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PRODUCTION OF BIOMASS FROM PLANTS USED IN PHYTOREMEDIATION OF SOIL CONTAMINATED BY CHROME AND NICKEL

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Abstract: The objective of this work was to evaluate the biomass 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 of the Escola de Agronomia, Universidade Federal de Goiás, Goiânia – GO, with a dystrophic red Latosol with a clayey texture from an area with outcrop of serpentinite rock, 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. Data were submitted to analysis of variance and Tukey test, both at 5% error probability. Elephant grass had the highest number of stems. The spontaneous flora had the highest number of tillers, due to the presence of brachiaria plantaginea and the lowest green mass. Plant growth and development were not harmed by the high levels of Cr and Ni, showing that plants have potential for phytoremediation of soils contaminated by metals.

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

PRODUÇÃO DE BIOMASSA DE PLANTAS UTILIZADAS NA FITOREMEDIAÇÃO DE SOLOS CONTAMINADOS POR CROMO E NÍQUEL

Resumo: O trabalho teve como objetivo avaliar a biomassa de plantas da família Poaceae usadas na fitorremediação de um solo com presença de metais potencialmente tóxicos. O exmperimento foi conduzido em casa de vegetação da Escola de Agronomia da Universidade Federal de Goiás, Goiânia – GO, com um Latossolo vermelho distrófico de textura argilosa 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. Os dados foram submetidos à análise de variância e ao teste Tukey, ambos à 5% de probabilidade de erro. O capim elefante apresentou o maior número de colmo. A flora espontânea teve o maior número de perfilhos, devido a presença da brachiaria plantaginea e a menor massa verde. O crescimento e desenvolvimento das plantas não foram prejudicados pelos altos teores de Cr e Ni, mostrando que as plantas possuem potencial para a fitorremediação de solos contaminados por metais.

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

1. INTRODUCTION

Soil contamination by potentially toxic metals is mainly associated with industrial development, agricultural practices, mining and other human activities considered significant sources of metals [1].

Phytoremediation is a bioremediation technique that consists of the direct use of living green plants considered hyperaccumulat for the transfer or stabilize all the toxic metals in polluted soil or ground water. Is an effective, cheap, non-invasive, and ecologically correct technique used to extract and accumulate heavy metal ions from the soil in roots, shoots, leaves, flowers, fruits [2]

In order to be successful in phytoremediation, it is necessary to use plant species that have characteristics that allow good absorption capacity, as well as a deep root system, rapid development and growth, high biomass production and resistance to the pollutant [3].

Poaceae family species (grasses) are tolerant to metals and they have mechanisms to grow in stress surroundings, for example salinity, scarcity of water, toxic metal stress, or scarcity of essential nutrients [4].

Therefore, the objective of this work was to evaluate the biomass of plants of the Poaceae family used for the phytoremediation of soils contaminated by 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 Latosol with a clayey 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 1.

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

Sand	**Clay**	**Silt**	**Cr**	**Ni**	**pH**
----------	**g kg^{-1}**	**----------**	**----------**	**mg dm^{-3}**	**----------**
					$CaCl_2$
470	440	90	4941	2786	5.1
Cu	**Fe**	**Mn**	**Zn**	**P**	**K**
----------	**----------**	**mg dm^{-3}**	**----------**	**----------**	**----------**
4,4	55	79	0.7	2.1	70
Ca	**Mg**	**H+Al**	**CEC**	**OM**	**V**
----------	**cmol$_c$ dm^{-3}**	**----------**		**%**	**%**
0.8	1.1	6.4	8.5	2.3	24.5

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) [5].

3. RESULTS AND DISCUSSION

There was no significant difference (Pvalue<0.05) in the parameters height and dry mass of the plants used for phytoremediation of soils contaminated by Cr and Ni (Table 2). As for the stem diameter, number of tillers and green mass, significant differences were found.

The grass that presented the largest stem diameter was elephant grass, followed by sugarcane, energy cane, capiaçu grass and spontaneous flora, which presented the smallest stem diameter. The spontaneous flora observed in the work is Brachiaria plantaginea, from the Poaceae family, which presented a high number of tillers. The large number of tillers and the reduced stem diameter is an intrinsic characteristic of the species because it has a stoloniferous habit through rooting in its internodes [6].

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	2.62 A	16.64 C	3.25 B	713.00 A	475.00 A
Sugarcane	1.87 A	17.54 B	3.00 C	654.00 A	478.00 A
Elefant grass	2.33 A	19.28 A	3.25 B	759.00 A	938.00 A
Capiaçú grass	2.63 A	12.99 D	3.00 C	661.00 A	362.00 A
Weed	1.44 A	5.00 E	27.00 A	360.00 B	208.00 A
Mean	2.17	14.29	7.90	0.62	0.49
MSD	2.04	0.90	0.10	0.28	0.84
P value	0.32^{ns}	$1{,}0x10^{-3**}$	$1{,}0x10^{-3**}$	$1{,}0x10^{-3**}$	0.110^{ns}

**, *, 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.

The observed averages of the parameters analyzed in the plants of the Poaceae family remained within the normal range for the species, according to the literature [7, 8]. Thus, plant growth and development were not negatively affected by the high levels of metals, showing themselves to be tolerant to Cr and Ni and with potential use in phytoremediation of soils contaminated with trace elements.

4. CONCLUSION

Plants of the Poaceae family, energy cane, sugarcane, elephant grass and capiaçú grass have good growth and development, with good biomass production in clayey Latosol with high levels of Cr and Ni, being potential plants for phytoremediation of soils contaminated by metals.

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