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Тезис

PHYSIOLOGICAL BASIS OF THE STABILITY OF TO SOILS POLLUTED BY HEAVY METALS

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Development of an effective method for remediation of soils contaminated by xenobiotics is an important environmental problem in Kazakhstan. Actuality of the problem is related to the soil contaminated by xenobiotics frequently happened around location of agricultural companies, in places where oil, gas, mining and processing industry are situated, as well as across military polygons. Soils around those areas are contaminated by zinc, fluorine, bromine, lead, nitrates and pesticides. Such contaminated sites have caused a high ecological risk to the environment and human health.

In order to prevent the toxic impact contaminated soils have to be remediated. Phytoremediation is now recognized as established set of technologies for remediation and considered to be effective alternative to physical or chemical processes [1,2].

One of the most promising species for bioremediation of contaminated soil from the genus *Miscanthus* is a plant of the second generation biofuel *Miscanthus x giganteus* Greef et Deu. *Miscanthus x giganteus* is high-yielding perennial grass, triploid, sterile. It is produced by crossing diploid *Micanthys sinensis Anders* with triploid *Micanthus sacchariflorus Hack* [3]. The practical use of perennial grass *M.x giganteus*, as a phytoremediant, and as a source of solid biofuels is promising from an economic point of view, compared with other bioenergy crops.

The first model experiments in greenhouses were carried out to determine the possibility of using *M.xgiganteus* in the phytoremediation of contaminated soils with heavy metals. *M.x giganteus* does not grow in Kazakhstan. Rhizomes of miscanthus were imported from Ukraine and Slovakia. Uncontaminated soil, Zn-contaminated soil, Pb-contaminated soil as soil culture were used. The uncontaminated soil artificially contaminated with 7-sulfate salts of zinc at concentrations of 3 MAC (67.5 ± 0.2 mg kg^{-1}) and nitrate salts of lead (II) at a concentration of 9 MAC (208 ± 42 mg kg^{-1}). MAC Zn – 20 mg kg^{-1} and MAC for Pb –23 mg kg^{-1}. pH soil was 7.7-7.8. Heavy metal concentrations were selected on the basis concentrations contaminants in soil around the zinc plant, located in the city of Tekeli, Almaty region. Control was uncontaminated soil. Water absorption capacity, content chlorophylls, carotenoids, free proline in the leaves of *M x giganteus* were determined [5] and dynamics of growth and development were studied in the flowering period. Free proline was determined by the method L.S. Bates [6]. The concentrations of heavy metals in above-grounds and the soil before the experiment were determined by inductively coupled plasma mass spectrometry ICP-MS Agilent 7500 series. All experimental data were statistically processed using "Microsoft Excel".

The obtained results showed that plants reacted differently to the presence of heavy metals in the soil. At the stage of seedlings outward signs of toxicity, this is expressed in slowing the rate of growth. The duration of *M.giganteus* vegetation (period from planting rhizomes before flowering) in the contaminated soil was 150 days (130 days control).

One of the most important eco-physiological parameters to assessing the impact of xenobiotics on growth and development of plants is a change in the photosynthetic apparatus, in particular the content of pigments in the leaves. Our studies showed that the total content of the pigments in leaves *M.giganteus* when growing in the contaminated soil was increased relative to control 56% (from 2.3 ± 0.01 to 3.6 ± 0.03 mg g^{-1} dry matter). It is noted that when soil was introduced by nitrate salts of lead the content of the total pigment and of chlorophylls in the leaves of a plant were higher than in the experiments with 7-sulfate salts of zinc. In all experimental variants compared to control the ratio of concentration chlorophylls to carotenoids in leaves of *M.giganteus* increased by 22%.

Water absorption capacity was determined to identify the ways to regulate the water balance in the cells of plants growing on contaminated soil. It is shown that as a result of adaptation *M.giganteus* to heavy metal in the form of protective reaction, water absorption capacity was reduced up to 30% relative to control. Violation water status indicates an increase in the synthesis of free proline in plant cells as a compatible osmolyte. When *M.giganteus* grows on Zn-contaminated soil the content of free proline in the leaves compared to control increased up to 267 times, and Pb-contaminated soil - up to 419 times. Increasing the content of free proline in the leaves under stress is to protect reaction of plants from the adverse impacts.

It was found that the plant extracted in the range 12.4 % Zn ions and 0.14 % Pb ions, when calculating the percentage of heavy metals introduced and handed down by aboveground during growth of *M.giganteus*. These data suggest that phytoextraction of Zn ions in contaminated conditions is more effective than Pb ions. It can be concluded about the possibility further application of this species for remediation of contaminated soil around the zinc plant in Almaty region. The main indicators of adaptive of the assimilation apparatus leaves *M.giganteus* to stress are a change in the ratio of the concentration of chlorophylls to concentration of carotenoids, the activity the water absorption capacity and of free proline.

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