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Effect of ascorbic acid on growth and chemical constituents of *Monstera delicious* under lead pollutant conditions

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Abstract: Pots experiment was conducted during the two successive seasons of (2013–2014) and (2014–2015) in the green house of National Research Centre (NRC), Giza, Egypt. It intended to find out the effects of ascorbic acid application at three concentrations (0, 100 and 200 ppm) on the growth and chemical constituents of *Monstera delicious* plants under four concentrations of lead (0, 25, 50 and 100 ppm). The results showed that the application of ascorbic acid at 200 ppm and lead at 25 ppm led to increase growth parameters (i. e. plant height, leaf area, neck leaf length, root length, number of leaves, stem diameter and fresh and dry weight of all plant organs. The same tendency was observed regarding N, P, K and total carbohydrates compared with control plants. Meanwhile, the plants treated with lead at 100 ppm gave the highest values of lead content of *Monstera delicious* plants. The data also indicated that the highest values of plant height, leaf area, neck leaf length, number of leaves, fresh and dry weight of leaves and stems were obtained from plants treated with ascorbic acid at 200 ppm combined with lead at 25 ppm. Moreover, the combined treatment between ascorbic acid at 200 ppm + lead at 50 ppm led to significantly increase root length and stem diameter. Whilst, spraying with ascorbic acid at 200 ppm combined with unspraying lead gave an significant increase in fresh and dry weight of roots. The highest increases in chemical constituents of *Monstera delicious* plants were obtained from plants treated with ascorbic acid at 200 ppm combined with lead at 25 ppm of N, P, K and total carbohydrates percentage, except for lead content, which gave the highest values when plants supplied ascorbic acid at 200 ppm combined with lead at 100 ppm.

Keywords: lead, ascorbic acid, *monstera delicious*, pollutant

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1 Introduction

Monstera delicious (Family, Araceae), a leaf of root infusion is taken daily to relieve arthritis in Mexico. It is a species of flowering plant native to tropical rainforests of southern Mexico, south to Colombia (Dilshad et al. 2014). A large plant leaves with deep divisions aerial roots growing from the trunk and its roots touching the ground. And securities in general shape resembling the heart and Eugdalleha holes and divisions similar to the rib cage to humans and the blossoms are very similar to the flora of giant tulips pet, the height than 70 feet (21.3 meters). All *Monstera delicious* parts are toxic except for ripe fruits. It contains oxalic acid and even ripe fruits may be a source of what? in convenience to people. (Edward, 1999). Ascorbic acid is required for regeneration of x-tocepheral, and it is one of the water soluble reductants, which is an important oxidant which protect plants by suppressing oxidative injury by affecting many enzymes activities. Ascorbate has benefits for human nutrition and possibly for tolerance of plants to photo oxidative stresses. It has been implicated in regulation of cell division and photo synthesis (Foyer et al., 1993; Abou leila, 1994; Smirnoff, 1995). Ascorbic acid (Vitamin C) is used to prevent or treat low levels of vitamin C in people who do not get enough vitamin from their diets. It is known as an antioxidant. This section contains this drug that are not listed in the approved professional labeling. Ascorbic acid

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plays an important role in the electron transport system and it is synthesized in the higher plants and affects growth and development (El- Kobisy et al., 2005). Abdel Aziz et al. (2009) reported that the highest recorded data were obtained in plants treated with ascorbic acid at 200 ppm of gladiolus plants. El- Quesni et al. (2009) on *Hibiscus rosa sineses* L. plant and Soha et al. (2010) on *Ocimum basilicum* plants, they found that application of ascorbic acid at 100, 150 and 200ppm significantly increased in all growth parameters, fresh and dry weights of plants. Metal contamination is of great importance in the world and the most important of these metals is Lead, which interferes with many physiological processes of the plant and considered as the more toxic components of the plant (Xia, 2004). The pollution by Pb drew a lot of attention of the world and we must find ways to clean up the pollution of soil caused by the lead that the phytoremediation safer and less expensive than chemical and physical remediation (Wong, 2003; Singer et al., 2007). Phytoremediation of heavy metal polluted soils essentially contains phytoextraction and phytostabilization (Salt and Kramer, 2000) The plain phytoremediation pursuit is to select metal – indulgent and rapid growing plants with high biomass that can survive in metal polluted and nutrient in complete soils, (Whiting et al., 2004).

The target of this present research was to discuss the effect of ascorbic acid on the growth and chemical constituents of *Monstera delicious* plants under lead pollutant conditions.

2 Material and Methods

The pot experiment was conducted during the two successive seasons of (2013-2014) and (2014-2015) in the green house of National Research Centre (NRC), Giza, Egypt. It intended to find out the effects of ascorbic acid on the growth and chemical constituents of *Monster delicious* plants under lead pollutant conditions. The seedlings of *Monster delicious* (1-2 leaves) were obtained from Research and Production Station, Nubaria. It was planted on the first week of June 2013 and 2014 seasons in black plastic pots 30 cm in diameter (one plant/pot) filled with 10 kg a mixture of peatmoss and sandy soil (1:1 v/v). Each pot was fertilized twice with 1.5 gm nitrogen as ammonium nitrate (33.5%N) and 1.0 gm potassium sulphate (48.5% K_2O), the fertilizers were applied at 30 and 60 days after transplanting. Phosphorus as Calcium superphosphate (15.5% P_2O_5) was mixed with media before transplanting at the rate of 3.0 gm/ pot. One month after transplanting, the seedlings were irrigated twice a week with the lead (Pb) treatments as lead sulphate ($PbSO_4$) at the rates 0, 25, 50 and 100 ppm. After two weeks, seedlings were sprayed with different concentrations of ascorbic acid ($C_6H_8O_6$) at 0, 100 and 200 ppm, the second spray after one month from first spray at both seasons. The experiments were sit in a completely randomized design with six replicates, and including 12 treatments which were the combination between three concentrations of ascorbic acid and four concentrations of lead. The untreated plants were irrigated with tap water. The following data were recorded on the first week of March 2014 and 2015 seasons: plant height (cm), number of leaves, stem diameter (cm), root length (cm), neck leaf length (cm) leaf area (cm^2), fresh and dry weight of leaves, stems and roots (gm/plant). Total carbohydrates were determined according to Dubois et al. (1956). Nitrogen, phosphorus and potassium were determined according to Cottenie *et al*. (1982), lead was determined according to Chapman and Pratt (1961). The data were statistically analyzed using L.S.D test as reported by Snedcor and Cochran (1980).

3 Results and discussion

Vegetative growth:

Effect of Ascorbic acid:

The results in Table 1 showed that spraying of ascorbic acid in both concentrations gave positive values compared with untreated plants. Spraying of ascorbic acid at 200 ppm significantly increased plant height, leaf area, neck leaf length, root length, number of leaves and stem diameter. The increments were 19.5, 57.8, 29.4, 44.1, 58.3 and 10.0%, respectively, compared with control plants. Data presented in Table 2 elucidated the foliar application of ascorbic acid on the growth parameters of *Monster delicious* plants. It has been found that the high concentration of 200 pm was better than 100ppm concentration and significantly increased fresh and dry weight of leaves, stems and roots. The increments were 17.1, 23.5, 91.6, 25.9, 30.0 and 101.8%, respectively, compared with untreated plants. These results are in conformity with those acquired by Gamal El-Din (2005), who reported that foliar application of ascorbic acid increased plant growth of sunflower plants. The effect of ascorbic acid on plant growth may be due to the fundamental role ascorbic acid in many metabolic and physiological processes (Shaddad et al., 1990). Ascorbic acid is presently abundant to be regulator on plant growth and development mature to their effects on cell division and differentiation and it is the most considered antioxidant which protect cell (Blokhima et al. 2003).

Effect of Lead:

Experimental results in Table 1 showed that the treatments plant component lead disagreed effect depending on the concentration, it was found that the concentration of 25 ppm gave the highest impact on growth traits values (plant, height, leaf area, neck leaf length, root length, number of leaves and stem diameter) compared with other concentrations. Application of lead at the concentration of 100 ppm gave the lowest values of plant height and neck leaf length, while lead at 50 ppm gave the lowest values of leaf area, root length, number of leaves and stem diameter less than control plants. These results are in agreement with Youbao et al. (2011) on *Chlorophytum comosum* plants. He found that the physiological indexes all increased significantly at lower Pb concentration, lead was prominent contaminant due to the ability to disband towards environmental multimedia (Alloway and Ayres, 1997).

Data presented in Table 2 noticed that the application of lead at 25 ppm led to increase fresh and dry weight of leaves, stems and roots compared with untreated plants. Treating plants with lead at 50 ppm gave the lowest values of fresh and dry weight of leaves comparing with other concentrations and control plants, while, application of lead at 100 ppm gave the lowest values of fresh and dry weight of stems and roots compared with other treatments.

Effect of interaction:

Examination of data in Tables 1, 2 revealed that the interaction treatments between ascorbic acid and lead gave a significant increase in all growth parameters under study. The highest values of plant height, leaf area, neck leaf length, number of leaves, fresh and dry weight of leaves and stems were obtained from plants treated with ascorbic acid at 200 ppm combined with lead at 25 ppm. The increments were 25.53, 82.32, 35.93, 91.5, 53.33, 80.65, 71.63 and 96.34%, respectively, compared with control plants. While the combined treatment between ascorbic acid at 200 ppm + lead at 50 ppm led to significantly increase root length and stem diameter. The increments were 51.27% and 11.24%, respectively, compared with the control plants. Whilst, spraying with ascorbic acid at 200 ppm combined with unspraying lead gave a significant increase in fresh and dry weight of roots followed by ascorbic acid at 200ppm and lead at 25 ppm. These results may be due to the effect of ascorbic acid at high concentration, which causes to increase IAA. IAA stimulates cell division and cell enlargement and this in turn improved plant growth (Abd-El Hamid, 2009). The another reason may be due to the increase of these physiological indicators at lower pb concentration (Youbao et al., 2011).

Chemical constituents:

Effect of ascorbic acid:

Results in Table 3 indicated that nitrogen (N), phosphorus (P), potassium (K) and lead (Pb) contents in leaves were increased by gradually increasing ascorbic acid level. Shao et al. (2008) reported that ascorbic acid conserved metabolic processes against H_2O_2 and other toxic derivatives of oxygen and reduced the damage caused by oxidative stress processes through collaboration with other antioxidants, which works to install the biosynthesis of membranes. The increase in N percentage on *Monstera delicious* plants could be expound by Talaat (1995) who noticed that collection of nitrate by ascorbic acid foliar application may be due to the positive effects of ascorbic acid on root growth, which consequently increased nitrate absorption. Hanafy Ahmed et al. (1995) found that the increment in P percentage by foliar application of ascorbic acid might increase the organic acids excreted from roots into the soil, and thus increased the solubility of most nutrients which redaction slowly into the rhizosphere zone where it may be utilized by the plant. The electrostatic binding of inorganic ions by organic ions such as organic acid is certainly implicated in the process of K ions accumulation (Hiatt and Lowe, 1967).

Table 1 Effect of ascorbic acid, lead and interaction between them on vegetative growth of *Monstera delicious* plants (average two seasons)

Treatments \ Characters	Plant height, cm	Leaf area, cm^2	Neck leaf length, cm	Root length, cm	No. of lleaves/plant	Stem diameter, cm
Control	71.10	710.00	42.30	59.00	4.00	4.08
Ascorbic 100 ppm	76.30	899.94	48.00	70.50	5.33	4.45
Ascorbic 200 ppm	85.00	1120.35	54.75	85.00	6.33	4.60
Lead 25 ppm	71.80	742.81	45.10	60.00	4.33	4.25
Lead 25 ppm+Ascorbic100 ppm	80.22	1210.50	52.70	79.50	7.00	4.63
Lead 25 ppm+Ascorbic 200 ppm	89.25	1294.44	57.50	77.00	7.66	4.30
Lead 50 ppm	65.50	617.40	36.70	41.00	3.00	3.78
Lead 50 ppm+Ascorbic 100 ppm	73.20	835.31	46.00	69.25	4.66	4.54
Lead 50 ppm+Ascorbic 200 ppm	77.75	915.00	49.25	89.25	6.00	4.65
Lead 100 ppm	61.50	640.50	33.00	44.75	3.33	3.90
Lead 100 ppm+Ascorbic 100 ppm	67.25	622.00	39.00	51.00	3.66	3.98
Lead 100 ppm+Ascorbic 200 ppm	70.50	675.40	41.10	56.50	4.00	4.10
LSD at 5%	6.27	86.08	4.51	6.50	0.47	0.39

Table 2 Effect of ascorbic acid, lead and interaction between them on vegetative growth of *Monstera delicious* plants (average two seasons)

Treatments \ Characters	F.W of leaves, g	F.W of stems, g	F.W of roots, g	D.W of leaves, g	D.W of stems, g	D.W of roots, g
Control	445.51	153.78	48.63	119.40	49.52	17.41
Ascorbic 100 ppm	498.74	175.22	58.40	141.14	58.35	21.37
Ascorbic 200 ppm	521.81	189.93	93.18	150.28	64.38	35.13
Lead 25 ppm	461.10	170.08	52.84	126.34	55.62	19.13
Lead 25 ppm+Ascorbic 100 ppm	569.66	241.22	80.12	166.34	82.50	29.80
Lead 25 ppm+Ascorbic 200 ppm	683.10	277.80	69.23	204.93	97.23	25.62
Lead 50 ppm	400.75	139.40	30.27	100.40	43.21	10.53
Lead 50 ppm+Ascorbic 100 ppm	468.43	170.22	39.30	130.69	56.17	13.87
Lead 50 ppm+Ascorbic 200 ppm	576.69	244.12	59.52	171.34	84.70	22.68
Lead 100 ppm	410.63	137.46	23.38	103.90	41.93	8.20
Lead 100 ppm+Ascorbic 100 ppm	432.49	148.95	27.38	111.70	47.07	9.11
Lead 100 ppm+Ascorbic 200 ppm	441.40	149.04	33.20	115.65	47.69	11.65
LSD at 5%	49.20	17.85	5.09	13.63	6.03	1.82

Table 3 Effect of ascorbic acid, lead and interaction between them on chemical constituents of *Monstera delicious* leaves (average two seasons)

Treatments \ Characters	N %	P %	K %	Pb, ppm	Carbohydrates %
Control	1.5	7.9	3.01	0.707	23.1
Ascorbic 100 ppm	2.0	8.6	3.08	0.946	27.9
Ascorbic 200 ppm	2.2	9.2	3.15	0.959	30.0
Lead 25 ppm	1.6	8.1	3.03	0.787	24.1
Lead 25 ppm+Ascorbic 100 ppm	2.4	10.0	3.19	0.876	31.9
Lead 25 ppm+Ascorbic 200 ppm	2.8	10.7	3.22	0.921	36.2
Lead 50 ppm	0.95	6.7	2.80	0.844	16.5
Lead 50 ppm+Ascorbic 100 ppm	1.8	8.3	3.06	0.906	26.8
Lead 50 ppm+Ascorbic 200 ppm	2.5	8.3	3.11	0.921	32.1
Lead 100 ppm	1.0	7.4	2.90	0.890	17.9
Lead 100 ppm+Ascorbic100ppm	1.0	7.2	2.87	1.012	18.4
Lead 100 ppm+Ascorbic200ppm	1.3	7.6	2.80	1.017	20.6

As regarding the effect of foliar application of ascorbic acid at 200 ppm, it led to increase lead and total carbohydrates content compared with the concentration at 100 ppm and control. Ascorbic acid has a wide range of important functions as antioxidant defense, photo protection and regulation of photosynthesis (Blokhima et al., 2003).

Effect of Lead:

For the time being, ornamental plants have become a new source of phytoremediation because they are not only used for landscaping but also have functional applications in air pollution control (Hemndez et al., 2005).

Data in Table 3 revealed that increasing the concentrate of lead from 25 to 100 caused the decrease of nitrogen, phosphorus, potassium and carbohydrates percentage. Application of lead at 25 ppm led to increase the most of chemical constituents compared with other concentrations and control plants. While, increasing the concentrations of lead from 25 to 100 led to increase the lead content of *Monstera delicious* plants. Lead (Pb) was noted as primary contaminate due to the ability to disperse across environmental multimedia (Allowny and Ayres, 1997). Remediation of heavy metals polluted soil, which could be executed using physic and chemicals processes such as precipitation, evaporation and chemical reduction. However, the measure required exterior man – made exchequer and expensive (Lasat, 2002). Alaoui et al. (2003) found that starch could tumble down because it has smaller units, resulting in the accumulation of soluble sugars in the cell. It may also lead the activity of enzymes involved in starch synthesis is inhibited these forms can interact with lipids and cause lipid peroxidation, membrane damage, enzyme in activation by hazard the life of the cell. (Dixi et al., 2001). These results are in agreement with investigation on the ability of plants in removing heavy metals from soil on *polygonum hydropiper* L. and *Rumex acetosa* L. plants (Wang et al., 2003) and on *Lolium perenne* plants (O'connor et al., 2003).

Effect of interaction:

In addition, the date of the interaction between ascorbic acid and lead concentrations indicated that the highest increase in chemical constituents of the *Monstera delicious* plants, which were obtained from plants treated with ascorbic acid at 200 ppm combined with lead at 25 ppm of N, P, K and total carbohydrates percentage, except for lead content. It gave the highest values when plants supplied by ascorbic acid at 200 ppm combined with lead at 100 ppm. These results may be due to that ascorbic acid reduced the harmful effects of reactive oxygen species and may be effective for improvement of stressed plants.

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