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Mitigation the effect of salinity as a result of climate change by using cobalt on tomato production in newly reclaimed lands

Nadia Gad[1], M. R. Abdel-Moez[1] and Doaa M. Abo- Basha[1] and Nagwa M.K. Hassan[2]

[1]*Plant Nutrition Dept., National Research Centre, Dokki, Egypt*
[2]*Vegetable Res. Dept., National Research Centre, Dokki, Egypt*

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ABSTRACT

Two field experiments were carried out to evaluate the effect of cobalt on growth and production of tomato plants under three levels of soil salinity in Wady El-Natron Site, Beheara Governorate, Egypt during 2016 and 2017 seasons. Five concentrations of cobalt (0.0, 7.5, 10.0, 12.5, and 15ppm) were tested as irrigation in seedlings (at the third truly leaves). The obtained results indicate that:-All cobalt treatments significantly increased tomato growth parameters, fruits yield quantity and its quality such as minerals composition and chemical constituents under various levels of soil salinity (3.35, 3.85, 5.40 dsm^{-1}). Cobalt at 12.5 ppm had the highest figures. As well as, Cobalt decrease the hazard effect of salt stress on tomato plant. Also, increased cobalt rate led to an increase in absesic acid significantly under different salinity levels.

Key words: Salinity, Tomato, Cobalt, Proline, Abscisic acid

Introduction

Climatic changes could be summarized in the increase in temperature, increase salinity soil levels, decrease of water, changes floods, amount of rainfall, dryness atmosphere humidity, increase in ozone concentration, the pollution resulting from burning fuel and the excessive in the use of mineral fertilizer.

Salinity became a serious problem for agriculture, all over the world. Egypt is adopting furrow irrigation systems and is also expanding in cultivating the desert. Salinity, water shortage and low water quality are the main problems for agriculture production under such circumstances. The north coast of Egypt is comprised of marginal land. Other areas in Egypt, and many other areas in the arid zones are experiencing similar problems of increased soil salinity. High level of salinity adversely affects growth, productivity as well as quality of vegetable crops by reducing photosynthetic capacity, enzyme activities. Saline soils have salt levels high enough that either crop yields begin to suffer or cropping is impractical. Excessive salts injure plants by disrupting the uptake of water into roots and interfering with the uptake of competitive nutrients (Daived Franzen, 2007).

Cobalt is a border elements, it has a positive effect on higher plants to adapt salinity stress. Mobilitu of cobalt was greatest with the saline soils but lowest with alkaline ones (Kumarr, 2002). Angelov *et al.* (1993) showed that cobalt reduced the salinity and/or ethyrel injury on tomato plants, a suggestion being introduced for possible use cobalt with transplants irrigated with saline water to overcome the salinity hazard on tomato. Wenzel *et al.* (1995) stated that, under salinity conditions, cobalt increased water content in pea plants. Soil salinity is considrable problem adversely affecting physiological processes. Finally, diminshing plant growth and yield. Shanon (2002) pointed out cobalt was used to reduce the harmful effect of salinity on tomato plants, transpiration rate being reduced. Nadia Gad and El-Metwally (2015) stated that cobalt at 20 ppm stimulated growth, dry watter content, yield quantity and quality, nutrients content of maize under salinity conditions. Cobalt increase proline content, leaf water potential and Abscisic acid in maize leaves. Cobalt help wheat plants to tolerate high soil salinity.

The aim of the present study was to evaluate the effect of cobalt on tomato growth, yield quantity and it`s quality under various levels of soil salinity.

Corresponding Author: Nadia Gad, Plant Nutrition Dept., National Research Centre, Dokki, Egypt.

Materials and Methods

Soil analysis:-

Soil samples were taken from Wadi El-Netron location, Beheara Governorate, Egypt. Such samples were air dried and then prepared for analyses using conventional techniques.

Physical analysis:-

Particle size distribution, saturation percentage curve, moisture characteristics curve, bulk density, hydraulic conductivity, total porosity and texture class were determined according to Blackmore (1972).

Chemical analysis:-

Electrical conductivity (ds/m^{-1}), pH in soil- water suspension (1:2.5), organic matter content (%), $CaCO_3$ (%), cation exchange capacity, Exchangeable sodium (%), cations and anions in meq/liter (in soil paste), macro and micronutrients were determined according to Black *et al.* (1982).

Cobalt analysis:-

Total cobalt were determined in Aqua regai extract (Cottanie, 1982). The water soluble cobalt as well as available cobalt (DTPA extractable) was assayed according to Black *et al.* (1982). Determination of cobalt was carried out using Atomic Absorption Spectrophotometer, Varian AA-20. Soma physical and chemical properties of studied soils are shown in (Table A).

Table A: Physical and chemical analysis of the experimental soils.

Physical	Particle size distribution (%)				Soil texture class
	Coarse sand	Fine sand	Silt	Clay	
Soil 1	5.6	16.5	39.4	38.5	Clay
Soil 2	5.5	15.9	40.5	39.0	Clay
Soil 3	5.5	15.8	40.7	39.4	Clay

Chemical	pH (1:2.5)	EC (1:5)	Soluble cations (meq/l)				Soluble anions (meq/L)			
			Ca^{++}	Mg^{++}	K^{+}	Na^{+}	CO_3^{-}	HCO3	Cl^{-}	$SO_4^{=}$
Soil 1	7.97	3.35	5.8	3.7	0.52	11.1	-	3.01	13.2	4.9
Soil 2	7.82	3.85	10.6	5.5	1.50	15.8	-	1.80	25.6	6.0
Soil 3	7.93	5.40	11.5	6.0	1.60	20.9	-	2.10	30.5	7.4

Plant Material and Experimental work:-

At 5th February, tomato seeds cv. Castle Rock (*Lycopersicon esculentum* Mil,) were sown in trays filled with a mixture of sand and peat moss (1:1 volume basis). Trays were kept under greenhouse condition with all agriculture managements required for production of tomato seedlings.

Five weeks-old seedlings, with almost the same stem thickness, were transplanted under three saline soils (3.35, 3.85and 5.40 ds/m^{-1})$^{.}$ in Wadi El-Natron Location, Beheara Governorate, Delta Egypt. (Table A).

Cobalt was add in the form of $CoSO_4$. 7 H_2O in 5 levels: 0.0, 7.5, 10.0, 12.5 and 15.0 ppm cobalt.

Measurement of plant growth:-

After 60 days from transplanting, just before flowering stage, plants growth parameters such as plant height, number of branches and leaves root length as well as shoot fresh and dry weights were determined according to FAO, (1980).

Measurement endogenous hormons:-

Fresh samples of shoot were taken for analysis of endogenous hormones (Auxins, Gibberllins and Abscisic acid) according to Shindy and Smith (1975) being adopted using a perken-Elmer SIGMA Gaschromatograph apparatus.

Measurement of chlorophyll content:-

Chlorophyll was determined in fresh leaves, using chlorophyll meter Spad 502 according to Wood *et al*. (1992).

Measurement of proline content:-

Leaves fresh samples (5 g) were taken for determination of proline content according to Bates *et al*. (1973).

Measurement leaf water potential:-

Using leaf water potenital meter, Set (PMS Instrument company, covallis, Oregon), leaf water potential were determined in plants fresh leaves.

Measurement of yield parameters:-

After 90-105 days from transplanting, fruits were harvested. Fruit weight (g), fruits weights per plant (kg) as well as fruits yield (ton/fed.) were recorded according to Gabal *et al.* (1984).

Measurement of nutrition status:-

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

Measurement of chemical constituents:-

In tomato fruits total proteins, total soluble solids, total soluble sugars and vitamin "C" (as L-Ascorbic acid) as well as titrable acidity 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

Vegetative growth:-

The present results in Table (1) outline the response of tomato plants growth under various levels of salinity to different rates of cobalt. Obtained results show increasing salinity levels in plant media significantly decrease all tomatoes growth parameters such as plant height, branches and leaves number per plant, root length, shoot fresh and dry weights. These results are in harmony with those obtained by Nasir Khan (2016) who stated that, regarding tomatoes growth parameters, BL-1076 (as a salt tolerant) gave higher values, while queen (as a salt sensitive) gave the lowest values for most of the growth parameters such as plant height, number of leaves, leaf area, shoot and root fresh and dry weights.

Table 1: Effect of cobalt on tomato plants growth parameters under various levels of soil salinity (Mean of two seasons).

Growth parameters	Salinity levels dsm^{-1}	Cobalt concentration (ppm) 0.0	7.5	10.0	12.5	15.0	LSD at 5%
Plant height (cm)	3.35	47.5	54.8	62.6	60.9	57.0	0.57
	3.85	43.2	50.0	55.2	54.3	50.6	
	5.40	37.7	40.6	48.8	47.5	44.3	
Branches number per plant	3.35	5.0	6.0	6.0	6.0	6.0	0.003
	3.85	5.0	5.0	6.0	6.0	6.0	
	5.40	3.0	3.0	5.0	4.0	4.0	
Leaves number per plant	3.35	12.0	15.0	18.0	16.0	15.0	0.005
	3.85	9	13.0	16.0	13.0	13.0	
	5.40	7.0	11.0	14.0	10.0	11.0	
Root length (cm)	3.35	5.8	7.2	10.3	10.0	9.2	0.03
	3.85	5.2	6.0	8.9	8.1	7.6	
	5.40	4.9	5.7	7.2	6.0	5.6	
Shoot fresh weight (g)	3.35	116.2	119.9	136.5	133.0	129.2	2.38
	3.85	113.5	116.6	128.8	124.2	119.5	
	5.40	104.8	108.0	118.9	114.5	111.0	
Shoot dry weight (g)	3.35	31.0	34.5	38.77	36.02	33.31	0.72
	3.85	27.3	30.8	34.80	33.51	29.70	
	5.40	20.8	24.6	27.91	24.77	22.61	

The present results in Table (1) also shows that all cobalt concentrations has a significantly promotive effect on the studied growth parameters compared with untreated plants. Increasing cobalt rates in plant media up to 12.5 ppm stimulate the growth parameters. Cobalt at 12.5 ppm gave the highest values of growth parameters. The greatest effect of cobalt on tomatoes growth was observed at 5.40 ds/m^{-1} soil salinity and 12.5 ppm cobalt. These results agrees with those obtained by Hussien (1984) who found that up to 5 ppm cobalt significantly increased tomato growth and yield under saline condition (in sand culture). Cobalt help tomato plants to resist stresses caused with high salinity more than 4 ds/m^{-1}. (Bischoff and Wemer, 1999). Confirm these results Stewart (2001) who found that cobalt reduced salinity harmful and /or other injury to tomato plants, a suggestion being introduced for possibility of cobalt to overcome the salinity hazard. Nadia Gad and Hala Kandil (2011) added that cobalt concentrations (from 7.5 to 20 ppm) significantly increase wheat growth parameters compared with control plants. Cobalt at 15 ppm gave the highest values.

Physiological contents of tomato plants:-

Data in Table (2) revealed that the effect of cobalt on physiological content in tomato plants (under various levels of salinity) such as chlorophyll content, proline content, leaf water potential, Endogenous hormones i.e Auxins, Gibberllins and Abscisic acid.

Chlorophyll content:-

Data in Table (2) shows that as salinity levels increase in plant growth media, the green pigments in tomato leaves significantly decrease. Increasing salinity levels play an important role in reducing toxicity symptoms. Results reflect that cobalt has a vital role in tomato resistance to salinity.

All cobalt concentrations significantly increased chlorophyll content in tomato upper leaves compared with control. Data show the chlorophyll content of tomato leaves followed a liner relationship with the increase of cobalt in plant media up to 12.5 ppm under various soil salinity. Cobalt decrease the hazard effect of iron status in upper leaves. Increasing cobalt level above 12.5 ppm chlorophyll content reduced. Bisht (1991) reported that cobalt and iron are competitive elements in the nutrition in tomato plants. Cobalt seemed to have efficient role in iron translocated from lower old leaves to upper young leaves. These results are in harmony with those obtained by Angelov *et al* (1993).

Proline Content:-

Data in Table (2) Cleary indicated that proline content significantly increase in tomato leaves, as soil salinity levels increased . All cobalt rates (from 7.5 to 15.0 ppm) increases proline content under various soil salinity compared with untreated plants. These results confirm those previously discussed by Kaul (1981) on guava and Shanmugavelu *et al.* (1996) on tomatoes. They stated that the salt stress increase proline content. Cobalt help tomato plants to resist stresses caused with high salinity (above 4 ds/m^{-1}). The vital role of cobalt on proline biosynthesis, in modifying the plant water economy in tomato leaves was confirmed. Proline content was much higher in plants were grown under high salinity soil 5.40 $dsim^{-1}$).

Table 2: Effect of cobalt on physiological contents of tomato plants grown under various levels of soil salinity (Mean of two seasons)

Physiological contents of plants	Salinity levels dsm^{-1}	Cobalt concentration (ppm)					LSD at 5%
		0.0	7.5	10.0	12.5	15.0	
Chlorophyll content (spad)	3.35	52.9	55.0	58.8	57.8	57.5	0.7
	3.85	50.2	52.5	53.6	54.5	54.0	
	5.40	43.0	45.8	48.4	49.0	48.2	
Proline content (g per 100 g dry weight)	3.35	0.14	0.16	0.21	0.26	0.28	0.002
	3.85	0.15	0.18	0.23	0.28	0.29	
	5.40	0.17	0.19	0.25	0.30	0.32	
Leaf water potential (-bar)	3.35	-18.31	-15.53	-13.90	-11.44	-9.55	0.17
	3.85	-17.92	-12.22	-10.66	-10.02	-7.12	
	5.40	-17.01	-10.24	-9.07	-8.62	-6.78	
Auxins (µg per g fresh tissue)	3.35	1.818	3.215	4.848	5.340	5.180	0.011
	3.85	1.790	3.040	4.502	5.062	5.051	
	5.40	1.587	2.982	3.870	4.787	4.303	
Gibberlins (µg per g fresh tissue)	3.35	1.822	3.802	4.566	5.840	5.751	0.019
	3.85	1.761	3.660	4.123	5.311	5.201	
	5.40	1.316	2.480	3.865	4.781	4.214	
Abscisic acid (µg per g fresh tissue)	3.35	0.989	1.615	1.850	2.740	3.786	0.016
	3.85	1.326	1.846	2.561	3.320	3.982	
	5.40	1.911	2.425	2.979	3.751	4.320	

Leaf water potential:-

Data in Table (2) also clearly indicate that increasing salinity levels in plant media significantly increase tomato leaves water potential. All cobalt concentrations (from 7.5 to 15 ppm) significantly increase tomato leaves water potential under soil salinity levels, compared with untreated plants. The greatest effect of cobalt on leaf water potential in tomato plants were grown under high salinity (5.40 dsm^{-1}). These results agree with those of Rathsooriya and Nagarajah (2003) who found that attributed the beneficial effect of cobalt in growth of salinized pea plants to an increase in the leaf water potential relative to those untreated with cobalt. The higher leaf water potential could enhance the photosynthesis process directly by influencing the photosynthesis system or indirectly by decreasing the total leaf resistance to the diffusion CO_2 into the leaf.

Endogenous hormones:

Data in Table (2) shows the content of endogenous Auxins and Gibberellins significantly increase with cobalt levels increase from 7.5 up to 12.5 ppm in compared with untreated plants. With increasing soil salinity, both Auxins and Gibberelins in tomato plants are reduced. Concentration of both Auxins and Gibberellins was much higher for plants were grown under low salinity conditions

(3.35 ds/m$^{-1)}$. These hormones has a beneficial effects of cobalt on growth of salinized tomato plants. Increasing cobalt more than 15.0 ppm reduce the promotive effect. These results are in harmony with those obtained by Nadia Gad (2005) who stated that cobalt being with positive effect due to several induced effects in hormonal (Auxins and Gibberellins) synthesis and decrease the activity of some enzymes such as peroxidase and catalase and hence increasing the anabolism rather than catabolism. Data in Table (2) also show that the Abscisic acid significantly increase as cobalt rate increase irrespective of salinity levels of tomato plants.

The content of Abscisic acid was much higher in plant which grown under high saline soil (5.40 dsm^{-1}). Cobalt help tomato plants to resist stresses caused by high salinity. The vital role of Abscisic acid in adjusting plant water balance under salinity levels and could modify the plant water economy before the leaves became stressed. These results agree with those of Anter and Nadia Gad (2001). Stewart (2001) added that, under salinity condition, proline oxidation rates were similar in leaves incubated in Abscisic acid and in water even through the proline level in Abscici acid-treated leaves was 2.5 times the level in the water-treated controls. These results indicated that the metabolic cause of Absciscic acid induced proline accumulation is a stimulation of proline synthesis from glutamic acid. Abscisic acid strongly induces plant stomatal closure and reduce the transpiration rate.

Yield characteristics:-

Data in Table (3) shows that, under salinity condition cobalt concentrations (7.5 to 12.5) significantly increase all tomato yield parameters such as, fruits weight (g) and fruits yield/plant (kg), fruits yield (ton/feddan). Data indicate that all cobalt levels (7.5 to 12.5 ppm) has a significant promotive effect on yield parameters compared with untreated plants.

The highest recorded of tomatoes yield were obtained in plants treated with 12.5 ppm cobalt under various salinity levels. Tomato fruits yield was much higher in plants grown under low salinity level (3.35 dsm-1). These results are in harmony with those obtained by Nadia Gad and El-Metwaly (2015) who found that cobalt concentrations (15 to 25 ppm) significantly increase all yield parameters of maize such as ear length, ear diameter, ear weight, ear grains weight per plant, 100-kernel weight as well as grains yield (ton/fed) compared with control. Cobalt at 20 ppm gave the greatest yield values.

Table 3: Effect of cobalt on fruits yield of tomato plants grown under various levels of soil salinity (mean of two seasons).

Yield parameters	Salinity levels dsm^{-1}	Cobalt concentration (ppm)					LSD at 5%
		0.0	7.5	10.0	12.5	15.	
Mean of Fruit weight (g)	3.35	110.8	126.6	132.9	145.7	139.2	0.09
	3.85	102.7	120.3	126.2	137.6	131.5	
	5.40	94.34	112.2	118.4	130.3	128.6	
Fruits yield per plant (kg)	3.35	2.105	2.785	3.588	3.788	3.341	0.261
	3.85	1.541	2.045	2.903	2.890	2.499	
	5.40	1.377	1.571	2.250	2.215	1.929	
Fruits yield (ton per fed)	3.35	9.925	10.924	11.924	12.261	11.905	0.325
	3.85	8.705	8.225	9.515	11.787	10.095	
	5.40	6.989	8.855	6.650	8.950	5.745	

Fruits chemical constituents:-

Data in Table (4) shows that all cobalt concentrations has a significant promotive effect on tomato fruits chemical constituents such as total protein ,total soluble solids, total soluble sugars, vitamin "C" as L. Ascorbic acid of tomato fruits under various salinity levels compared with untreated plants. These results agree with those obtained by Vinay *et al.* (1996) who stated that cobalt gave a significant variations in tomato total soluble solids, total soluble sugars, vitamin "C" compared with control.

Data in Table (4) also shows that the titrable acidity (as citric acid) gave negative response to all cobalt levels with of tomato under different levels of salinity, Titrable acidity was decreased as cobalt addition increased sit is improved the fruits quality.

Table 4: Effect of cobalt constituents of tomato fruits under various levels of soil salinity Mean of two seasons).

Yield parameters	Salinity levels dsm^{-1}	Cobalt concentration (ppm)					LSD at 5%
		0.0	7.5	10.0	12.5	15.0	
Total protein %	3.35	2.73	2.82	3.09	3.04	2.91	0.06
	3.85	2.61	2.70	2.97	2.93	2.79	
	5.40	2.42	2.55	2.81	2.75	2.64	
Total soluble solids (%)	3.35	4.39	4.51	4.86	4.67	4.42	0.033
	3.85	3.82	3.96	4.20	4.12	3.90	
	5.40	3.34	3.21	3.87	3.52	3.49	
Total soluble sugars	3.35	2.37	2.39	2.44	2.48	2.45	0.002
	3.85	2.26	2.29	2.32	2.39	2.36	
	5.40	1.97	2.02	2.06	2.14	2.12	
Vitamin "'C" mg per 100g fresh weight	3.35	16.45	16.49	17.35	17.42	17.22	0.003
	3.85	16.34	16.38	17.18	17.26	17.03	
	5.40	16.05	16.11	16.84	16.92	16.75	
Titrable acidity as citric acid (%)	3.35	0.54	0.51	0.47	0.44	0.40	0.001
	3.85	0.60	0.56	0.53	0.49	0.46	
	5.40	0.66	0.63	0.61	0.58	0.54	

Nutritional status in fruits

Macronutrients:-

Date in Table (5) shows that as salinity levels increase, the content of N, P, K, Ca, Mg in tomato decreased. All cobalt rates significantly increase the studied macronutrients content compared with control plant. Cobalt rates (7.5 to 12.5) has a beneficial effect on the status of these elements. Cobalt at 12.5 ppm gave the highest macronutrients content. These results agree with those obtained by Castro *et al*. (1996).

Data in Table (5) also show that both Na^+ and cl^- were increased as salinity levels increased. The content of Na^+ and Cl^+ was much higher in plants were grown under high salinity level ($5.4 dsm^{-1}$). These results are in harmony with those obtained by Dahiya and Singh (1996).

Micronutrients (Mn, Zn, Cu):

According to Suhayda *et al*. (1994), Salinity affected plant contents of Mn, Zn and Cu by :-

1- Changing the available levels of these elements in plant media.
2- Altering their absorption by plant roots.
3- Inhibiting cell expansion and plant growth.

Data in Table (6) indicated that increasing salinity levels in the plant media significantly decrease these elements in tomato fruits. Salinity stress may have stimulate or inhibitory effects of uptake these elements by plants. These results agree with those obtained by El-Kholi *et al*. (1988).

Data in Table (6) also indicate that all cobalt concentrations significantly increase Mn, Zn, and Cu in tomato fruits compared with control. Cobalt at 12.5 ppm gave the greatest values. These results are in harmony with those obtained Nadia Gad *et al.* (2011) who stated that under salinity conditions cobalt significantly increased the content of macro (N,P and K) and micro (Mn, Zn and Cu) nutrients of Barley plants.

Table 5: Effect of cobalt on macronutrients content of tomato fruits under various levels of soil salinity (Mean of two seasons).

Macronutrients %	Salinity levels dsm^{-1}	Cobalt concentration (ppm)					LSD at 5%
		0.0	7.5	10.0	12.5	15.0	
N	3.35	0.436	0.451	0.494	0.486	0.465	0.033
	3.85	0.418	0.432	0.475	0.468	0.446	
	5.40	0.387	0.408	0.449	0.439	0.422	
P	3.35	0.375	0.390	0.405	0.402	0.381	0.007
	3.85	0.332	0.356	0.372	0.366	0.345	
	5.40	0.289	0.314	0.334	0.322	0.293	
K	3.35	3.67	3.89	4.06	4.01	3.92	0.02
	3.85	3.40	3.61	3.88	3.81	3.75	
	5.40	2.74	2.90	3.11	3.06	2.85	
Ca	3.35	2.35	2.52	2.64	2.61	2.56	0.054
	3.85	2.19	2.33	2.48	2.43	2.38	
	5.40	1.88	1.98	2.14	2.09	2.03	
Mg	3.35	0.445	0.448	0.524	0.518	0.514	0.003
	3.85	0.429	0.432	0.506	0.501	0.493	
	5.40	0.405	0.411	0.487	0.480	0.469	
Na	3.35	1.71	1.55	1.48	1.41	1.36	0.022
	3.85	1.85	1.63	1.56	1.50	1.44	
	5.40	2.69	2.43	2.37	2.29	2.22	
Cl	3.35	1.55	1.68	1.89	2.11	2.34	0.023
	3.85	2.73	2.98	3.17	2.49	3.61	
	5.40	3.36	3.51	3.72	2.98	4.22	

Table 6: Effect of cobalt on micronutrient and cobalt content of tomato fruits under various levels of salinity (Mean of two seasons).

Micronutrient (ppm)	Salinity levels dsm^{-1}	Cobalt concentration (ppm)					LSD at 5%
		0.0	7.5	10.0	12.5	15.0	
Mn	3.35	29.2	31.7	34.9	33.2	32.1	0.33
	3.85	25.0	27.5	30.2	29.4	38.2	
	5.40	19.1	20.9	22.0	20.6	19.3	
Zn	3.35	32.2	35.5	38.0	36.5	33.9	0.11
	3.85	29.0	31.2	33.4	31.0	29.1	
	5.40	22.5	24.6	26.6	24.2	21.8	
Cu	3.35	26.0	27.9	29.5	28.2	26.0	0.35
	3.85	22.4	24.2	26.0	24.4	22.1	
	5.40	15.5	17.9	19.3	17.9	15.0	
Fe	3.35	137	135	132	128	125	1.96
	3.85	131	126	123	118	116	
	5.40	119	114	111	108	106	
Co	3.35	1.22	3.04	6.11	7.08	8.21	0.07
	3.85	1.22	2.93	4.42	7.22	8.80	
	5.40	1.25	2.65	4.19	7.69	8.83	

Iron content:-

Data in Table (6) show that, increase in cobalt levels in plant media consistently decreased iron content. This may be explained on the basis of results obtained by Bisht (1991) who indicated certain antagonistic relationships between the two elements (Co-Fe).

Cobalt content:

Data in Table (6) also show that increasing cobalt levels in plant media increased cobalt content in tomato fruits. 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 cobalt in tomato fruits (7.08 - 7.93 ppm) with the application cobalt at 12.5 ppm.

Conclusion

It could be concluded that the cobalt has a positive effect on tomato to resist stresses caused from high salinity. As well as, applying cobalt caused increasing in growth, yield, nutritional status and chemical constituents, leaf water potential and Abscisic acid content of tomato plant under salinity conditions.

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