

The Effectiveness of Using Cobalt on the Productivity of Summer Squash

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ABSTRACT

Two field experiments were carried out to evaluate the effect of cobalt on summer squash growth, quality and yield. Experiments were conducted at Research and Production Station, National Research Centre, El-Nobararia Site, Beheara Governorate, Egypt under drip irrigation system during 2017 and 2018 seasons. Seedlings (at three truly leaves) irrigated once with cobalt levels (0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm). The obtained results indicate that: All cobalt rates significantly increased squash growth and yield parameters, minerals composition and chemical contents were compared with untreated plants, Cobalt at rate of 10 ppm resulted the superior values for all parameters of squash plants. As cobalt rate increasing in plant media, the promotive effect of cobalt reduced.

Keywords: Squash, (*Cucurbita pepo* L.), cobalt, growth, yield

Introduction

In Egypt squash (*Cucurbita pepo* L.) is one of the most important vegetable crops. The "Esandrany" variety is the main cultivar of squash grown as summer and autumn crop near cities where most of the crop is used for local consumption as well as for export. The total area devoted for this crop was estimated to be 37000 ha, and their yield 17798 kg/ha. (Arab Organization for Agricultural Development, 2016).

Physiological and biochemical processes of plant growth are mainly affected by the nutrition status of the plant.

Cobalt is a beneficial element for higher plants, also an essential element for the synthesis of vitamin B₁₂ which is required for human and animals nutrition (Young, 1983). Cobalt does not accumulate in human today with age as the other heavy metals (Smith, 1991).

Cobalt-dense compounds found are necessary for the plant to resist fungal and insect attack. Consumed by animals and humans, these compounds act as anti-oxidant (Griffiths and Lunce, 2001).

Cassan *et al.* (2001) pointed that, both Auxins and Gibberellins enhance the activation of specific enzymes which participate in RNA and protein synthesis. Nadia Gad (2005) showed that the addition of 7.5 ppm cobalt had significant promotive effect on tomato and cucumber plants dry weight and fruit quality. Cobalt at 7.5 ppm increased the content of N, P and K but further increase reduced it.

Nadia Gad and Abd El-Moez (2011) added that cobalt addition significantly increased the broccoli growth, head yield and its quality compared with untreated plants. Nadia Gad *et al.* (2017) stated that, under salinity condition, cobalt helps cucumber plants to tolerate. Cobalt (from 10 to 20 ppm) significantly increased cucumber growth and yield parameters with control. Holah *et al.*, (2019) show that, all cobalt rates significantly increased tomato plants growth, yield quantity and quality.

Materials and Methods

Two field experiments were carried out to evaluate the effect of cobalt on summer squash growth, yield, mineral composition and chemical constituents of squash fruits. Experiments were conducted at Research and production station, National Research Centre, EL-Nobararia Site, Beheara Governorate, Delta Egypt under drip irrigation system during 2017 and 2018 seasons.

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Soil analysis:

Physical and chemical properties of Nubaria soil were determined and particle size distributions along with soil moisture were determined as described by Blackmore (1972). Soil pH, EC, cations and anions, organic matter, CaCO₃, total nitrogen and available P, K, Fe, Mn, Zn, Cu were run according to Black *et al.*, (1982). Determination of soluble, available and total cobalt was determined according to method described by Cottenie *et al.*, (1982). Physical and chemical properties of Nubaria soil are shown in Table (1)

Table 1: Physical and chemical analysis of the experimental soils in Nobaris Station

Physical	Particle size distribution (%)			Soil texture class	Water saturation	Field capacity	Wetling point %	Available water				
	Sand	Silt	Clay									
	82.6	14.6	2.8	Sandy loam	32.0	14.4	3.9	10.5				
Chemical	pH ^a		EC ^b		Soluble cations (meq/l)				Soluble anions (meq/L)			
	8.0		1.0		Ca ⁺⁺	Mg ⁺⁺	K ⁺	Na ⁺	HCO ₃ ⁻	CO ₃	Cl ⁻	SO ₄ ⁼
					9.0	1.4	0.268	3.26	-	1.18	0.60	12.15
Total	Available (mg/100g)			Available micronutrients (ppm)				CaCO ₃	OM ^c	Cobalt (ppm)		
	N	P	K	Fe	Mn	Zn	Cu			%	Soluble	Available
	15.2	13.0	21.2	10.7	4.47	3.62	5.22	3.17	0.19	0.39	1.78	9.68

a Soil pH was measured in 1 : 2.5 soil-water suspension.

b EC was measured as dSm-1 in soil paste.

c organic matter.

Experimental works:

Two field experiments. Each experiment contains 18 plot. Each plot area 15m² (5 X 3 m) containing 3 rows. Each row planted with 10 plants. Seeds of squash (*Cucurbita pepo* L.), cultivar Eskandrany were sown on September 20th and 22th 2017 and 2018 seasons. Seedlings (at three truly leaves) irrigated once with cobalt concentrations: 0.0, 5.0, 7.5, 10.0, 12.5 and 15.0 ppm at the cobalt sulphate form. All plants received natural agriculture practices whenever needed.

Measurement of plant vegetative growth:

After 30 days from sowing, plant height, number of leaves per plant, fresh and dry weights of both shoots and roots were recorded according to FAO (1980).

Measurement of flowering characteristics:

Three plants from each treatment were labeled for recorded the following characters:

- * Average of days from sowing until the appearance of first female flower.
- * Average number of male flower/ plant.
- * Average number of female flower/ plant.

$$* \text{ Average sex ratio} = \frac{\text{No. of male flower/ plant.}}{\text{No. of female, flower/ plant.}} \quad \text{according to Gabal } et al. (1984).$$

Measurement of fruits yield:

Squash fruits number/plant, fruits length, fruits diameter as well as fruits weight/plant were recorded according to Gabal *et al.*, (1984).

Early yield per Fadden:

Were calculated as the sum of the yield the first four pickings.

Total yield per Fadden:

Were calculated as the sum of total all pickings.

Statistical analysis:

The obtained data were statistically analyzed of variance procedure outlined by (SAS 1996) computer program and means were compared by LSD method according to Snedecor and Cochran (1980).

Result and Discussion

Vegetative growth

Data on Table (2) outline the response of squash growth parameters to different cobalt levels. Data show that, all cobalt concentrations has a significant promotive effect on squash growth parameters such as plant height, number of leaves per plant, fresh and dry weights of both shoots and roots compared with control. Cobalt at 10 ppm resulted the greatest values. As cobalt rates were ranged above 10 ppm, the promotive effect reduced. These results are in harmony with those obtained by Nadia Gad and Nagwa Hassan (2013) who found that all cobalt levels significantly increased sweet pepper growth and yield parameters compared with control. Cobalt at 5 ppm gave the highest values.

Table 2: Effect of cobalt on vegetative growth of squash plants (Mean of two seasons).

Cobalt treatments (ppm)	Plant height (cm)	Number of Leaves Per plant	Fresh weight Per Plant (g)		Dry weight Per Plant (g)	
			Shoot	Root	Shoot	Root
Control	31.40	14.81	44.61	10.12	14.52	2.54
5.0	35.54	16.55	46.33	10.58	14.81	2.68
7.5	37.91	18.78	48.05	12.03	15.69	3.01
10.0	40.76	21.14	50.60	12.86	16.88	3.46
12.5	40.19	20.36	48.91	12.25	16.57	3.12
15.0	18.86	19,23	46.75	11.68	15.82	2.89
LSD 5%	2.32	1.65	2.51	0.41	1.12	0.32

Flower characteristics

Data on Table (3) show cobalt has a significant promotive effect on the acceleration onset of female flowers on squash plants in two seasons. As cobalt concentration increase in plant media, the number of days from sowing decrease. Among the various, cobalt at 15 ppm showed the lowest number of days from sowing until the appearance the first female flower.

Table 3: Effect of cobalt on flower characters of squash plants (Mean of two seasons).

Cobalt treatments (ppm)	Number of days for flower	Female flowers	Male flowers	Sex ratio
Control	40.25	26.06	53.36	2.048
5.0	39.50	29.54	51.71	1.751
7.5	37.23	31.28	50.03	1.599
10.0	35.08	33.77	48.11	1.425
12.5	34.91	31.18	47.92	1.569
15.0	34.79	29.86	46.69	1.564
LSD 5%	1.24	1.60	1.63	-

Cobalt at 10 ppm was the third concentration for early flowing while control plants resulted the highest values for number of days in two seasons.

Data in table (3) also indicate that, the control plants gave the highest number of male flowers and lowest number of female flowers per plant. Concerning sex ratio resulted the significant reduction with cobalt level in plant media increased.

Yield characteristics

Data presented in Table (4) clearly indicate that cobalt significantly increased squash yield parameters compared with control. Cobalt at 10 ppm the greatest values of yield parameters such as fruits number per plant, fruits weight per plant, fruits length fruits diameter as well as early and total yield in two seasons. Cobalt at 10 ppm significantly increased early yield about 1.68 ton per feddan

while total squash yield gave 2.96 ton per feddan. These results are agree with those obtained by Nadia Gad (2005) who found that cobalt significantly promoted all tomatoes yield parameters compared with control.

Table 4: Effect of cobalt on squash yield (Mean of two seasons).

Cobalt treatments (ppm)	Fruits number/plant(g)	Fruits weight/plant (g)	Fruit length (cm)	Fruit diameter (cm)	Early yield (Ton/fed.)	Total yield (Ton/fed.)
Control	4.750	386	11.37	2.673	1.780	4.868
5.0	4.980	471	14.80	4.022	2.166	5.934
7.5	5.619	566	15.18	4.332	2.376	6.904
10.0	6.260	649	15.72	4.550	2.631	7.823
12.5	5.781	579	15.08	4.532	2.455	7.142
15.0	5.652	560	14.92	4.398	2.127	6.607
LSD 5%	0.632	17	0.52	0.31	0.251	1.064

Nutritional statuses

Data in Table (5) show that macro-nutrients (N, plant K) in squash fruits significantly increased with all cobalt treatment compared with control in two seasons. Cobalt at 10 ppm resulted the highest values. As cobalt rate in plant media increasing above 10 ppm, the promotive effect reduced. These results are good agreement with those obtained by Boureto *et al.* (2001) who stated that cobalt at 2.5 ppm in solution culture significantly increased the contents of N, P and K in tomato plants. Confirm these results Holah *et al.* (2019) who pointed that cobalt at 7.5 ppm has a positive effect on N, P and K contents in tomato fruits.

Table 5: Effect of cobalt on nutrient status of squash fruits (Mean of two seasons)

Cobalt treatments (ppm)	Macronutrients (%)			Micronutrients (ppm)				Cobalt (ppm)
	N	P	K	Mn	Zn	Cu	Fe	
Control	0.783	0.375	0.488	20.3	16.2	22.1	151	0.98
5.0	0.811	0.396	0.522	22.5	18.7	24.3	149	1.86
7.5	0.867	0.421	0.556	26.0	21.0	26.0	136	3.55
10.0	0.926	0.450	0.578	28.7	23.6	28.7	129	5.08
12.5	0.917	0.439	0.570	28.0	21.9	28.0	118	6.91
15.0	0.906	0.422	0.559	27.1	20.7	26.9	115	8.22
LSD 5%	0.28	0.25	0.32	0.5	0.9	0.7	3.0	0.86

Data in Table (5) also indicate that all the used levels of cobalt gave the significant beneficial effect on the contents of micronutrients (Mn, Zn and Cu) of squash fruits compared with untreated plants. These results agrees with those obtained with James (2005) who found that cobalt significantly increased Mn, Zn and Cu content of tomato fruits.

Also Table (5) clearly indicate that the addition of cobalt in plant media resulted in a reduction in Fe content in tomatoes. The reduction rate of Fe was more or less proportion with the concentration of added cobalt. This indicates, again, the competition between Fe and Co in absorption. This may be explained on the basis of results reported by Blaylock (1995) who showed certain antagonistic relationships between the two elements (iron and cobalt). While the content of cobalt in squash fruits significantly increased with the increasing cobalt rate in plant media. These results are agrees with those obtained by Nadia Gad and Nagwa Hassan (2013) who stated that as increasing cobalt level in plant, cobalt sweet pepper. Young (1983) reported that the daily cobalt.

Requirement for human nutrition could reach 8 ppm depending on cobalt levels in the local supply of drinking water without health hazard. Levels of 8.22 ppm in the highest cobalt treatment (15 ppm) is below the dangerous level, since the daily consumption of tomato fruits does not exceed a few grams.

Chemical constituents

Data concerning effect of cobalt on chemical contents of squash fruits are given in Table (6). The results reveal that, all cobalt rates has a significant favourable effect in all chemical constituents compared with control. These results are agree with those obtained by Nadia Gad (2012) who reported that cobalt is hence all chemical content in eggplant fruits.

Table 6: Effect of cobalt on chemical constituents of squash fruits (Mean of two seasons).

Cobalt treatments (ppm)	Total soluble solids	Total proteins	Total soluble sugars	Vitamin "A"
		%		µ/100g Fresh tissue
Control	3.16	4.89	1.33	13.44
5.0	3.45	5.07	1.70	13.92
7.5	4.22	5.42	2.09	14.39
10.0	5.69	5.79	2.45	14.88
12.5	5.62	5.73	2.45	14.81
15.0	5.42	5.66	2.39	14.76
LSD 5%	0.6	0.65	0.37	0.46

Conclusion

Cobalt promising element in the newly reclaimed soils in Egypt. It's help plants tolerate the harmful weathering in this soils. Also it has a promotive effect of squash growth, yield quantity and its quality. Therefore, considerable attention should be taken concerning applying this element (cobalt) as a fertilizer.

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