

Piatã and Paiaguás grass fertilized with wood ash in Entisol

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 in 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. 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 Paiaguás 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].

To assess the influence of the nutrient content of soybean grains, a study was undertaken to assess the consequences of adding soybean oil to the soybean grain yield [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. MATERIAL AND METHODS

The experiment was conducted in a greenhouse on the premises of the Federal University of Mato Grosso-UFMT, Campus Universitário de 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 N = 0.28%; P₂O₅ = 2.98%; K₂O = 3.32%; Zn = 0.011%; Cu = 0.011%; Mn = 0.070%; B = 0.015%; Ca = 3.15%; 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 [12], 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 for the experimental unit. The soil revealed the chemical and granulometric characteristics as given: pH (CaCl₂) = 4.1; P = 1.1 mg dm⁻³; K = 12 mg dm⁻³; Ca = 0.2 cmol-dm⁻³; Mg = 0.2 cmol-dm⁻³; Al = 0.8 cmolc dm⁻³; H = 3.0 cmol-dm⁻³; M.O. = 12.3 g dm⁻³; SB = 0.4 cmol dm⁻³; CTC = 4.2 cmolc dm⁻³; sand = 773 g kg⁻¹; silt = 49 g kg⁻¹; clay = 178 g kg⁻¹; and V = 10.4%.

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].

3. RESULTS AND DISCUSSION

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 Paiguás 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.

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

Cultivar	Shoot dry matter (g pot^{-1})
Piatã	16,44 a
Paiguás	12,78 b

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

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.

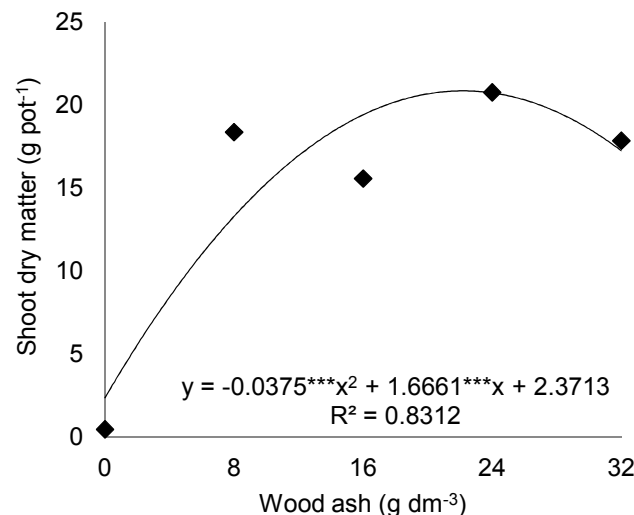


Fig. 1. Shoot dry matter, at the time of the first cut of the forage grasses cultivated in the Entisol, based on the wood ash doses.

Test drugs: 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 Paiguás grass (Table 2), similar to the findings of the first evaluation cut.

Table 2. Shoot dry mass, at the second cut, of the Piatã and Paiguás grasses with wood ash as the fertilizer, in the Entisol

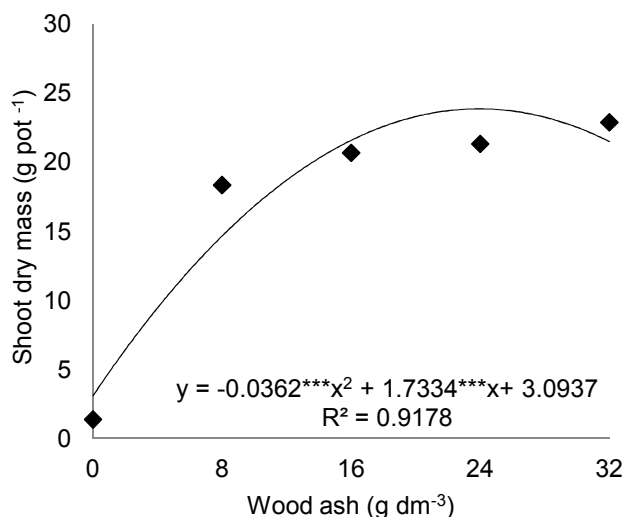
Cultivar	Shoot dry mass (g pot^{-1})
Piatã	17,98 a
Paiguás	15,85 b

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

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

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

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120

121 **Fig. 2. Shoot dry mass (MSPA) of the forage grasses raised in the Entisol, at the time of the**
 122 **second cut, in response to the wood ash doses.**
 123 **Test drugs:** significant from normal control, *** $P < 0.001$

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

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

131 The wood ash thus added raised the soil pH [6], and because it contains several oxides and
 132 hydroxides the wood ash shows alkaline characteristics [16]. By raising the soil pH with the addition of
 133 alkaline agents, the soil quality is improved because of the spurt in nitrification and plant productivity
 134 [17].

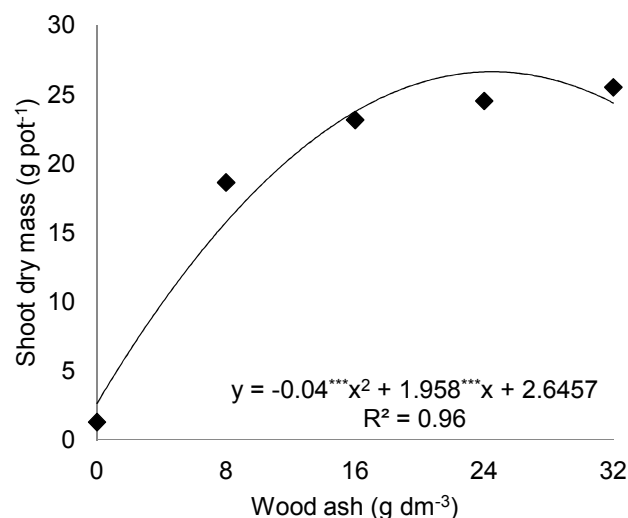


Fig. 3. Shoot dry mass, at the time of the third cut of the forage grasses raised in the Entisol, in response to the plant ash doses.

Test drugs: 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 3).

Table 3. Leaf dry mass (g pot⁻¹) of the Piatã and Paiaguás grasses raised in the Entisol with wood ash as the fertilizer.

Cultivar	Massa seca de folhas (g pot ⁻¹)
Piatã	12,43 a
Paiaguás	8,98 b

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

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).

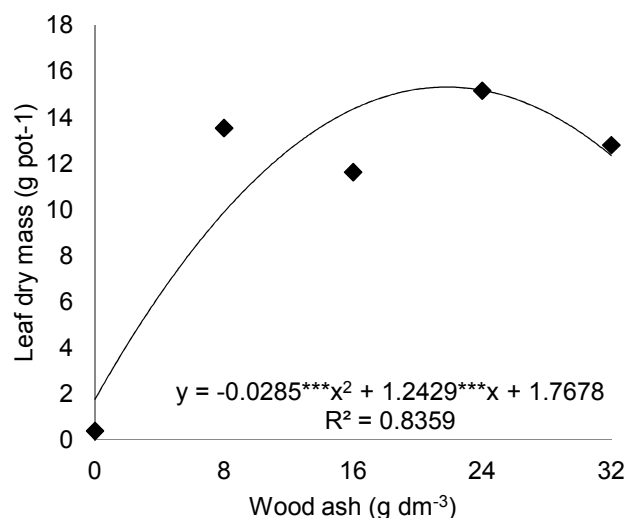


Fig. 4. Leaf dry mass, at the time of the first cut of the forage grasses, in response to the wood ash doses, in the Entisol.

Test drugs: 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 4).

Table 4. Leaf dry mass of the Piatã and Paiaguás grasses in the Entisol, with wood ash as the fertilizer.

Cultivar	Massa seca de folhas (g pot^{-1})
Piatã	11,09 a
Paiaguás	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).

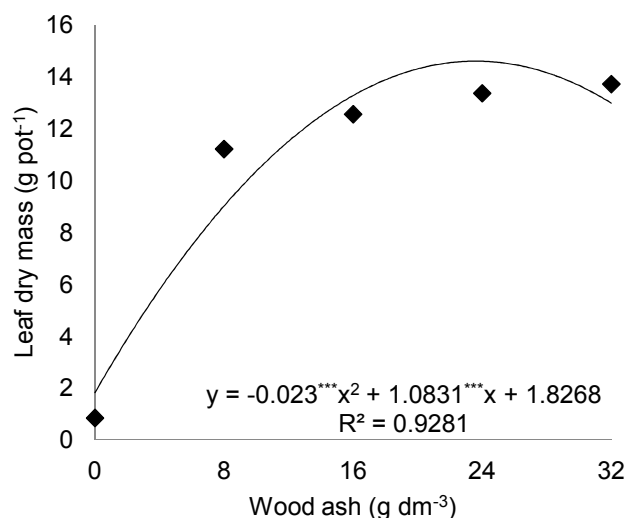


Fig. 5. Leaf dry mass, at the time of the second cut of the forage grasses in the Entisol in response to the wood ash doses.

*Test drugs: 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).

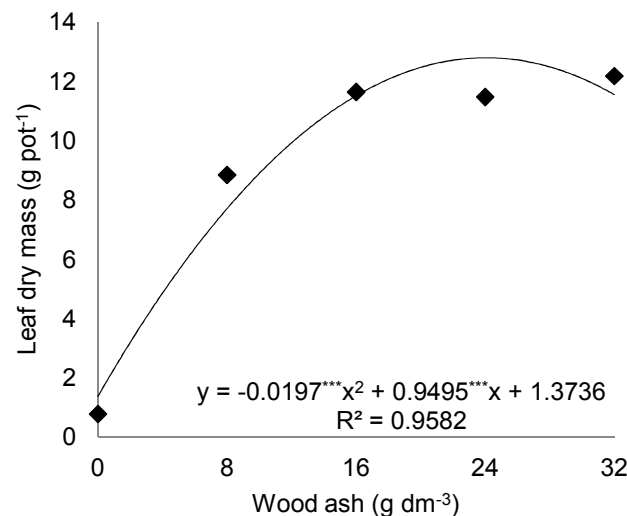


Fig. 6. Leaf dry mass, at the time of the third cut in the forage grasses raised in the Entisol, in response to the plant ash doses.

*Test drugs: 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.

For the factor dry mass of shoots 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).

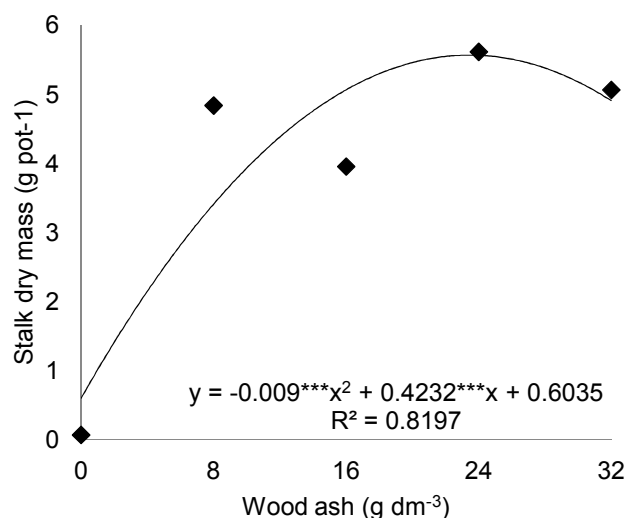


Fig. 7. Stalk dry mass, at the time of the first cut of the forage grasses raised in the Entisol with wood ash as the fertilizer

Test drugs: 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 5).

Table 5. 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).

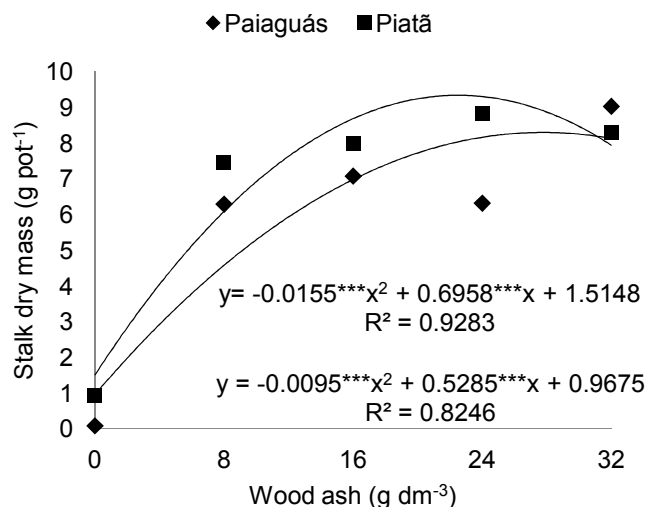


Fig. 8. Stalk dry mass, at the time of the second cut of the forage grasses raised in the Entisol with wood ash as the fertilizer

Test drugs: 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).

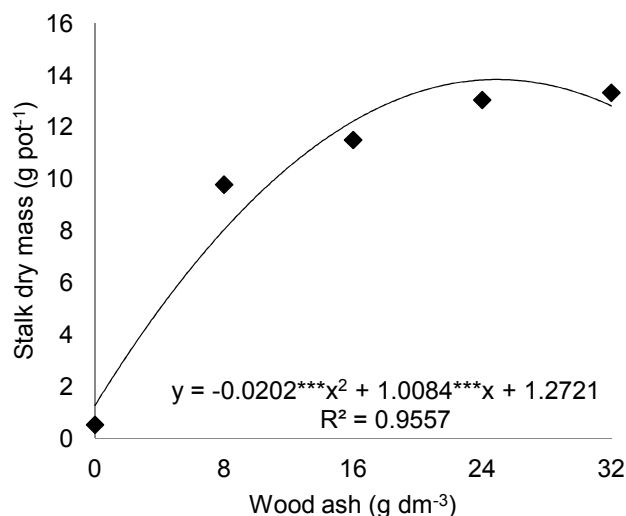


Fig. 9. Stalk dry mass, at the time of the third cut of the grasses, cultivated in the Entisol, in response to the wood ash doses.

Test drugs: significant from normal control, *** $P < 0.001$

4. CONCLUSION

Wood ash was found to influence the dry mass production of the shoot, leaves, and stalk of the Piatã and Paiaguás grasses positively, producing the maximum yield in the experimental interval of wood ash in the 20 and 30 g dm^{-3} dosage.

The Piatã grass induced a larger quantity of the shoot dry mass, including the leaves and stems.

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