Proceedings of the 8th World Congress on New Technologies (NewTech'22)
Prague, Czech Republic– August 03-05, 2022
Paper No. ICEPR 170
DOI: 10.11159/icepr22.170

Heavy Metals and Polycyclic Aromatic Hydrocarbons in Soils and Plants Cultivated On Contaminated Soil after Application of Fertilizers with the Addition of Zeolite Composites Mixed With Leonardite

Justyna Szerement[1], Krzysztof Jurek[2], Adam Kowalski[2], Jakub Mokrzycki[1], Renata Jarosz[1], Lidia Marcińska-Mazur[1], Monika Mierzwa-Hersztek[1]

[1]AGH University of Science and Technology; Faculty of Geology, Geophysics and Environmental Protection, Department of Mineralogy, Petrography and Geochemistry, Mickiewicza 30, 30-059 Krakow,
jsze@agh.edu.pl, jmokrzycki@agh.edu.pl, jarosz@agh.edu.pl, marcinsk@agh.edu.pl, mierzwa@agh.edu.pl
[2]AGH University of Science and Technology, Department of Environmental Analysis, Geological Mapping and Economic Geology, Mickiewicza 21 31-120 Krakow
kjurek@agh.edu.pl, akowalsk@agh.edu.pl,

Industrialization, urbanization, and intensification of agriculture are the main causes of increased levels of pollution in the environment [1]. Among pollution heavy metals and polycyclic aromatic hydrocarbons (PAHs) are recognized as one of the wider distributed worldwide. Their excessive accumulation in soils may pose a potential risk of contamination of cultivated plants and human health risks. One of the most effective ways to maintain ensure adequate soil functionality and soil fertility, limiting the possibility of uptaken harmful compounds by plants is to provide enough soil organic matter, or soil organic carbon pools, in the soil [2]. It was also reported that the application of zeolite can be an effective soil amendment in the soil remediation process [3].

The aim of the study was to evaluate the effect of mineral-organic mixtures on 1) accumulation of heavy metals (Pb, Zn, Cd in plants and soils 2) accumulation of PAHs in plants and soils 3) changes in the activity of dehydrogenase (DhA) in soils 4) changes in the content of organic carbon and black carbon in soils. The experiment included six different objects: two reference: C – soil without fertilization; MF – soil with NPK mineral fertilization, and four treatments with addition of NaX-Ver3%Leo3% (3% of zeolite-vermiculite composite and 3% of leonardite); NaX-Ver9%Leo6% (9% of zeolite-vermiculite composite and 6% of leonardite); NaX-C3%Leo3% (3% of zeolite-carbon composite and 3% of leonardite); NaX-C9%Leo6% (9% of zeolite-carbon composite and 6% of leonardite). The pot experiment was conducted in the vegetation hall of the University of Agriculture on soil classified as loamy sand. After maize cultivation (variety of Kosynier), the following laboratory analysis were conducted in the soil and plant materials: determination of the content of Zn, Cd, and Pb in soils and plants using inductively coupled plasma optical emission spectrometry, extraction of PAHs by Soxtec method and the separation of PAHs using an Agilent Technologies 7890A gas chromatograph coupled with an Agilent 5975C, determination of the activity of dehydrogenase, determination of organic carbon and black carbon content.

It was found that both type and dose of the applied mineral-organic mixture had an effect on the growth of maize plants and the accumulation of heavy metals and PAHs in plants and soils. Among applied fertilization, the highest biomass of maize was determined for MF fertilization, however, for this treatment, the highest accumulation of heavy metals and PAHs was also observed. The application of zeolite-carbon composite resulted in the highest decrease of accumulation of heavy metals and PAHs in straws and seeds in comparison to MF. It was found that all applied fertilizers have no significant effect on accumulation of Cd in grains, however the highest concentration of Zn was observed for the application of zeolite-carbon composite with 6% of leonardite. In tested soils, there was a strong correlation between the content of organic carbon and the total concentration of PAHs in soils (0.91), and strong correlation between the content of organic carbon and DhA (0.73).

In conclusion, the zeolite-carbon composite applied with addition of leonardite (especially NaX-C9%Leo6%) could be an effective additive to fertilizers, minimalizing the accumulation of heavy metals and PAHs in maize cultivated on the polluted soils.

Acknowledgments

This study was supported by the project "Fly ashes as the precursors of functionalized materials for applications in environmental engineering, civil engineering and agriculture" - project is carried out within the TEAM-NET programme of the Foundation for Polish Science POIR.04.04.00-00-14E6/18-00.

References

[1] J. Szerement, A. Szatanik-Kloc, R. Jarosz, T. Bajda, M. Mierzwa-Hersztek, „Contemporary applications of natural and synthetic zeolites from fly ash in agriculture and environmental protection", *J. Clean. Prod.*, vol. 311, pp.127461, 2021.

[2] J. Kwiatkowska-Malina, „Functions of organic matter in polluted soils: The effect of organic amendments on phytoavailabilit of heavy metals", Appl. Soil Ecol., vol. 123, pp. 542-545, 2018.

[3] T. Głąb, K. Gondek, M. Mierzwa-Hersztek, „Biological effects of biochar and zeolite used for remediation of soil contaminated with toxic heavy metals", *Sci. Rep.*, vol. 11, pp. 6998, 2021.