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Improvement of Growth and Productivity of Mango Trees Using Some Growth Stimulants Under Salinity Conditions

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Abstract: A study was carried out in a mango orchard on reclaimed land for two seasons in 2019 and 2020. The experiment was implemented on fifteen years old mango trees "Fagri Kalan" budded on seedling mango rootstock and planted at 4 × 4 m. This experiment involved two soil growth stimulants (K humate, magnetite) and foliar application with cobalt. The experiment involved two factors, the first one was soil application with K humate by two levels (50 and 100 g/tree/year) and magnetite by two levels (250 and 500 g/tree /year) plus control, whereas the second factor was a foliar application with Co as cobalt sulfate by three levels (0, 15, and 30 ppm Co). The experiment was carried out in a factorial experiment in split plot design with three replicates whereas each replicate was represented by two trees. Result indicated that soil application with K humate at 100 g/tree followed by magnetite at 250 g/tree or foliar application with Co at 15 ppm alone or the combination between (K humate at 100 g/tree and cobalt at 15 ppm) gave the highest values of yield/tree, fruit weight, TSS, reducing sugars, leaf N, P, K, and Fe content of "Fagri Kalan" mango trees grown under salinity conditions.

1 Introduction

Mango (*Mangifera indica* L.) is a member of the Anacardiaceae family and is one of the world's major tropical and subtropical fruits. It succeeds in a variety of climatic and soil conditions. Mango is Egypt's third-largest crop after citrus and grapes.

Salinity is a significant abiotic factor that limits the growth and production of different crops in the world (Tester and Davenport 2003). Excess salts can cause growth loss by disrupting ion homeostasis, water balance, mineral nutrition, and photosynthetic carbon metabolism (Munns 2002).

Mango cultivation is successful on various types of soil, particularly newly reclaimed land; however, orchards may produce low tree output and death as a result of higher salty levels in soil or irrigation water; whereas, mangoes are susceptible to salt, which causes leaf tips and margins to burn, leaves to curl, and, in extreme situations, leaf growth, breaking, as well as tree mortality.

Furthermore, potassium promotes plants in coping with the harmful effects of salt by improving morphological, physiological, and biochemical characteristics. Whereas, among the major macronutrients, potassium plays a critical role in plant survival in salt-stressed environments (Mengel and Kirkby 2001). A well-balanced K/Na ratio is required for proper stomatal function regulation. Magnetite has a positive influence on immobile plant additives, minimizing toxicity in raw materials and enhancing food safety (Esitken and Turan 2004). Also, Magnetic field could be a substitution for chemical additives, which can reduce toxins in raw materials and raise food safety.

Cobalt is a helpful element for higher plants, as well as an essential component of vitamin B_{12} synthesis, which is required for human and animal nutrition (Young 1983). Cobalt, unlike the other heavy metals, does not accumulate in humans as they age. Cobalt concentrations in plants range from 0.1 to 10 ppm (Palit and Sharma 1994), they rarely surpass 1 ppm, and 25-100 ppm is regarded as the threshold for toxicity in plants.

According to Young (1983) depending on cobalt levels in the local supply of drinking water, daily cobalt requirements for human nutrition could exceed 8 ppm without putting one's health at risk. Singh and Agrez (2002) discovered that foliar treatment of cobalt sulfate 200 mg/l raised mango fruit set and retention, as well as fruit yield, TSS: acid, and total sugars, as compared to trees that were not sprayed.

Given the following information, The target of this present investigation was to examine the effect of soil application with two growth stimulant compounds named (K humate, magnetite) and foliar application with cobalt on yield, fruit quality, and leaf mineral content of "Fagri Kalan" cv., mango trees cultivated in new reclamation land and irrigated with saline water (E.C. = 3.26 ds/m) to determine the best combination between them which improve "Fagri Kalan" mango trees yield and fruit quality under this salinity conditions.

2 Material and Methods

2.1 Plant materials and experimental application

The present investigation was carried out during two seasons 2019 and 2020 in a private mango orchard in new reclamation land located at “Mahfouz Moghazi farm“, Abo Ghaleb Road, Giza Governorate , located 68 km from Cairo, Alex. Desert road, Egypt. The experiment was implemented on fifteen years old mango trees “Fagri Kalan” cv., budded on mango seedling rootstock, planted in sandy soil at 4 × 4 m with drip irrigation. This investigation aimed to improving the productivity, fruit quality and mineral content of “Fagri Kalan” mango trees, which are irrigated with well water that contains a relatively high salinity rate (E.C = 3.26 ds/m) by using some growth stimulants potassium humate (KH.) and magnetite (Mag.) as soil application and foliar application with cobalt as cobalt sulfate (Co). The soil and water analyses are shown in **Tables 1, 2 and 3**. The chosen trees had a consistent shape and were treated to regular horticultural techniques.

The experiment was set up as a split-plot design, with the main plot representing five soil application treatments, including two levels of potassium humate (KH_1: 50 and KH_2:100g/tree) and two levels of magnetite (Mag_1:250 and Mag_2:500 g/tree) plus control treatment (untreated trees) and the subplot representing by foliar application with three levels of cobalt (Co_1: untreated, Co_2:15 and Co_3: 30 ppm Co) cobalt sulfate. So the experiment involved fifteen treatments each represented by three replicates and two trees for each one. Potassium humate and magnetite were added once as soil application (Mid-January) around the trees in drilling under the drippers and were covered after each implementation in the two seasons. Regarding cobalt treatments, selected trees were sprayed twice (the first at the end of February at the beginning of the appearance of new leaves and the second after a month later) with aqueous solutions of (Co) until the point of runoff with the various cobalt concentrations: (0, 15, and 30 ppm) using cobalt sulfate. The control was even sprayed with tap water until the point of runoff.

At the end of each season (late September) data were recorded to evaluate the tested treatments:

2.2 Yield parameters

In the maturity stage (late September) the average number of fruits per tree was counted. Furthermore, three fruits from each tree (replicate) were used to calculate the average fruit weight (g) by weighing a sample of three fruits from each replicate as well as determining the average fruit weight (g).

The average yield /tree (kg) was calculated by multiplying the average number of fruits/tree by the average weight of fruits of each replicate and yield/feddan (Ton) was calculated by the average yield/tree (kg) with the number of trees/feddan.

2.3 Fruit quality

Each season, three fruits/trees were selected random of each replicate and used to determine the following physical and chemical properties.
Physical characteristics of fruits include:

Fruit length (cm), fruit width (cm), and fruit shape were estimated using the formula: Fruit shape index = fruit length (cm) of each replicate/Fruit width (cm).

Table 1. Some physical properties of the experimental soil

Soil depth cm	Partical size distribution							
	C. Sand %	F. Sand %	Silt %	Clay %	Texture	F.C %	W.P %	B.D g/cm^3
0 – 30	92.8	3.7	2.0	1.5	Sandy	10	4.8	1.83
30 – 60	91.5	1.8	0.2	6.5	Sandy	11	6.3	1.79
60 – 90	93.1	0.6	0.4	5.9	Sandy	13	5.5	1.72

Table 2. Some chemical properties of the experimental soil

Soil depth cm	pH	EC ds/m	TDS ppm	Ca^{++}	Mg^{++}	Na^{++}	K^{+}	Co_3^{--}	HCo_3^{-}	So_4^{--}	CL^{-}
				Soluble Cations, meq/l				Soluble Anions, meq/l			
0 – 30	6.9	2.5	1600	9.52	1.3	13.88	0.3	--	0.8	8.97	15.23
30 – 60	7.1	3.03	1939.2	9.6	6.9	13.6	0.2	--	1.8	4.7	23.8
60 – 90	7.3	2.48	1587.2	10.2	3.21	11.2	0.19	--	0.8	7.6	16.4

Table 3. Some chemical properties of the used irrigation water

pH	EC ds/m	TDS ppm	Soluble Cations, meq/l				Soluble Anions, meq/l			
			Ca^{++}	Mg^{++}	Na^{++}	K^{+}	CO_3^{--}	HCO_3^{-}	SO_4^{--}	Cl^{-}
6.9	3.26	2086.4	12	1.22	19.28	0.1	-	0.8	9.8	22

Fruit thickness (cm): Measured using a vernier caliper.

Fruit volume (cm^3): Volume of three fruits from each replicate was determined and the average fruit volume (ml) was calculated by the water displacement method.

Fruit chemical properties include:
Total sugars %: were determined using 3, 5-dinitrosalisylic acid (DNS) according to James (1995).
Total soluble solids (T.S.S): were determined as percentage in juice by means of hand refractometer.
Total acidity (%): was determined as citric acid content using diluted flesh extract with titration against NaOH 0.1 N and phenol phthalein as indicator according to A.O.A.C. (1995).
T.S.S / acid ratio was calculated.

2.4 Leaf mineral content

Leaf mineral content was determined as follows: ten leaves were taken in each season from 6 -7 month old leaves from the middle part of non-fruiting shoots in late September. According to Chadha et al (1980). The leaf samples were washed and dried grinded then digested using sulphoric acid and hydrogen peroxide according to Parkinson and Allen (1975).

Total Nitrogen: was determined using a modified micro-Keldahl method, as described in Bremner's method (Bremner 1996).

Phosphorus, Potassium, manganese, iron, zinc, and cobalt leaf samples: were digested using nitric acid and hydrogen peroxide in Microwave Digestion Labstation Ethos Pro, closed system, Milestone, Italy Inductivity Coupled Argon Plasma, ICAP 6500 Duo, Thermo Scientific, England, was used to measure the results. Merck, Germany, provided a 1000 mg/l multi-element certified stander system for instrument standardization.

2.5 Statistical Analysis

The obtained data was subjected to analysis of variances (ANOVA) according to (Snedecor and Cochran 1989). The least significant differences were calculated using the Statistix 9 package. At a probability of 0.05, LSD letters were used to compare the means of different treatments according to Wallar and Duncan (1969).

3 Results and Discussion

3.1 Yield parameters

Table 4 show the effect of soil application with potassium humate & magnetite and foliar application with cobalt on yield and its characters of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons.

Data concerning fruit No. /tree, fruit weight and yield affected significantly by the different levels of soil application with potassium humate, magnetite or foliar application with cobalt and their interaction in the two seasons, adding high level from KH_2 (100 g/tree) gave the highest significant values of fruit No. /tree, fruit weight and yield in the two seasons followed by Mag_2 (500g/tree) and Mag_1 (250 g/ tree) in the first and second season, respectively. In the two seasons Co_2 (15 ppm Co) as cobalt sulfate gave the highest significant values of fruit No. /tree. Regarding the interaction (untreated trees X Co_1) almost gave the lowest significant values of fruit No. /tree, fruit weight and yield in the two seasons when combining with different rates of soil application and foliar application with cobalt. Whereas, fruit No. /tree, fruit weight and yield affected significantly. Generally, in the two seasons the highest value was obtained by certain treatment (KH_2X Co_2) but some other treatments gave more or less similar values with the same statistical stand point.

Abobatta pointed out that Valencia orange trees were treated 1000 g/tree magnetic iron + 50 g/tree K humate under salinity conditions, improved yield production, fruit quality, and chemical composition (Abobatta 2015).

Gad et al (2008) demonstrated that the addition of 15ppm cobalt had significant promotive effect on yield of cucumber plants.

3.2 Fruit quality

3.2.1Fruit physical properties

Table 5 show the effect of soil application of potassium humate & magnetite and foliar application with cobalt on the fruit length, fruit width and fruit shape index of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons.

Results proved that in the two seasons, fruit length and fruit width affected significantly by the levels of soil application with potassium humate & magnetite, foliar application with cobalt and their interaction. Untreated trees gave the lowest significant value of fruit length and fruit shape index compared with any other treatment in the first season only. Soil application with potassium humate at 100 g/tree had the greater fruit length and fruit width in the first and second seasons except fruit length in the second season followed by the first level of magnetite 250 g/ tree in the first and second seasons. Regarding to foliar application of cobalt 15 ppm had the greater fruit length and fruit width in the two seasons it seems that than other levels. Results revealed that the interaction was significant in the two seasons between the two studied factors. It is quite clear that trees received potassium humate at 100 g/tree plus foliar application with cobalt at 15 ppm achieve the highest fruit length and fruit width.

Fruit shape index was affected significantly by the levels of soil application with potassium humate & magnetite, foliar application with cobalt and their interaction in the two seasons. In the first season soil application with potassium humate at 50 g/tree (KH_1) and magnetite at 500 g/tree (Mag_2) had the greatest fruit shape index without significant differences between them except magnetite at 500 g/tree (Mag_2) in the second season. Regard to foliar application of cobalt by Co_2 (15 ppm) gave the high significant values of fruit shape index in the first season. With respect to combination between magnetite at 500 g/tree and cobalt at 15 ppm (Mag_2XCo_2), it was observed that, in the first season recorded the highest fruit shape index. On the other hand, in the second season soil application of potassium humate at 50 g/tree (KH_1) and Co_1 (without Co spray) had the great fruit shape index.

Table 6 show the effect of soil application with potassium humate& magnetite and foliar application with cobalt on fruit thickness and fruit volume of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons.

Fruit thickness and fruit volume were significantly affected by soil application of potassium humate & magnetite, cobalt foliar application and their interaction in the two seasons. In both seasons, the soil application with potassium humate at a rate of 100 g/tree significant increase in fruit thickness and volume followed by magnetite at 250 g/ tree compared to other treatments. Regarding to the effect of cobalt, one can notice that spraying trees with 15 ppm exhibited the highest fruit thickness and fruit volume in the first and second seasons. Concerning to the interaction, it is worthy to mention that, trees received potassium humate at 100 g/tree as soil application with spring cobalt at 15 ppm resulted in the highest fruit thickness and fruit volume in the first and second seasons.

Table 4. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on yield and its characters of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons

Table 4. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on yield and its characters of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)															
	Fruit No. /tree				Fruit weight (g)				Yield / tree (kg)				Yield / Ton (feddan)			
2019 season																
	Co$_1$: 0	Co$_2$: 15	Co$_3$: 30	Mean	Co$_1$: 0	Co$_2$: 15	Co$_3$: 30	Mean	Co$_1$: 0	Co$_2$: 15	Co$_3$: 30	Mean	Co$_1$: 0	Co$_2$: 15	Co$_3$: 30	Mean
Untreated	17.3 ef	24.3 cd	17.0 ef	**19.7 BC**	503.5 i	587.4 b	490.3 l	**527.1 D**	8.7 e-g	14.3 c	8.3 e-g	**10.5 BC**	2.3 e-g	3.7 c	2.2 e-g	**2.7 BC**
*KH$_1$: 50	12.0 f	15.0 ef	18.0 d-f	**15.0 D**	481.3 n	501.7 j	544.4 e	**509.1 E**	5.8 g	7.5 fg	9.8 d-f	**7.7 D**	1.5 g	1.0 fg	2.6 d-f	**2.0 D**
*KH$_2$: 100	31.0 ab	36.0 a	17.0 ef	**28.0 A**	582.5 c	649.9 a	492.4 k	**574.9 A**	18.1 b	23.4 a	8.8 e-g	**16.6 A**	4.7 b	6.1 a	2.2 e-g	**4.4 A**
**Mag$_1$: 250	16.0 ef	12.3 f	21.0 c-e	**16.4 CD**	533.7 f	525.4 g	582.5 c	**547.2 B**	8.5 e-g	6.5 fg	12.2 cd	**9.1 CD**	2.2 e-g	1.7 fg	3.2 cd	**2.4 CD**
**Mag$_2$: 500	20.0 c-e	26.0 bc	17.0 ef	**21.0 B**	580.2 d	519.4 h	487.4 m	**528.0 C**	11.6 c-e	13.5 c	8.3 e-g	**11.1 B**	3.0 c-e	3.5 c	2.2 e-g	**2.9 B**
Mean	**19.3AB**	**22.7 A**	**18.0 B**		**536.2 B**	**556.8 A**	**519.4 C**		**10.5 B**	**13.0 A**	**9.4 B**		**2.8 B**	**3.4 A**	**2.5 B**	
2020 season																
Untreated	10.0 j	38.0 b	15.0 g	**21.0 B**	581.0 j	681.7 b	590.0 hi	**617.6 D**	5.8 l	25.9 b	8.9 gh	**13.5 C**	1.5 l	6.8 b	2.3 gh	**3.5 C**
*KH$_1$: 50	16.0 g	13.0 h	30.3 d	**19.8 C**	603.0 g	601.0 g	644.0 c	**616.0 D**	9.7 g	7.8 ij	19.5 d	**12.3 D**	2.5 g	2.1 ij	5.1 d	**3.2 D**
*KH$_2$: 100	32.0 c	49.0 a	19.0 f	**33.3 A**	633.3 d	749.3 a	592.0 h	**658.2 A**	20.3 d	36.7 a	11.3 f	**22.7 A**	5.3 d	9.6 a	2.0 f	**5.0 A**
**Mag$_1$: 250	21.0 e	10.7 ij	33.0 c	**21.6 B**	633.0 d	625.0 e	682.0 b	**646.7 B**	13.3 e	6. 7 kl	22.5 c	**14.2 B**	3.5 e	1.8 kl	5.9 c	**3.7 B**
**Mag$_2$: 500	20.0 ef	13.0 h	12.0 hi	**15.0 D**	680.3 b	619.0 f	587.0 i	**628.8 C**	13.6 e	8.1 hi	7.0 jk	**9.6 E**	3.6 e	2.1 hi	1.9 jk	**2.5 E**
Mean	**19.8 C**	**24.7 A**	**21.8 B**		**626.1 B**	**655.2 A**	**619.00 C**		**12.5 C**	**17.0 A**	**13.8 B**		**3.3 C**	**4.5 A**	**3.6 B**	

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.
* (KH) Potassium humate, ** (Mag) Magnetite and *** (Co) Cobalt Sulphate.

Table 4. Effect of

Table 5. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on the fruit length, fruit width and fruit shape index of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)											
	Fruit length (cm)				Fruit width (cm)				Fruit shape index			
2019 season												
	Co 1 : 0	Co 2 : 15	Co 3 : 30	Mean	Co 1 : 0	Co 2 : 15	Co 3 : 30	Mean	Co 1 : 0	Co 2 : 15	Co 3 : 30	Mean
Untreated	8.5 j	14.8 b	14.3 c	**12.5 C**	6.9 j	9.0 b	8.0 de	**7.0 B**	1.2 k	1.6 hi	1.8 ef	**1.6 D**
*KH 1 : 50	13.7 e	13.8 e	14.2 cd	**13.9 B**	7.3 h	7.5 g	7.8 f	**7.5 C**	1.9 bc	1.8 cd	1.8 de	**1.8 A**
*KH 2 : 100	15.1 b	16.3 a	11.8 h	**14.4 A**	8.9 b	10.1 a	8.0 de	**9.0 A**	1.7 g	1.6 i	1.5 j	**1.6 C**
**Mag 1 : 250	14.2 c	14.2 cd	12.8 g	**13.7 B**	7.9 ef	8.1 d	7.9 ef	**7.0 B**	1.8 ef	1.8 f	1.6 i	**1.7 B**
**Mag 2 : 500	13.9 de	14.3 c	13.3 f	**13.8 B**	8.3 c	7.2 h	7.0 i	**7.5 C**	1.7 gh	1.0 a	1.9 b	**1.9 A**
Mean	**13.1 B**	**14.7 A**	**13.3 B**		**7.9 B**	**8.4 A**	**7.8 C**		**1.7 C**	**1.8 A**	**1.7 B**	
2020 season												
Untreated	15.3 f	16.3 b	16.0 c	**15.9 A**	8.9 i	10.9 b	10.0 de	**9.9 B**	1.7 a	1.5 f	1.6 d	**1.6 B**
*KH 1 : 50	15.7 e	15.8 de	16.2 b	**15.9 A**	9.3 h	9.5 g	9.8 f	**9.5 C**	1.7 b	1.7 bc	1.7 c	**1.7 A**
*KH 2 : 100	16.3 b	16.8 a	13.8 h	**15.6 C**	11.0 b	12.1 a	10.0 de	**11.0 A**	1.5 f	1.4 g	1.4 g	**1.4 E**
**Mag 1 : 250	16.2 b	16.2 b	14.8 g	**15.7 B**	9.9 ef	9.9 ef	10.1 d	**9.0 B**	1.6 c	1.6 c	1.5 f	**1.6 C**
**Mag 2 : 500	15.9 cd	16.0 c	10.5 i	**14.1 D**	10.3 c	9.2 h	9.0 i	**9.5 C**	1.5 e	1.7 a	1.2 h	**1.5 D**
Mean	**15.9 B**	**16.2 A**	**14.3 C**		**9.9 B**	**10.3 A**	**9.8 C**		**1.6 A**	**1.6 B**	**1.5 C**	

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.

* (KH) Potassium humate, ** (Mag) Magnetite and *** (Co) Cobalt Sulphate.

Table 6. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on fruit thickness and fruit volume of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)							
	Fruit thickness (cm)				Fruit volume (cm^3)			
2019 season								
	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean
Untreated	5.7 f	6.7 c	5.3 g	**5.9 D**	540.5 i	624.4 b	527.3 1	**564.1 D**
*KH_1 : 50	5.8 f	5.3 g	6.3 d	**5.8 E**	518.3 n	538.7 j	581.4 e	**546.1 E**
*KH_2 : 100	7.4 b	11.9 a	5.7 f	**8.3 A**	619.5 c	686.9 a	529.4 k	**611.9 A**
**Mag_1 : 250	6.1 e	6.3 d	6.6 c	**6.3 B**	570.7 f	562.4 g	619.5 c	**584.21 B**
**Mag_2 : 500	6.2 de	5.7 f	6.6 c	**6.2 C**	617.2 d	556.4 h	524.4 m	**565.0 C**
Mean	**6.3 B**	**7.2 A**	**6.1 C**		**573.2 B**	**593.8 A**	**556.4 C**	
2020 season								
Untreated	7.7 e-g	7.3 f-h	7.3 fg	**7.4 D**	618.0 j	718.0 b	627.0 hi	**654.0 D**
*KH_1 : 50	7.8 d-f	7.3 fg	8.3 b-d	**7.8 C**	640.0 g	638.0 g	681.0 c	**653.0 D**
*KH_2 : 100	8.7 b	12.9 a	8.1 c-e	**9.9 A**	670.0 d	786.0 a	629.0 h	**695.0 A**
**Mag_1 : 250	8.4 bc	8.3 b-d	7.7 e-g	**8.1 B**	670.0 d	662.0 e	719.0 b	**683.0 B**
**Mag_2 : 500	7.2 gh	6.7 h	7.6 e-g	**7.2 D**	717.0 b	656.0 f	624.0 i	**665.0 C**
Mean	**7.0 B**	**8.5 A**	**7.8 B**		**663.0 B**	**692.0 A**	**656.0 C**	

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.
* (KH) Potassium humate, ** (Mag) Magnetite and *** (Co) Cobalt Sulphate.

The application of magnetite to Le Conte pear trees resulted in the greatest yield values (Atallah et al 2010).

While the application of potassium humate as an organic fertilizer for improving the quality and quantity of the sensitive wheat cultivar Gemeza.9 cultivated in salty lands and increases its productivity (Osman et al 2017).

3.2.2 Fruit chemical properties

Table 7 show the effect of soil application with potassium humate& magnetite and foliar application with cobalt on total sugars and total soluble solids of mango "Fagri Kalan" fruit cultivar in the 2019 and 2020 seasons.

Total sugars, total soluble solids percentage and TSS/acid ratio of mango Fagri Kalan fruits were significantly affected due to the soil application of potassium humate & magnetite, cobalt foliar application and their interaction in the two seasons. Soil application with potassium humate at 100 g/tree resulted in the greatest total sugars and total soluble solids percentage in the first and second seasons. Followed by magnetite at 500 g/tree. Regarding to cobalt, spraying trees with 15 ppm cobalt proved to be the best treatment for total sugars and total soluble solids percentage in the two seasons. Concerning to the interaction, it is obvious that trees received certain treatment (KH_2XCo_2) had the greatest total sugars and total soluble solids percentage in the two seasons.

Total acidity percentage was significantly affected by soil application, foliar application treatments and their interaction in the two seasons. The untreated trees with soil application of potassium humate, magnetite and cobalt foliar application showed the highest acidity percentage in the two seasons. Soil application of potassium humate at 100 g/tree gained the lowest total acidity percentage in the two seasons. Followed by the first level of magnetite 250 g/tree. On the other side, there was significant differences among all cobalt levels in the in the two seasons. Whereas foliar application with 15 ppm cobalt exhibited the lowest total acidity percentage. As for the interaction, it is apparent that trees received potassium humate at 100 g/tree plus 15 ppm cobalt (KH_2XCo_2) exhibited the lowest acidity percentage in the first and second seasons.

These findings are in line with Ali et al (2013) who discovered that saline conditions and water deficit stress increased sugar accumulation in Valencia orange fruit, resulting in an increase in TSS and acid concentration in the fruit juice, causing a delay in ripening. Humic acid boosted soil microbial activity, which improved nutrients cycling, resulting in increased growth and fruit quality. Furthermore, Humic substances also lowered acidity in a number of fruits. In Valencia orange fruit juice, however, magnetic field and magnetite treatments increased TSS and lowered acidity.

The addition of 6 ppm cobalt to broccoli had a significant positive impact on growth, yield total amount, and quality (Gad and Abd El-Moez 2011).

3.3 Leaf macro/nutrient content

Table 8 show the effect of soil application with potassium humate& magnetite and foliar application with cobalt on nitrogen, phosphorus and potassium content in leaves of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons.

Data in **Table 8** revealed that significant effect was found on leaf nitrogen, phosphorus and potassium content of Fagri Kalan due to the levels of soil application of potassium humate & magnetite, foliar application with cobalt and their interaction in the two seasons. Soil application with KH_2 (100 g/tree) resulted in the greatest leaf nitrogen, phosphorus and potassium percentage in the first and second seasons. After that Mag_1 (250 g/ tree) in the both seasons. Regardless of cobalt application, spraying trees with Co_2 (15 ppm cobalt) proved to be the beneficial treatment in the first and second seasons. As for the combination between the two variables, it is quite clear that trees received potassium humate soil application at 100 g/tree plus cobalt foliar spray at 15 ppm (KH_2XCo_2) had the maximum leaf nitrogen, phosphorus and potassium percentage in the both seasons.

3.4 Leaf micro/nutrient content

Table 9 show the effect of soil application with potassium humate & magnetite and foliar application with cobalt on iron, zinc and cobalt content in leaves of mango "Fagri Kalan" cultivar in the 2019 and 2020 seasons.

Leaf iron, zinc and cobalt in **Table 9** was significantly affected by soil application with potassium humate & magnetite, cobalt foliar application and their interaction in the two seasons. Soil application with potassium humate at 100 g/tree resulted in the greatest leaf iron, zinc and cobalt content, followed by 250 g/ tree in the both seasons. Conversely, foliar application by cobalt at 15 ppm showed the highest iron, zinc and cobalt content in the both seasons. As for the interaction, it is apparent that trees received potassium humate at 100 g/tree plus cobalt at 15 ppm had the maximum leaf iron content in the two seasons.

These findings are in agreement with Mohammed et al (2010), who discovered that humic acid promotes plant nutrition by promoting root growth and enhancing the rate of mineral ions absorption on root surfaces and their penetration into plant tissue cells, resulting in increased plant metabolism and respiratory activity.
The findings are consistent with those of (Gad and Hassan 2013), who found that cobalt boosted macro and micronutrients in sweet pepper fruits considerably when compared to control.

Potassium humate improves nutrient uptake, increases plant biomass, and decreases soil compaction (Canellas et al 2015).

As a chelating agent, humic acid improves nutrient availability, particularly microelements, in calcareous soils by promoting nutrient uptake. Furthermore, humic elements may stimulate root growth in the same way that auxins do (Tatini et al 1991, Khattab et al 2012).

In this regard, Co isn't required for plant survival, but it does affect plant development and metabolism, Co is a component of many enzymes and co-enzymes, according to Akeel and Jahan (2020). As a result, Co is regarded as a helpful ingredient for plants. At trace levels, Co promotes plant development, while at high levels, it has the opposite effect, Co is necessary for legume nitrogen fixation and vitamin B_{12} synthesis.

Increased yield and improved components in saline conditions are critical for the cultivation of economically viable crops. The results showed that Co increased the number and weight of fruits. The capacity of Co to decrease sodium and chloride in mango leaves has been noted. Chen et al (2020) shown that lowering sodium and chloride levels in cucumber plants improves production during salinity stress.

Table 7. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on total sugars in fruit of mango "Fagri Kalan" fruit cultivar in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)															
	Total sugars (%)				Total soluble solids (%)				Total acidity (%)				TSS/Acid Ratio			
2019 season																
	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean
Untreated	8.4 h	15.2 b	10.3 fg	**11.3 C**	14.3 i	19.0 bc	16.9 ef	**16.7 C**	0.67 a	0.25 k	0.26 j	**0.39 C**	21.4 l	67.5 cd	73.1 c	**53.0 C**
*KH_1 : 50	10.5 f	12.5 cd	10.7 ef	**11.2 CD**	15.3 g-i	14.9 hi	15.6 gh	**15.3 D**	0.50 c	0.37 e	0.67 a	**0.51 A**	30.6 k	40.2 j	23.3 l	**31.4 E**
*KH_2 : 100	15.8 ab	16.3 a	14. 0 b	**15.7 A**	20.1 b	23.2 a	18.1 cd	**20.5 A**	0.25 k	0.18 l	0.36 f	**0.26 E**	80.3 b	129.4 a	50.3 hi	**86.7 A**
**Mag_1 : 250	11.7 de	9.6 f-h	10.8 ef	**10.7 D**	15.3 g-i	16.9 d-f	16.0 d-f	**16.5 C**	0.27 i	0.26 j	0.32 g	**0.28 D**	56.7 fg	65.0 de	53.0 gh	**58.3 B**
**Mag_2 : 500	13.7 c	9.0 gh	15.5 ab	**12.7 B**	17.8 c-e	18.9 bc	16.2 fg	**17.6 B**	0.30 h	0.41 d	0.53 b	**0.41 B**	59.3 ef	46.1 i	30.6 k	**45.3 D**
Mean	**12.0 A**	**12.5 A**	**12.4 A**		**16.6 B**	**18.6 A**	**16.8 B**		**0.39 B**	**0.29 C**	**0.43 A**		**49.7 B**	**69.6 A**	**46.1 C**	
2020 season																
Untreated	9.5 g	15.8 ab	8.9 g	**11.4 C**	15.6 g	17.9 d-f	20.0 a-c	**17.8 B**	0.54 a	0.39 d	0.41 c	**0.45 A**	28.9 j	45.8 i	48.8 hi	**41.2 C**
*KH_1 : 50	10.5 f	13.5 cd	11.5 ef	**11.9 C**	16.3 fg	15.9 g	16.6 e-g	**16.2 C**	0.50 b	0.37 e	0.31 h	**0.39 B**	32.6 j	42.9 i	53.5 gh	**42.0 C**
*KH_2 : 100	**15.0 b**	16.4 a	15.5 ab	**15.7 A**	17.0 e-g	21.0 a	19.3 b-d	**19.1 A**	0.20 m	0.19 n	0.36 f	**0.25 E**	85.2 C	110.0 a	53.7 gh	**83.3 A**
**Mag_1 : 250	12.5 de	10.9 f	11.5 ef	**11.7 C**	16.3 fg	17.9 de	18.7 cd	**17.6 B**	0.25 k	0.26 j	0.32 g	**0.28 D**	65.2 de	68.9 D	58.3 fg	**64.1 B**
**Mag_2 : 500	13.9 c	10.9 f	13.1 cd	**12.6 B**	18.0 de	19.3 b-d	20.2 ab	**19.2 A**	0.30 i	0.41 c	0.21 l	**0.31 C**	60.0 ef	47.2 i	96.3 B	**67.8 B**
Mean	**12.3 B**	**13.5 A**	**12.1 B**		**16.7 B**	**18.4 A**	**18.0 A**		**0.36 A**	**0.32 B**	**0.32 B**		**54.4 B**	**63.1 A**	**62.1 A**	

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.
* (KH) Potassium humate, ** (Mag) Magnetite and *** (Co) Cobalt Sulphate.

Table 8. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on nitrogen, phosphorus and potassium content in leaves of mango "Fagri Kalan" in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)											
	N (%)				P (%)				K (%)			
2019 season												
	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean	Co_1 : 0	Co_2 : 15	Co_3 : 30	Mean
Untreated	2.22 fg	2.39 ab	2.29 c-f	**2.30 B**	0.43 h	0.48 a	**0.45 ef**	**0.45 C**	1.94 m	2.39 c	2.22 j	**2.18 E**
*KH_1 : 50	2.20 g	2.19 g	2.32 b-d	**2.24 C**	0.47 bc	0.47 bc	**0.46 c-e**	**0.46 B**	2.28 h	2.20 k	2.18 l	**2.22 D**
*KH_2 : 100	2.39 ab	2.41 a	2.33 bc	**2.38 A**	0.47 ab	0.48 a	**0.46 cd**	**0.47 A**	2.41 b	2.49 a	2.33 f	**2.41 A**
**Mag_1 : 250	2.34 bc	2.24 e-g	2.34 a-c	**2.31 B**	0.47 bc	0.45 fg	**0.44 h**	**0.45 C**	2.35 e	2.22 j	2.29 g	**2.29 B**
**Mag_2 : 500	2.30 c-e	2.25 d-g	2.33 bc	**2.29 B**	0.46 de	0.44 gh	**0.46 cd**	**0.45 C**	2.23 i	2.37 d	2.23 i	**2.28 C**
Mean	**2.29 A**	**2.30 A**	**3.32 A**		**0.46 A**	**0.46 A**	**0.45 B**		**2.24 C**	**2.33 A**	**2.25 B**	
2020 season												
Untreated	2.49 a-d	2.33 b-d	2.53 ab	**2.45 AB**	0.41 fg	0.46 b	0.44 b-e	**0.43 B**	2.39 a	2.30 a	2.31 a	**2.34 A**
*KH_1 : 50	2.39 a-d	2.30 cd	2.29 d	**2.33 CD**	0.45 b-d	0.44 b-d	0.42 e-g	**0.44 AB**	2.00 b	2.28 a	2.26 a	**2.18 B**
*KH_2 : 100	2.45 a-d	2.59 a	2.50 a-c	**2.51 A**	0.44 c-e	0.48 a	0.43 d-f	**0.45 A**	2.37 a	2.40 a	2.18 ab	**2.32 A**
**Mag_1 : 250	2.46 a-d	2.33 b-d	2.40 a-d	**2.40 BC**	0.41 fg	0.43 c-e	0.41 fg	**0.42 C**	2.31 a	2.21 ab	2.32 a	**2.28 AB**
**Mag_2 : 500	2.34 b-d	2.05 e	2.34 b-d	**2.24 D**	0.45 bc	0.43 c-e	0.40 g	**0.43 BC**	2.26 a	2.21 ab	2.16 ab	**2.21 AB**
Mean	**2.42 A**	**2.32 A**	**2.41 A**		**0.43 B**	**0.45 A**	**0.42 C**		**2.27 A**	**2.28 A**	**2.25 A**	
##Optimum levels	**1.88**				**1.15**				**0.95**			

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.
* (KH) Potassium humate, ** (Mag) Magnetite, *** (Co) Cobalt Sulphate

Table 9. Effect of soil application of potassium humate & magnetite and foliar application with cobalt on iron, zinc and cobalt content in leaves of mango "Fagri Kalan" in the 2019 and 2020 seasons

Soil application (g/tree)	***Co foliar application (ppm)											
	Fe (ppm)				Zn (ppm)				Co (ppm)			
2019 season												
	Co 1 : 0	**Co 2 : 15**	**Co 3 : 30**	**Mean**	**Co 1 : 0**	**Co 2 : 15**	**Co 3 : 30**	**Mean**	**Co 1 : 0**	**Co 2 : 15**	**Co 3 : 30**	**Mean**
Untreated	130.3 i	136.9 c	132.3 gh	**133.2 D**	10.1 d	12.5 a	12.2 ab	**11.6 B**	3.25 g	3.29 a-c	3.25 g	**3.26 B**
***KH 1 : 50**	131.7 h	132.8 g	130.8 i	**131.8 E**	11.4 c	11.4 c	11.6 c	**11.5 B**	3.27 ef	3.28 c-e	3.29 b-d	**3.28 A**
***KH 2 : 100**	138.8 b	139.0 a	134.7 e	**137.8 A**	12.4 a	12.7 a	11.4 c	**12.2 A**	3.26 fg	3.31 a	3.29 b-d	**3.28 A**
****Mag 1 : 250**	136.4 c	133.7 f	131.9 h	**134.0 D**	11.6 c	11.8 bc	11.6 c	**11.6 B**	3.28 de	3.26 fg	3.25 g	**3.26 B**
****Mag 2 : 500**	135.9 d	136.7 c	135.3 d	**135.0 B**	10.2 d	12.4 a	11.5 c	**11.4 B**	3.27 ef	3.27 ef	3.30 ab	**3.28 A**
Mean	**134.6 B**	**135.0 A**	**133.0 C**		**11.2 C**	**12.2 A**	**11.6 B**		**3.26 C**	**3.28 A**	**3.27 B**	
2020 season												
Untreated	205.4 f	210.8 bc	210.0 b-d	**208.7 B**	13.6 d	15.6 ab	13.5 d	**14.3 B**	3.25 a	3.28 a	3.29 a	**3.27 AB**
***KH 1 : 50**	204.9 f	211.2 bc	206.5 ef	**207.5 C**	13.7 d	13.5 d	14.3 c	**13.8 C**	3.15 b	3.30 a	3.26 a	**3.24 B**
***KH 2 : 100**	208.2 de	215.3 a	209.0 cd	**210.8 A**	15.3 b	15.8 a	14.4 c	**15.2 A**	3.26 a	3.31 a	3.31 a	**3.29 A**
****Mag 1 : 250**	199.1 g	209.0 b-d	210.9 bc	**206.7 C**	13.4 d	15.6 ab	15.6 ab	**14.9 A**	3.28 a	3.29 a	3.25 a	**3.27 AB**
****Mag 2 : 500**	206.1 f	211.0 bc	211.8 b	**209.6 B**	13.6 d	14.4 c	13.7 d	**13.9 C**	3.27 a	3.25 a	3.28 a	**3.27 AB**
Mean	**204.7 C**	**211.6 A**	**209.6 B**		**13.9 C**	**14.0 A**	**14.3 B**		**3.24 B**	**3.29 A**	**3.28 A\B**	
##Optimum levels	**657-961**				**7.71-18.3**				**# 8**			

Values having the same letters in the same column, row or interaction in each season are not statistically different at 5 % level.
* (KH) Potassium humate, ** (Mag) Magnetite. *** (Co) Cobalt Sulphate .

4 Conclusion

From the foregoing results, It is possible to come to the conclusion that all soil implementation levels with (KH) and (Mag), was affected significantly on yield, fruit characteristics, macro-, micronutrients content and in most cases second rate of potassium humate as soil application (KH_2)100 g/tree followed by the first rate of (Mag_1) 250 g/tree was sufficient for gave the high values. As for, all cobalt rates enhanced yield, fruit characteristics, macro and micronutrient content in the majority of cases, whereas, spring with (Co_2) 15 ppm and (Co_3) 30 ppm gave the highest values of yield, fruit characteristics, macro and micronutrients content. Regarding the combination between soil application and cobalt foliar application in most cases, it is clear that yield, fruit characteristics and nutrient content were increased by KH_2 as a soil application (100 g/tree) with spring cobalt (Co_2) at 15 ppm (KH_2X Co_2) followed by magnetite (Mag_1) 250 g/tree with Co_2 at 15 ppm (Mag_1X Co_2). Meanwhile, with the same statically stand point, other soil combinations provided more or less similar result. Therefore, it could be recommended by treated mango "Fagri Kalan" with (KH_2X Co_2) treatment which sufficient for helping trees to alleviate salinity stress and as an effective treatment for increasing yield, fruit characteristics, and leaf nutrient content (N, P, K, Fe, Zn and Co) especially in new reclaimed land conditions under drip irrigation system with salinity water.

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