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Effect of Magnetic Water Irrigation and Biochar on Fruiting and Fruit Characteristics of Hayany Date Palm Cultivar under North Sinai Conditions

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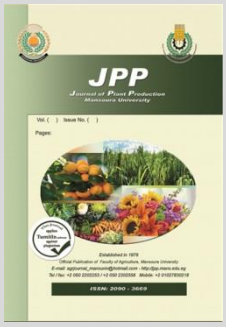

ABSTRACT

The purpose of this study was to see how biochar treatments with and without magnetic water irrigation affected fruiting, fruit characteristics, and mineral content of the Hayany date palm cultivar grown at the South Sinai Research Station (Ras Sudr), Desert Research Center, South Sinai Governorate, Egypt during the 2018 and 2019 seasons. According to the findings, biochar treatments and magnetic water irrigation had a substantial effect in both seasons. In combination with magnetic water irrigation, biochar treatment at 3 kg/tree resulted in increased production and bunch weight. In both seasons, the identical treatment resulted in the highest fruit weight, flesh weight, volume, and dimensions. Furthermore, research revealed that biochar treatment at 3 kg/tree and magnetic water irrigation significantly boosted total soluble solids, decreasing sugars, and total sugars content. In comparison to the control and other treatments, treatment biochar at 3 kg/tree gave higher values of N, P, K, Ca, and Mg contents in pinnae of Hayany date palm cultivar in the first and second seasons.

Keywords: Biochar**,** Yield, Fruiting and fruit characteristics, Hayany, Pinnae, Leaf mineral content, Date palm, Total soluble solids, Sugars content.

INTRODUCTION

The date palm (*Phoenix dactylifera* L.) is the most important fruit crop growing in the Middle East and North Africa's dry and semiarid areas. In Egypt, there are approximately two and a half million fertile female Hyani palms (2,469,648 planted in 5604 feddan), which generated 352,298 tonnes. According to Agricultural Statistics Ministry of Agriculture, the number of productive female palms is over fifteen million, with 14,379,648 planted in roughly 117073 feddan, producing 1,644,417 tonnes of soft, semi-dry, and dry dates (2019).

Date palm cultivars are classified into three categories based on the moisture level of their fruits: soft, semi-dry, and dry varieties Selim *et al*. (1968). As a result, date palm is regarded as one of the appropriate plants for cultivation in newly recovered desert areas. Date palm fruits are one of Egypt's most significant export commodities, and they are collected and sold at three phases of maturity. Halal (bisr), rutab, and tamar Kassem are the three steps (2012). The chemical makeup of dates varies depending on a variety of factors including cultivar, area, climate, fertilisation, and cultural techniques. Al-Rawahi *et al*. (2005).

Biochar has an aromatic structure that makes it durable and chemically and biologically resistant in soil Brahim *et al*. (2014). According to Sohi *et al* (2010), the feedstock utilised and the pyrolysis temperature are the most important factors in the physicochemical features of biochar. There is prevalent debate about the use of biochar and its agricultural paybacks in soil from the history of terra preta soil to the use of biochar in current time in arid area Sohi *et al*. (2010) and Omondi *et al*. (2016). Biochar is increasingly being utilised as a soil supplement to enhance the physical, chemical, and biological aspects of soils, as well as to reduce greenhouse gas emissions and sequester carbon by removing organic carbon from the photosynthetic and decomposition cycles. Biochar sequestration takes carbon dioxide from the atmosphere in a direct manner according to Sohi *et al*. (2010) and Muhammad *et al*. (2017). However, numerous studies have shown that adding biochar increases overall porosity by more than 10% with plenty of nano-scale micropores Omondi *et al*. (2016), this change in soil structure increases accessible water capacity (AWC) according to Laghari *et al*., (2016), biochar improves the chemical properties of soil, and the pH in soil amended with biochar decreases or increases depending on soil and biochar properties Saran and Lopez-Capel (2009). However the increased cation exchange capacity (CEC) after pouted biochar in soil, which is consistent with many research Laird *et al*. (2010), also the use of biochar increased plant nutients such as Ca, P and K Sohi *et al*. (2010) and Laghari *et al*. (2016). Many studies have attempted to use biochar in arid areas with sandy soil (Omondi *et al*. (2016)), but two studies conducted in Dubai by Al-Shankiti and Gill (2014) and in the United Arab Emirates by Khalifa and Yousef (2015) suggested that adding date palm waste biochar to sandy soil increases water holding capacity, which may increase water availability for plant use and chemical properties. Converting garbage to biochar and then using it in the soil might be an useful way to deal with a troublesome waste stream while also improving the soil quality in South Saini.

The goal of this research was to see how biochar affected soil quality, date palm productivity, and fruit attributes in South Saini. However, combining biochar with magnetic water irrigation may be a method for improving

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soil physical and chemical properties, as well as Hayany date palm productivity and fruit attributes.

MATERALS AND METHODS

This work was conducted in the two succeeding seasons 2018 and 2019 at Ras Sudr Experimental Station, in South Saini Governorate, Egypt in order to study the effect of biochar with and without magnetic water irrigation on fruiting and fruit features 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 culture practices and planted at 8 X 8 meters apart in sandy soil, and they were irrigated by drip irrigation system (irrigation with saline water concentration available in the area, about 6000 ppm). Only 8 bunches were left on each experimental tree.

The study was involved four levels of biochar and two methods of magnetic water irrigation. The experimental treatments were decided in a randomized complete block design with three replicates and one tree was used to symbolise each replication. The yield of experimental palm trees was harvested through the first half of September in each season. Five biochar treatments (0, 1, 2, 3 and 4 kg/tree/year) with and without magnetic water irrigation were organized in a completely randomized design having three repetitions (1replicate = 1 palm) per treatment (i.e. 5 X 2 X 3 = 30 Palms).

Different biochar treatments were added once in the winter (January) around the trees in the two seasons.

Irrigation water was trickle irrigation 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 water irrigation used for irrigation were examined using Chapman and Pratt's method (1961), and the data are presented in Tables 1 and 2.

Table 1. Some physical properties of soil surface (0-30) at Ras Sudr area, South Sinai.

Soil depth	Particle Size distribution (%)			Texture class	$CaCO_3$ (%)	Organic matter
	Sand	Silt	Clay			
0-30	73.3	14.8	11.9	Sandy loam	47.8	1.51

Table 2. Some water chemical properties of the studied water.

Magnetic treatment	pH	EC ds/m	Cations (meq./l)				Anions (meq./l)				SAR
			Ca	Mg	Na	K	CO_3	HCO_3	Cl	SO_4	
Nonmagnetic water	6.4	9.19	16.65	10.25	82.14	2.3	0	2.24	90.32	19.12	2.16
Magnetic water	6	8.12	14.2	11.3	70.02	3.1	0	1.23	87.24	10.23	1.94

SAR: Sodium adsorption ratio.

The effect of biochar with and without magnetic water irrigation on fruiting, fruit characteristics and leaf minerals content of Hayany date palm cultivar in the two studied seasons was investigated as follows:

1- **Fruit set percentage:** For 10 strands per spath, abnormal and normal fruit set were documented. Fruit setting percentage was calculated by using the following formula:

$$\text{Fruit set \%} = \frac{\text{No. of retained fruits on the strand}}{\text{No. of retained fruits + No. of flowers scars on the same strand}} \times 100$$

2- **The averages yield and bunch weight (kg & ton/fed):** The average bunch weight and palm yield were measured at harvest time.

3- **Fruit physical characteristics:** Samples of 80 fruits per tree (10 fruits per bunch) were taken for the determination of fruit, flesh and seed weight (g), pulp percentage, fruit dimension (fruit length, fruit width), fruit shape, fruit volume and pulp percentage were determined according to (A O A C, 2005).

4- **Fruit chemical characteristics:** Preparation of sample for chemical analysis: fruits were taken on the first half of September in each seasons, they were in rutab stage. Twenty date fruits were cut into pieces from each treatment, and the seeds were removed. Fifty grammes of fragments were combined with 100 mL distilled water in a special electric mixer for extraction, then filtered and the filtrate used for determinations:

Moisture content, soluble solids content (SSC) as a percentage were recorded by using hand refractometer, acidity percentage as malic acid was determined by titration (A O A C, 2005), total, reducing and non-reducing sugars percentage were determined according to Miller (1959).

Crude fiber of fruit content was determined according to the procedure described by the (A O A C, 2005). Tannins content was determined using Indigo carmine indicator after Winton & Winton (1958), titration was carried out using 0.1 N potassium permanganate solution. Tannins per 100 grams fresh weight of the flesh according to the following equation: 1 ml. oxalic acide (0.1 N) = 0.00416 gm tannins.

5- **Leaf mineral content:**

For leaf mineral analysis, a newly emerging leaf from each palm was selected and composted for three Hayany cultivar palms. Leaflets were collected in the second part of September and rinsed with tap water before being treated with distilled water to remove dust and any chemical spray residues. They were washed and dried in an electric oven at 70°C for 72 hours after being washed. In an electric mill, the dry material was ground and kept in paper bags for examination. According to Parkinson and Allen, (1975) wet washing of plant material was done using hydrogen peroxide and sulfuric acid.

Total nitrogen in ground material was determined using semi-micro Kjeldahl techniques, as recommended by Bremner (1965). According to Chapman and Pratt, (1961) phosphorus was evaluated by calorimetry using the molybdenum blow method.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).

Statistical Analysis: The obtained data of both seasons were subjected to analysis of variance as reported by Snedecor and Cochran (1989) and the means were differentiated using Duncan Multiple Range Test at 5% level Duncan (1955).

Table 3. Chemical analysis of wood ash.

Humidity %	pH	EC ds/m	OM %	N %	P %	K %	Na %	Ca %	Mg %	CaCO3 %	C:N	Fe %	Zn mg/kg	Cu mg/kg	Mn mg/kg	Co mg/kg
2.4	7.85	2.15	37.2	0.21	0.91	0.16	0.15	4.1	2.1	5.2	170.3	6.66	91	52	668	20

RESULTS AND DISSCATION

1- Fruit set percentage, yield per tree (kg & ton/fed) and bunch weight (kg):

The data in Table 4, clearly indicated the effect of biochar treatments with and without magnetic water irrigation on the fruit set percentage, yield per tree (kg & ton/fed) and bunch weight (kg). Regarding fruit set (%), results showed that, in the two seasons all biochar treatments with magnetic water irrigation significantly produced higher fruit set percentage. Treatment biochar at 3 kg/tree gave the highest fruit set percentage (44.41%) in the first, but in the second seasons, biochar at 4 kg/tree gave the highest fruit set percentage (46.40%), regardless of magnetic water irrigation. On the other hand, magnetic water irrigation gave the highest fruit set percentage in the two seasons (42.71 & 43.79%) opposite to those without magnetic water irrigation (38.75 & 39.26%) in the first and second seasons, respectively regardless of biochar. Morever the interaction, it is quite clear that date palm trees received biochar at 4 kg/tree with magnetic water irrigation had the highest fruit set percentage (48.10 & 49.79%) in the first and second seasons respectively opposite to those without magnetic water irrigation with biochar at 3 kg (41.72%) in the first season, while in the second season biochar at 4 kg/tree gave the highest fruit set (43.33%) compared with the control and other treatments. Concerning yield per tree (kg) data showed that application of biochar and magnetic water irrigation caused significant increases in palm yield per tree of Hayany date palm cultivar in both seasons. However, biochar treatment at 3 kg/tree and biochar at 4 kg gave the highest yield per tree (180.3 & 186.2 kg) in the first and second seasons, respectively regardless of magnetic water irrigation. While, magnetic water irrigation gave the highest yield per tree (165.8 & 170.4 kg) opposite to those without magnetic water irrigation (148.1 & 151.8 kg) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree and biochar at 4 kg/tree with magnetic water irrigation had the highest yield weight (194.5 & 201.5 Kg) opposite to those without magnetic water irrigation with biochar at 3 kg/tree (166.2 & 170.9 Kg) in the first and second seasons, when compared to the control and other treatments. However the palm yield per tree (ton/fed) results showed that the palm yield (ton/fed) exhibits similar trend as the palm yield (kg). Concerning the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree and biochar at 4 kg/tree with magnetic water irrigation had the highest yield weight (12.64 & 13.10 ton/fed) opposite to those without magnetic water irrigation with biochar at 3 kg/tree (10.80 & 11.11 ton/fed) in the first and second seasons, when compared to the control and other treatments.

Table 4. Effect of biochar with and without magnetic water irrigation of Hayany date palm cultivar on fruit set (%), yield and bunch weight during 2018 and 2019 seasons.

Treatments Biocher	Fruit set percentage (%)			Yield/tree (kg)			Yield/tree (ton/fed)			Bunch weight (kg)		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
						2018						
0 g	35.69 d	34.71 d	35.20 D	116.0 d	101.0 e	108.5 D	7.54 d	6.57 e	7.05 D	14.50 d	12.63 e	13.56 D
1 kg	40.28 bc	37.63 c	38.96 C	158.4 bc	150.6 c	154.5 C	10.30 bc	9.79 c	10.04 C	19.80 bc	18.82 c	19.31 C
2 kg	42.36 b	39.46 bc	40.91 B	166.4 b	157.3 bc	161.9 B	10.82 b	10.22 bc	10.52 B	20.80 b	19.66 bc	20.23 B
3 kg	47.11 a	41.72 b	44.41 A	194.5 a	166.2 b	180.3 A	12.64 a	10.80 b	11.72 A	24.31 a	20.77 b	22.54 A
4 kg	48.10 a	40.23 bc	44.17 A	193.6 a	165.4 b	179.5 A	12.58 a	10.75 b	11.67 A	24.20 a	20.67 b	22.44 A
Mean	42.71 A	38.75 B		165.8 A	148.1 B		10.78 A	9.63 B		20.72 A	18.51 B	
						2019						
0 g	36.57 g	34.77 h	35.67 E	117.7 e	102.0 f	109.8 D	7.65 e	6.63 f	7.14 D	14.71 e	12.75 f	13.73 D
1 kg	41.48 e	37.00 g	39.24 D	160.6 c	153.1 d	156.9 C	10.44 c	9.95 d	10.20 C	20.07 c	19.14 d	19.61 C
2 kg	44.32 c	39.22 f	41.77 C	171.1 b	162.3 c	166.7 B	11.12 b	10.55 c	10.84 B	21.39 b	20.29 c	20.84 B
3 kg	47.10 b	42.00 de	44.55 B	201.3 a	170.9 b	186.1 A	13.08 a	11.11 b	12.10 A	25.16 a	21.37 b	23.26 A
4 kg	49.47 a	43.33 cd	46.40 A	201.5 a	170.8 b	186.2 A	13.10 a	11.10 b	12.10 A	25.19 a	21.35 b	23.27 A
Mean	43.79 A	39.26 B		170.4 A	151.8 B		11.08 A	9.87 B		21.30 A	18.98 B	

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

On the other hand, data of both years indicated that bunch weight was significantly higher by applying biochar with magnetic water irrigation in the two seasons. Biotchar treatment at 3 kg/tree and biochar at 4 kg gave the highest bunch weight (22.54 & 23.26 kg) in the first and second seasons, respectively regardless of magnetic water irrigation. While, magnetic water irrigation gave the highest bunch weight (20.72 & 21.30 kg) opposite to those without magnetic water irrigation (18.51 & 18.98 kg) in the first and second seasons, respectively regardless of biochar. On the other side, interaction, it is quite clear that date palm trees received biochar at 3 kg/tree and biochar at 4 kg/tree with magnetic water irrigation had the highest bunch weight (24.31 & 25.19 Kg) opposite to those without magnetic water irrigation with

biochar at 3 kg/tree (20.77 & 21.37 Kg) in the first and second seasons, when compared to the control and other treatments.

In summary, the results revealed that using magnetic water irrigation increased moisture retention in the soil, which had an impact on all plant characteristics, including fruit set and yield. When compared to the control, magnetically treated water increases the concentration of photosynthetic pigments. Magnetic water benefited treated water plants in increasing their chlorophyll content, resulting in a rise in carbohydrate product in the plant, which creates energy for fruit qualities. Khoshravesh *et al*. (2011), Podlesny and Pietruszewski (2009), Hozayn *et al*. (2011), and Abd El-All *et al*. (2013) all found similar findings.

Fruit physical characteristics:

Fruit, flesh & seed weight (g) and pulp percentage:

The effect of biochar and magnetic water irrigation on fruit, flesh & seed weight (g) and pulp percentage: during two seasons are presented in Table, 5.

Data illustrated in Table 5, indicated that, fruit weight significantly affected by applying biochar with magnetic water irrigation of Hayany date palm cultivar in both seasons. While, treatment biochar at 3 kg/tree gave the highest fruit weight (19.10 & 19.84 g) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other side, magnetic water irrigation gave the highest fruit weight (18.39 & 18.93) opposite to those without magnetic water irrigation (17.53 & 18.84 g) in the first and second seasons, respectively regardless of biochar. However interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest fruit weight (19.65 & 20.13 g) opposite to those without magnetic water irrigation (18.55 & 19.55 g) in the first and second seasons, when compared to the control and other treatments. that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest fruit weight (19.65 & 20.13 g) opposite to those without magnetic water irrigation (18.55 & 19.55 g) in the first and second seasons, when compared to the control and other treatments. In the same table, in this concern, treatment biochar at 3 kg gave higher flesh weight (17.26 & 17.91 g) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other hand, magnetic water irrigation gave the highest flesh weight (16.36 & 16.94 g) opposite to those without magnetic water irrigation (15.29 & 16.74 g) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest flesh weight (17.89 & 18.21 g) opposite to those without magnetic water irrigation (16.62 & 17.61 g) in the first and second seasons, when compared to the control and other treatments. Concerning the seed weight, the obtained results indicated that there were significant differences between all biochar treatments with magnetic water irrigation during both seasons. Treatment biochar at 3 kg gave the lowest seed weight (1.84 & 1.73 g) in the first and second seasons, respectively regardless of magnetic water irrigation. While, magnetic water irrigation gave the lowest seed weight (2.04 & 1.99 g) opposite to those without magnetic water irrigation (2.24 & 2.10 g) in the first and second seasons, respectively regardless of biochar. On the other side the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the lowest seed weight (1.76 & 1.57 g) opposite to those without magnetic water irrigation (1.93 & 1.88 g) in the first and second seasons, when compared to the control and other treatments. On the other side, data illustrate that pulp percentage significantly affected by applying biochar with magnetic water irrigation of Hayany date palm cultivar in the two seasons. Treatment, biochar at 3 kg/tree gave the highest pulp percentage (90.33 & 91.16 %) in the first and second seasons, respectively regardless of magnetic water irrigation. However, magnetic water irrigation gave the highest pulp percentage (88.82 & 89.37 %) opposite to those without magnetic water irrigation (87.13 & 88.76 %) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest pulp percentage (91.04 & 92.04 %) opposite to those without magnetic water irrigation (89.61 and 90.28 %) in the first and second seasons, when compared to the control and other treatments.

Table 5. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on fruit, flesh, seed weight and flesh percentage during 2018 and 2019 seasons.

Treatments Biocher	Fruit weight (g)			Flesh weight (g)			Seed weight (g)			Pulp percentage		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
						2018						
0 g	16.73 e	16.62 e	16.67 E	14.35 f	14.06 g	14.20 E	2.38 b	2.56 a	2.47 A	85.79 d	84.58 e	85.18 E
1 kg	17.63 c	16.86 e	17.24 D	15.45 d	14.51 f	14.98 D	2.18 c	2.35 b	2.26 B	87.64 c	86.08 d	86.86 D
2 kg	18.51 b	17.30 d	17.90 C	16.56 c	14.86 e	15.71 C	1.95 d	2.44 ab	2.19 B	89.46 b	85.92 d	87.69 C
3 kg	19.65 a	18.55 b	19.10 A	17.89 a	16.62 c	17.26 A	1.76 d	1.93 d	1.84 C	91.04 a	89.61 b	90.33 A
4 kg	19.46 a	18.34 b	18.90 B	17.55 b	16.41 c	16.98 B	1.91 d	1.93 d	1.92 C	90.18 ab	89.48 b	89.83 B
Mean	18.39 A	17.53 B		16.36 A	15.29 B		2.04 B	2.24 A		88.82 A	87.13 B	
						2019						
0 g	16.85 b	16.78 b	16.82 C	14.59 c	14.45 c	14.52 C	2.26 ab	2.33 a	2.30 A	86.57 e	86.11 e	86.34 E
1 kg	18.44 a	18.83 a	18.64 B	16.24 b	16.59 ab	16.41 B	2.20 ab	2.24 ab	2.22 B	88.07 d	88.08 d	88.08 D
2 kg	19.49 a	19.67 a	19.58 A	17.49 ab	17.55 ab	17.52 A	2.01 cd	2.12 bc	2.06 C	89.71 bc	89.22 c	89.46 C
3 kg	20.13 a	19.55 a	19.84 A	18.21 a	17.61 ab	17.91 A	1.57 e	1.88 d	1.73 E	92.04 a	90.28 bc	91.16 A
4 kg	19.73 a	19.38 a	19.56 A	18.16 a	17.50 ab	17.83 A	1.92 d	1.93 d	1.93 D	90.46 b	90.11 bc	90.29 B
Mean	18.93 A	18.84 A		16.94 A	16.74 A		1.99 B	2.10 A		89.37 A	88.76 B	

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

Fruit dimension (length & width), fruit shape and volume

The effect of biochar and magnetic water irrigation on fruit dimension, fruit shape and volume during two seasons are presented in Table, 6.

Results presented in Table 6, show that fruit dimensions **(**fruit length and fruit width) were significantly affected by all biochar treatments and magnetic water irrigation in both seasons. Regarding fruit length, treatment, biochar at 3 kg/tree gave the highest fruit length (5.23 & 5.22 cm) in the first and second seasons, respectively regardless of magnetic water irrigation. Whereas, magnetic water irrigation gave the highest fruit length (5.03 & 5.09 cm) opposite to those without magnetic water irrigation (4.76. & 4.77 cm) in the first and second seasons, respectively regardless of biochar. On the other hand the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest fruit length (5.47 & 5.45 cm) opposite to those without magnetic water irrigation (4.98 & 4.99 cm) in the first and second seasons, when compared to the control and other treatments. However fruit width, treatment, biochar at 3 kg/tree gave the highest fruit width (2.76 & 2.79 cm) in the first and second seasons, respectively regardless of magnetic water irrigation. However, magnetic water irrigation gave the highest fruit width (2.59 & 2.61 cm) opposite to those without magnetic water irrigation (2.48 & 2.57 cm) in the first and second seasons, respectively regardless of biochar. On the other side the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation gave the highest fruit width (2.88 & 2.86 cm) opposite to those without magnetic water irrigation (2.64 & 2.71 cm) in the first and second seasons, when compared to the control and other treatments.

Regarding fruit shape untreated palm trees gave the highest fruit shape (1.98&1.94) followed by biochar at 1 kg/tree (1.97 & 1.96) in the first and second seasons, respectively. However, biochar at 3 or 4 kg/tree gave the lowest fruit shape (1.89 & 1.87) in the first and second seasons, respectively regardless of magnetic water irrigation. Whereas, magnetic water irrigation gave the lowest fruit shape (1.94 & 1.95) opposite to those without magnetic water irrigation (1.92 & 1.86 cm) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 4 kg/tree and biochar at 3 kg/tree gave the lowest fruit shape (1.87 & 1.91) opposite to those without magnetic water irrigation with biochar at 3 kg/tree and biochar at 2 kg/tree (1.88 & 1.80) in the first and second seasons, when compared to the control and other treatments. On the other hand, results showed that, in the two seasons all biochar treatments with magnetic water irrigation significantly produced higher fruit volume. Treatment biochar at 3 or 4 kg/tree gave the highest fruit volume (17.01 & 17.06 cm^3) and (17.27 & 17.39 cm^3) in the first and second seasons, respectively, regardless of magnetic water irrigation. On the other hand, magnetic water irrigation gave the highest fruit volume (16.47 & 16.91 cm^3) opposite to those without magnetic water irrigation (16.06 & 16.46 cm^3) in the first and second seasons, respectively regardless of biochar. Morever the interaction, it is quite clear that date palm trees received biochar at 4 kg/tree with magnetic water irrigation had the highest fruit volume (17.15 & 17.32 cm^3) and (17.48 & 17.52 cm^3) in the first and second seasons respectively opposite to those without magnetic water irrigation (16.88 & 16.79 cm^3) and (17.06 & 17.26 cm^3) in the first and second seasons, when compared to the control and other treatments.

Table 6. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on fruit dimensions (fruit length and diameter), fruit shape and fruit volume during 2018 and 2019 seasons.

Treatments Biocher	Fruit dimensions (cm)						Fruit shape			Fruit volume		
	Fruit length (cm)			Fruit width (cm)								
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
						2018						
0 g	4.27 h	4.42 g	4.34 E	2.17 e	2.22 e	2.20 E	1.97 ab	1.99 a	1.98 A	15.37 e	15.13 f	15.25 D
1 kg	4.98 d	4.68 f	4.83 D	2.46 cd	2.43 d	2.45 D	2.02 a	1.93 bc	1.97 A	16.11 d	15.40 e	15.76 C
2 kg	5.12 c	4.78 e	4.95 C	2.61 b	2.51 c	2.56 C	1.96 ab	1.90 bc	1.93 B	16.42 c	16.12 d	16.27 B
3 kg	5.47 a	4.98 d	5.23 A	2.88 a	2.64 b	2.76 A	1.90 bc	1.88 c	1.89 C	17.15 a	16.88 b	17.01 A
4 kg	5.31 b	4.95 d	5.13 B	2.84 a	2.58 b	2.71 B	1.87 c	1.92 bc	1.89 C	17.32 a	16.79 b	17.06 A
Mean	5.03 A	4.76 B		2.59 A	2.48 B		1.94 A	1.92 B		16.47 A	16.06 B	
						2019						
0 g	4.43 e	4.44 e	4.44 D	2.23 f	2.34 e	2.29 D	1.99 a	1.89 b	1.94 A	15.60 e	15.27 f	15.44 D
1 kg	5.02 c	4.71 d	4.87 C	2.51 d	2.46 d	2.49 C	2.00 a	1.91 b	1.96 A	16.65 c	16.30 d	16.48 C
2 kg	5.14 b	4.75 d	4.95 B	2.63 c	2.64 c	2.63 B	1.96 ab	1.80 c	1.88 B	17.30 ab	16.39 d	16.85 B
3 kg	5.45 a	4.99 c	5.22 A	2.86 a	2.71 b	2.79 A	1.91 b	1.84 c	1.87 B	17.48 a	17.06 b	17.27 A
4 kg	5.43 a	4.95 c	5.19 A	2.83 a	2.71 b	2.77 A	1.92 b	1.83 c	1.87 B	17.52 a	17.26 ab	17.39 A
Mean	5.09 A	4.77 B		2.61 A	2.57 B		1.95 A	1.86 B		16.91 A	16.46 B	

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

The influence of magnetic water on growth parameters of Hayany date palm trees, with magnetic water irrigation promoting vegetative development, which reflects on this characteristic, may be related to the effect of magnetic water on fruit and flesh weight, fruit size, fruit length, and fruit diameter. According to magnetic water, several changes in physical characteristics of water, such as hydrogen bonding, polarity, surface tension, conductivity, pH, and salt solubility, have happened, and these changes in water properties may be capable of altering plant development. They hypothesised that alterations in hydrogen bonding and greater ion mobility caused the decrease in pH and increase in EC in magnetic water. Hilal & Hillal (2000b) and Grewal & Maheshwari (2011).

2- Fruit chemical characteristics:

Moisture content, soluble solids content and fruit acidity

The effect of biochar and magnetic water irrigation on moisture content, soluble solids content and fruit acidity during two seasons are presented in Table, 7.

Data illustrates in Table 7, clearly indicated that different fruit constituents were significantly affected in most cases by biochar and magnetic water irrigation in both seasons. Whereas, the highest moisture content were obtained from fruits produced from applying biochar at 4 kg/tree and 3 kg/tree (72.66 & 77.45 %) in the first and second seasons, respectively regardless of magnetic water irrigation. However, magnetic water irrigation gave the highest moisture content (72.17 & 76.64 %) opposite to those without magnetic water irrigation (67.83 & 68.81 %) in the first and second seasons, respectively regardless of biochar. On the other side interaction, it is quite clear that date palm trees received biochar at 4 kg/tree and biochar at 3 kg/tree gave the highest moisture content (74.60 & 83.50 %) opposite to those without magnetic water irrigation with biochar at 4 kg/tree (70.78 & 71.47) in the first and second seasons, when compared to the control and other treatments. Regarding the soluble solids content, varied significantly according to the biochar and magnetic water irrigation in the two seasons. Treatment, biochar at 3 kg/tree gave the highest soluble solids content (32.17 & 33.95 %) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other hand, magnetic water irrigation gave the highest soluble solids content (32.39 & 33.30 %) opposite to those without magnetic water irrigation (30.18 & 32.23 %) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree and biochar at 4 kg/tree gave the highest soluble solids content (34.00 & 34.82 %) opposite to those without magnetic water irrigation with biochar at 3 kg/tree (30.33 & 33.30) in the first and second seasons, when compared to the control and other treatments. On the other hand, total acidity of fruit was significantly affected by biochar and magnetic water irrigation of Hayany date palm cultivar in both seasons. However, biochar treatment at 3 kg/tree gave the lowest total acidity (0.060 & 0.062 %) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other side, magnetic water irrigation gave the lowest total acidity (0.070 %) opposite to those without magnetic water irrigation (0.079 %) in both seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the lowest total acidity (0.049 & 0.052 %) opposite to those without magnetic water irrigation (0.071 & 0.072 %) in the first and second seasons, when compared to the control and other treatments.

Table 7. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on moisture content, soluble solids content, total acidity percentage and tss/acidity during 2018 and 2019 seasons.

Treatments Biocher	Moisture content (%)			Soluble solids content (%)			Total acidity (%)		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
2018									
0 g	68.87 d	63.30 f	66.08 D	31.63 a-c	33.57 a	32.60 A	0.082 ab	0.085 a	0.084 A
1 kg	70.60 c	67.30 e	68.95 C	31.00 a-c	28.00 c	29.50 C	0.080 a-c	0.083 ab	0.082 A
2 kg	72.27 b	68.30 de	70.28 B	32.00 a-c	29.00 bc	30.50 BC	0.075 a-c	0.080 a-c	0.078 B
3 kg	74.60 a	69.47 cd	72.03 A	34.00 a	30.33 a-c	32.17 A	0.049 e	0.071 c	0.060 D
4 kg	74.53 a	70.78 c	72.66 A	33.33 ab	30.00 a-c	31.67 AB	0.064 d	0.074 bc	0.069 C
Mean	72.17 A	67.83 B		32.39 A	30.18 B		0.070 B	0.079 A	
2019									
0 g	69.47 b-d	64.30 d	66.88 D	31.57 bc	34.87 a	33.22 A	0.081 B	0.085 a	0.083 A
1 kg	72.20 bc	67.53 cd	69.87 C	32.40 a-c	29.33 d	30.87 C	0.078 B	0.084 a	0.081 B
2 kg	75.17 b	69.33 b-d	72.25 B	33.11 ab	30.67 cd	31.89 B	0.072 C	0.080 b	0.076 C
3 kg	83.50 a	71.40 bc	77.45 A	34.60 a	33.30 ab	33.95 A	0.052 E	0.072 c	0.062 E
4 kg	82.87 a	71.47 bc	77.17 A	34.82 a	33.00 ab	33.91 A	0.068 d	0.073 c	0.071 D
Mean	76.64 A	68.81 B		33.30 A	32.23 B		0.070 B	0.079 A	

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

Total sugars, reducing & non-reducing sugars, tannins, fibers and Proline content.

The effect of biochar and magnetic water irrigation on Total sugars, reducing & non-reducing sugars and tannins content during two seasons are presented in Table, 8.

The obtained results as presented in Tables 8, showed that application of biochar and magnetic water irrigation caused significant increases in total sugars percentage of Hayany date palm cultivar in the two seasons. While, biochar treatment at 3 kg/tree gave the highest total sugars percentage (30.72 & 31.91 %) in the first and second seasons, respectively regardless of magnetic water irrigation. Whereas, magnetic water irrigation gave the highest total sugars percentage (31.01 & 31.97 %) opposite to those without magnetic water irrigation (27.58 & 28.60 %) in the first and second seasons, respectively regardless of biochar. On the other side interaction, it is quite clear that date palm trees received biochar at 3 kg/tree and biochar at 4 kg/tree with magnetic water irrigation had the highest total sugars percentage (32.19 & 33.36 %) opposite to those without magnetic water irrigation with biochar at 3 kg/tree (29.25 & 30.69 %) in the first and second seasons, when compared to the control and other treatments. Where, reducing sugars percentage significantly affected by applying biochar with magnetic water irrigation of Hayany date palm cultivar in both seasons. However, biochar treatment at 2 and 4 kg/tree gave the highest reducing sugars percentage (22.15 & 22.79 %) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other side, magnetic water irrigation gave the highest reducing sugars percentage (21.74 & 22.24 %) opposite to those without magnetic water irrigation (19.67 & 20.78 %) in the first and second seasons, respectively regardless of biochar. On the other side interaction, it is quite

clear that date palm trees received biochar at 4 kg/tree with magnetic water irrigation had the highest reducing sugars percentage (22.83 & 23.32 %) opposite to those without magnetic water irrigation with biochar at 2 and 4 kg/tree (22.22 & 22.27 %) in the first and second seasons, when compared to the control and other treatments. The average of non-reducing sugars percentage was increased significantly by different biochar treatments with magnetic water irrigation of Hayany date palm cultivar in both seasons. Treatment, biochar at 3 kg/tree gave the highest non-reducing sugars percentage (9.46 & 9.26 %) in the first and second seasons, respectively regardless of magnetic water irrigation. However, magnetic water irrigation gave the highest non-reducing sugars percentage (9.27 & 9.73 %) opposite to those without magnetic water irrigation (7.91 & 7.82 %) in the first and second seasons, respectively regardless of biochar. As for the interaction, it is quite clear that date palm trees received biochar at 3 and 4 kg/tree with magnetic water irrigation had the highest non-reducing sugars percentage (9.88 & 10.05 %) opposite to those without magnetic water irrigation with biochar at 4 followed by 3 kg/tree (9.06 & 9.05 %) in the first season, but in the second season (8.61 %) in the first and second seasons, when compared to the control and other treatments.

Table 8. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on total, reducing, non-reducing sugars and tannins content during 2018 and 2019 seasons.

Treatments Biocher	Total sugars content (%)			Reducing sugars content (%)			Non-reducing sugars content (%)			Tannins content		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
						2018						
0 g	29.47 d	23.35 f	26.41 D	20.75 b	16.25 d	18.50 D	8.73 c	7.10 e	7.91 C	0.52 e	0.51 e	0.52 D
1 kg	30.33 c	27.63 e	28.98 C	20.73 b	19.51 c	20.12 C	9.60 ab	8.12 d	8.86 B	0.54 e	0.57 d	0.55 C
2 kg	31.18 b	28.44 d	29.81 B	22.07 a	22.22 a	22.15 A	9.11 bc	6.22 f	7.66 C	0.63 c	0.61 c	0.62 B
3 kg	32.19 a	29.25 d	30.72 A	22.31 a	20.20 bc	21.26 B	9.88 a	9.05 bc	9.46 A	0.76 a	0.68 b	0.72 A
4 kg	31.87 ab	29.24 d	30.55 A	22.83 a	20.18 bc	21.50 B	9.04 bc	9.06 bc	9.05 B	0.75 a	0.68 b	0.72 A
Mean	31.01 A	27.58 B		21.74 A	19.67 B		9.27 A	7.91 B		0.64 A	0.61 B	
						2019						
0 g	29.44 b	24.26 c	26.85 C	20.73 a	17.18 b	18.95 C	8.72 ab	7.08 c	7.90 C	0.54 d	0.53 d	0.54 D
1 kg	31.81 ab	28.69 b	30.25 B	21.74 a	21.63 a	21.69 B	10.07 a	7.06 c	8.57 B	0.61 bc	0.60 c	0.61 C
2 kg	32.10 ab	28.94 b	30.52 B	22.17 a	20.75 a	21.46 B	9.93 a	8.19 bc	9.06 A	0.64 b	0.62 bc	0.63 B
3 kg	33.13 a	30.69 ab	31.91 A	23.23 a	22.09 a	22.66 A	9.90 a	8.61 ab	9.26 A	0.81 a	0.79 a	0.80 A
4 kg	33.36 a	30.41 ab	31.89 A	23.32 a	22.27 a	22.79 A	10.05 a	8.14 bc	9.09 A	0.80 a	0.79 a	0.80 A
Mean	31.97 A	28.60 B		22.24 A	20.78 B		9.73 A	7.82 B		0.68 A	0.67 B	

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

The same table cleared that tannins content, was significantly affected by biochar treatments with magnetic water irrigation of Hayany date palm cultivar in the two seasons. However, biochar at 3 or 4 kg/tree gave the highest tannins content (0.72 & 0.80) in the first and second seasons, respectively regardless of magnetic water irrigation. While, magnetic water irrigation gave the highest tannins content (0.64 & 0.68) opposite to those without magnetic water irrigation (0.61 & 0.67) in the first and second seasons, respectively regardless of biochar. On tne other hand, the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest tannins content (0.76 & 0.81) opposite to those without magnetic water irrigation with biochar at 3 and 4 kg/tree (0.68 & 0.79) in the first and second seasons, when compared to the control and other treatments.

The effect of biochar and magnetic water irrigation on fibers and proline content during two seasons are presented in Table, 9.

Data in Table 9, revealed that significant effect was found in fiber content of Hayany date palm cultivar due to the biochar and magnetic water irrigation in the two seasons. Treatment biotchar at 3 or 4 kg/tree gave the highest fibers content in the first season, but in the second season, biochar at 4 kg/tree followed by 3 kg/tree gave the highest fibers content (1.67 & 1.65) regardless of magnetic water irrigation. While, magnetic water irrigation gave the highest fibers content (1.44 & 1.45) opposite to those without magnetic water irrigation (1.42 & 1.39) in the first and second seasons, respectively regardless of biochar. Concerning the interaction, it is quite clear that date palm trees received biochar at 4 kg/tree followed by 3 kg/tree with magnetic water irrigation had the highest fibers content (1.71 & 1.71) followed by (1.70 & 1.69) opposite to those without magnetic water irrigation with biochar at 4 and 3 kg/tree (1.68 & 1.62) in the first season, but in the second season treatment 3 or 4 kg/tree (1.62) in the second season compared with the control and other treatments. On the other side, Data in same table revealed that significant effect was found in proline content of Hayany date palm cultivar due to the biochar and magnetic water irrigation in the two seasons. Magnetic water irrigation gave the highest proline content (2.02 & 2.13 %) opposite to those without magnetic water irrigation (1.85 & 1.94 ppm) in the first and second seasons, respectively regardless of biochar. On the other side, biochar at 3 kg/tree gave the highest proline content (2.46 & 2.54 ppm) in the first and second seasons, respectively regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest proline content (2.56 & 2.66 ppm) opposite to those without magnetic water irrigation (2.35 & 2.41 ppm) in the first and second seasons, when compared to the control and other treatments.

Leaf mineral content:

Nitrogen, phosphorus, potassium, calcium and magnesium content.

The effect of biochar and magnetic water irrigation on leaf nitrogen and phosphorus content content during two seasons are presented in Table, 9.

Data in Table 9, revealed that significant effect was found in leaf nitrogen content of Hayany date palm cultivar due to the biochar and magnetic water irrigation in the two seasons. Magnetic water irrigation gave the highest nitrogen concentration in leaves (2.03 and 2.08 %) opposite to those without magnetic water irrigation (1.87 & 1.86 %) in the first and second seasons, respectively regardless of biochar. On the other side, biochar at 3 kg/tree gave the highest nitrogen concentration in leaves (2.21 & 2.24 %) in the first and second seasons, respectively regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest nitrogen concentration in leaves (2.28 & 2.32 %) opposite to those without magnetic water irrigation (2.14 & 2.15 %) in the first and second seasons, when compared to the control and other treatments. Concerning phosphorus concentration, magnetic water irrigation gave the highest values of phosphorus concentration (0.41 & 0.42 %) opposite to those without magnetic water irrigation (0.39 & 0.40 %) in the first and second seasons, respectively regardless of biochar. On the other side, biochar at 3 kg/tree gave the highest phosphorus concentration in leaves (0.44 & 0.45%) in the first and second seasons, respectively regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest phosphorus concentration (0.45 & 0.46 %) opposite to those without magnetic water irrigation (0.44 & 0.43 %) compared with the control and other treatments in the first and second seasons, respectively.

Table 9. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on fibers, proline, nitrogen and phosphorus content during 2018 and 2019 seasons.

Treatments Biocher	Fibers content			Proline content (ppm)			Nitrogen content (%)			Phosphorus content (%)		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
						2018						
0 g	0.79 f	0.78 f	0.79 D	1.19 c	0.97 c	1.08 D	1.62 de	1.54 e	1.58 D	0.340 d	0.310 e	0.325 D
1 kg	1.49 d	1.46 e	1.48 C	1.83 b	1.70 b	1.76 C	1.85 c	1.69 d	1.77 C	0.410 bc	0.400 c	0.405 C
2 kg	1.51 cd	1.53 c	1.52 B	2.00 b	1.91 b	1.96 B	2.12 b	1.88 c	2.00 B	0.420 a-c	0.413 bc	0.417 B
3 kg	1.70 ab	1.67 b	1.69 A	2.56 a	2.35 a	2.46 A	2.28 a	2.14 b	2.21 A	0.450 a	0.437 ab	0.443 A
4 kg	1.71 a	1.68 b	1.69 A	2.50 a	2.33 a	2.41 A	2.27 a	2.10 b	2.19 A	0.437 ab	0.433 ab	0.435 A
Mean	1.44 A	1.42 B		2.02 A	1.85 B		2.03 A	1.87 B		0.411 A	0.399 B	
						2019						
0 g	0.82 f	0.79 g	0.80 D	1.41 d	1.18 e	1.30 E	1.67 f	1.51 g	1.59 D	0.350 d	0.330 d	0.340D
1 kg	1.51 cd	1.45 e	1.48 C	1.94 c	1.79 c	1.87 D	1.91 d	1.68 f	1.80 C	0.420 bc	0.407 c	0.413 C
2 kg	1.54 c	1.49 d	1.52 B	2.29 b	1.89 c	2.09 C	2.20 b	1.80 e	2.00 B	0.440 a-c	0.420 bc	0.430 B
3 kg	1.69 a	1.62 b	1.65 A	2.66 a	2.41 b	2.54 A	2.32 a	2.15 c	2.24 A	0.460 a	0.430 a-c	0.445 A
4 kg	1.71 a	1.62 b	1.67 A	2.38 b	2.40 b	2.39 B	2.30 a	2.14 c	2.22 A	0.450 ab	0.427 bc	0.438 AB
Mean	1.45 A	1.39 B		2.13 A	1.94 B		2.08 A	1.86 B		0.424 A	0.403 B	

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

The effect of biochar and magnetic water irrigation on pinnae potassium, calcium and magnesium content during two seasons are presented in Table, 10.

As shown in Table 10, was significantly affected by biochar and magnetic water irrigation in both studied seasons. Data showed that, magnetic water irrigation gave the highest potassium concentration in leaves (1.65 & 1.73 %) opposite to those without magnetic water irrigation (1.58 & 1.61 %) in the first and second seasons, respectively regardless of biochar. On the other side, biochar at 3 kg/tree gave the highest potassium concentration in leaves (1.83 & 1.91 %) in the first and second seasons, respectively regardless of magnetic water irrigation. Furthermore the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest potassium content (1.89 & 1.98 %) opposite to those without magnetic water irrigation (1.76 & 1.83 %) in the first and second seasons, when compared to the control and other treatments. Concerning the effect of biochar treatments and magnetic water irrigation on leaf calcium percentage, it is found that the concentration of calcium in pinnae of Hayany date palm responded positively to biochar and magnetic water irrigation. Magnetic water irrigation gave the highest calcium content (2.12 & 2.17 %) opposite to those without magnetic water irrigation (1.90 & 1.94 %) in the first and second seasons, respectively regardless of biochar. However, biochar at 4 kg/tree gave the highest calcium content (2.26 & 2.36 %) in the first and second seasons, respectively regardless of magnetic water irrigation. On the other side the interaction, it is quite clear that date palm trees received biochar at 3 and 4 kg/tree with magnetic water irrigation had the highest calcium content (2.45 & 2.56 %) opposite to those without magnetic water irrigation and biochar at 4 and 3 kg/tree (2.08 & 2.17 %) in the first and second seasons, when compared to the control and other treatments. However magnesium content, leaves magnesium content was significantly affected by biochar and magnetic water irrigation in both seasons. Magnetic water irrigation gave the highest magnesium content of leaves (0.43 & 0.44 %) opposite to those without magnetic water irrigation (0.41 & 0.42 %) in the first and second seasons, respectively regardless of biochar. While, biochar at 3 kg/tree gave the highest magnesium content of leaves (0.44 & 0.45 %) in the first and second seasons, respectively regardless of magnetic water irrigation. As for the interaction, it is quite clear that date palm trees received biochar at 3 kg/tree with magnetic water irrigation had the highest magnesium content of leaves (0.45 & 0.46 %) opposite to those without magnetic water irrigation (0.43 & 0.44 %) in the first and second seasons, when compared to the control and other treatments.

Table 10. Effect of biochar with and without magnetic water irrigation of Hyany date palm cultivar on potassium, calcium and magnesium content during 2018 and 2019 seasons.

Treatments Biocher	Potassium content (%)			Calcium content (%)			Magnesium content (%)		
	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean	Magnetic water irrigation	Non-magnetic water irrigation	Mean
				2018					
0 g	1.36 e	1.34 e	1.35 D	1.76 c	1.74 c	1.75 C	0.400 bc	0.390 c	0.395 C
1 kg	1.42 d	1.40 d	1.41 C	1.84 c	1.79 c	1.82 C	0.420 a-c	0.407 bc	0.413 B
2 kg	1.69 c	1.67 c	1.68 B	2.11 b	1.82 c	1.97 B	0.430 a-c	0.427 a-c	0.428 A
3 kg	1.89 a	1.76 b	1.83 A	2.45 a	2.06 b	2.25 A	0.450 a	0.430 a-c	0.440 A
4 kg	1.88 a	1.75 b	1.82 A	2.44 a	2.08 b	2.26 A	0.440 ab	0.427 a-c	0.433 A
Mean	1.65 A	1.58 B		2.12 A	1.90 B		0.428 A	0.416 B	
				2019					
0 g	1.39 e	1.35 e	1.37D	1.78 c	1.75 c	1.76 D	0.410 ab	0.380 b	0.395 C
1 kg	1.61 d	1.41 e	1.51 C	1.94 bc	1.80 c	1.87 C	0.420 ab	0.410 ab	0.415 B
2 kg	1.72 c	1.64 d	1.68 B	2.12 b	1.84 c	1.98 B	0.433 a	0.420 ab	0.427 B
3 kg	1.98 a	1.83 b	1.91 A	2.46 a	2.17 b	2.32 A	0.460 a	0.443 a	0.452 A
4 kg	1.97 a	1.82 b	1.89 A	2.56 a	2.16 b	2.36 A	0.450 a	0.440 a	0.445 A
Mean	1.73 A	1.61 B		2.17 A	1.94 B		0.435 A	0.419 B	

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

Through a variety of processes, biochar has been found to increase plant productivity and output. When compared to controls, biochar affects physical circumstances; its dark hue alters temperature dynamics and enables quick germination, enabling more time for development Genesio *et al* (2012). Biochar can also help soils store more water, according to Laird *et al* (2010). Biochar-induced changes in soil nutrient conditions, notably the cycling of P and K, can also impact plant development Dempster *et al* (2012). Following biochar application, we discovered that plant tissue K concentrations and soil P and K rose. This impact, however, is dependent on the biochar's production characteristics and is transient, since the nutrients are utilised by plants or leached from the soil. Major *et al* (2010). Biochar's long-term impacts on nutrients are caused by complicated physiochemical interactions with soil particles, according to Spokas *et al* (2012). Increases in soil alkalinity (liming) caused by biochar are one such response that impacts phosphorus. Phosphorus can be adsorbed onto iron oxides in acidic soils, rendering it inaccessible to plants.

The influence of magnetic water on growth parameters of Hayany date palm trees, with magnetic water irrigation promoting vegetative development, which reflects on this feature, might explain the increased fruit and flesh weight, fruit size, fruit length, and fruit diameter. According to magnetic water, various changes in chemical characteristics of water, namely hydrogen bonding, polarity, surface tension, conductivity, pH, and salt solubility, have occurred, and these changes in water properties may be capable of altering plant development. They hypothesised that alterations in hydrogen bonding and greater ion mobility caused the drop in water pH and EC in magnetic water. Similar results were reported by Hilal & Hillal (2000b) and Grewal & Maheshwari, (2011).

Because of its influence on several physical and chemical characteristics of water and soil, magnetic treatment of irrigation water is a well-known approach for obtaining high water usage efficiency. As a result of these changes, the soil's capacity to remove salts improves, resulting in higher nutrition and fertiliser uptake in plants throughout the vegetative stage. These findings are similar to those published by Abobatta (2015) for the Valencia orange.

In conclusion, biochar treatments with magnetic water irrigation has improved yield and fruit characteristics. Treatment biochar at 3 kg/tree with magnetic water irrigation was the most effective for Hayany date palm cultivar under South Sinai conditions in improving the yield and fruit characteristics as compared with the control and other treatments.

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تأثير الرى بالماء الممغنط والفحم الحيوى على الإثمار والصفات الثمرية لنخيل البلح الحيانى تحت ظروف جنوب سيناء

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أجريت هذه الدراسة خلال موسمى ٢٠١٨ ، ٢٠١٩ لدراسة تأثير عدد ٥ معدلات من الفحم النباتى (صفر – ١ – ٢ – ٣ – ٤ كجم/شجرة) مع الرى بالماء الممغنط من عدمه على الإثمار والصفات الثمرية ومستوى بعض العناصر فى أوراق نخيل البلح الحيانى المنزرع بمحطة بحوث جنوب سيناء (رأس سدر). وقد أوضحت النتائج ما يلى: أدى الرى بالماء الممغنط لنخيل البلح الحيانى إلى تحسين النمو بأشجار نخيل البلح الحيانى وأدى أيضا إلى زيادة نسبة العقد والإثمار وتحسين خصائص الثمار الطبيعية والكيمائية خلال موسمى الدراسة. أدى الرى بالماء الممغنط إلى زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم والبرولين خلال موسمى الدراسة. وجد أيضاً أن إضافة ٣ كجم من الفحم النباتى لأشجار نخيل البلح الحيانى أدى إلى تحسين النمو وزيادة نسبة العقد والإثمار وكذلك خصائص الثمار الطبيعية والكيمائية خلال موسمى الدراسة. أيضاً أن إضافة ٣ كجم من الفحم النباتى لأشجار نخيل البلح الحيانى أدى إلى زيادة محتوى الأوراق من عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم والبرولين خلال موسمى الدراسة. أيضاً أوضحت النتائج أن إضافة ٣ كجم من الفحم النباتى لأشجار نخيل البلح الحيانى مع الرى بالماء الممغنط أدى إلى تحسين النمو وأيضا أدى إلى زيادة نسبة العقد والإثمار وكذلك متوسط وزن الثمرة واللحم وأبعاد الثمرة (الطول والعرض) والمواد الصلبة الذائبة والسكريات الكلية والمختزلة وكذلك زيادة محتوى الأوراق من النيتروجين والفوسفور والبوتاسيوم والكالسيوم والمغنيسيوم والبرولين خلال موسمى الدراسة. وبناء على هذه النتائج المتحصل عليها من تلك الدراسة فأنه يمكن التوصية بإضافة ٣ كجم من الفحم النباتى لأشجار نخيل البلح الحيانى مع الرى بالماء الممغنط للتغلب على مشكلة ملوحة مياه الرى وللحصول على إثمار جيد وثمار ذات صفات جودة عالية.