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Research Paper

Effect of cobalt nutrition on rosemary (*rosmarinus officinals L.*) B-endogenous hormons, chemical and nutritional contents

Nadia Gad *, Abd El-Moez M-R, Hala Kandil

Plant Nutrition Dep. National Research Centre, Dokki, Cairo, Egypt
**Corresponding author E-mail: drnadiagad @yahoo.com*

Abstract

Two field experiments were conducted in Research and Production Station, National Research Centre, Nobaria Location, Beheara Governorate, Delta Egypt under drip irrigation system. Experiments were conducted to evaluate the effect of cobalt levels (0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm) on Rosemary endogenous hormons, chemical constituents and nutritional status during 2012 and 2013 seasons.
The obtained results are summarized in the following:

- Cobalt significantly increase Rosemary herb endogenous hormons such as Auxins, Gibberllins, Cytokinens and Abscisic acid as well as chemical and nutritional contents compared with control.
- Cobalt at 10 ppm gave the greatest figures.
- Increasing cobalt levels more than 10 ppm reduces the positive effect. Finally, Cobalt enhancement Rosemary – oil- quality.

Keywords: *Rosemary; Cobal; Endogenous Hormons; Mineral Composition; Chemical Content.*

1. Introduction

Rosemary (Rosmarinus officinalis L.), Family Lamiaceae, is an evergreen subshrub with erect or ascending branches, which are bale green and downy when young, later brown and woody. Rosemary is native to the Mediterranean region. It is now widely cultivated for ornamental, culinary, medicinal and perfumery purposes. The leaves and young shoots are used medicinally. The constituents include an essential oil (up to 2%) with cineole and camphor and borneol as the main components, plus tannins, saponin and organic acids. These substances give Rosemary a pronounced rubefacient action and dried herb and Rosemary oil, obtained by steam distillation from fresh parts, are components of antiheumatic liniments and aintments. Rosemary also has sedative, diuretic, stomachic, cholagogic, tonic, aromatic, antispasmodic and antiseptic properties. It is especially beneficial for fatigue and neuralgia [1].
Cobalt is beneficial element for plant growth, in higher plants. Cobalt is an essential element for the synthesis of vitamin B_{12} which is required for human and animal nutrition [2].
Laila Helmy and Nadia Gad [3] reported that cobalt at 25 mg Kg^{-1} soil significantly increased parsley growth expressed as plant hight, leaf fresh and dry weights, and number of leaves per plant as well as root fresh and dry weights. Cobalt fertilization also significantly increased essential oil yield of parsley leaves. The main aroma constituent, 1,3,8-p-menthatriene which forms about (76%) of leaves essential oil, showed about (10%) increase over than of control with 50 mg Kg^{-1} soil.
Nadia Gad [4] domonstrated that,in tomato plants cobalt at 7.5 ppm being with positive effect of due to several induced effects in hormonal Auxins and Giberellins 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 anabolism. Also, cobalt at 7.5 gave the highest values of both macronutrients (N, P and K) and micronutrients (Fe,Mn, Zn and Cu) in tomato plants as well as chemical constituents compared with control.
Nadia Gad et al [5] reported that cobalt at 6 ppm gave the highest nutritional status and chemical content of spinach leaves while with the jew`s mallow, cobalt at 8 ppm gave the greatest values. Nadia Gad and Aziz, Eman [6]

domonstrated that cobalt at 22.5 ppm had a significant promotive effect of the lemongrass endogenous hormones (Auxins, Gibberlins and cytokinens), herbs quality such as total soluble solids, total protein, total lipids, total phenols and the contents of N, P, K, Mn, Zn and Cu as compared with other doses. With increasing cobalt, abscisic acid gradually increased while Fe decreased. Higher cobalt concentration more than 22.5 ppm decreased the promotive effect. Generally, the obtained results showed that cobalt had a positive role on herbs of lemongrass. Nadia Gad and Hala Kandil [7] showed that all cobalt treatments significantly increased coriander herb yield, minerals composition (except Fe), chemical constituents as well as essential oils components compared with control plants. Cobalt at 12.5 ppm resulted the maximum figures in each harvests during two studied seasons.

Recently, [8] stated that appling cobalt at 15 ppm gave a significant increasing in endogenous hormones such as Auxins, Gibberllins, cytokinens and abscisic acid compared with control. Cobalt at 15 ppm also gave the synergistic effect on chemical constituents as well as nutritional status of basilicum herbs.

2. Expermintal

2.1. Materials and methods

Two field experiments were conducted in Research and Production Station, National Research Centre, Nobaria Location, Beheara Governorat, Delta Egypt: under drip irrigation system during 2012 and 2013 seasons.

2.2. Soil analysis

Physical and chemical properties of Nobaria Soil were determined and particle size distributions along with soil moisture were determined as described by Blackmore [9]. Soil pH, EC, cations and anions, organic matter, $CaCO_3$, total nitrogen and available P, K, Fe, Mn, Zn, Cu were run according to Black et al., [10]. Determination of soluble, available and total cobalt was determined according to method described by Cottenie et al., [11]. Some physical and chemical properties of Nobaria soil are shown in Table (1).

2.3. Plant material and experimental work

Experimental were carried out the effect of cobalt nutrition on Rosemary herb yield quantity and quality.
A preliminary pot experiment was conducted at Wire house of National Research Centre during 2011 season to define cobalt concentrations range which gave growth and yield response. Seedlings of Rosemary (at the true leaves) irrigated once with cobalt concentrations: 0.0, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, 22.5 and 25.0 ppm.

Table 1: Some Physical and Chemical Properties of 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 ($meq^{-1}L$)				Soluble anions ($meq^{-1}L$)			
pH 1:2.5	EC ($dS\ m^{-1}$)	CaCO3%	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	-	1.9	0.5
Cobalt				Total	Available		Available micronutriments				
ppm				mg 100 g^{-1} soil			ppm				
Soluble	Available		Total	N	P	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).

According to the preliminary experiment results, the concentrations range of cobalt which gave the Rosemary response 0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm. Cobalt at 10 ppm gave the best growth and yield parameters of Rosemary.
Seeds of Rosemary (Rosmarinus officinals L.) were sown in second week of August during both 2012 and 2013 successive seasons. After one month from sowing, seedlings were irrigated once with cobalt sulphate (0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm Cobalt). Each experiment consisting of 6 treatments. Each treatment represented by three plots. Each plot area was 5x3 meters consisting of three rows. Twenty five plants in each row (20 cm a part) were planted. All the plants received natural agriculture practices whenever they needed. One month after transplanting were harvested (10 cm above soil surface), and then plants reharvested second harvest after one month from first harvest.

2.4. Determination endogenous hormones

Auxins (IAA), Gibberllins (GAS), cytokinens and Abscisic were determined according to Shindy and Smith [12].

2.5. Measurement of herb nutritional status

Micronutrients (N, P and K) and micronutrients (Fe, Mn, Zn and Cu) as well as cobalt were determined according Black et al [10].

2.6. Measuring of herb chemical constituents

Total protein, Total soluble solids, total soluble sugars, L-Ascorbic acid, titrate acidity were determined according to A.O.A.C [13].

2.7. Statistical analysis

The obtained data were statististically analyzed of variance procedure outlined by (SAS, [14]) computer program and means were compared by LSD method according to Snedecor and Cochran [15].

3. Results and discussion

3.1. Endogenous hormons

Fig. 1 shows that cobalt has a positive effect on Rosemary endogenous hormons such as Auxins, Gibberllins, cytokinens and Abscisic acid.

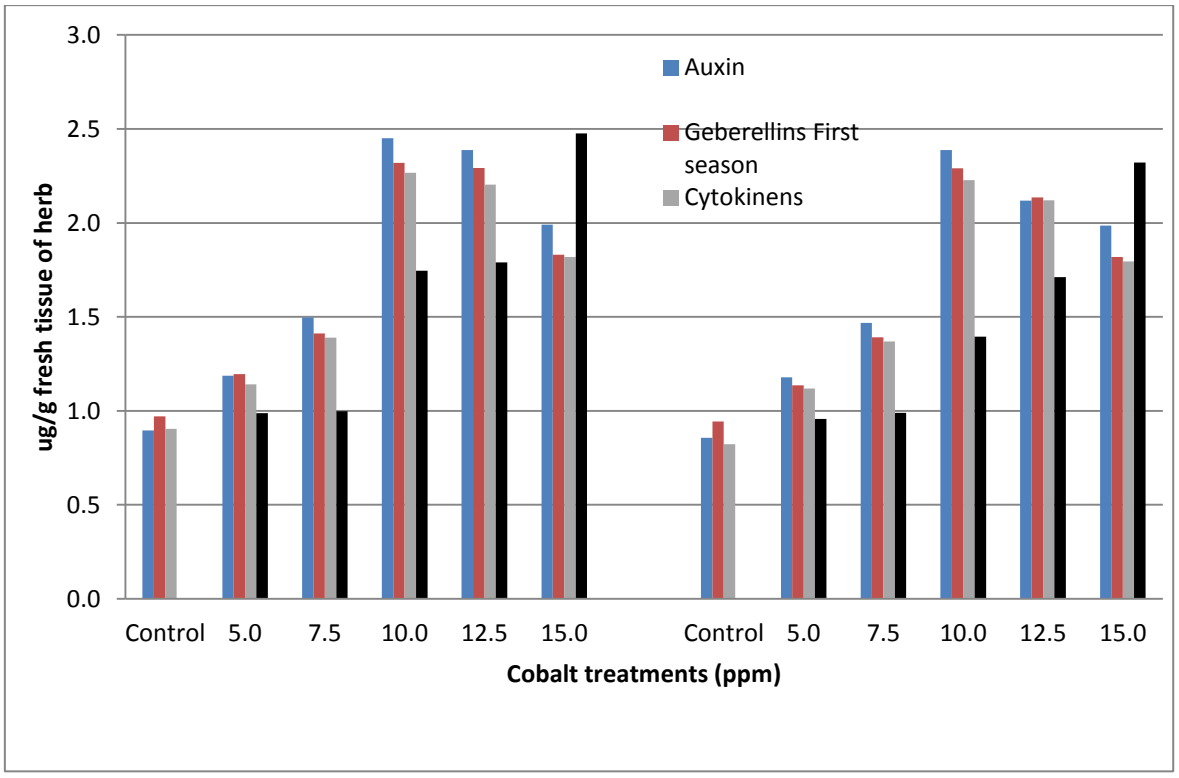

Fig. 1: Effect of cobalt on endogenous hormones of Rosemary herb.

All cobalt concentrations significantly increased the content of endogenous hormons such as Auxins, Gibberllins and cytokinins compared with control plants. Cobalt at 10 ppm resulted the greatest ones of Rosemary herb. Plant hormons are natural products; they stimulate the physiological response of plant growth. Different strategic are being employed to maximize plants growth and yield. When cobalt doses were ranged above 10 ppm, the promotive effect is reduced of growth and yield parameters. These results are in harmony with those obtained by Atta-Ali et al [16] who found that,

cobalt significantly increased both auxins and gibberllins. These hormones enhancement growth and yield parameters of tomatoes. Confirm these results Cassan et a.,l [17] who stated that, Auxins and Gibberllins enhancement the activation of specific enzyme which participates RNA and protein synthesis in rice plants. Nadia Gad and Eman Aziz [18] added that, cobalt had a significant beneficial effect in lemongrass herb hormonal thynthesis and hence increasing the anabolism rather than catabolism. Morever, higher cobalt concentrations were found increase the activity of peroxidase and catalase in tomato plants and hence increasing the catabolism rather than anabolism [19].

Fig. 1 also reveals the gradual abscissic acid synthesis with cobalt addition in plant media and increased as cobalt dose increased. Under newly reclaimed soils, cobalt significantly increases dramatically abscisic acid which was previously supposed to play a central role in hormonal control of water balance and help plants to tolerate the drought. These results are in harmony with those obtained by Nadia Gad [19] who stated that cobalt application reduced water loss as well as water consumption by tomato leaves, symptoms of wiltting being revealed with cobalt application which significantly increased the percentage of stomatal closure and decreased the rate of transpiration.

3.2. Nutritional status in herb

Results presented in Table 2 shows the effect of the different levels of cobalt (0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm) on macronutrients and micronutrients (Mn, Zn, Cu and Fe) in Rosemary herb for two cuts during two seasons.

3.2.1. Macronutrients (N, P and K)

Data reveal that, all cobalt concentration significantly increased the content of N, P and K as compared with control. The greatest values of N, P and K were obtained by using 10 ppm cobalt. This mean that increasing cobalt more than 10 ppm in plant media, the beneficial effect on N, P and K content in Rosemary herb decreased. Confirm these results Basu et a., [20] who found that, low levels of cobalt significantly increased the status of N, P and K in groundnut plants as compared with higher ones. Nadia Gad [21] added that the addition of low cobalt level of 7.5 ppm had significantly highest values on the status of N, P and K in eggplant fruits while the higher concentrations reduced the promotive effect.

Table 2: Effect of Cobalt on Nutritional Status of Rosemary Herb (Mean of Two Seasons).

Cobalt treatment	Macronutrients (%)			Micronutrients (ppm)				Cobalt
(ppm)	N	P	K	Mn	Zn	Cu	Fe	(ppm)
1st Cut								
Control	0.87	0.51	1.57	38.6	61.9	24.4	151	1.82
5.0	1.33	0.66	1.72	42.0	64.0	26.0	149	2.91
7.5	2.21	0.75	2.29	45.8	66.7	28.4	146	4.36
10.0	2.38	0.79	2.52	48.9	69.6	29.6	143	6.19
12.5	1.89	0.63	2.48	46.2	66.9	27.1	139	6.89
15.0	1.82	0.60	2.31	43.5	64.2	25.3	135	7.56
LSD 5%	0.2	0.3	0.21	0.4	0.2	0.7	2.0	0.70
2nd cut								
Control	0.96	0.54	1.77	39.5	62.3	24.9	153	1.84
5.0	1.41	0.69	1.89	43.9	65.7	27.1	151	3.01
7.5	2.26	0.78	2.30	49.0	68.5	28.6	147	4.67
10.0	2.46	0.86	2.63	53.42	71.0	30.8	143	6.33
12.5	2.12	0.80	2.58	51.0	67.3	28.0	140	7.03
15.0	1.93	0.82	2.49	48.4	65.0	26.5	136	7.76
LSD 5%	0.5	0.2	0.5	0.6	0.7	0.6	2.0	0.43

3.2.2. Manganese, Zn and Cu content

Data in Table 2 shows that all cobalt doses had significantly synergistic effect on the content of Mn, Zn and Cu in Rosemary herb for two cuts during two seasons compared with control. Cobalt at 10 ppm gave the highest valus of these elements. Increasing cobalt in plant media reduce the promotive effect. Eman, Aziz et al., [22] indicated that cobalt at 15 ppm gave the greatest Mn, Zn and Cu content in peppermint herb. As cobalt increased above 15 ppm, the positive effects are reduced.

Iron content: Data in Table 2 demonstrated that, increasing cobalt concentration in plant media resulted in a progressive depression effect in Fe content in Rosemary herb for two cuts during two seasons. These results are in harmony with those obtained by Bisht [23] who showed certain antagonistic relationships between these elements (Co & Fe) in plants. Confirm these results Nadia Gad and Eman, Azia [18] who stated that the relative response of Fe to control indicated continuous decrease of this element as a result of cobalt addition from (5 to 15 ppm). They also added that the hazardous effect of cobalt being severely involved in wilting appearance and reduction for net photosynthesis process.

Cobalt content: - Data in Table (2) also indicate, increasing cobalt levels in plant media increased cobalt content in Rosemary herb for two cuts during two studied seasons. 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 Nadia Gad and Aziz, Eman [18] who found that, increasing cobalt in plant media increased cobalt content in lemongrass herb.

Chemical Constituents:- The amounts of (proteins %, total carbohydrates %, total soluble sugars %, total soluble solids % and vitamin "C" as L-Ascorbic acid (mg per 100 g fresh tissue) in Rosemary herb as affected by different cobalt levels are given in Table (3). Results indicate that all the mentioned parameters were significantly increased by the addition cobalt doses (5.0, 7.5, 10.0, 12.5 and 15.0 ppm) as compared with control. In this concern, Nadia Gad et al., [24] revealed that all cobalt concentrations significantly increased total soluble solids, total carbohydrates, total protein and total phenols in sweet herbs. Cobalt at 10 ppm gave the greatest figures. Increasing cobalt concentrations above 10 ppm decreased the promotive effect.

The Results in Table (3) show also the relative calculated values as percentage from control. It is evident that cobalt rate at 10 ppm increased the contents of proteins 173.5 – 156.3 %, total carbohydrates 40.9 – 38.1%, total soluble sugars 137.9 – 142.1%, total soluble solids 33.7 – 33.1% and vitamin "C" as L-Ascorbic acid 10.1 – 10.1% in two cuts of Rosemary herb respectively during the two seasons. These results are in harmony with those obtained by Nadia Gad and Hala Kandil [25] who showed that cobalt at 10 ppm increased the relative calculated values as percentage from control in sweet potato roots: Carotenoids 27 – 31 %, protein 26 – 27 %, starch 7 -8 %, total soluble sugars 18 – 21 % and L-Ascorbic acid 19 – 21 % respectively in the two seasons. Vitamin "C" is an antioxidant and is necessary to several metabolic plant processes [26].

Table 3: Effect of Cobalt on Chemical Constituents of Rosemary Herb (Mean of Two Seasons).

Cobalt treatment (ppm)	Proteins	Total carbohydrates	Total soluble sugars	Total soluble solids	Terrible acidity	L-Ascorbic acid
	%					
1st Cut						
Control	5.44	10.57	1.03	11.38	0.63	10.70
5.0	8.31	11.94	1.67	12.65	0.61	10.92
7.5	13.81	13.82	2.08	13.96	0.61	11.19
10.0	14.88	14.89	2.45	15.22	0.58	11.78
12.5	11.81	13.46	2.33	14.78	0.05	11.41
15.0	11.38	13.8	2.08	14.19	0.56	11.09
LSD 5%	0.43	0.38	0.12	0.68		0.10
2nd Cut						
Control	6.00	10.86	1.14	11.61	0.64	10.79
5.0	8.81	12.33	1.78	12.77	0.62	11.02
7.5	14.13	14.05	2.30	14.02	0.60	11.24
10.0	15.38	15.00	2.76	15.45	0.59	11.88
12.5	13.25	14.79	2.58	15.08	0.57	11.60
15.0	12.06	14.52	2.19	14.81	0.56	11.21

Confirm these results, Franceschi and Tarlyn, [27] who stated that leaf ascorbic content in plant cells and is involved in photo protection metal and xenoboiotec detoxification, the cell cycle, cell wall growth and cell expansion. It acts as Co-enzyme is metabolic changes and involved in photosynthesis and respiration processes. For human high vitamin "C" directly intake correlates with reduced gastric cancer risk [26].

4. Conclusion

Cobalt had significant promotive effect of Rosemary herb endogenous hormones, minerals composition as well as chemical contents. From this study it could be suggested that cobalt is consider a beneficial element for higher plants. Therefore, considerable attention should be taken concerning applying this element (Co) as a fertilizer, but further studies are needed to learn more about this element and its mechanisms in soil and plant.

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