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INFLUENCE OF COBALT ON TOLERATING CLIMATIC CHANGE (SALINITY) IN ONION PLANT WITH REFERENCE TO GROWTH, YIELD AND MINERAL COMPOSITION

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Abstract

Onion has been classified as salt sensitive crop. Increasing the level of soil salinity over 1.2 dSm^{-1} showed pronounced decrease in yield. Two field experiments carried out at Wadi El-Natron Location, Beheara Governorate, Delta Egypt during 2017 and 2018 seasons to study the effect of applying different rate of cobalt on growth, yield and mineral composition of onion plants under three saline soils. The seedlings (at the third truly leaf) were irrigated with six levels of cobalt (0.0, 10.0, 12.5, 15.0, 17.5 and 20.0 ppm).
The obtained results could be summarized as follows:

- All cobalt treatments significantly increased the tested growth, yield parameter and mineral composition compared with untreated plants.
- Cobalt at 12.5 ppm resulted the highest values on onion bulbs yield and its quality under various salinity levels.
- As increasing cobalt rate more than 12.5 ppm, the promotive effect was decreased.
- Cobalt help onion plants to tolerate high salinity (4.35 and 5.40 dS m^{-1}).

***Keywords*:** Onion-Cobalt-Growth-Yield-Nutrient status.

Introduction

Climatic changes could be summarized in the increase in temperature, global warming, the decrease of waters, increase in soil salinity floods and the change in the amount of rainfall, dryness, the increase in atmosphere humidity, the increase in ozone concentration, the pollution resulting from burning fuel and the excessive in the use of mineral fertilizers. Climate change impacts on water availability, crop yield, crop water productivity and food security. Many climate models have been developed to predict climate change impacts with higher spatial resolution climate models being helpful to provide more accurate predictions for future climate scenarios (Kang Yinhong *et al*., 2009). 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. Lisnik and Toma (2003) found that cobalt have a favorable effect in both tomato and cucumber plants dry weight, leaf number, leaf area as well as fruit yield. Nadia Gad (2005) found that the addition of 7.5 ppm cobalt had a significant promotive effect on tomato growth, yield and fruit quality. According to Saranga (2001), the adverse effect of salt stress on tomato plant growth is attributed to the specific toxic effect or to the imbalanced nutritional cations in tissues of the salt affected plants or due to reduction in carbon fixation during photosynthesis and to increasing carbon release in respiration. Also, Stewart (2001) showed that cobalt reduced salinity and /or ether injury to tomato plants, a suggestion being introduced for possibility of cobalt to overcome the salinity. Shanon, (2002) pointed out that cobalt was used to reduce the harmful effect of salinity on tomato plants, transpiration rate being reduced. Rathsooriya and Nagarajah (2003) 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. Kaul (2004) stated that the salt stress increased proline content in guava leaves cv. Lucknow-49. He added that intercellular concentration of proline increased with decreasing external water potential.

The present study was designed under field condition to study the effect of cobalt on Onion growth, yield and mineral composition under three saline soils**.**

Materials and Methods

Soil analysis

Soil samples were taken three saline soils (3.35, 4.35, 5.40 dS m^{-1}) from Wadi El-Netron location, Beheara Governorate, Delta Egypt. Such samples were air dried and then prepared for analyses using conventional techniques.

Particle size distribution along with soil moisture constants of used soil sample, as described by Blackmore *et al.* (1972) were determined. Contents of $CaCO_3$, Organic matter, pH and EC as well as soluble cations and Anions were assayed according to Black *et al*. (1982). Total and available macro and micro nutrients were determined according to Jackson, (1973). Total cobalt was determined in Aqua regain extract, soluble and available cobalt being assayed according to Cottenie *et al.* (1982).

Some physical and chemical properties of Wadi El-Netron soils sample are shown in Table (1).

Table 1 : Physical and chemical analysis of the experimental saline soils.

Soil Sample	pH (1:2.5)	EC dSm^{-1} (soil past)	Particle size distribution (%)				Soil texture class	
			Coarse sand	Fine sand	Silt	Clay		
S_1	7.97	3.35	5.6	16.5	39.4	38.5	Clay loam	
S_2	7.82	4.35	5.5	15.9	40.5	39.0	Clay loam	
S_3	7.93	5.40	5.5	15.8	40.7	39.4	Clay loam	
Soil Sample	**Soluble cations (meq/l)**				**Soluble anions (meq/L)**			
	Ca^{++}	Mg^{++}	K^+	Na^+	CO_3^-	HCO_3	Cl^-	$SO_4^=$
S_1	5.8	3.7	0.52	11.1	-	3.01	13.2	4.9
S_2	10.6	5.5	1.50	15.8	-	1.80	25.6	6.0
S_3	11.5	6.0	1.60	20.9	-	2.10	30.5	7.4

Experimental work

A field experiment 15th and 17th September 2017 and 2018. Seeds of onion (*Allium cepa* var. Giza 6) 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 onion seedlings.

Five weeks-old seedlings, with almost the same stem thickness, were transplanted under various salinity levels in the 3 saline soils,

Experiment consisting of 18 treatments. Each treatment were represented by 3 plots. Each plot area was 5 X 3 meter, consisting of three rows. Thirty seedling in each row (30 cm apart) were planted. All the plants received natural agricultural practices whenever they needed.

Cobalt was add once in the form of $CoSO_4$. 7 H_2O in 6 levels: 0.00, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm cobalt. All agricultural management required for production of onion.

Measurement of onion growth parameters:

After 45 days from transplanting, plant height, leaves number/plant as well as leaves fresh and dry weights were determine according to FAO (1980).

Measurement of yield parameters

After 130 days from transplanting, Bulbs were harvested. Bulbs diameter, Bulbs fresh and dry weight (g), as well as Bulbs yield (ton fed^{-1}) were recorded according to Gabal *et al.* (1984).

Measurement of nutrition status

In Onion bulbs, 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).

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

Onion has been classified as salt sensitive crop. Increasing the level of soil salinity over 1.2 dsm^{-1} showed pronounced decrease in yield.

Vegetative growth

The present results in Table (2) show the effect of different cobalt levels on onion plant growth such as leaves height, leaves number, leaves fresh weight, leaves dry weight and leaves area per plant under different concentrations of soil salinity.

Table 2 : Effect of cobalt on Onion plants growth parameters under various levels of soil salinity.

Growth parameters Leaf height (cm)	Salinity levels (S) ($dS\ m^{-1}$)	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
Leaf height (cm)	3.35	53.6	55.0	56.8	57.6	58.2	55.8	*S*	0.98
	4.35	46.9	47.8	50.5	52.1	52.9	50.9	*Co*	1.62
	5.40	39.4	40.6	42.0	43.7	44.2	42.5	*S*Co*	2.70
Leaves number per plant	3.35	9.0	10.0	11.0	10.0	11.0	9.0	*S*	0.40
	4.35	7.0	8.0	9.0	9.0	9.0	8.0	*Co*	0.66
	5.40	5.0	6.0	7.0	7.0	7.0	6.0	*S*Co*	1.10
Leaves fresh weight (gm)	3.35	38.32	38.80	39.21	40.05	40.31	39.91	*S*	0.84
	4.35	34.11	34.42	34.72	35.37	35.19	35.25	*Co*	1.38
	5.40	27.6	27.90	28.04	28.41	28.20	28.15	*S*Co*	2.30
Leaves dry weight (g/plant)	3.35	9.66	9.71	10.83	11.49	11.61	11.45	*S*	0.69
	4.35	7.81	7.85	8.16	8.33	8.38	8.28	*Co*	1.14
	5.40	5.52	5.56	5.79	5.79	5.86	5.74	*S*Co*	1.90
Leaves area per plant (cm^2)	3.35	35.81	35.96	36.75	38.11	38.80	37.87	*S*	1.38
	4.35	32.62	32.77	33.52	34.08	34.79	33.91	*Co*	2.28
	5.40	27.01	27.24	28.40	29.32	29.62	28.19	*S*Co*	3.80

Result clearly indicate that all studied growth parameters significantly decreased as soil salinity rate increased. These results are in harmony with those obtained by Chinnusamy *et al.* (2005) who found that salinity inhibits rapidly stems and leaves growth. Ion toxicity is the primary cause of growth reduction under salt stress.

Data in Table (2) also show that all studied cobalt levels (from 5.0 to 15.0 ppm) significantly increased the studied onion growth parameters compared with control. Cobalt at 12.5 ppm gave the highest values under various soil salinity levels. As cobalt concentration in plant media increased, the promotive effect decreased. Cobalt rates being the positive effect due to several induced effects in hormonal synthesis and metabolic activity. These results are good agreement with those obtained by Nadia Gad (2005a) who stated that cobalt has a favourable responses on Auxins and gibberellins synthesis increased along with attributed catalase and peroxidase activities were significantly increased and hence increasing that anabolism rather than catabolism. Confirm these results Nadia Gad *et al.* (2011) who found that under various salinity levels, increasing cobalt in plant media up to 10 ppm stimulated barley growth, dry matter content as well as seed yield quantity and quality.

Yield Characteristics

Under various soil salinity levels, the amounts of onion yield such as bulb diameter, bulb fresh and dry weights and bulb yield (ton/fadden) as affected by cobalt are given in Table (3).

Table 3 : Effect of cobalt on bulb yield of Onion plants grown under various levels of soil salinity.

Yield parameters	Salinity levels (S) (dS m^{-1})	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
Bulb diameter (cm)	3.35	4.32	4.61	4.93	5.39	5.70	5.57	*S*	0.20
	4.35	4.16	4.19	4.98	5.46	5.88	5.61	*Co*	0.32
	5.40	3.82	3.88	3.94	4.24	4.46	4.35	*S*Co*	0.54
Bulb fresh weight (g)	3.35	112.7	114.1	117.0	118.8	121.0	117.7	*S*	2.51
	4.35	97.8	104.2	106.5	109.3	112.0	109.2	*Co*	4.14
	5.40	89.2	92.6	94.3	97.0	101.2	98.5	*S*Co*	6.90
Bulb dry weight (g)	3.35	37.14	37.22	38.41	38.9	40.0	38.3	*S*	0.91
	4.35	32.21	32.28	32.39	32.44	33.0	31.7	*Co*	1.50
	5.40	25.46	25.67	25.81	26.03	26.29	26.08	*S*Co*	2.50
Bulb yield (ton/fed)	3.35	4.79	5.23	5.29	5.31	5.45	5.39	*S*	0.08
	4.35	4.71	4.91	4.98	5.09	5.15	5.10	*Co*	0.14
	5.40	4.22	4.28	4.37	4.43	4.48	4.48	*S*Co*	0.23

Data in Table (3) clearly indicate that, as salinity levels of soil increased, all studied yield parameters of onion significantly deceased. These results are agree with those obtained by Khodadad (2011) who stated that salinity causes reduction in germination percentage, seedling length, root/shoot ratio, plant growth and yield. Data also indicate that all cobalt concentrations (from 5 to 15 ppm) has a significant promotive effect on bulb yield parameters of onion under various soil salinity levels. The highest of onion bulb yield were obtained in plants which treated with12.5 ppm cobalt under various salinity levels. Increasing cobalt rate in plant media more than 12.5 ppm the promotive effect reduced. These results are in harmony with those obtained by Nadia Gad and El-Metwaly (2015) who found that cobalt concentrations (from 15 to 25 ppm) significantly increase all maize yield parameters such as ear length, ear diameter, ear weight, ear grains weight per plant, 100-kernel weight as well as grains yield (ton/feddan) compared with control, under different levels of salinity. Cobalt at 20 ppm gave the greatest values.

Nutritional status in bulbs:

Data in Table (4) clearly indicate the following:

Macronutrients

Data in Table (4) show that as salinity levels increasing, the content of N, P, K, Ca, S and Mg significantly decreased. While both Na^{+} and Cl^{-} significantly increased as salinity levels increased. These results are in harmony with those obtained by Siddiqi *et al.* (2011) who found that, in salt-affected soil, high build up of Cl^{-} and Na^{+} in plant root, leads to strong nutritional imbalance in plant. This is due to antagonism of these ions with other essential mineral elements like calcium (Ca), nitrogen (N), potassium (K), magnesium (Mg) and phosphorous (P).

Table 4 : Effect of cobalt on bulbs macronutrients content of Onion plants grown under various levels of soil salinity.

Macronutrients (%) content	Salinity levels (dS m^{-1})	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
N	3.35	1.82	1.86	1.93	2.05	2.14	2.10	*S*	0.033
	4.35	1.68	1.74	1.82	1.91	1.97	1.93	*Co*	0.054
	5.40	1.35	1.41	1.47	1.53	1.60	1.55	*S*Co*	0.090
P	3.35	0.520	0.524	0.531	0.537	0.543	0.539	*S*	0.008
	4.35	0.487	0.491	0.497	0.504	0.511	0.509	*Co*	0.014
	5.40	0.431	0.435	0.441	0.446	0.452	0.448	*S*Co*	0.023
K	3.35	1.70	1.73	1.78	1.84	1.89	1.86	*S*	0.065
	4.35	1.62	1.66	1.70	1.74	1.78	1.76	*Co*	0.108
	5.40	1.54	1.57	1.60	1.64	1.70	1.67	*S*Co*	0.180
Ca	3.35	2.46	2.49	2.54	2.59	2.63	1.63	*S*	0.040
	4.35	2.21	2.24	2.27	2.31	2.35	2.33	*Co*	0.066
	5.40	1.85	1.89	1.94	1.89	2.04	2.02	*S*Co*	0.110
M	3.35	0.456	0.460	0.463	0.467	0.471	0.468	*S*	0.004
	4.35	0.447	0.450	0.454	0.459	0.463	0.469	*Co*	0.007
	5.40	0.431	0.434	0.438	0.453	0.457	0.457	*S*Co*	0.012
S	3.35	1.68	1.71	1.75	1.79	1.84	1.81	*S*	0.062
	4.35	1.59	1.62	1.66	1.70	1.75	1.72	*Co*	0.102
	5.40	1.51	1.54	1.58	1.62	1.66	1.63	*S*Co*	0.170
Na	3.35	1.92	1.86	1.81	1.74	1.68	1.63	*S*	0.076
	4.35	2.63	2.57	2.51	2.47	2.42	2.36	*Co*	0.126
	5.40	3.44	2.40	2.35	2.29	2.24	2.18	*S*Co*	0.210
Cl	3.35	1.67	1.62	1.47	1.41	1.36	1.30	*S*	0.113
	4.35	2.34	2.29	2.25	2.19	2.14	2.09	*Co*	0.186
	5.40	3.52	3.48	2.44	2.39	2.33	2.28	*S*Co*	0.310

Data in Table (4) also show that cobalt rates (from 5 to 15 ppm) has a significant promotive effect on the content of the studied macronutrients in cucumber fruits under different salinity levels while Na^+ and Cl^- significantly reduced as affected by cobalt addition. These results are good agreement with those obtained by Nadia Gad *et al*. (2018).

Manganese, Zn and Cu

Data in Table (5) show that with increase soil salinity the content of Mn, Zn and Cu significantly decreased. These results are agree with those obtained by Munns (2005). Data also indicate that cobalt gave a positive effect on the content of these elements of onion bulbs. Cobalt at 12.5 ppm gave the highest figures. These results are in harmony with those obtained by Suhayda *et al.* (1994) who pointed that:

1- Changing the available levels of these elements in plant media.

2- Altering their absorption by plant roots.

3- Inhibiting cell expansions and plant growth.

Table 5 : Effect of cobalt on bulbs micronutrients content of Onion plants grown under various levels of soil salinity.

Micronutrients (%) content	Salinity levels (S) (dS m^{-1})	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
Mn	3.35	26.2	26.9	27.4	28.1	28.8	27.1	*S*	1.35
	4.35	22.6	23.0	23.7	25.0	25.3	23.9	*Co*	2.22
	5.40	18.7	19.3	20.4	21.5	21.8	19.8	*S*Co*	3.70
Zn	3.35	20.9	21.4	22.0	22.6	22.8	21.5	*S*	0.87
	4.35	16.5	16.9	18.0	18.8	19.2	17.7	*Co*	1.44
	5.40	13.0	13.7	14.8	15.6	15.9	14.4	*S*Co*	2.40
Cu	3.35	23.8	24.5	25.7	26.9	27.2	25.8	*S*	0.91
	4.35	19.9	21.0	21.0	23.2	23.7	22.0	*Co*	1.50
	5.40	16.8	18.0	18.7	20.0	29.4	19.0	*S*Co*	2.50
Fe	3.35	145	141	138	133	136	126	*S*	4.22
	4.35	13.9	135	131	126	127	118	*Co*	6.96
	5.40	129	126	121	115	118	107	*S*Co*	11.60
Co	3.35	1.26	3.01	4.71	6.21	8.12	10.08	*S*	0.47
	4.35	1.19	2.97	4.04	6.15	8.05	10.03	*Co*	0.78
	5.40	0.96	1.31	3.96	5.98	7.59	9.89	*S*Co*	1.30

Iron Content

Data in Table (5) reveal that, as increasing salinity levels in plant media, iron content significantly decreased. These results are agree with those obtained El-Kobbia and Osman (1987). 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 (Fe and Co).

Cobalt Content:

Data in Table (5) reveal that increasing cobalt in plant media, cobalt content in onion bulbs significantly increased at all levels of salinity. Confirm these results Nadia Gad *et al.* (2018). Cobalt help plants to tolerate high salinity levels. Hussien (1984) pointed out that cobalt was used to reduce the harmful effect of salinity on tomato plants, transpiration rate being reduced.

Conclusion

Cobalt help onion plants to tolerate various soil salinity. Cobalt levels in onion bulbs of 8.12, 8.05 and 7.59 ppm with the levels of soils salinity levels 3.35, 4.35 and 5.40 dSm^{-1} respectively with 12.5 ppm cobalt. Young (1983) reported that the daily cobalt requirements for human nutrition could reach 8 ppm. Cobalt is promising element under salinity condition due to climatic changes. Cobalt help onion plants to tolerate (high salinity) climatic changes.

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