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CROTALARIA (Crotalaria juncea L.) HEAVY METAL UPTAKE IN EASTERN HUNGARY

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Summary: Soil condition, plant production and ecological protection are most important parts of the sustainable agricultural activity on all over the world nowadays. Soils, their fertility, their content of different macro-, mezo-, micro-, trace elements have almost always dictated the spread of agricultural farmlands, including the plant production-, yield harvest levels and yield element contents possible. The success of agriculturists in the 20th and 21th century, particularly in the Europe has relied on inproved soil fertility managements, appropriate crop production and environmental protection. We can test and improve the situations by using different plant species (Crotalaria juncea L.) x macro nutrients (nitrogen) x chelating agents (Desferal as deferoxamine-mesilate: C25H48N6O8-CH4O3S) methods. Crotalaria has a very potential and important role in soil fertility as a green manure crop in the design of plant rotation to field plant production, in the animal foraging as a fodder-crop with a high protein content (30%) and in the pytoremediation possibilities. Field experiment was carried out on a calcareous chernozem meadow soil (Kunság-region of Hungary, Kunmadaras) in partly of crotalaria experiment series (5 years) in 2001. The agrochemical parameters of the ploughed layer of the region soils were as follows: humus 2.5-3.0%, pH (H2O) 7.7, pH (KCl) 7.0, LE (Lakanen & Erviö 1971 [3])-P2O5 183-218 mg kg-1, LE-K2O 82-115 mg kg-1, LE-Ca 1.3%, LE-Mg 56-60 mg kg-1, LE-Mn 45 mg kg-1 according to soil analysis. Nitrogen (N) x Desferal ("D"-Novartis Pharma AG Basie [7], Switzerland, Suiza 500 mg) x Genotype ("G"-India-University of Agricultural Sciences, Bangalore) x Time (T) experiment involved The N levels were 0, 100, 200 and 300 kg ha-1 year-1, and Desferal 0 and 20 kg ha-1 year-1. The plot size had an area of 4x2=8 m2. Experimental datas were estimated by MANOVA of SPSS. The main results can be summarised as follows: a., At harvest, total air dry phytomass (straw+leaf) yield ranged between 8.7-16.5 t ha-1, depending on the N-treatment applied. By N+Desferal combinations the air dry straw+leaf mass achieved 19.3 t ha-1, changed between 14.2-19.3 t ha-1 depending on the treatment rates. b., On this humus-rich calcareous chernozem soil the toxic element translocation from soil (actual toxic element translocation index "ATETI" [4]) to plants can be characterized by x1 nutrient concentration of plant divided by x1 nutrient concentration of soil-1 by N treatment average effects of Al: 1.55, Ba: 0.58, Cd: 1.08, Co: 0.02, Cr: 1.88, Hg: 2.02, Mn: 0.17, Mo: 24.14, Ni: 0.05, Pb: 0.09, Se: 0.36 and Sr: 3.85. The "ATETI" values by N+D treatment average effects were in case of the Al: 1.48, Ba: 0.98, Cd: 1.17, Co: 0.02, Cr: 1.53, Hg: 0.59, Mn: 0.14, Mo: 30.15, Ni: 0.02, Pb: 0.09, Se: 0.80 and Sr: 3.06. c., Depending on the N and N+D treatments 1.9-2.3 kg Al, 1.3-1.4 kg Sr, 1.0 kg Mn, 242-523 g Ba, 31-42 g Mo, 14-17 g Pb, 3-6 g Ni, 4-5 g Cr, 2 g Cd, 0.5-2.0 g Se, 1 g Co and 0.2-0.6 g Hg accumulated in the 12.6 t ha-1 (average of N treatments) and 16.1 t ha-1 (average of N+Desferal treatments) phytomass (straw+leaf) air-dry aboveground yield by crotalaria toxic element uptake. d., On the given soil the highest quantity of 300 kg ha-1 year-1 N+20 kg ha-1 year-1 D chelating agent seemed to give already over fertilization negativ effects on all experimental results and on all possible eco-risk factors. Thus, the maintenance and improvement of the fertility of our soils has never been more important than it is today.

Key words: toxic elements, bioavailability, translocation, Crotalaria juncea L.

Introduction

Today sustainable agricultural production has become the major issue following global change in all the world over. It is well known that it has a well established on soils. The functioning and their ability to supply nutrients, store water, release gases, modify pollutants, decrease physical degradation and produce crops is profundly influenced by their fertiliy. During the last fifty years phenomenal progress has been made in several areas of ecology of different toxic elements in soils. Concerns regarding heavy metals contamination in the environment affecting all ecosystem componets, including "soil-plant-animal-human" chain, have been identified with increasing efforts on limiting their bioavailability. Many sites have been identified as hasardous waste sites because of the presence of elevated concentrations of these elements [2]. They will remain a threat to the environment until they are removed or immobilized. We can test and improve these situation by using different plant species [8]-(Crotalaria juncea L.) x macro nutrients (nitrogen) x chelating agents [9]-(Desferal as deferoxamine-mesilate: $C_{25}H_{48}N_6O_8$-CH_4O_3S) methods. Crotalaria has a very potential and important role in soil fertility as a green manure crop [5], in the design of plant rotation to field plant production [6], in the animal foraging as a fodder-crop with a high protein content (30%) and in the pytoremediation possibilities. Nitrogen can be of considerable importance for cation-anion balance in plants. The content of this element required for optimal growth varies between 2 and 5% of the plant dry weight [1]. When the supply is suboptimal growth is retarded, nitrogen is mobilized in mature leaves and retranslocated to areas of new growth. An increase in the supply delays senescence and stimulates growth [10]. Chelating agents as the Desferal has a very important deal of ion exchanges in soils. It is regulate anion and cation concentrations in rooth zone [9].

Material and Method

Field experiment was carried out on a calcareous chernozem meadow soil (Kunság-region of Hungary, Kunmadaras) in partly of crotalaria experiment series (5 years) in 2001. The agrochemical parameters of the ploughed layer of the region soils were as follows: humus 2.5-3.0%, pH (H_2O) 7.7, pH (KCl) 7.0, LE (Lakanen & Erviö 1971 [3])-P_2O_5 183-218 mg kg-1, LE-K_2O 82-115 mg kg-1, LE-Ca 1.3%, LE-Mg 56-60 mg kg-1, LE-Mn 45 mg kg-1 according to soil analysis. Nitrogen (N) x Desferal ("D"-Novartis Pharma AG Basie [7], Switzerland, Suiza 500 mg) x Genotype ("G"-India-University of Agricultural Sciences, Bangalore) x Time (T) experiment involved 4Nx2DxGx3T=24 treatments in 3 replications giving a total of 72 plots. The N levels were 0, 100, 200 and 300 kg ha-1 year-1, and Desferal 0 and 20 kg ha-1 year-1. The plot size had an area of 4x2=8 m2. Composite soil samples consisting of 15 subsamples were collected at harvest time (20.10.2001) from the ploughed layer (0-40 cm) of each plot. Plant samples were taken using 15 plants (leaf+straw) plot-1 randomly at the beginning of flowering (23.08.2001). In the soil samples the so-called "mobile" fraction extracted with ammonium-acetate+EDTA (AAc+EDTA, Lakanen & Erviö 1971 [3]) was determined by inductively coupled plasma atomic emission spectrometry (ICP-AES) detecting 23 elements at Research Institute for Soil Science and Agricultural Chemistry of the Hungarian Academy of Sciences (RISSAC-HAS). The total amount of the elements in homogenized plant samples were measured after microwave digestion using cc. HNO_3+H_2O_2. The composition of prepared samples was analysed by ICP-AES technics detecting 23 elements at RISSAC-HAS. Experimental datas were estimated by MANOVA of SPSS.

Results

At harvest, total air dry phytomass (straw+leaf) yield ranged between 8.7-16.5 t ha-1, depending on the N-treatment applied. By N+Desferal combinations the air dry straw+leaf mass achieved 19.3 t ha-1, changed between 14.2-19.3 t ha-1 depending on the treatment rates. It was increased on average with an 28 % compared to mean of N doses effect. The mobile, i.e. available toxic element fraction in soil-extracted with the mixture of AAc+EDTA-varied widely for the different examined treatments. Toxic element rates (%) in soils by N and N+Desferal treatments (x1 toxic element concentration at the N-150 kg ha-1 year-1 multipled by 100 and divided by x1 toxic element concentration at the N-150+Desferal-10 kg ha-1 year-1) were 77% in case of the Se, 99% in case of the Sr, Ba, Cr, 100%: in case of the Co, Ni Mn, 101%: Cd, 102%: Al, 105%: Pb, 115%: Hg and 118%: Mo. Toxic element concentrations of plants were also influenced greatly by treatments applied. Rates of toxic elements (%) in plants by N and N+Desferal treatments (x1 toxic element concentration at the N-150 kg ha-1 year-1 multipled by 100 and divided by x1 toxic element concentration at the N-150+Desferal-10 kg ha-1 year-1) were 34% in case of the Se, 59%: Ba, 94%: Mo and Cd, 101%: Co, 107%: Al and Pb, 118%: Mn, 121%: Cr, 124: Sr, 220%: Ni and 396% Hg. On this humus-rich calcareous chernozem soil the toxic element translocation from soil (actual toxic element translocation index "ATETI" by [4]). to plants can be characterized by x1 nutrient concentration of plant divided by x1 nutrient concentration of soil-1 by N treatment average effects of Al: 1.55, Ba: 0.58, Cd: 1.08, Co: 0.02, Cr: 1.88, Hg: 2.02, Mn: 0.17, Mo: 24.14, Ni: 0.05, Pb: 0.09, Se: 0.36 and Sr: 3.85. The "ATETI" values by N+D treatment average effects were in case of the Al: 1.48, Ba: 0.98, Cd: 1.17, Co: 0.02, Cr: 1.53, Hg: 0.59, Mn: 0.14, Mo: 30.15, Ni: 0.02, Pb: 0.09, Se: 0.80 and Sr: 3.06. c., Depending on the N and N+D treatments 1.9-2.3 kg Al, 1.3-1.4 kg Sr, 1.0 kg Mn, 242-523 g Ba, 31-42 g Mo, 14-17 g Pb, 3-6 g Ni, 4-5 g Cr, 2 g Cd, 0.5-2.0 g Se, 1 g Co and 0.2-0.6 g Hg accumulated in the 12.6 t ha-1 (average of N treatments) and 16.1 t ha-1 (average of N+Desferal treatments) phytomass (straw+leaf) air-dry aboveground yield by crotalaria toxic element uptake. d., On the given soil the highest quantity of 300 kg ha-1 year-1 N+20 kg ha-1 year-1 D chelating agent seemed to give already over fertilization negativ effects on all experimental results and on all possible eco-risk factors. This paper presents the maintenance and improvement of the fertility of our soils has never been more important than it is today.

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References

[1] Horst M. 1986. Mineral nutrition of higher plants. Academic Press, London Orlando San Diego New York Austin Boston Sydney Tokyo Toronto
[2] Kádár I. 1992. Principles and methods in plant nutrition. RISSAC-HAS, Budapest, 398p.
[3] Lakanen E. & Erviö R. 1971. A comparison of eight extractants for the determination of plant available micronutrients in soils. Acta Agr. Fenn, 123, 223-232.
[4] Márton L. 2001. Scientific report. RISSAC-HAS, Budapest
[5] Márton L. & Jose E.M. 2001. Effects of Crotalaria juncea L. and Crotalaria spectabilis ROTH on soil ferility and soil conservation in Hungary. Acta Agronomica Óváriensis, 43, 1-8.
[6] Márton L. & Pekli J. 2003. Crotalaria (Crotalaria juncea L.) production. SZIE, Gödöllő
[7] NPAG. 2001. Databank, Basie
[8] Purseglove J.W. 1974. Tropical crops. I-II. Longman Group Limited, London
[9] Shenker M., Hadar Y. & Chen Y. 1996. Stability constants of the fungal siderophore rhizoferrin with various microelements and calcium. Soil Sci. Soc. Am. J., 60, 1140-1144.
[10] Werner B. 1992. Nutritional disorders of plants development, visual and analytical diagnosis. Gustav Fischer Verlag Jena, Stuttgart, New York. 741p.