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CULTIVATION OF A *MISCANTHUS GIGANTEUS* ON SOILS POLLUTED WITH HEAVY METALS AND THE USE OF THE RESULTED BIOMASS

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ABSTRACT. The paper presents our results in cultivation on soils polluted with heavy metals (Pb, Cd) of Miscanthus sinensis x giganteus, a sterile hybrid, as well as the tests we have performed for the use of the stems cropped after two years. The results are very encouraging and we expect more and more farmers to cultivate this plant, with benefit for them and for environment.

Keywords: polycythemia vera; PV; rbcs, red blood cells; erythrocyte viability; phosphatidylserine exposure; caspase-3; caspase-8; Annexin-V; Calcein-AM; flow cytometry

INTRODUCTION

Soils polluted with heavy metals (Pb, Cd) pose a great environmental risk, but when these soils are cultivated with edible/forage plants, as the case of Copsa Mica region in Romania, the risks are much greater. Even though the situation is well documented (Dumitru 2004, Lacatusu 2008, Constantinescu 2008), and there are some attempts in remediation of these soils (Barbu and Grovu 2001, Barbu et al. 2006, Dumitru et al. 2002, Dumitru 2004), until now no feasible solution for the decontamination of this large region has been found. On world scale, after a boost of phytoremediation and especially phytoextraction, with thousands of research papers, it turned out that this method, although elegant and environmental friendly, is not sustainable on large pieces of land, and even the greatest names in this field suggested other approaches, such as phytoexclusion, i.e. selecting crops that do not translocate high concentrations of metals to edible parts (Dickinson et al. 2009). In our work we have started from the following assumptions: heavy metals already existing in soil are difficult to be removed, due to the very high costs and/or long time to perform any known remediation method; because groundwater level is quite deep (3-10 m), it is unlikely to be contaminated; until a feasible method will be used, farmers in the area depend on their land, and cultivation of non-edible plants, with market value, could be a solution for their well-being. After screening many species of non-edible plants, we have chosen for our research a new hybrid, *Miscanthus sinensis x giganteus* (Poaceae), trying to determinate if it can be cultivated on these lands (considering the climate and the pollution degree) and what is the amount of heavy metals in its useful parts.

MATERIALS AND METHODS

Miscanthus sinensis x giganteus Greef et Deu. is a triploid hybrid between M. sinensis Anderss. (a diploid species) and M. sacchariflorus Hack (a tetraploid species), which is unable to produce viable seed, thus reducing the risk to become invasive (JONES and WALSH, 2001). Giant miscanthus is a perennial warm-season grass, with a special type of photosynthesis (C4), which implies the return of the nutrients in the rhizome during the cold season (FRÜHWIRTH and LIEBHARD, 2004). As temperatures decrease in the fall, the dark green foliage fades to buff and drops, leaving stems (and sometimes sterile flowers at their terminus). Stems are the most commercially important portions of miscanthus, and harvesting the dried stems takes place during late winter or early spring (March-April). Propagation is made mainly by rhyzomes and, in the third year of cultivation plants reach a height of 3-4 m, with a yield of 20 tons per hectare (at 15 % humidity). It is worth to state that there is a big difference between *M. sinensis* and *M. sacchariflorus*, on one hand and their "off-spring" *M. giganteus*, on the other, in what invasiveness concerns: while the "parents" produce seeds and therefore can be invasive, 'giganteus' gives a sterile blooming, and all the attempts to multiply it otherwise than by rhizomes or seedlings have failed. A major mistake is given by the similarity of names: *Miscanthus sinensis* and *Miscanthus sinensis x giganteus*. Even the most thorough research made in U.S.A. and Europe have proven no sign of invasiveness and therefore 'giganteus' is NOT on the European invasive species list.

Its current use is for energy, but research is performed for other industrial uses, as pulp and paper, additive in concrete walls, plastics replacement (PYTER et al. 2007).

For our experiments we have chosen a piece of land (5000 m2) at the borders of Copsa Mica town, situated two km eastwards from the pollution source (Sometra Company). Land characteristics were determined according to the current Romanian standards, the average sample consisting on 10 sub-samples taken from different places. Soil and then plants loading with heavy metals were determined in solid state, using a

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High-resolution continuum source atomic absorption spectrometer ContrAA 700, manufactured by Analytik Jena (Germany). On this land, after soil preparation, we have planted manually, in May 2008, Miscanthus rhizomes (from Fa. ARGE GmbH, Austria), in rows (1 x 1 m), at a depth of 8-10 cm. No pesticides and fertilizers were used. In April 2010 we have cropped the aerial parts, using a trimmer, and then we grinded them using a household cereal mill, the product looking similar to saw-dust. This dust was sent to be analyzed by a certified combustion tests laboratory (Oscar von Muller Co., Bucharest) and briquetted on a sawdust press. To determine the amount of heavy metals, soil and vegetal samples were oven dried at 105 oC, for two hours and then grinded under 10 µm (Fritch – Pulverisette 0). For each analysis there were taken at least four samples. In the AAS graphite furnace there were introduced amounts of 1.0000 mg at a time.

RESULTS AND DISCUSSION

The piece of land where we have performed our research was a poor one, acidic (pH=5.2) heavily polluted with Cd (13.47 mg.kg-1 dry weight) and Pb (682.50 mg.kg-1 d.w.) (BARBU et al. 2009). Despite these, the results are encouraging: the plants have grown, with a survival rate of more than 90 %, and from rhizomes have developed rootlets until the depth of 1.2 m, where the pollution degree is lower, this demonstrating that Miscanthus sinensis x giganteus can be successfully cultivated in Romania, even on poor, acidic soils, heavily polluted with Pb and Cd. The amounts of Cd and Pb in the aerial parts were 2.12±0.44 mg.kg-1 d.w. and 3.71±0.73 mg.kg-1 d.w., respectively). These very low values make the plant unsuitable for phytoextraction, but allow its almost unrestricted use for energy, and not only. In what the chemical composition and combustion characteristics concern, as determined by a third party laboratory, the results are presented in Table 1:

Table 1

Chemical composition and combustion characteristics of Miscanthus dust

Characteristic	Value (% wt)	Test method
Total moisture	9.30	SR 5264:1995
Ash	1.70	ASTM D 3174:2004
Volatile matter	74.28	STAS 5268:1990
Carbon	44.21	
Hydrogen	6.21	ASTM D 5373:2006,
Oxygen (by difference)	48.57	ISO 351:1996
Sulfur	0.00	CEN/TS 15104:2005
Nitrogen	0.56	
Chlorine	0.45	ISO 3634:1979
Lower heating value	16039 kJ/kg	ISO 1928:2009
Higher heating value	17673 kJ/kg	CEN/TS 15148:2005

These results, very similar with those reported by COLLURA et al. (2005), show clearly that Miscanthus, even cultivated on polluted soils, has very few ash, no sulfur, and its heating value is comparable to that of lignite. Preliminary tests with the briquettes (cylinders 10 cm diameter, 7-12 cm length), obtained for the first time in Romania, gave also good results, without ash agglomeration, which is a major concern in biomass use for energy. Different types of integrated studies on the development of new policies under dynamic action plans in agriculture, according to environmental factors, the impact of climate change and the degree of tolerance of different local varieties, may lead to increase productivity (Antofie et. al., 2010).

CONCLUSIONS

1. *Miscanthus sinensis x giganteus*, a valuable energy plant, can be successfully cultivated in Romania, even on soils heavily polluted with Pb and Cd.

2. The amount of Pb and Cd in the upper parts of the plants, even cultivated on soils heavily polluted with Pb and Cd, is very small, this allowing its unrestricted industrial and energetic use.

3. Combustion characteristics of Miscanthus dust and briquettes are very good, making possible the partial replacement of coal in new or existing heating units.

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