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Research Paper

Influence of Cobalt Rates and Nitrogen Sources on Moringa Yield Quantity and Quality

Science

KEYWORDS : Moringa - Cobalt- Ammonium sulphate- Ammonium nitrate- Urea.

Author	Affiliation
Nadia Gad	Plant Nutrition Dep., National Research Centre, El Buhoth St., Dokki, Cairo, Egypt
Lyazzat Bekbayeva	Biology Programme, School of Distance Education
Misni Surif	Centre for Marine and Coastal Study, Universiti Sains Malaysia

ABSTRACT

Twopot experiments were conducted to evaluate the influence of cobalt rates and nitrogen sources on Moringa yield quantity and quality during 2012 and 2013 seasons. Experiments were carried out in the wire house, National Research Centre. Nitrogen sources namely, ammonium sulphate, ammonium nitrate and urea were used. Cobalt was added once in the form of cobalt sulphate at the rates of 0.0, 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm cobalt.

The obtained results are summarized in the following:-

- *All nitrogen sources increased the concentrations of both NO3-N and NO2-N in Moringa leaves.*
- *The contents of NO3-N and NO2-N in Moringa leaves were greater in N fertilized plants as compared to that of the unfertilized one.*
- *The highest concentrations of NO3-N, NO2-N in Moringa leaves were recorded with urea compared with ammonium nitrate, while the lowest figures recorded with ammonium sulphate.*
- *All cobalt rates significantly reduced the content of No3-N and No2-N Moringa leaves compared with control under different nitrogen sources in two studied seasons.*
- *Cobalt has a significant promotive effect on all growth and yield parameters as well as nutritional and chemical contents compared with control.*
- *The best yield (fresh weight of herb) and growth parameters were evident with ammonium sulphate and at a record increment of cobalt, i.e. 10 ppm.*
- *Cobalt at 10 ppm had a favorable effect onMoringa growth and yield parameters as well as nutritional status, carbohydrates, proteins, vitamin A, vitamin C and chlorophyll content.*
- *All cobalt treatments were not significant effect of chlorophyll content in Moringa leaves with different sources of nitrogen in two studied seasons.*

1. Introduction:-

Moringa (*Moringa oleifera L.*)plantbelonges to moringaceae-family, consists of one genus and fifteen recognized species. It is cultivated mainly in several tropical countries. Moringa is the multiple uses, but it has been more intensive use in industry, medicine and feeding of human and animals as a protein source. It is economical importance in the production of several commodities, such as oil, food, condiments and medicines. It is also rich in phenolic compounds, antioxidant activities [1]. Moringa plant family is rich in compounds containing the simple sugar, rhamnose and it is rich in a fairly unique group of compounds called glucosinolates, anticancer and antibacterial [2]. In fact, the nutritional properties of Moringa are now so well known that there seems to be little doubt of the substantial health benefit to be realized by consumption of Moringa leaf poder in situations where starvation is imminent. Nonetheless, the outcomes of well controlled. Moringa leaves can be eaten fresh, cooked or stored as dried powder for many months without refrigeration and reportedly without loss of nutritional value. Moringa trees had in recent times been advocatedas, an outstanding indigenous source of highly digestible protein, calcium, iron, vitamin "C" and carotenoids (vitamin "A")[3]. Moringa roots, leaves, flowers and fruits are used as vegetables [4]. Njoku and Adikwa[5] reported that, Moringa leaves are a potential source of iron, calcium, B-carotene, phenolics, riboflarin, vitamin "A" and vitamin "C".

Cobalt (Co) is considered as a beneficial element for higher plant despite absence of evidence of its direct role in plant metabolism. **Boureto *et al.*,[6]** found that 2.5 ppm cobalt is sand culture was found to promote the effects on N, P and K of tomato plants. The acceptable safety limit adopted by some countries ranged from 2000 and 2500 ppm fresh for spinach and lettuce [7].**Munzert[8]**showed that nitrate content in vegetables range from 20 to 400 ppm; with mean of 150 ppm and a peak value of 6500 ppm found in lettuce and spinach. **Lui et al., [9]**found that growth of onion roots increased with the cobalt addition at 3 kg/ha. **Naybari*et al.*,[10]r**eported that groundnut seed protein and oil contents were the highest with a combination 1.0 ppm cobalt treatment and *Rhizobium* inoculation. Nadia **Gad *et al.*, [11]** stated that the best yields (fresh weight of leaves), growth parameters and physiological trait were evident in both Jew's Mallow and spinach plants with ammonium sulfate or N sources and at record increment of cobalt; i.e. 6 ppm for spinach and 8 ppm for Jew's Mallow. **Nadia Gad and AbdEl-Moez[12]** demonstrated that the cobalt addition significantly increased the broccoli growth, head yield and its quality compared with control. Cobalt at 6 ppm had a greatest values of broccoli growth, head yield, mineral composition as well as heads chemical contents such as total soluble solids, sugar, phenols, vitamin "A" and vitamin "C". On the other hand tetrible acidity as citric acid showed negative response to all levels of cobalt which mean increasing the heads quality of broccoli. **Nadia Gad and HalaKandil [13]** showed that cobalt treatments significantly increased coriander *(coriandrum sativum L.)* herb yield, minerals composition, chemical constituents as well as essential oils components compared with control plants. Cobalt at 12.5 ppm resulted the maximum figures in each three harvests during two studied seasons. **Eman Aziz *et al.*,[14]**stated that all cobalt doses gave a significant positive effect on sweet basil growth, herb yield and essential oil compared with control. Cobalt at 15 ppm gave the greatest values of fresh and dry herb yield along with essential composition.

Recently, **[15]** stated that all cobalt doses significantly increased Dill growth, herb yield, nutritional status, chemical constituents as well as essential oil content and its composition compared with control. Cobalt at 10 ppm resulted the superior growth, herb yield quantity and quality of Dill.

This work aimed to study the effect of cobalt rates and nitrogen sources on the Moringa yield quantity and quality.

2. MATERIALS AND METHODS

2.1.Soil analysis: - Physical and chemical properties of El-Nobaria soil samples were determined well as particle size distributions and soil moisture were determined as described by **[16]**. Soil pH, EC, cations and anions, organic matter, $CaCO_3$, total nitrogen and available P, K, Fe, Mn, Cu were run according to **[17].** Determinations of soluble, available and total cobalt were determined according to the method described by [18]. Some physical and chemical properties of El-Nobaria soil sample are shown in Table (1).

2.2. Experimental works:-

Two pot experiments were conducted to evaluate the effect of different cobalt levels and nitrogen sources on the growth, yield quantity and quality of Moringa.

Plastic pots (40 cm diameter) of ten kg capcity were filled with sandy loam-soil: Samples, taken from El-Nubaria farm-National Research Centre. Seeds of Moringa olifera were sown in 8 August during 2012 and 2013 Seasons.

Table (1). Some physical and chemical properties of El-Nobaria soil

Physical properties											
Particle size distribution %				Soil moisture constant %							
Sand	Silt	Clay	Soil texture	Saturation	FC	WP	AW				
70.8	25.6	3.6	Sandy loam	32.0	19.2	6.1	13.1				
Chemical properties											
				Soluble cations (meq⁻¹L)				Soluble anions (meq⁻¹L)			
pH 1:2.5	EC ($dS m^{-1}$)	$CaCO_3$ %	OM %	Ca^{++}	Mg^{++}	K^+	Na^+	HCO_3^-	$CO_3^=$	Cl^-	$SO_4^=$
8.49	1.74	3.4	0.20	0.8	0.5	1.6	1.80	0.3	0.0	1.9	0.5
Cobalt (ppm)			Micronutriments (mg 100 g^{-1} soil)			Available micronutriments (ppm)					
Soluble	Available	Total	Total N	Available P	Available K	Fe	Mn	Zn	Cu		
0.35	4.88	9.88	15.1	13.3	4.49	4.46	2.71	4.52	5.2		

FC (Field capacity), WP (Welting point), AW (Available water).

The seedlings were treated with three N sources i.e. Ammonium sulfate (20% N), Ammonium nitrate (31.5%N) and Urea (46%N) at the rate of 300 /hectar; seedlings (at the third true leaves.) irrigated with 7 cobalt levels (o.o, 2.5, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm) once. Cobalt sulphate was used as a source of cobalt. All plants received natural agricultural practices whenever they needed. Recommended doses of the N, P and K fertilizers were applied as follow: 150 kgsuperphosphate, 50 kg potassium suphate, 20 N unit ammonium sulphate, 20 N unit ammonium nitrate, 20 N unite urea. The recommended agricultural practices for commercial Moringa production were followed harvesting carried out after 75 days from transplanting. The second harvests after 45 days from first harvest, and thenplants reharvested third harvest after 45 days from second harvest.

2.3. MeasurementMoringa growth and yield parameters:-

All growth parameters such as plant high, leaves number/plant, leaves area/plant, root length, herb fresh weight/plant and herb dry weight/plant were recorded according to **[19] and[20].**

2.4. Measurementof mineral composition:-

Macronutrients (N, P and K) as well asmicronutrients (Mn, Zn, Cu and Fe) along with cobalt contents were determined according to [18].

2.5. Measurement NO_3-N and NO_2-N concentrations:-

NO_3-N and NO_2-N concentrations in leaves based on fresh weight were determined according **[17].**

2.6. Measurementchlorophyll content in leaves:-

Chlorophyll content was determined in fresh leaves of Moringa using chlorophyll meter spad 502 according to **[21].**

2.7.Measurementchemical constituents:-

Total carbohydrates, total soluble solids, total phenoles, vitamin "C" as L-Ascorbic acid and vitamin "A" as carotene were determined according to [22].

2.8.Statistical analysis:-

The obtained data were statistically analyzed of variance procedure outlined by [23] computer program and means compared by LSD method according to [24].

3. RESULTS and DISCUSSION

3.1 Vegetative growth:-

Data in Table (2) indicate that the application of nitrogen fertilizers had a promotive effect of Moringa growth parameters such as plant high, leaves number per plant and leaves areaindex, plant and root length, in the three harvests during two studied seasons.

Ammonium sulfate gave the highest figures of Moringa growth parameters followed by ammonium nitrate. Using urea fertilizer as a source of nitrogen resulted in lowest ones.

Data in Table (2) also show that cobalt treatments significantly increased all growth parameters of Moringa with all nitrogen sources (ammonium sulphate, ammonium nitrate and urea) compared with control plants. Cobalt addition at 7.5 ppm resulted the greatest values of all studied parameters with all nitrogen sources. As well known, plant growth can be expressed through several parameters, one of which is the dry matter content. Table (3) presents data obtained for dry matter content of Moringaherb. Obtained results show the highest effect for the dose of applied cobalt (10 ppm) on both fresh and dry weights of Moringaherb. When cobalt addition increased over than 10 ppm, the promotive effect reduced. These observations are in consistent with previous reports obtained by **[25]** who showed that, low level of cobalt (7.5 ppm) in tomato, being with positive effect of due to several induced effects in hormonal (Auxins and Gibbrellins) synthesis and metabolic activity, while the higher cobalt levels were found to increase the activity of enzymes such as peroxidase and catalase in plant and hence increasing the catabolism rather than the anabolism.

Table (2): Growth parameters of Moringa as affected by different cobalt rates and nitrogen sources (mean of two seasons).

[illegible]	[illegible]	[illegible]			[illegible]			[illegible]			[illegible]		
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Cobalt at 7.5 ppm combined with ammonium sulfate gave the superior figures of Moringa growth parameters**.** Confirm these data **[26]** who reported that all cobalt levels significantly increased the content of endogenous hormones such as Auxins, Gibberllins and cytokinins compared to control. Plant hormones are natural products; they stimulate the physiological response of plant growth. Different strategic are being employed to maximize plant growth and yield.

3.2.Chlorophyll content:-

Table (3) show data concerning the effect of applied cobalt on the green pigments in Moringa leaves under conditions of different cobalt levels and nitrogen sources. Data show that all cobalt treatments were not significant effect of chlorophyll content with the different sources of nitrogen in two studied seasons.

3.3.NO_3-N and NO_2-N contents:-

Data in Table (3) show that the concentrations of NO_3-N and NO_2-N (mg kg^{-1} fresh weight) in Moringa leaves were greater in nitrogen fertilizer plants as compared to that of the unfertilized plants. The content of NO_3-N in Moringa leaves ranged between 1422- 1083 mg kg^{-1} fresh weight. **Gianquinto *et al.*,[7]** reported that safety limits of nitrate adopted by some countries ranged between 20-2500 ppm fresh weights for spinach and lettuce. Data in Table (3) clearly indicate that ammonium sulfate decreased NO_3-N concentration in Moringa leaves compared with ammonium nitrate and urea. The highest NO_3-N concentrations were recorded as using urea fertilizer. These results are in harmony with those obtained by **[27]** who found that nitrate accumulation in spinach leaves was lowest with ammonium sulfate compared to both urea and ammonium nitrate. Data in Table (3) also show cobalt gave noticeable effect on the content of NO_3-N in Moringa leaves with all nitrogen sources, which increased leaves quality. Increasing cobalt levels in plant media decreased NO_3-N content. These results are agree with those obtained by **[28]**who stated that increasing the content of NO_3-N and oxalate in spinach leaves decreased the leaves quality. Data in Table (3) also indicated that the content of NO_2-N in lMoringa leaves ranged between 4.44- 5.67 mg kg^{-1} fresh weight

Table (3): Chlorophyll, NO_3-N and NO_2-N contentsas affected by different cobalt rates and nitrogen sources (mean of two seasons)

Nitrogen source	Cobalt concentration (ppm)	Chlorophyll (spad)			NO_3-N Mg Kg^{-1} Fresh weight			NO_2-N		
Ammonium Sulphate	Control	52.1	52.1	52.1	1121	1121	1121	5.23	5.23	5.23
Ammonium sulphate	2.5	52.1	52.1	52.1	1084	1086	1084	5.23	5.23	5.11
	5.0	52.1	52.1	52.1	1076	1077	1075	4.98	4.98	4.97
	7.5	52.0	52.1	52.1	1064	1066	1063	4.88	4.86	4.85
	10.0	52.0	52.0	52.0	1052	1054	1051	4.76	4.75	4.73
	12.5	52.0	52.1	52.1	1040	1042	1040	4.65	4.63	4.60
	15.0	52.1	52.0	52.1	1031	1033	1030	4.54	4.52	4.50
	LSD 5%	NS	NS	NS	11	9	10	0.10	0.11	0.10
Ammonium nitrate	Control	52.1	52.1	52.1	1121	1121	1121	5.23	5.23	5.23
	2.5	52.1	52.1	52.1	1096	1098	1098	5.19	5.17	5.16
	5.0	52.1	52.1	52.1	1083	1086	1084	5.07	5.04	5.04
	7.5	52.0	52.0	52.0	1071	1075	1073	4.98	4.95	4.92
	10.0	52.1	52.1	52.1	1060	1063	1060	4.86	4.83	4.80
	12.5	52.0	52.0	52.0	1049	1052	1094	4.74	4.71	4.69
	15.0	52.0	52.1	52.1	1040	1043	1040	4.62	4.60	4.58
	LSD 5%	NS	NS	NS	9	11	9	0.12	0.09	0.11
Urea	Control	52.1	52.1	52.1	1121	1121	1121	5.23	5.23	5.23
	2.5	52.1	52.1	52.1	1105	1105	1103	5.20	5.19	5.19
	5.0	52.0	52.0	52.0	1093	1092	1090	5.09	5.07	5.06
	7.5	52.1	52.0	52.1	1081	1080	1078	4.97	4.95	4.94
	10.0	52.0	52.1	52.0	1070	1069	1066	4.86	4.84	4.83
	12.5	52.0	52.0	52.0	1059	1058	1056	4.76	4.74	4.72
	15.0	52.0	52.0	52.0	1049	1048	1045	4.65	4.63	4.61
	LSD 5%	NS	NS	NS	10	10	10	0.10	0.09	0.11
	LSD interacti	NS	NS	NS	6	5	5	0.7	0.7	0.6

The content of NO_2-N in Moringa leaves decreased with ammonium sulphate compared with both ammonium nitrate and urea. These results are in harmony with those obtained with **[7]** who reported that the content of NO_2-N in Jew's mallow leaves which received nitrogen fertilizer were higher than that of the untreated plants. Confirm **[27]** who found that ammonium sulphate decreased NO_2-N concentration in spinach leaves followed by ammonium nitrate while urea recorded the highest NO_2-N one. Data in Table (3) also indicate that all cobalt doses decreased the content of NO_2-N in Moringa leaves under different nitrogen sources in two studied seasons. These data are good agreement with those obtained by **[11]** who stated that cobalt gave noticeable effect on the content of NO_3-N and NO2-N and oxalate in spinach leaves with all nitrogen sources. She added that increasing levels of cobalt in plant media, both NO_3-N and NO_2-N concentrations decreased. The content of NO_3-N and NO_2-N was greater in plants fertilized with l nitrogen sources alone compared plants treated with cobalt and nitrogen fertilizers.

Cobalt hence the quality of Moringa leaves under the condition of different nitrogen sources during two studied seasons.

3.4.Yield characteristics:-

Data in Table (4) show yield parameters of Moringa as affected by cobalt levels and different nitrogen sources. Data clearly indicate that all cobalt doses significantly increased Moringa yield parameters such as herb fresh weight, herb dry weight, total fresh weight, compared with control plants. Cobalt at 7.5 ppm cobalt gave the maximum values, with different nitrogen sources during two studied seasons. Increasing cobalt concentrations in plant media, the promotive effect reduced. These observations are in consistent with previous reports obtained by **[15]** who demonstrated that cobalt significantly increased soybean seed and oil yield, Nutrition status (N, P, K, Mn, Zn, Cu and Fe) as well as chemical contents especially with 100% and 75% nitrogen fertilizer. Cobalt addition to the soil save 75% nitrogen fertilizer and could be reduced. Confirm these data **[15]** who stated that, all cobalt concentrations significantly increased all Dill growth and yield parameters as well as nutritional status, chemical constituents as well as essential oil content and its composition compared with control. Cobalt at 10 ppm resulted the superior growth, yield quantity and quality of Dill.

3.5. Nutritional status:-

Data in Table (5) show that all macronutrients (N, P and K) and micronutrients (Mn, Zn and Cu) in Moringa leaves significantly increased as affected by cobalt doses with different nitrogen source, compared with control plants. Cobalt at 7.5 ppm gave the maximum values. Increasing cobalt concentrations in plant media reduce the promotive effect. These data are in harmony with those obtained by **[15]** who found that cobalt significantly increased Dill status of N, P, K, Mn, Zn and Cu compared with untreated plant. Ammonium sulphate resulted highest mineral composition followed by ammonium nitrate followed by urea.

Table (4): Yield parameters of Moringa as affected by herb-different cobalt rates and nitrogen sources. (Mean of two seasons)

[illegible]	Cobalt treatments (ppm)	Herb fresh weight/plant (g)			Herb dry weight/plant (g)			Total Fresh Weight (g)	Total Dry Weight (g)
		Cut 1	Cut 2	Cut 3	Cut 1	Cut 2	Cut 3		
Ammonium sulphate	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LSD at 5%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ammonium nitrate	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LSD at 5%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Urea	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LSD at 5%		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LSD interaction		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table (5): Nutritional status of herb Moringa as affected by different cobalt rates and nitrogen sources. (Mean of two seasons)

Nitrogen source	Cobalt treatments (ppm)	Macronutrients (%)			Micronutrients (ppm)				Cobalt (ppm)
		N	P	K	Mn	Zn	Cu	Fe	
Ammonium sulphate	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	LSD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ammonium nitrate	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	LSD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Urea	Control	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	10.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	LSD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Interaction		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Data in Table (5) also indicate that increasing cobalt concentration in plant media resulted in a progressive depression effect on iron content in Moringa leaves. These results are agree with

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those obtained by **[29]** who showed certain antagonistic relationships between cobalt and iron. Confirm these data [**13**] who found that increasing cobalt level in plant media significantly reduced iron content in coriander plants. Table (5) show that increasing cobalt doses in plant media significantly increased cobalt content in Moringa leaves. These results clearly indicate that cobalt content goes along with the concentration of added cobalt. The obtained results are in good agreement with those obtained by **[30]** who stated that as increasing cobalt concentration in plant media, cobalt content in sweet pepper fruits, increased levels of 8.04- 8.07 ppm cobalt ammonium sulfate, ammonium nitrate and urea respectively, in the highest cobalt treatment (15 ppm) is below the dangerous level, since the daily consumption of Moringaherb does not exceed a few grams. **Young [31]** 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.

3.6.Chemical constituents:-

Data in Table (6) show that all cobalt levels significantly increased proteins, total carbohydrate, total soluble solids, total phenols vitamin "A" and vitamin "C" in Moringa herb compared with untreated plant with different nitrogen sources during to studied seasons. Ammonium sulphate gave the greatest chemical constituents such as total protein, total carbohydrate, vitamin "A" and vitamin "C". Urea recorded the lowest ones. These observations are in consistent with previous reports obtained by **[11]** who pointed that the amount of total carbohydrate, protein, vitamin "A" and vitamin "C" as L-Ascorbic acid contents in Jew' mallow leaves as affected by cobalt with ammonium sulphate gave the highest figures followed by ammonium nitrate. While urea gave the lowest ones. Data in Table (6) reveal that cobalt concentrations significantly increased vitamin "C" as L-Ascorbic acid in Moringa herb with different nitrogen sources. L-Ascorbic acid (vitamin "C") is the major antioxidant in plant cell and in involved in photo protection metal and xenobiotic detoxification, the cell cycle, cell wall growth and cell expansion. It acts as Co-enzyme in metabolic changes and involved in photosynthesis and respiration processes **[32].** For human high vitamin "C" diith reduetary intake correlates with reduced gastric cancer risk [33]**.**

Table (6): Chemical constituents of lettuce leaves as affected by cobalt rates.

Nitrogen source	Cobalt treatments (ppm)	Protein	Total carbohydrate	Vitamin "A"	Vitamin "C"
		(%)			
Ammonium sulphate	Control	21.13	11.43	24.19	11.91
	2.5	22.81	12.08	24.77	12.33
	5.0	23.50	12.33	24.93	12.85
	7.5	23.81	13.19	25.22	13.24
	10.0	23.63	13.48	25.46	13.62
	12.5	23.25	13.77	25.67	13.79
	15.0	22.94	13.89	25.81	13.91
	LSD at 5%	1.4	0.5	0.7	0.4
Ammonium nitrate	Control	3.29	1.12	24.19	11.91
	2.5	3.48	1.27	24.32	13.11
	5.0	3.87	1.44	24.56	12.35
	7.5	4.14	1.58	24.68	12.80
	10.0	4.26	1.81	24.79	12.91
	12.5	3.90	1.78	24.88	13.05
	15.0	3.78	1.75	24.88	13.11
	LSD at 5%	0.6	0.3	0.6	0.3
Urea	Control	21.13	8.17	24.19	11.91
	2.5	21.38	8.36	24.25	12.03
	5.0	21.63	8.87	24.39	12.24
	7.5	22.31	9.29	24.52	12.71
	10.0	21.94	9.76	24.63	12.85
	12.5	21.75	9.91	24.71	12.98
	15.0	21.56	9.91	24.75	13.02
	LSD at 5%	0.3	0.2	0.2	0.3
LSD interaction		0.2	0.1	0.1	0.2

Conclusion:-

Cobalt had a favourable effect of Moringa growth and yield parameters as well as nutrients status and some chemical constituents. Cobalt is consider a beneficial element for higher plants. Therefore, considerable attention should be taken concerning applying this element (Co) as a fertilizer.

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