HEAVY METALS IN PLANTS GROWN ON NEW FLY ASH DEPOSITS

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ABSTRACT

The paper presents the results of studies with leguminous species grown on experimental parcels of new fly ash fertilized with biosolids (municipal sludge) and untreated indigenous volcanic tuff or pillared indigenous volcanic tuff. Fly ash comes from the dumps of ash from burning lignite in power plants. The resulting amount of biomass grown on new fly ash deposits is dependent on the treatment of topsoil (new fly ash). The experimental variants with new fly ash treated with biosolids and pillared indigenous volcanic tuff determined 50% germination and an increase of harvest by 2.5-2.7 times vs. others. In addition, the treatment of new fly ash with pillared indigenous volcanic tuff and biosolids caused a reduction in the bioaccumulation of heavy metals in the aerial part of plants by 35-45%, for Cu respectively Ni, 60 % for Cr, and 78% for Pb.

INTRODUCTION

Studies on the development and behavior of plants growing on new fly ash dumps are a forward step in the context of ecological studies in the world with special significance [1-3]
The addition of bio fertilizers of the organic-zeolite kind has greater advantages than the addition of chemical fertilizers. Numerous examples in literature are given on the properties of a component, that is, volcanic tuff, as clinoptilolite that when used as addition of biodegradable organic waste to initiate and maintain components of nitrogen (ammonia, nitrogen etc.) and gradually releasing it for the needs of the plant. In this way the loss of volatile nitrogen compounds in the environment (atmosphere) is much reduced [4-5].
It was also shown a similar effect when the soil is polluted with heavy metals and fertilizer organic-zeolite treated. Population development studies in soils fertilized with organic-zeolite bacterial support shows that the quantity of microorganisms increased 2.5 times and soil quality changes. The microbial activity in soil fertilized with organic-zeolite fertilizers did not decrease during winter as shown for the addition of mineral fertilizers [6].
The addition of soil amendments as volcanic tuff for polluted soils reduces the metal accumulation in different parts of the plant [7].
The study was to determine the influence of treated topsoil (top layer of new fly ash deposits):

1. The degree of vegetation of new fly ash deposit; 2. The amount of biomass harvested (leguminous species); 3. Bioaccumulation of heavy metals in the aerial parts of the plants and the toxic potential of metals.

MATERIALS and METHODS

The study is carried out on four experiments: new fly ash fertilized with biosolids mixed with pillared indigenous volcanic tuff, [8], new fly ash fertilized with biosolids mixed with untreated indigenous volcanic tuff, new fly ash fertilized with biosolids, new fly ash / blank experimental parcels (three replicas for each experiment). The experimental area had 3 m^2 and the distance between the experimental parcels was 1 meter. New fly ash was fertilized with municipal sludge 25t/ha DM (biosolids). The biosolids used had the following characteristics: total nitrogen 0.73%, phosphorus 0.75%, and pH 6.5.
The amount of indigenous volcanic tuff and pillared indigenous volcanic tuff was 2% wt. The indigenous volcanic tuff contains up to 70% clinoptilolite and comes from the Mirsid quarry, Romania, and the pillared indigenous volcanic tuff is prepared according to patent [8]. Table 1 shows the content of heavy metals in the topsoil of experimental parcels.

Table 1. Content of heavy metals in the topsoil of experimental parcels.

Nr.crt.	Experimental parcel*	Average content of heavy metals in topsoil [mg/kg D.M.]					
		Cr	Cu	Fe	Ni	Pb	Zn
1	New fly ash + pillared tuff + biosolids	84.6	67.1	4,731.8	50.1	13.7	84.5
2	New fly ash + tuff + biosolids	84.0	66.1	4,636.4	48.0	12.9	83.3
3	New fly ash +biosolids	85.6	65.9	4,711.9	49.3	14.1	82.6
4	New fly ash	85.8	63.8	4,636.4	50.1	12.9	65.8

* three replicas for each experimental variant

Topsoil sample analysis was done to determine the total iron, zinc, copper, chromium, nickel and lead concentrations according to the analysis method: heavy metals were extracted from the soil samples by heating with Aqua Regia for 2 hrs, at reflux. After interrupting the heat the system was left in stand-by for 16 hrs. Then the samples were diluted in a flask with de-ionized water to exactly 50 ml. The *Onobrochis viciifolia* specie was selected to be planted into the experimental parcel. Plant tissues were thoroughly washed with de-ionized water to remove any soil particles attached to plant surfaces. The tissues were dried (105°C) to a constant weight. Plant samples with constant weight are then brought to 550°C; to the residual materials 5ml of concentrated hydrochloric acid are added, samples are maintained 30 minutes on the dry sand bath. After filtering those in a paper filter with small porosity, they were taken to a calibrated flask with hydrochloric acid 1:1 solution. Plant and soil extracts analysis was done using a spectrophotometer, Varian Spectra AAS. The detection limit of the device is 0.001 mg/l.

RESULTS

Table 2 shows germination and vegetation degree of parcels cultivated with *Onobrochis viciifolia* and the amount of biomass harvested from mature plants.

Onobrochis viciifolia species does not grow on the experimental parcels of untreated new fly ash. Parcels fertilized with biosolids determine a delay in plant growth. During harvesting, and surface is covered with plants grown at a rate of 35%. Addition of unmodified tuff has the effect of increasing the number of plants that grow on this experimental variant. Although the area covered by plants reaches 50% the amount of harvested biomass is much lower than when using the pillared tuff. Table 2 shows the amount of biomass harvested from the fly ash + pillared tuff + biosolids parcels 2.5-2.7 times higher vs. new fly ash + tuff + biosolids or new fly ash + biosolids biomass harvest.

Table 3 shows the content of heavy metals in *Onobrochis viciifolia* aerial plant tissue of plants

Table 2. Germination and vegetation degree of parcels cultivated with *Onobrochis viciifolia* and the amount of biomass harvested from mature plants.

Nr.crt.	Experimental parcels	Germination degree [%]	Coverage degree [%]	Blanquet – Braun scale coverage	Harvest [kg/ha]
1	New fly ash + pillared indigenous tuff + biosolids	50	50	Level 3 25-50%	3050
2	New fly ash + indigenous tuff + biosolids	50	45	Level 3 25-50%	1250
3	New fly ash +biosolids	Some plants	35	Level 3 25-50%	1125
4	New fly ash	No plants	-	-	-

Table 3. Content of heavy metals in *Onobrochis viciifolia* aerial plant tissue.

Nr. crt.	Experimental parcels	Content of heavy metals in *Onobrochis viciifolia* aerial plant tissue [mg/kg D.M.]					
		Cr	Cu	Fe	Ni	Pb	Zn
1	New fly ash + pillared indigenous tuff + biosolids	3.3	6.5	3,793.7	2.9	0.6	24.2
2	New fly ash + indigenous tuff + biosolids	8.3	9.7	4,488.9	5.7	2.3	25.2
3	New fly ash + biosolids	8.0	9.6	4,523.9	5.3	4.1	36.7
4	New fly ash*	-	-	-	-	-	-

* no plant

Table data shows that the addition of fertilizer/biosolids and fertilizer/biosolids and unmodified tuff caused similar bioaccumulation of heavy metals (chromium, copper, iron, nickel and zinc) in tissue of the aerial part of growing plants. Plants grown on experimental

parcels new fly ash + pillared indigenous tuff + biosolids bioaccumulated smaller amounts of heavy metals in the aerial parts of plants (35% less for Cu, 45% for Ni, 60% for Cr and 78% for Pb). Pillared indigenous volcanic tuff (treated tuff) has the ability to reduce the access of certain heavy metals in plants of *Onobrochis viciifolia* species.

CONCLUSIONS

1. *Onobrochis viciifolia* species did not grow on new deposits of new fly ash deposits.
2. The addition of fertilizer as biosolids resulted in reduced germination of seeds and a surface covered with vegetation by 35%.
3. The addition of fertilizer mixed with unmodified indigenous volcanic tuff caused good germination of seeds and vegetation cover of 45%.
4. The addition of fertilizer mixed with pillared indigenous volcanic tuff determined good development of crops. The amount harvested was 2.4-2.7 times higher than that obtained in other variants. At the same time pillared indigenous volcanic tuff caused heavy metals reduction in the aerial part of plants in the following order: 35% for Cu, 45% for Ni, 60% for Cr and 78% for Pb. This is a good new fly ash vegetation variant.

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