THE ACCUMULATION OF HEAVY METALS IN RHUBARB (*RHEUM RHABARBARUM* L.)

ACUMULAREA UNOR METALE GRELE ÎN REVENT (*RHEUM RHABARBARUM* L.)

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Abstract. *Rhubarb (Rheum rhabarbarum L.) is a perennial plant, adapted to cold and temperate climate, less spread crop in Romania. Due to the fact, in some areas of our country, rhubarb found favorable conditions for growth and development (Transylvania, Moldavia), the culture of this species require special attention in terms of sustainability. Through the application of differentiated technology, the content of organic acids, minerals, carbohydrates, proteins, vitamins and contaminants differs of the cultivar and the harvesting period. Based on these considerations, the aim of the present study was to highlight the content of any heavy metals (Cu, Cd, Zn and Pb), in two cultivars of rhubarb. In all samples, the Cd content was below the detection limit of the device (<10 ppm). The highest accumulation of heavy metals in the petioles of rhubarb was achieved in cultivar Glaskins perpetual which was planted at distances of 1,1 m x 0,75 m, with a density of 12120 pl/ha, as: Cu – 36 ppm/100 fresh weight; Zn – 166 ppm/100 g fresh weight and Pb – 18 ppm/100 g fresh weight.*

Key words*: rhubarb, heavy metals, planting distances, cultivars*

Rezumat. *Reventul sau rhubarba (Rheum rhabarbarum L.) este o plantă perenă, adaptată climatului rece şi temperat, foarte puţin răspândită în cultură, in România. In acest sens, reventul găseşte condiţii bune pentru creştere şi dezvoltare în câteva zone din ţara noastră (Transilvania, Moldova), insă cultura acestei specii necesită o atenţie deosebită din punct de vedere al sustenabilităţii. Prin aplicarea diferenţiată a tehnologiei de cultivare, conţinutul de acizi organici, minerale, carbohidraţi, proteine, vitamine dar şi contaminanţi, diferă în funcţie de cultivar şi de perioada de recoltare. Bazându-ne pe aceste consideraţii, scopul studiului de faţă a fost acela de a scoate în evidenţă prezenţa unor metale grele (Cu, Cd, Zn şiPb), la două cultivare de revent, în funcţie de tehnologia aplicată. În toate probele, conţinutul de Cd a fost sub limita de detecţie a aparatului (<10 ppm). Cel mai ridicat conţinut de metale grele în peţiol a fost întâlnit la cultivarul Glaskins perpetual care a fost plantat la distanţe de 1,1 m x 0,75 m, cu o densitate de 12120 pl/ha, astfel: Cu – 36 ppm/100 subst. proaspătă; Zn – 166 ppm/100 g subst. proaspătă şi Pb – 18 ppm/100 g subst. proaspătă.*

Cuvinte cheie*: revent, metale grele, distanţe de plantare, cultivare*

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INTRODUCTION

The rhubarb (*Rheum rhabarbarum* L.) is a perennial vegetable species adapted to cold and temperate climate, known and spread least crop in Romania (Ciofu et al., 2003; Indrea et al., 2007).

Through the application of differentiated technology, the content of organic acids, minerals, carbohydrates, proteins and vitamins differs of the cultivar and the harvesting period (Beceanu, 2002; Butnariu, 2012; Patras, 2013).

Botanically speaking, rhubarb is a vegetable because it has both leaf and stem. Fresh rhubarb is generally available across the country from April to October. Hothouse rhubarb appears from December through March and may be available year-round in some markets. Rhubarb originated in the Himalayas, where its root was an important medicine believed to purge the body of ill humans.

Heavy metal pollution is an issue of global importance which, although associated particularly to intensely industrialized areas, has become highly typical for farm land as well (Munteanu et al., 2010; 2012). Considering at least 90 pollutant metals, zinc (Zn), copper (Cu) and lead (Pb) are most commonly detected (Hura, 2007; Patras et al., 2013; Hura et al., 2013; Gavrilescu, 2009; Butnariu et al., 2014).

In the same time, heavy metals are the most significant pollutants of the natural environmet, by their negative effects on the plants, animals and men health (Butnariu et al., 2005; Hlihor et al., 2009;Stoleru, 2013; Stefan, 2008).

The level of heavy metals in the agricultural ecosystem depends by soil pH, type of plant, organic matter, technology applied and vegetation plants period.

The main goal of this paper ist o present the result of a comparative study regarding the level of hevy metals in rhubarb petiole depending by cultivars and planting distances (Stoleru et al., 2012; Samfira et al., 2013).

MATERIAL AND METHOD

The research has been carried out at U.A.S.V.M. Iasi where was organized an experience in a rhubarb crop, established during 2013, on a research plot of 1800 square meter, used two varieties (Glaskin's perpetual cv. (cultivar) and a Local population cv. from Moldova) at densities of 9.090 pl./ha (1.1 m x 1.0 m) and 12.120 (1.1 m x 0.75 m) pl./ha. For setting up of experience was used for both cultivars, rhizomes from the crop of 2012.

The determinations revealed that the density underlying the variety and technology are two factors significantly influence the content of organic acids in the leaf petioles, and the harvest time was on 27 July 2013.

The analyses carried out at U.A.S.V.M.B. Timisoara. Samples have been dried in an oven at 105°C, then weighed 1 g of each sample. They were submitted digestion for bringing them into solution. For determination of mineral elements and heavy metals in the samples studied using atomic absorption spectrometry AAS atomic absorption spectrometer AAS Contra 300, Analytik Jena. The significance of the differences was analyzed using the Analysis of Variance test (Butnariu, 2012).

Analytical data were compared with admitted maximum limits (AML), according to Romanian Regulation (Order 756/1997) and European Regulation (EC Regulation 1881/2006).

RESULTS AND DISCUSSION

In correlation with the interaction between the two factors resulted in four experimental variants (V_1-V_4), which were organized in three replications (R_1-R_3), as presented in Table 1.

The table 1 shows the data on the content of heavy metals varied in each replication.

Table 1.

The content of heavy metals in the petiols from rhubarb (µ/kg fresh weight)

Variants	Heavy metal contents			
	Cu ppm	Cd ppm	Zn ppm	Pb ppm
V_1R_1	42	<10	195	55
V_1R_2	37	<10	235	0
V_1R_3	28	<10	162	0
V_2R_1	27	<10	146	0
V_2R_2	28	<10	161	22
V_2R_3	25	<10	169	28
V_3R_1	38	<10	163	18
V_3R_2	30	<10	188	8
V_3R_3	26	<10	161	23
V_4R_1	26	<10	148	22
V_4R_2	32	<10	181	13
V_4R_3	31	<10	201	0
□	**30.83**	<10	**175.83**	**15.75**

V_1-Glaskin's perpetual cv. X 12.120 pl./ha; V_2-Glaskin's perpetual cv. X 9.090 pl./ha; V_3-Local population cv. X 12.120 pl./ha; V_4- Local population cv. X 9.090 pl./ha., R1, R2, R3 – replications.

Regarding tothe content of Cu in rhubarb, it ranged from25 ppm in V_2-Glaskin's perpetual cv. X 9.090 pl./ha till to 42 ppm in V_1- Glaskin's perpetual cv. X 12.120 pl./ha, compared to the average value that is30.83 ppm. In all variants analyzed, the average contentis less than the maximum limit, which shows tha in the crop of rhubarb, no treatments have been applied based on Cu or Cu $(OH)_2$.

Cadmium (Cd) is another chemical that can be found in soil and plants in several forms: Cd^{2+}, Cd^{3+}, Cd^{6+}, but in high quantities can be toxict o humans.

In all variants studied, the content was lower than the detection limit of the device that is below 10 ppm.

Zinc content limits lower than AML has favorable effects on plant growth and development, but if it exceeds the AML, can be toxic for both plants and especially to humans.

In the crop of rhubarb, the average content was175.83 ppm, but in variants increased from 146 ppm in V_2- Glaskin's perpetual cv. X 9.090 pl./ha; to 235 ppm in V_1- Glaskin's perpetual cv. X 12.120 pl./ha (Fig. 1).

Lead (Pb) as a toxic chemical in the soil,varies within very wide limits, in the study carried out from undetectable if V_1- Glaskin's perpetual cv. X 12.120 pl./ha; to 55 ppm in the same variant in R1.

In the case of Pb, we conclude that Pb accumulationin petiole is not conditioned by variety or planting distances.

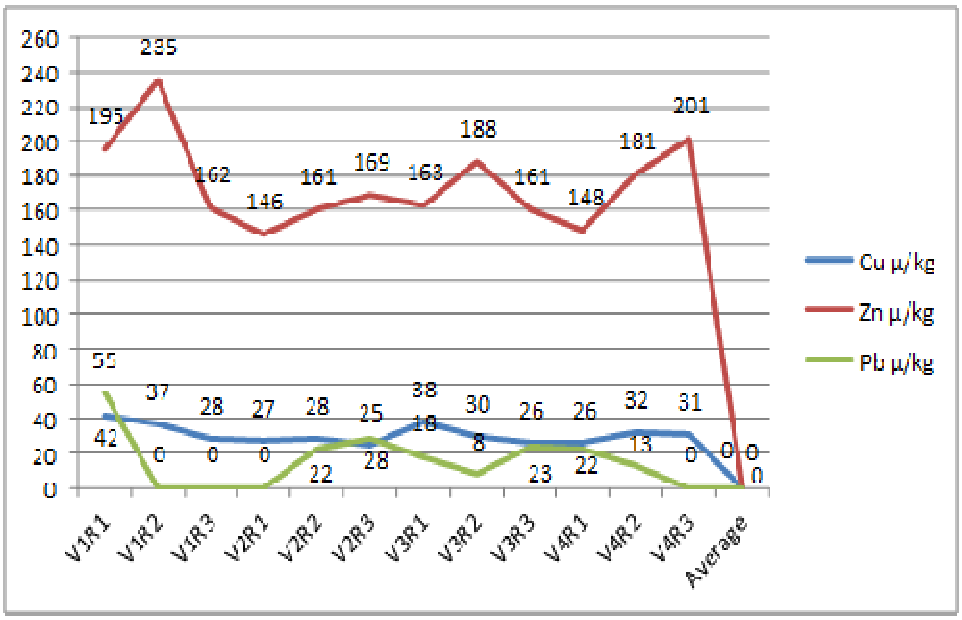

Fig. 1 - Graphical representation of the content of heavy metals in the petiols from rhubarb (µ/kg fresh weight)

Average content in toxic element shad higher values in variants planted at densitie shigher than densities of 9090 pl./ha.

From the data presente in Table 2 it can be seent hat all values of toxic elements are below the maximum limits of EC regulation 1881/2006

Table 2.

The average content of heavy metals from rhubarb (µ/kg fresh weight)

Variants	Heavy metal contents			
	Cu ppm	**Cd ppm**	**Zn ppm**	**Pb ppm**
V_1	35.66	<10	197.34	18.34
V_2	26.67	<10	158.67	16.66
V_3	31.33	<10	170.66	16.33
V_4	29.67	<10	176.67	11.67
□	**30.83**	<10	**175.83**	**15.75**

V_1-Glaskin's perpetual cv. X 12.120 pl./ha; V_2-Glaskin's perpetual cv. X 9.090 pl./ha; V_3-Local population cv. X 12.120 pl./ha; V_4- Local population cv. X 9.090 pl./ha.

The lowest content of heavy metal, was found in the Glaskin's perpetual cultivar has been planted at a density of 9.090 pl./ha (Fig. 2.).

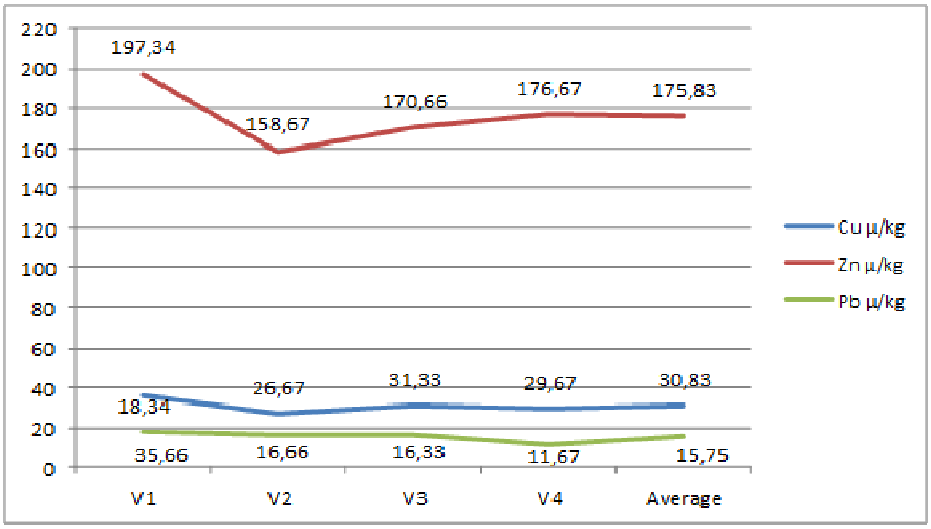

Fig. 2 - Graphical representation of the average content of heavy metals from rhubarb petiols (µ/kg fresh weight)

CONCLUSIONS

Inside most soil samples and vegetable products comming from the lands chosen for measurements, the main chemical contaminants were within the maximum accepted limits according to European and national regulation, 293/640/2001-1/2002.

The high content of metals analyzed has been recorded in Zn, average content was 175.83 µ / kg fresh weight.

In the case of Cd, the metal content was below the detection limit of the device fits in AML.

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