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Effect of different concentration of cobalt on growth and chemical constituents of paulownia seedlings

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ABSTRACT

Two pot experiments were carried out during two successive seasons (2018/2019- 2017-2018) in the green house of National Research Centre, Dokki, Giza, Egypt. The main objective of this study was to investigate the effect of spraying different concentration of cobalt (0, 10, 20,30,40,50 and 60 ppm) on growth and some chemical composition of paulownia hybrid seedlings. Application of all the different concentrations cobalt led to increment in all vegetative growth parameters. The same trend was also observed concerning photosynthetic pigments (chlorophyll a, b and carotenoid), total carbohydrates, Nitrogen, Phosphorus, Potassium and Cobalt concentration. Generally using cobalt 40 ppm gave the highest values of growth parameters except leaf area, phosphorus % and cobalt content in leaves.

Keywords: Paulownia, Cobalt, vegetative growth, chemical constituents.

Introduction

Paulownia woody species are native from china. Paulownia has been introduced into the USA and Europe as an ornamental plant and is studied extensively due to its ability to uptake nitrates and land contaminants. This high- yielding tree can be used for the production of energy, paper pulp and wooden building materials, (Kalmukov, 1995). Paulownia is a genus of six to seventeen species (depending on taxonomic authority) of flowering plants in the family paulowniaceae, related to and sometimes included in the Scrophulariaceae. They are deciduous trees12 -15 m tall, with large, heart shaped leaves 15 -40 cm across, arranged in opposite pairs. The flowers are produced in early spring on panicles 10 -30 cm long, with a tubular corolla resembling a foxglove flower. The fruit is a dry capsule, containing thousands of minute seeds. Paulownia wood is very light, fine- grained, and warp-resistant. It is the growing hard wood. It is used for chests boxes, and clogs (geta). Its low silica content reduces dulling of blades, making it preferred wood for boxes (Lincoln, 1986 and Yungying and Zhaohua, 1997).They also great for landscaping in urban and industrial regions, Paulownia can also be used for reclamation of mined areas (Zhu *et al.,* 1986). Paulownia growers believe that the trees value is I more than just furniture and other carvings, it lies is even air purification (Donald, 2015).

Cobalt, a transition element, is an essential component of several enzymes and co- enzymes. It has been shown to effect growth and metabolism of plants, in different degrees, depending on concentration and status of cobalt in rhizosphere and soil. Cobalt inter acts with other elements to form complexes (Manley, 1984 ad Merckx *et al.,* 1986). Cobalt is considered to beneficial element for higher plants in spite of 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*. Cobalt is an essential element for certain microorganisms particularly those fixing atmospheric nitrogen, its deficiency seems to depress the efficiency of nitrogen fixation (Yadav and Khanna, 1988). Cobalt is an essential element for the synthesis of vitamin B_{12}which is required for human and animal nutrition (Smith, 1991).

The aim of this investigation was to study the effect of different concentrations of cobalt on vegetative growth and some chemical constituents of Paulownia seedlings.

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Materials and Methods

The experiment was carried out at the greenhouse of National Research Centre. The soil of the experimental site was of the following characteristics ,38.43% Coarse sand, 37% fine sand, 9.85% silt, 14.72 clay, pH 7.4, EC 8.9 dsm $^{-1}$, $CaCO_3$ 50.91%, OM 0.19%, Ca 37.71, Mg 13.53, Na 21.8, K 1.56, Cl 42.30, HCO_3 3.35, and SO_4 24.31 meqL^{-1}.

Plant materials and procedure:

One year seedlings of paulownia trees were obtained from nursery of forestry Department Horticulture Research institute, Agriculture Research Centre. The average height of seedling was (20-25 cm). The seedlings were planted at the third week of March 2017 as one seedling/pot 30 cm diameter field with 12 kg soil. The experiments were set in completely randomized design with 5 replicates the treatments used as seven concentrations (0, 10, 20, 30, 40, 50 and 60 ppm) cobalt. Cobalt as were used after dissolving in distilled water and added as surface irrigation depending on the field capacity. Irrigation regime began after 30 days from transplanting and repeated twice every week till the end of the season.

The available commercially fertilizer used through this experimental NPK was Kristalon N: P: K (19:19:19) produced phayzon Company, Holand. The used rate of fertilizer was 5.0g per pot in four doses. The plants were fertilized after 4,8,16 and 20 week.

The following data will be recorded: Plant height (cm).,number of leaves /plant ,stem diameter (cm), leaf area (cm ^{2}),Fresh and dry weight of all plant organs (leaves , stem and roots)(g).

The layout of the experiment will be complete randomized design, including 7 treatments. The treatments will be arranged in completely randomized design (CRD). Each treatment will have six replicates.

The following chemical analysis will be determined: Chlorophyll a, b and carotenoids content will be determined according to Saric *et al*., (1967). Total carbohydrates percentage will be determined according to the method by Herbert *et al*., (1971). Nitrogen, phosphorus, potassium and cobalt will be determined according to the method described by Cottenie *et al.,* (1982). The physical and chemical properties of the soil will be determined according to Chapman and Pratt (1961).

Statistical analysis:

All obtained will be statistically analyzed by LSD method according to Snedecor and Cochran (1980).

Results and Discussions

Vegetative growth:

The growth parameters as affected by cobalt treatments are shown in Table (1). Data mentioned that plant height, leaves number / plant, stem diameter and leaf area increased with all cobalt applications. Cobalt at 40 ppm gave the highest values of plant height (123.30 cm) number of leaves / plant (18.10) and stem diameter (4.41cm) compared with control and other treatments. But the highest value of leaf area (361.10cm3) was obtained by 50ppm cobalt compared with the untreated plants and the other treatments.

Table 1: Effect of cobalt on plant height, number of leaves, stem diameter and leaf area of paulownia seedlings

Treatments	Plant height (cm)	No. of leaves /plant	Stem diameter (cm)	Leaf area (cm)
Control	86.40	10.40	2.21	178.00
Cobalt 10 ppm	92.80	12.50	2.98	206.80
Cobalt 20 ppm	95.50	14.30	3.00	273.60
Cobalt 30 ppm	110.20	16.90	4.04	274.40
Cobalt 40 ppm	123.30	18.10	4.41	350.40
Cobalt 50 ppm	108.50	16.30	4.12	361.10
Cobalt 60 ppm	100.00	13.20	3.32	268.10
LSD 5%	6.07	3.19	0.16	8.75

From the given data in Table (2) it could be concluded that fresh and dry weight of all plant organs (leaves, stem and roots) as affected by different cobalt concentrations. The heaviest fresh and dry weight of leaves (260.00 and 75.40 g), stem (470.30 and 253.96 g) and roots (500.10 and 206.11g), respectively, due to cobalt treatment at 40 ppm compared with the control and other cobalt applications .Generally, the lowest values of all vegetative growth parameters were obtained by untreated plants. These observations are in consonance with previous reports obtained by (Abdul Jaleel *et al*., 2009 and Jayakumar *et al*., 2009).They indicated that the increase of different vegetative growth parameter associated with cobalt may be attributed to catalase and peroxidase activities.

Table 2: Effect of cobalt on fresh and dry weight of leaves, stem and root of paulownia seedlings.

Treatments	Fresh weight (g)			Dry weight (g)		
	Leaves	Stem	Roots	Leaves	Stem	Roots
Control	192.80	237.20	320.30	57.84	130.46	112.0
Cobalt 10 ppm	201.75	365.80	336.35	62.54	201.80	134.54
Cobalt 20 ppm	208.80	385.60	345.40	64.73	208.22	145.30
Cobalt 30 ppm	253.40	455.45	473.25	73.49	245.94	179.84
Cobalt 40 ppm	260.00	470.30	500.10	75.40	253.96	206.11
Cobalt 50 ppm	239.32	460.25	489.90	67.01	248.54	191.06
LSD 5%	8.28	11.17	6.91	5.58	7.50	6.13

Chemical constituents:

Pigment content:

The obtained results of average of two seasons as shown in Table (3) revealed that chlorophyll (a, b) and carotenoids increased by using all cobalt concentrations. The highest values of chlorophyll a, b and carotenoids were gained from Cobalt treatment at 40 ppm which gave (0.93, 0.38 and 0.37 mg/g F.W.) respectively compared with the other treatments. Untreated plants gave the lowest values of photosynthesis pigments. These results are harmony with the finding and illustrated by Zengin and Munzuroglu (2005); Kadhim (2011) and Rawia *et al*. (2015).

Carbohydrates content (% D.W.):

The results in Table (3) cleared that, carbohydrates percentage in the leaves increased by adding different concentrations of cobalt in comparison with control plants. The plants which treated with cobalt at 40 ppm had the highest total carbohydrates (24.50%) compared with the other treatments The results are characteristically accompanied by with Nadia Gad and Kandil, (2008) and Korayem *et al*., (2014).

Table 3: Effect of cobalt on chlorophyll a, b, carotenoid and carbohydrate of paulownia seedlings.

Treatments	Chl-a mg/g (F.W.)	Chl-b mg/g (F.W.)	Carotenoids mg/g (F.W.)	Carbohydrates (%)
Control	0.40	0.15	0.27	14.30
Cobalt 10 ppm	0.55	0.22	0.30	16.69
Cobalt 20 ppm	0.67	0.25	0.23	17.85
Cobalt 30 ppm	0.74	0.27	0.28	20.42
Cobalt 40 ppm	0.93	0.38	0.37	24.50
Cobalt 50 ppm	0.86	0.32	0.30	21.33
Cobalt 60 ppm	0.50	0.21	0.29	18.19

Minerals Content:

Data presented in table (4) reveal that, the addition of cobalt enhanced the content of macronutrients and cobalt in the leaves of paulownia plants. The most effective treatment was using cobalt at 40 ppm concerning to nitrogen and potassium percentages (2.41 and 1.12 % respectively) compared with control (1.38 and 0.53% respectively) or other treatments. While, applying 30 ppm of cobalt gave the highest value of phosphorus percentage (0.49%) as compared to the other treatments. The highest value of cobalt (3.15 ppm) was recorded in plants which inoculated with 60 ppm of cobalt compared to other treatments. The lowest value of cobalt (1.66ppm) of cobalt was obtained by control treatment. These results are in agreement with those obtained by Gad and Kandil (2010) found that cobalt addition increased N, P, K % and cobalt with all sources of phosphorus fertilizers in tomato plant.

Table 4: Effect of Cobalt on Nitrogen %, Phosphorus %, Potassium % and Cobalt of Paulownia seedlings

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Cobalt (ppm)
Control	1.38	0.33	0.53	1.66
Cobalt 10 ppm	1.66	0.31	0.69	2.00
Cobalt 20 ppm	1.74	0.42	0.79	2.14
Cobalt 30 ppm	2.13	0.49	0.90	2.86
Cobalt 40 ppm	2.41	0.45	1.12	3.09
Cobalt 50 ppm	1.90	0.43	1.10	3.11
Cobalt 60 ppm	1.53	0.39	0.96	3.15

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