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Effect of Cobalt on Eggplant (*Solanum melongena* L.) Yield Quantity and Quality

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ABSTRACT

Two field experiments had been in Research and Production Station, National Research Centre, Nubaria Site, Beheara Governorate, Delta Egypt, under drip irrigation system. Experiments were conducted to evaluate the effect of diferent cobalt levels (0.0, 2.5, 5.0, 7.5, 10.0 and 12.5ppm cobalt) on eggplants vegetative growth, fruits yield quantity and quality. The obtained results indicate that the addition of 7.5 ppm cobalt had a significant promotive effect on eggplants, growth, yield, minerals (N, P, K, Mn, and Cu) status. Cobalt is hence all chemical constituents in eggplant fruits such as, proteins, total soluble solids, total carbohydrates and vitamin “C” as L-Ascorbic acid. On the other hand, titrable acidity (as citric acid) showed the negative response to all cobalt doses. Decreasing of titrable acididy improve the quality of eggplant fruits.

Key words: Eggplant – Cobalt – Yield – Minerals and chemical content.

Introduction

Eggplant is one of the most important crops which grown in the summer season of Egypt. Eggplant fruits contain a considrable amount of carbohydrates, proteins and some minerals i.e.Nitrogen, Phosphorus, Potasium and iron as well as Vitamin “C” (Rahman and Hoque, 1994 and Mahmoud, 2000).

Cobalt is considered a beneficial elemant for higher plants due to its direct role in their metabolism. Cobalt promoted many developmental processes including stem and coleoptile elongation opening of hypocotyl, leaf expansion and bud development (Howell and Skoog,1975).Vyrodova (1981) reported that the application of 0.7kg cobalt sulphate per hectar before transplanting has increased the dry matter yield of tomatoes, cucumber and egg plants. Abd El-Rahman (1994) stated that increasing cobalt level up to 2.5ppm in sand culture resulted in an increase in the dry matter content of tomato plants; a concentration above 2.5ppm being depressive. Liu *et al* (1995) showed that growth of onion roots decreased with increasing cobalt concentration above 3kg/hectar, such roots became also twisted. Boureto *et al* (2001) reported that, 2.5ppm cobalt in sand culture was found to be promotive effect for N,P, and K in tomato plants. Abd-El-Moez and Nadia Gad (2002) found that the addition of 8 ppm cobalt in plant media increased fresh and dry weights of shoots and roots of cowpea plants. Also, cobalt increased the contents of macronutrients (N, P and K) as well as micronutrients (Fe, Mn and Zn). Nadia Gad and Zaghloul (2007) indicated that the addition of cobalt significantly increased fresh and dry weights of lettuce plants which grown in contaminated soils. Cobalt also decreased the content of heavy metals such as Pb, Cd, Fe and Ni. Nadia Gad *et al* (2008) domonstrated that the addition of 15ppm cobalt had significant promotive effect on vegetative growth, fruits yield and minerals composition of cucumber plants. Recently, Nadia Gad and Abd El-Moez (2011) showed that the addition of 6 ppm cobalt had a significant positive effect on Broccoli growth, heads yield quantity and quality, but further increasing in cobalt concentrations gave the adverse effect.

Thus the aim of this investigation is to study the effect of cobalt nutrition on Eggplants growth, yield quantinty, menirals compostion and chemical constituents.

Materials and Methods

Soil analysis:

Physical and chemical properties of Nubaria Soil were determined and particle size distributions along with soil moisture were determined as described by Blackmore (1972). 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.,* (1982). Determination of soluble, available and total cobalt was determined according to method described by Cottenie *et al.,* (1982). Some physical and chemical properties of Nubaria soil are shown in Table (1).

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Table 1: Some physical and chemical properties of Nubaria soil

<table>
<tr><td colspan="12">Physical properties</td></tr>
<tr><td colspan="7">Particle size distribution %</td><td colspan="5">Soil moisture constant %</td></tr>
<tr><td colspan="2">Sand
70.8</td><td>Silt
25.6</td><td>Clay
3.6</td><td colspan="3">Soil texture
Sandy loam</td><td colspan="2">Saturation
32.0</td><td>FC
19.2</td><td>WP
6.1</td><td>AW
13.1</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td colspan="12">Chemical properties</td></tr>
<tr><td colspan="4"></td><td colspan="4">Soluble cations (meq^{-1}L)</td><td colspan="4">Soluble anions (meq^{-1}L)</td></tr>
<tr><td>pH
1:2.5</td><td>EC
(dS m^{-1})</td><td>CaCO3%</td><td>OM
%</td><td>Ca^{++}</td><td>Mg^{++}</td><td>K^{+}</td><td>Na^{+}</td><td>HCO_3^{-}</td><td>CO_3</td><td>Cl^{-}</td><td>$SO_4^{=}$</td></tr>
<tr><td>8.49</td><td>1.74</td><td>3.4</td><td>0.20</td><td>0.8</td><td>0.5</td><td>1.6</td><td>1.80</td><td>0.3</td><td>-</td><td>1.9</td><td>0.5</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td colspan="4">Cobalt</td><td>Total</td><td colspan="2">Available</td><td colspan="5">Available micronutrients</td></tr>
<tr><td colspan="4">Ppm</td><td colspan="3">mg 100 g^{-1} soil</td><td colspan="5">ppm</td></tr>
<tr><td colspan="2">Soluble</td><td>Available</td><td>Total</td><td>N</td><td>P</td><td>K</td><td colspan="2">Fe</td><td>Mn</td><td>Zn</td><td>Cu</td></tr>
<tr><td colspan="2">0.35</td><td>4.88</td><td>9.88</td><td>15.1</td><td>13.3</td><td>4.49</td><td colspan="2">4.46</td><td>2.71</td><td>4.52</td><td>5.2</td></tr>
</table>

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

Plant material and experimental work:

A preliminary experiment was conduct of Wire house of National Research Centre to define cobalt concentrations range which gave growth and yield during 2009 season. Seedings of eggplants (at the third true leaves) irrigated once with cobalt levels: 0.0, 2.5, 5.0, 7.5, 10.0, 12.5, 15.5, 17.5 and 20ppm. According to the preliminary experiment results, the concentrations range of cobalt which gave the eggplant response growth and yield were: 0.0, 2.5, 5.0, 7.5, 10.0 and12.5ppm. Cobalt at 7.5ppm gave the best growth and yield.

Two field experiments were carried out in Research and Production Station, National Research Centre, Nubaria location, Beheara Governorate, Delta Egypt under drip irrigation system.

Seeds of eggplant (*Solanum melongena var.e esculenta* L.) were sown in nursery at first week of March during both 2010 and 2011 seasons in plates filled with a mixtrue sand and peat moss (l:l).Plates were kept in Wire house and receeived natural agricaltural practies whenere they neded during 5 weeks. Each experiment consisting 6 treatments. Each treatment was represented by 3 plots.

Each plot area was 5 ×3 meter, consisting of three rows. After 45 days from sowing eggplants seedlings were transplanting in plots (40 Cm apart). The seedlings (at the third truly leaves) were irrigated with cobalt concentrations (0.0, 2.5, 5.0, 7.5, 10.0 and 12.5 ppm cobalt) once as cobalt sulphate form. All the plants received natural agricultural practices whenere they needed.

Measurement of plant Vegetative growth:

After 45 days from transplanting, plant hight, number of branches and leaves per plant, fresh and dry weights of both shoots and roots of eggplants according to FAO (1980).

Measurement of fruits yield quantity:

After 65-70 days, eggplant-fruit length, diameter and weight as well as early yield and total yield (ton/fed) were recorded according to Gabal *et al* (1984).

Measurements of nutritional status:

In eggplant fruits, macronutrients (N, P and K), micronutrients (Fe, Mn, Zn and Cu) as well as cobalt were determined according to Cottenie *et al* (1982).

Measurement of chemical constituents:

In eggplant fruits, total soluble solids, total carbohydrates, vitamine “C” as L-ascorbic acid and titrable acidity were determined according to A.O.A.C (1990).

The obtained data were statistically analyzed according to outlined by (SAS, 1996) computer program and means were compared by LSD method according to Snedcor and Conchran (1982).

Results and Discussion

Vegetative growth parameters:

Data presented in Table (2) outline in the response of eggplants growth parameters to different cobalt levels. Cobalt at 7.5ppm had a significantly promotive effect of all growth parameters such as plant hight,

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number of branches and leaves per plant along with fresh weights of both shoots and roots. Cobalt also improved eggplants shoots and roots biomass. These results are good in harmony with those obtained by Vyrodova (1981) who reported that cobalt application of 0.7 kg Co SO4/hectar has incresed the dry matter yield of tomatoes, cucumber and eggplants.

Table 2: Eggplants vegetative growth parameters as affected by cobalt nutrition after 45 days from transplanting (mean of two seasons).

Cobalt treatments (ppm)	Plant height (Cm)	Number/Plant		Fresh Weight/plant (g)		Dry weights/plant (g)	
		Branches	Leaves	Shoots	Roots	Shoots	Roots
Control	57.5	5.56	47.3	151.3	25.2	50.3	7.20
2.5	60.2	6.60	49.4	155.0	26.8	51.4	7.82
5.0	66.7	7.38	53.2	158.8	26.7	52.8	8.35
7.5	70.0	9.00	57.6	165.7	28.5	56.6	9.56
10.0	68.2	8.11	55.0	163.0	27.2	54.3	9.08
12.5	67.3	7.51	53.4	161.5	26.0	53.5	8.67
LSD at 5%	0.6	0.13	0.2	1.5	0.5	0.7	0.31

Data in Table (2) also indicate that, as cobalt concentrations were ranged above 7.5 ppm, the promotive effect on all growth parameters was reduced. These results are good agree with those obtained by Nadia Gad (2005a) who stated that cobalt at 7.5 ppm being with several induced in Auxins and Gibberllins endogenus hormones synthesis and decreased the activity of some enzymes such as peroxidase and catalase of tomato plants. While the higher cobalt levels above 7.5ppm were resulted the adverse effect and hence increasing the catabolism rather than anabolism.

Yield charachteristics:

Tables (3) clearly indicate that all cobalt levels significantly increase eggplant yield compared with control. Cobalt at 7.5ppm had a significant favourable effect on all yield parameters such as fruit length, fruit diameter, fruit weight.

Table 3: Eggplants yield characteristics as affected by cobalt nutrition after 65-70 days from transplanting (mean of two seasons).

Cobalt treatments (ppm)	Fruit length (Cm)	Fruit diameter (Cm)	Fruit weight (g)	Early Yield (ton/fed)	Total Yield (ton/fed)	% Increase
Control	10.52	1.90	21.31	0.73	4.73	100
2.5	10.91	2.17	22.61	0.93	5.04	6.55
5.0	11.64	2.51	23.35	1.12	5.86	23.89
7.5	13.27	2.96	27.34	1.62	6.39	35.09
10.0	12.72	2.72	25.14	1.40	6.13	29.59
12.5	11.95	2.66	24.88	1.26	5.72	20.93
LSD at 5%	0.3	0.15	0.26	0.14	0.16	-

Data in Table (3) also show that, cobalt at 7.5ppm resulted the highest production of eggplant fruits, which was observed by about 35.09% compared with control. Increasing cobalt doses in plant media above 7.5ppm decrease the beneficial effect. These results are in harmony with Nadia Gad *et al* (2008) who reported that cobalt at 15 ppm cobalt gave the highest cucumber fruits yield. Increasing cobalt concentration above 15ppm decreased fruits yield. Nadia Gad and AbdEl-Moez (2011) added that cobalt at 6ppm gave the maximum heads yield of Brocooli, so superior resulting in enhancement the photosynthesis rate and consequently increased plant growth and yield.

Nutritional Status in Fruits:

Data in Table (4) reveals the following:-

Macronutrints (N, P and K):

Results presented in Table (4) show that cobalt at 7.5ppm gave maximum content of N, P and K compared with the control. This means that increasing cobalt levels in plant media more than 7.5ppm decreased the positive effect. These results are agree with Basu *et al* (2006) who stated that low level of cobalt significantly increased the status of macronutrients (N, P and K) in groundnuts compared with the higher ones.

Confirm, Kagawa *et al* (2001) and Nadia Gad et al (2008), cobalt exerted a promotive effect on N, P and K contents in both squash and cucumber plants; higher concentration being hazards compared with the optimum level of cobalt.

Micronutrients (Mn, Zn and Cu):

Presented data in Table (4) show that all cobalt levels gave a significant positive effect of the status of Mn, Zn and Cu compared with control. Cobalt at 7.5ppm had a maximum figure of these elements. The positive effect was reduced as cobalt concentration increasing in plant media. Confirm these results Nadia Gad (2006a) indicated that cobalt at 7.5ppm had a significant promotive effect for better status of Mn, Zn and Cu in tomato plants. She added that a higher cobalt concentration has decreased the promotive effect.

Iron Content:

Results presented in Table (4) indicate that increasing cobalt concentration in plant media resulted in a progressive effect of iron content of eggplant fruits. Blaylock *et al* (1993); Nadia Gad and Hala Kandil (2008) who stated certain antagonistic relationships between two elements in both tomatoes and sweet potatoes. They added that the hazards cobalt effect gave reducation for net photosynthesis process.

Table 4: Eggplants fruits mineral composition as affected by cobalt nutrition (mean of two seasons).

Cobalt treatments	Macronutrients (%)			Micronutrients (ppm)				Cobalt
(ppm)	N	P	k	Mn	Cu	Zn	Fe	(ppm)
Control	0.87	1.10	2.40	38.0	26.6	32.3	137	0.87
2.5	0.96	1.22	2.47	39.6	28.0	34.6	134	1.23
5.0	1.08	1.38	2.53	42.5	30.2	37.6	132	3.44
7.5	1.33	1.45	2.58	46.2	33.6	39.8	129	5.69
10.0	1.26	1.42	2.55	44.4	32.2	38.1	127	6.01
12.5	1.19	1.39	2.51	41.3	30.6	37.0	121	7.71
LSD at 5%	0.11	0.3	0.2	1.2	0.4	0.6	2	0.36

Cobalt Content:

Increasing Cobalt doses in plant media from 2.5ppm significantly increased cobalt content in eggplant fruits compared with untreated plants (Table, 4). 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. Level of 7.71ppm in the highest cobalt treatment (12.5ppm) is below the dangerous level, since the daily consumption of eggplant fruits does not exceed a few grams.

Chemical constituents of eggplant fruits:

The favorable effect of cobalt on the pereentages of proteins, total soluble solids, total Carbohydrates and Vitamin “C” as L-Ascorbic acid in eggplant fruits are given in Table (5).

Table 5: Eggplants chemical composition of fruits as affected by cobalt nutrition (mean of two seasons).

Cobalt treatments (ppm)	Protein	Total Soluble solids	Total carbohydrates	L-Ascorbic acid	Titrable acidity
	(%)				
Control	5.44	3.36	11.76	20.12	0.53
2.5	6.00	3.45	11.98	21.33	0.49
5.0	6.75	3.74	12.31	23.19	0.45
7.5	8.31	4.32	12.85	24.44	0.41
10.0	7.88	4.08	12.66	24.00	0.36
12.5	7.44	3.86	12.41	23.78	0.32
LSD at 5%	0.43	0.4	0.19	0.44	0.4

The results in Table (5) show also the relative calculated as percentage from control. It is evident that cobalt at 7.5 ppm increased the contents of: proteins 52.8%, total soluble solids 28.6%, total carbohydrates 9.27% and vitamin “C” as L-Ascorbic acid 21.5% respectirely. These data are agree with Nadia Gad and Hala Kandil (2008).

Data in Table (5) also indicat that the titrable acidity (as a citric acid) of eggplant fruits show negative response to all cobalt levels. The reducation of titrable acidity hence fruits quality. These results are in harmony with those obtained by Nadia Gad and Hala Kandil (2010).

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Conclusion:

Cobalt is promosing element in the newly reclaimed soils. It had a significant synergestic effect of eggplant growth, yield fruits quantity and quality. Cobalt enhance the nutritional status and chemical constituents of eggplant fruits.

Reference

A.O.A.C., 1995. Method of analysis. Association of Official Agriculture. 16th Ed., Washington, D.C.USA.

Abd El-Moez, M.R. and Nadia Gad, 2002. Effect of organic cotton compost and Cobalt application on cowpea plants growth and mineral composition. Egypt. J. Appl. Sci., 17(1): 426-440.

Abd El-Rahman, L.M., 1994. Plant tolerance to salt and heavy metals. J. Soil Sci., 35: 169-173.

Basu, M., P. Mondal, A. Datta, T.K. Basu, 2006. Effect of cobalt, *Rhizobium* and phosphobacterium inoculations on growth attributes of summer groundnut (*Arachis hypogaea* Linn).Environment and Ecology, 21 (4): 813-816.

Black, C.A., D.D. Evans, L.E. Ensminger, G.L. White and F.E. Clarck, 1982. Methods of Soil Analysis Part 2. Agron. Inc. Madison. Wisc.

Blackmore, L.C., 1972. Methods for chemical analysis of Soil. Newzealand Soil Durean, P. A21: 10.

Blaylock, A.D., T.D. Davis, V.D. Jolley and R.H Walse, 1993. Influence of cobalt on photosynthesis, chlorophyll and nutrient content in regreening chlorotic tomatoes and soybeans. J. of plant Nutrition., 8: 813-828.

Cottenie, A., M. Verloo, L. Kiekens, G. Velgh and R. Camerlynk, 1982. Chemical Analysis of Plants and Soils. P 44-45. State Univ. Ghent, Belgium, 63.

FAO., 1980. Soil and olant testing as a basis fertilizer recommendations. Food and Agric. Org. of UN, Rome Italy

Gabal, M.R., I.M. Abd-Allah, F.M. Hass and S. Hassannen, 1984. Evaluation of some American tomato cultivars grown for early summer production in Egypt, Annals of Agriculture Science Moshtohor., 22: 487-500.

Howell, R.W. and F. Skoog, 1975. Effect of adenine and other subsurfaces on growth of excised pisum epicotyls cultured in Vitro. Am. J. Bot., 49: 645-649.

Kagawa, N.J., A.M. Castro and A.E. Boureto, 2001. Treatments of Phaseolus Vulgaris L. with cobalt. Agron., 82: 973-876.

Liu, D., L. Zhai, W. Jiag and W. Wang, 1995. Effect of Mg^{+2}, Co^{+2} and Hg^{+2} on the nucleus in root tip cells of Allium cepa. Bulletin of Enviromental Contamination and Toxicotology, 55: 779-787.

Mahmoud, H.A.F., 2000. Effect of sulphur and phosphorus on some eggplant cultivars under calcareous soil conditions. Res. Bull., Fac. of Agric., Cairo Univ., 51(2): 209-225.

Nadia Gad and Hala Kandil, 2010. Impact of cobalt and phosphate fertilizer on tomatoes growth and yield. Agriculture and Biological J. of North America, 1(5): 1069-1075.

Nadia Gad and A.M. Zaghloul, 2007. Minimizing the health hazard of lettuce cultivated in the some heavy metals affected soils. Australian J. Basic and Applied Sci., 1(2): 79-86.

Nadia Gad and Hala kandil, 2008. Response of sweet potato (*Ipomoea batatas* L.) plants to different levels of cobalt. Australian J. Basic and Applied Sci., 2(4): 949-955.

Nadia Gad and Hala Kandil, 2010. Impact of cobalt and phosphate fertilizer on tomatoes growth and yield. Agriculture and Biological J. of North America, 1(5): 1069-1075.

Nadia Gad and M.R. AbdEl-Moez, 2011. Broccoli Growth, Yield Quantity and Quality as Affected by Cobalt Nutrition. Agriculture and Biological J. of North America., (2): 226-231.

Nadia Gad, 2005a. Interactive effect of cobalt and salinity on tomato plants I- Growth and mineral composition as affected by cobalt and salinity. Research Journal of Agriculture and Biological Sciences Pakistan., 1(3): 261-269.

Nadia Gad, 2006 a. Increasing the efficiency of water consumption through cobalt application in the newly reclaimed soils. J. Apllied Sci. Resarch, 2(11): 1081- 1091.Pakistan

Nadia Gad, A.M. Shafie and M.S. Abdel-Fattah, 2008. Effect of cobalt on cucumber growth, fruits yield and mineral composition. J. Agric. Sci. Mansoura Univ., 33(1): 909-915.

Rahman, M. and M.M. Hoque, 1994. Yield response of brinjal *(Solanum melongena, L.)* to sulphur fertilizer. Bangladesh, J. Sci. ana Indust. Res., 29 (4): 151 (C.F. Hort. Abstr., 66(4): 3250.

Snedecor, G.W. and W.G. Cochran, 1980. Statistical Analysis Methods. 6^{th} Ed. Iowa State Univ. Press. Ames., Iowa, USA.

Vyrodova, L.P., 1981. Influence of soil properties on the sorption of cobalt. Pochvovedenic Moskova " Naauka" 7: 64-73.

Young, S.R., 1983. Recent advances of cobalt in human nutrition. Victoria B.C. Canada. Micronutrients News., 3: 59-62.