HEAVY METALS IN YHE SOIL AND CEREALS PLANTS ON CNEMICAL PLANT

Yury V.Lykholat

Department of Plant Physiology and Ecology, Dniepropetrovsk National University,
Naucovy Bystr., 13, Dniepropetrovsk, 49050, Ukraine
e-mail:bmi:ff.dsu.dp.ua

Abstract

One of the negative consequences of industry and agriculture development in Ukraine's steppe zone is all ecosystem components (air, soil, plants etc) contamination by organic and nonorganic pollutants. Considerable part ones is composed by heavy metals and its concentration constantly grows in the environment.

Investigation carried out on agricultural chemical enterprises territories has been found out its soil was characterized by significant accumulation of Cd, Co, Cu, Ni, Zn and other heavy metals in the superficial stratum with depth to 20 sm. Migration of the elements in soil-plant system has some peculiarities: its solid mass accumulates by root system of the plant. Mechanic composition and agrochemical structure of the soil, species assortment of the plants prevailing in the grass influence on this processes too. The most informative parameter is metal biological accumulation index (MBAI). In condition soil contamination by heavy metals root system metal biological accumulation index was higher than over ground organs. High accumulation ability of the cereals grass manifestoes on early stage of its development and then constantly grows.

Thus, metals accumulative ability of cereals grasses is indicator of level of environment contamination by heavy metals and it allows to use this parameters for passive monitoring.

Introduction

Under functioning of some enterprise wide elements admission with industrial emanations treats into the environment. In according Ecological passport of Dniepropetrovsk (this is big industrial city of South Ukraine) (1) 20 elements are contained in the waste composition and 3-7 of ones are basic, the rest ones are in two-bits. On our research experience on determination of these matters shows that its not obligatorily can be associated with issue of basic production, but enter to admixtures composition. Consequently, on territory of metallurgical region enterprises, exclusive of iron, manganese, to copper, to zinc and to nickel, a lead and cadmium is represented in the soils in considerable amount in point of control areas (2,3). Main aim of presented research was analyze of level and contamination disposition of the environment on territories of different industrial enterprises of steppe Ukraine on base of sod-forming grasses metal accumulative ability study.

Methods

The researches included study of absorption intensity of heavy metals by basic sod-forming grasses in dependence on its contents in the soils at different contamination

levels of the environment by mining, machine-building, chemical, coke chemical, metallurgical enterprises. Monitoring areas were laid on different distances from emission sources and depended on production type and pollutants distribution specific character. Examined allotments were disposed in zones with different contamination level dependency on distance to emission sources: conditionally weak, middle and strong contamination. For metallurgical enterprises this distances were 3000, 2000, 500 meters (m), coke chemical - 2000, 500, 300 m, chemical - 1000, 300, 50 m, machine-building - 500, 300, 50 m, mine “Steppe" - 500, 300, 50 m. Comparative description of examined allotments was carried out on analysis of agrochemical structure of the soils, type of forest plant conditions and damping. Suitable objects from steppe virgin soil disposed into 90 by km from emission sources were used as control, where on data regional sanitary epidemiological station contaminating matters practically weren't determined.
Contents of heavy metals in vegetable samples and soil was indicated by method of atomically-absorption analysis (4) on AAS-30 apparatus. The obtained results were statistic analyzed on level of faultless prognoses 95-99 %. Multifactor (main component method), claster (method of single intercourse) and discriminative (5) analysis was used. CPU Intel Pentium-100 MMX base with applied programs: "Microsoft Excel 97" was used for computations of the data.

Results

Considerable barrier on migration way of heavy metals into plant organism is soil. It is supported by obtained factual results on this elements accumulation in soils on territories of industrial zones. Consequence of heavy metals big volume accumulation, as a rule, exceeding limit admitted concentration (LAC) are known beforehand: sharp changes of structure of herbaceous cover, taking place replacement of one kinds of the plants on other, appearing necrotic macules on the plants and etc. (6). Scales of negative action of industrial troop are associated, the first, with specific bioclimatic condition. For example, in arid conditions vertical migration of the pollutants is absent or takes place in insignificant scales. At humid landscape, in contrast, heavy metals migration over soil profile edge takes place that creates a real threat for expansion of concrete industrial enterprise zone of action to the surround.
On data of our researches for heavy metals, even if its fall out in anomaly epicenter of environment basic sources of contamination by ions of these elements (metallurgical works), the metals penetration depth into soils doesn't exceed 35-40 sm. This bears witness decisive sense in determination of enterprises territory contamination scales belongs to influence of air transferring, intensity of which depends on natural bioclimatic conditions typical for the region. Narrow tie exists between amount of toxic substances in atmosphere and substrate that also justly for heavy metals.
It's more in detail considering absorption intensity of heavy metals by Poa angustifolia L., Festuca rubra L., Elytrigia repens (L.) Nevski and Lolium perenne L. in dependence on its contents in the soils at different contamination levels of the environment by machine-building, chemical, coke chemical and metallurgical enterprises. Carried out researches showed that the highest elements level is accumulated by the roots. On the root-stem edge physiological protective barrier exists allowing to penetrate overground part only two-bits of treating metal. For example, on metallurgical group of enterprises territory zinc and to nickel were accumulated by underground Elytrigia repens part in 3,7 times more

than by its overground part, on industrial grounds of coke chemical works the root of this plant contained nickel in 5,8 times more than its overground part..
There are the proofs on receipt into plants of heavy metals immediately from air for condition of high levels of atmospheric contamination (7). At this condition the metals associate with cuticle and cultural walls in form of inert conjugates and its cloths spread faintly or quite don't spread in the tissues. At this toxic effect is weaker than at receipt of conjugates through the root system. It's possible equilibration of metals contents in the plant overground and underground parts. Analogic phenomenon was found out on metallurgical enterprises territories, when a copper contents was identical in the overground and underground parts of Elytrigia repens.
Research of **iron** level in the soils on industrial enterprises territories of Dniepropetrovsk showed exceeding into 2,6 times of metal contents in comparison with control variant soil. This is connected with receipt of the metal into substrate with atmospheric downfalls and aerosols forming at industrial troop landings. Because of absence of unanimity on LAC iron contents in soil (8) we have used the norm indexes not exceeding the background ones more than in 2 times. This metal contents in plants was characterized by such data: Poa angustifolia concentrated this element in underground part from 382 mg/kg (machine-building works) to 1270 mg/kg (heavy presses works); Festuca rubra - from 360 mg/kg (machine-building works) to 1250 mg/kg (heavy presses works); Elytrigia repens - from 566 mg/kg (machine-building works) to 1340 mg/kg (heavy presses works); Lolium perenne - from 538 mg/kg (machine-building works) to 1320 mg/kg (works). Change of coefficient of biological absorption (BAC) took place also in wide diapason: from 0,48 (Poa angustifolia, machine-building works) to 0,99 (Lolium perenne, chemical works).
For overground Poa angustifolia part iron accumulation was in limits from 319 mg/kg (machine-building works) to 1178 mg/kg (heavy presses works); Festuca rubra - from 310 mg/kg (machine-building works) to 1190 mg/kg (heavy presses works); Elytrigia repens - from 430 mg/kg (machine-building works) to 1130 mg/kg (heavy presses works); Lolium perenne - from 405 mg/kg (machine-building works) to 1280 mg/kg (chemical works). The BAC computations showed that this parameter was lesser than 1 for all conditions. This index changed from 0,27 (Festuca rubra, machine-building works) to 0,80 (Festuca rubra, heavy presses works).
Carried out researches showed unevenness of contamination of the plants and the soil by heavy metals dependency on distance to emission sources. That's why these components of biogeocenosis have the determined distinctions as for accumulation of the metals under influence of industrial enterprises and transport highways. In lesser rate this influence is expressed in remote zones - sanitary-protective, housing and other. We considered accumulation degree of heavy metals by Poa angustifolia and Elytrigia repens as most typical kinds of sod-forming cereals in dependence on metals concentration in soil. The first from these kinds was selected as one of most valuable from examination on decorative and antierosive properties, the second kinds - on its spreading and steadiness in industrial contaminated conditions.
In dependence on metals concentration in soil in all variants of the investigation accumulation specific character of less of metals ions in assimilating organs confirmed by BAC indexes was found out. Raised

accumulation ability of root system demonstrates protective roots action taking away contrast of the contents of heavy metals in the soil. At the same timed on territories of coke chemical and metallurgical enterprises of Dniepropetrovsk new varieties of Poa angustifolia and Elytrigia repens accumulating iron ions in a great mains were discovered. However, the iron ions concentration was different in underground and overground plants organs. In all monitoring points of industrially contamined territories a contents of this element in Poa angustifolia organs was higher in roots of examined plants on 907-1678 mg/kg, in the leaf - 900 1514 mg/kg, in Elytrigia repens, accordingly, - 697-1460 mg/kg and 726-1150 mg/kg in comparison with the control variant plants. Under this Poa angustifolia had greater accumulating ability. The biggest iron contents was observed in both plants on territory of coke chemical works. Iron amount of in the soil of industrial grounds exceeded the indexes of unpolluted (control) territories on 551 1289 mg/kg. Iron BAC index of underground part in Poa angustifolia exceeded 1 in all monitoring points. Highest its index (1,43) was marked on territory of metallurgical group of enterprises. For overground part BAC index was near to 1 or exceeded it. Maximum BAC index (1,22) was observed in the plants also on territory of metallurgical group of enterprises. Iron most intensively was absorbed by Elytrigia repens underground part (BAC = 1,39) and underground part (BAC = 1,13) on territory of metallurgical group of enterprises too.

Employing discriminate analysis formulas for contamination level diagnostics of nearby environment has gotten:

for steady kinds (Poa angustifolia) - in conventionally “clean" zone

$Y=-0,0118X^1+0,0168X^2+0,0063X^3-0,0041X^4+0,0389X^5+0,0473X^6-0,0105X^7+0,0426X^8+0,3019X^9-13,278;$

in condition of industrial contamination:

$Y=-0,0752X^1+0,0068X^2+0,1016X^3+0,1656X^4+0,0746X^5+0,2105X^6+0,0107X^7+0,0817X^8+0,2703X^9-95,947.$

For presence of less steady kinds (Elytrigia repens) - in conventionally “clean" zone:

$Y=0,0373X^1-0,0098X^2-0,0289X^3+0,1265X^4-0,032X^5+0,0217X^6-0,0121X^7+0,033X^8-0,0556X^9-13,607;$

in conditions of industrial contamination:

$Y=-0,0248X^1+0,0111X^2-0,0099X^3+0,0081X^4+0,1644X^5+0,118X^6+0,0759X^7+0,817X^8-0,0897X^9-80,602,$ where

X^1- iron contents in soil, X^2 - in underground part, X^3 -in overground part of plants;

X^4 - manganese contents in soil, X^5 –in underground part, X^6 -in overground part of plants;

X^7 - nickel contents in soil, X^8 -in underground part, X^9 -in overground part of plants.

It's noted than more number got parameters (from 0 to 1), that more likelihood of enterprise belonging to group with concrete contamination level. Computations for formulas have taken by entering element contents definited in the underground and overground part of sod-forming grasses in examined conditions and expressed as mg/kg. On got result we can have conception about level of contamination of concrete industrial area. During accumulation of data about contents of heavy metals in investigated objects diagnostics exactness will rise.

Conclusions

Thus, the diapasons of metal accumulating ability of sod-forming cereals in dependence on specific plants peculiarities and contamination type of the environment are fixed. Peculiarities of accumulation of heavy metals by overground and underground organs of vegetable organism are indicated: in conditions of metallurgical enterprises leaves and roots of sod-forming cereals accumulate in great quantity iron, copper and cadmium, on chemical works - nickel, zinc and manganese. On base of discriminate analysis of experimental data on contents to element in the soils, underground and overground part of sod-forming cereals in investigated conditions the formulas for contamination level diagnostics of environment are offered.

References

1. Pavlov V.A. et al. Ecological passport of Dniepropetrovsk. – Dniepropetrovsk, Ukraine (1999). - 72 pp.
2. Lykholat Y.V., Sapa Y.S., Lykholat E.A. et al Air condition in industrial Prydniprovya // School of Fundamental Medicine Journal. - **Vol.4**, №2. - P. 51-52. (1998.)
3. Lykholat Y.V., Sapa Y.S., Lykholat E.A. et al. Condition of ground and water sources in industrial Prydniprovya // School of Fundamental Medicine Journal. - **Vol.5**, №2. - P. 88-89. (1999).
4. Chaverdov I., Tsalev D. Atomic-absorption analysis. - Leningrad, USSR (1983).- 144 pp.
5. Who G., Muller Ch.Y. et al. Factor, discriminate and clacter. Finances and statistics, Moscow, Russia (1989). - 216 pp.
6. Lykholat Y.V. Ecological-physiological peculiarities of long-term sod-forming cereals of technogenic territories at Dniepropetrovsk. Dniepropetrovsk un-ty edit., Dniepropetrovsk, Ukraine (1999). - 188 pp.
7. Korshokov I.I., Kotov V.S., Mycheev I.P. et al. Interaction between plants and technogenic contaminated environment. - Naukova dumka edit., Kyev, Ukraine (1995).-191 pp.
8. Alecseev Y.V. Heavy metals in the soil and the plants.- Agropromisdat edit, Leningrad, USSR (1987). - 142 pp.