THE INFLUENCE OF LIGNITE FLY ASH ON REPRODUCTION OF SPECIES EISENIA FETIDA (A MICROCOSM EXPERIMENT)

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Abstract: *The aim of the study was to distinguish the effect of the lignite fly ash on several biological indicators of earthworms Eisenia fetida (Savigny, 1826) like reproduction parameters (prolificacy expressed through the number of cocoons, the hatching capacity) and mortality. Within the experiment was used fly ash resulted from the combustion of a solid fuel, the lignite, in a thermal power plant, in laboratory conditions. The content of heavy metal has been established for the soil of each experimental variant: zinc, copper, manganese, iron, and nickel. The earthworm mortality increased with the increase of concentration of heavy metals. The highest hatching capacity was at the lowest amount of lignite ash and at the lowest concentration of heavy metals. Generally, the hatching capacity was much inferior related to the potential of this species. There was noticed a decrease of cocoon number at higher concentrations of heavy metals. No abnormalities regarding the locomotion behaviour were noticed.*

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Key words**:** *Eisenia fetida, earthworms, mortality, reproduction, prolificacy, larvae, cocoons, lignite ash*

INTRODUCTION

The aim of the study was to distinguish the effect of the lignite fly ash on several biological indicators of earthworms *Eisenia fetida* (Savigny, 1826) like reproduction parameters (prolificacy expressed through the number of cocoons, the hatching capacity) and mortality.

Similar studies have been previously performed [DWORSCHAK, 1997], several of them during vermicomposting, pointing out that biomass and cocoon production had an inverse relationship with the percentage of fly ash [SAROJINI ET AL., 2009] or revealing the toxic effects on earthworms [MANIMEGALA ET AL., 2009]. Other experiments involving earthworms *Eisenia fetida* and fly ash showed an increase of different bio-available forms of nitrogen [BASU ET AL., 2009].

The lignite ash resulted from the thermal power plants represents an environmental problem under aspects concerning storage and air pollution.

However, fly ash is a useful ameliorant that may improve the physical, chemical and biological properties of soils and is a source of readily available plant macro and micronutrients when it is used with biosolids [SAROJINI ET AL., 2009; MALIK AND THAPLIYAL, 2009].

Thus, the motivation of the study arises from the need to manage the lignite fly ash through biological mechanisms.

MATERIAL AND METHODS

Within the experiment was used lignite fly ash resulted from the combustion of lignite, a solid fuel, , in a thermal power plant, in laboratory conditions, in order to obtain data about several biological characteristics of earthworms *Eisenia foetida* (Savigny, 1826), commonly named red worm (Phyllum *Annelida*, Class *Oligochaeta*, Family *Lumbricidae*): mortality, prolificacy (number of cocoons) and hatching capacity.

The experimental variants were the following:
- Variant 1: 1 part lignite fly ash + 3 parts soil.
- Variant 1: 2 part lignite fly ash + 3 parts soil.
- Variant 1: 3 part lignite fly ash + 3 parts soil.

The pedological features of the soil used within experiment are shown in table 1.

Table 1

Physical, hydro-physical and chemical characteristics of the soil used within experiment

PEDOLOGICAL LAYER (cm)	0-20 cm	20-35 cm	35-55 cm	55-75 cm	75-100 cm	100-120 cm	120-160 cm	160-200 cm
pH in water (pH unities)	7.78	7.99	8.18	8.26	8.54	8.68	8.84	8.84
Coarse sand (2.0-0.2 mm) (%)	0.3	0.2	0.1	0.1	0.1	0.1	0.4	1.1
Fine sand (0.2-0.02mm) (%)	41.3	41.2	45.1	42.7	43.1	44.9	46.3	46.0
Dust (0.02-0.002 mm) (%)	25.1	25.1	24.9	24.5	24.0	22.8	23.3	23.7
Colloidal clay (<0.002 mm) (%)	33.3	33.5	33.5	32.7	32.8	32.2	30.1	29.2
Physical clay (<0.01 mm) (%)	45.7	45.6	44.8	43.4	43.6	41.9	39.5	39.0
$CaC0_3$ (%)	9.05	9.69	18.1	23.1	23.3	25.0	20.9	16.2
Humus (%)	4.25	2.57	1.80	-	-	-	-	-
Mobile phosphorus (ppm)	75.5	43.9	20.2	-	-	-	-	-
Mobile potassium (ppm)	191	88	50	-	-	-	-	-

The content of heavy metal has been established for the soil of each experimental variant: zinc (Zn), copper (Cu), manganese (Mn), iron (Fe), and nickel (Ni), using the method of atomic absorption spectrometry enounced by the international standard ISO 11047:1998. The samples of soil have been prepared according to the international standard ISO 11466:1995. The concentrations of heavy metals found in the experimental soil are listed in table 2.

Table 2

The concentrations of heavy metals of the experimental soil

Heavy metals (symbol)	Experimental variants / Concentrations (ppm)		
	Variant 1	Variant 2	Variant 3
Fe	13300	29025	47875
Ni	53,2	126,5	175,7
Zn	48,29	56,02	58,98
Cu	72,2	78,9	85,5
Mn	259,2	351,1	368,1

The experimental soil represented the environment of studying the hatching capacity of earthworm larvae by incubating the cocoons. In each experimental recipient six cocoons were added at adequate humidity (essential parameter for hatching). The hatching period ranged between 25-30 days.

RESULTS AND DISCUSSION

The mortality, prolificacy (number of cocoons) and locomotion of earthworms have been studied. In each experimental recipient were introduced 10 adult individuals of *Eisenia fetida* and after 14 and respectively 28 days the alive worms were counted. The experiment was carried out at room temperature, at adequate humidity of soil, and also earthworms have been fed with special food commercially available. There were noticed that earthworms tolerated the concentrations of heavy metals, so that no mortality was detected in the variant 1, neither after 14 days nor after 28 days. In the variant 2, the percentage of mortality was 10% after 28 days.

In the variant 3, where the concentrations of heavy metals were higher, the mortality was 20% after 14 days and 30% after 28 days (table 3).

Table 3

The mortality of species *Eisenia fetida* (mean values)

Alive earthworms (mean values)	Experimental variants		
	Variant 1	Variant 2	Variant 3
After 14 days	10	10	8
After 28 days	10	9	7

Regarding the prolificacy of species *Eisenia fetida*, there was noticed a decrease of cocoon number at higher concentrations of heavy metals (table 4).

Table 4

The prolificacy of species *Eisenia fetida* (mean values)

Number of cocoons (mean values)	Experimental variants		
	Variant 2	Variant 2	Varianta 3
After 14 days	10	8	6
After 28 days	16	12	9

In table 5 are presented the data describing the hatching capacity of earthworm larvae within experimental variants. The highest hatching capacity was recorded in the recipient with the lowest amount of lignite ash and with the lowest concentration of heavy metals. Generally, the hatching capacity was much inferior related to the potential of this species (figure 1).

Table 5

The hatching capacity of species *Eisenia fetida* (mean values)

Parameter	Experimental variants		
	Variant 1	Variant 2	Variant 3
Hatched larvae	3,66 ± 0,57	2,66 ± 0,57	1,33 ± 0,57
Percentage of hatching (%)	61,10 ± 9,61	44,44 ± 9,62	22,21 ± 9,62

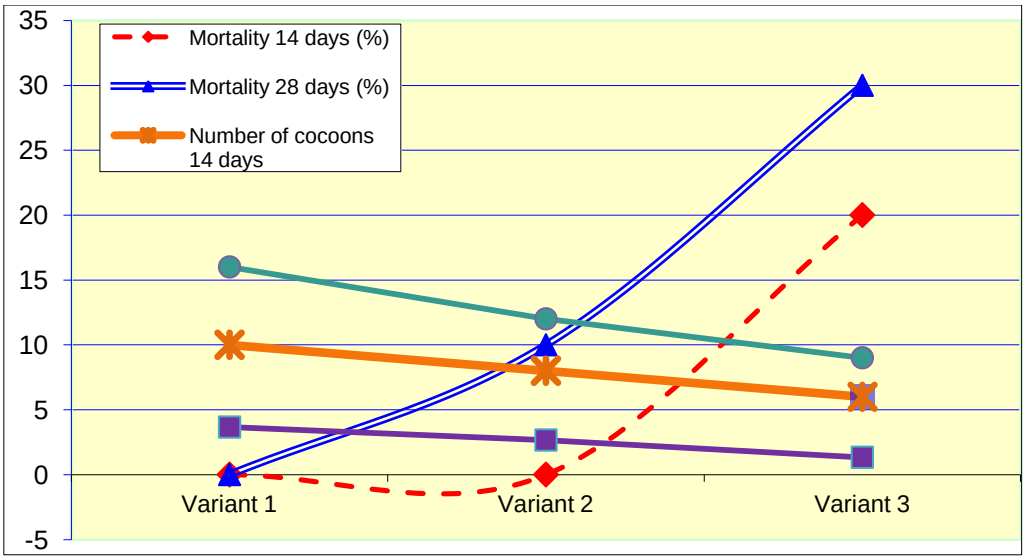

Figure 1. Mortality, prolificacy (number of cocoon) and hatching capacity of species *Eisenia fetida* (mean values)

The locomotion behaviour of earthworms has been observed both at the moment of hatching and after this moment, and also in the 14th day and in the 28th day of experiment. There were no abnormalities regarding the locomotion behaviour.

CONCLUSIONS

The performed study led to the following conclusions:

- The earthworm mortality increased with the increase of concentration of heavy metals.
- The highest hatching capacity was recorded at the lowest amount of lignite ash and at the lowest concentration of heavy metals. Generally, the hatching capacity was much inferior related to the potential of this species.
- The number of cocoon decreased at higher concentrations of heavy metals.
- No abnormalities regarding the locomotion behaviour were noticed.

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