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ABSTRACTS

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ABSTRACTS OF THE 4TH WORLD ALFALFA CONGRESS

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- Poster

Mineral composition of alfalfa grown in soils with increased concentrations of trace elements

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Growing plants in soils with increased content of potentially toxic elements requires careful management due to the elements entry into the food chain through crops. In this study, the alfalfa (*Medicago sativa* L.) was grown in the two locations on Fluvisol with different increased nickel (Ni) concentrations: location Mala Ivančica (near Belgrade) with 58 mg kg⁻¹ and location Globoder (near Kruševac) with 195 mg kg⁻¹ of Ni. In addition, the soil near Kruševac has increased concentrations of chromium (Cr) and lead (Pb). Inoculation of alfalfa with different rhizobial strains (*Ensifer meliloti*) was performed. The experiments were established both under the field and greenhouse conditions in spring 2024. In the field conditions inoculation of alfalfa seeds (variety K-28) was performed with the strains of rhizobia, E. meliloti 218, 224, G-nov, 4193cs, 217k, 252. Inoculation of alfalfa grown in pots (greenhouse conditions) with additional seven strains of rhizobia (GPD2, 225, Melxx, 10-2BM, L3Si, L4, 4148ss) was done. The dry mass yield and elements concentrations in alfalfa plants (N, As, Co, Cd, Cr, Cu, Fe, Mn, Zn, Ni, Pb) were measured. The plants analysis was done in first cut at the beginning of flowering. It was shown that dry mass yield and Ni concentrations were influenced by the soil characteristics, treatment as well as their interaction. In some inoculated treatments the increase in dry mass yield (up to 20%) and nitrogen content compared to non-treated control plants was observed. The differences between two soil locations were more pronounced under the field conditions than in the greenhouse, where the best performant characteristic showed two treatments E.meliloti 252 and 4193cs. Inoculation with some strains decreased Ni concentration (up to 40%) compared to the control, depending on the strain and type of soil. Alfalfa Ni concentrations in shoots varied from 1.73 up to 7.35 mg kg⁻¹, depending on the soil type, the treatment and culture conditions. The significantly higher concentration of Ni, Cr and Pb in plants of all treatments were detected in the soil with their higher concentrations. Generally, more elements were stored in roots than in alfalfa shoots. Concentrations of all tested elements were mainly within the range of common values for plants. Further research is necessary to evaluate the effects on growth in the second and third year of the trial.

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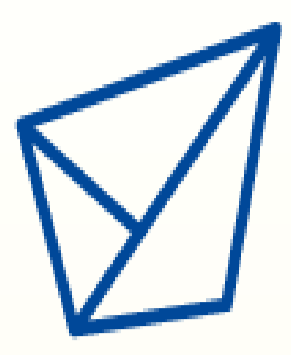
Mineral composition of alfalfa grown in soils with increased concentrations of trace elements

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Introduction

Growing plants in soils with increased content of potentially toxic elements requires careful management due to the elements entry into the food chain through crops. In Serbian soils, nickel (Ni) and chromium (Cr) are found in elevated concentrations over significant areas, often these elements origin is geochemical (from basic and ultrabasic rocks which account for about 4% of territory), but it can also be the result of anthropogenic pollution. Elevated Ni and Cr concentrations often occur in soils which are generally suitable for agricultural production including alfalfa cultivation. The aim of this research was to determine the influence of different rhizobium strains in soils with elevated Ni (and other metals) on the uptake and accumulation of heavy metals (especially Ni) in alfalfa.

Material and Methods

In this study, the alfalfa (*Medicago sativa* L.) was grown in the two locations on soil type Fluvisol with different increased nickel (Ni) concentrations: location Mala Ivanča (near Belgrade) with 52 mg/kg and location Globoder (near Kruševac) with 195 mg/kg of Ni. In addition, the soil near Kruševac has increased concentrations of chromium (Cr) and lead (Pb). Inoculation of alfalfa with different rhizobial strains (*Ensifer meliloti*) was performed.



The experiments were established both under the field and greenhouse conditions in spring 2024. In the field conditions inoculation of alfalfa seeds (variety K-28) was performed with the strains of rhizobia, *E. meliloti* 218, 224, G-nov, 4193cs, 217k, 252. Inoculation of alfalfa grown in pots (greenhouse conditions) with additional seven strains of rhizobia (GPD2, 225, Melxx, 10-2BM, L3Si, L4, 4148ss) was done. The dry mass yield and elements concentrations in alfalfa plants (N, As, Co, Cd, Cr, Cu, Fe, Mn, Zn, Ni, Pb) were measured. The first cut at the beginning of flowering was used for plant material analysis.

Initial characteristics showed that at both locations MI and KŠ the soil is light clay in texture, slightly acidic in reaction (pH_{KCl} 6.45 and 6.06), with medium humus content (2.8 and 2.62%) and total N (0.2 and 0.12%), medium and low P supply (12.24 and 6.91 mg/100g), and medium and high K supply (24.62 and 32.25 mg/100g).

Trace elements in soil mg/kg	As	Cd	Co	Cr	Cu	Mn	Ni	Pb	Zn
Location 1	6.2	0.51	17.24	46.81	20.08	721.2	52.69*	23.46	66.22
Location 2	19.43	1.12	22.61	127.80*	24.16	822.8	195.00*	130.00*	136.00

*above maximum allowed concentration

Results - field

The dry mass yield and elements concentrations were influenced by the soil characteristics, treatment as well as their interaction.

In some inoculated treatments the increase in dry mass yield (up to 20%) and nitrogen content compared to non-treated control plants was observed.

The differences between two soil locations were more pronounced under the field conditions than in the greenhouse, where two treatments *E. meliloti* 252 and 4193cs showed the best performant characteristics.

The significantly higher concentration of Ni, Cr and Pb (as well as As, Cd, Co, Zn) in plants of all treatments were detected in the soil with their higher concentrations (location Kruševac).

Average Ni concentrations in shoots by treatments varied from 1.90 up to 7.75 mg/kg, depending on the soil type, the treatment and culture conditions. At the MI site a reduction of Ni in the above-ground part, compared to the control, was with treatments 218 (2%), G-nov (19%), and in KŠ with variants 4193cs (45%), 218 (34%), 217 (31%), 252 (25%). There is a high correlation of the content of Ni and Cr, Co, Mn, Zn in the above-ground part, which indicates that the mentioned strains are effective in reducing of these heavy metals.



Results - pots

The concentrations of accumulated elements in the above-ground part of the plant in the pots are generally lower than in the field experiment, except for Zn, which had similar values. The significantly higher concentration of Ni in plants was detected in soil Kruševac, where higher concentration of this element was detected in soil. Alfalfa Ni concentrations in shoots varied from 0.87-3.97 mg/kg. Inoculation with most of the strains significantly reduced Ni compared to uninoculated plants with mineral N fertilization (control 2). Compared to the control without N fertilization (control 1), lower Ni values were obtained in some treatments, but differences were not significant: variants GPD2, G-nov, 4193cs, L3Si, 217 in MI and G-nov, Melxx in KŠ.

Conclusion

Concentrations of all tested elements were mainly within the range of common values for plants. In some inoculated treatments the reduction Ni and other heavy metals and increase in dry mass yield and nitrogen content in above-ground part of the plant compared to non-treated control plants was observed. Further research is necessary in order to obtain relevant results on the effects of strains on alfalfa growth and uptake and accumulation of element.