



Influence of Magnetic Iron and Some Antioxidant Natural Plant Extracts on the Vegetative Growth and Nutritional Status of Keitt Mango Trees

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Abstract

During two successive experimental seasons in the years 2019 and 2020, this study was carried out on 14-year-old fruitful mango trees of Keitt cultivars budded on Succary mango rootstock. In an orchard with sandy soil that received drip irrigation and was situated along the Cairo-Alexandria desert road, 54 kilometers from Cairo, next to the town of El-Solimania, Egypt. Trees were planted at (3 x 5 m) apart. The two factors in the factorial experiment were magnetic iron at (0, 200 and 400 g per tree and some natural antioxidant plants (ginger, cinnamon, and Roselle) at (62.5 g) of pure powder from each type foliar spray in 5 liters under ceroon net shading conditions. The specific and interaction effects of two studied factors were evaluated through determining the changes (response) exhibited in the vegetative growth (Shoot length and diameter, number of leaves per each individual shoot, trunk diameter and average leaf area as well leaf (N, P, K, Ca, Mg, Fe, Zn and Mn content). The combination of foliar spraying Roselle extract and adding 400 g/tree of magnetic iron to the soil proved to be the most effective treatment for the majority of the parameters examined in this study.

Keywords: Keitt, Mango, Natural antioxidant plants, Magnetic iron, Vegetative growth and leaf mineral contents

Introduction

Mangoes (*Mangifera indica* L.) belong to family Anacardaceae, native to South Eastern Asia and considered one of the most important evergreen fruits of the tropical and sub-tropical countries. It is one of the most popular and favorite fruits because of its rich and delicious flavor (aroma & taste). It is considered to be the queen of fruits.

Mango is one of the popular tropical cultivated fruit crops in Arab Republic of Egypt. Mango trees were introduced to Egypt around 1825 year and ever since, its' cultivation has gradually expanded throughout the country and became one of the main fruits grown in Egypt, which recently ranking third after citrus and grape crops. The total cultivated area in Egypt reached to 310019 feddans that produced about 1203743 tons (Ministry of Agriculture and land reclamation, 2020). The production areas are focused in Ismailia, Sharkia, Behira and Giza Governorates.

The "Keitt" mango is a late-season (October-December), large fruit size with small seed size and fruit lacked color. It quickly gained commercial acceptance for its long shelf life, flavor, productivity and lack of fiber to be more widely planted mango cv. in Egypt. The "Keitt" mango tree growth habit is

characterized by long, arching branches with poor growth in the subtropics. The trees are vigorous, but do not to reach heights much over 20 feet. It has a low spreading habit that is not as compact as most other mango cultivars, and develops an open canopy with a relative heavy and consistent production (Tomer *et al.*, 1993).

Magnetite (Magnetic iron) is one of the most important factors affecting plant growth; magnetite is a natural row rock that has very iron content, magnetite has a black or brownish-red, it has a hardness of about 6 on the Mosh hardness scale. It's one of two natural row rocks in the world that is naturally magnetic (Mansour, 2007). Magnetite may be play an important role in cation uptake capacity and has a positive effect on immobile plant nutrient uptake (Esitken, 2003), and Magnetic field could be substitution of chemical additives, which can reduce toxins in raw materials and these raise the food safety.

Water extracts of some plant organs such as Roselle, Cinnamon and Ginger, has long been recognized and applied turmeric, onion, seaweed moringa, licorice, garlic as a sources of antioxidants. The small antioxidant molecule vitamin C (L-ascorbic acid, AA) fulfills essential metabolic functions in the life of animals and plants. Some

fungi can synthesize erythro-ascorbic acid, a vitamin C analogue with similar metabolic functions. Among prokaryotes, only cyanobacteria have been reported to have a small AA amount (Arrigoni and De Tullio, 2002).

Antioxidant compounds have an auxinic action, since they have synergistic effect on growth and productivity of most fruit trees. Their practical use on fruit trees under field conditions is favorably possible. Further and additional studies are needed to elucidate their mode of action on fruit trees and to find cheap antioxidants that are beneficial for enhancing growth and productivity. At the same time, they are safe to human, animal and environment. Moreover, Plant extracts were found by many authors to enhance growth, nutritional status, yield and fruit quality of fruit crops (Obagwu *et al.*, 1997; Paik and Chung, 1997; Okigbo and Emoghene, 2003; Chawdhury *et al.*, 2007; El-Shayeb 2009; Bhdwaj *et al.*, 2010; Abd El-Rahman and El-Masry, 2012; Ahmed *et al.*, 2013; Mohamed and Mohamed, 2013; Faissal *et al.*, 2014; El-Gioushy *et al.*, 2016; El-Badawy *et al.*, 2017a ,b; Eid *et al.*, 2018; Kahramanoglu *et al.*, 2018; El-Rokiek *et al.*, 2019; El-Gioushy *et al.*, 2021).

The purpose of this study was to improve the vegetative growth and leaf mineral contents of Keitt mango cv. through soil addition of magnetic iron and some antioxidant natural plants foliar spray under ceroon net shading conditions.

Materials and Methods

This study was conducted on 14 year old fruitful mango trees of Keitt cultivars budded on Succary mango rootstock during two successive experimental seasons through 2019 and 2020 years. Trees were planted at (3 × 5 m) apart i.e., (280) trees per feddan in sandy soil orchard subjected to drip irrigation system, orchard located at Cairo-Alexandria desert road, 54 km from Cairo, beside E;-Solimania town, Egypt.

Factorial experiment with two factors was included, the 1st factor was magnetic iron, while the 2nd some antioxidant natural plants foliar spray under ceroon net shading conditions as follows:

- a- Control (without Magnetic iron) soil addition.
- b- First concentration at 200 g soil addition.
- d- Second concentration at 400 g soil addition.

The four investigated spray treatments i.e., three antioxidant natural plants foliar spray plus control were prepared as follows:

- T1- Control (tap water spray).
- T2- Foliar spray with Ginger antioxidant natural plants extracts.
- T3- Foliar spray with Cinnamon antioxidant natural plants extracts.
- T4- Foliar spray with Roselle antioxidant natural plants extracts.

* Taking into consideration that spray treatments were prepared by using 62.5g pure powder from every type of the following (Ginger, Cinnamon and Roselle).

Experimental layout:

The complete randomized block design with three replications was employed for arranging the differential treatments (combinations between two studied factors included in this study). Each replicate was represented by three trees. Accordingly, required trees for each investigated were estimated as follows: thirty six healthy uniformed as possible and diseases/insects free Keitt mango trees were carefully selected that representative of soil addition of magnetic iron "3 concentrations" and four types antioxidant natural plants extracts (Ginger, Cinnamon and Roselle) foliar spray under ceroon net shading conditions. Besides, 36 additional trees were also included so a reserve would be available. One half of 108 Keitt mango trees devoted for this experiment i.e., 36 trees were grown under shading with ceroon net construction were separately divided according to their growth vigour into three equal categories (each included 12 trees). Herein, the investigated treatments were arranged within the 12 trees of each category. Soil addition of magnetic iron was in 1st week of January during two experimental season as well as foliar spray application of different solutions even tap water spray (control) were applied three times yearly on early February, April and June (2019) and (2020) years during 1st and 2nd experimental seasons, respectively. Taking into consideration that spray solution of every treatment was applied till running off, whereas three liters per each tree were so enough in this regard.

The specific and interaction effects of two studied factors in either 1st or 2nd experimental seasons were evaluated through determining the changes (response) exhibited in the following measurements:

1. Vegetative growth parameters:

Shoot length and diameter (cm), number of leaves per each individual shoot, trunk diameter (cm) and average leaf area (cm²) were the five evaluated growth parameters of the Keitt mango trees in this regard. Herein, such measurements were determined at last week of September.

2- Leaf mineral contents (leaf N, P, K, Ca, Mg, Fe, Zn and Mn) content:

Full expanded leaves of the spring flushed shoots were sampled during each season on the last week of September during 1st and 2nd seasons. Then roughly cleaned with dampened clothes, followed with distilled water and dried in an electric oven at 80 °c till a constant weight, thereafter finally ground using a stainless steel knife mill to avoid any metal contamination. The wet digestion of about 0.5 g leaves dry matter was carried out with sulphoric and

perchloric acids mixture as described by **Chapman and Pratt (1961)**.

Total N was determined by micro Kjeldahl according to **Pregl (1945)**, phosphorus was determined using a Spekol spectrophotometer at 882.0 UV according to the method described by **Murphy and Riely (1962)**. K was determined using Flam photometer according to **Chapman and Pratt, (1961)**. However, Ca, Fe, Mg, Mn and Zn were determined using Atomic absorption (3300) according to **Jackson (1973)** and **Wild et al., (1985)**.

Statistical Analysis:

Data obtained during both experimental seasons from each experiment were subjected to analysis of variance and significant differences among means were determined according to (**Snedecor and Cochran, 1977**). In addition, significant differences among means were differentiated according to the Duncan's, multiple test range (**Duncan, 1955**) where capital and small letters were used for distinguishing between values of specific and interaction effects, respectively.

Results

Vegetative growth:

The response of Kielt mango trees to soil addition magnetic iron of two levels (200 and 400 g/tree) and three antioxidant natural plant extracts (Ginger, Cinnamon and Roselle) was studied through the determination of five vegetative growth parameters (shoot length and diameter, trunk diameter, average number of leaves per shoot and average leaf area).

Vegetative growth measured parameters:

A. Specific effect:

Table 1. Shoot length and diameter (cm) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters	Shoot length (cm)				Shoot diameter (cm)			
	Treatment/tree	M. iron concentration (g)			M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00	Mean	0.00	200.00	400.00	Mean
First season; 2019								
Control (zero)	49.17e	40.17h	40.50h	43.28D	0.67g	0.73ef	0.87b	0.76B
Ginger	49.00e	46.37g	51.00c-e	48.79C	0.70fg	0.73ef	0.83bc	0.76B
Cinnamon	48.00f	50.33cd	58.50b	52.28B	0.87b	0.77de	0.87b	0.83A
Roselle	49.77de	50.00c-e	59.50a	53.09A	0.73ef	0.80cd	1.03a	0.86A
Mean	48.99B	46.72B	52.38A		0.74B	0.76B	0.90A	
Second season; 2020								
Control (zero)	24.67j	32.83f	34.00e	30.50C	0.43f	0.47ef	0.50de	0.47C
Ginger	27.00i	40.17c	31.00g	32.72B	0.53cd	0.47ef	0.53cd	0.51B
Cinnamon	37.00d	29.00h	33.00f	33.00B	0.43f	0.57bc	0.60b	0.53B
Roselle	44.00b	31.00g	52.00a	42.33A	0.57bc	0.47ef	0.70a	0.58A
Mean	33.17B	33.25B	37.50A		0.49B	0.49B	0.58A	

Means followed by the same letter/s within each column didn't significantly differ at 5% level

B. Interaction effect:

Concerning the specific effect of the two investigated factors (magnetic iron soil addition and antioxidant natural plant extracts) on the five investigated parameters (shoot length and diameter, trunk diameter, average leaf area) of Kielt mango trees. Data presented in Tables (1, 2 and 3) clear that the two checked factors were moving together and at the same amount in their effects on the following four investigated parameters (shoot length and diameter, average No. of leaves/shoot and average leaf area). The highest significant values of the four investigated parameters which were mentioned earlier were associated with Roselle foliar spray as compared with the other investigated antioxidant natural plant extracts (Ginger and Cinnamon). Meanwhile, magnetic iron at 400 g/tree was the superior level as it achieved the highest values in such respect and skipped the lower concentration level (200 g/tree) during both seasons of study.

As for the specific effect of the two investigated factors on trunk diameter parameter of Kielt mango trees, data tabulated in Table (3) obviously clear that Roselle and Cinnamon plant extracts foliar spray had the significant values as compared with Ginger plant extracts during the first season of study. On the contrast, the significant differences were disagreed in the second season of study. Meanwhile, magnetic iron at 400 g/tree was more effective than 200 g/tree in the second season, but in the first season of study the two levels (200 and 400 g/tree) were equal in their effect and subsequently. The response of trunk diameter parameter was similar as compared with untreated trees (control).

With referring to the interaction between the two investigated factors magnetic iron at two levels 200

and 400 g/tree and three antioxidant natural/plant extract (Ginger, Cinnamon and Roselle) on the three vegetative investigated parameter (stem length and diameter and average leaf area) of Keitt mango trees, data presented in Tables (1, 2, and 3) reveal that the maximum values of the three investigated was detected with the combination between Roselle extract foliar spray and soil adding of magnetic iron at 400 g/tree during both seasons of study.

As for average No. of leaves/shoot as impacted by the combination between the two investigated factors, data in Table (2) clear that the maximum average No. of leaves/shoot was recorded with Roselle extract foliar combined with magnetic iron soil addition at 4000g/tree during the first season. Meanwhile, the highest an increment in average No. of leaves/shoot was achieved when

Roselle plant extract was replicated by Cinnamon plant extract foliar spray combined with the highest level of magnetic iron (400 g/tree).

With regard to the interaction effect between the two investigated factors (magnetic iron at 200 and 400 g/tree and the three antioxidant natural plant extracts i.e., Ginger, Cinnamon and Roselle) on trunk diameter, data presented in Table (2) indicate that the higher was achieved when the trees were treated with either magnetic iron at 400 g/tree alone or magnetic iron at 200 g/tree combined with Cinnamon extract during the first season of study, while the combination between the higher level of magnetic iron (400 g/tree) and Roselle extracts outperformed the other combination and untreated trees (control) during the 2nd season of study.

Table 2. Average number of leaves and trunk diameter (cm) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters Treatment/tree	Average number of leaves				Trunk diameter (cm)			
	M. iron concentration (g)			Mean	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00		0.00	200.00	400.00	
First season; 2019								
Control (zero)	17.33f	23.00b	19.33e	19.89C	12.43d	13.53c	14.50a	13.49B
Ginger	19.00e	23.00b	18.67ef	20.22C	13.40c	13.80bc	13.90bc	13.70AB
Cinnamon	23.33b	21.00cd	21.33c	21.89B	13.47c	14.70a	13.67c	13.95A
Roselle	19.67de	17.33f	36.33a	24.44A	13.90bc	13.67c	14.30ab	13.96A
Mean	19.83C	21.08B	23.92A		13.30B	13.93A	14.09A	
Second season; 2020								
Control (zero)	15.00g	23.33cd	27.00b	21.78C	10.47g	12.30ab	11.87bc	11.55A
Ginger	20.00e	28.00b	22.33d	23.44B	12.33ab	11.10d-f	11.57cd	11.67A
Cinnamon	20.00e	23.33cd	30.67a	24.67A	12.17b	11.47c-e	11.23d-f	11.62A
Roselle	23.67cd	18.00f	24.00c	21.89C	10.87bc	10.97e-g	12.73a	11.52A
Mean	19.67C	23.17B	26.00A		11.46B	11.46B	11.85A	

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Table 3. Average leaf area (cm³) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters Treatment/tree	Average Leaf area (cm)			
	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00	
First season; 2019				
Control (zero)	56.75i	53.37j	63.84h	57.99D
Ginger	65.15g	74.43b	68.26f	68.27C
Cinnamon	70.65d	70.69d	69.77e	70.37B
Roselle	64.42gh	73.08c	75.95a	72.16A
Mean	64.24C	66.75B	70.60A	
Second season; 2020				
Control (zero)	62.99i	64.27gh	65.49f	64.25D
Ginger	64.85fg	65.55f	67.77e	66.06C
Cinnamon	70.51c	68.79d	65.52f	68.27B
Roselle	63.67hi	74.77b	75.56a	71.33A
Mean	65.51B	68.35A	68.59A	

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Leaf mineral contents:

A. Specific effect of leaf minerals:

Regarding the specific effect of the two studied factors (magnetic iron of 200 and 400 g/tree and three antioxidant natural plant extracts i.e., (Ginger, Cinnamon and Roselle) on leaf mineral content of Kiett mango trees, data recorded in Tables (4, 5, 6,7 and 8) indicates that magnetic iron as soil addition at higher level (400 g/tree) surpassed the lower level of magnetic iron (200 g/tree), as such treatment led to an increment in leaf content of the eight tested mineral elements (N, P, K, Ca, Mg, Fe, Zn and Mn) during both seasons of study.

With regard to specific effect of antioxidant extracts on leaf mineral content, data presented in Tables (4, 5, 6,7 and 8) reveal that Roselle extract spray caused highest significant values in leaf content of N, Ca, Fe and Mn elements during both seasons of study.

Meanwhile, K and Zn concentrations in the leaves were maximized when the trees were sprayed with Cinnamon extract as compared with the other tested plant extract spray during the 1st and 2nd seasons of study.

As for leaf P content, it was clear from recorded in Table (5) that there were no significant differences between the different investigated natural plant extracts during the first season, while the Cinnamon plant extract was more effective in the 2nd season and therefore maximized leaf P content as compared with the other tested plant extract.

Concerning leaf Mg content, it was clear from data tabulated in Table (7) that the significant differences between the three investigated natural plant extracts were nil during both seasons of study.

B. Interaction effect:

Regarding the interaction effect between the two studied factors (magnetic iron at 200 and 400 g/tree and three antioxidant Ginger, Cinnamon and Roselle) on leaf mineral content of Kiett mango trees. Data presented in Table (4) obviously clear that the combination between Ginger plant extract foliar spray and magnetic iron as soil addition at 200 g/tree, beside the combination between Cinnamon plant extract foliar spray and magnetic iron soil addition at higher level 400 g/tree, were the best two combinations as both combinations increased the significant values of Kiett mango leaf N content during both seasons of study.

As for leaf P content, data tabulated in Table (4) indicated plant either Ginger or Cinnamon plant foliar extract combined with magnetic iron as soil application at higher level (400 g/tree) were able to encourage P leaf accumulation to the optimum level as compared with the rest of investigated natural plant extracts during both seasons of study.

With referring to leaf K and Ca content as impacted by the interaction effect of the two studied factors, data in Table (5) refer that leaf response to both elements under the influence of the interaction was similar and identical to each other.

So, it can be said that the highest similar significant values of both elements (K and Ca) were associated with the combination between Cinnamon extract foliar spray combined with the higher level of magnetic iron (400 g/tree) during both seasons of study.

With respect to leaf Mg content of Kiett mango trees, data presented in Table (7) referring that the combination between Roselle plant extract foliar spray and magnetic iron at the higher level (400 g/tree) was more effective in increasing Mg concentration in the leaves as compared with the other combinations during both seasons of study.

Concerning leaf Fe content as impacted by the interaction between the two investigated factors, data recorded in Table (6) indicate that Cinnamon plant extract foliar spray combined with the higher level of magnetic iron (400 g/tree) was more pronouncing than the other tested plant extracts during the 1st season, meanwhile Ginger plant extract was replaced by Cinnamon plant extract in the 2nd season and reflect an optimum level of leaf Fe content.

Regarding leaf Zn content, it was clear from Tables (7) that such element was highly enhanced in the leaves when the trees were sprayed with Cinnamon plant extract combined with the higher and the lower levels of magnetic iron (400, 200 g/tree) in the 1st and 2nd season, respectively.

Referring to the interaction effect of the two tested factors on Mn element concentration in the leaves, data presented in Table (7) clearly indicate that Mn leaf content was maximized when the trees were sprayed either Cinnamon plant extract in the 1st season or Roselle plant extract in the 2nd season and each was combined with the lower level of magnetic iron as soil addition (200 g/tree) during both seasons of study.

Table 4. Nitrogen and phosphorus (%) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters	Leaf N (%)				Leaf P (%)				
	Treatment/tree	M. iron concentration (g)			Mean	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00			0.00	200.00	400.00	
First season; 2019									
Control (zero)	1.61de	1.63cd	1.68b	1.64B	0.130cd	0.140bc	0.140bc	0.137A	
Ginger	1.63cd	1.75a	1.63cd	1.67A	0.140bc	0.130cd	0.150ab	0.140A	
Cinnamon	1.59e	1.61de	1.75a	1.65B	0.120d	0.140bc	0.160a	0.140A	
Roselle	1.65c	1.64cd	1.73a	1.67A	0.130cd	0.140bc	0.150ab	0.140A	
Mean	1.62C	1.66B	1.70A		0.130B	0.138B	0.150A		
Second season; 2020									
Control (zero)	1.59ef	1.66c	1.65cd	1.63B	0.130cd	0.120d	0.130cd	0.127B	
Ginger	1.75a	1.60e	1.60e	1.65A	0.130cd	0.150ab	0.150ab	0.143A	
Cinnamon	1.63d	1.57f	1.73a	1.64AB	0.120d	0.140bc	0.160a	0.140A	
Roselle	1.60e	1.67c	1.70b	1.66A	0.140bc	0.150ab	0.140bc	0.143A	
Mean	1.64B	1.63C	1.67A		0.130B	0.140A	0.145A		

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Table 5. Potassium and calcium (%) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters	Leaf K (%)				Leaf Ca (%)				
	Treatment/tree	M. iron concentration (g)			Mean	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00			0.00	200.00	400.00	
First season; 2019									
Control (zero)	3.03d	2.74f	2.90e	2.89C	2.00f	1.26j	2.11d	1.79D	
Ginger	2.80f	3.03d	3.09b-d	2.97B	1.80h	2.15c	1.82g	1.92C	
Cinnamon	3.05cd	3.15ab	3.20a	3.13A	1.38i	2.14c	2.35a	1.96C	
Roselle	2.80f	3.14a-c	3.01d	2.98B	2.09e	2.28b	1.80h	2.06A	
Mean	2.92B	3.02A	3.05A		1.82C	1.96B	2.02A		
Second season; 2020									
Control (zero)	2.85c	3.00b	2.84c	2.90C	1.90f	1.36j	2.12d	1.79D	
Ginger	2.90c	2.90c	3.03b	2.94C	1.82g	2.13d	1.79h	1.91C	
Cinnamon	3.03b	2.85c	3.13a	3.00B	1.37j	2.21c	2.35a	1.98B	
Roselle	3.05ab	3.13a	3.05ab	3.08A	2.10e	2.25b	1.75i	2.03A	
Mean	2.96B	2.97B	3.01A		1.80C	1.99B	2.00A		

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Table 6. Magnesium (%) and iron (ppm) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters	Leaf Mg (%)				Leaf Fe (ppm)				
	Treatment/tree	M. iron concentration (g)			Mean	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00			0.00	200.00	400.00	
First season; 2019									
Control (zero)	0.184e	0.193c-e	0.208a-c	0.195A	297.5e	425.0h	492.5c	405.0D	
Ginger	0.183e	0.201b-e	0.216ab	0.200A	506.3b	432.5g	373.8k	437.5C	
Cinnamon	0.190c-e	0.206a-d	0.217ab	0.204A	393.8j	420.0b-d	512.5a	442.1B	
Roselle	0.196c-e	0.188de	0.223a	0.202A	467.5e	442.5f	471.3d	460.4A	
Mean	0.188C	0.197B	0.216A		416.3C	430.0B	462.5A		
Second season; 2020									
Control (zero)	0.185d	0.183d	0.207a-c	0.192A	302.5l	435.0g	492.5c	410.0D	
Ginger	0.189cd	0.206a-c	0.207a-c	0.200A	397.8k	410.0j	515.0a	440.9C	
Cinnamon	0.186d	0.200b-d	0.216ab	0.201A	462.5f	432.5h	480.3d	458.4B	
Roselle	0.195cd	0.187d	0.222a	0.201A	500.8b	417.5i	472.8e	463.7A	
Mean	0.189B	0.194B	0.213A		415.9C	423.8B	490.2A		

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Table 7. Zinc and manganese (ppm) of "Keitt" mango trees as impacted by specific and interaction effects of soil adding magnetic iron and some antioxidant natural plants foliar spray during 2019 and 20120 seasons, respectively.

Parameters	Leaf Zn ppm				Leaf Mn ppm				
	Treatment/tree	M. iron concentration (g)			Mean	M. iron concentration (g)			Mean
Natural plant extracts 62.5 g/powder in 5 liter per tree	0.00	200.00	400.00			0.00	200.00	400.00	
First season; 2019									
Control (zero)	157.5c	110.0j	150.0f	139.2B	146.3h	165.0f	131.3l	147.5D	
Ginger	112.5i	120.0h	127.5g	120.0D	158.8g	142.5i	171.3e	157.5C	
Cinnamon	78.77l	162.5b	180.0a	140.4A	132.5k	210.0a	182.5d	175.0B	
Roselle	100.0k	152.5e	153.8d	135.4C	186.3c	136.3i	207.5b	176.7A	
Mean	112.2C	136.3B	152.8A		156.0C	163.5B	173.2A		
Second season; 2020									
Control (zero)	147.0d	118.8k	145.5e	134.4B	145.3g	163.0e	130.8k	146.4D	
Ginger	117.5i	130.5h	139.5g	129.2C	158.5f	140.0i	170.8d	156.4C	
Cinnamon	82.77l	172.5a	170.0b	141.8A	183.3c	138.3j	209.5b	177.0B	
Roselle	113.0j	142.5f	148.0c	134.5B	142.5h	218.0a	182.5c	181.0A	
Mean	115.1C	139.1B	150.8A		157.4C	164.8B	173.4A		

Means followed by the same letter/s within each column didn't significantly differ at 5% level

Discussion

These findings supported earlier research by **Sayed et al., (2007)** and **Barakat et al., (2012)** showing humic compounds have a significant role in delivering nutrients that promote soil fertility and increase the availability of nutritional elements. Furthermore, the root mass, leaf size, and stem may all be individually changed by utilizing various magnetic field combinations. These findings are in line with those of **Ismail et al., (2010)** who found that applying magnetite to grapevines increased the length of the Superior grapevine cv. shoots. While also causing a remarkable lengthening of the plant's roots and stems. These early effects are extremely positive as they seem to enhance the ability of the developing shoot to absorb nutrients and water while also providing it with more structural support. Moreover, these findings are consistent with those of **Abada (2009)**, **Mohammed et al., (2010)**, and **Abd El-Monem et al., (2011)** who reported that the addition of natural mineral products, such as magnetic iron ore, has numerous advantages for crop growth. These advantages include improved soil structure, increased soil organic matter, improved water properties, increased energy and vigor, and "Magneto biology." In addition, the magnetic process removes all chlorine and other poisonous and hazardous gases from the soil, improves salt movement and nutrient solubility, which in turn helps the soil retain water and moderate soil temperature.

These findings are consistent with those made by **Munns (2002)**, **Eissa et al., (2007 a & b)**, **Garcia-Sanchez et al., (2006)**, **Alva and Syvertsen (1991)**, **Munns (2002)**, **Garcia-Sanchez et al., (2006)**, **Mehanna et al., (2010)** and **Atawia et al., (2017)**. They suggested that magnetite may help to reduce Na toxicity at the cellular level by detoxifying Na, either by limiting the entry of Na In most crops, high Na concentrations are a limiting factor for plant

growth. Additionally, salinity decreased elements in conc. and increased soil ECe, Na+, and Cl-. It's also noteworthy to observe that the trees' growth may have continued with fewer negative impacts on overall production due to the apparent reduced accumulation of Na in plants with magnetite and humate treatments.

Conclusion

In conclusion, it is clear that the most successful treatment for the majority of the parameters studied in this study was the combination of foliar spraying Roselle extract and adding 400 g/tree of magnetic iron to the soil. Therefore, under the same conditions, this treatment is a prospective agent to enhance vegetative growth and nutritional status of Keitt mango trees.

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تأثير الحديد المغناطيسي وبعض المستخلصات النباتية الطبيعية المضادة للأوكسدة على النمو الخضري والمحتوى المعدني للأوراق لأشجار

المانجو الكيت

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قسم البساتين كلية الزراعة بمشتر جامعة بنها مصر

خلال عامين متتاليين نجاحين هما 2019 و 2020 أجريت تجربة على أشجار المانجو الكيت عمرها 14 عام وكانت الأشجار مطعومة على أصل السكري، في مزرعة خاصة بالكيلو 54 في طريق مصر الإسكندرية الصحراوي من القاهرة بجوار السليمانية في أرض رملية وتروى بالتنقيط وكانت مسافات الزراعة (3 × 5م). وكانت التجربة عاملية (2 عامل) وهما العامل الأول إضافة الحديد الممغنط بثلاثة تركيزات (الصفر، 200 و 400 جرام / شجرة) أم العامل الثاني هو الرش ببعض المركبات النباتية الطبيعية المضادة للأوكسدة (الزنجيل، القرفة و الكركدية) بمعدل 62.5 جم مسحوق نقي من كل نوع تم الرش بـ 5 لترات وكانت الاشجار منزرعة تحت السيران. وقد أظهرت النتائج المتحصل عليها أن معاملة الكركدية التي تم إضافتها مع الحديد الممغنط بمعدل (400 جم/شجرة) أفضل النتائج مقارنة مع باقي المواد المضادة للأوكسدة أو المتداخلة مع الحديد الممغنط في معظم القياسات المختبرة سواء القياسات الخضرية (طول وقطر الفرع، عدد الأوراق على الفرع، قطر الساق متوسط مساحة الورقة) والمحتوى المعدني للأوراق (ومحتوى الورقة من العناصر الغذائية من النيتروجين، الفوسفور، البوتاسيوم، الكالسيوم، الماغنسيوم، الحديد، الزنك والمنجنيز) خلال موسمي الدراسة وبالتالي يمكن ان نوصي بها تحت نفس ظروف التجربة.