BIOMETRIC RESPONSES OF GRASSES IN THE PHYTOREMEDIATION OF SOIL CONTAMINATED BY CHROME AND NICKEL

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Abstract: The objective of this work was to evaluate the biometric components of plants of the Poaceae family used in the phytoremediation of a soil with the presence of potentially toxic metals. The experiment was carried out in a greenhouse at Escola de Agronomia, Universidade Federal de Goiás, Goiânia – GO, with a sandy textured red-yellow Latosol from an area with a serpentinite rock outcrop, containing high levels of Cr and Ni. The experimental design was in randomized blocks, with 5 treatments and 4 replications. The treatments were composed of: sugarcane, energy cane, elephant grass, capiaçu grass and spontaneous flora. The plants were cut at 250 days after planting and height, stem diameter, number of tillers, green mass and dry mass were analyzed. Sugarcane had the largest stem diameter and high dry biomass, followed by energy cane. Spontaneous flora resulted in lower green biomass. Plants of the Poaceae family perform well in soil with high levels of potentially toxic metals.

Keywords: *Saccharum officinarum*; *Saccharum spontaneum*; *Pennisetum purpureum* Schum. e *P. purpureum* cv Capiaçú.

RESPOSTAS BIOMÉTRICAS DE GRAMÍNEAS NA FITOREMEDIAÇÃO DE SOLO CONTAMINADO POR CROMO E NÍQUEL

Resumo: O trabalho teve como objetivo avaliar os componentes biométricos de plantas da família Poaceae usadas na fitorremediação de um solo com presença de metais potencialmente tóxicos. O experimento foi conduzido em casa de vegetação da Escola de Agronomia da Universidade Federal de Goiás, Goiânia – GO, com um Latossolo vermelho-amarelo distrófico de textura arenosa de uma área com afloramento da rocha serpentinito, contendo altos teores de Cr e Ni. O delineamento experimental foi em blocos casualizados, com 5 tratamentos e 4 repetições. Os tratamentos foram compostos por: cana-de-açúcar, cana-energia, capim-elefante, capim-capiaçú e flora espontânea. As plantas foram cortadas aos 250 dias após o plantio e analisadas altura, diâmetro de colmo, número de perfilhos, massa verde e massa seca. A cana-de-açúcar apresentou o maior diâmetro de colmo e alta biomassa seca, seguidas pela cana-energia. A flora espontânea resultou em menor biomassa verde. As plantas da família Poaceae possuem bom desempenho em solo com altos teores de metais potencialmente tóxicos.

Palavras-chave: *Saccharum officinarum*, *Saccharum spontaneum*, *Pennisetum purpureum* Schum. e *P. purpureum* cv Capiaçú.

1. INTRODUCTION

High levels of potentially toxic metals in the soil can cause phytotoxicity to plants, leading to the appearance of visual symptoms of toxicity, such as chlorosis, necrosis, loss of turgor, damage to the photosynthetic apparatus, reduction in the germination rate of seeds and in growth and development [1].

Unlike organic pollutants, metals cannot be chemically or biologically degraded. They are relatively stable in the environment and can only be transformed or immobilized in different chemical forms. Its dynamics depend on factors related to soil and environment characteristics, which will influence its availability and mobility [2].

There are remediation practices that can reduce the availability of metals in the soil. Phytoremediation is a technique that consists of the use of hyperaccumulating plants, capable of absorbing high levels of metals and storing them in their tissues. For a plant to have potential in phytoremediation, it must have a deep root system, rapid development and growth, high biomass production and resistance to pollutants, as well as species in the Poaceae family [3].

Thus, the objective of this work was to evaluate the biometric components of plants of the Poaceae family used in the phytoremediation of a soil with the presence of potentially toxic metals.

2. MATERIAL AND METHODS

The soil used in the experiment was collected in a rural area in the municipality of Cromínia-GO, Brazil, located 86 km from Goiânia, with geographic coordinates 17° 17' 21" South, 49° 22' 49" West and 694 meters of altitude. It is a dystrophic Red-yellow Latosol with a sand texture located in an outcrop of serpentinite rock with the presence of chromium metals (Cr) and zinc (Zn). At the time of soil collection to be used in the experiment, samples were also collected to carry out the analysis of the chemical and textural attributes of the soil, which was sent to the Soil Laboratory of the UFG School of Agronomy and the data are presented in table

Table 1. Chemical and textural analysis of dystrophic Red-yellow Latosol with a sand texture from Cromínia-GO, Brazil, used in the experiment.

Sand	Clay	Silt	Cr	Ni	pH
------------ g kg^{-1} ------------			----- mg dm^{-3} -----		$CaCl_2$
50	32	18	4023	1369	5.8
Cu	**Fe**	**Mn**	**Zn**	**P**	**K**
------------------------ mg dm^{-3} ------------------------					
3.6	53	79	0.6	0.6	215
Ca	**Mg**	**H+Al**	**CEC**	**OM**	**V**
---------------- $cmol_c$ dm^{-3} ----------------				%	%
0.9	1,6	6.8	9.8	1.7	31

CEC: Cation exchange capacity; OM: organic matter; V: Base saturation. Cr and total Ni (nitro-perchloric digestion). The content of the other elements was obtained using the Mehlich 1 extractor.

The work was carried out in a greenhouse of the Escola de Agronomai, of the Universidade Federal de Goiás, Campus Samambaia, municipality of Goiânia – Goiás, Brazil. The soil was sieved to remove roots and rocks and packed in PVC columns, whose dimensions are 1.20 m high by 0.25 m in diameter, lined internally with raffia bags.

The experimental design was in randomized blocks, with 5 treatments and 4 replications. The treatments consisted of plants of the Poaceae family with the potential to phytoremediate soils with high levels of metals: sugarcane (*Saccharum officinarum*), energy cane (*Saccharum spontaneum*), elephant grass (*Pennisetum purpureum* Schum.), capiaçu (*P. purpureum* cv Capiaçu) and weed (spontaneous plants).

Planting took place on November 22, 2021. Each PVC column received 3 buds of the appropriate species with 700 g of single superphosphate and was irrigated. At 30 days after planting, the plants were thinned, keeping 1 plant per column and replanting when necessary. The soil was irrigated daily so that it reached field capacity (after saturation and gravitational drainage of water).

Plants were cut at 250 days after planting (eight consecutive months). A hand saw blade was used for this. At the time of cutting, plant height, stem diameter and number of tillers were measured. For this, with the aid of a measuring tape, the height of the plant was measured, from the soil surface to the collar of the leaf +1, in cm. For the stem diameter, a digital caliper was used, taking the measurements in the first stem close to the ground, in cm. Tillers were quantified per pot.

The biomass was weighed on an analytical balance to determine the green mass, in kg. Then, the samples were packed inside paper bags and sent to the forced air ventilation oven at 149 °F (65 °C) until reaching constant mass. Subsequently, the samples were weighed on an analytical balance to quantify the dry mass, in kg.

The data were submitted to analysis of variance by the F test, at 5% error probability and when differences were found, the means were compared by the Tukey test, at 5% error probability, using the statistical program SAS® (Statistical Analysis System) [4].

3. RESULTS AND DISCUSSION

Table 2 presents the plant species of the Poaceae family analyzed as phytoremediators of potentially toxic metals in the soil. There was no significant difference (Pvalue<0.05) in the height parameter of plants used for phytoremediation of soils contaminated by Cr and Ni (Table 2). As for the stem diameter, number of tillers, green mass and green mass, significant differences were found.

Table 2. Plant height, stem diameter and number of tillers of plants used in the phytoremediation of clay soil contaminated by Cr and Ni. Goiânia – GO, Brazil.

Treatment	plant height (m)	Stem diameter (cm)	Number of tillers	Green biomass (g)	Dry biomass (g)
Energy cane	1.86 A	18.84 B	2.00 E	480.00 A	348.00 B
Sugarcane	1.69 A	19.62 A	2.25 D	511.00 A	398.00 A
Elefant grass	1.59 A	15.01 D	2.50 C	516.00 A	235.00 C
Capiaçú grass	1.67 A	16.75 C	3.00 B	517.00 A	265.00 C
Weed	0.90 A	4.01 E	19.00 A	288.00 B	157.00 C
Mean	1.54	14.84	5.75	0.46	0.28
MSD	1.13	0,50	0,20	0.16	0.13
P value	0.10^{ns}	$1.0x10^{-3**}$	$1.0x10^{-3**}$	$2.0x10^{-3**}$	$4.0x10^{-4**}$

**, *, ns: significant at 1 and 5% error probability and not significant, respectively. Means followed by the same letter do not differ from each other at a 5% error probability, by Tukey's test. MSD: minimum significant difference.

Among the four species of the Poaceae family used and the spontaneous flora, energy cane presented the largest stem and dry biomass diameters. Energy cane, unlike sugar cane, is a type of plant that has been improved to have greater biomass production due to its high fiber content. It presents greater rusticity and adaptability to marginal agricultural areas, that is, it tolerates greater environmental adversities and soils with low fertility [5]. Due to the high production of dry biomass, this work indicated that energy cane has the potential to be used in the phytoremediation of soils with the presence of high levels of metals, as it presented a good development.

The four grass species produced higher green biomass than that observed in the spontaneous flora. One of the techniques used to achieve success in phytoremediation is the use of plants with high biomass production, because, in this way, there are greater chances of phytoextracting the elements and decontaminating the soil [6].

The spontaneous flora observed in the study was composed of *Brachiaria plantaginea* [7]. It resulted in lower green biomass, showing that this may not be the best choice for a soil contaminated with metals.

4. CONCLUSION

The plants of the Poaceae family, energy cane, sugarcane, elephant grass and capiaçú grass, showed a good performance in soil with high levels of Cr and Ni. Being plants in potential use for the phytoremediation of soils contaminated with metals.

5. REFERÊNCIAS

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