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EFFECT OF BIOCHAR ON AGROCHEMICAL AND PHYSICAL AND CHEMICAL INDICATORS OF SOIL

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Introduction

The emergence of new concepts and requirements in the sustainable development of the world economy could not but affect such an important sector as agriculture, which directly depends on nature and causes no small environmental damage [1]. Current concerns about global food security combined with the need to develop more sustainable agricultural systems heavy metal reduced major changes in agricultural management. Heavy metals are non-degradable and easily accumulate in soils [2]. Soils contaminated with heavy metals pose a risk to the environment and to human health [3] due to biomagnifications. Recently, studies have paid considerable attention to in situ remediation such as the addition of soil amendments [4]. Biochar is a porous substance that is obtained by burning organic waste (wood, shells, corn stalks, etc.) without oxygen. The use of biochar in agriculture can lead to an increase in carbon sequestration from the atmosphere, preserving and improving the physical, biological and physicochemical quality and stability of the soil. Since biochar is chemically relatively stable and its destruction in the soil environment is slow, introducing it into the soil is considered as one of the effective means of reducing the concentration of carbon dioxide in the atmosphere and reducing the rate of climate change on Earth. Among the methods, biosorption technique is the most common and cost effective. This is because biosorbents are environmentally friendly and readily available in large quantities, and one of the most popular biosorbents is biochar. Biochar is a carbon-rich, fine-grained, and porous material. It has received increasing attention due to its ability to store large amount of carbon, increase crop yield, reduce soil emission of greenhouse gases, improve soil quality, decrease nutrient leaching, and reduce irrigation and fertilizer requirements [5,6,7].

Materials and Methods

The objects of study was leached black soil contaminated with heavy metals from emissions from the zinc plant of the Ridder city, East Kazakhstan region. Soil samples were collected from 0 to 30 cm depth. To obtain biochar, a carbonization reactor was used. The impact of industrial emissions on soil and vegetation cover was determined by eroded processes, external signs of plants, their death and absence.

Results and Discussion

For biochar used rice husk. The SEM of the biochars (Figure1) showed many porous structures on their surface, but the sizes and shapes were different, which indicated potentially different capabilities for adsorption. The results of polluted soil sample analyses: pH-7.85; humus content 5.31%; total nitrogen 0,120%; mobile phosphorus (P_2O_5) 35 mg/kg; zinc 8804.84 mg/kg; lead 429.2 mg/kg. In uncontaminated soil (initial state) content of humus was 6.9%. Thus, the effect of HMs on organic humus was determined: HMs degrade the soil, as humus decreases to 24%. In order to determine the effectiveness of the biochar obtained by us, biochar was introduced into the soil. There were 3 replicates for each group. Samples were kept under static conditions at room temperature (21±10°C). The results of the study showed that the introduction of biochar led to an increase in the mobile phosphorus (P2O5) - 35 mg/kg to 48.40%, in soil pH 7.85 to 6.56, the content of exchangeable potassium (K2O) increases significantly - 433.8 mg/kg to 589.8 mg/kg, nitrogen 0.120% to 0.130% increased by comparison in the control variants of the experiment.

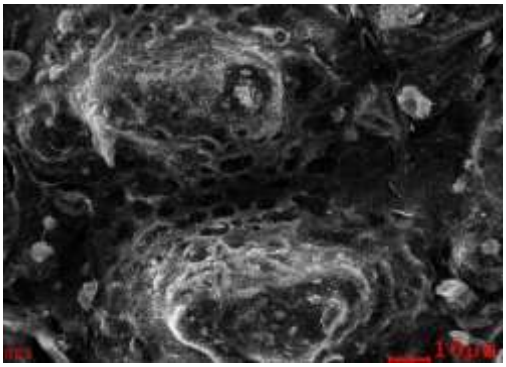

Figure 1. Scanning electron microscope (SEM) results of rice husk biochar

Conclusions

The results of the study showed that the introduction of biochar led to an increase in the mobile phosphorus (P_2O_5) - 35 mg/kg to 48.40%, in soil pH 7.85 to 6.56, the content of exchangeable potassium (K_2O) increases significantly - 433.8 mg/kg to 589.8 mg/kg, nitrogen 0.120% to 0.130% increased by comparison in the control variants of the experiment. Thus, as a result of our research, the research suggests that the use of domestic biochar allows us to solve a dual problem: first, having high sorption rates, they can be used in various industries, while reducing costs compared to previous technologies, second, improves the ecological state of the soil cover.

References

1. Bastaubayeva Sh. O., Bekbatyrov M. B., Ospanova S. O. (2018) The biological efficiency of crop rotations and green manures to improve the productivity of irrigated lands //News of National Academy of Sciences of the Republic of Kazakhstan. Series of agricultural sciences. Almaty: NAS RK, 5(47). P. 60-64

2 Jiang T.Y., Jiang J., Xu R.K., Li Z. (2012) Adsorption of Pb (II) on variable charge soils amended with rice-straw derived biochar. Chemosphere 89:249–256

3. Lu K., Yang X., Shen J., Robinson B., Huang H., Liu D., Bolan N., Pei J., Wang H. (2014) Effect of bamboo and rice straw biochars on the bioavailability of Cd, Cu, Pb and Zn to Sedum plumbizincicola. Agr Ecosyst Environ 191:124–132

4. Xu D., Zhao Y., Sun K., Gao B., Wang Z., Jin J., Zhang Z., Wang S., Yan Y., Liu X. (2014) Cadmium adsorption

on plant-and manure-derived biochar and biochar-amended sandy soils: impact of bulk and surface properties. Chemosphere 111:320–326
5. Kimetu J.M., Lehmann J., Solomon O.N., Mugendi D.N., Kinyangi J.M., Riha S., Verchot L., Recha J.W., Pell A.N. (2008) Reversibility of soil productivity cecline with organic matter of differing quality along a degradation gradient. Ecosystems 11, 726-739. https://doi.org/10.1007/s10021-008-9154-z
6. Lehmann J. (2007) Bio-energy in the black. Front. Ecol. Environ. 5, 381-387. https://doi.org/10.1890/1540-9295(2007)5[381:BITB]2.0.CO;2
7. Nguyen B., Lehmann J., Kinyangi J., Smernik R., Riha S., Engelhard M. (2009) Longterm black carbon dynamics in cultivated soil. Biogeochemistry 89, 163-176.