

Performance of Piatã and Paiaguas Grasses fertilized with Wood Ash in Entisol Soil

ABSTRACT

The aim of this study was to assess the yield of the Piatã and Paiaguás cultivars of the *Urochloa brizantha* grass, grown in the Entisol utilizing wood ash as the fertilizer. Performed under greenhouse conditions, the randomized complete block design was adopted for the experiment in a 2x5 factorial scheme, using two *Urochloa brizantha* cultivars (Piatã and Paiaguás) in five treatments (0, 8, 16, 24 and 32 g dm⁻³) with five replications. The experimental units included plastic pots, 5 dm³ in capacity, filled with Entisol. The soil was enriched with wood ash 30 days prior to planting. Each experimental unit supported the cultivation of five plants. Three evaluations of the plants were done in 30-day intervals, in which the leaf dry weight, shoot dry weight and shoot mass were evaluated. After submitting the data to the analysis of variance, further analysis was done by the Tukey test for the qualitative data (cultivars) and polynomial regression for the quantitative data (doses of wood ash), with up to 5% probability. Comparing the two cultivars, the shoot dry mass production was higher in the Piatã cultivar, in all evaluated cut. As a function of the plant ash doses, the shoot dry mass data were adjusted to the quadratic regression model, with a maximum yield of 26.6 g pot⁻¹ at the dose of 24.47 g dm⁻³ in the third cut. For leaf dry mass, the highest yield was obtained in the dose of 21.8 g dm⁻³ in the first cut, reaching 15.3 g dry mass of leaves per pot. In the third cut, the maximum yield of stalk dry mass was observed at the dose of 24.9 g dm⁻³. This experiment showed that plant ash influenced the dry mass production of the shoots, as well as leaves and shoots of the Piatã and Paiaguás grasses positively, inducing a maximum yield of between 20 and 30 g dm⁻³ of wood ash.

Keywords: Alternative fertilizer, *Urochloa brizantha*, Organic waste

1. INTRODUCTION

Besides other challenges, management of the pasture system must simultaneously encourage the production of sufficient forage for the herd, as well as ensure that the cycle and survival of the forage are uninterrupted [1].

To attain maximum pasture efficiency, many forage cultivars were developed having different adaptations to climate and various soil types. Species belonging to genus *Urochloa* (previously known as *Brachiaria*) are most popular in Brazil for pasture production, and the Piatã and Paiaguas cultivars have been identified as suitable for soils of medium fertility, like the Cerrado soils [2].

The Piatã grass (*Urochloa brizantha* cv. BRS Piatã) bears a close resemblance to the Marandu grass (*Urochloa brizantha* cv. Marandu) in dry mass production, although it reveals a greater percentage of leaves and quicker and higher quality regrowth during the dry seasons, besides showing resistance to the grasshopper pest [3]. The Paiaguás cultivar (*Urochloa brizantha* cv. BRS Paiaguás) was developed for a higher dry mass yield than the Piatã cultivar during the dry season and for higher efficiency under systems of intensive grazing, apart from providing good nutritive value [2].

Pasture is produced principally in an extensive system and planted in areas characterized by soils low in fertility and those lacking appropriate management of fertilization, as the mineral fertilization costs were prohibitive for the cattle rancher. Therefore, a low-cost substitute included the addition of industrial solid waste like wood ash as an excellent option as a fertilizer [4].

Wood ash is the residue acquired from the burning of plant biomass to generate energy in industries. This residue is a good source of phosphorus, potassium, calcium, and magnesium, besides others, based on the source and the time of application to the soil, as it lowers the soil acidity [5].

The wood ash has been studied as a viable alternative as fertilizer [4,6–10]. However, a few studies are available on the ways it affects fodder development and yield, chiefly in the Entisols. This study, therefore, was intended to estimate the output of the two *Urochloa brizantha* cultivars of grass, viz., the Piatã and Paiaguás, cultivated in the Entisol, using wood ash as the fertilizer.

2. MATERIALS AND METHODS

The experiment was conducted in a greenhouse on the premises of the Federal University of Mato Grosso-UFMT, University Campus of Rondonópolis. Based on the Köppen classification of climate, the region experienced the characteristic tropical Aw type, with drought during the winters and rain in summers [11].

The randomized complete block design was adopted for the experiment in a 2x5 factorial scheme, using two *Urochloa brizantha* cultivars (Piatã and Paiaguás) in five treatments (0, 8, 16, 24 and 32 g dm⁻³) with five replications. The wood ash used as a fertilizer was analyzed and found to be composed of Nitrogen (N) = 0.28%; Phosphor (P₂O₅) = 2.98%; Potassium (K₂O) = 3.32%; Zinc (Zn) = 0.011%; Copper (Cu) = 0.011%; Manganese (Mn) = 0.070%; Boron (B) = 0.015%; Calcium (Ca) = 3.15%; Sulfur (S) = 0.15% and PN (Neutralizing Power) = 20.3.

Each experimental unit comprised a plastic pot 5 dm³ in capacity. The Entisol used as potting soil, was brought in from a region supporting Cerrado vegetation. The soil gathered from the 0 to 0.2 m layer was sieved through a 4 mm mesh to ensure the right composition of the experimental unit.

The soil revealed the chemical and granulometric characteristics as given: pH (Calcium Chloride - CaCl₂) = 4.1; Phosphor (P) = 1.1 mg dm⁻³; Potassium (K) = 12 mg dm⁻³; Calcium (Ca) = 0.2 cmol-dm⁻³; Magnesium (Mg) = 0.2 cmol-dm⁻³; Aluminum (Al) = 0.8 cmolc dm⁻³; Hydrogen (H) = 3.0 cmol-dm⁻³; Organic Matter O.M. = 12.3 g dm⁻³; Base Sum (BS) = 0.4 cmol dm⁻³; Cation Exchange Capacity CEC = 4.2 cmolc dm⁻³; sand = 773 g kg⁻¹; silt = 49 g kg⁻¹; clay = 178 g kg⁻¹; and Base Saturation V = 10.4%. According to the reference [12].

Next, the plant ash was combined with the soil and homogenized to suit each treatment. It was then left undisturbed for a 30-day period, with 80% of the field capacity, to lower the soil pH during this incubation process [6].

Post incubation, 10 seeds were sown in each experimental unit. During the establishment period of the crop (i.e. 15 days post-emergence) slabs were made so that only five plants remained per pot at the end of this period. Irrigation was performed during the experiment, adopting the gravimetric method, ensuring that the soil moisture was maintained at 60% of the pot capacity [6].

Nitrogen fertilization was accomplished in each experimental unit utilizing 200 mg dm⁻³ of nitrogen (urea) in three applications - the first (50%) at seven days post-emergence, and the others (25% each) at seven-day intervals. For each evaluation cut, the identical sequence of nitrogen fertilization was repeated.

The plants were evaluated thrice, at every 30-day interval, the first two being done when the plants reached 5 cm of height from the ground level to facilitate regrowth, and the final cut being performed close to the soil. Each time the plants were cut, an analysis was done of the shoot dry mass, leaf dry mass and stalk dry mass.

At each evaluation cut, the leaves on the plant stalks were plucked off and separately packed in paper bags to be dried using forced air at 65 °C until constant mass was achieved. They were then weighed in a semi-analytical balance to record the leaf and stem dry masses. The shoot dry mass was calculated by adding the sum of the dry mass of the leaves and stems.

The data were first submitted to the analysis of variance and, when found to be significant, were further analyzed using the Tukey test for the qualitative data (cultivars) and polynomial regression for

the quantitative data (doses of wood ash), with up to 5% probability, employing the SISVAR statistical program [13].

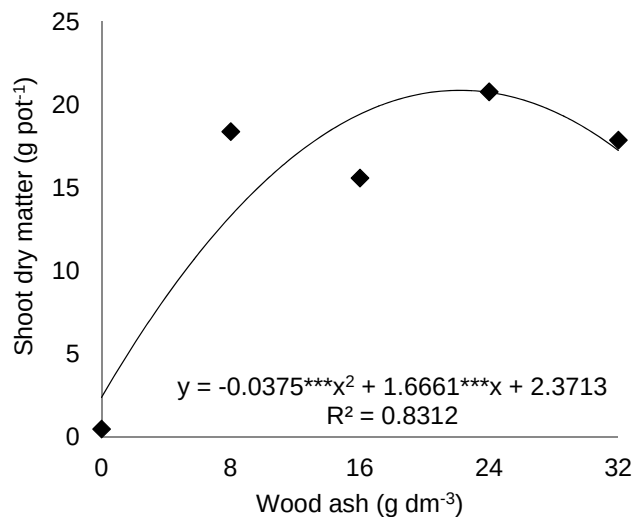
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3. RESULTS AND DISCUSSION

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A notable difference was observed in the yield of the dry mass of the shoot between the two cultivars under study, and the wood ash doses also exerted a strong effect on the variable. At the first cut, the Piatã cultivar revealed the highest value for the dry mass of the shoot (16.44 g pot⁻¹) when compared with that of the Paiaguás cultivar (Table 1). This finding highlighted the fact that the grass species assessed were different in dry mass production when the fertilization management factor was isolated with the wood ash, which emphasizes the significance of examining the features of each cultivar prior to crop implantation.

The data on the production of the aerial dry mass in response to the plant ash doses were adjusted to the quadratic regression model, which revealed that the highest shoot dry mass production (20.9 g pot⁻¹) for the plant ash dose of 22.21 g dm⁻³ (Figure 1). Thus, the wood ash used as fertilizer induces a steady and unhurried solubilization of the macro- and micro-nutrients [14], facilitating the plant to develop according to the wood ash dose supplied to it.



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Fig. 1. Shoot dry matter, at the time of the first cut of the forage grasses cultivated in the Entisol, based on the wood ash doses.

Significant from normal control, *** $P < 0.001$

Shoot dry mass, at the time of the second cut, showed an isolated effect for the factors assessed. The Piatã grass revealed a higher yield of the dry mass of the shoot in comparison to the Paiaguás grass (Table 1), similar to the findings of the first evaluation cut.

Table 1. Shoot dry mass, at the first and second cut, of the Piatã and Paiaguás grasses with wood ash as the fertilizer, in the Entisol

Cultivar	Shoot dry matter (g pot ⁻¹)	
	1º cut	2º cut
Piatã	16,44 a	17,98 a
Paiaguás	12,78 b	15,85 b

Means followed by different letters in the column differ from each other, by the Tukey test ($P = .05$).

Considering the dry mass yield as a response to the plant ash doses as fertilizer, the results were adjusted to the quadratic regression model, and the maximum dry mass of the shoot produced (23.84 g pot⁻¹) was recorded for the wood ash dosage of 23.94 g dm⁻³ (Figure 2).

The authors cited in the reference [7], in their assessment of the forage yield by the genus *Urochloa*, dosed with wood ash as the fertilizer, in two poorly fertile soils, identified a linear behavior in the yield of the shoot dry mass at the time of the first two cuts. The differences between their results and those found in the present study were most likely due to the lower doses cited in the reference [7] compared to the ones employed in this study.

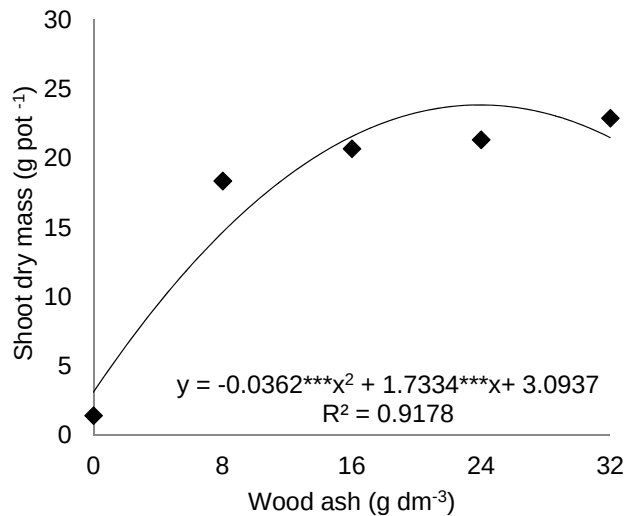


Fig. 2. Shoot dry mass (MSPA) of the forage grasses raised in the Entisol, at the time of the second cut, in response to the wood ash doses.

*Significant from normal control, *** P < 0.001*

At the time of the third cut, a statistical difference was observed between the dry shoot mass values recorded in response to each wood ash dose; therefore, the data were adjusted to the quadratic regression model. The plant ash dose of 24.47 g dm⁻³ induced the highest yield of the dry mass of the shoot (26.60 g pot⁻¹) (Figure 3).

The wood ash added to the soil supporting the pasture increased the grass growth (dry matter yield and plant height), as it induced a greater cumulative nutrient uptake (N, P, K, Na and Ca) post the first year of its application [15].

The wood ash thus added raised the soil pH [6], and because it contains several oxides and hydroxides the wood ash shows alkaline characteristics [16]. By raising the soil pH with the addition of alkaline agents, the soil quality is improved because of the spurt in nitrification and plant productivity [17].

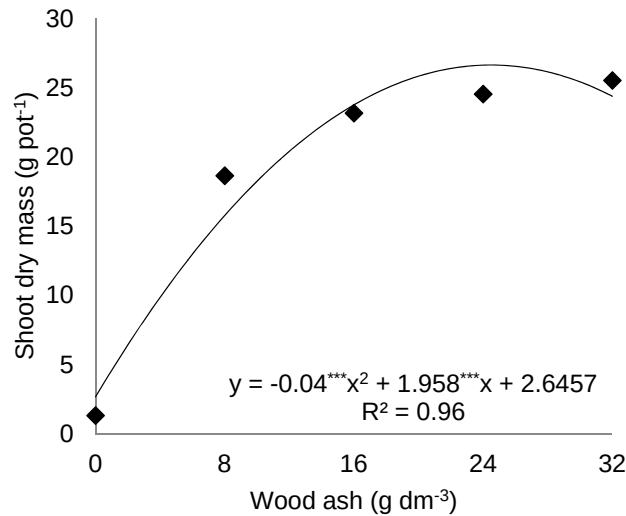


Fig. 3. Shoot dry mass, at the time of the third cut of the forage grasses raised in the Entisol, in response to the plant ash doses.

Significant from normal control, *** $P < 0.001$

On analyzing the dry matter leaf yield of the Piatã and Paiaguás grasses, an isolated difference was noted between the variables of the plant ash and *Urochloa brizantha* cultivars at the time of the first cut.

Among the cultivars assessed, the Piatã grass was prominently showing a greater yield than the Paiaguás grass (Table 2).

The leaf dry matter variable was adjusted to the quadratic regression model for plant ash doses showing the greatest leaf dry matter production (15.3 g pot^{-1}) at the plant ash dosage of 21.8 g dm^{-3} (Figure 4).

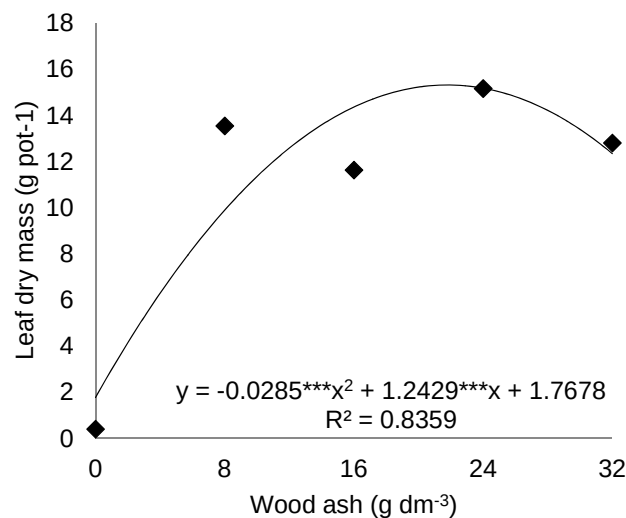


Fig. 4. Leaf dry mass, at the time of the first cut of the forage grasses, in response to the wood ash doses, in the Entisol.

Significant from normal control, *** $P < 0.001$

The second evaluation revealed an isolated difference in the leaf dry mass for the factors of plant ash and *Urochloa brizantha* cultivars. For the grasses, identical to the first evaluation, the Piatã cultivar revealed the greatest dry leaf output (11.09 g pot⁻¹) when compared with the Paiaguás grass (9.6 g pot⁻¹) (Table 2).

Table 2. Leaf dry mass of the Piatã and Paiaguás grasses in the Entisol, with wood ash as the fertilizer.

Cultivar	Leaf dry mass (g pot ⁻¹)	
	1º cut	2º cut
Piatã	12,43 a	11,09 a
Paiaguás	8,98 b	9,60 b

Means followed by different letters in the column differ from each other, by the Tukey test ($P = .05$).

Regarding the plant ash doses, a quadratic regression adjustment was done, with the highest leaf dry matter yield (14.5 g pot⁻¹) observed for the wood ash dose of 23.50 g dm⁻³ (Figure 5).

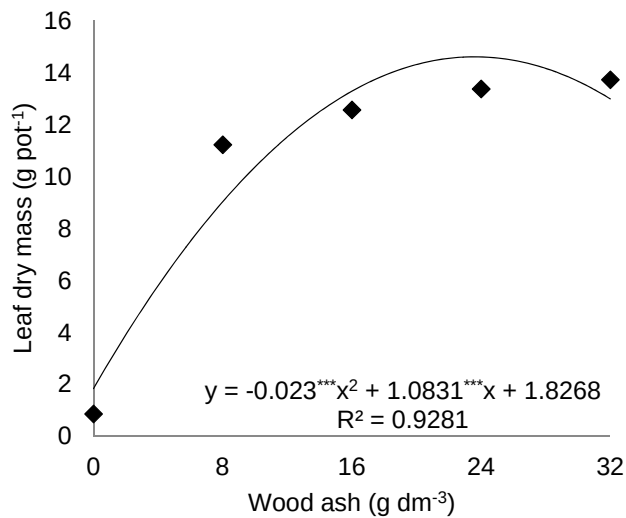


Fig. 5. Leaf dry mass, at the time of the second cut of the forage grasses in the Entisol in response to the wood ash doses.
Significant from normal control, *** $P < 0.001$

At the time of the third cut, a difference was noted in the dry mass of the leaves only for the factor wood ash doses, with adjustment to the quadratic model of regression, to obtain the maximum yield for the various doses of the wood ash. The highest dry matter leaf production (12.5 g pot⁻¹) was seen for the plant ash dosage of 20.1 g dm⁻³ (Figure 6).

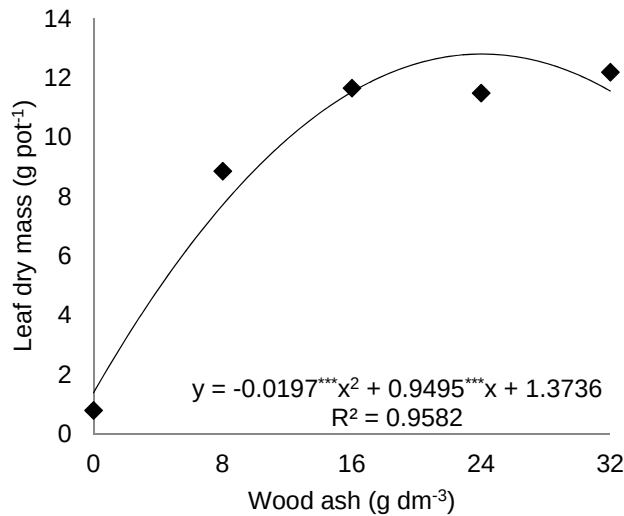


Fig. 6. Leaf dry mass, at the time of the third cut in the forage grasses raised in the Entisol, in response to the plant ash doses.

Significant from normal control, *** $P < 0.001$

On analyzing the dry matter yield of leaves in response to the wood ash doses of up to 15 g dm⁻³, the reference [8], reported a linear adjustment in the yield according to the wood ash doses, recording an output from 2.5 to 10.0 g pot⁻¹ in the three cuts assessed, whereas in the present study the results are higher than the one referred.

The application of wood ash increases of the leaf dry mass, the author mentioned in the reference [18], observed similar results when studying the effects of the application of wood ash on the production of leaf dry mass in *Brachiaria brizantha* cv. Maraundu and Xaraés. In addition to the soil pH corrective effect, wood ash increases the availability of nutrients available to plants [19].

Similar to the present study, increased of the leaf dry mass was observed in *Brachiaria brizantha* cv. Maraundu fertilized with vegetal ash in soils of the Cerrado of Mato Grosso, thus justifying the use of vegetal ash as an alternative fertilizer in pasture management [7].

For the factor stalk dry mass of the Piatã and Paiaguás grasses, an isolated effect was observed only for the wood ash doses, showing a maximum yield of 5.58 g pot⁻¹ of stalk dry mass in response to the wood ash dose of 23.51 g dm⁻³ (Figure 7).

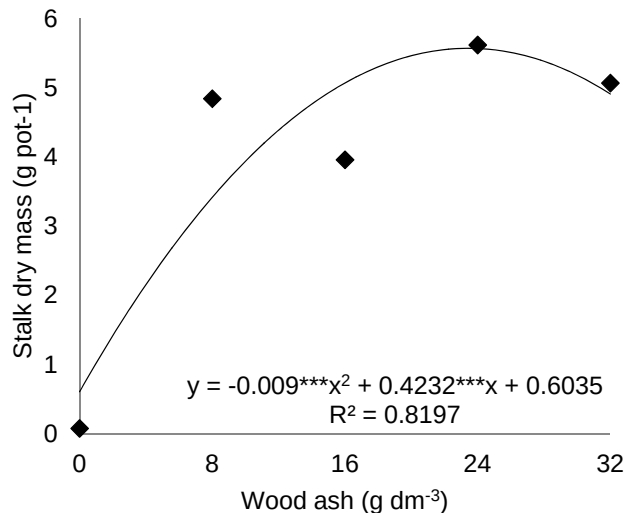


Fig. 7. Stalk dry mass, at the time of the first cut of the forage grasses raised in the Entisol with wood ash as the fertilizer

Significant from normal control, * $P < 0.001$**

At the time of the second cut, the stalk dry mass revealed interaction between the factors, plant ash doses and the *Urochloa brizantha* cultivars, indicating a notable difference between the grasses only in response to the 24 g dm⁻³ dose, in response to which the Paiaguás grass yielded a total of 6.33 g pot⁻¹ of dry mass of the stalks, while the Piatã grass produced 8.85 g pot⁻¹ (Table 3).

Table 3. At the time of the second cut, the interaction between the factors *Urochloa brizantha* cultivars and plant ash doses is noted for the yield of the stalk dry mass.

Cultivar	Wood ash (g dm ⁻³)				
	0	8	16	24	32
Paiaguás	0,094 a	6,301 a	7,082 a	6,325 b	9,038 a
Piatã	0,938 a	7,474 a	7,999 a	8,845 a	8,294 a

Means followed by different letters in the column differ from each other, by the Tukey test ($P = .05$).

In terms of the plant ash doses, the Paiaguás cultivar showed the maximum yield at the wood ash dose of 27.81 g dm⁻³ producing 8.31 g pot⁻¹, while the Piatã grass showed an output of 9.37 g pot⁻¹ of stalk dry mass at the wood ash dose of 22.60 g dm⁻³ (Figure 8).

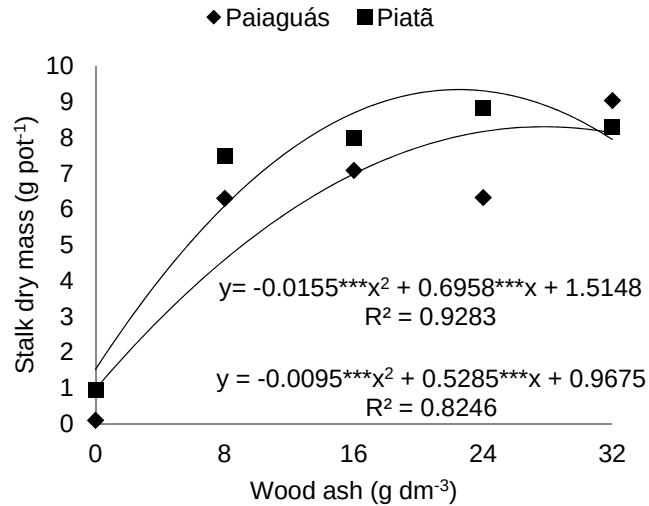


Fig. 8. Stalk dry mass, at the time of the second cut of the forage grasses raised in the Entisol with wood ash as the fertilizer

*Significant from normal control, *** $P < 0.001$*

A comparison of the results of the stalk dry mass with the findings reported by reference [8] reveals a difference between the regression adjustments and the higher yield recorded in the present study.

The yield of the stalk dry mass at the time of the third cut showed a difference only for the factor wood ash doses. The highest stalk dry mass (13.80 g pot⁻¹) was reported for the wood ash dose equivalent to 24.96 g dm⁻³ (Figure 9).

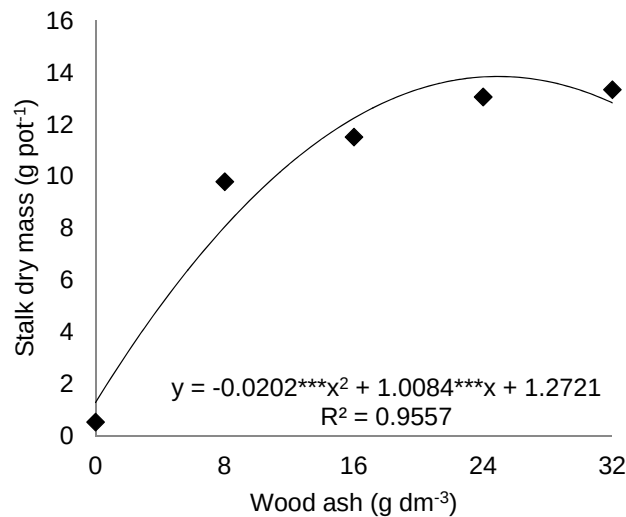


Fig. 9. Stalk dry mass, at the time of the third cut of the grasses, cultivated in the Entisol, in response to the wood ash doses.

*Significant from normal control, *** $P < 0.001$*

The behavior of the results of stalk dry mass was similar to the other variables observed, that is, adjusted to the quadratic model of regression with maximum yields on the doses of wood ash between 22 and 25 g dm⁻³. This behavior demonstrates that the application of wood ash promotes an increase in the total accumulation of dry mass without the loss of grazing quality since the increase in

stalk dry mass yield was similar to the increase in dry mass of leaves. The authors mentioned in reference [20], when they worked *Cynodon dactylon* cv. Coastcross observed a similar behavior.

4. CONCLUSION

The production of leaf, stalk, and shoot dry mass is increased by the fertilization with wood ash, without loss of quality in the pasture produced.

Wood ash improves the conditions of fertility of the Entisol soil, promoting a better development environment of the Piatã and Paiaguás grasses. The ideal dose of wood ash for maximum grass yield is between 20 and 30 g dm⁻³.

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