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EFFECT OF COBALT ON CUCUMBER GROWTH, FRUITS YIELD AND MINERAL COMPOSITION

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ABSTRACT

A field experiment was conducted to evaluate the effect of cobalt on cucumber growth, fruits yield and mineral composition. Seedlings of five weeks-old with almost the same stem thickness were transplanted to the field under drip irrigation system. Cobalt was added once in the form of cobalt sulphate in five concentrations namely, 0.0, 7.5, 15.0, 22.5 and 30.0 ppm.

The obtained results indicated that the addition of 15.0 ppm cobalt had significant primitive effect on cucumber growth, fruits yield and mineral content. Higher concentrations exerted hazardous effect on vegetative growth, yield and Mn, Zn and Cu in fruits. Cobalt contents in fruits was increased with every increase in cobalt application. On the other hand, opposite trend was observed for Fe. Cobalt level of 15.0 ppm increased fruits N, P and K content but further increases in cobalt addition up to 30 ppm decreased N, P and K in cucumber fruits.

Keywords: Cucumber – Cobalt – Nobareia – Drip irrigation – Macro and micronutrients.

INTRODUCTION

In spite of the absence of evidence for direct role of cobalt in plant metabolism, it is considered to be a beneficial element for higher plants. Vyrodova (1981) reported that the application of 0.7 Kg $CoSO_4$/ hectare before transplanting has increased dry matter yield of cucumber, tomato and egg-plants. Yagodin and Sablina (1990) found that growth of tomato and cucumber plants as well as their leaves area and dry weight were improved by cobalt addition. Atta-Aly *et al*. (1991) pointed that supplementing nutrient solution with the low level of cobalt improved growth of tomato plants and enhanced both flowering and fruiting. Lisnik (1994) found that cobalt at rate of 2.3 kg/hectare increased sugar content in sugar beats by 0.4 – 1.2%. Liu *et al.* (1995) reported that growth of onion roots was decreased with increasing cobalt concentration above 3 kg/hectare; such roots became twisted. Vinay *et al*. (1996) reported that both fresh and dry yields of clusterbean increased with application of 2 mg cobalt and 40 mg, phosphorous/kg soil. Barik and Naybari (1999) showed that seed yield of ground nut was increased by 1.0 ppm cobalt treatment and Rhizobium inoculation, seed protein and oil contents were the highest with a combination of both cobalt sulphate and Rizobium as N, P and K contents of seeds in all treatments. Morkova (2001) also showed that soil application of 0.7 kg $CoSO_4$/ hectare before transplanting increased both total soluble solids and total soluble sugars compared with untreated tomato plants. Nadia Gad (2005) reported that as cobalt concentration in the growing media increased, tomato plants content of Mn, Zn, Cu and Co increased with a reduction in Fe content. Laila Helmy and

Nadia Gad (2002) pointed that the addition of 25 or 50 mg Co/kg soil had a significant beneficial effect on the status of N, P, K, Ca and Mg in leaves of parsley as well as Mn, Zn, Cu and Co contents, such treatment resulted in depression in Fe content.

It thus seems that beneficial and depressive effect of enriching the soil with cobalt is a function of soil conditions and plant response.

This work was carried out to study the effect of cobalt fertilization on cucumber production and mineral content of the fruits.

Cucumber plant was selected as index crop. Responses of growth, fruits yield and mineral content of cucumber was evaluated.

MATERIALS AND METHODS

Soil analysis:

Physical and chemical properties of the chosen soil are shown in Table (1). Particle size distribution along with soil moisture of the soil sample was determined as described by Blackmore *et al.* (1972). Soil organic matter, $CaCO_3$, Ec, pH and also cations and anions were determined according to Black *et al.* (1982). Determination of soluble and available macro and micronutrients were run according to the method described by Jackson (1973).

Plant material and experimental design:

The experiment had been carried out in research and production station, National Research centre, Nobareia location, to study the effect of cobalt on cucumber growth, fruit yield and mineral composition.

Seeds of cucumber (*Cucumis sativus L.)* were sown in trays filled with a mixture of sand and peat moss (1:1 volume), trays being kept under greenhouse condition with practicing all agricultural management required for production of cucumber seedlings. The experiment containing form 5 plots. The field plots were $15m^2$ (5x3) containing 3 rows each planted with 10 plants.

Seedlings of five weeks – old with almost the same stem thickness were transplanted in the soil under drip irrigation system.

Cobalt sulphate salt was used enrich the soil with cobalt. The concentrations used were: 0.0, 7.5, 15.0, 22.5 and 30.0 ppm. After 45 days, plant growth parameters were determined.

Measurement of plant growth parameters:

After 45 days, plant height, stem diameter, (in cm), number of leaves per plant and leaf area (of the 5^{th} leaf from top) after 60 days and fruit yield was determined according to Gabal *et al. (*1984).

Fruits mineral contents namely (N, P, K, Co, Fe, Mn, Zn and Cu) were determined according to Black *et al*. (1982).

RESULTS AND DISCUSSION

Data present in Table (2) show the response of cucumber growth to different cobalt levels. All cobalt concentrations promote growth parameters of cucumber plants significantly in vegetative stage, compared to control. Cobalt level of 15 ppm gave the highest primitive effect on all growth parameters. Increasing cobalt concentration above 15 ppm, reduced all growth parameters significantly. These results are in harmony with those obtained by Nadia Gad (2005), who found that cobalt significantly promoted all growth parameters of tomato plant and the higher concentration decreased it. Also data in Table (2) indicate that cobalt level of 15 ppm has a synergistic effect on both fresh and dry weights of cucumber plants at all growth stages.

Table (2): Effect of cobalt on vegetative growth parameters of cucumber plants after 45 days from transplanting.

Cobalt treatments (ppm)	Plant hight (cm)	Stem diameter (cm)	Number of leaves per plant	Plant leaf area (cm^2)	Shoot fresh weight (g/plant)	Shoot dry weight (g/plant)
Control	87.2	1.30	18	212	226	20.33
7.5	98.6	1.33	23	243	256	23.89
15.0	107.2	1.40	27	267	264	25.67
22.5	100.5	1.15	24	245	249	23.05
30.0	89.6	1.04	22	224	237	21.32
LSD at 5%	7.13	0.17	2.2	11.39	17.75	2.45

On the other hand, higher cobalt concentration, namely, 22.5 up to 30.0 ppm, resulted in proportion significant reduction in cucumber fresh and dry weight. The results reveal, as expected and as mentioned by Vinay *et al.* (1996) who studied the promotive effect for the low doses of cobalt on both fresh and dry weights of plant.

Scotti. (1986) reported that, high levels of cobalt application, inhibited cucumber plant growth. High levels of cobalt reduced plant net photosynthesis as has been observed by Terry (1981), who found that bean plants exposed to high levels of cobalt decreased plant photosynthesis and photosynthetic electron transport capacity.

While, photosynthesis may be depressed and increased catalase and peroxidase enzymes activity, known to enhance plant respiration possibly resulting in successive consumption for products of photosynthesis and subsequently affect plant growth (Flanagan and Owens, 1985, Atta – Ali, 1991) and Nadia Gad (2006).

Data in Table (3) clearly indicated that the applied of 15.0 ppm cobalt had the highest production of cucumber fruits, which was observed by about 212% compared to control. Increasing cobalt concentration over 15.0 ppm decreased the crop production of cucumber. Nevertheless, the decreasing order of cucumber fruits production still higher than untreated plants. Data also, showed that increasing cobalt addition in plant media over 15 ppm, cucumber fruit yield was decreased. All cobalt concentrations had a significant synergistic effect on cucumber fruits yield compared to control. Level of 7.5 ppm cobalt had the high production of cucumber fruits, which was observed by about 152% compared to control.

While the addition of cobalt 15.0 ppm, gave the highest yield fruit production which was observed by about 212% compared to control. Increasing cobalt concentration in plant media over 15.0 ppm, cucumber yield fruit production was decreased by about 193% with 22.5 ppm and 168% with 30.0 ppm. These results agree with findings of Nadia Gad (2006).

Table (3): Effect of cobalt on cucumber fruit yield (absolute and relative values) after 60 days from transplanting.

Cobalt treatments (ppm)	Fruit Number (fruit/plant)		Fruit weight per plant (kg/plant)	Fruit yield (ton/fed)	Relative yield values from the control (%)
	One - harvest	10 - harvests			
Control	12	120	8.9	7.12	100
7.5	18	180	13.5	10.80	152
15.0	22	220	18.9	15.12	212
22.5	19	190	17.2	13.76	193
30.0	16	160	16.5	12.00	168
LSD at 5%	2.3	14.1	1.56	1.27	25.0

Data in Table (4) revealed that the addition of 15.0 ppm cobalt had a significant primitive effect on nitrogen, phosphorous and potassium content in fruits, as compared with that of control and another cobalt levels. Increasing cobalt concentration up to 30.0 ppm, resulted in proportion significant reduction. These results agree with those obtained by Kagawa *et al*. (2001) who showed that, cobalt level of 2.5 ppm in solution culture exerted a primitive effect on N, P and K in squash plants; higher concentration being hazardous. Obtained results also indicated that increasing cobalt level in the cucumber growing media increased Mn, Zn and Cu content in cucumber fruits. These results are in harmony with those of Liala Helmy and Nadia Gad (2002).

Table (4): Effect of cobalt on mineral composition of cucumber fruits.

Cobalt treatments (ppm)	Macro- nutrients (%)			Micro-nutrients (ppm)				Cobalt(ppm)	
	N	P	K	Mn	Zn	Cu	Fe	Shoots	Fruits
Control	0.98	0.86	2.26	42.1	29.1	26.5	139	3.20	0.76
7.5	1.25	1.01	2.38	49.6	32.9	29.0	135	5.02	0.98
15.0	1.41	1.06	2.95	55.3	38.4	34.4	129	11.8	1.14
22.5	1.37	1.11	2.70	58.6	44.3	37.6	126	18.1	2.66
30.0	1.34	1.05	2.38	61.2	48.2	39.5	119	21.4	3.72
LSD 5%	0.09	0.03	0.07	1.96	4.3	3.08	6.9	0.67	0.10

Also data in Table (4) clearly indicate that, the addition of cobalt resulted in a reduction of Fe which was more or less proportion with the concentration of added cobalt. This incidates, the competition between Fe and Co in absorption. This may be explained on the basis of results reported by Bisht (1991) and Blaylock (1995) that showed certain antagonistic relationships between the two elements.

Data in Table (4) also indicated that cobalt content of cucumber shoots was generally increased to be 3-7 folds that of fruits cobalt levels in cucumber fruits less than 8ppm. Young (1983) 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. Levels of 3.72 ppm in the highest cobalt treatment (30 ppm) is below the dangerous level, since the daily consumption of cucumber fruit does not exceed a few grams.

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تأثير الكويلت على نمو نباتات الخيار ومحصول الثمار ومحتواها المعدنى

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أجريت تجربة حقلية فى محطة البحوث والإنتاج – المركز القومى للبحوث بالنوبارية حيث تم زراعة شتلات الخيار صنف "بلدى" ثم معاملتها بالكوبلت فى صورة سلفات كوبلت بالتركيزات الآتية: صفر ، 7.5 ، 15.0 ، 22.5 ، 30.0 جزء فى المليون تحت ظروف الرى بالتنقيط. وتم مراعاتها بعمليات الخدمة المختلفة حتى جمع المحصول.

فى نهاية المرحلة الخضرية (مع ظهور أول زهرة) تم تسجيل بعض البيانات الدالة على النمو مثل ارتفاع النبات - سمك الساق – عدد الأوراق – دليل مساحة الأوراق – الوزن الطازج والوزن الجاف للمجموع الخضرى.

بعد 60 يوم من الزراعة تم جمع المحصول فى عشر جمعات متتالية وتسجيل عدد الثمار لكل نبات فى الجمعة الواحدة وفى العشر جمعات تم حساب كمية المحصول بالطن للفدان، أيضاً تم تقدير محتوى ثمار الخيار من العناصر الكبرى والصغرى.

وتشير النتائج إلى: أن التركيز 15.0 جزء فى المليون كوبلت أعطى أفضل نمو وأعلى محصول وأكبر محتوى من العناصر الغذائية الكبرى والصغرى مقارنة بالكنترول والتركيزات الأخرى من الكوبلت. كما أعطت كل معاملات الكوبلت تأثير إيجابى على النمو والمحصول والمحتوى المعدنى مقارنة بالكنترول.

Table (1): Physical and chemical properties of the soil of research and production station, National Research Centre, Nobareia location.

Soil properties	Particle Size distribution %			Soil texture class	Water saturation	Field capacity	Wilting point
	Sand	Silt	Clay		%		
Physical	70.8	25.6	3.6	Sandy loam	37.0	20.1	5.1

Soil properties			Soluble cations (meq/L)				Soluble anions (meq/L)				$CaCO_3$ %
	pH	EC dsm^{-1}	Ca^{++}	Mg^{++}	K^{+}	Na^{+}	HCO_3^{-}	CO_3	CL^{-}	$SO_4^{=-}$	
Chemical	7.9	0.12	2.4	2.0	0.162	1.87	1.5	-	0.65	4.282	3.57

Soil properties	Organic matter %	Available macronutrients mg/100g			Available micronutrients (ppm)			Cobalt (ppm)		
		N	P	K	Fe	Zn	Cu	Soluble	Available	Total
Chemical	0.23	15.1	13.0	21.0	2.61	1.44	4.0	0.49	2.43	9.21