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Research Paper

Effect of Cobalt on Moringa Oliferagrowth, Yield Quantity and Quality

Science

KEYWORDS : Moring olifera- Cobalt – growth –yield quality.

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ABSTRACT

Two pot experiments were carried out in the wire house, National Research Centre-, Dokki, Egypt to evaluate the effect of cobalt on Moringa growth, yield quantity and quality.Seeds of Moringa olifera were sown in 8 August during 2012 and 2013 Seasons. Seedlings of Moringa Olifera (at the true leaves) irrigated once with cobalt concentrations; 0.0, 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm. Cobalt sulphate salt was used to enrich the soil with cobalt. All treatments were 5 replicates and arranged in a randomized complete block design. Irrigation with tap water was practiced to keep soil almost at field capacity for 120 days. After 60 days from sowing, plants were harvest (10 cm above soil surface). Plants were harvested after 45 days from first harvest, and then plants re-harvested third harvest after 45 days from second harvest.

The obtained results are summarized in the following:

- *All cobalt treatments significantly increased growth and yield parameters, minerals composition and chemical constituents compared with untreated plants.*
- *Cobalt at 10 ppm resulted the superior growth, yield quantity and quality of Moringa olifera herb.*
- *Increasing cobalt level in plant media above 10 ppm the promotive effect of cobalt was reduced.*

1.Introduction:-

The morning tree, (*Moringa Oleifera*), has probably been the most popular plant in ECHO'S seed bank of underutilized tropical crops. The tree is native to India but has been planted around the world and is naturalized in many locales. Moringa goes by many names. In the Philippines, where the leaves of the moringa are cooked and fed to babies, it is called "mother's best friend" and "malunggay". Other names for it include the benzolive tree (Haiti), horseradish tree (Florida), Nebeday (Senegal) and drumstick tree (India).

There are about 13 species of moringa trees in the family Moringaceae. They are native to India, the Red Sea area/or parts of Africa including Madagascar. Of these species, Moringa oleifera is the most widely known. In this document, the term "moringa" refers to moringa oleifera. All other species are referred to by their Latin name [1]. Moringa roots, fruits, leaves and flowers are used as vegetables [2]. Moringa leaves are potential source of vitamin "A" and "C", iron, calcium, riboflavin, B-cartain and phenolic. Its leaves and oil contain powerful natural antioxidants [3]. Moringa leaves contain more vitamin "A" than carrots, calcium than milk, more iron than spinach, more vitamin "C" than orange, and more potassium than bananas, and that the protein quality of moringa leaves rivals that of milk and eggs [4]. Moringa species have long been recognized by folk medicine practitioners as having value in Tumar therapy we examined compounds and for their cancer preventive potential [5].

Cobalt is considered to be a beneficial element for higher plants. Cobalt is an essential element for the synthesis of vitamin B_{12} which is required for human and animal nutrition [6]. Unlike other heavy metals, cobalt is saver for human consumption up to 8 ppm can be consumed on a daily basis without health hazard. Cobalt do not accumulate in human body as the other heavy metals with the increase in age. Cobalt is known that human body could get rid of cobalt through urination [7] who added that cobalt-dense compounds found in the pigments are necessary for the plant to resist fungal and insect attack consumed by animals and humans, these compounds act as antioxidants. Atta Aly [8] reported that cobalt is required in low cobalt levels for maintaining high yields of squash, parsley [9], tomato [10] ,groundnut [11], Soybean [12], rice [13].

Chao-Zhou et al [14] found that cobalt increase cytoplasmic osmotic pressure, leaf resistance to dehydration and decreased the wilting coefficient of potato plants. Eman Aziz *et al*[15] reported that all cobalt doses significantly increased peppermint growth and yield parameters compared with control. Cobalt at 15 ppm gave the greatest fresh and dry herb yield; the highest essential oil yield. Cobalt improves the status of macro (N, P and K) and micro (Mn, Zn and Cu) nutrients content. The highest cobalt level (30 ppm) increased the principal components of menthone (37.84%) and iso menthone (15.19%).

Nadia Gad and Hala Kandil [16] showed that cobalt doses significantly increased coriander (*Cariandrum Sativum L.)* herb yield minerals composition, chemical constituents as well as essential oils and its components compared with control plants. Cobalt at 12.5 ppm resulted the maximum figures in each three harvests during to studied seasons. Nadia Gad *et al*[17] stated thatapplying cobalt in suitable concentration gave a significantly increase in sweet basil endogenous hormones such as Auxins Gibberllins, Cytokinens and Abscisic acid.

Cobalt improves the nutritional status as well as chemical constituents. Cobalt at 15 ppm gave the superior values. Nadia Gad *et al*[12] reported that all cobalt doses significantly increased all growth and yield parameters as well as nutritional status, chemical constituents, essential oil content and its composition of Rosemary herb compared with control plants. Cobalt at 10 ppm resulted the highest figures.

1. Materials and Methods

1.1. Soil analysis: - Physical and chemical properties of Nubaria soil samples were determined as well as particle size distributions and soil moisture were determined as described by [18]. Soil PH, EC, cations and anions, organic matter, $CaCo_3$, total nitrogen and available P, K, Fe, Mn, Cu were run according to [19]. Determinations of soluble, available and total cobalt were determined according to method described by [20]. Some physical and chemical properties of Nubaria soil sample are shown in Table (1).

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2.2. Plant material and experimental work:
Two experiments were conducted in Plastic pots (40 cm diameter) of ten kg capacity were filled with sandy loam-soil enriched with recommended N, P and K fertilizers as follow: 0.5, 2.0 and 0.75 gm as ammonium sulphate (21 % N), Ca-superphosphate (15.5 % P_2O_5) and potassium sulphate (50 %K_2O), respectively at wire house of National Research Centre, Egypt, to define cobalt concentrations range which gave growth and yield response. Seedlings of Moringa Olifera (at the third true leaves) irrigated once with cobalt concentrations; 0.0, 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm. Cobalt sulphate salt was used to enrich the soil with cobalt. All treatments were 5 replicates and arranged in a randomized complete block design. Irrigation with tap water was practiced to keep soil almost at field capacity for 120 days. After 60 days from sowing, plants were harvest (10 cm above soil surface). Plants were harvested after 45 days from first harvest, and then plants re-harvested third harvest after 45 days from second harvest.

2.3. Measurement of herb growth parameters: At each harvesting time, Moringa growth parameters such as plant height, leaves number per plant leaf area per plant and root length were recorded according to [21].

2.4. Measurement of herb yield parameters: At each harvesting time, Moringa yield parameters i.e. herb fresh weight, herb dry weight, total fresh weight, total dry weight and dry matter percentage were recorded according to [22].

2.5. Measurement chlorophyll content in leaves:
Chlorophyll content was determined in fresh leaves of Moringa using chlorophyll meter spad 502 according to [23]

2.6. Determination of endogenous hormones:
Auxins, Gibberellins, Cytokinins and Abscissic acid in Moringa herb were determined in the third harvest according to [24].

2.7. Measuring of herb chemical constituents:
Total soluble solids, total carbohydrates**,** total phenols, vitamin "A" as carotene and vitamin "C" as L-Ascorbic acid, in each harvesting time were determined according to [25]

2.8. Measurement of herb nutritional status:
At each harvesting time, macronutrients (N, P and K) as well as micronutrients (Mn, Zn, Cu and Fe) along with cobalt content were determined according to [20].

2.9. Statical analysis:
The obtained data were statistically analyzed of variance procedure outlined by [26] computer program and means were compared by LSD method according to [27].

3. Results and Discussion
1.2. Vegetative growth:
Data presentin Table (2) outline the response of Moringa olifera growth parameters to different cobalt levels. Data indicate that all cobalt rates had a significant promotive effect on Moringa growth parameters compared with control. Cobalt significantly, increased plant hight, leaves number per plant, leaf area per plant and root length. Cobalt at 10 ppm resulted the maximum values of the three harvests, during two growing seasons. Increasing cobalt in plant media above 10 ppm, the promotive effect reduced. These results are in harmony with those obtained by [28]who found that the optimum cobalt level of tomato (7.5 ppm) being with positive effect due to several induced effect in hormonal (Auxins and Gibberllins) synthesis and metabolic activity, while the higher cobalt doses were found to increase the activity of some enzymes such as peroxidase and catalase in plant and hence increasing the catabolism rather than the anabolism.

Table (2): Some growth parameters of Moringa as affected by cobalt supplement (mean of two seasons).

Cobalt treatments (ppm)	Plant height (cm)			Leave number/plant			Leaf area/plant (cm^2)			Root length (cm)		
	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3
Control	65.0	67.4	69.8	7	7	7	41.8	43.1	46.5	9.9	10.3	10.7
2.5	72.0	75.1	78.0	7	8	9	42.2	49.3	59.8	10.5	10.9	11.8
5.0	77.4	79.6	81.9	8	9	9	48.3	55.6	62.9	11.6	13.5	14.6
7.5	81.9	83.2	85.0	9	9	10	54.4	62.8	68.2	12.8	13.8	15.0
10.0	87.2	89.0	90.8	10	11	11	60.3	69.7	77.8	12.3	12.7	14.8
12.5	84.5	85.8	86.6	9	10	10	55.0	63.2	66.4	11.7	12.3	14.0
15.0	81.6	83.3	85.2	8	9	9	48.5	53.8	61.6	11.0	11.9	13.4
LSD 5%	0.3	2.5	0.6	1.0	1.0	1.0	0.6	0.4	1.8	0.5	0.6	0.4

1.3. Endogenous hormons:-
Fig. (1) Clearly indicate that all cobalt levels had a synergistic effect of Moringa endogenous hormonesin the third harvest (mean of two seasons) compared with control plants. Cobalt significantly increase the content of endogenous hormones such as Auxins, Gibberllins and Cytokinins compared with untreated plants. Cobalt at 10 ppm resulted the highest figures of Moringa phytohormons. As cobalt concentrations were ranged more than10 ppm the promotive effect reduced. Plant hormones are naturalproducts; they stimulate the physiological response of plant growth. Different strategies are being employed to maximize plant growth and yield. These results are in good agreement with those obtained by **[29]** who stated that, Auxins and Gibberellins enhances the activation of specific enzyme which participates with RNA and protein synthesis in rice plants. Confirm these data by [28].

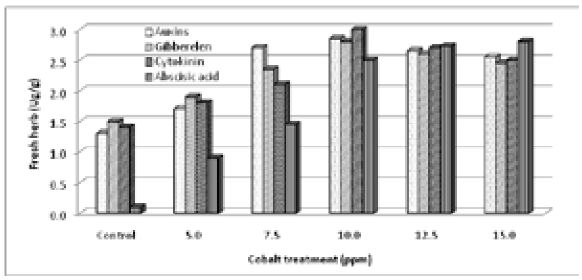

Fig (1): Endogenous hormons (Auxins,Gibberllins, Cytokinins and Abscissic acid) in third harvest of moringa herb as affected by cobalt supplement (mean of two seasons).

Fig. (1) Also indicate a gradual Abscissic acid synthesis with cobalt addition in plant media and increased as cobalt concentrations increased. Under newly reclaimed soils conditions, cobalt significantly increases dramatically Abscissic acid which was previously supposed to play a central role in hormonal control of water balance and help plants to tolerate the drought. These observations are consistent with previous parts obtained by **[30]** who demonstrated that cobalt application reduced water loss as well as water consumption by tomato and squash plants, symptoms of wilting being revealed with cobalt application which significantly increased the percentage of stomatal closure and reduced the transpiration rate. Confirm **[1]**, stomatal resistance was significantly correlated with both leaf water potential and net photosynthesis of peach seedlings.

1.4. Herb Yield:
Data present in Table (3) shows that fresh and the dry herb yield of Moringa gradually increased by increasing cobalt levels in the growing plant media. Cobalt at 10 ppm gave the superior fresh herb and biomass in each of the three harvests, during two growing seasons. When cobalt addition increased more than 10

ppm the promotive effect reduced. The percentages of dry matter cotent increasing as cobalt content ration in plant media increased up to 10 ppm. It is a good indicator of plant growth. These data are in harmony with those obtained by **[12]** who reported that cobalt at 10 ppm resulted the greatest growth and yield of Dill herb as compared with higher ones.Eman Aziz *et al* [15] added that, low level of cobalt (7.5 ppm) recorded the highest fresh and dry weight of peppermint herb.

Table (3): Fresh weight, Biomass and dry matter percentage of Moringa herb as affected by cobalt supplement (mean of two seasons).

Cobalt treatments (ppm)	Herb fresh weight (g)			Herb dry weight (g)			Total fresh weight	Total dry weight	Dry matter
	Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3	(g)		%
Control	80.2	82.0	84.2	17.8	18.4	18.9	241.9	55.1	77.22
2.5	86.8	88.9	89.8	18.2	20.3	20.9	265.5	59.4	77.63
5.0	89.9	91.7	93.9	19.0	19.6	21.8	275.5	60.4	78.08
7.5	98.9	103.9	106.4	20.5	21.3	22.0	309.2	63.8	79.37
10.0	118.8	123.9	126.8	21.8	23.3	23.9	269.6	70.0	81.6
12.5	109.6	112.5	114.7	21.8	22.3	23.1	336.6	67.2	80.03
15.0	100.5	104.2	109.3	20.8	20.9	22.0	314.0	63.7	70.71
LSD 5%	3.1	2.8	4.1	1.0	0.5	0.2	22.4	3.3	3.34

1.5. Chlorophyll Content:

Table (4) show data concerning the effect of applied cobalt on chlorophyll content in Moringa leaves. Data reveals that all cobalt treatments were not significant effect of the Moringa chlorophyll content. These data are in harmony with those obtained by [15].

Table (4): Some chemichal constituents of Moringa herb as affected by cobalt supplement (mean of two seasons).

Cobalt treatments (ppm)	Total Protein	Total Soluble solids	Total carbohyd rates	Total phenoles	Vitamin "A" as Carotene	Vitamin "C" as L-Ascorbic acid	Chloroph yll
	%				mg	100g F.W	spad
	First harvest						
Control	4.75	31.2	25.9	2.02	15.9	17.1	48.8
2.5	5.06	31.8	26.4	2.09	16.5	17.8	48.8
5.0	6.00	32.2	26.9	2.17	16.9	18.5	49.2
7.5	7.25	32.7	27.5	2.31	17.7	19.3	49.3
10.0	8.69	33.5	28.1	2.46	18.4	19.9	49.0
12.5	8.13	33.0	27.8	2.41	18.1	19.5	48.8
15.0	7.63	32.6	27.1	2.39	17.8	19.2	48.7
LSD 5%	0.38	0.5	0.3	0.7	0.3	0.2	NS
	Second harvest						
Control	4.88	31.2	25.9	2.03	15.9	17.1	48.8
2.5	5.25	31.9	26.6	2.11	16.7	18.2	48.8
5.0	6.08	32.4	27.2	2.19	17.2	18.9	49.0
7.5	7.44	32.9	27.9	2.24	17.9	19.6	49.0
10.0	8.88	33.7	28.6	2.40	18.6	20.2	49.8
12.5	8.19	33.1	28.3	2.35	18.2	19.8	48.7
15.0	7.75	32.8	28.0	2.00	17.9	19.5	48.6
LSD 5%	0.31	0.5	0.3	0.8	0.4	0.3	NS
	Third harvest						
Control	4.88	31.5	25.9	2.03	15.9	17.1	48.8
2.5	5.38	32.1	26.9	2.14	17.0	18.5	48.8
5.0	6.19	32.7	27.8	2.25	17.8	19.4	48.9
7.5	7.63	33.3	28.5	2.36	18.3	20.0	49.6
10.0	8.94	33.9	29.0	2.48	18.9	20.8	49.2
12.5	8.38	33.5	28.6	2.43	18.6	20.4	49.0
15.0	7.94	32.6	28.3	2.39	18.1	19.7	48.7
LSD 5%	0.31	0.6	0.2	0.9	0.3	0.4	NS

1.6. Chemical Constituents:

The favorable effect of cobalt on the percentages of protein, total soluble solids, total carbohydrates, total phenols, vitamin "A" and vitamin "C" in Moringa herb are given in Table (4).Results indicate that all the mentioned chemical parameters were significantly increased by the addition of cobalt levels compared with control plants. Cobalt had a significant beneficial effect on proteins, total soluble solids, total carbohydrate, as well as vitamin "A" and vitamin "C". Cobalt at 10 ppm gave the greatest values. Increasing cobalt concentration more than 10 ppm reduced the promotive effect.

Data in Table (4) shows also the relative calculated values as percentage of control. It is evident that these results agree with those obtained by [17] who found that all cobalt treatments (0.0, 7.5, 15.0, 22.5 and 30 ppm) significantly increased the studied chemical contents in sweet basil (total soluble solids, total carbohydrates, proteins and vitamin "C" compared with control. Cobalt rate at 10 ppm increased the contents of:Proteins 22.89–25.70%, total soluble solids 7.37-7.62%, total carbohydrates 8.49–11.97%, total phenols 21.78-22.17%, vitamin "A" 15.72-18.87% and vitamin "C" 16.37-21.64% respectively. Vitamin "A" as carotenoids are now recognized an important antioxidant and is essential to human growth, normal physiological functions, health of the skin as well as mucous membranes. Moreover, vitamin "C" is an antioxidant and is necessary to several metabolic processes, especially with energy Co-enzy mes of tomato plants [32]. For human vitamin "C" dietary intake correlates with reduced gastric cancer risk[33]

1.7. Nutritional Status

3.6.1. Macronutrients (N, P and K):

Present data in Table (5) show the effect of different cobalt levels on macronutrients in Moringa herb. Data reveals that all cobalt treatments significantly increased the content of N, P and K as compared with untreated plants. The highest values of N, P and K content were obtained by cobalt at 10 ppm. Increasing cobalt concentration in plant growing media above 10 ppm the promotive effect of cobalt reduced.These results are in harmony with those obtained by [34] who found that seed yield of groundnut was increased by cobalt at 1.0 ppm treatment and Rhizebium inoculation. Cobalt sulphate gave the highest N, P and K content as well as seed oil and protein contents. Confirm these data **[12]** who found that cobalt significantly increased macronutrients (N, P and K) of Dill herb compared with untreated plants.

3.6.2. Micronutrients (Mn, Zn and Cu):

Data in Table (5) indicate that all cobalt treatments had a significant positive effect on the Moringa herb content of Mn, Zn and Cu compared with control plants. Cobalt at 10 ppm resulted the maximum values. Increasing cobalt addition in plant media more than 10 ppm, the positive effect of cobalt reduced. These data are good agree with those obtained by [35] who found that cobalt level of 2.5 ppm in solution culture exerted promotive effect on Mn, Zn and Cu content in tomatoes. Nadia Gad and Abd El-Moez [36] added that cobalt had a positive effect on the content of Mn,Zn and Cu of brocooli heads compared with untreated plants.

3.6.2. Iron content:

Data presented in Table (5) show also that Fe content in Moringa herb significantly decreased with the increasing cobalt doses in plant media. These results reveal as mentioned by [37] who found a certain antagonistic relationship between Fe and Co elements. Confirm these results [38] who stated that cobalt were suggested to be competitive elements in the nutrition of tomato plants. When cobalt level increased in plant media, iron contents in tomato shoots signigiantly reduced.

Table (5): Nutritional status of Moring herb as affected by cobalt supplement (mean of two seasons).

Cobalt treatments (ppm)	Macronutrients (%)			Micronutrients(ppm)				Cobalt (ppm)
	N	P	K	Mn	Zn	Cu	Fe	
	First harvest							
Control	0.76	0.66	0.90	20.5	31.0	13.1	113.6	0.86
2.5	0.81	0.68	1.29	21.1	31.9	14.2	111.0	1.08
5.0	0.96	0.73	1.57	22.6	32.5	15.0	108.2	1.82
7.5	1.16	0.76	1.72	23.0	33.2	16.3	104.5	2.79
10.0	1.39	0.80	1.86	24.4	34.6	17.1	98.7	4.12
12.5	1.30	0.77	1.83	24.4	34.1	17.0	91.6	7.61
15.0	1.22	0.72	1.80	21.6	33.7	16.7	91.3	9.23
LSD 5%	0.3	0.2	0.3	0.4	0.5	0.4	2.6	0.12
	Second harvest							
Control	0.78	0.66	0.92	20.6	31.2	13.4	113.6	0.86
2.5	0.84	0.69	1.32	21.5	32.1	14.5	111.5	1.12
5.0	0.97	0.75	1.60	22.9	32.9	15.3	108.3	1.87
7.5	1.19	0.78	1.73	23.8	33.5	16.7	105.2	2.90
10.0	1.42	0.83	1.90	25.2	34.3	17.6	101.0	4.39
12.5	1.31	0.79	1.85	24.7	32.0	17.2	98.3	7.71
15.0	1.24	0.74	1.85	22.5	30.6	16.7	96.2	9.40
LSD 5%	0.5	0.3	0.5	0.4	0.6	0.4	2.1	0.15
	Third harvest							
Control	0.78	.066	0.94	20.6	31.2	13.8	113.9	0.87
2.5	0.85	0.70	1.40	21.4	32.5	14.9	112.2	1.19
5.0	0.99	0.76	1.69	22.9	33.1	16.0	109.0	1.93
7.5	1.22	0.79	1.86	23.5	34.2	16.6	106.3	2.94
10.0	1.43	0.85	1.97	24.8	34.9	17.9	103.1	4.60
12.5	1.34	0.82	1.88	24.5	33.8	17.4	106.2	7.80
15.0	1.27	0.78	1.81	23.1	31.6	16.9	98.7	9.69
LSD 5%	0.13	0.2	0.2	0.3	0.4	0.3	1.7	0.22

2.5.3. Cobalt Content:

Data in Table (5) also reveal that cobalt content in Moringa herb significantly increased when cobalt addition increasing in plant media. These results are in harmony with those obtained by [15] who stated that increasing cobalt concentration in plant media significantly increased cobalt content in peppermint herbs for two harvests as compared with control.Data in Table (5) reveal that cobalt levels of 7.71 and 7.80 ppm, respectively in the three harvests of Moringa with cobalt dose of 12.5 ppm. Young [7]reported that the daily cobalt requirements for human nutrition could reach 8 ppm depending on cobalt levels in the local supply of drinking water without health hazard.

3. Conclusion:

Cobalt had a significant promotive effect of Moringa olefira growth, yield, chemical constituents and nutrients status. It could be suggested that cobalt is consider a beneficial element for higher plants. Therefore, considerable attention sould be taken concerning applying this element (cobalt) as a fertilizer.

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