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BIOACCUMULATION OF METALS IN MUSTARD AND MARIGOLD CULTIVATED ON A POLLUTED AGRICULTURAL SOIL

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Introduction

Elements such as copper (Cu), zinc (Zn), nickel (Ni), cobalt (Co), iron (Fe), molybdenum (Mo) and manganese (Mn) are considered essential mineral nutrients, playing a significant role in protein biosynthesis, nucleic acids, growth, chlorophyll synthesis and secondary metabolites, as well as in the metabolism of carbohydrates and lipids. In the processes of germination and development of plants subjected to the stress of metal pollution, self-defense / resistance / adaptation mechanisms of the plant to the metallic elements are activated. The presence of anti-stress factors, respectively high content of Ca, Zn and Mg, microelements necessary for the growth, development and functioning of photosynthesis processes allowed the development of plants even in conditions of exceeding the value of the intervention threshold for sensitive uses of the soil, such as agricultural soil.

Some metals such as As, Cd, Pb or even essential metals (Cu, Ni) in higher concentration may cause adverse effects on the development of medicinal plants.

The aim of the study was to investigate the effects on germination and development of mustard and marigold plants, cultivated in a polluted soil, sampled from 100 m of a pyrite ash storage dump.

Materials and methods

The mustard and marigold seeds were planted in polluted soil with As (500 mg/kg), Cu (554 mg/kg), Pb (860 mg/kg), Zn (1470 mg/kg) in two different experiments for each plant.

In the same time, a control sample for each plant was planted, the soil used was a commercial one for garden purpose.

At the end of the experiment, the plants were divided in tissues (root, stem and leaves). The plant parts were dried in a oven at 50°C. Around 0.5g from each part was digested with 9 mL of HNO_3 ultrapure and 1 mL of H_2O_2, the mixture was heated until complete digestion in a microwave system.

The obtained solutions were analyzed for metals content using ICP-EOS technique.

Results and conclusions

The development of mustard plants was carried out until the flowering, but the flowers withered before the grains reached maturity.

Mustard plants from polluted soil have grown much less than those grown on the control soil, probably as result of high concentration of metals in the soil, acidic pH and low organic carbon content. However, due to the very low mobility of toxic metals (As <1.5%; Cu <10%, Pb <4%, Zn <6%), the metals remain in the soil and only a small proportion move to the plants. But their cumulative effect proved to be negative on the development of mustard plants (Figure 1a).

a) b)

Fig. 1. Plant development one month after planting: a) mustard; b) marigold

The germination yield of marigold seeds was about 43% in the polluted soil, compared to that of the seeds germinated on the control soil which was around 95%.

Marigold plants registered Cu concentrations 2.5 times higher than the value reported in the literature as phytotoxic (20 mg/kg). Another metal that proves to be above phytotoxic value was Pb, the concentration being 2.5 times higher both in the root and in the leaves, the value in the leaves indicating even a bioaccumulation. The obtained results shows bioaccumulation of Cd in the root, but also translocation to the leaves, the Cd values being above the normal values, but below the phytotoxic value, translocation factor having 1.25 value. In the marigold plants were recorded As concentration above 50 mg/kg in roots and leaves, the normal level of As in plant tissue being 5 mg/kg.

All these data explain the poor development of the plants (Figure 1b). The soil used in the experiments, originating from cultivated agricultural soil with corn crops at the sampling moment, having an acidic pH and a low content of organic matter proved to be unsuitable for the development of marigold plants.

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