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RESPONSE OF TOMATO *(LYCOPERSICUM ESCULENTUM)* TO COBALT SUPPLEMENT

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Abstract

A Pot experiment was conducted to evaluate influence of cobalt on tomato growth and yield. The experiment was carried out at wire house, National Research Centre, Cairo, Egypt during (2016) season. Plastic pots of 10 kg capacity were filled with used.Tomato seedlings at the third truly leaves were irrigated once with 0.0 - 2.5 - 5.0 - 7.5 - 10.0 - 12.5 - 15.0 - 17.5 and 20 ppm cobalt**.** The obtained results indicate that, all cobalt rates significantly increased tomato plants growth, yield, mineral composition and chemical constituents. Cobalt at 7.5 ppm gave the greatest values.As cobalt increasing in plant media the promotive effect decreased.

Key words : Cobalt-Tomato-Yield quantity and quality.

Introduction

The tomato (*Lycopersicum esculentum* MILL.) belongs to the family solanaceae. Tomato is a very important vegetable crop in the world. The fruits is used as a fresh salad vegetable and is also a popular ingredient in soups stews, sauces and various other dishes.

Cobalt is considered to be a beneficial element for higher plants.Tomatoes, the most important vegetable crop in the world, is known to response well to cobalt application. Smith 1991) stated that, cobalt is a border element. Cobalt is essential for the synthesis of vitamin B_{12} which is required for human and animal nutrition. (Young 1983) stated that cobalt does not accumulate in human body, as the other heavy metals with the increase in age. (Atta – Ali *et al.,* 1991) pointed that supplementing nutrient solution with low level of cobalt (0.25ppm) enhanced growth of tomato plants and improved both flowering, fruiting as well as mineral composition in both shoots and roots. (Walser *et al.,* 1996) showed that cobalt application (2.7 kg Co/ha soil) containing 0.81 mg available (Co / kg) increased tomato leaf number as well as surface of chloroplasts/unit leaf area, leaf chlorophyll content, leaf area and rate of photosynthesis. (Markova 2001) found that soil application of 0.7 kg cobalt sulphate per hectar before transplanting increased both total soluble solids and total soluble sugars compared with untreated tomato plants (Jolley, 2004) stated that cobalt is considered a border element for plant nutrition. It is proved to be beneficial for higher plants such as tomato, cucumber and olive in spite of the absence of evidence for direct role in their metabolism. (Nadia Gad, 2005) added that The addition of 7.5 ppm cobalt gave significant promotive effect on tomato growth, yield and fruits quality. Higher concentrations more than 7.5 ppm reduce the promotive effect. Cobalt at 7.5 ppm significantly increased the content of nitrogen, phosphorous, potassium, Mn, Cu and Zn. According to (Saraf and Twari 2004), the high rates of nitrogen being favorable for cobalt uptake by tomato plants. Cobalt improved the fruits quality. (Nadia Gad and Nagwa Hassan 2013). Found that all cobalt levels significantly increase growth and yield parameter of sweet pepper compared with control. Chao-Zhou *et al.,* (2005) showed that, when the stress lasted 20 h and 24 h, treatment with cobalt effectively restrained the increament in the levels of reactive oxygen species, hampered the decline in the content of putrescine, spermidineand spermine.

The decline in the activities of anti oxdative enzymes, thus inhibited the accumulation of thiobarbituric acid

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reacting substances and alleviated the reduction of chlorophyll content. It can be concluded that when the potato leaves were deeply stressed and damaged through the inhibition of ethylene production, cobalt alleviated the decline in polyamine content and the activities of anti oxidative enzymes and hence alleviated the increment in reactive oxygen species levels and membrance damage and showed protective effects on the leaves. Vijayarengan *et al.,* (2009) stated that, the high cobalt concentration *i.e.* 100, 150, 200 and 250 mg cobalt soil has a negative effect on bio chemicals content such as total sugar, starch, amino acids of groundnut seeds compared with untreated plants while gave a positive response upon low concentrations of cobalt in the soil. They also added that cobalt increased the mineral composition of fruits.(Nadia Gad *et al.,* 2016) stated that all cobalt concentrations (3, 6, 9 and 12 ppm) significantly increase cabbage growth, yield parameters, nutritional status and chemical constituents compared with control Cobalt at 6 ppm gave the greatest figures.

Nadia Gad *et al.,* (2018) found that as soil salinity level increased, cucumber growth and yield parameters significantly reduced. Cobalt concentrations (from 10 to 20 ppm) have a significant promotive effect on all cucumber growth and yield parameters compared with untreated plants. Cobalt at 15 ppm gave the greatest values. Cobalt hence both nutritional status and chemical constituents in cucumber fruits compared with control. Cobalt help cucumber plants to tolerate water stress (80% and 60%) from water requirement. The aim of this work was carried to elaborate further the effect of cobalt application on tomato plant growth, yield quantity and quality.

Material and Methods

Soil analysis

Particle size distributions of the Research and Production Station, National Research Centre, Noubaria Site, Beheara Governorate Cairo, Egypt along with soil moisture were determined as described by (Blackmore *et al.,* 1972). Soil pH, Ec, Cations and anions, organic matter, Ca CO_3, total nitrogen, available phosphorous, potassium, iron, manganese, zinc and copper were run according to Black *et al.,* (1982). Determinations of soluble, available and total cobalt were determined according to method described by Cottenie *et al.,* (1982). Some physical and chemical properties of Noubaria soil are shown in Table 1.

Plant material and experimental work

At 22 September 2016 seeds of tomatoes *(Lycopersicon esculentums* Mill crs. 448) were sown in trays filled with a mixture of sand and peat moss (1:1 volume). Trays being kept under Wire-house condition with practicing agricultural management required for production of tomato seedlings. Plastic pots of ten kg capacity were filled with sandy loam soil taken from Research and Production Station, Egypt, National Research Centre, Noubaria site, Beheara Governorate, Delta Egypt Cairo, Egypt. Six Seedlings of five weeks – old with almost the same stem thickness were transplanted to 54 pots. Cobalt sulphate salt was used to in rich the soil with cobalt.

The concentrations used were 2.5, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5 and 20 ppm cobalt once beside the control. Each treatment was six replicates and arranged in a randomized complete block design.Seedlings were Irrigated with tap water and practiced to keep soil at for 105 days. All required agriculture managements for growth and production were carried out as recommended by Ministry of Agriculture.

Measurements of plant growth

After 60 days from transplanting, just before flowering stage, plant growth parameters such as plant height,

Table 1: Some physical and chemical properties of Noubaria soil samples.

Physical			Particle size distribution (%)		Soil texture class		Saturation	Field capacity(%)	Welting point	Available water	
Chemical		Sand	Silt	Clay							
		69.8	26.7	3.5	Sandy loam		20.0	14.4	3.9	10.5	
		PH (1:2.5)			EC(ds/m)Soluble cations (meq/l)				Soluble anions (meq/l)		
				Ca++	Mg++	K+	Na+	HCO_3-	CO_3-	Cl-	SO_4=
		8.0	1.0	9.0	1.4	5.4	3.26	—	1.18	6.60	2.4
Total		Available		Available micronutrients			Cobalt	$CaCO_3$		OM	
	(PPm)			(PPm)			(PPm)		%		
N	P	K	Fe	Mn	Zn	Cu	Soluble	Available	Total		
25.2	15.3	10.2	23.0	10.5	3.62	5.22	0.39	1.78	9.68	3.17	0.19

number of branches per plant, number of leaves per plant, root length, shoot and root fresh and dry weights per plant were determined according to (FAO. 1980).

Measurements of yield characteristics

After 90 – 105 days from transplanting tomato fruits were harvested and yield parameters such as number of fruits per plant, fruits fresh and dry weights per plant were recorded according to Gabal *et al.,* (1984).

Measurements of nutritional status

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

Measurements of chemical constituents

In tomato fruits total proteins, total soluble solids, total soluble sugars, vitamin C as L – Ascorbic acid and tetrable acidity as citric acid were determined according to (A.O.A.C. 1995).

Statistical analysis

All data were subject to statistical analysis according to procedure outlined by (SAS 1996) computer program and means were compared by LSD method according to (Snedecor and Cochran 1982).

Results and Discussion

Plant Growth

Data presented in Table 2 outline the response of tomato plant growth to different cobalt concentrations. Data show that all cobalt levels gave a promotive effect of tomato growth parameters compared with control. Cobalt at 7.5 ppm has a highest figure of studied growth parameters such as plant hight, number of both branches and leaves, root length as well as fresh and dry weights of both shoot and root.

Increasing cobalt level in plant media above 7.5 ppm, the promotive effect reduced. These data are in harmony with those obtained by (Nadia Gad, 2005a) who stated that cobalt significantly increased tomato growth parameters compared with control. Cobalt at 7.5 ppm has a positive effect due to several induced effects in hormonal (Auxins and Gibberlens) synthesis and metabolic activity and decrease the peroxidase and catalase enzymes activity. These enzymes are known to induce plant respiration, so superior resulting in successive consumption for products of photosynthesis and consequently reduced in plant growth and hence increasing the anabolism rather than the catabolism.

Yield Characteristics

Data concerning the effect of cobalt on tomato yield parameters such as number of fruits per plant, fresh and dry weights of fruits per plant, fruits yield (kg/plant) are given in Table 3. The results clearly indicate that all cobalt levels has a favorable effect on the studied yield parameters compared with control. Cobalt at 7.5 ppm gave the highest values. Increasing cobalt level in plant growth media more than 7.5 ppm, the positive effect reduced, These results agrees with those obtained by (Vyrodova, 1981) who reported that the application of 0.7 kg $CoSO_4^{h-1}$ increased the dry matter yield of tomatoes, cucumber and egg-plants. The results in Table 3 also show the relative calculated values as percentage from control.

Also, (Lisnik and Toma, 2003) added that cobalt has a favorable effect in both tomato and cucumber plants dry weight, leaves number, leaf area index as well as fruits yield.

Nutritional status

Macronutrients

Results in Table (4) indicate that the addition of cobalt

Table 2: Effect of cobalt levels on growth parameters of tomato plants after 60 days from transplanting.

Cobalt treatments (ppm)	Plant height (Cm)	Number \plant		Root length (Cm)	Fresh weight/plant (g)		Dry weight/plant (g)	
		Leaves	Brunches		Shoot	Root	Shoot	Root
Control	38.8	12.23	6.27	7.93	28.2	6.01	7.83	1.73
2.5	42.3	14.93	6.87	8.73	37.8	7.05	10.63	1.87
5.0	46.8	16.03	7.43	9.83	42.2	8.19	11.17	2.03
7.5	51.3	16.77	8.63	11.53	45.6	8.63	12.73	2.17
10.0	49.4	15.97	8.03	10.97	43.3	8.41	12.17	2.11
12.5	48.8	14.57	7.77	9.77	41.8	7.70	11.73	2.08
15.0	47.7	12.67	7.23	9.13	40.5	7.31	11.27	2.01
17.5	46.4	11.83	6.77	8.57	38.7	6.71	10.73	1.92
20.0	45.6	11.63	5.97	8.17	36.9	6.32	9.98	1.86
LSD 0.05	0.589	0.206	0.114	0.114	0.1094	0.0127	0.0934	0.0114

Table 3: Effect of cobalt levels on yield parameters of tomato plants after105 days from transplanting.

Cobalt treatments treatments (ppm)	No. of Fruits/plant 3 harvests	Fresh W. of Fruits/plant (g)	Fresh W. of Fruits/plant (kg)	Relative from control (%)
Control	15.22	1597.1	1.59	100
2.5	15.69	1678.8	1.68	105.1
5.0	16.68	1785.8	1.79	111.8
7.5	17.91	1918.7	1.92	120.1
10.0	17.67	1890.5	1.89	118.4
12.5	17.43	1856.2	1.86	116.2
15.0	17.07	1809.4	1.81	113.3
17.5	16.74	1757.7	1.76	110.1
20.0	16.44	1726.2	1.73	108.1
LSD 0.05	0.0136	0.1143	1.144	....

in plant media has a significant synergestic effect on the status of nitrogen, phosphorous and potassium in tomato fruits compared with control. Cobalt at 7.5 ppm gave the greatest values. Increasing cobalt levels more than 7.5 ppm reduces the promotive effect. These data are in harmony with those obtained by Boureto *et al.,* (2001) who pointed that cobalt at 2.5 ppm in solution culture significantly increased N, P and K contents in tomato plants. Confirm these results (Xiong and Xia, 1985) who showed that the treatment with certain levels of cobalt gave the high contents of nitrogen, phosphorous and potassium in tomato plants.

Micronutrients (Mn, Zn and Cu)

Data in Table 4 also indicate that all cobalt rates significantly increase the status of Mn, Zn and Cu compared with untreated plants

The addition of 7.5 ppm cobalt has a significant promotive effect for better status of Mn, Zn and Cu in tomato fruits. These results are agree with those obtained by Castro *et al.,* (1996) who found that cobalt addition in plant media has a positive effect on the contents of Mn, Zn and Cu in bean (phaseolus vejlgarisl)$^{-L}$ compared with control.

Iron status

Results in Table 4 reveal that the certain antagonistic relationships between cobalt and iron (Bisht, 1991**).** The relative response of Fe to control indicates continous decrease of this element as a result of cobalt addition from 7.5 ppm till 20.0 ppm. These results are good agreement with those obtained by (James, 2005) who stated that cobalt and iron were suggested to be competitive elements in tomato plants nutrition.

Cobalt status

Obtained results in Table 4 pointed that, as cobalt increased in plant media, cobalt in tomato fruits significantly increased.(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. A level of 7.50 ppm in the highest cobalt treatment (20.0 ppm) is below the dangerous level, since the daily consumption of tomato fruits does not exceed a few grams. Cobalt is also an essential constituent of vitamin B_{12} which is considered yet found in human body.In fact cobalt is one of the most physiological potent compounds about a millionth of grams per day being required in human nutrition for normal growth and formation of red blood corbucels(Woodward and Easwaran, 2005).

Chemical Constituents

Data concerning the effect of cobalt on chemical constituents of tomato fruits are given in Table 5. The

Table 4: Effect of cobalt levels on nutritional status of tomato fruits.

Cobalt treatments	Macro nutrients (%)			Micro nutrients (ppm)				Cobalt (ppm)		
	N	P	K	Mn	Zn	Cu	Fe	Shoot	Root	Fruit
Control	0.389	0.238	0.422	19.77	14.57	20.97	123.67	1.59	0.86	1.03
2.5	0.397	0.266	0.446	20.43	14.87	21.87	121.66	2.41	1.13	1.61
5.0	0.422	0.294	0.468	22.03	15.53	23.63	118.67	4.03	2.31	2.41
7.5	0.468	0.319	0.491	24.83	18.23	26.03	114.67	5.22	3.43	2.51
10.0	0.461	0.319	0.487	23.87	17.77	25.13	110.66	7.83	4.81	3.46
12.5	0.454	0.311	0.478	22.53	17.17	23.87	110.66	8.43	6.01	4.19
15.0	0.448	0.308	0.469	21.73	16.86	23.27	107.67	10.53	7.62	4.83
17.5	0.440	0.289	0.459	20.67	15.77	22.77	105.67	11.33	8.91	6.27
20.0	0.431	0.281	0.453	20.13	15.13	21.67	103.66	13.97	10.17	7.50
LSD 0.05	9.904	9.904	9.904	0.114	0.099	0.099	0.990	0.094	0.058	0.034

Table 5: Effect of cobalt levels on chemical constituents of tomato fruits.

Cobalt treatments (ppm)	Chemical constituents				
	(%)			Mg/100g fresh weight	(%)
	Total proteins	Total soluble solids	Total soluble sugars	Vitamin C as L- Ascorbic acid	Tertable acidity as cetric acid
Control	2.43	3.36	2.23	14.11	0.82
2.5	2.48	3.87	2.31	15.51	0.76
5.0	2.64	4.01	2.56	16.49	0.69
7.5	2.93	4.83	2.98	17.51	0.54
10.0	2.87	4.79	2.91	17.22	0.47
12.5	2.83	4.74	2.87	16.70	0.42
15.0	2.79	4.68	2.83	16.32	0.38
17.5	2.75	4.64	2.76	15.79	0.35
20.0	2.69	4.55	2.72	15.39	0.33
LSD 0.05%	0.0099	0.0099	0.0099	0.0099	0.0099

results clearly indicate that, all cobalt levels significantly increase the studied chemical constituents compared with control. Cobalt at 7.5 ppm has a highest value for total soluble solids, total soluble sugars, total proteins as well as vitamin C as (L – Ascorbic acid). On the other hand, titrable acidity (as citric acid) showed negative response to all levels of cobalt as a fruits quality. These results are in harmony with those obtained by Nadia Gad *et al.,* (2017).

Conclusions

Cobalt is promising element in the newly reclaimed soils and had a significant promotive effect of tomato growth, fruits yield, mineral composition as well as chemical constituents parameters. Cobalt at 7.5 ppm has superior values. Therefore, considerable attention should be taken concerning applying this element (cobalt) as a fertilizer. Cobalt significantly increases tomato fruits quantity and quality compared with control.

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