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HUMIC SUBSTANCES IN THE PRODUCTION AND DEVELOPMENT OF MARANDU AND MOMBAÇA GRASS

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ABSTRACT - The effects of humic substances in plants are related to the increase in the absorption of nutrients, due to the influence on the permeability of the cell membrane and the chelating power, as well as photosynthesis, the formation of ATP, amino acids and proteins. In order to optimize the use of humic substances for tropical grasses, it was carried out in pots in a greenhouse. Humic substances were extracted from vermicompost. For the application of humic substances, a humic solution was produced by diluting the concentrated solution in water at concentrations of 0; 12.5; 25 and 50%, and the solution was applied with a hand sprayer (300 mL). The experimental design used was completely randomized in a 2 x 4 factorial scheme (two forages, four SH concentrations), with 5 replications. At 45 days, the plants were cut, separating them into shoots and roots. The samples were removed, for determination of dry matter, crude protein and neutral detergent fiber (NDF). The leaves and roots of the samples were, after weighing (for green matter) and before drying, digitalized to determine leaf area and leaf area index. The objective was to evaluate the leaf area, shoot and root yield of *Brachiaria brizantha* (Syn *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn *Megathyrsus maximus*) cv. Mombaça subjected to different concentrations of humic substances. The best concentrations of humic substances for better aerial part yield were 50% for cv. Mombaça and 25% for cv. Marandu, but considering that the roots must have the necessary organic reserves for a new regrowth. The best concentrations of humic substances for better root yield were 50% for cv. Mombaça and 25% for cv. Marandu.
Keywords: *Brachiaria brizantha*, *Panicum maximum*, humic acid.

SUBSTÂNCIAS HÚMICAS NA PRODUÇÃO E DESENVOLVIMENTO DE CAPIM MARANDU E CAPIM MOMBAÇA

RESUMO - Os efeitos das substâncias húmicas nas plantas estão relacionados com o aumento da absorção de nutrientes, devido à influência na permeabilidade da membrana celular e no poder quelante, bem como na fotossíntese, na formação de ATP, aminoácidos e proteínas. A fim de otimizar o uso de substâncias húmicas para gramíneas tropicais, foi realizado em vasos em casa de vegetação. Substâncias húmicas foram extraídas do vermicomposto. Para aplicação de substâncias húmicas, a solução húmica foi produzida diluindo a solução concentrada em água nas concentrações de 0; 12,5; 25 e 50%, e a solução foi aplicada com um pulverizador manual (300 mL). O delineamento experimental utilizado foi inteiramente casualizado em esquema fatorial 2 x 4 (duas forrageiras, quatro concentrations de SH), com 5 repetições. Aos 45 dias, as plantas foram cortadas, separando-as em parte aérea e raiz. As amostras foram retiradas, para determinação da matéria seca, proteína bruta e Fibra em detergente neutro (FDN). As folhas e raízes das amostras foram, após pesagem (para matéria verde) e antes da secagem, digitalizadas para determinação da área foliar e índice de área foliar. Objetivou-se avaliar a área foliar, a parte aérea e a produção de raízes de *Brachiaria brizantha* (Syn *Urochloa brizantha*), cv. Marandu e *Panicum maximum* (Syn *Megathyrsus maximus*) cv. Mombaça submetida a diferentes concentrations de substâncias húmicas. As melhores concentrações de substâncias húmicas para melhor rendimento da parte aérea foram 50% para a cv. Mombaça e 25% para a cv. Marandu, mas considerando que as raízes devem ter as reservas orgânicas necessárias para uma nova rebrota. As melhores concentrações de substâncias húmicas para melhor rendimento de raízes foram 50% para a cv. Mombaça e 25% para a cv. Marandu.
Palavras-chave: *Brachiaria brizantha*, *Panicum maximum*, ácido húmico.

INTRODUCTION

Pastures represent a lower cost food source and in accordance with society's demand for quality and preservation of environmental resources. However, cattle production is characterized as a situation of extractive exploitation, where pastures are conducted in soils of low natural fertility, with no restitution of nutrients extracted by forages, leading to a condition of degradation (IEIRI et al., 2010) conditioning the loss of the productive capacity of pastures. It is critical for the rational management and control of animals, in order to exploit maximum accumulation for exploitation, sustainability and grazing efficiency by animals in order to obtain greater potential for

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use, management of access to animals and sustainability (BARBERO et al., 2021).

Thus, it is important to remember that the climatic variation between spring/summer (waters or rainy season) and autumn/winter (dry) results in variations in forage accumulation. This variation implies differences in the carrying capacity of pastures throughout the year. The available forage is not fully ingested by cattle (trample, selectivity and residue), where the percentage effectively consumed represents grazing efficiency (BARBERO et al., 2021). Considering the annual forage dry mass accumulation between 12 and 18 t ha^{-1} [*Brachiaria brizantha* (Syn *Urochloa brizantha*) and *Panicum maximum* (Syn. *Megathyrsus maximus*)], approximately 80% of the accumulation occurs in the rainy season (CASTRO et al., 2013; BARBERO et al., 2014). Faced with the need for busyness livestock, pasture assumes an important role for the success of the activity, making it necessary to conduct it seeking to maintain its productive capacity

Faced with the need to occupy livestock, pasture assumes an important role for the success of the activity, the search to maintain its productive capacity, for this reason, since almost four decades, several species have been made available by companies and institutions to meet the needs of the population. demand from ranchers. However, there is a great need to elucidate the peculiarities inherent to the characteristics of the existing pastures, such as, for example, the most productive forage species, as well as the characteristics and morphology of each plant, fundamental issues for forage planning and an adequate management of the pastures (TUFFI SANTOS et al., 2004; POCZYNEK et al., 2016).

However, in practice, what is observed is the predominance of degraded pastures. The degradation of pastures causes great environmental and economic damages in Brazil, recent estimates suggest that at least half of the pasture areas in ecologically important regions are in degradation or degraded. The degradation of the great environmental and preservation areas of the past regions are important in the reduction of the environmental and preservation areas of the last ecologically important regions that favor the areas of environmental degradation and of preservation of the last ecologically important regions that favor the areas of environmental degradation and the conservation areas of the last ecologically important regions. main environmental, social and economic problems: making the soil (DIAS-FILHO, 2002; BRAZ et al., 2012).

The recovery of productivity in these areas should be a priority, since environmental restrictions tend to reduce the possibilities of continuous incorporation of areas still unchanged for the formation of new pastures. To recover degraded pastures, different methods and technologies are available. Among the methods available for the recovery of degraded pastures, there are direct methods that are used when the pastures are in an initial degree of degradation. These techniques consist of the use of mechanical practices and the use of pasture. The techniques used in indirect cultures in a superior way can be made viable as past indirect cultures so that they can be made viable, they consist of other cultures economically capable of their recovery (DIAS-FILHO, 2006; IRRE et al., 2014). And finally, there are silvipastoris systems that are also used on very degraded pastures (NARANJO et al., 2012). The choice of recovery quality used will depend on the situation of soil degradation, vigor and density of forage plants, availability of time and technical development conditions, considering the climatic conditions of the region (CARVALHO et al., 2017).

One possibility that can be associated with pasture recovery strategies is the use of liquid humic substances aiming at stimulating the forage by physiological effect, increasing their productive capacity, since the beneficial effects of these substances on plants are proven. The preservation of soil organic matter is the first step in the agroecosystem recovery process.

Conservationist agricultural practices are needed afterwards to increase soil carbon stocks and stability so that they can be retained in the system (sequestration) (BALDOTTO et al., 2010). The preservation of organic matter in the soil helps to ensure high soil quality (CARVALHO et al., 2010; BALDOTTO et al., 2015; IHSS, 2021). These substances have activity similar to that of plant hormones and increase nutrient absorption and plant growth. Interest in the application of products based on humic substances in commercial crops has grown due to the responses obtained especially in crops of high economic interest (BALDOTTO; BALDOTTO, 2018).

In this context, the objective was to evaluate the leaf area, shoot and root yield of *Brachiaria brizantha* (Syn *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn *Megathyrsus maximus*) cv. Mombaça subjected to different concentrations of humic substances. The best concentrations of humic substances verified in the present study, for better yield of the shoot and root, were 50% for cv. Mombaça and 25% for cv. Marandu.

MATERIAL AND METHODS

In order to optimize the use of humic substances for tropical grasses, it was carried out in pots in a greenhouse, of the type arch house, “arched ceiling” model in the inverted economy format with arrow, adapted to the local experimental conditions, with dimensions of 5 m in width by 10 m in length and 3 m in height and windows closed sides with anti-aphid mesh allowing ventilation inside the room while the ceiling was covered with plastic transparent, in Teixeira de Freitas County, 17° 32' 45" South, 39° 43' 26" West, in the extreme south of the State of Bahia, Brazil. characterized by well-distributed rainfall throughout the year and absence of a dry season. Sowing was carried out in plastic pots with a capacity of 500 mL, containing washed sand, and 10 seeds per pot, with dimensions: mouth: 13 cm, height: 7 cm and bottom: 8 cm. The water control was performed daily, by weighing the pots, keeping the soil at 80% of its field capacity (500 mL). The seeds were acquired from a processing company located in Goiania County, in Goiás state.

The pots were placed 0.25 m apart, on plastic canvas, at ground level. The cultural treatments consisted of manual control of spontaneous weeds; the substrate of the pots was washed sand. Humic substances were extracted from vermicompost, from Institute of Agricultural Sciences of the Federal University of the Jequitinhonha and Mucuri Valleys, Unaí County, according to the International Society of Humic Substances (IHSS). After extraction, the composition was analyzed to determine the carbon concentration, finding the value of 20% carbon. For the application of humic substances, a humic solution was produced by diluting the concentrated solution in water at concentrations of 0; 12.5; 25 and 50%, and the solution was applied with a hand sprayer (300 mL).

The experimental design used was completely randomized in a 2 x 4 factorial scheme, with two forage species, with four concentrations of humic substances, with 5 replications, and 3 plants per repetition (experimental unit), making a total of 40 treatments. After germination, two thinning were performed every five days until five plants remained per pot, the parameters used for plant selection were homogeneity, position inside the pot and size. At 15 days after germination, treatments (concentrations of humic substances) were applied.

At 25 and 35 days after germination, evaluations of the number of live leaves were performed. At 45 days, the plants were cut, separating them into shoots and roots. The samples were weighed and placed in a forced ventilation oven at 55ºC for 72 h. The samples were removed from the oven, left for 24 h at room temperature, and weighed for the determination of dry matter.

The pre-dried samples were ground in a stationary mill "Thomas-Wiley", model 4, using a sieve of 1 mm. Then, they were stored in jars with a lid for the analysis of crude protein and fiber in neutral detergent. The dry matter content was determined by weighing the green material in the field and drying it in a ventilated oven at 55ºC for 72 h with a new weighing. The total nitrogen of the forage was determined by the Kjeldhal method, and the NDF contents, according to the methodology developed by Van Soest (1965), as described by Silva (1990).

The leaves, after weighing (for green matter) and before drying, were scanned in a reading scanner, with a resolution of 300 dpi and 100% of the original size, later they were measured using the graphic programming program "ImageJ" to determine the area leaf and leaf area index. The roots were digitized in an optical scanner, at a resolution of 400 dpi, providing the mean diameter (mm) and root length (cm) using the Delta-T Scan software; the root length density (cm cm^{-3}) was determined by dividing the root length by the volume of soil collected. The average root radius was obtained by: R02 = root volume = (green matter)/p x L (root length). The surface occupied by the roots (S) was calculated using the formula: S = 2p x R x. L.

The variables studied were analyzed using the statistical analysis program Sisvar 5.6 (FERREIRA, 2011). The results were submitted to analysis of variance and regression at a 5% level using the "F" test. The estimates of the regression parameters were evaluated by the "t" test at a 5% significance level.

RESULTS AND DISCUSSION

By the regression analysis, a significant difference (P>0.05) was observed only for the dry matter content of leaves (Figure 1) and dry matter production of leaves in grams per pot, considering the accumulated production of 45 days of growth (Figure 2). The forage that presented the highest moisture content in its forage material was cv. Mombaça, when subjected to 0, 10, 20, 30 and 40% of humic substances (HS), when subjected to 50% HS showed no significant difference.

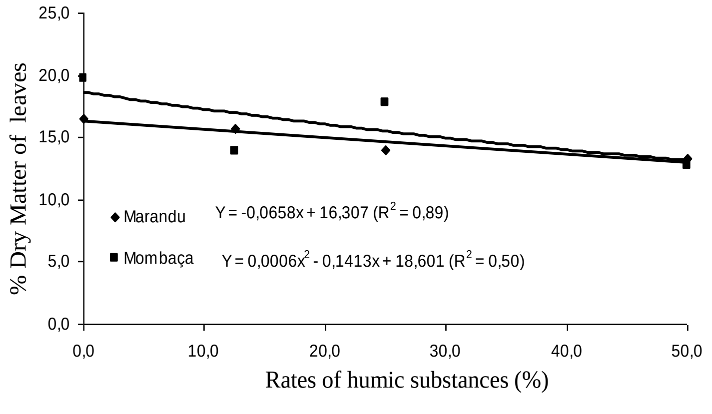

FIGURE 1 - Dry matter content of leaves of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations of humic substances.

Similarly, to the results found in the present study, for the response curve to treatment with humic substances *in Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça (BALDOTTO and BALDOTTO, 2014), it was observed, in Figure 1, that for the dry matter content of the leaves, there was a behavior dependent on the concentration of humic acid. In other words, the accumulation of plant biomass (Figure 2) presented a curvilinear response (quadratic equations) to the application of the biostimulant, allowing the determination of a concentration of maximum efficiency.

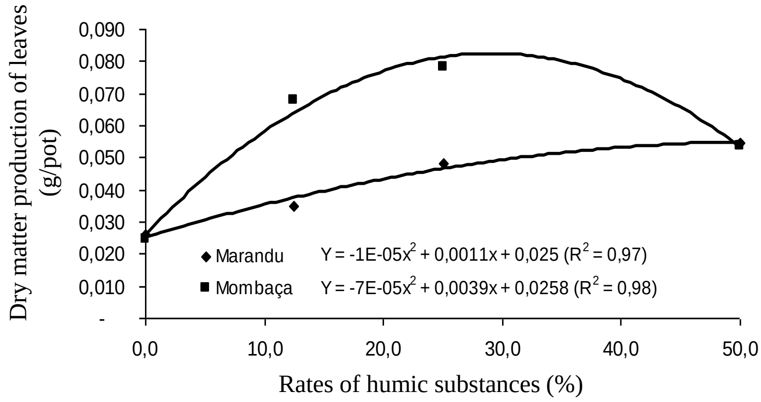

FIGURE 2 - Dry matter production of leaves of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

As for the production of shoot dry matter (g/plant), the species showed differences between them, and by the regression analysis a significant difference (P>0.05) was observed in the dry matter production for *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça subjected to concentrations of HS, the best response being obtained between 25 and 30% (Figure 3).

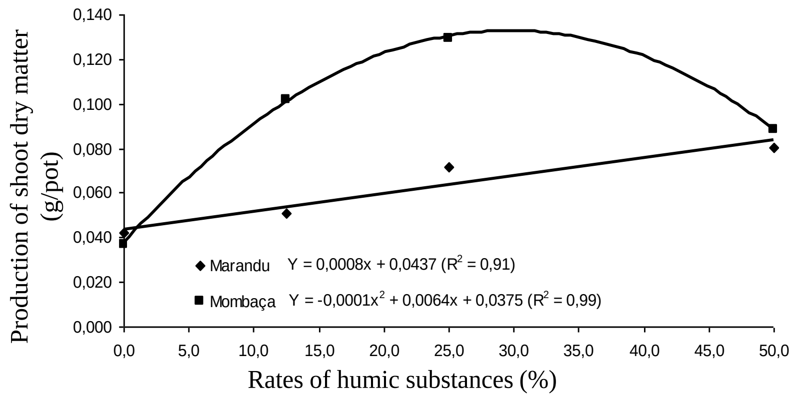

FIGURE 3 - Dry matter production of leaves of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

With this observation, it is possible to estimate the production per hectare, being about 60 t ha^{-1}, it is quite expressive, considering the conditions of the substrate used (washed sand, pH = 7.0). In general, it was observed that, for all analyzed variables, there was an initial increase, following the elevation of the humic acid concentration, followed by stabilization and decreasing increments in the highest concentrations used, characterizing a behavior dependent on the concentration

The regression equations fitted between the dependent variables, estimates of the performance of the leaf: stem ratio of plants of cv. Marandu and cv. Mombaça and the increasing concentrations of the extracted humic substances showed a curvilinear behavior, with quadratic variations (Figure 4).

In this same figure, the values of the coefficient of determination of each regression equation appear. When the equation did not show a degree of adjustment ($R^2 \geq 0.88$ for cv. Marandu and 0.34 for cv. Mombaça was considered) and significance ($P \leq 0.10$), the mean concentrations were presented. The regression equation was used for the leaf area of *Brachiaria brizantha* (Syn. *Urochloa brizantha*) cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça (Figure 5), to estimate the concentration of humic substance of maximum physical efficiency, that is, the one that resulted in the highest production of leaf area.

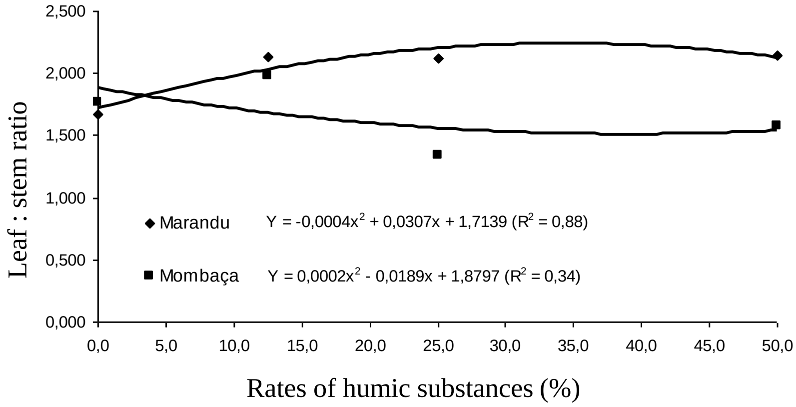

FIGURE 4 - Leaf: stem ratio of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

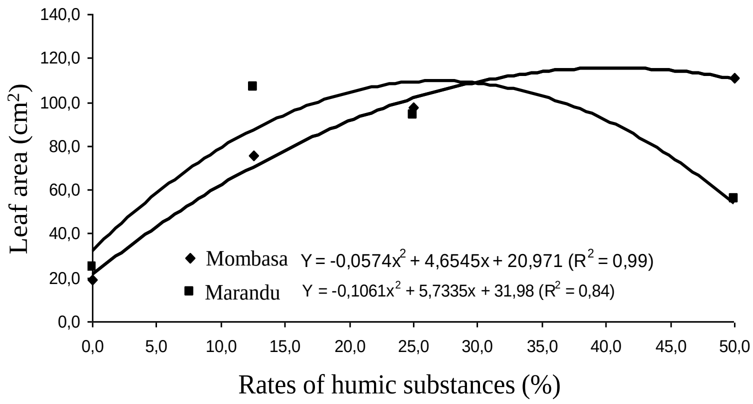

FIGURE 5 - Leaf area of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

Compared with the control treatment, with the other treatments (12.5; 25 and 50%) a significant difference ($P \leq 0.10$) can be observed between cultivars and between HS concentrations. In the best concentration of humic substance, there was an increase of 0.095 g/plant (211%), as shown in Figure 6, for the other treatments (managements). Analogously, it can be seen in the same figure that the different concentrations of humic substances applied to the different species revealed that the increase over the control was 167.03 and 105% for *Brachiaria brizantha* (Syn. *Urochloa brizantha*) cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, respectively, for the best concentration of each treatment.

Thus, the increase in root growth is one of the main physiological effects of humic substances and depends both on the species and age of the plants and on the source and concentration used (CANELLAS and OLIVARES, 2014). Testing HS of vermicompost produced with bovine manure and sugarcane bagasse mixture on lettuce seedlings, Rodda et al. (2006) observed significantly higher root development than the control. These authors verified that the HS provided increases of 180 and 190% in the root area, and of 150 and 140% in the total root length, respectively, in relation to the control.

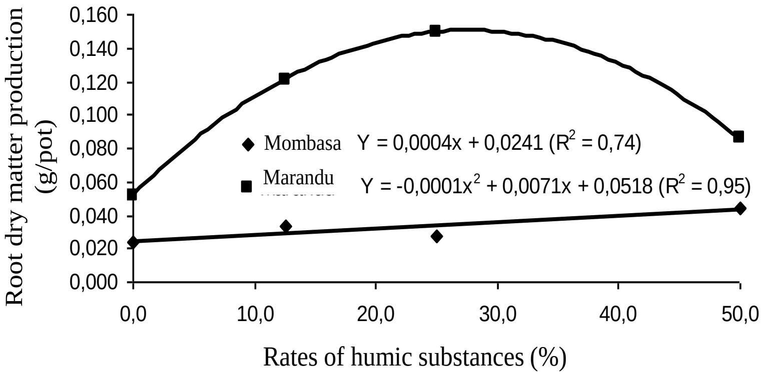

FIGURE 6 - Root dry matter production (g/plant) of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

In the present study, compared with the control treatment, with the other treatments (12.5; 25 and 50%) a significant difference ($P \leq 0.10$) can be observed between cultivars and between HS concentrations, and verify that provided average increases of 83% and 23% in root area, respectively, for *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça (Figure 7). Thus, it is possible to verify that, in addition to the influence of humic substances on the absorption of nutrients, the amount absorbed also depends on the surface area of the roots, which is consequently influenced by the availability of HS to the plants.

The optimal stimulus concentration was obtained by deriving the dose-response curve using humic substances. As for the percentage of whole plant crude protein (CP), the species showed a difference ($P<0.05$), however between the HS concentrations, and by the regression analysis, no significant difference was observed ($P>0.05$). The general average was 9.83%, and 5.18% for *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça and *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu, respectively.

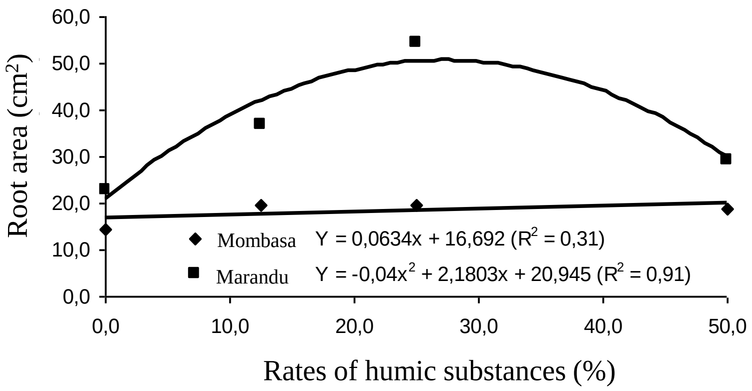

FIGURE 7 - Root area of *Brachiaria brizantha* (Syn. *Urochloa brizantha*), cv. Marandu and *Panicum maximum* (Syn. *Megathyrsus maximus*) cv. Mombaça, under to HS concentrations.

For NDF the behavior was similar to that observed for the crude protein content, with a general average of 72.51% for cv. Mombaça and 72.59% hp. for Marandu.

CONCLUSIONS

The best concentrations of humic substances for better aerial part yield were 50% for cv. Mombaça and 25% for cv. Marandu, but considering that the roots must have the necessary organic reserves for a new regrowth. The best concentrations of humic substances for better root yield were 50% for cv. Mombaça and 25% for cv. Marandu.

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