spacing of the hydrogen bonds, which leads to the dissolution of gases in water, where the proportion of gases increases, especially oxygen gas. Increasing the concentration of oxygen, soil moisture and soil temperature, which leads to exert strong control on the rate of soil organic matter (SOM) decomposition as reported by Ali, (2018) and Abo Gabin et al. (2020).

Soil Micronutrient

The results in Fig. (9,10,11 and 12) show the micronutrients Zn, Mn, Fe and Cu mg/kg in experimental soil over mean of two seasons. The effect of MW and M Fe gave highest significant values of all micronutrients. The order of result was descending order as follow 300>200>100>control gm/tree with MW compared with control and treatments without MW. These results due to potassium humate is one such material which has a potential to improve soil properties and nutrient dynamics. Potassium humate is a very concentrated form of humus in the naturally occurring Lignite which is the brown coal that accompanies coal deposits. Humic acid (HA) consists of chemical conglomerate reactive functional groups, including carboxyls, phenolic,

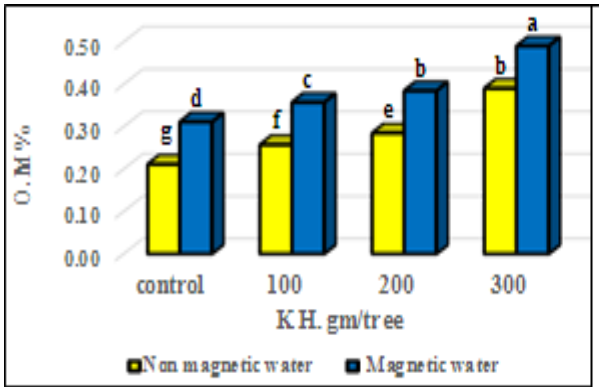

Fig. 5. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on OM%, values followed by different letters are significantly at p < 0.05.

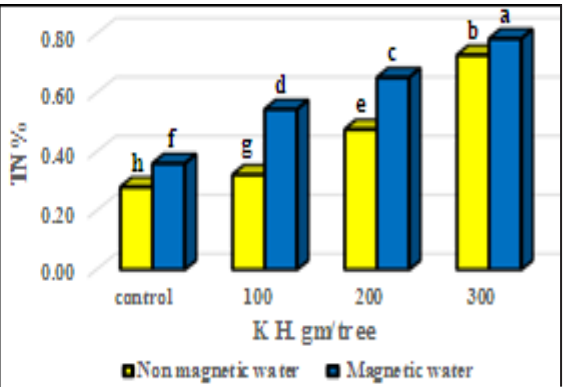

Fig. 6. Effect of Magnetic treated water (MTW) and K Humate (K.H (g/tree) on TN%, values followed by different letters are significantly at p < 0.05.

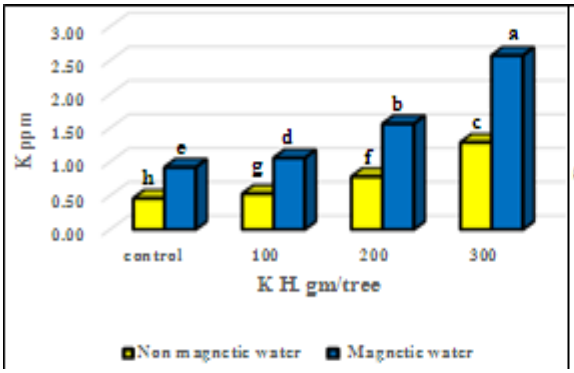

Fig. 7 Effect of Magnetic treated water (MTW) and K Humate (K.H (g/tree) on K ppm, values followed by different letters are significantly at p < 0.05.

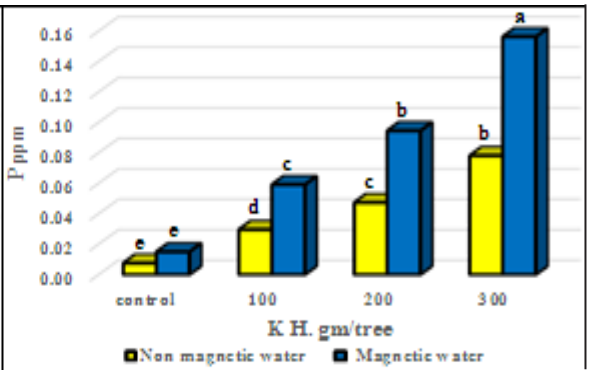

Fig. 8. Effect of Magnetic treated water (MTW) and K Humate (K.H (g/tree) on P ppm, values followed by different letters are significantly at p < 0.05.

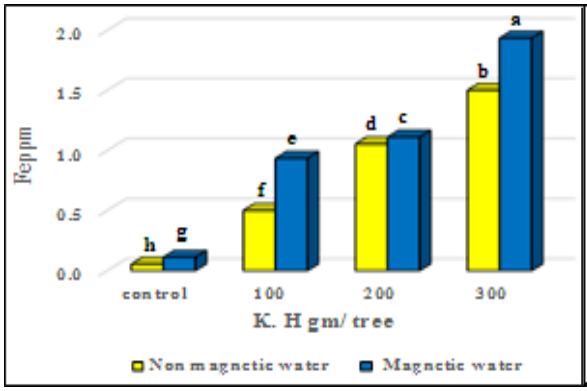

Fig. 9. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on Fe ppm, values followed by different letters are significantly at p < 0.05.

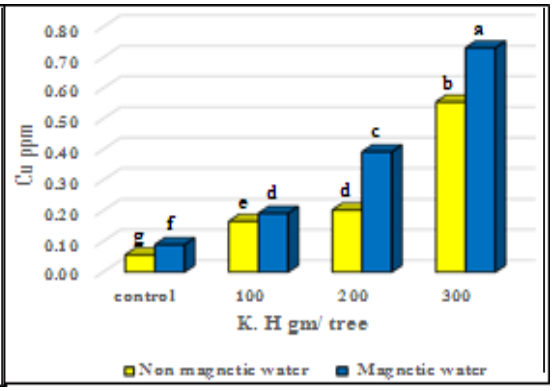

Fig. 10. Effect of Magnetic treated water (MTW) and K Humate (K.H) (g/tree) on Cu ppm, values followed by different letters are significantly at p < 0.05.

and alcoholic hydroxyls. Humic acid improved Fe bioavailability which protects Fe from deficiency. Also, improved Zn, Cu, and Mn bioavailability as reported by, Hilal et al. (2012) and Mohamed and Sherif (2020).

Soil properties and relative yield (RY) of Hayany date palm:

The ameliorative role of the previous amendments in salt affected soils may be attributed to these materials increase the tolerance of plants to salinity at physiological growth stages through improved soil properties. Similar results were showed by Amer, (2016) and Abo Gabian et al., (2020). On other hand, from the abovementioned, it observed that, the organic matter has a positive influence on nutrient availability and several soil processes. Subsequently, it is the most important indicators of crop productivity as reported by Wassif, (2010). Hence, there was a relationship between organic matter, soil salinity and yield or crop production of Hayany date palm tree as shown in Fig. 13 and 14. There was a negative relationship with highly significant between relative yield (RY%) and ECe %. On other hand, there was a positive relation with highly significant between RY% and OM%. In addition, K humate causes increased of growth and yield response due to effects of increased water holding capacity, nutrient availability, hormonal activity or microbial growth, and an increased organic matter mineralization as reported by Kumar and Singh (2017), Ibrahim and Ali (2018) and Abdeen (2020).

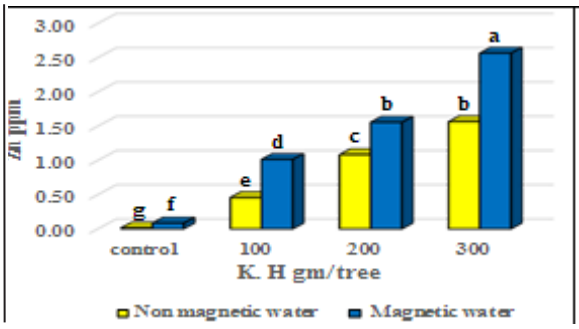

Fig. 11. Effect of Magnetic treated water (MTW) and K Hematite (K.H) (g/tree) on Zn ppm, values followed by different letters are significantly at $p < 0.05$.

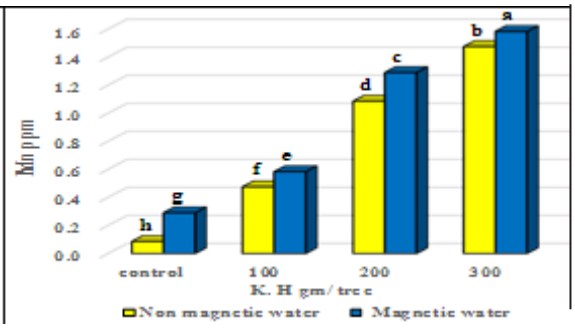

Fig. 12. Effect of Magnetic treated water (MTW) and K Hematite (K.H) (g/tree) on Mn ppm, values followed by different letters are significantly at p < 0.05.

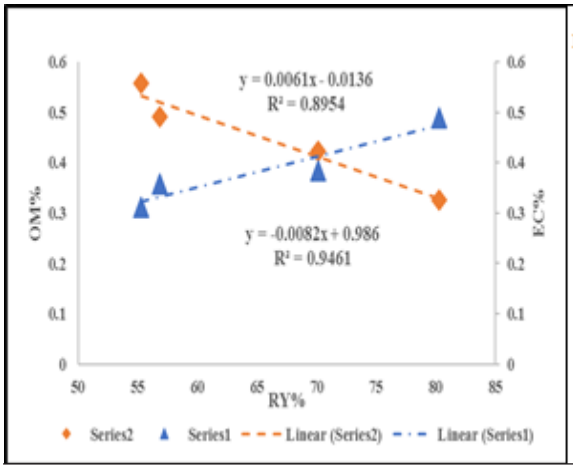

Fig. 13. Relationship between soil organic matter (SOM %), Electric conductivity (EC%) and Relative yield (RY%) calculated based on effect of treatment of K Hematite (control, 100,200,300 g/tree) with magnetic water.

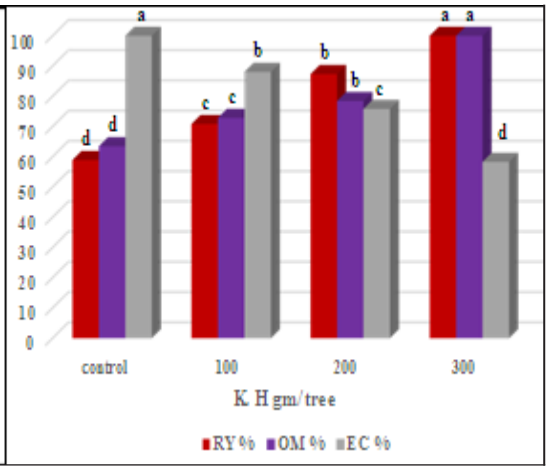

Fig. 14. Effect of OM % and EC% under treated by magnetic water (MW) and K Hematite (K.H) (g/tree) on relative yield (RY%), values followed by different letters are significantly at p < 0.05.

Conclusion

According to the results of the current study, showed that, K-humate as a soil application with magnetic water irrigation under trickle irrigation has good potential to reduce soil salinity and improve soil properties under salt soil conditions. Therefore, it was there an improvement at yield and fruit quality of Hyani date palm. The treatment of K-humate at 300 g/tree with magnetic water irrigation recorded the highest values in improving soil properties and thus, follow increased in yield of Hayany date palm tree. Therefore, this can be recommended doses under the same conditions.

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Conflicts of interest
No conflict interest

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تحسين إنتاجية نخيل البلح الحيانى تحت تأثير هيومات البوتاسيوم والماء الممغنط بجنوب سيناء

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أجريت هذه الدراسة خلال موسمى ٢٠١٨ ، ٢٠١٩ لدراسة تأثير عدد ٤ معدلات من هيومات البوتاسيوم (صفر – ١٠٠ – ٢٠٠ – ٣٠٠ جم/شجرة مع او بدون الرى بالماء الممغنط على المحصول وجودة الثمار ومستوى بعض العناصر فى أوراق نخيل البلح الحيانى المنزرع بمحطة بحوث جنوب سيناء (رأس سدر). وقد أوضحت النتائج ما يلى:

أعطت معاملة الرى بالماء الممغنط وكذلك إضافة ٣٠٠ جم من هيومات البوتاسيوم لنخيل البلح الحيانى أعلى محصول وأعلى وزن للثمار وأعلى نسبة سكريات كلية ومختزلة وغير مختزلة للثمار كما أدت إلى زيادة محتوى الأوراق من عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم خلال موسمى الدراسة مقارنة بالأشجار الغير معاملة والمعاملات الأخري.

وبناء على هذه النتائج المتحصل عليها من تلك الدراسة فأنه يمكن التوصية بإضافة ٣٠٠ جم من هيومات البوتاسيوم مع الرى بالماء الممغنط للتغلب على مشكلة ملوحة مياه الرى والحصول على محصول جيد وثمار ذات جودة عالية.