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INFLUENCE OF COBALT ON POTATO (*SOLANUM TUBEROSUM*) PRODUCTIVITY

Nadia Gad and M.E. Fekry Ali
Plant Nutrition Dept., National Research Centre, El–Buhouthst. Dokki,Cairo, Egypt

Abstract

Field experiments were conducted at the Research and Production Station of the National Center for Research, Nubaria District, Beheira Governorate, West Delta, Egypt, by the drip irrigation system during two successful seasons of cultivation 2017, 2018, where an assessment was made of the effect of six levels of cobalt, namely (0.0, 5.0, 75, 10.0, 12.5 and 15.0 ppm) on vegetable growth and potato yield

The results indicated the following:

- Significant increase in the vegetative growth rate of the studied characteristics by increasing all levels of added cobalt compared to plants that were not treated with cobalt.
- The addition of cobalt at a rate of 10% ppm has led to increased green and productive growth of the potato crop and the formation of chemical components, as well as the formation of minerals in the crop.
- As cobalt level increasing in plant media over than 10 PPm, the favourable effect was reduced.

***Keywords*: Potato, Cobalt, Yield quantity and quality.**

Introduction

The potato (*Solanum tuberosum* L.) is considered one of the most important agricultural crops in the world, as it comes in the fourth place after each of the wheat, rice and corn crops, as it is one of the major food crops in most of the countries of the world along with the other crops mentioned above. In Egypt, potato considered to be one of the most important vegetable crops for local consumption and exportation, belong to the family solanaceae which includes about 90 general and 2000 species (Cobley, 1976).

Cobalt is one of the most important key components that lead to vitamin B12 conditioning because it is so necessary for food for both humans and animals (Young, 1983 and Smith, 1991).

Cobalt is considered one of the very important elements in the growth of plants and it is one of the heavy non-dangerous minerals present in the soil, (Hanson *et al*., 2001) as cobalt does not accumulate in the human body as it increases its age like other heavy elements, and despite this there is no direct evidence of the role of cobalt in the plant metabolism (Young, 1983).

Boureto and Kagawa (2001) mentioned that application of cobalt at rate of 2.3 kg per ha increased sugar beet growth, roots and sugar yield. Lisnik and Toma (2003) stated that cobalt have a favorable effect in both tomato and cucumber plants dry weight, leaf number, leaf area as well as fruits yield.

Choo-Zhou *et al*. (2005) mentioned that the cobalt element helps to increase the osmotic pressure process by plant cell cytoplasm, helps to resist leaves to dehydration and also helps to reduce wilt rates for potato plants, and experiments have shown that cobalt treatments have resulted in a decrease in the content of polyamine It also reduced activity in antioxidant enzymes in the case of osmotic potential (Tewari *et al*., 2002).

Nadia Gad and Abdel-Moez (2011) found that the addition of cobalt significantly increased broccoli growth, head yield and its compared of the quality with the control. The cobalt treatment at 6 ppm had a maximum values of brocooli vegetative growth, head yield, mineral composition as well as chemical constituents. Nadia Gad Nagwa Hassan (2013) reported that, all the cobalt rates (2.5; 5.0; 7.5 and 10.0 ppm) significantly increased sweet pepper growth and yield parameters compared with untreated plants. The cobalt rate at 5 ppm resulted the vegetative growth, yield and quality measments. Holah *et al*. (2019) found that all cobalt rates (from 2.50 to 20 ppm) significantly increased tomato plants growth, yield nutritional status and chemical contents. The cobalt rate at 7.5 ppm gave the greatest value. As cobalt has increased in the plant media, the promotive effect was decreased,

Materials and Methods

Soil analysis

Soil samples were taken and 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 regia extraction (Cottenie *et al*., 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.

Table 1 : Physical and chemical analysis of the experimental soils samples from Nobaria Station.

Physical	Particle size distribution (%)			Soil texture class	Water saturation	Field capacity	Welting point	Available water
	Sand	Silt	Clay		%			
	69.8	26.7	3.5	Sandy loam	20.0	14.4	3.9	10.5

Chemical	pH (1:2.5)	EC (dS m^{-1})	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 (ppm)			$CaCO_3$ %	OM %
(ppm)			(ppm)				Soluble	Available	Total		
N	P	K	Fe	Mn	Zn	Cu					
25.2	15.3	10.2	23.0	10.5	3.62	5.22	0.39	1.78	9.68	3.17	0.19

Plant Material and Experimental work

Two field experiments were carried out in Research and Production Station National Research Centre. Nubaria Site, Beheara Governorate, Delta Egypt under drip irrigation system during winter seasons of 2017 and 2018 to examine the effect of cobalt addition on potato growth and production.

The experimental design was randomized complete block with-four replicates. Each experiment consisting 5 treatments beside control. Four plots represented each treatment. Each plot area 5X3 meter. Each plot consisting of three rows. Each row consisting 10 plants (50 cm apart). Seeds of potato tubers (*Solanum tuberosum* sponta cv.) were planted at 3th January during both 2017 and 2018 seasons. All the plants received natural agricultural practices when are needed. Seedlings at the third truly leaf were irrigated once with cobalt concentrations (0.0, 5.0, 75, 10.0, 12.5 and 15 ppm) as cobalt sulphate form.

Measurement of plant vegetative growth

After 70 days from planting, the growth parameters such as plant height, number of branches and leaves as well as fresh and dry weights of both shoots and roots were determined according to FAO (1980).

Measurement of yield characteristics

After 110 days from planting, potato tubers yield parameters such as tuber length, tuber diameter, specific gravity, fresh and dry weight of tuber, tuber yield (kg/plot) as well as tubers yield (ton/feddan) were determined according to Gabal *et al*. (1984).

Measurement nutritional status

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

Measurement of chemical constituents

In potato tubers, total proteins, starch, total soluble solid is along with vitamin “A” and vitamin “C” were determined according to A.O.A.C (1995).

Statistical analysis

All data were subjected to statistical analysis according to procedure outlined by SAS (1996) computer program and means were compared by LSD method according to Sndecor and Cochran (1980).

Result and Discussion

Vegetative growth

The data in Table 2, showing the effect of the different cobalt levels on the potato growth media significantly increased the studied growth parameters, as mention in colums: plant height (cm), number of branches and leaves, fresh and dry weights (g) of both shoots and roots per plants compared with control.

Table 2: Effect of cobalt levels after 70 days on vegetative growth parameters of potato plants (average of the two seasons).

Cobalt levels (ppm)	The plant hight (cm)	Number/plant		The fresh weight (g)		The dry weight (g)	
		Branches	Leaves	Shoot	Root	Shoot	Root
Control	48.82	4.79	13.66	237	41.42	39.34	13.8
5.0	51.98	5.19	15.84	249	44.23	41.14	14.2
7.5	55.86	5.78	17.64	258	48.71	42.80	15.5
10.0	64.71	6.24	20.05	289	52.33	47.91	16.6
12.5	58.31	5.94	19.89	271	49.18	44.70	16.1
15.0	55.82	5.77	17.78	256	46.51	42.27	15.9
LSD 5%	**2.31**	**0.42**	**1.5**	**0.8**	**2.12**	**1.62**	**1.1**

Cobalt at 10 PPm resulted the highest values of the mentioned parameters of potato, during the two growing seasons. The results are in harmony with those obtained by Nadia Gad (2006 a) found that the minimum doses of cobalt gave the heighest growth and yield of cucumber plants compared by the higher ones. She reported that the low cobalt levels may be due to the endogenous hormones such as: Auxins, Gibberllins and Cytokinin which were found to increase with the low levels of cobalt and decrease with the higher ones. Cobalt had a positive effect in hormonal synthesis and metabolic which help in decrease of the activity of some enzymes such as: peroxidase and catalase in tomato plants and hence of the increasing of the anabolism, while the higher level of cobalt more than 7.5 ppm found to increase the activity of the studied enzymes and increasing the catabolism rather than anabolism. Confirm these results Nadia Gad and Nagwa Hassan (2013) Who found that all cobalt rates significantly increase sweet pepper growth and yield parameters compared with control.

Yield characteristics

The data in Table 3, outline response of potato yield measurments to different levels of cobalt concentrations. All cobalt levels has a promotive effect on potato tuber yield compared with control. Cobalt at 10 PPm has a greatest values of yield parameters such as number and weight of tubers per plant, tuber length and diameter, early yield and total yield (ton/fed). As cobalt rates were ranged above 10 ppm, the promotive effect was reduced. This results agreed with those obtained by Nadia Gad and Nagwa Hassan (2013).

Table 3: The effect of cobalt levels after 110 days from planting on potato tubers yield measuments (average of the two seasons).

Cobalt levels (PPm)	Tuber length (cm)	Tuber diameter (cm)	Specific gravity (g/cm^3)	Fresh weight (g)	Dry weight (g)	Tuber yield Kg/plot	Tuber yield (Ton/fed)
Control	8.90	14.6	37.9	170	39/8	23.61	9.11
5.0	9.71	17.5	44.5	182	45.0	24.25	9.17
7.5	10.9	18.8	46.0	199	47.4	26.85	9.99
10.0	13.6	20.7	48.6	221	51.6	29.89	11.52
12.5	13.0	18.7	45.9	218	50.7	27.25	10.82
15.0	12.3	17.8	44.8	212	48.8	26.37	10.34
LSD 5%	**1.16**	**1.3**	**2.2**	**12**	**2.2**	**0.63**	**1.5**

Yadove (1981) who reported that the application of 0.7 kg cobalt sulphate before trans planting increased the dry matter yield of tomatoes, cucumber and egg-plants. Confirm these results Nadia Gad and Abdel-Moez (2011) who found that, the cobalt has a significant favourable effect on vegetative growth, yield as well as minerals composition of Broccoli.

Nutritional status

In potato tubers mineral composition as the effect of cobalt levels addition are given in the Table 4. Data reveal that, the all cobalt levels has significantly increased mineral composition compared with control.

Macronutrients (N; P; and K) contents

The presented data in Table 4, showing all the cobalt levels has a significantly increased the content of N; P and K in potato tubers as a compared by the control plants. The highest values of N; P and K contents obtained by 10 ppm, compared with other cobalt doses. Increasing cobalt levels in potato growth media above 10 ppm, the poromotive effect was reduced.

Table 4 : Effect of cobalt levels on minerals composition of potato tubers (average of the two seasons).

Cobalt levels (ppm)	The macronutrients (%)			The micronutrients (%)				Cobalt (ppm)
	N.	P.	K.	Mn.	Zn.	Cu.	Fe.	
The control	0.765	0.584	2.02	17.4	13.7	11.2	255	0.89
5.0	0.774	0.615	2.19	18.2	14.1	11.8	251	1.72
7.5	0.805	0.657	2.59	19,8	14.9	12.4	247	2.84
10.0	0.822	o.692	3.09	21.1	15.3	13.7	242	4.51
12.5	0.816	0.673	2.88	20.6	15.0	13.2	237	7.49
15.0	0.811	0,644	2.74	19.3	14.3	12.8	231	9.61
LSD 5%	**0.17**	**0.12**	**0.16**	**0.6**	**0.4**	**1.2**	**4.0**	**1.12**

The results were good agreed with Jana *et al.* (1994), they found that the cobalt has significantly increased the content of N; P and K in groundnut seeds compared by the untreated plants. These results had been confirmed by Nadia Gad and Mohamed El-Bassuny (2019) who stated that, all cobalt rates had positive effects on the content of N; P and K of spinach leaves compared by the untreated plants.

Iron content

The data in Table 4, indicates to the iron contents in potato tubers has a significantly decreased with the increasing iron concentration in plant media. The results has in harmony with the data had obtained by (Blaylock *et al.*, 1993), they found, certain antagonistic relationship between both Fe and Co elements.

Cobalt content

The data in Table 4, indicates to the cobalt contents in the potato tubers significantly increased when cobalt addition increasing in plant media. The results has agreed with the other obtained by Nadia Gad and Mohamed El-Bassuny (2019) they found that as increased the cobalt rates in the plant media, cobalt content in spinach leaves has a significantly increase .

Chemical constituents

Amount of the total proteins, starch, the total soluble solids, the total carbohydrates along with vitamins “A” and “C” contents in potato tubers as affected by different cobalt levels are giving in Table 5. The results revealed that the all mentioned measurments were significantly increased by the levels of cobalt concentrations.

Table 5 : The effect of cobalt levels on chemical composition of potato tubers (average of the two seasons).

Cobalt levels (ppm)	Proteins	Starch	The total Soluble solids	The total carbohydrate	Vitamin "A"	Vitamin "C"
	(%)			Mg/100 g fresh tissue		
Control	4.77	64.4	4.87	70.59	11.13	1.54
5.0	4.84	65.2	5.61	71.12	11.71	1.57
7.5	5.03	66.9	5.68	72.19	12.83	1.61
10.0	5.14	68.5	5.86	73.67	13.44	1.70
12.5	5.10	67.8	5.81	73.21	13.44	1.68
15.0	5.07	66.3	5.76	73.11	13.19	1.65
LSD 5%	**0.25**	**1.6**	**0.73**	**1.05**	**1.12**	**0.4**

(5.0, 7.5, 10.0, 12.5 and 15.0 ppm) compared by the control plants. In this concern Nadia Gad and Ismail (2011), they stated that all the cobalt levels has a significantly increased of the chemical constituents in the sugar beet roots such as the total soluble solids, the total carbohydrates, the total proteins and the vitamin "C". Cobalt at level of 7.5 ppm resulted the maximum values in the all chemical contents in the sugar beet roots compared by the other concentrations.

Conclusion

Cobalt is considered one of the most promising elements in the newly reclaimed lands, as it is used for the purpose of reducing the harmful effects of climate changes, such as (high temperature, drought and excess soil salts), Cobalt is one of the most important basic elements in human and animal nutrition alike.

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