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Research Article

Tolerance of Hyacinth (*Hyacinthus orientalis* L. c.v. *"Blue Star")* to Lead Contaminated Media

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Abstract

The objective of this study was to determine the tolerance of hyacinth (*Hyacinthus orientalis* L. c.v. "*Blue Star*") as a hyper accumulator plant to lead contaminated media. This research was carried out in a completely randomized experimental design with three replications in green house conditions. Four doses of lead (control, 20 mg kg-, 40 mg kg^{-1}, 80 mg kg^{-1}) were applied to each growing media having 500 g soil: sand mixture in 2:1 ratio. The distillate water was used in irrigation and Hoagland solution was applied for fertilization. At the end of the experiment, effects of lead applications on all of plant growth criteria and flowering were found significant (P<0.01) except leaf number and stem diameter. The lowest first flowering time, full flowering time and first floret withering time were obtained as 77.00 day, 79.20 day and 82.39 day in control, respectively. The highest plant length and flower length were obtained as 229.91 mm and 146.36 mm in 20 mg Pb kg^{-1} application. The highest flower diameter and floret number were found as 63.03 mm and 42.42 in 40 mg Pb kg^{-1} application. Generally, while the lead doses increased flowering time, leaf length, plant length, flower length, flower diameter and floret number increased.

Keywords

Hyacinth, lead, tolerance, plant growth, flowering

INTRODUCTION

The serious environmental problems including release of considerable amounts of toxic waste materials into environment caused by increasing of population and fast industrialization growth (Zhuang et al., 2007). Although, heavy metals are natural components of the Earth's crust, the concentration of several heavy metals reached toxic levels due to consequence of anthropogenic activities (Padmavathiamma and Li, 2007). Singh et al. (2003), reported that the annual worldwide release of heavy metals were determined as 22.000 t (metric ton) for cadmium, 939.000 t for copper, 783.000 t for lead and 1.350.000 t for zinc during last few decades. Baudouin et al. (2002), reported that toxic heavy metals have carcinogenic effects and cause DNA damage due to their mutagenic ability in animals and humans.

Scientific researches focused to ecological threats caused by heavy metal and intensive researches of new plant species based remediation technologies recently. It was reported that the removal and recovery of heavy metals from contaminated media have great importance in achieves of protection of the environment (Kim et al., 2004). Hyperaccumulator plants represent a resource for remediation of metal polluted area. They may to extract wide range of metals and to concentrate them in their upper parts. Therefore they have character of metal tolerance (Reeves and Baker, 2000). About 101 family including 501 plant species have been reported by Kramer (2010). Phytoremediation was recognized a new green technology and an ecofriendly approach for remediation of contaminated soil and water (Prasad, 2003). Thus investigation of novel plant species with high biomass yield coupled with to tolerate and accumulate metals has become an important aspect of phytoremediation research (Gleba et al., 1999). Kulakow et al. (2000) reported that plant species selection is a critical management decision for remediation and grasses are thought to be excellent candidates because their fibrous rooting systems can stabilize soil and provide a large surface area for root-soil contact.

Hyacinthus orientalis is an ornamental plant species belong on Liliaceae. Ornamental plants are an important type of higher plants and have hyperaccumulation properties. They can be applied to remediation of contaminated soils (Liu et al., 2008). It is known that some ornamental plants are hyperaccumulator plants and they

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are used for phytoremediation (Özay and Mammadov, 2013). It was noticed available data if we can find hyper accumulative ornamental plants which can be used to remedy contaminated soils, they may bring economic benefits and they can beautify the environment at the same time. This case is the special advantage of ornamental plants to be different from hyperaccumulators.

There is no systematic identification on possible hyperaccumulation ability of ornamental plants and growth responses to metal toxicity in literature knowledges. In this study, tolerance of *Hyacinthus orientalis* to lead contaminated media was determined and investigated its utility for phytoremediation.

MATERIALS and METHOD

This study was carried out in completely randomized plot experimental design with three replicates in a greenhouse. Each replication was formed with five pots. *Hyacinthus orientalis* L. c.v. "*Blue Star*") was used as a plant variety. Hyacinth bulbs were planted to each pot including 500 g soil: sand mixture in 2:1 ratio. Four doses of lead (0 mg Pb kg^{-1}, 20 mg Pb kg^{-1} 40 mg Pb kg^{-1} and 80 mg Pb kg^{-1}) were applied to each pot. Distilled water was used for irrigation and Hoagland nutrient solution (Hoagland and Arnon, 1938) was applied two times for fertilization. The experiment was ended after four months. Phenological observations were made during the experimental period (Figure 1) First flowering time, full flowering time, first flower withering time were determined. On the other hand, the physical parameters were measured in harvested plants and leaf number, leaf length, leaf width, plant length, flower length, flower diameter, floret number and stem diameter were measured (Figure 2).

Statistical analyses was done using SPSS package program to show difference among the mean values of measured plant growth criteria from the different treatments.

Figure 1. Phenological observations in flowers.

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Figure 2. Morphological measurements on the plants.

RESULTS and DISCUSSION

The effects of lead applications on plant growth criteria of hyacinth were found significant (p<0.001) except leaf number and stem diameter (Table 1, Figures 3 and 4).

Table 1. The effects of different lead doses on plant growth criteria of hyacinth

Treatments	Leaf number	Floret number***	Leaf width mm***	Flower diameter mm***	Stem diameter mm
0 mg Pb/kg	7.22	26.89 D	21.27 A	60.37 A	11.45
20 mg Pb/kg	7.13	34.13 C	20.74 A	61.92 B	11.45
40 mg Pb/kg	7.20	42.42 A	18.56 B	63.03 A	12.04
80 mg Pb/kg	7.05	35.75 B	18.13 B	61.37 B	11.89
	NS	P<0.001	P<0.001	P<0.001	NS

NS: Non significant, ***: Means followed by the same letter indicate no statistical difference at 0.1%

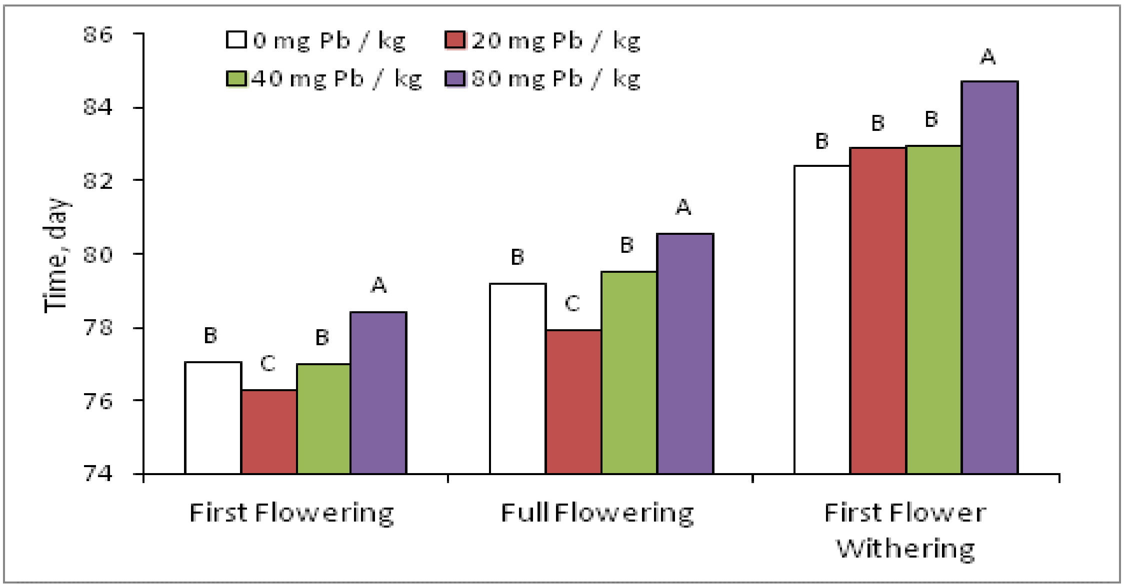

Figure 3. The effects of different lead doses on first and full flowering time, and first flower withering time of hyacinth.

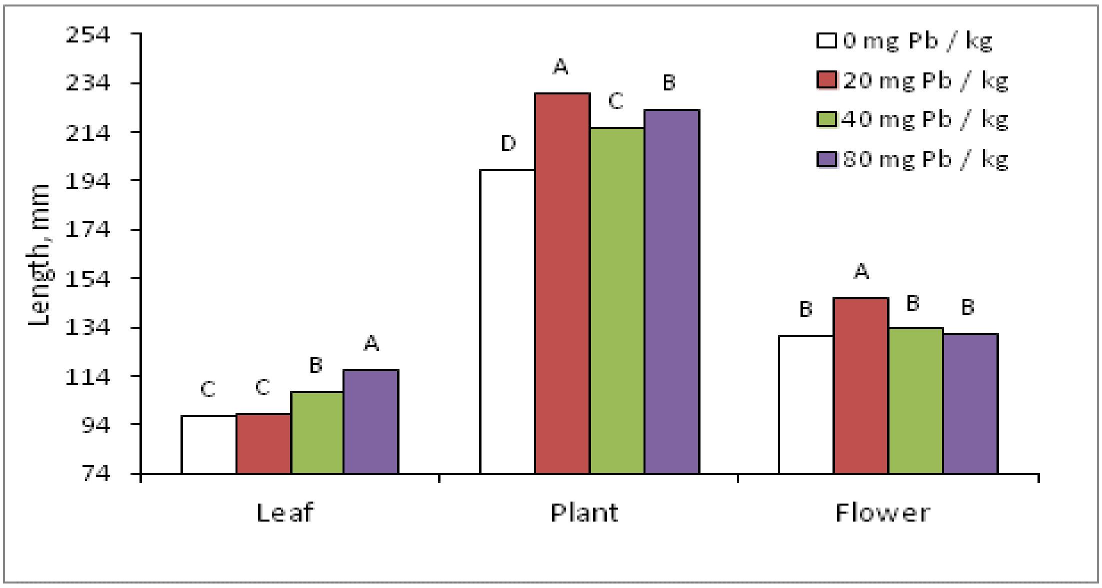

Figure 4. The effects of different lead doses on leaf, plant and flower length of hyacinth.

Generally, first flowering time, full flowering time and first floret withering time were late at the highest lead dose (80 mg Pb kg^{-1}) application (Figure 3). The lowest first flowering time, full flowering time and first floret withering time were obtained as 77.00 day, 79.20 day and 82.39 day in control treatment.

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Similarly, leaf length, leaf width, plant length, flower length, flower diameter, floret number increased by increasing the lead doses. The highest mean value for plant length and flower length were obtained as 229.91 mm and 146.36 mm in 20 mg Pb kg^{-1} application, respectively. The highest flower diameter and floret number were found as 63.03 mm and 42.42 in 40 mg Pb kg^{-1} application, respectively (Figure 4).

It was reported that high growth rate and biomass yield are the most important criteria in selecting plant species for phytoremediation (Rock et al., 2000). The biomass production level of hyperaccumulator plants depends on the concentration of the metals and duration of exposures (Selvam and Wong, 2008).

Kaplan et al. (1990) reported that biomass production is inhibited in *Glycine max* and *Phaseolus vulgaris* in treated high level $VOSO_4$. The biomass production of *Vallisneria spiralis* L. decreased in treatment by enhanced the cromium toxicity (Vajpayee et al., 2001). Liu et al. (2008) reported that that *Althaea rosea* and *Calendula officinalis* which are also ornamental plants had strong tolerance to Cd treatments with increasing in the dry biomass of plants. Similarly it was reported that *Althaea rosea, Impatiens balsamina* and *Calendula officinalis* showed tolerance to Cd and Pb and grew well while increasing doses of these metals in growth media (Wang, 2005). Sönmez and Çığ (2019) reported that hyacinth cadmium contents accumulate in more bulbs than leaves.

In this study *Hyacinthus orientalis* showed tolerance to increasing lead doses and grew well without toxicity syndrome. Lead applications had no inhibitor effects on biomass production of hyacinth. As a result, it was thought that hyacinth may be regarded for phytoremediation treatments initiated all over globe and considered one of the low-cost novel green technologies.

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