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ACCUMULATION AND DISTRIBUTION OF Pb, Cu, Zn AND Cd IN SUNFLOWER (*Helianthus annuus* L.) GROWN IN AN INDUSTRIALLY POLLUTED REGION

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SUMMARY

Investigations conducted during last years showed serious violations of ecological equilibrium in many agricultural regions.

Crops produced in these regions are commonly used as food and feed. It has been established that the content of heavy metals in the soils and agricultural crops grown nearby the metallurgical factories is much above the admissible concentration. Micro-particles of Pb, Cu, Zn and Cd separated in the atmosphere by aerosols, accumulate in the soil, plants and water areas. From the studied heavy metals the coarse particles of Zn commonly pile in soil nearby the contaminator, and the heavier particles of Pb are distributed by the prevailing winds. These elements accumulate shallow in the upper layer and confined to quantity move down. The irregular contamination of soil around certain factory is in great part dependent on turbulent movement of air, windlessness and the condition of fluctuating atmosphere - inversion. Contamination with heavy metals is most oftenly in according with areas. Maximum accumulation is found out on boundary areas in a distance at about 1000 m from the factory called the area of accumulation, and 15 000 m away from the factory called area of distraction. Commonly, on this area is grown one of the specific for Bulgaria culture - the sunflower. This needs solving of many problems connected with studying the accumulation and depous of localization of heavy metals in sunflower grown on contaminated soil, as well as their influence upon soil fertility.

Key words: accumulation, distribution, heavy metals, sunflower

INTRODUCTION

Anthropogenic contamination with heavy metals is a problem of many countries in the world and so it is in Bulgaria. The main heavy metals which contaminate the environment are Cd, Zn, Cu, Pb and Ni.

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In Bulgaria on data of Board of Environment technogenetic dirty with heavy metals soil is 45600 ha. Nevertheless that the tempos of dirty with heavy metals is lowered in the recent years with the usage of high effective clearer instalment in metalurgical plants.

The problems of already dirty soils stay on extremely heavy is the situation in the region of the Plant for Production the Non - Ferrous metals, Plovdiv, where the rich soils dirty with heavy metals.

On these soils are grown many agricultural cultures which afterwards are used in production of food for animals and man (Nikolov, 1977). This needs solving of many problems connected with making clear the way of accumulation of metals in plants depots of localization as well as their influence on the richness of soil.

Although the well known from the scientific literature data are not satisfying and often different, undoubtedly true is the under standing (theers) that the distribution of heavy metals in plant organs has selective character, usually in the following sequence root, stem, leaves, fruit, seed (Kastori, 1998; Simon, 1998).

Accumulation of some heavy metals much in the roots and less in the fruit and the seeds is argumented by another investigators (Andersen, 1986; El - Kobbia *et al.*, 1988; Reeves *et al.*,1994). At the same time the reaction of the different cultures differ quite lot (Gorlach, 1994; Gadallah, 1995; Simon, 1999). The investigation in this field on one of the traditional for Bulgaria culture - the sunflower are quite little and not satisfying. In the regions with much durty it is recommended to grow technical cultures and seed production of grain cultures.

It is proved that the quality of the oil of peppermint, lavander and etc. grown on dirty with heavy metals soil are high. The yield lower only in the case of high dirty with heavy metals soil rather overpoising the acceptable concentration.

The aim of the test was to determine the quantity and depots of distribution of Pb, Cu, Zn and Cd in sunflower grown in industrially dirty region.

Gaining information of the ways of dirtiness made important analyses of soil and plant of different distance (1000 m, 15 000 m) from the main dirty making the Plant for Production the Non - Ferrous metals, Plovdiv.

MATERIALS AND METODS

1. Apparatus and reactives used:

A. In preparing part of the tests for analyses is used microwave system MLS - 1200 MEGA of Milestone with rotator MDR 300/100 with 10 positions making possible work to 30 bars.

B. In determing the quantity of heavy metals in the tests is used Atomic - emissive spectroscopy of “Spectro“ in the following length of waves: Pb 220.353 nm, Cu 324.745 nm, Zn 206.190 nm.

C. In chemical tests is used chemical reactives with clearans p.a. (HCl, HF, HNO_3, $HClO_4$). In all the stages of preparing the tests is used bidestillate water.

2. Preparing of tests for analyses:

A. Soil test

The tested soil is Mollic Fluvisols in depth 30 cm with following soil indicators as organic matter 1.8%, pH value 7.05 and total carbonates 16.32%.

Soil tests were prepared for analyses treated with king water giving full practical optain of heavy metals.

B. Plant materials (roots, stems, leaves and seeds)

To lower to minimum the loss of easy volatile lead and cadmium in this case microwave mineralization is used.

C. Seeds

Because of the high quantity of oil of seeds and low quantity of heavy metals in them microwave mineralization is not acceptable. That's why we used the classical method of dry mineralization.

RESULTS AND DISCUSSION

Results from investigation of Pb, Cu, Zn, Cd content in soil and sunflower (root, stem, leaves, capsule and seeds) grown at different distances from the main contaminator- the Plant for Production the Non - Ferrous Metals, Plovdiv (Tables 1, 2).

Table 1: Content of lead, copper, zinc and cadmium in soil, roots, stems, leaves, capsuls and seeds of sunflower (hybrid Albena), grown at various distances away from the main pollutor-the Plant for Production the Non - Ferrous Metals, Plovdiv (mg/kg)

Element	Distance	Soil	Roots	Shoots	Leaves	Capsule	Seeds
	to 1000 m	554	38.85	22.64	4.25	1.71	11.56
Pb	to 15000 m	18	1.69	1.83	5.04	1.56	3.66
	LAC*	80					
	to 1000 m	343	24.21	12.05	8.37	15.01	3.29
Cu	to 15000 m	49	4.39	3.11	7.23	9.46	1.26
	LAC	360					
	to 1000 m	10	121.85	95.00	20.09	31.31	62.15
Zn	to 15000 m	0.3	27.55	52.11	13.00	12.52	27.50
	LAC	270					
	to 1000 m	95	0.84	0.67	0.50	0.28	1.03
Cd	to 15000 m	37	0.16	0.18	0.15	0.09	0.86
	LAC	2.00					

LAC - Limited Admissible Concentrate

It is obvious that the content of Zn and Cu in soil is under the admissible concentrations, but at the same time Pb and Cd are considerably above the admissible values.

Essential is the difference in distribution of heavy metals in different parts of plants. Great part of the four studied elements is localized in the root and their quantity significantly reduces, as show the results of other authors.

Table 2: Content of lead, copper, zinc and cadmium in soil, roots, stems, leaves, capsuls and seeds of sunflower (cult. Favorit), grown at various distances away from the main pollutor-the Plant for Production the Non - Ferrous Metals, Plovdiv, (mg/kg)

Elements	Distance	Soil	Roots	Shoots	Leaves	Capsule	Seeds
	to 1000 m	554	5.50	5.93	43.51	1.32	0.93
Pb	to 15000 m	18	6.61	1.52	4.09	1.46	0.17
	LAC	80					
	to 1000 m	343	12.45	14.64	15.85	13.30	29.36
Cu	to 15000 m	49	10.96	3.60	8.19	10.73	11.62
	LAC	360					
	to 1000 m	10	36.25	140.70	118.91	23.45	209.60
Zn	to 15000 m	0.3	30.81	36.21	11.06	13.54	48.65
	LAC	270					
	to 1000 m	95	0.78	0.61	0.96	0.38	1.65
Cd	to 15000 m	37	0. 85	0.19	0.14	0.10	0.53
	LAC	2.00					

LAC - Limited Admissible Concentrate

This is explained by the fact that, when these element penetrate in the plasma goes inactivation and accumulation of great part of them, because of the formation of little soluble compounds with organic substances. The accumulation of heavy metals in the other parts of the plants is considerably different. The content of Zn and Cu in the leaves does not depend on their content in the soil, and in Favorite cult. these values are repeatedly greater. About Pb and Cd this dependence remains the same in Albena hybrid and Favorite cult., and again in the leaves of Favorite cult. the concentration of the studied elements is greater.

This can be explained by the regulating quality of plants in accumulating the studied elements. In leaves, capsule and seed the content of Cu and Zn reduces with remotness from the contaminator and in all cases it is under ALC. The situation with Cd, which is accumulated selectively in the seeds and its values are 3-4 times greater in comparison with the values of capsule in the both distances (1000 and 15 000 m) is quite different. The quantities of the 4 elements are measured in Albena hybrid and Favorite cult. but their content in the seeds is quite different, more over it is in the opposite direction.

As it can be seen, the content of heavy metals in the roots of the plants considerable exceed the content in the stems and leaves, especially in Albena hybrid. It is difficult to estimate the accumulation and localization by the results in Table 1 and Table 2. That's why clarifying this question needs searching the connection and dependence between the content of Pb, Cu, Zn and Cd in soil on the one hand, and on the other in leaves.

In the root, stem and capsule there is similar dependence. This supports thesis that the accumulation of heavy metals in the root and other parts of the plants is

possible not only by soil but also by aerosols accumulated in leaves. Pb in seeds is under the content determination made by the methods used in every experiment nevertheless that the content in root and leaves is greater. It is obvious that the leaves function as selective filter during the accumulation of heavy metals by the root up to the seed.

CONCLUSIONS

- Pb, Cu and Zn are selectively accumulated mainly in the root and leaves. Cd is localized in roots and seeds, and its content significantly exceeds the admissible concentrations.
- Heavy metals are accumulated in sunflower by the root as well as aerosols in leaves and stem. The leaves function as selective filter in the accumulation up to the seeds.
- Accumulation of Cd in seeds in contents exceeding the admissible concentrations necessitates very careful approach in growing sunflower in regions with industrial contamination.

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ACUMULACION Y DISTRIBUCION DE Pb, Cu, Zn Y Cd EN EL GIRASOL (*Helianthus annuus* L.) CULTIVADO EN LA REGION INDUSTRIALMENTE POLUCIONADA

RESUMEN

Las investigaciones durante los ultimos cinco años han mostrado que el equilibrio ecologico esta considerablemente desordenado en muchas regiones agricolas.

Las plantas que se cultivan en esas regiones son muy importantes, y se utilizan para la nutricion de hombres y animales. Fue constatado que el conte-

nido de metales pesados en el suelo y los productos agricolas producidos cerca de fabricas metalurgicas era considerablemente sobre la concentracion permitida. Las micro-particulas de Pb, Cu, Zn y Cd extendidas en la atmosfera en forma de aerosol, se acumulan en el suelo proximo, las plantas y superficies de agua. Con respecto a los metales pesados investigados, las particulas groseras de Zn se acumulan generalmente cerca de las fuentes de polucion, y las particulas pesadas de Pb son dispersadas por los vientos dominantes. Estos elementos se recogen en la capa superficial del suelo y se derrubian en las capas de suelo mas profundas. La desigualdad de polucion del suelo alrededor de ciertas fabricas depiende en alto grado del movimiento turbulente de aire, del periodo sin viento y de la aparicion de la inversion atmosferica. El perimentro de polucion por los metales pesados es por lo mas la funcion de distancia de la fuente de polucion. La acumulacion maxima en la zona fronteriza y a distancia de mas 1000 m desde la fabrica. Esta zona se llama la area de acumulacion. La zona hasta 15.000 m desde la fabrica se llama la area de distribucion. En estas areas se cultiva la planta especifica-girasol. Eso exige la solucion de muchos problemas ligados con la acumulacion y localizacion de metales pesados en las plantas de girasol cultivadas en las areas cercadas, asi como de los problemas ligados con el efecto de metales pesados sobre la fecundidad del suelo.

ACCUMULATION ET DISTRIBUTION DE Pb, Zn ET DE Cd DANS LE TOURNESOL (*Helianthus annuus* L.) CULTIVÉ DANS LES RÉGIONS DE POLLUTION INDUSTRIELLE

RÉSUMÉ

Les recherches effectuées au cours des cinq dernières années ont démontré que l'équilibre écologique est bouleversé dans de nombreuses régions agricoles.

Les cultures produites dans ces régions sont d'une grande importance pour l'alimentation des hommes et des animaux. Il a été démontré que le sol et les produits cultivés près des usines métallurgiques contenaient beaucoup plus de métaux lourds que la quantité admissible. Les micro particules de Pb, Cu, Zn et de Cd projetées dans l'atmosphère sous forme d'aérosols, s'accumulent dans le sol environnant, dans les plantes et dans l'eau. Les particules brutes de Zn s'accumulent habituellement près de la source de pollution et les particules plus lourdes de Pb sont dispersées par les vents dominants. Ces éléments s'accumulent dans la couche superficielle du sol et sont lessivées dans les couches plus profondes. Les différences de contamination du sol autour de certaines usines dépendent pour une grande part des turbulences de l'air, des périodes sans vent et du phénomène d'inversion de l'atmosphère. Le niveau de pollution par les métaux lourds est le plus souvent fonction de la distance de la source de pollution. L'accumulation maximale est observée dans la zone limitrophe et à une distance d'environ 1000 m de l'usine. Cette zone est appelée zone d'accumulation. Celle qui est éloignée de 15.000 m de l'usine est appelée zone de distribution. En Bulgarie, dans ces zones, on produit généralement une culture spécifique - le tournesol. Ceci incite à la recherche d'une solution aux nombreux problèmes liés à l'accumulation et à la localisation de métaux lourds dans le tournesol cultivé dans les zones pollués ainsi qu'à ceux liés aux effets des métaux lourds sur la fertilité du sol.