

## Response of Growth and Yield of Sweet Pepper (*Capsicum annuum* L.) To Cobalt Nutrition

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**Abstract:** Two field experiments carried out in the Research and Production Station, National Research Centre, El-Nubaria Location, Beheara Governorate, Delta Egypt under drip irrigation system. Experiments were conducted to evaluate the effect of cobalt nutrition (0.0, 2.5, 5.0, 7.5 and 10.0 ppm) on sweet pepper growth and productivity. The obtained results indicate that:

- All cobalt concentrations significantly increased all growth and yield parameter compared with control plants.
- Cobalt at 5 ppm gave the superior growth, yield quantity and quality.
- As increasing cobalt levels in sweet pepper growing media, the favourable effect reduced.
- Titrable acidity (as citric acid) showed negative response. It is decreasing values improve sweet pepper quality.

**Key words:** Sweet pepper • Cobalt • Yield quantity and quality

### INTRODUCTION

Sweet pepper (*Capsicum annuum* L.) is generally enlisted as a classical commodity for local consumption and export. As might be expected with crops of such promising potentialities, efforts to improve its production should be of interest [1]. The nutritional requirements from a major component in crop improvement [2].

Cobalt is considered a beneficial element for higher plants due to its direct role in their metabolism. Cobalt promoted many developmental processes including stem and coleoptile elongation opening of hypocotyl, leaf expansion and bud development [3]. Cobalt is an essential element for the synthesis of vitamin B<sub>12</sub> which is required for human and animals [4]. Unlike other heavy metals, cobalt is safer for human consumption up to 8 ppm can be consumed on a daily basis without health hazard [5].

Vyrodova [6] reported that the application of 0.7 Kg CoSO<sub>4</sub> h<sup>-1</sup> before transplanting increased the dry matter yield of tomatoes, cucumber and egg-plants. Atta-Aly *et al.* [7] stated that, 0.25 ppm cobalt in nutrient solution improved growth of tomato plants.

Liu *et al.* [8] showed that growth of onion roots decreased with increasing cobalt concentration above 3 kg h<sup>-1</sup>, such roots became also twisted. Markora [9] demonstrated that soil application of 0.7 kg CoSO<sub>4</sub> h<sup>-1</sup> before transplanting increased both total soluble solids and total soluble sugars compared with untreated tomatoes. Nadia Gad [10] found that, 7.5 ppm cobalt in sand culture was found to be a promotive effect for N, P, K, Mn, Zn and Cu in tomato fruits as compared with control while higher concentrations being hazardous. Nadia Gad and Hala Kandil [11] showed that the addition of 10 ppm Cobalt had a synergistic effect on the sweet potato growth, roots yield quantity and quality as starch, sugars, carotenoids, total soluble solids, L-ascorbic acid and the contents of N, P, K, Mn, Zn and Cu compared with control and other concentrations.

Nadia Gad and Abd El-Moez [12] showed that the addition of 6 ppm cobalt had a significant positive effect on Broccoli growth, heads yield quantity and quality, but further increasing cobalt concentrations gave the adverse effect.

Recently, Nadia Gad [13] found that cobalt at 7.5 ppm cobalt had a significant promotive effect of growth, yield

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and mineral (N, P, K, Mn, Zn and Cu) status of Eggplants and hence all chemical constituents in Eggplant fruits such as total soluble solids, total carbohydrates and vitamin “C” as L-ascorbic acid. Bisht [14] and Nadia Gad [13] showed that increasing cobalt leaves in plant media decreased Fe content in both tomato and Eggplant fruits. They showed certain antagonistic relationships between the two elements.

The aim of this study was to investigate the influence of cobalt on sweet pepper growth, yield quantity and quality.

## MATERIAS AND METHODS

**Soil Analysis:** Physical and chemical properties of Nubaria Soil were determined and particle size distributions along with soil moisture were determined as described by [15]. Soil pH, EC, cations and anions, organic matter,  $\text{CaCO}_3$ , total nitrogen and available P, K, Fe, Mn, Zn, Cu were run according to [16]. Determination of soluble, available and total cobalt was determined according to method described by [17]. Some physical and chemical properties of Nubaria soil are shown in Table 1.

**Plant Material and Experimental Works:** Two field experiments were carried out in Research and Production Station, National Research Centre, Nubaria location, Beheara Governorate, Delta Egypt under drip irrigation system.

Seeds of sweet pepper (*capsicum unnuum* cv. California winder) were sown at 7 and 10 November during both 2011 and 2012 seasons in plates filled with a mixtrue sand and peat moss (1:1), plates were kept in Wire house and received natural agricultural practices whenever they needed during 5weeks. Each experiment consisting 5 treatments. 3 plots represented each treatment. Each plot area was  $5 \times 3$  meter, consisting of three rows. After 45 days from sowing sweet pepper seedlings were transplanting in plots (40 cm apart). The seedlings (at the third truly leaves) were irrigated once with cobalt concentrations (0.0, 2.5, 5.0, 7.5 and 10.0 ppm cobalt) as cobalt sulphate form. All the plants received natural agricultural practices whenever they needed.

**Measurement of Plant Vegetative Growth:** After 45 days from transplanting, plant hight, Number of branches and leaves per plant, fresh and dry weights of both shoots and roots of sweet pepper according to [18].

**Measurement of Fruits Yield Quantity:** After 65-90 days from transplating, sweet pepper fruits were picked and the total number and weight in each experimental plot were recorded. All yield parameters such as: number of fruits per plant, fruit length, fruit diameter, early yield (ton/fed) and fruit yield (ton/fed) as well as % yield increases were recording according to [19].

Table 1: Some physical and chemical properties of Nubaria soil

Physical properties											
Particle size distribution %						Soil moisture constant %					
-----						-----					
Sand	Silt	Clay	Soil texture	Saturation	FC	WP	AW				
	25.6	3.6	Sandy loam	32.0	19.2	6.1	13.1				
Chemical properties											
				Soluble cations (meq <sup>-1</sup> L)				Soluble anions (meq <sup>-1</sup> L)			
				-----				-----			
pH 1:2.5	EC (dS m <sup>-1</sup> )	CaCO <sub>3</sub> %	OM %	Ca <sup>++</sup>	Mg <sup>++</sup>	K <sup>+</sup>	Na <sup>+</sup>	HCO <sub>3</sub> <sup>-</sup>	CO <sub>3</sub>	Cl <sup>-</sup>	SO <sub>4</sub> <sup>=</sup>
8.49	1.74	3.4	0.20	0.8	0.5	1.6	1.80	0.3	-	1.9	0.5
Cobalt			Total	Available			Available micronutriments				
-----			-----	-----			-----				
----- ppm -----			----- mg 100 g <sup>-1</sup> soil -----			----- ppm -----					
Soluble	Available	Total	N	P	K	Fe	Mn	Zn	Cu		
0.35	4.88	9.88	15.1	13.3	4.49	4.46	2.71	4.52	5.2		

FC (Field capacity), WP (Welting point), AW (Available water)

**Measurments of Nutritional Status:** In sweet pepper fruits, macronutrients (N, P and K), micronutrients (Fe, Mn, Zn and Cu ) as well as cobalt were determined according to [17].

**Measurment of Chemical Constituents:** In sweet pepper fruits, total soluble solids, total carbohydrates, Vitamine "C" as L-ascorbic acid and titrable acidity were determined according to [20].

**Statitital Analysis:** All data were subjected to statistical analysis according to procedure outlined by SAS (21) computer program and means were compared by LSD method according to (22).

## RESULTS AND DISCUSSION

**Vegetative Growth:** The presented data in Table 2, show that all sweet pepper growth parameters such as plant height, number of branches and leaves per plant, shoot and root fresh and dry weights The growth increased gradually by increasing cobalt concentration from 0.0 to 5 ppm.

All cobalt concentrations have a significant promotive effect on all growth parameters of sweet peppers compared with control plants. Cobalt at 5 ppm gave the greatest values. When cobalt addition increased more than 5 ppm, the promotive effect on all growth parameters reduced. These results are in harmony with those obtained by Sablina and Yagodin [23] who found that the growth of tomato plants as well as leaves area and dry weight were improved by cobalt applications. Nadia Gad [13] showed that, cobalt significantly increased all growth parameters of eggplants compared with control. While the higher levels of cobalt (7.5 and 10 ppm) decreased all growth parameters of sweet peppers for two seasons. With the increasing cobalt levels the activity of some enzymes such as peroxidase and catalase was increased and hence increasing catabolism rather than the anabolism [10].

**Yield Characteristics:** Data presented in Table (3) outline the response of sweet pepper yield parameters to different cobalt levels. All application levels of cobalt significantly increase all yield parameters of sweet pepper compared with control. Cobalt at 5 ppm had a superior values of yield parameters such as number and weight of fruits per plant, fruit length, fruit diameter, early yield (ton/fed) and total yield fruits (ton/fed). As cobalt concentrations were ranged above 5ppm, the promotive effect was

significantly reduced. These results are good agreement with those obtained by Nadia Gad [13] who showed that cobalt at 7.5ppm had a significant promotive effect on eggplant growth and yield. Increasing cobalt levels more than 7.5 significantly decreased the promotive effect.

Data in Table 3, also indicate that all cobalt doses increased early yield (12.5%, 23.2%, 22.1% and 21.6%) respectively with 2.5, 5.0, 7.5 and 10.0ppm cobalt. Also, data in Table 3, reflecte that all cobalt concentration significantly induced the percent of fruits yield increase. With different cobalt levels i.e 2.5, 5.0, 7.5 and 10 ppm; the percent yield of fruits increase, 11.65%, 30.30%, 29.14% and 24.48% respectively. Cobalt at 5ppm gave the greatest percent increase of sweet pepper fruits yield (30.30%). Cobalt induced the agriculture cost for more money of farmers especially with early yield. These results are agree with those obtained by Nadia Gad and Hala Kandil [24] who found that cobalt at 15ppm gave the greatest values of fresh and dry herb yield up to 66.20 ton h<sup>-1</sup> coriander herb compared with control ones.

**Minerals Composition in Fruits:** Data in Table (4) reveals the following:

**Macronutrients (N, P and K):** Presented data in Table (4) show that, all cobalt concentrations hence the content of N, P and K in sweet pepper fruits compared with control. Cobalt at 5 ppm gave the highest values. Obtained results also indicate that increasing cobalt doses in the sweet pepper growing media significantly decreased the promotive effect. These results are in harmony with those obtaiend by Boureto *et al.* [25] who showed that, cobalt level of 2.5 ppm had a promotive effect of N, P and K in tomato fruits; higher concentrations being hazardous. Nadia Gad and Abd El-Moez [12] dded that, cobalt had a positive effect on the contents of N, P and K of broccooli heads. While increasing cobalt concentrations exerted adverse effect.

**Micronutrients (Mn, Zn and Cu) Contents:** Obtained results also indicate that all cobalt levels significantly induced Mn, Zn and Cu contents of sweet pepper fruits compared with that of untreated plants. Cobalt at 5 ppm gave the greatest figures. While, increasing cobalt concentrations in plant media reduced the beneficial effect. These observations are consistent with previous reports obtained by Nadia Gad *et al.* [26] who found that cobalt at 8 ppm significantly increased the contents of Mn, Zn and Cu in faba bean. While increasing cobalt levels in plant media being reversed.

Table 2: Effect of cobalt nutrition on the vegetative growth parameters of sweet pepper plants after 45 day from transplanting (mean of two seasons)

Cobalt treatment (ppm)	Plant height (cm)	Number of leaves/plant		Fresh weight (g)		Dry weight (gm)/plot	
		Branches	Shoot	Shoot	Root	Shoot	Root
Control	63.8	5.2	60.2	168.1	28.5	54.6	8.42
2.5	68.7	5.6	70.5	180.8	31.6	58.2	8.97
5.0	76.6	8.0	81.0	196.5	35.4	64.1	10.41
7.5	74.5	7.2	78.1	191.1	32.2	61.9	9.63
10.0	72.2	7.0	76.4	187.0	31.7	60.4	9.29
LSD 5%	0.7	0.2	1.7	5.4	0.6	1.5	0.32

Table 3: Effect of cobalt nutrition on sweet pepper fruit yield characteristics after 90 days from transplanting (mean of two seasons)

Cobalt treatment (ppm)	No. of fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Early yield (ton/fed)	Fruits weight/plant	Fruit yield Ton/fed	% yield increase
Control	20.0	5.3	3.2	0.76	93.6	4.29	100
2.5	26.3	6.2	3.6	0.95	98.5	4.79	11.65
5.0	31.2	7.1	4.5	1.76	121.0	5.59	30.30
7.5	29.0	6.8	4.2	1.68	118.2	5.54	29.14
10.0	27.1	6.5	4.2	1.64	116.6	5.34	24.48
LSD 5%	0.8	0.3	0.3	0.4	1.6	0.5	-

Table 4: Effect of cobalt nutrition on the nutritional status of sweet pepper fruits (mean of two seasons)

Cobalt treatment (ppm)	Macronutrients (%)			Micronutrients (ppm)				Cobalt (ppm)
	N	P	K	Mn	Zn	Cu	Fe	
Control	1.02	0.556	1.29	27.70	17.45	11.91	74.90	0.88
2.5	1.91	0.594	1.89	28.41	18.73	13.50	73.11	1.29
5.0	2.55	0.655	0.40	29.80	21.61	16.09	70.87	3.56
7.5	2.47	0.620	0.33	29.55	20.12	15.01	68.34	5.78
10.0	2.44	0.593	0.28	29.26	19.3	14.56	66.45	7.09
LSD 5%	0.3	0.01	0.5	0.29	0.57	1.08	1.78	0.41

Table 5: Effect of cobalt nutrition on chemical constituents of sweet pepper fruits (mean of two seasons)

Cobalt treatment (ppm)	Protein	Total soluble solids	Total carbohydrates	L-Ascorbic acid	Titrate acidity
	%				
Control	6.38	3.45	9.14	11.42	1.86
2.5	11.94	3.54	9.76	11.90	1.82
5.0	15.94	4.26	10.24	12.35	1.76
7.5	15.44	4.11	10.09	12.00	1.70
10.0	15.25	3.86	9.88	11.96	1.67
LSD 5%	0.19	0.17	0.12	0.35	0.3

**Iron Content:** Table 4, clearly indicate that the addition of cobalt in sweet pepper growing media, significantly decrease the status of iron in sweet pepper fruits. As cobalt concentrations increased resulted in reduction in Fe content in sweet pepper fruits. The reduction rate of Fe was more or less proportion with the levels of added cobalt. These results are agree with those obtained by [27] who showed that, certain antagonistic relationships between Fe and Co. This indicates again, the competition between the two elements absorption. Nadia Gad [13] added that, increasing the concentrations of eggplant growing media resulted in a progressive depression effect.

**Cobalt Content:** Data in Table 4, also show that cobalt content in sweet pepper fruits significantly increased when cobalt addition in plant media increased. Cobalt increased from 0.88 ppm to 7.09 ppm by increasing the level of application to 10 ppm. These results are in harmony with those obtained by [5] who 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. Level of 7.09 ppm in the highest cobalt treatment (10 ppm) is below the dangerous level, since the daily consumption of sweet pepper fruits does not exceed a few grams.

**Chemical Constituent in Fruits:** Data concerning the effect of cobalt on chemical contents of sweet pepper fruits are given in Table 5.

The results clearly indicate that, all cobalt concentrations had a significant favourable effect in all chemical constituents (except titrable acidity). Cobalt at 5 ppm gave the maximum values of total soluble solids, total carbohydrates, proteins and vitamin "C" as L-Ascorbic acid. Increasing cobalt doses in sweet pepper growing media reduced the favourable effect. On the other hand, titrable acidity (as citric acid) showed negative response to all cobalt levels. Decreasing of titrable acidity improve the quality of sweet pepper fruits. These results are agree with those reported by [13] who stated that cobalt is hence all chemical contents (except titrable acidity) in eggplant fruits such as proteins, total soluble solids, total carbohydrates and vitamin "C" as L-Ascorbic acid while titrable acidity gave the reduction.

## CONCLUSION

Cobalt is promising element in the newly reclaimed soils in Egypt. It had a significant favourable effect in sweet pepper growth, yield quantity and quantity such as minerals composition, chemical constituents as well as the decreasing of titrable acidity.

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