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Effects of Lead Contamination on Nutrient Contents of Hyacinth (*Hyacinthus orientalis* L. c.v. “*Blue Star*”)

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Abstract: The aim of this study was to determine the effects of lead on nutrient contents of hyacinth (*Hyacinthus orientalis* L. c.v. "*Blue Star*") in lead contaminated media. This research was conducted in a completely randomized experimental design with three replications in green house conditions. Four doses of lead as control, 20 mg kg^{-1}, 40 mg kg^{-1}, 80 mg kg^{-1} were applied to each pot having 500 g soil:sand mixture in 2:1 ratio. The irrigation was made by distillate water and hoagland solution was applied for fertilization. At the end of the experiment the highest Mg, Fe and Cu contents of hyacinth bulbs were obtained as 0.59 %, 36.00 mg kg^{-1} and 3.40 mg kg^{-1} in control while the highest K (9.72 %), Zn (32.27 mg kg^{-1}) and Ca (2.69 %) were in 40 mg kg^{-1} and 80 mg kg^{-1} lead applications respectively. On the other hand the highest Mg (1.46 %) and Cu (13.75 mg kg^{-1}) contents of hyacinth leaves were obtained in control. The highest K (2.41 %), Ca (4.82 %), Fe (129.86 mg kg^{-1}) and Zn (50.14 mg kg^{-1}) contents of leaves were obtained in lead contaminated media. Lead applications generally increased Fe and Zn contents and decreased of Cu content of hyacinth leaves.

Keywords: *hyacinth, lead, nutrient contents*

Introduction

Heavy metals are dangerous environmental pollutants. Some heavy metals e.g. Mn, Fe, Cu, Zn, Mo and Ni are essential as micronutrients for microorganisms, plants and animals (Welch, 1995). They are necessary for plant metabolism as enzyme activators, regulators, photosynthesis. The others e.g. Cd, Hg, Pb, Cr are not required for plant metabolism. They have no know biological function. Chehregani and Malayeri (2007) reported that high concentrations of all heavy metals have strong toxic effects and regarded as environmental pollutants. They lead many alterations of some physiologic functions such as photosynthesis, chlorophyll production, enzyme activity and pigment synthesis in the plant cell (Kanoun-Boule *et al*., 2008).

They influence amounts and disturbances of plant nutrients by competition with other nutrients (Siedlecka, 1995). Sharma and Dubey (2005) reported that among heavy metals, lead is one of the most hazardous pollutants of the environment and Pb pollution in air, water and agricultural soil is an ecological problem because of its impact on human health and environment. The main sources of Pb, pollution in the environment are mining and smelting of Pb, industrial effluents, fertilizers, pesticides, and municipal sewage sludge. Lead toxicity leads to decreases in the percentage of seed germination, as well as growth, dry biomass of root and shoots, distruption of mineral nutrition, reduction in cell division and inhibition of photosynthesis.

Hyacinthus orientalis used as plant material in this study is an ornamental plant species belong on *Liliaceae*. Ornamental plants are an important type of higher plants and have hyperaccumulation properties (Liu *et al*., 2008). In this study, effects of lead on nutrient contents of hyacinth leaves and bulbs were investigated in lead contaminated media.

Materials and Methods

This research was conducted in a completely randomized experimental design with three replications in green house conditions. Four doses of lead as control, 20 mg kg^{-1}, 40 mg kg^{-1}, 80 mg kg^{-1} were applied to each pot having 500 g soil:sand mixture in 2:1 ratio. *Hyacinthus orientalis* belong on *Liliaceae* family used as plant variety. Hyacinth bulbs were planted to each pot. The irrigation was made by distillate water and hoagland solution was applied for fertilization. The experiment was

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ended after four months. Harvested plant samples were washed, dried and crushed for macro and micro nutrient elements analysis. After wet digestion of plant samples, calcium, magnesium, potassium, iron, zinc, copper and manganese contents were analysed by atomic absorption spectrophotometer (Kacar & İnal, 2008). Statistical analyses was done using SPSS package programme to show difference among the mean values of nutrient contents from the different applications.

Results and Discussions

The effects of lead applications on Ca, Mg, K, Cu, Mn contents ($p<0.01$) and Fe, Zn contents ($p<0.05$) of hyacinth bulb and leaf were found significant (Table 1, 2).

Table 1. Effects of Pb application on macro element contents in bulb and leaf parts of hyacinth

Plant part	Pb doses mg kg^{-1}	K %	Mg %	Ca %
Bulb	0 (control)	0.77 d	0.06	0.25
	20	0.80 d	0.05	0.21
	40	0.97 c	0.06	0.24
	80	0.94 c	0.06	0.27
Leaf	0 (control)	2.31 b	0.15	0.46
	20	2.41 a	0.13	0.42
	40	2.30 b	0.15	0.45
	80	2.30 b	0.15	0.48
Sign. level		at 1%	ns	ns

Table 2. Effects of Pb application on micro element contents in bulb and leaf parts of hyacinth

Plant part	Pb doses mg kg^{-1}	Fe mg kg^{-1}	Cu mg kg^{-1}	Zn mg kg^{-1}	Mn mg kg^{-1}
Bulb	0 (control)	36.0 c	3.4 d	26.1	12.8 cd
	20	33.2 c	2.1 d	31.1	10.9 e
	40	29.6 c	3.2 d	32.3	12.6 d
	80	33.6 c	3.2 d	21.7	8.4 f
Leaf	0 (control)	59.9 cd	13.8 a	33.3	16.2 b
	20	129.9 a	10.5 b	49.5	14.1 c
	40	87.1 bc	6.8 c	50.1	13.9 cd
	80	120.0 ab	8.6 bc	48.1	18.0 a
Sign. level		at 5%	at 1%	ns	at 1%

Increasing lead doses decreased Fe, Cu, Mn contents of hyacinth bulbs. The highest Fe (36.0 mg kg^{-1}), Cu (3.4 mg kg^{-1}) and Mn (12.8 mg kg^{-1}) contents of bulbs were obtained in control application. The highest K and Zn contents of bulbs were obtained as 0.97 % and 32.30 mg kg^{-1} in 40 mg kg^{-1} Pb application. The nutrient contents of leaves generally increased by lead applications. The highest Ca (0.48 %), Mn (18.0 mg kg^{-1}) contents were obtained in 80 mg kg^{-1} Pb application while the highest Fe (129.9 mg kg^{-1}) and Zn (50.1 mg kg^{-1}) were in 20 mg kg^{-1} Pb and 40 mg kg^{-1} P applications respectively. The nutrient contents of hyacinth leaves were found higher than ones in the bulbs. The micronutrient contents of hyacinth leaves were found inadequate levels reported by Jones et al. (1991) for *Lilium longiflorum* while the macro nutrient contents were inadequate.

Effects of interactions among lead doses and hyacinth organs had no significant effects on Mg, Ca, Zn contents of hyacinth. K, Cu, Mn contents influenced ($p<0.01$) by interactions while effects of interactions on iron contents were also found at 0.05 significance level.

It was noticed that interactions, the highest K (2.41 %) and Fe (120.9 mg kg^{-1}) contents were obtained in leaves by 20 mg kg^{-1} Pb application. The highest Cu content was found as 13.8 mg kg^{-1} in leaves and control while the highest Mn content was determined as 18.0 mg kg^{-1} in leaves by 80 mg kg^{-1} Pb application.

In this study, lead applications did not decrease nutrient contents of hyacinth leaves except copper content. Hyacinth used in this study is an ornamental plant species and have hyperaccumulation properties (Liu et al., 2008).

Malar et al. (2014) reported that water hyacinths (*Eichhornia cracsipes* (Mart.)) have efficient mechanism to tolerate Pb toxicity as evidenced by an increased level of antioxidative enzymes.

Similarly, Gülser and Çığ (2015) determinate that lead applications had no inhibitor effects on biomass production of *Hyacinthus orientalis* and hyacinth showed tolerance to increasing lead doses. As a result, lead applications had no effect on nutrition of hyacinth tolerate to heavy metal stress is recognized hyperaccumulator plant.

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