Plant Archives Vol. 20, Supplement 1, 2020 pp. 1496-1500 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

INFLUENCE OF COBALT ON TOLERATING CLIMATIC CHANGE (SALINITY) IN ONION PLANT WITH REFERENCE TO PHYSIOLOGICAL AND CHEMICAL APPROACH

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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 physiological and chemical approach 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 ppm).

The obtained results could be summarized as follows:

- All cobalt levels significantly increased the chlorophyll and proline content in onion leaves under various levels of salinity compared with control.
- Cobalt rates has a positive effect on both Abscisic acid, Auxins and Gibberellins in onion leaves compared with untreated plant.
- Cobalt treatments gave a significant increasing chemical constituents of bulbs compared with control.
- Cobalt at 12.5ppm resulted the superior values of all studied ones 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- Physiological and chemical contents.

Introduction

Climate change caused by increasing evaporation due to global warming. Previous assessments of historic change in drought over the late twentieth and early twenty-first centuries illustrated that phenomena may already be happening globally (Sheffield *et al.,* 2012). Drought affects more than 10% of arable land; leading to desertification, while sanitization is rapidly increasing dramatically declining average yields of different crops. Moreover, increasing salt accumulation in the soil decreased the water potential of soil that badly affects plant tissue relative water content and plant water conductance (Munns, 2002).

Excess salts accumulation in soil causes reduction in water potential of soil solution that causes difficulty for plants to absorb the water from soil leading to "osmotic stress." High salts decrease plant growth because these buld salts stimulates the utilization of energy that the plant should use to take water from the soil solution and to improve the biochemical adjustments. This leads to reduced yield and growth of plants. Salt stress decrease the relative leaf water content, water potential, leaf water relation parameters, osmotic potential, turgor potential, and ultimately inhibited plant growth and decreased the crops fresh weight (Jabeen and Ahmad 2012).

Stewart (1980) showed that, under salinity condition, proline oxidation rates were similar in leaves incubated in Abscisic acid and in water even through the proline level in Abscisic acid treated leaves was 2.5 times the level in the water-treated controls. These results were interpreted to indicate that the metabolic cause of Abscisic acid induced proline accumulation is a stimulation of proline synthesis from glutamic acid. Hussein (1984) showed that up to 5 ppm cobalt concentration could be used in sand culture to reduce the harmful effect of salinity on tomato plants.

Wenzel *et al.* (1995) found that, under salinity conditions, cobalt increased water content in pea plants. The rates of both photosynthesis and transpiration processes have decreased but stomatal resistance were increased. Soil salinity is considerable problem adversely affecting physiological and metabolic processes, finally, diminishing plants growth and yield. Attia *et al.* (2014) showed that, under salinity stress, decreasing in dry weight and regeneration capacity, in contrast, an increasing in free proline accumulation was observed. The presence of cobalt sulfate decreased the negative impact of salt stress that observed in these indicators. Also, the levels of macro and micronutrients that affected by salt stress were not occurred in the presence of cobalt sulfate. RAPD studies were conducted using eight primers to find out the differences among them by occurrence of polymorphic bands due to the studied treatments. Distinguished specific bands identified salt stress and cobalt treatments effects on the studied genotypes (Mohamed and Yacout, 2014). It could be concluded that, exposure to cobalt sulfate before exposure to salt stress led to reducing its harm full effects on the studied parameters. The present study was designed under field condition to study the effect of cobalt on Onion growth physiological and chemical approach under three saline soils.

Materials and methods

Soil analysis

Soil samples were taken from three saline soils (3.35, 4.35, 5.40 dS m^{-1}). in 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 Nubaria soil 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 Clay	
S_2	7.82	4.35	5.5	15.9	40.5	39.0	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 in the form of Co SO_4. 7 H_2O in 5 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 endogenous hormones

Fresh samples of leaves were taken for analysis of endogenous hormones (Auxins, Gibberellins and Abscisic acid) according to Shindy and Smith (1975).

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

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

Measurement leaf water potential

Using leaf water potential were determined in fresh leaves.

Measurement of chemical constituents

In Onion bulbs total proteins, total soluble solids, stable oil /bulb and volatile oil / bulb 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

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

Physiological contents of onion leaves

Data in Table (2) reveal the effect of cobalt on the physiological contents in onion leaves such as chlorophyll content, proline content, leaf water potential, endogenous harmons (Auxins, Gibberellins and Abscisic acid), under various levels of soil salinity.

Chlorophyll content

Data in Table (2) show that increasing salinity levels in plant growth media, chlorophyll content in onion leaves significantly reduced. These results are in harmony with those obtained by Qados (2011) who stated that photosynthesis is adversely affected by salinity in different ways, such as the inhibition of CO_2 fixation and concentration due to stomatal closure, the reduction in photosynthesis process due to salinity resulted reduction in chlorophyll concentration and content. All cobalt rates has a promotive effect in chlorophyll content in onion leaves under various levels of salinity. These results are agree with those obtained by Bedoglio and Cole (2004) who found that cobalt increased potato leaf area and chloroplasts per unit leaf area as well as chlorophyll content.

Proline Content

Data in Table (2) show that the proline content in onion leaves significantly increased with the increasing soil salinity levels. These results are agree with those obtained by El-Hefnawy (1986) who pointed that, under salinity stress condition, proline content significantly increased in gauava leaves. Data also reveal that cobalt concentrations (from 5 to 15 ppm) has a favourable effect on proline content of onion leaves under various soil salinity levels. Proline content was much higher in leaves of onion which growth in high salinity level (5.40 dS m^{-1}). These results are in harmony with those obtained by Nadia Gad (2005b) who found that cobalt significantly increased proline content in tomato leaves under different salinity levels.

Table 2 : Effect of cobalt on physiological contents of onion plants grown under various levels of soil salinity.

Physiological contents of leaves	Salinity levels(S) (dS m^{-1})	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
Chlorophyll content (SPAD)	3.35	50.2	50.5	51.0	51.4	51.6	51.0	S	0.76
	4.35	47.4	47.6	47.9	48.2	48.6	48.3	Co	1.26
	5.40	43.6	43.9	44.3	44.7	45.2	45.0	S*Co	2.1
Proline content (g per 100 g dry weight)	3.35	0.18	0.20	0.22	0.25	0.29	0.27	S	0.25
	4.35	0.21	0.24	0.27	0.30	0.33	0.30	Co	0.42
	5.40	0.26	0.29	0.31	0.34	0.38	0.36	S*Co	0.7
Leaf water potential (-bar)	3.35	- 13.3	11.9-	10.0-	9.30-	8.6-	7.4-	S	0.40
	4.35	13.8 -	12.7-	19.9-	8.50-	6.4-	5.5-	Co	0.66
	5.40	14.2 -	13.0-	9.80-	7.30-	5.7-	5.3-	S*Co	1.1
Auxins (µg per g fresh tissue)	3.35	2.319	2.332	2.366	2.390	2.408	2.408	S	0.08
	4.35	1.980	1.997	2.021	2.126	2.146	2.134	Co	0.13
	5.40	1.842	1.864	1.885	1.898	2.056	2.032	S*Co	0.212
Gibberellins (µg per g fresh tissue)	3.35	2.242	2.255	2.271	2.289	2.305	2.301	S	0.07
	4.35	2.111	2.126	2.143	2.160	2.187	2.179	Co	0.12
	5.40	1.983	1.994	2.018	2.025	2.048	2.065	S*Co	0.198
Abscisic acid (µg per g fresh tissue)	3.35	0.991	0.998	2.011	2.023	2.039	2.048	S	0.06
	4.35	1.340	1.352	1.369	1.422	1.458	1.472	Co	0.09
	5.40	2.133	2.165	2.189	2.216	2.244	2.277	S*Co	0.154

Leaf water potential

Data in Table (2) indicate that the onion leaves water potential significantly decreased with the increasing soil salinity levels. These results are agree with those obtained by Jabeen and Ahmed (2012) who showed that under salinity stress leaf water potential was reduced. Data in Table (2) also indicate that cobalt addition (from 5 to 15 ppm) significantly increase leaf water potential in onion leaves. These results reveal as mentioned by Rathsooriya and Nagarajah (2003) who found that attributed the beneficial effect of cobalt on 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 in influencing the photosynthesis system or indirectly by decreasing the total leaf resistance to the diffusion CO_2 into the leaf.

Auxins and Gibberellins

Data in Table (2) show that the content of both Auxins and Gibberellins significantly decreased as salinity level increased. These results are in harmony with those obtained by Spaepen *et al.* (2009). Data in Table (2) also indicate that cobalt has a promotive effect on the content of Auxins as well as Gibberellins which significantly increased the studies growth parameters in onion. Cobalt at 12.5 ppm gave the greatest values. Increasing cobalt level more than 12.5 ppm reduce the promotive effect. Nadia Gad (2005b) stated that cobalt has a positive effect due to several induced effects in hormonal synthesis (Auxins and Gibberellins) and decreased the activity of some enzymes (catalase and Peroxidase) and hence increasing the anabolism rather than catabolism.

Abscisic Acid

Data in Table (2) clearly indicate that as increasing levels of soil salinity, the content of Abscisic acid in onion leaves significantly increased. The content of Abscisic acid was much higher in onion leaves which grown under high soil salinity (5.40 dS m^{-1}). Stewart (2001) showed that, under salinity conditions, proline oxidation rates were similar in leaves incubated in Abscisic acid and in water even through the proline level in Abscisic acid treated leaves was 2.5 times the level in the water - treated controls. These results indicated that the metabolic cause of Abscisic acid induced proline accumulation is a stimulation of proline synthesis from glutamic acid. Data in Table (2) also indicate that cobalt significantly increased Abscisic acid content in onion leaves under various levels of salinity. These results are in harmony with those obtained by Nadia Gad *et al.* (2017) who stated that cobalt significantly increased Abscisic acid content in tomato plants under various levels of soil salinity. The vital role of Abscisic Acid in adjusting plan water balance under salinity levels and could modify the plant water economy before the leaves became stressed. Cobalt help onion plants to resist stresses caused by high salinity (5.40 ds lm^{-1}).

Bulbs chemical constituents

Effect of cobalt on chemical constituents such as total proteins, total soluble solids, stable oil per bulb and volatile oil per bulb are given in Table (3).

Results indicate that all the mentioned parameters were significantly reduced with the increasing salinity level. These results are agree with those obtained by Ashraf and Foolad (2007) who found that salinity stress-stimulates production of ROS, which causes oxidative damages of biochemical constituents such as proteins, lipids, macromolecules like DNA which disturb vital cellular functions of plant.

Table 3 : Effect of cobalt on bulbs chemical constituents of Onion plants grown under various levels of soil salinity.

Chemical constituents	Salinity levels (S) (dS m^{-1})	Cobalt treatments (ppm)						LSD at 5%	
		0.0	5.0	7.5	10.0	12.5	15.0		
Total proteins (%)	3.35	11.38	11.63	12.06	12.81	13.38	13.13	S	0.436
	4.35	10.50	10.88	11.38	11.94	12.31	12.06	Co	0.720
	5.40	8.44	8.81	9.19	9.56	10.00	9.69	S*Co	1.200
Total soluble solids (%)	3.35	4.48	4.53	4.61	4.69	4.76	4.76	S	0.047
	4.35	4.22	4.26	4.31	4.37	4.45	4.42	Co	0.078
	5.40	4.09	4.13	4.18	4.26	4.33	4.30	S*Co	0.130
Stable oil/bulb (%)	3.35	14.80	15,11	16.71	17.39	18.13	18.03	S	0.509
	4.35	12.32	12.80	13.66	14.42	15.22	15.11	Co	0.840
	5.40	10.43	10.71	11.55	12.69	14.11	14.02	S*Co	1.400
Volatile oil/bulb (%)	3.35	0.168	0.186	0.219	0.247	0.289	0.281	S	0.018
	4.35	0.153	0.175	0.198	0.220	0.242	0.233	Co	0.030
	5.40	0.139	0.159	0.171	0.209	0.226	0.218	S*Co	0.050

Data in Table (3) also indicate that cobalt addition (from 5 to 15 ppm) has a favorable effect on the studied chemical constituents increasing bulb chemical constituents reveal the high bulb quality. Cobalt at 12.5 ppm gave the greatest values under various soil salinity levels. These results are in harmony with those obtained by Vinay *et al.* (1996) who pointed that cobalt gave a significant variations in tomato total soluble solids, total soluble sugars, vitamin "C" compared with control.

Conclusion

Under salinity conditions, cobalt help both onion and garlic plants to resist stresses. Cobalt was used to reduce the harmful of salinity. Also cobalt hence the onion bulb quality with the various levels of soil salinity (climatic changes).

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