BY0200224

PHYSIOLOGICAL FACTORS INTO PLANT UPTAKE MODELS FOR POLLUTANT

Goncharova N, Kalinkevich E, Pytyrskaya V. Lopareva E, Suvorov D.
International Sakharov Environmental University, Minsk, Belarus

The main principles of biological control of the intensity of pollutant flow into system soil-plant have been analysed. It demonstrated that functional state of plants is so far significant factor in determination of rate of pollutant tum on trophycal chains as physical-chemical property of mineral elements

Most biosphere and contamination assessment models are based on uniform soil conditions,since single coefficients are used to describe the transfer of contaminants to the plant.The main pathway of the functional control intensity of pollutant flow such as possibility of plant to increase mobility of mineral elements into soil and change of ion'sexchange characteristics of plant tissues, which determine the degree of attraction and capacity of accumulation of non biogenic elements by a plant have been considered.

It is known that there are two groups of factors which determine the level of pollutant accumulation by plant. The first group is connected with determination of the level of biological availability of pollutants for a plant in soil, the second group of factors determine attractive of the higher plants and capacity of radionuclides and heavy metals accumulation in biomass.

At the same time in accordance with modern ecophysiological data, different alive organisms can play active part in processes of the mineral elements migration. Metabolites of the coil microorganisms and especially root excretion of higher plants.

Our inverstigations carried out earlier demonsstated that there is high correlation between the level of Cs, Cu, Zn and Co accumulation and cation exchange capacity of the intact plant tissues and on the other hand similar changes of these characteristics in condition of the experimental modification of radionuclide and heavy metals accumulation by different environmental factors. These data suggest that namely cation exchange capacity may be one of the main "driving force" and physiological characteristics in absorption of nonbiogenic elements.

The investigation was carried out in a conditions of laboratory experiment.

Samples for each type of experimental measurements and biochemical investigation have been obtained from oat and pea seedlings of 12 days grow.

Root and stem biomass and cell walls CEC was determined the metod involved saturation of the tissues with H^+ ions with 1 M KCl at pH7. The quantity of H^+ ions displaced from the tissues by 1 M KCl being calculated from the change in pH-meter. Cell walls were extracted usind the method of Stessard [1].

The estimate the kinetic and concentration regularities of the Cs, Cu, Zn and Co absorption "material" with concentration 10^{-5}-10^{-3}.

Concentration curves were plotted on the base of the family of the kinetic curves by means 'zero' rate principle so to say the rate of mineral element uptake by plants at the beginning of these processes [2-5].

The results of our investigation indicate that the kinetic curves have complex structure and are combination of tree or more phases. It is well known that kinetic methods are widely used in the inverstigation of the compartmentalization of the macro- and trace elements in plant tissues. When each phase of the kinetic curve associates with intake of chemical elements in definite plant compartments.

The first phase is reflection of superficial absorption by root and usually has duration from 5 to 15 min. The second phase corresponds to transfer of ions to free spase and saturation of apoplast and has duration usually from 1 to 3 hours.

The third phase corresponds to active, metabolic-dependent absorption and transfer off ions from apoplast to simplistic space

The fourth phase is reflection of the ions. Modem experimental data on kinetics of the ions transfer from root to stem are very limited. At barley intact seedlings lag-phase has been observed as a long enough retention of this process [6]. At the same time in accordance with results of other authors potassium translocation from root to the shoot has been realized during very shot time, that is in several seconds [7].

Different CEC and the level of accumulation for pea and oat was demonstrated in the experiment. Present data suggest, that biological factors are powerful lever of the control of the pollutants availability and accumulation and may be taken into account under development of the modern transfer model.

References

1. Stassart J.M.,Neirinckx L., Dejaegere R. The interaction between monovalent cations during their adsorption on isolated cell walls and absorption by intact barley roots. Ann.bot.-1981. 47.N 5, pp.647-652.

2. Kravets A. Cation exchange capacity of plants cell walls as factor of accumulation nonbiogenic iones. J."Biopolymers and cell" 1995,11.N2 pp.88-106

3. Baker D.A. The transport of ions across plant cell membranes. Journal of Biological Education. 1981,15,N2.pp.90-95

4. Demidchik V.V, sokolik A.I, Yrinn V.M. The effect of Cu^{2+} on ion transport systems of the plant cell plasmalemma. Plant Physiology.1997,114,N8,pp.1313-1335.

5. Goncharova N. The transport of ^{137}Cs and ^{90}Sr across root cell membranes. Revue de Cytologie et Biologie vegetales-Le Botaniste. 2001.23 N1-2 ,pp 15-20

6. Buysee J.K., Van der Brande, R.Merckx.The Distribution of Radiocesium and Potassium in Spinach Plants Grown at Different Shoot Temperatures. J.Plant Physiol. 1995, v.146 No3.pp 263-268

7. Van Iren F.M.L.,Joolen A.F.C.,Gurristen M.A.W., et.al.The lag-phase of potassium translocation studies.Physiol.Plant.1981, v.52, pp.15-22

PHYTOTOXIC EFFECTS OF BOTTOM SEDIMENTS FROM IGNALINA NPP WASTEWATER CANALS AND COOLER

Montvydiene D.

Institute of Botany, Vilnius, Lithuania

ФИТОТОКСИЧЕСКИЕ ЭФФЕКТЫ ДОННЫХ ОТЛОЖЕНИЙ ВОДОЕМА-ОХЛАДИТЕЛЯ И КАНАЛОВ СТОЧНЫХ ВОД ИГНАЛИНСКОЙ АЭС. В 1993–2000 г.г. проводились исследования с целью определить токсичность донных отложений оз. Друкшяй – водоема-охладителя и каналов сточных вод Игналинской АЭС на тест-организмы – *Tradescantia* и *Lepidium sativum*, оценить влияние стоков ИАЭС, загрязненных радиоактивными и химическими веществами, на экотоксикологическое состояние оз. Друкшяй, а также сравнить генотоксичность донных отложений оз. Друкшяй и Киевского водохранилища (после аварии на Чернобыльской АЭС).

Ignalina Nuclear Power Plant (INPP) is located in the Northeast part of Lithuania at a large Lake Druksiai utilized as a water basin-cooler. This lake suffers not only a thermal pollution from INPP but it is also contaminated with water from the power station. This waste water adds to the lake biogenic elements like nitrogen and phosphorus, diluted weak organic acids, heavy metals, radionuclides, and so on.

In the present paper impact of INPP waste upon phytotoxicity of bottom sediments from Lake Druksiai was recognized. Effect of radioactive and chemical pollution of the wastes upon ecotoxicological conditions of Lake Druksiai could be evaluated from the comparison of the genotoxicity of bottom sediments from this lake and Kiev water reservoir (after Chernobyl NPP accident).

Samples of bottom sediments were collected from various wastewater canals of INPP, from the canal of wastewater treatment plant (WWTP), small lake and rivulet, which are on the route of that wastes into Lake Druksiai. In 1995, 132 sites of Lake Druksiai were observed in order to assess the phytotoxicity of its bottom sediments. The research was carried out in July of 1993–2000. Bottom sediments from different sites of Kiev water reservoir were collected in 1992.

Genotoxicity of bottom sediments from INPP wastewater canals and Lake Druksiai were carried out following the Mericle and Mericle (1967) and Osipova and Shevchenko (1986) method. Number of somatic mutations (pink, colourless and morphological) and nonviable stamen hairs (the quantity of whose indicates lethality, when hair contains less than 12 cells) in *Tradescantia* (clone 02) stamen hair (SH) system was counted. Genotoxic effect of bottom sediments on *Tradescantia* was estimated according to Sparrow et al. (1972) and Marciulioniene et al. (1996). Genotoxic effects were considered weak if amount of somatic mutations not exceeded 1%, there were no non-viable stamen hairs, and medium effect was when the number of somatic mutations was between 1.0–4.0% and non-viable stamen hairs did not reach 40,0%. As well as strong effect was when numbers of somatic mutations and non-viable stamen hairs exceeding 4.0% and 40.0%, respectively.

L. sativum is a rather sensitive, widely applied biotest because of its simplicity, cheapness and short duration. This test based on Magone (1989) method and lasted for 48 hours, after which time the seeds germination and root length of seedlings was measured. Tested bottom sediments causing percent inhibitions of 100–60%, 61–40%, 41–20%, and 20–0% were classified as highly toxic, moderately toxic, slightly toxic and non-toxic, respectively. Estimations in both cases were run in triplicates. The data were estimated using the analysis of variance (ANOVA) with significance defined at $\alpha = 0{,}05$.

It was established that in accordance with the phytotoxic impact, the wastes discharged by INPP into Lake Druksiai in 1993–2000 are attributed to the wastes of low toxicity (Montvydiene et al, 2000). However, certain substances present in them irrespective of the water stream in waste canals can accumulate in bottom sediments of these canals and in sediments of the route of wastes from WWTP. The impact caused by the said bottom sediments on *L. sativum* and *Tradescantia* varied within rather wide limits – from strong to weak or non-toxic. Such variation could have been caused by the amount of pollutants discharged from INPP, the water stream and sorption features of bottom sediments. The largest toxic impact on *L. sativum* (root growth fluctuated from 5.4% to 65.0%) was caused by lake, which is on the route of WWTP waste, bottom sediments consisting of aleurite-pelite silt mixed with sand, which accumulated part of the toxic substances present in WWTP. The said bottom sediments caused the strongest genotoxic impact on *Tradescantia*, too. The amount of somatic mutation and nonviable stamen hair in *Tradescantia* SH system fluctuated from 8.2% to 52.7% and from 12.0% to 21.0%, respectively. Although in 1993–2000 the amount of somatic mutations of *Tradescantia* SH system caused by bottom sediments from WWTP canal and from the lake and rivulet which are on the route of that wastes, decreased (r – 0.59; 0.82 and 0.82, respectively), the amount of nonviable stamen hair increased (r – 0.85; 0.58 and 0.88, respectively). That shows the increase of genotoxicity of said bottom sediments. Therefore, in the future the sediments of the WWTP canal and of the lake and rivulet, which are on the route of that wastes may become a secondary source of pollution of Lake Druksiai.

The bottom sediments from the monitoring station of Lake Druksiai most distant from INPP objects were less phytotoxic upon test-organisms, than those from the stations, which occurring in the zones of INPP wastes impact. Toxic matters from INPP wastes as well as aleurite and aleurite-pelite silt prevailing in these sediments and distinguishing in distinct absorptive characteristics probably induced higher phytotoxicity of sediments in these zones. However, impact of bottom sediments from the monitoring stations of Lake Druksiai was lower than the INPP waste canals.

Various substances including radioactive matters discharged from the INPP into Lake Druksiai, therefore, in accordance with the proposition of Shevchenko and Pomeranceva (1985) 1% of somatic mutations caused in *Tradescantia* SH system showed genetic changes, which stipulate disappearance of sensitive species of plant, as well as serious changes in ecosystem. So, the obtained data allow claiming that the changes present in ecosystems of this lake and INPP canals can caused the degradation of the community or the decrease of amount of their species.