THE INFLUENCE OF LEAD ON THE GROWTH AND FLOWERING OF *HYACINTHUS ORIENTALIS* SPECIE

INFLUENŢA PLUMBULUI ASUPRA CREŞTERII ŞI ÎNFLORIRII LA SPECIA *HYACINTHUS ORIENTALIS*

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Abstract. *Experiment was conducted to investigate the growth and flowering at Hyacinthus orientalis exposed to lead toxicity. The experience was organized in five variants, each with three repetitions, and each repetition having 10 bulbs. The experience was organized in five variants, the watering process of the substrate was performed using distilled waterfor the control variant and Pb $(NO_3)_2$ solutions for the other variants. The influence of lead on the plant growth and development has been assessed byplant height, number of flowers and the photosynthetic pigmentscontent.The growth in height and capacity of plant flowering wereinhibeted by applying the lead, regardless of the dosage used.*
Key words: *Hyacinthus orientalis*, lead, photosynthetic pigments

Rezumat. *Scopul experimentului a fost de a studia influenţa toxicităţii plumbului asupra creşterii şi înfloririi speciei Hyacinthus orientalis. Experienţa a fost organizată în cinci variante, cu câte trei repetiţii, iar fiecare repetiţie având 10 bulbii. În cadrul celor cinci variante experimentale, umectarea substratului a fost realizată utilizând apă distilată pentru varianta martor şi soluţii de $Pb(NO_3)_2$ pentru celelalte variante. Influenţa plumbului asupra creşterii şi dezvoltării plantelor a fost evaluată prin înălţimea plantelor, numărul de flori şi conţinutul de pigmenţi fotosintetici. Indiferent de doza utilizată, creşterea plantelor şi capacitatea de înflorire a fost inhibată prin aplicarea plumbului.*
Cuvinte cheie: *Hyacinthus orientalis*, plumb, pigmenţi fotosintetici

INTRODUCTION

In recent years, the concept of using plants to remediate the sites contaminated with heavy metals (phytoremediation) has gained a great deal of attention (Raskin *et al.*, 1994; Jarvis and Leung, 2002). Like any new approach, phytoremediation advocates for the implementation of phytoextraction as a technology to depollute the contaminated soils, withlow-cost and aesthetic advantages, which allow the application of phytoremediation on wide surfaces, even in polluted areas (Vander Lilie *et al*., 2001). Lead (Pb) is one of the heavy metals commonly found in large quantities since antiquity and

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it has gained considerable importance as a major pollutant of the environment. Although lead occurs naturally in the environment, the environment got contaminated with this metal as a result of the manufacture of gasoline, paints and explosives, as well as the elimination of sludge from municipal wastewater treated with lead (Chaney and Ryan, 1994). Some studies have shown that there is a correlation between the concentration of lead and decreased photosynthesis in plants, most probably caused by the closing of the stomata than by any direct effect of lead on the process of photosynthesis (Bazzaz *et al.,* 1975). According to Kosobrukhov and his collaborators (2004), the photosynthetic activity of plants is governed by many factors, cell size, number of stomata, stomatal conductance (Savari *et al,* 2002).

MATERIAL AND METHOD

In order to achieve the objectives of the experiment, it has been studied the species *Hyacinthusorientalis*, 'Blue Jacket' variety, which belongs to the category of rustic flowering geophyte. The studies were conducted on the Teaching Field of the Section of Floriculture within The Faculty of Horticulture, while analyses and calculations were performed within the Horticultural Research Centre of The Faculty of Horticulture within USAMV Iasi, Romania.

The biological material consisted of bulbs of *Hyacinthus orientalis*, the variety 'Blue Jacket', purchased from a firm specialized in the production of seeds and seedlings. The experiment was organized in containers with a capacity of 8 kg and consisted of 4 variants and three repetitions, each repetition containing 9 bulbs. In order to determine the influence of lead on plants' development, the contamination was done with solutions of Pb $(NO_3)_2$ in different concentration (100ppm variant V_1, 300ppm in variant V_2, 500ppm in variant V_3, 700ppm in variant V_4), while in the control variant the substrate was left uncontaminated. The influence of the heavy metal on the plants' growth was assessed through phenological observations, biometric measurements and physiological analyses.

RESULTS AND DISCUSSION

The observations carried out in order to determine the influence of lead toxicity on the development of the vegetation pheno-phases in 'Blue Jacket' indicated a delay associated with increased concentration of lead. The vegetation started 5 days after the contamination in the plants of the control variant and in the variant with 100ppm lead concentration. The increase of lead concentration in the substrate resulted in a delay of the vegetation, with the most important differences being noted in the groups of plants belonging to variant V_3 (10 days) and variant V_4 (11 days) (table 1). Compared to the plants from the control group, the most important differences were obtained in plants of the variant V_3 (4 days) and V_4 (5 days). Comparing the results obtained in the three variants contaminated with lead did not show important delays in the beginning of flowering in the groups of plants contaminated with high concentrations of lead. In the control group, the flowering took place 4 days faster as compared to the groups of plants with a content of lead of 500ppm (V_3) and 700ppm (V_4).

Table 1

Influence of lead on the vegetation pheno-phases in species *Hyacinthus orientalis* variety ' Blue Jacket '

Species / variety	Variant	Date of contamination	Starting vegetation	Beginning of flowering	Wilting flowers
Hyacinthus orientalis 'Blue Jacket'	control	27.02.2015	05.03.2015	06.04.2015	12.05.2015
	V_1	27.02.2015	05.03.2015	12.04.2015	15.05.2015
	V_2	27.02.2015	07.03.2015	12.04.2015	15.05.2015
	V_3	27.02.2015	09.03.2015	13.04.2015	14.05.2015
	V_4	27.02.2015	10.03.2015	16.04.2015	18.05.2015

The plants grown in conditions of lead pollution showed a reduction of the decorative period as compared to the plants of the control group, by 5 days in groups V_3, V_4 and by 4 days ingroups V_1, V_2 (tab. 1). Determinations regarding the average height of the plants highlighted the influence of the concentration of lead on the growth and development of plants (tab. 2). The largest growth of the flowering rod was obtained in the control group (21.98 cm), while the lowest increase was obtained in the group of plants from variant V_4 (17.85). Compared to the control group, all experimental variants showed a decrease of the height of flowering rods, with the most significant ones recorded in the group of plants from V_3 (5.72 cm) and V_4 (6.53 cm). Regarding the height of the flowering rods of plants grown on substrate containing lead in 100ppm concentration, the differences compared to the control group were insignificant (1.21 cm). The statistical interpretation of the results regarding the average height of the flowering rods showed very significant negative differences in variants V_4 and V_3, and significant in variant V_2 as compared to those obtained in the control group.

Statistical interpretation of the results showed negative differences in the variant V_2 and very significant negative values in variants V_3 and V_4, as compared to the control group.

Table 2

Influence of lead on the growth of plants of *Hyacinthus orientalis* variety 'Blue Jacket'

Variant	Height of flowering rod (cm)	Leaf length (cm)	Length of the inflorescence (cm)
control	$24.38^{(Mt)}$	$7.80^{(Mt)}$	$17.55^{(Mt)}$
V_1	$23.17^{(0)}$	7.40	16.33
V_2	$20.88^{(00)}$	$6.95^{(0)}$	$16.25^{(0)}$
V_3	$18.66^{(000)}$	$6.55^{(000)}$	$15.56^{(000)}$
V_4	$17.85^{(000)}$	$6.25^{(000)}$	$14.99^{(000)}$
LSD 5%	0.6	0.4	0.3
LSD 1%	0.8	0.8	0.5
LSD 0.1%	1.2	1.5	0.7

The length of the inflorescence showed very significant negative differences in variants V_4 and V_3 when comparing the plants from the control group with the plants grown in substrate contaminated with different doses of lead. The smallest lengths were observed in the group of plants from V_3 and V_4, which recorded a shorter inflorescence by 1.99 cm and 2.56 cm as compared to the control group. In the case of these experimental variants (V_3 and V_4), the statistical interpretation of the results highlighted very significant negative differences as compared to the control group.The lowest average number of flowers was obtained in the group of plants contaminated with 700ppm Pb, where there was a decrease of 11 flowers as compared to the control group. The statistical interpretation of the results obtained in conditions of lead pollution showed significant negative differences in variant V_3 and very significant negative differences in variant V_4 (tab. 3).

Table 3

The mean number of inflorescence and flower lengthof Blue Jacket 'variety

Variant	Inflorescence flowers/number (pcs)	The length of the flowers (cm)
control	$46^{(Mt)}$	$3.4^{(Mt)}$
V_1	44	3.2
V_2	42	3.3
V_3	$41^{(00)}$	$4.0^{(x)}$
V_4	$35^{(000)}$	$4.2^{(x)}$
LSD 5%	3.4	0.3
LSD 1%	4.4	0.4
LSD 0.1%	6.6	0.6

Observing the growth trend of the flowers in the inflorescences, we can notice that the variants that have been contaminated with higher doses of lead registered a slight elongation of the flower as compared to the uncontaminated group. At first sight we can say that the presence of lead in the substrate stimulate the growth of flowers on inflorescences in 'Blue Jacket ' variety. Nevertheless, analysing things in detail and consulting the specialty studies, the elongation of flowers in the inflorescences was ascribed to the toxic effects of lead on the plants. Thus, an increase in the levels of lead in the substrate caused an elongation of the flower with 4.0 cm in the plants from variant V_3 and 4.20 cm in the plants from variant V_4, as compared to the control group (tab. 3). Determinations concerning the content of assimilating pigments in plants grown in lead-contaminated substrate have highlighted the potential for adaptation of the variety ‘Blue Jacket’ to lead polluted soil (fig. 1). The total content in chlorophyll pigments ranged between 2.74 mg/g s.p. in the control variant and 1.35 mg/g s.p. in the variant contaminated with a concentration of lead of 700ppm (V_4). As compared to the control variant, the variants contaminated with lead showed major declines of the total content of assimilating pigments, thus confirming

that lead pollution in the species *Hyacinthus orientalis* the variety 'Blue Jacket' causes stress at physiological level.

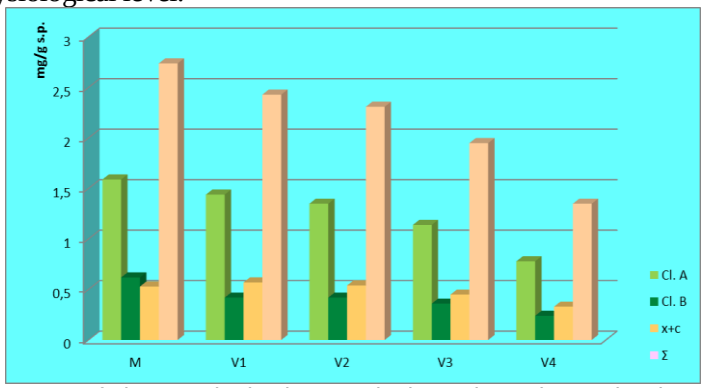

Fig. 1 Content of photosynthetic pigments in the variety 'Blue Jacket' in substrate contaminated with lead

Regarding the content ofchlorophyll *a*, compared to the control variant, there can be observed a slight decrease in all experimental variants with values ranging between 1.59 mg/g s.p. in the control group and 0.78 mg/g s.p. in the group of plants with the highest dose of lead (V_4). The values for the content of chlorophyll b have shown important differences, ranging from 0.62 mg/g s.p. in the plants from the control group and 0.24 mg/g s.p. in the group of plants from V_4. The increase in the concentration of lead causes a decrease in the content of chlorophyll b. An important indicator in the assessment of plant adaptation to stress conditions is the ratio of chlorophyll a/chlorophyll b (Lichtenthaler *et al.,* 1981). In the case of the plants within the experimental variants grown in lead contaminated substrate, the ratio chlorophyll a/chlorophyll b varied between 3.43 mg/g s.p. in variant V_1 and 3.25 mg/g variant s.p. in V_2 (fig. 1). The results fall within the theoretical limits and the ratio ofchlorophyll *a*/chlorophyll *b* is around 3:1 in all variants.

Table 4

The ratio of assimilating pigments obtained in the species *Hyacinthusorientalis*, the variety 'Blue Jacket' grown in substrate contaminated with different doses of lead

Variant	Σ	CL. a/CL. b	CL. a + b/x + c
control	2.74	2.56	4.17
V_1	2.43	3.43	3.26
V_2	2.31	3.21	3.28
V_3	1.95	3.17	3.33
V_4	1.35	3.25	3.09

Research results show that in the case of plants grown in conditions of lead pollution the ratio of chlorophyll pigments and carotenoids is between 3.26 mg/g s.p. in variant V_1 and 3.09 mg/g s.p. in variant V_4. Comparing the results obtained

in the contaminated variants with those of the control variant, it is observed that the value of the ratio (CL. *a*+ CL. *b*)/(c + x) is below the value of 4.2, indicating a stress caused by both climatic conditions and lead toxicity.

CONCLUSIONS

1. In the species of *Hyacinthus orientalis*, the highest concentrations of lead have delayed the vegetation of plants by 10 days in the group of plants from V3 and by 11 days in V_4, as compared to the control group.

2. The presence of lead in the substrate affects the decorative period of the plants regardless of its concentration, as it has been revealed by a reduction of the number of days by 4 invariants V_1, V_2 and by 5 days invariants V_3, V_4.

3. The statistical interpretation of the results regarding the average height of the flowering rods showed very significant negative differences in variants V_4 and V_3, and distinctly significant in variant V_2, as compared to the control group.

4. Statistical interpretation of the results regarding the size of the flowers in inflorescences showed a significant positive difference in plants contaminated with high doses of lead representing the level of intervention (V_3) and those contaminated with doses above this level (V_4).

5. The content of chlorophyll pigments from plants grown in contaminated substrate showed major decreases as compared to the control variant, which confirms that lead pollution in the variety 'Blue Jacket' causes stress at physiological level.

REFERENCES

1. **Bazzaz F.A., Carlson R.W., Rolfe G.L., 1975** - *The inhibition of corn and soybean photosynthesis by lead*. Physiol. Plant. 34:326-329.
2. **Chaney R.L., Ryan J.A., 1994 -** *Risck based standards for arsenic lead and cadmium in urban soils.* Dechema, Franchfurt, Germany.
3. **Jarvis M.D., Leung D.W.M., 2002** - *Chelated lead transport in Pinusradiata: an ultrastructural study.* Environ. Exp. Bot. 48:21-32.
4. **Kosobrukhov A., Knyazeva I., Mudrik V., 2004 -** *Plantago major plants responses to increase content of lead in soil: growth and photosynthesis*. Plant Grow Regul. 42: 145-151.
5. **Lichtenthaler H.K., 1987** -*Chlorophylls and carotenoids*: Pigments of photosynthetic biomembranes. Methods Enzymol. 148:350-382.
6. **Raskin I., 1994** - *Bioconcentration of metals by plants*. *Environ. Biotechnol.*, 5, 285–290.
7. **Savari E., Gaspar L., Fodor F., Cseh E., Kropfl K., Varga A., Baron M., 2002** - *Comparison of the effects of Pb treatment on thylakoid development in poplar and cucumber plants. Acta. Biol. Szeged. 46:163-165.*
8. **Vander Lilie D., Schwitzguebel J.P., Glass D., Vangronsveld J., Baker A., 2001** - *Assessing phytoremediation's progress in the United States and Europe.Environmental Science and Technology.*Volume 35, pp. 446 A-452 A.24.