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Impact of Cobalt Form and Level Addition on Wheat Plants *(Triticum aestivum L.)*: I. Growth Parameters and Nutrients Status

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Abstract : Two pot experiments were conducted at greenhouse of National Research Center. Experiments were carried out to studies the effect of cobalt levels (0, 5, 10, 15, 20 and 25 mg kg^{-1}) and forms (cobalt sulphate, cobalt oxide and cobalt chloride) on growth and nutrient status of wheat.

The obtained results are summarized in the following:

1. Cobalt had a significant positive effect on wheat growth parameters and yield parameters under different cobalt forms and levels compared with the untreated plants. Cobalt sulphate recorded the maximum wheat growth parameters and cobalt oxide recorded the minimum wheat growth parameters.
2. The highest growth such as plant height, no. of leave $plant^{-1}$, fresh and dry weight of shoot and roots were obtained at the rate of 10 mg kg^{-1} soil as cobalt sulphate. It is clear.
3. Cobalt gave the significant increase of all minerals like N, P, K, Zn, Mn and Cu with all cobalt forms. Generally, the obtained data show that the highest macronutrients and micronutrient (except Fe) were obtained by using cobalt sulphate followed by cobalt chloride and cobalt oxide in decreasing order.
4. Addition cobalt significant decreased iron content in wheat shoots and roots in the end of vegetative stage compared with untreated plants.
5. Cobalt content in shoots and roots of wheat significantly increased with increasing cobalt concentration in plant media.

Key words: Wheat, Nutrient Status, Cobalt Sulphate, Cobalt chloride, Cobalt oxide.

Introduction:

Cobalt is considered to be a beneficial element for higher plants in spite of the absence of evidence for direct role in their metabolism. This is true in spite of essentiality for photosynthetic activities of lower plants such as euglena gracilis; it was frequently reported to be localized in various sub-cellular fractions as in chloroplasts[1]**.** Cobalt is an essential element for certain micro organisms particularly those fixing atmospheric nitrogen. The family leguminasae (fabaceae), which is a third largest angiosperm family, contains a number of important crop plants and woody trees.

Studying the effect of adding cobalt in the form of $CoSO_4$ at the rates 0, 5, 10, 20, 40, 80 and 100 mg Co/kg soil using three soils on relative cobalt availability to barley plants. The higher dry matter yields were obtained with the application of cobalt to the soils at the rate of 20 mg Co kg^{-1} soil[2].

The effect cobalt concentration 0, 2.5, 5.0, 7.5, 10.0 and 12.5 ppm cobalt as cobalt sulphate on sugar beet plants. All cobalt treatments significantly increased the growth and yield of roots, as well as sugar yield

and root mineral composition and the rate of 7.5 ppm cobalt caused the maximum growth parameters [3]. The foliar application of cobalt chloride (50 ppm cobalt), molybdenum at 50 ppm and boron at 0.2 % significant increase in the number and weight of nodules, biomass production, plant height and grain yield [4]. The effect of cobalt as finely powdered ($CoCl_2$) as (0, 50, 100, 150, 200 and 250 mg kg^{-1} soil) on pigment accumulation of soybean. Cobalt at lower concentrations has some beneficial values on soybean[5].

Studying the biochemical's and nutrients of maize plants (*Zea mays* L.) grown under different concentrations of cobalt (50, 100, 150, 200, 250 mg kg^{-1} soil as cobalt chloride). The growth and yield parameters such as seedling vigour, number of cobs, number of seeds per plant; photosynthetic pigments viz., chlorophyll 'a', chlorophyll 'b', and total chlorophyll contents; biochemicals like total sugars (reducing and non reducing), starch, amino acids and protein content and various macro- and micronutrients are determined 90 days after sowing (DAS). All the growth parameters, pigment content, biochemicals and mineral content increase at 50 mg Co kg^{-1} soil when compared with the control. Further increase in the Co levels (100-200 mg kg-1 soil) has a negative effect on all the above parameters [6].

Wheat (*triticum aestivum L.)* is one of the most important strategy crops, which plays an especial role in people's nutrition. It is the main food crop for the population of Egypt. Increasing wheat production is an ultimate goal to reduce the wide gap between production and consumption.

Materials And Methods:

Soil analysis:

Particle size distribution and soil texture along with soil moisture constants of the representative soil samples collected from Research and Production Station, National Research Centre (Nobaria) were determined by [7]**.** Contents of organic matter and $CaCO_3$ as well as EC and pH along with soluble cations and anions were evaluated according to [8]**.** Total N and available P, K, Fe, Mn, Zn and Cu were also determined according to [9]. Total cobalt was determined in Aqua rejia extract, the water soluble cobalt as well as available cobalt (DTPA extractable) being assayed according to [10].

Physical and chemical properties of the used soil are given in Table (1).

Table (1): Some physical and chemical properties of El-Nobaria soil.

Field capacity (%)	**Particle size distribution**			
	Soil Texture	**Clay(%)**	**Silt(%)**	**Sand(%)**
21.2	Sandy loam	3.5	26.7	69.8

Chemical properties						
Cobalt (ppm)			O.M (%)	$CaCO_3$ (%)	pH (1:2.5)	EC dsm^{-1}
Total	Available	Soluble				
7.66	1.67	0.34	0.02	3.21	7.8	0.13

Soluble anions (meq L^{-1})				Soluble cations (meq L^{-1})			
$SO_4^{=}$	Cl^-	HCO_3^-	CO_3^-	Na^+	K^+	Mg^{++}	Ca^{++}
1.93	0.8	1.60	-	1.09	0.24	1.10	2.0

Available micronutrients (ppm)				Available (mg/100g)		Total N (mg/100g)
Cu	Zn	Mn	Fe	K	P	
3.01	1.78	2.12	7.77	11.0	13.4	16.5

Pot experiment was conducted in a wire house of the National Research Center, Dokki, Egypt to study the effect of cobalt source and level on growth and nutrients status of wheat plants.

The sampled soils were air dried, passed through a 2 mm sieve and packed uniformly in plastic pots containing 5 kg of soil. The experiment included three cobalt source (cobalt sulfate, cobalt oxide and cobalt chloride) and each source application level at (0, 5, 10, 15, 20, 25 $mg.kg^{-1}$ cobalt) and three replicates for each treatment.

The pots were arranged in a complete randomized design, and moisture content was maintained at field capacity using distilled water. Each pot was planted with 8 grains of wheat (*Triticum aestivum* cvs Mill Sakha-93) on the 19th of November 2009, then after three weeks seedlings were thinned to 4 ones per pot. On the 13th December 2009 (at third truly leaves) were irrigated once with cobalt different sources and levels both by his treatment. Super phosphate (15.5%P_2O_5) was applied during seed- bed preparation at the rate of 13.1 kg P ha^{-1}. Nitrogen was applied at a rate of 120 kg N fed^{-1} as urea at the beginning of growth, while potassium was added as potassium sulfate (48 % K_2O) at rate of 50 kg K_2O fed^{-1}. All required agricultural managements for plants and production were carried out as recommended. All growth parameters were determined for the tested plant at 100 days age according to [11].

Results and Discussion:

Vegetative growth:

The effects of cobalt level and form on investigated characters of wheat were given in (Table 2). The highest growth parameters such as plant height, no. of leave/plant, no. of spikes/plant and no. of grain/spike were obtained at the rate of 10 mg kg^{-1} as cobalt sulphate, at 25 mg kg^{-1} as cobalt oxide and at 10 mg kg^{-1} as cobalt chloride. It is clear that cobalt enhance all growth parameters compared with the untreated. These data are harmony with those obtained by Hanson *et al.* [12] who found that cobalt is considered to be a beneficial element for higher plants and is a kind of trace element and heavy metal found in soil. Supplementing nutrient solution with cobalt improved the growth of tomato plants and enhanced both flowering and fruiting [13]. These results agree with those of [14] who pointed out that cobalt increased all growth parameters of tomato.

Cobalt had a significant positive effect on wheat growth parameters under different cobalt forms and levels compared with the untreated plants. Cobalt sulphat recorded the maximum wheat growth parameters and cobalt oxide recorded the minimum wheat growth parameters. These results agree with those of [2] who found that adding cobalt in the form of $CoSO_4$ at the rates of 0, 5, 10, 20, 40, 80 and 100 mg Co/kg soil using three soils on relative cobalt availability to barley plants. The higher growths were obtained with the application of cobalt to the soils at the rate of 20 mg Co kg^{-1} soil.

Table 2: Effect of cobalt level and form on growth parameters of wheat plant at 100 days of growth.

Treatments		Plant height (cm)	No. of leaves/ plant	No. of spikes/ plant	No. of grain/ spike
Cobalt form	**Co rate (mg kg^{-1})**				
None	**0**	54.6	6.55	3.11	33.9
Cobalt sulphate	**5**	63.8	7.33	4.50	39.8
	10	69.5	10.05	5.58	54.2
	15	67.1	9.33	5.36	52.3
	20	64.3	8.66	5.00	50.5
	25	61.5	7.66	4.76	48.6
Mean		65.2	8.61	5.04	55.9
LSD at 5%		0.03	0.05	0.02	0.01
Cobalt oxide	**5**	57.3	6.78	3.28	35.2
	10	58.6	6.99	3.78	35.8
	15	59.6	7.33	3.89	36.7
	20	60.4	7.94	4.11	38.4
	25	61.2	8.45	4.66	39.8
Mean		59.42	7.50	3.94	37.2
LSD at 5%		0.06	0.02	0.02	0.03
Cobalt chloride	**5**	59.2	7.00	4.05	37.6
	10	63.7	8.66	5.00	49.8
	15	62.5	8.33	4.78	48.2
	20	60.0	7.78	4.33	47.3
	25	56.8	7.11	4.00	45.6
Mean		60.4	7.78	4.43	45.7
LSD at 5%		0.04	0.03	0.02	0.04
LSD of interaction at 5%		0.07	0.09	0.08	0.06

Data in Fig.1 show that the effect of cobalt levels and forms on fresh weight and dry weight of shoots and roots of wheat plant at 100 days of growth. The obtained data indicated that fresh weight and dry weight of wheat plants increased due to application of cobalt compared with control treatments. In general, fresh and dry weight of wheat plant significant increased by the application of all cobalt forms. The greatest effect of cobalt on dry matter of wheat shoots and roots production was observed at 10 mg kg^{-1} cobalt sulphate However, higher cobalt levels above 10.0 mg.kg-1 as cobalt sulphate or cobalt chloride caused reduce of increased rate in fresh and dry weight. The positive effect of cobalt on fresh and dry wheat shoots and roots are full agreement with those obtained by [15] who found that addition of different cobalt levels to the soybean growth media significantly increased all growth parameters.

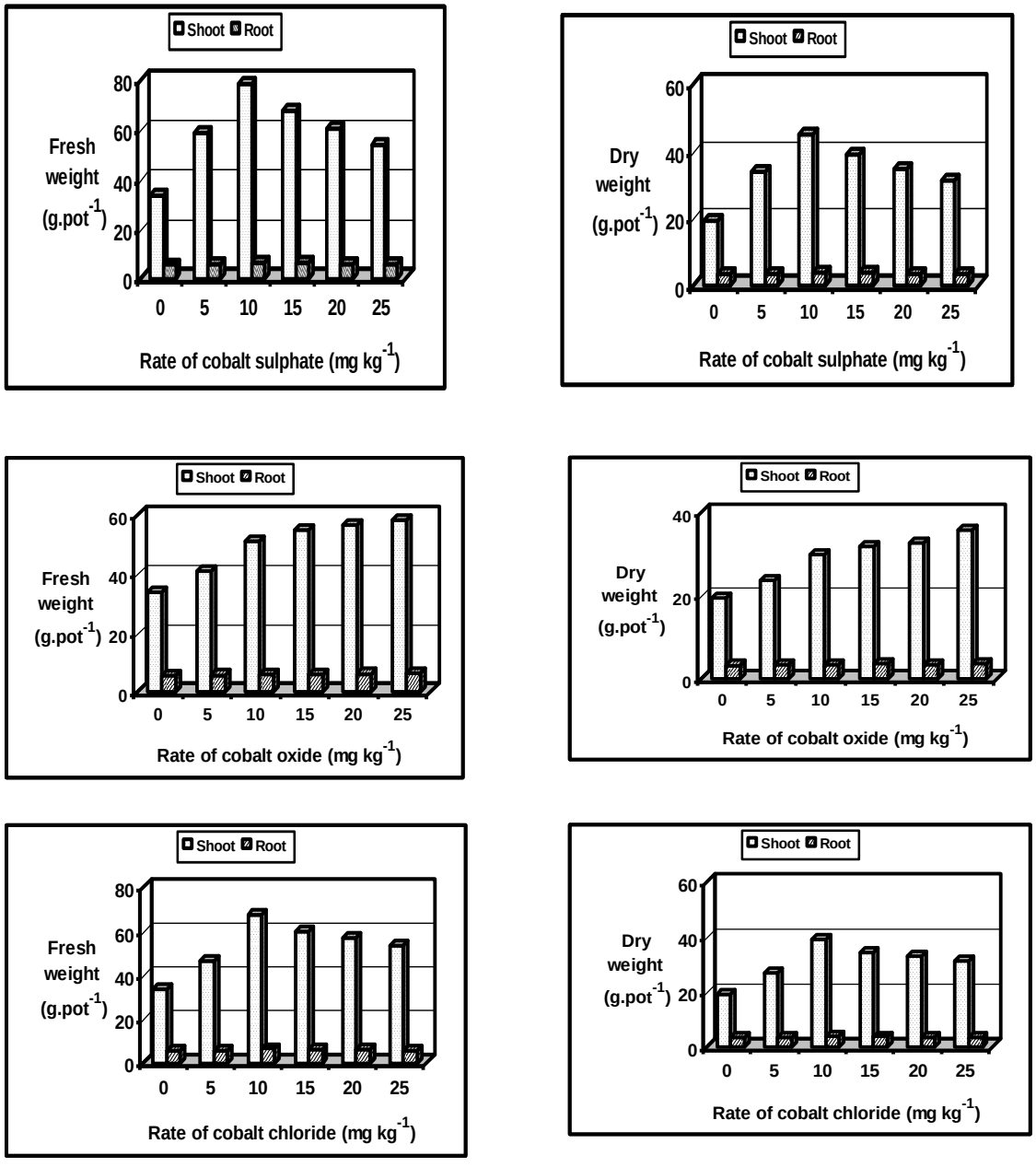

Fig. 1: Effect of cobalt level and form on fresh weight and dry weight of wheat plant (shoot and root) at 100 days of growth.

Nutritional status of shoots and roots:

Nitrogen, phosphorus and potassium content

The concentration of macronutrients (N, P and K) in wheat shoots and roots is one of the most important productivity parameters for evaluation the treatment of forms and application rates of cobalt. Results presented in Figs. 2, 3 and 4 revealed that the effect of cobalt level and form on macronutrients (N, P and K) in wheat

shoots and roots. Obtained data indicated that the addition of cobalt to plant media up to 10.0 mg kg^{-1} as cobalt sulphate, 10.0 mg kg^{-1} as cobalt chloride are shown a significant beneficial effect on the status of N, P and K in wheat plants compared with the untreated. Increasing cobalt concentration above 10.0 mg kg^{-1} as cobalt sulphate or cobalt chloride reduced the promotive effect. This may be explained on the basis of results obtained by [16] who reported that cobalt at 7.5 ppm increased macronutrients (N, P and K) content in both shoot and roots of okra plants.

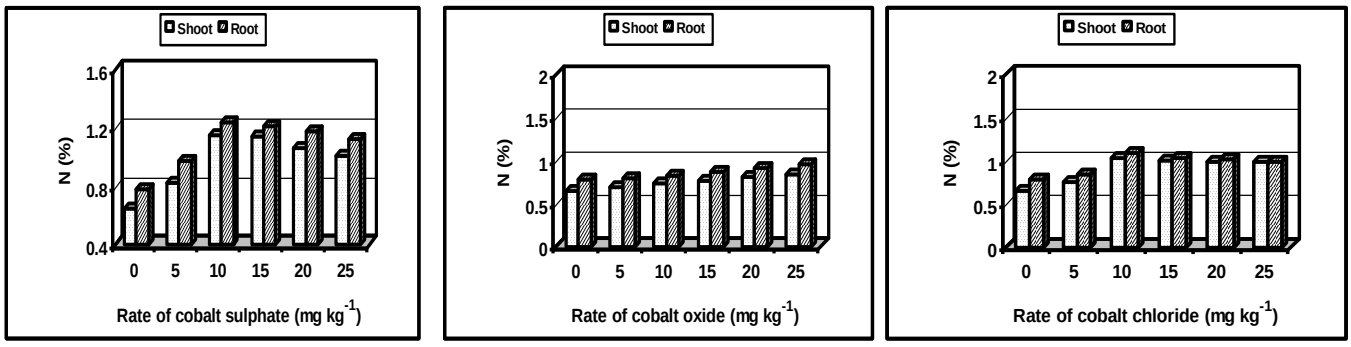

Fig. 2: Effect of cobalt level on N content in shoots and roots of wheat plant at 100 days of growth.

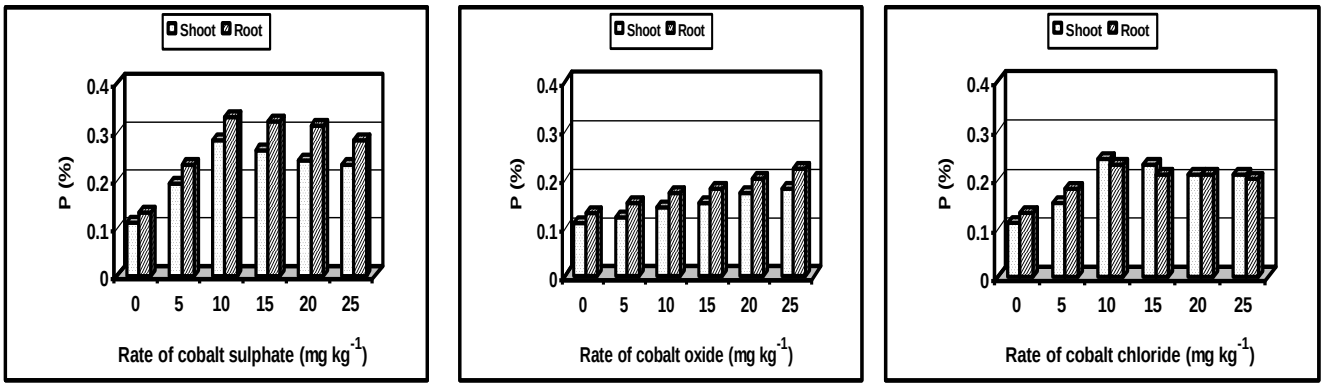

Fig. 3: Effect of cobalt level on P content in shoots and roots of wheat plant at 100 days of growth.

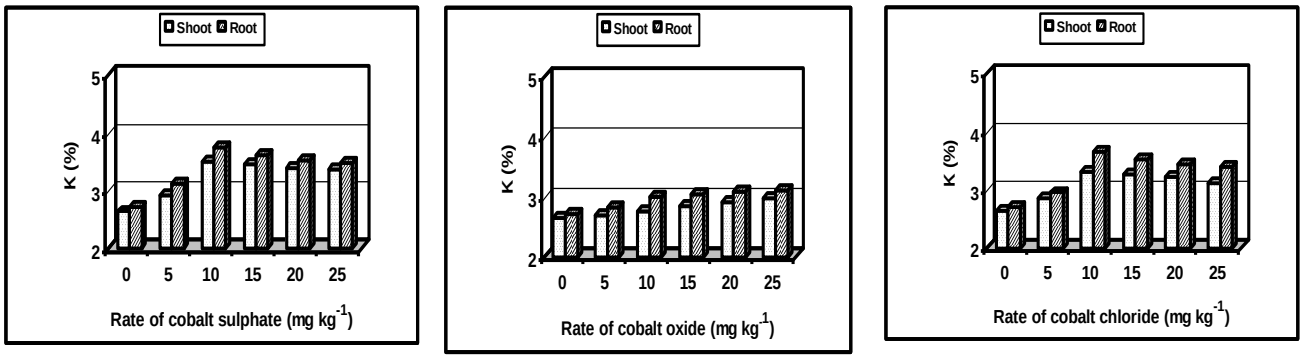

Fig. 4: Effect of cobalt level on K content in shoots and roots of wheat plant at 100 days of growth.

According to the obtained results in Figs. 2 to 4, the tested forms of cobalt could be arranged due to their inducing effect on macronutrients concentration in shoots and roots of wheat plants in the following descending order: cobalt sulphate > cobalt chloride > cobalt oxide respectively. Roots of wheat plants under all cobalt forms and levels have higher content of macronutrients than the obtained in the corresponding shoots. These results are in good agreement with those obtained by [16].

Iron content

The present data in Fig. 5 indicated that addition cobalt significant decreased iron content in wheat shoots and roots at 100 days compared with untreated plants. These results are expected and mentioned by [17].

They found that cobalt addition in plant media in progressive depression effect on iron status in tomatoes, soybean, faba bean and canola plants and added that certain antagonistic relationship between cobalt and iron. Hazardous effects of increasing cobalt level in the media being severely involved in wilting appearance and reductions for net photosynthesis.

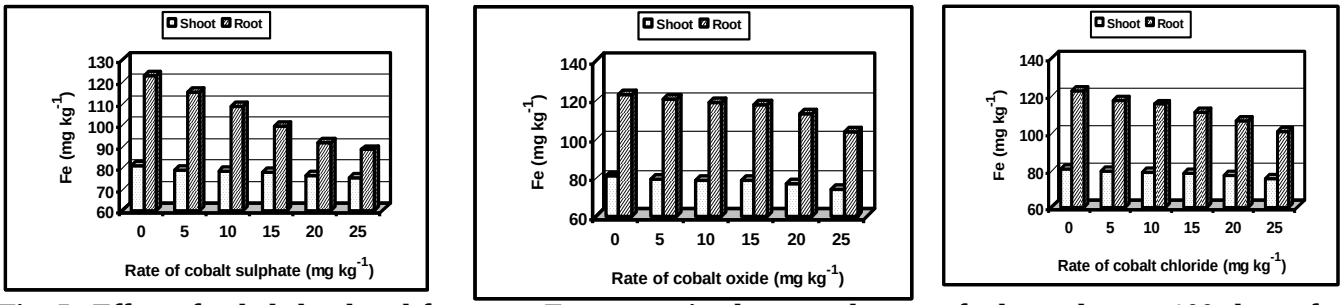

Fig. 5: Effect of cobalt level and forms on Fe content in shoots and roots of wheat plant at 100 days of growth.

Zinc, manganese and copper content

The content of Zn, Mn and Cu in wheat plant parts as affected by cobalt levels and forms are given in Figs.6, 7 and 8. Data show that cobalt sulphate increased the (Zn, Mn and Cu) contents of roots and shoots of wheat plants as compared with those obtained by using other cobalt forms treatments. The highest values of (Zn, Mn and Cu) in wheat shoots and roots in the end of vegetative stage were found in 10 mg kg^{-1} cobalt sulphate compared with the untreated plants. These results are harmony with those reported by [18] who found that increasing cobalt doses in plant media of fenugreek plant up to 12.0 ppm increased all chemical contents compared with control and other cobalt concentration. But increasing cobalt above 12.0 ppm decrease the promotive effect of chemical constituents. On the other hand, Jayakumar *et al.*, [19] who found that all minerals composition of blackgram were increased with cobalt at 50 mg/kg soil, when compared with control. These results may go along with [20] who found that cobalt had a beneficial in nutritional status of maize plant.

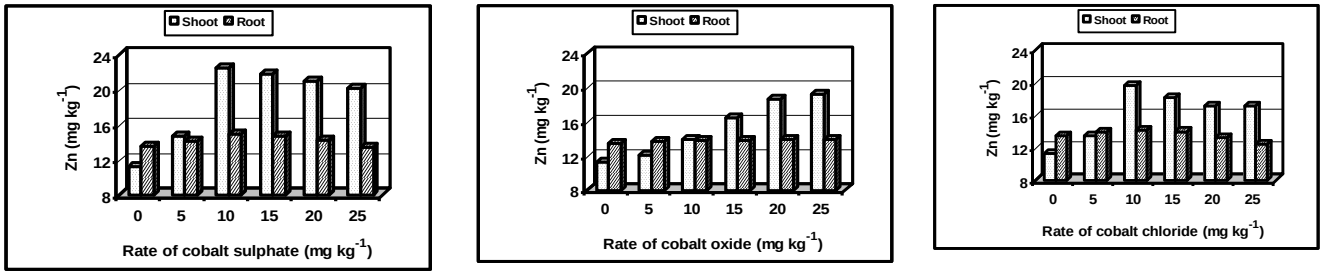

Fig. 6: Effect of cobalt level and forms on Zn content in shoots and roots of wheat plant at 100 days of growth.

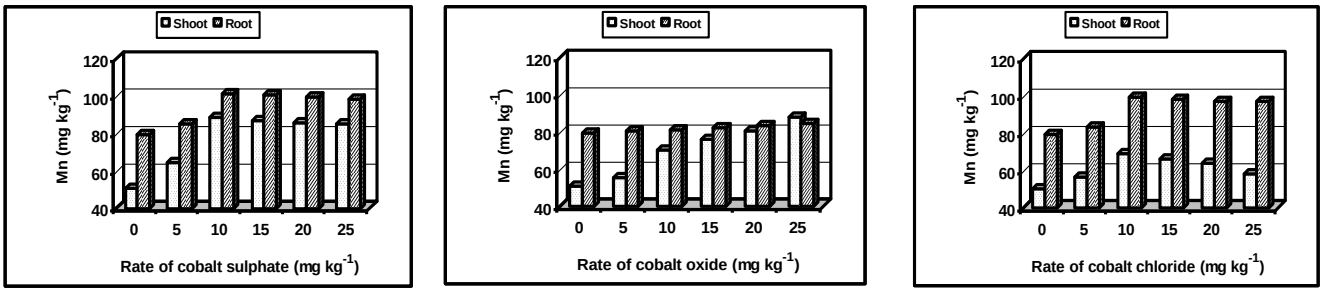

Fig. 7: Effect of cobalt level and forms on Mn content in shoots and roots of wheat plant at 100 days of growth.

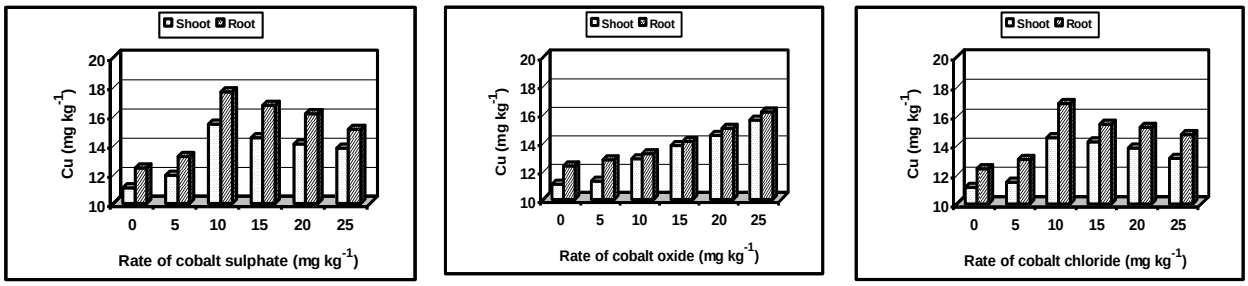

Fig. 8: Effect of cobalt level and forms on Cu content in shoots and roots of wheat plant at 100 days of growth.

Cobalt content

Data in Fig. 9 show that cobalt content in shoots and roots of wheat significantly increased with increasing cobalt concentration in plant media. These results are harmony with those obtained by [18] who reported that cobalt content in fenugreek significantly increased with the increasing cobalt rate in plant media.

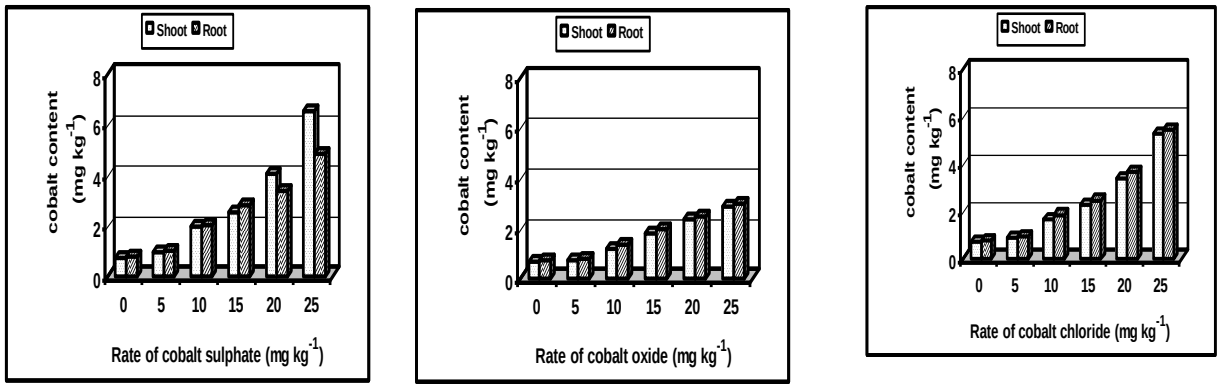

Fig. 9: Effect of cobalt level and forms on Co content in shoots and roots of wheat plant at 100 days of growth.

Conclusion:

The obtained data show that the highest macronutrients (N, P and K) and micronutrient (Zn, Mn and Cu) except Fe were obtained by using cobalt sulphate followed by cobalt chloride and cobalt oxide in decreasing order. These results agree with those of [15] who reported that cobalt at 12 ppm as cobalt sulphate had a significant promotion effect for status of N, P, K, Mn, Zn and Cu except Fe in both shoots and roots of soybean plants.

References

1. Evans, H.J. and M. Kliwer, (1964). Vitamin B compounds in relation to the requirements of cobalt for higher plants and nitrogen fixing organisms. Annals of New York Academic Scinsce. 2: 732-755.
2. Nessim M. and Y.H. Abdalla (2008). Effect of cobalt on growth and cobalt uptake of barely in relation to cobalt availability in Alkaline soils. International meeting on Soil Fertility Lan Management and Agroclimatology. Turkey, 511-518.
3. Gad, N. and H. Kandil (2009). The influence of cobalt on sugar beet *(Beta vulgaris L.)* production. International Journal of Academic Research. 1(2): 52-58.

4. Bolachander, D.; P. Nagarajan and S. Gunasekaran (2003). Effect of organic amendments on nodulation and yield of blackgram in acid soil. National PulsesResearch Centre, Vamban Colony-622303 India. Legume Research, 26: 192-195.
5. Jayakumar, K.; C. Abdul Jaleel; Z. Chang-Xing and M.M. Azooz (2009 b). Cobalt Induced Variations in Growth and Pigment Composition of Arachis hypogaea L. Academic Journal of Plant Sciences. 2 (2): 74-77.
6. Jaleel, CA.; K. Jayakumar; Zhao Chang-Xing and M. Iqbal (2009). Low concentration of cobalt increases growth, biochemical constituents, mineral status and yield in zea mays. J. of Scientific Research, 1: 128- 137.
7. Blackmore, A.D.; T.D. Davis, Jolly and R.H. Walser (1972). Methods of Chemical Analysis of Soils. Newzealand. Soil Dureau.P A2.1, Dep. No. 10.
8. Black, C.A.; D.D. Evans; L.E. Ensminger; G.L. White and F.E. Clarck (1982). 'Methods of Soil Analysis', Part 2. Agron. Inc. Madison Wise.
9. Jackson, M. L. (1973). Soil chemical analysis. Constable Co. L. d., London.
10. Cottenie, A.; M. Verloo; L. Kiekens; G. Velgh and R. Camerlynck (1982).Chemical Analysis of Plant and Soils.Lab. Anal. Agrochem. State Univ. Gthent, Belgium, 63.
11. FAO, (1980). Soil and plant testing as a basis of fertilizer recommendations. Soil Bull., 3812.
12. Hanson, H.; T. Larsen; H. M. Seip and R. D. Vogt. (2001). Trace metals in soils at four sites in southern china. Water, Air, Soil pollut. 130: 1721- 1726.
13. Milletti, G. (1981). Effect of cobalt on tomato plants grown in soilless culture. Ortoflorofruttic Ital. (45):51-56. (C.F. Hort. Abstr. 33: 425).
14. Walser, R. H.; V. D. Jolley and T. D. Davis (1996). Effect of cobalt application on structural organization of photosynthetic apparatus of tomato leaves. Journal of Plant Nutrition. 19:358-363.
15. Hala Kandil; Ihab M. Farid and Amal El-Maghraby (2013). Effect of Cobalt Level and Nitrogen Source on Quantity and Quality of Soybean Plant. J. Basic. Appl. Sci. Res., 3(12): 185-192.
16. Nadia Gad; M.R. Abdel-Moez and Hala Kandil (2015). Response of okra (Hibiscus esculantus) growth and productivity to cobalt and Humic acid rates. International Journal of ChemTech Research, 8 (3): 1782-1791.
17. Hala Kandil (2007) Effect of cobalt fertilizer on growth yield and nutrients status of faba bean (*Vicia faba L.)* plants. J.of Appl. Sci. Research. 3 (9): 867-872.
18. Nadia Gad and M.R. Abdel-Moez (2015). Effect of cobalt on growth and yield of fenugreek plants. International Journal of ChemTech Research, 8 (11): 85-92.
19. Jayakumar, K.; C. Abdul Jaleel and M.M. Azooz (2008). Mineral Constituent Variations under Cobalt Treatment in *Vigna mungo* (*L.*) Hepper. Global Journal of Molecular Sciences. 3 (1): 32-34.
20. Nadia Gad and I.M. El–Metwally (2015). Chemical and physiological response of maize to salinity using cobalt supplement. International Journal of ChemTech Research, 8 (10): 45-52.

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