МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
НАЦІОНАЛЬНИЙ УНІВЕРСИТЕТ БІОРЕСУРСІВ І ПРИРОДОКОРИСТУВАННЯ УКРАЇНИ

ФАКУЛЬТЕТ ЗАХИСТУ РОСЛИН, БІОТЕХНОЛОГІЙ І ЕКОЛОГІЇ
ЕКОНОМІЧНИЙ ФАКУЛЬТЕТ
ЮРИДИЧНИЙ ФАКУЛЬТЕТ
КАФЕДЕРА ЕНТОМОЛОГІЇ
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«РЕСУРСОЗБЕРІГАЮЧІ ТЕХНОЛОГІЇ ТА ЇХ ПРАВОВА І ЕКОНОМІЧНА ОЦІНКА В СІЛЬСЬКОГОСПОДАРСЬКОМУ ВИРОБНИЦТВІ»

«SUSTAINABLE TECHNOLOGIES AND THE LEGAL ECONOMIC ASPECTS OF AGRICULTURAL PRODUCTION»

Збірник матеріалів доповідей
Міжнародної науково-практичної конференції

27-28 квітня 2016 р.
m. Київ
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 × giganteus Oerst et Deu. Miscanthus × giganteus is high-yielding perennial grass, triploid, sterile. It is produced by crossing
diploid Miscanthus sinensis Anders with triploid Miscanthus 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. x giganteus 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 nitrates 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. x 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 the leaves.
pigments in leaves M.giganteus when growing in the contaminated soil was increased relative to control 50% (from 1.3 ± 0.01 to 3.6 ± 0.01 mg g⁻¹ dry matter). It is noted that when soil was of a plant were higher than in the experiments with 7-sulfide salts of zinc. In all experimental variants compared to control the ratio of concentration chlorophyll a 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 207 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 banded 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 Altyn region. The main indicators of adaptive of the assimilation apparatus leaves M.giganteus to stress are a change in the ratio of concentration of chlorophyll a to concentration of carotenoids, the activity the water absorption capacity and of free proline.

References:

This research was financed by Ministry Education and Science Republic Kazakhstan and NATO.