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Ash-based organomineral fertilizer improves soil chemical quality and forage yield of *Urochloa brizantha*

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Abstract: A promising strategy that is gaining ground in agricultural production is the use of organomineral fertilizers as a sustainable alternative for forage production, which allows for the reuse of agroindustrial waste and reduces dependence on synthetic fertilizers. Thus, the objective of this research was to evaluate the effect of an organomineral fertilizer based on biomass ash on the chemical attributes of the soil and the agronomic performance of *Urochloa brizantha* cultivars (BRS Piatã and Marandu) under controlled conditions. The experiment was conducted in a protected environment, in a randomized block design arranged in a 6 x 2 factorial scheme with four replicates. Throughout the forage cycle, soil pH, SPAD index, shoot dry mass productivity, root volume, and root dry mass were evaluated. The use of organomineral fertilizer contributed to pH increases above 50%, SPAD index approximately 23 units higher than treatments without this fertilizer, and a 45% increase in aerial and root mass productivity, with these increases varying with the genetics of the cultivars. The Marandu cultivar obtained higher shoot dry mass productivity, while Piatã showed higher SPAD index values. The use of biomass ash is an effective and sustainable alternative as a component of organomineral fertilizers for the sustainable and productive management of tropical grasses.

Keywords: Wood ash; Agricultural reuse; Alternative fertilizers; Biomass ash; Forage crops; Soil fertility; Sustainable development goals.

Introduction

Organomineral fertilizers, formulated from a mixture of organic materials and mineral sources, have been studied as alternatives to increase fertilization efficiency and improve soil quality in sustainable agricultural systems (Albuquerque et al., 2021; Bouhia et al., 2022; Chojnacka et al., 2025). Such fertilizers have been used as a promising strategy aimed at increasing the efficiency with which plants use nutrients, as well as reducing dependence on synthetic fertilizers, whose production chain is highly energy-intensive, emits greenhouse gases, and is associated with significant environmental impacts, such as the acidification of water bodies and the degradation of terrestrial ecosystems (Demir et al., 2023; Dzvene et al., 2024).

One approach that has gained prominence is the use of agro-industrial waste, such as wood ash from plant biomass, in the production of organomineral fertilizers since this practice mitigates the environmental impacts of synthetic fertilizers, such as high fossil energy consumption, greenhouse gas emissions, and degradation of agro-ecosystems (Kalita et al., 2024; Mohanty et al., 2025). This practice promotes the reuse of by-products and reduces dependence on mineral inputs, aligning with the Sustainable Development Goals -SDG, which are: SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action) (ONU - United Nations Brazil, 2025).

The advantages of wood ash from plant biomass are its high corrective and fertilizing potential, as it contains essential nutrients such as calcium, magnesium, potassium, and phosphorus, as well as contributing to raising the pH and reducing soil acidity by neutralizing exchangeable aluminum and converting hydrogen into hydroxyl (Bonfim-Silva et al., 2022; Elliott et al., 2022; Lopes et al., 2021). In this context, the use of organomineral fertilizers formulated with wood ash provides improvements in the soil's physical and chemical attributes (Meneghetti et al., 2025), reducing operating costs by making it feasible to apply organic and mineral components together, as well as increasing the production of fresh and dry mass of forage plants and the soil's pH (Oshunsanya et al., 2014; Uddin et al., 2025).

These benefits have been corroborated by recent studies with grasses and other species Oliveira et al. (2023), which showed increases of up to 66.3% in shoot dry mass, 69.6% in root dry mass, and 47% in leaf area of *Panicum maximum* cv. BRS Zuri, compared to conventional mineral fertilizer. In a complementary way, in an experiment with chrysanthemum, Meneghetti et al. (2023) and Meneghetti et al. (2025) demonstrated, that the use of organomineral fertilizer based on biomass ash increased shoot and root dry mass, root volume, and water use efficiency, surpassing the performance of mineral fertilization. In addition, the application of the organomineral increased the pH of the soil even in the absence of liming.

Although the effects of organomineral fertilizers have already been observed in forage species such as *Panicum maximum*, there is still a need for specific studies on widely used tropical forage crops, such as the cultivars of *Urochloa brizantha* (cv. BRS Piatã and Marandu). These cultivars stand out in Brazil due to their adaptability, hardiness, and high yields, playing an essential role in the production of hay and silage (Ribeiro Martins, 2023). Recent studies on these species have demonstrated that the application of organomineral fertilizers enhances soil fertility and nutrient availability, thereby contributing to increased forage production (Costa et al., 2022; Omete et al., 2021).

Given this context, the hypothesis is that the application of increasing doses of organomineral fertilizer based on wood ash improves soil pH, the SPAD index, shoot dry mass productivity, as well as the volume and dry mass of the roots of *Urochloa brizantha* cultivars (cv. BRS Piatã and Marandu). This research aimed to evaluate the effects of organomineral compost, formulated with wood ash from plant biomass, on soil pH, SPAD index, shoot dry mass productivity, volume, and root dry mass of two cultivars of *Urochloa brizantha* under controlled conditions.

Results

Thirty days after plant emergence, soil pH was significantly influenced by the doses of organomineral fertilizer and cultivars alone ($p \leq 0.01$), the SPAD index was significantly influenced only by the doses of organomineral fertilizer ($p \leq 0.01$), and the shoot dry mass was influenced by the interaction between the doses of organomineral fertilizer and the cultivars of *Urochloa brizantha* ($p \leq 0.05$) (Table 3).

At 60 DAE, the SPAD index varied significantly only among the cultivars analyzed ($p \leq 0.05$), while the interaction between the doses of organomineral fertilizer and the cultivars of *Urochloa brizantha* significantly influenced soil pH and shoot dry mass productivity ($p \leq 0.01$) (Table 3). At 90 DAE, soil pH and SPAD index of plants were influenced by the interaction between organomineral fertilizer doses and *Urochloa brizantha* cultivars, while shoot dry mass productivity, root volume, and root dry mass were influenced by the factors in isolation (Table 3).

At 30 DAE, there was a linear increase in soil pH as a function of higher doses of organomineral fertilizer, with pH ranging from 5.1 to 6.16 from the lowest to the highest dose, respectively (Figure 1A). In addition, the pH of the soil cultivated with *Urochloa brizantha* cv. Marandu (5.75) was significantly higher than the pH of the soil cultivated with Piatã (5.51) (Figure 1B).

The increase in organomineral fertilizer doses promoted a linear increase in soil pH for the two cultivars evaluated at 60 and 90 DAE (Figures 2a and b). At 60 DAE, the pH of the soil cultivated with Marandu grass ranged from 3.59 in the control treatment to 4. 88 at a dose of 25 g kg^{-1}, while the soil cultivated with Piatã grass varied from 3.74 to 5.62 between the lowest and highest fertilizer doses, showing an increase of 35.93% and 50.27%, respectively (Figure 2A).

At 90 DAE, the soil pH with the Marandu cultivar increased by 51.98%, rising from 3.54 in the control treatment to 5.38 at the organomineral fertilizer dose of 25 g kg^{-1} (Figure 2B). In the soil cultivated with Piatã grass, the pH ranged from 3.41 in the soil without organomineral fertilizer application to 4.36 in the highest dose, representing an increase of 27.86% in the respective variable (Figure 2B).

The SPAD index of *Urochloa brizantha* plants adjusted polynomially to the increase in doses of organomineral fertilizer at 30 DAE (Figure 3A). The dose of 18.09 g kg^{-1} resulted in the highest SPAD index, corresponding to 51.27 units. At 60 days after plant emergence, the SPAD index of the Piatã cultivar (32.83 units) was 19% higher than that of the Marandu cultivar (Figure 3b).

At 90 DAE, the highest SPAD index value for the Piatã cultivar was 41.03 units at the estimated dosage of 19.01 g kg^{-1} (Figure 4). For the Marandu cultivar, no significant variations were observed as a function of the different doses of organomineral fertilizer, obtaining an average SPAD index of 30.92 units (Figure 4).

At 30 DAE, organomineral fertilizer doses of 17.11 and 21.62 g kg^{-1} provided the highest shoot dry mass productivity (SDMP) for the Marandu and Piatã cultivars, corresponding to 1.35 and 1.47 g pot^{-1}, respectively (Figure 5A). At 60 DAE, the highest SDMP for the Marandu and Piatã cultivars was observed at doses of 19.19 and 21.1 g kg^{-1}, corresponding to 11.09 and 8.79 g pot^{-1} (Figure 5B).

At 90 DAE, the doses of organomineral fertilizer provided a linear increase in the shoot dry mass of the plants, ranging from 0.42 to 2.96 g pot^{-1} between the lowest and highest doses (Figure 6A). At the same time, the Marandu cultivar (2.19 g pot^{-1}) had 45.2% higher SDMP than the Piatã cultivar, both statistically different (Figure 6B).

The estimated dose of organomineral fertilizer of 17.68 g kg^{-1} promoted the highest root volume (RV), corresponding to 178.89 mL (Figure 7A). The highest root dry mass (RDM) was observed at the estimated organomineral fertilizer dose of 17.28 g kg^{-1}, equivalent to 54.92 g pot^{-1} (Figure 7B).

Marandu grass obtained the highest root volume and dry mass compared to the Piatã cultivar, differing statistically ($p \leq 0.001$) (Figure 8A and B). Root volume and dry mass varied by 34.3 and 46.6% between Marandu and Piatã grass, respectively.

In order to verify possible correlations between soil pH, favored by the addition of organomineral fertilizer, and plant biomass variables, Pearson's correlation test was performed. In all seasons evaluated, significant correlations were observed between soil pH and shoot dry mass productivity (SDMP) of *Urochloa brizantha* plants, indicating an increase in SDMP as a result of increased soil pH (Table 4).

Discussion

The results confirm the hypothesis that the application of organomineral fertilizer, formulated based on wood ash, promoted increases in soil pH, SPAD index, shoot dry mass productivity, root volume, and root dry mass of *Urochloa brizantha* cultivars (cv. BRS Piatã and Marandu). In addition, different behaviors were observed between cultivars, with the Marandu cultivar showing a greater accumulation of shoot dry mass and root system, while Piatã showed a higher SPAD index. Thus, the efficiency of organomineral fertilization is influenced by the cultivar used, and the formulated organomineral fertilizer has the potential to be an acidity corrector and source of mineral nutrients.

Given this scenario, the use of organomineral fertilizer, obtained from the formulation of agroindustrial waste (wood ash) plus synthetic mineral fertilizer, is a current technique that prioritizes mitigating the excessive use of synthetic fertilizers, whose production chain is highly polluting and generates severe impacts on agroecosystems (Demir et al., 2023; Dzvene et al., 2024).

Table 1. Chemical and granulometric characterization of the Latossolo Vermelho (equivalent to Ferralsol) collected in the 0-0.20 m layer prior to setting up the experiment.

pH	Al	H+Al	Ca	Mg	K	CEC	SB	V	m	OM
$CaCl_2$	-----------cmolc kg^{-1}-----------				g kg^{-1}	cmolc kg^{-1}		---------%--------		g kg^{-1}
4.30	0.60	4.80	0.50	0.20	0.018	5.58	0.80	13.50	44.40	21.30
P	S	Zn	Cu	Fe	Mn	B		Clay	Sand	Silt
-----g kg^{-1}-----		-----------------mg kg^{-1}-----------------						------------g kg^{-1}------------		
0.0015	0.002	0.70	0.20	64.0	21.80	0.15		570	330	100

Al: Aluminum; H: Hydrogen; Ca: Calcium; Mg: Magnesium; K: Potassium; CEC: Cation Exchange Capacity; SB: Sum of bases; V: Base Saturation; m: Aluminum Saturation; OM: Organic Matter; P: Phosphorus; S: Sulfur; Zn: Zinc; Cu: Copper; Fe: Iron; Mn: Manganese; B: Boron.

Table 2. Chemical characterization of the wood ash used to formulate the organomineral fertilizer. The material was evaluated for its corrective potential (pH, neutralizing power - NP, relative total neutralizing power - RTNP) and fertilizing potential (macro and micronutrients).

pH	NP	RTNP	N	P_2O_5	K_2O	S	Ca	Mg	Zn	Cu	Fe	Mn	B
$CaCl_2$	------%------		------------------g kg^{-1}------------------						------------mg kg^{-1}-------------				
10.67	30.0	24.76	4.90	7.90	32.5	6.0	49.60	42.0	200	1000	7200	400	400

Table 3. Summary of variance analysis for SPAD index, shoot dry mass productivity (SDMP), root volume (VR), and root dry mass (MSR) of *Urochloa brizantha* cultivated with doses of organomineral fertilizer.

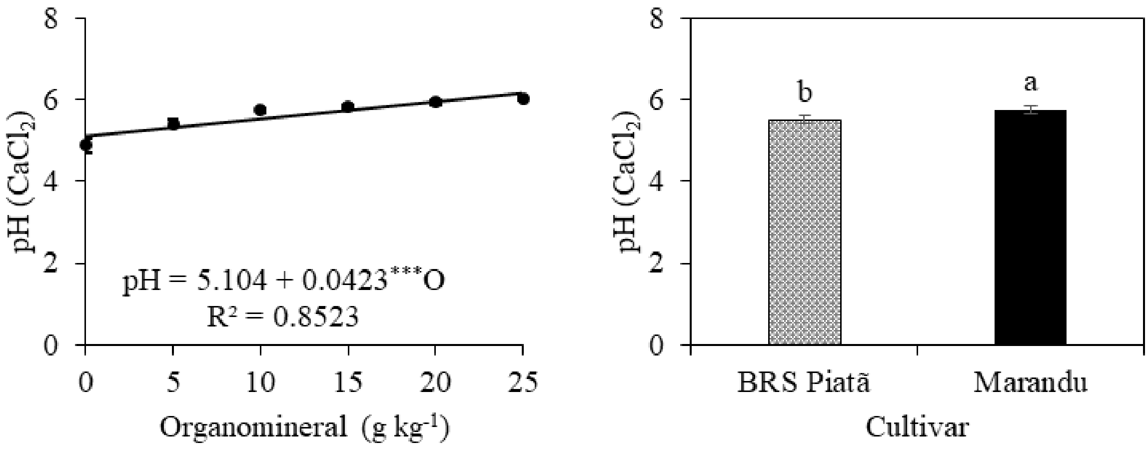
SV	DF	SPAD	SDMP (g pot^{-1})	RV (mL pot^{-1})	RDM (g pot^{-1})
		Mean Squares			
		30 DAE			
Block	3	19.86^{ns}	0.198^{*}	-	-
Dose (D)	5	731.21^{***}	2.037^{***}	-	-
Cultivar (C)	1	17.8^{ns}	0.004^{ns}	-	-
D x C	5	44.85^{ns}	0.137^{*}	-	-
Error	33	25.44	0.046	-	-
CV (%)		11.46	21.41	-	-
		60 DAE			
Block	3	21.641^{ns}	1.025^{ns}	-	-
Dose (D)	5	100.60^{ns}	105.37^{***}	-	-
Cultivar (C)	1	476.50^{*}	35.312^{***}	-	-
D x C	5	61.715^{ns}	2.101^{**}	-	-
Error	33	69.462	0.474	-	-
CV (%)		28.05	10.07	-	-
		90 DAE			
Block	3	30.833^{ns}	0.306^{ns}	2262.59^{ns}	5.006^{*}
Dose (D)	5	473.35^{***}	7.811^{***}	30573.06^{**}	30.852^{***}
Cultivar (C)	1	13.335^{ns}	11.725^{***}	35466.1^{***}	38.235^{***}
D x C	5	473.614^{***}	0.441^{ns}	1944.78^{ns}	2.656^{ns}
Error	33	73.466	0.199	785.52	1.666
CV (%)		28.2	26.45	21.37	22.04

SV: sources of variation; CV: coefficient of variation; DF: degrees of freedom; ns, *, **, and ***: not significant, and significant at $p \leq 0.05$, $p \leq 0.01$, and $p \leq 0.001$ by the F-test, respectively. DAE: Days after emergence.

Table 4. Pearson correlation between soil pH and shoot dry mass productivity (SDMP) of *Urochloa brizantha* plants at 30, 60, and 90 DAE.

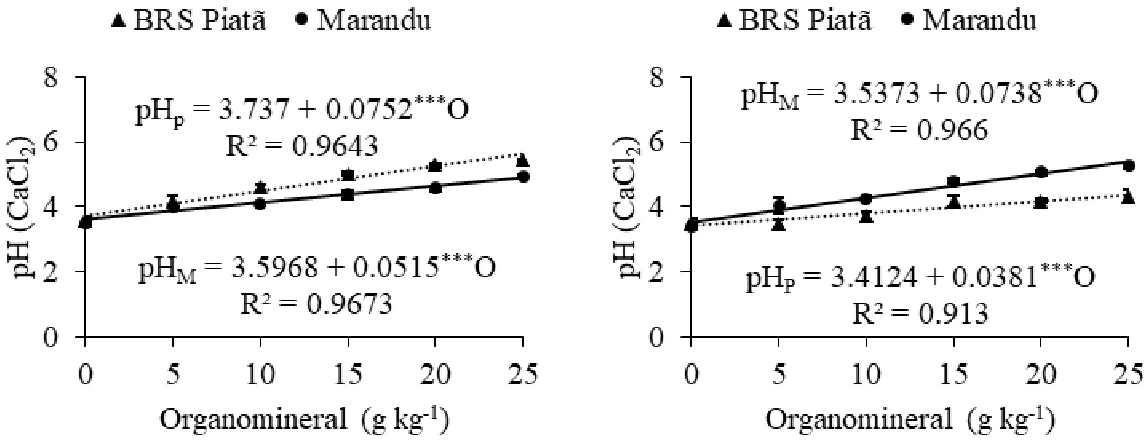
	$SDMP_{30DAE}$	$SDMP_{60DAE}$	$SDMP_{90DAE}$
pH_{30DAE}	0.753^{***}	-	-
pH_{60DAE}	-	0.699^{***}	-
pH_{90DAE}	-	-	0.829^{***}

***Significant at a probability of 0.001. DAE: Days after emergence.



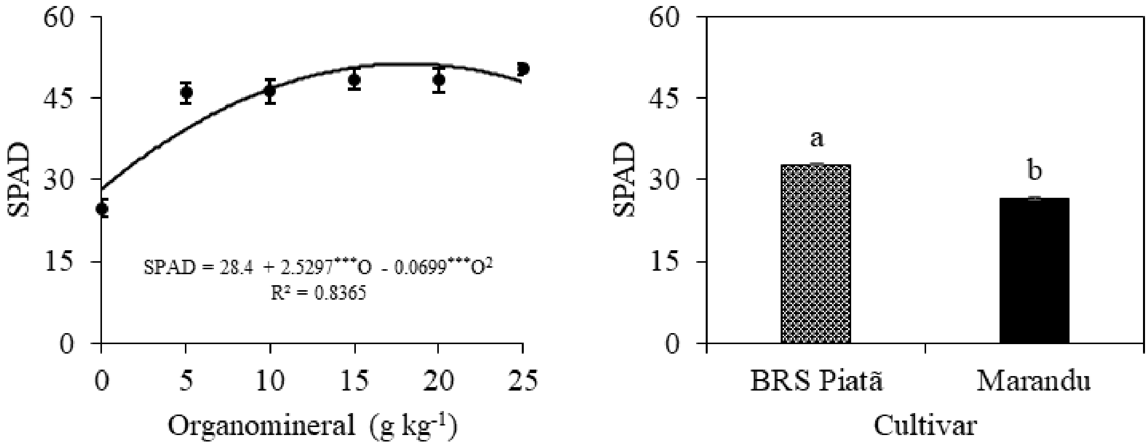
(A) (B)

Figure 1. Soil pH as a function of doses of organomineral fertilizer (0, 5, 10, 15, 20 e 25 g kg^{-1}) (A) and Tukey test for soil pH between the BRS Piatã and Marandu cultivars (B) at 30 days after emergence.



(A) (B)

Figure 2. Soil pH of the BRS Piatã and Marandu cultivars as a function of organomineral fertilizer doses at 60 (A) and 90 (B) days after emergence.



(A) (B)

Figure 3. SPAD index of *Urochloa brizantha* plants as a function of organomineral fertilizer doses at 30 days after emergence (A) and Tukey test for the SPAD index between BRS Piatã and Marandu cultivars (B) at 60 days after emergence.

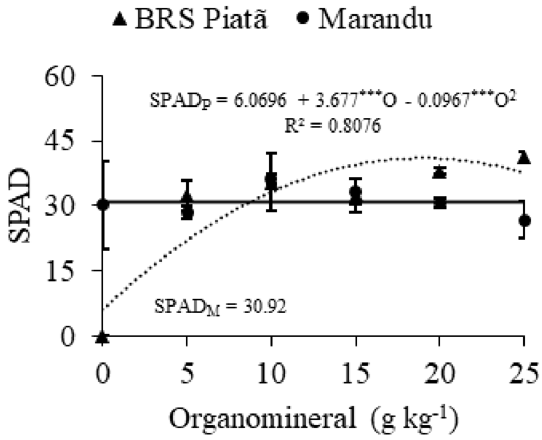
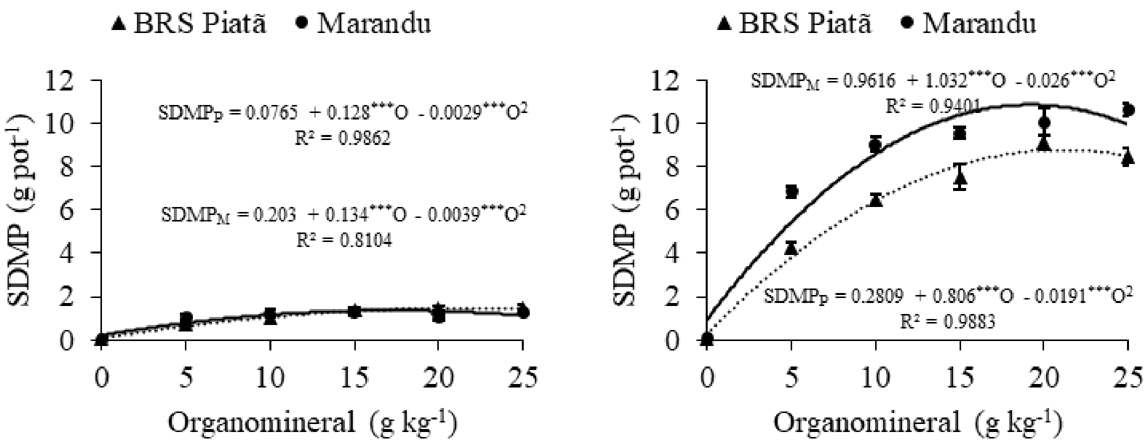
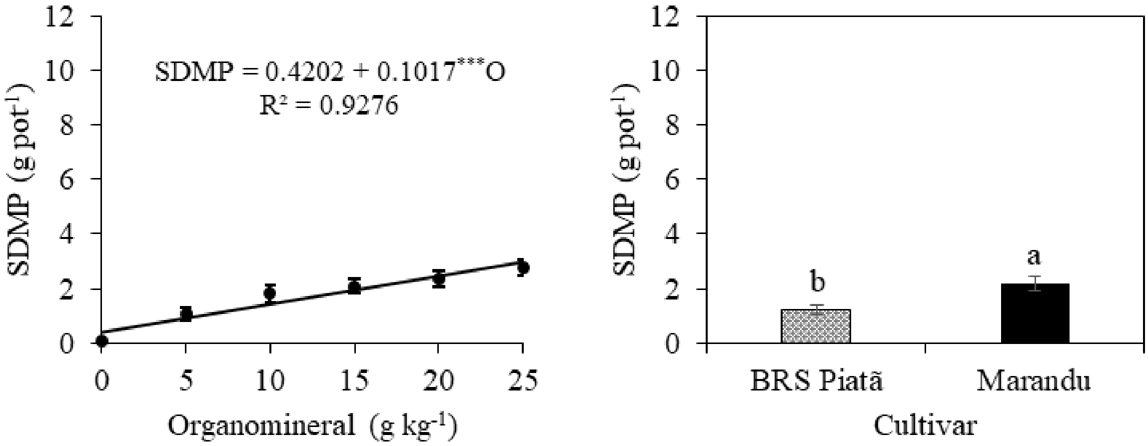


Figure 4. SPAD index of the BRS Piatã and Marandu cultivars as a function of organomineral fertilizer doses at 90 days after emergence. of the plants.



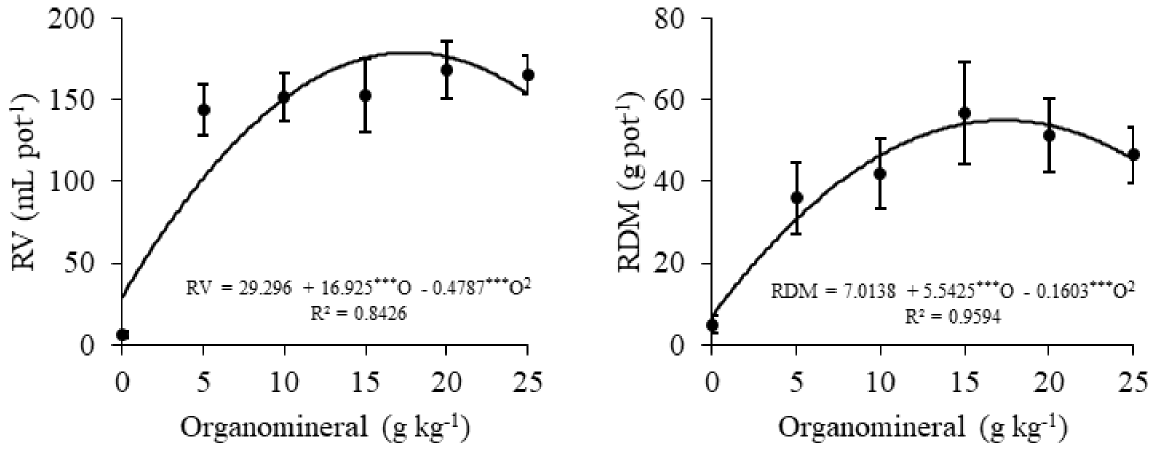
(A) (B)

Figure 5. Shoot dry mass productivity (SDMP) of the cultivars BRS Piatã and Marandu as a function of doses of organomineral fertilizer at 30 (A) and 60 (B) days after emergence.



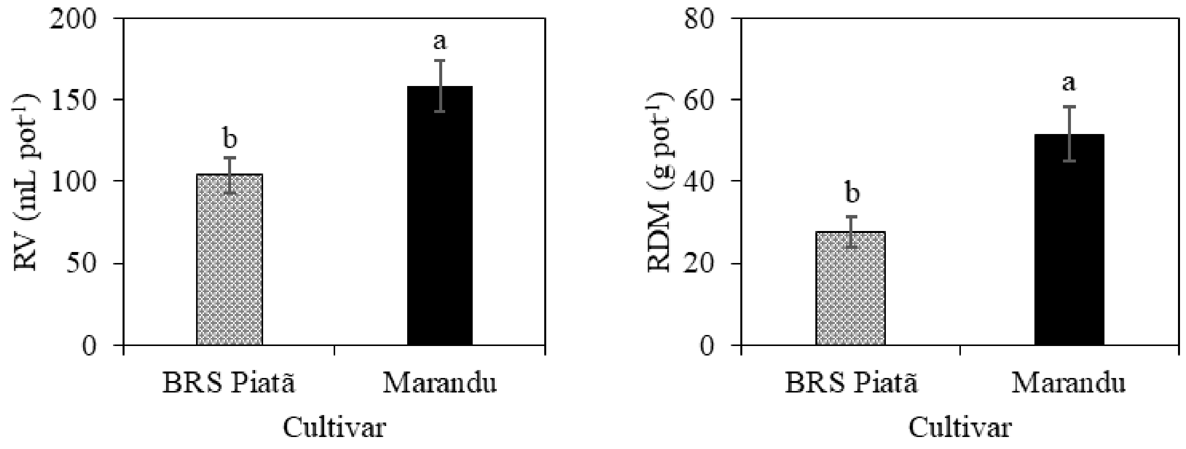
(A) (B)

Figure 6. Shoot dry mass productivity (SDMP) of *Urochloa brizantha* plants as a function of organomineral fertilizer doses (A) and Tukey test for SDMP between the BRS Piatã and Marandu cultivars (B) at 90 days after emergence.



(A) (B)

Figure 7. Root volume (RV) (A) and root dry mass (RDM) (B) of *Urochloa Brizantha* plants as a function of organomineral fertilizer doses.



(A) (B)

Figure 8. Comparison test of mean root volume (A) and dry mass (B) between the BRS Piatã and Marandu cultivars.

The increase in soil pH with increasing doses of organomineral fertilizer is directly associated with the presence of calcium, magnesium, and potassium oxides and carbonates in agroindustrial waste (wood ash), the main component of the fertilizer produced. The reaction process that causes the neutralization of H^+ and insolubilization of exchangeable Al^{3+} promotes an increase in base saturation and a reduction in potential acidity, with consequent acidity correction (Uddin et al., 2025). The corrective effect was evident in all cutting seasons and cultivars evaluated, with increases above 50% in the initial pH to the highest dose applied (25 g kg^{-1} of soil), reaffirming the corrective efficiency of the organomineral fertilizer.

The increase in the hydrogen ion potential of the soil is reported in several studies, such as those by Meneghetti et al. (2023); Meneghetti et al. (2025); Oliveira et al. (2023), who studied organomineral fertilizers based on agroindustrial waste (wood ash) in soils cultivated with both grass and chrysanthemums, indicating the consistency of the corrective effect, regardless of the species.

The indirect measurement of chlorophyll content in the leaves of *Urochloa brizantha* (cv. BRS Piatã and Marandu) was obtained using the SPAD Index, which was directly influenced by the increase in the dose of organominerals fertilizer up to a threshold of approximately 18. 55 g kg^{-1}, which represents a gain in the SPAD index of 41.09 units regardless of the cutting season. The increase in the SPAD index resulting from the application of fertilizer based on wood ash is related to its association with mineral fertilizer rich in phosphorus, potassium, and nitrogen.

The mineral nutrients in the fertilizer, combined with the fractional application of nitrogen in each cut, contributed to the increase in the SPAD index since potassium plays a fundamental role in the osmotic regulation of plants, controlling the opening and closing of stomata, regulating the entry of CO_2 necessary for photosynthesis, as well as helping with osmoregulation, maintaining the water balance of the leaves (Hasanuzzaman et al., 2018; Sardans et al., 2021). It should also be noted that magnesium is the structural molecule of chlorophyll and an enzyme activator for the functioning of the Rubisco enzyme, responsible for CO_2 fixation in the Calvin cycle (Chen et al., 2018).

Based on the report, it is evident that increasing doses of fertilizer, associated with nitrogen input, contribute to the photosynthetic capacity of forage plants, reflected in the higher concentration of chlorophyll present in the leaves, quantified by the SPAD index, so that the higher the SPAD index, the greater the gain in terms of forage productivity (Oliveira et al., 2023; Taiz et al., 2021).

The shoot dry mass productivity of *Urochloa brizantha* cultivars increased significantly with the use of organomineral fertilizer. Doses between 17 and 21 g kg^{-1} were the most efficient, according to regression analysis. The strong correlation between soil pH and SDMP (r from 0.699 to 0.829) indicates that the increase in pH was a determining factor for the increase in productivity, as demonstrated by (Uddin et al., 2025)

The effect is attributed to the correction of soil acidity and the supply of nutrients present in wood ash, such as calcium, magnesium, phosphorus, and potassium, in combination with nitrogen fertilizer. These nutrients are essential for vegetative development and the synthesis of shoot biomass (Bonfim-Silva et al., 2022).

The Marandu cultivar showed greater biomass accumulation in the shoot compared to Piatã, indicating a greater response to organomineral fertilizer management. It shows that the productive response is associated with both the dose and the cultivar used.

The performance of root variables, root volume, and root dry mass reinforces the positive effects of organomineral fertilizer application. The increase in soil pH reduces aluminum toxicity. It increases nutrient availability, which is corroborated by a significant increase up to a dose of 17 g kg^{-1} for root volume and dry mass, as there is a greater supply of macro- and micronutrients.

The morphological architecture of the grass root improves proportionally with the increase in P and K absorption provided by the alternative fertilizer (Zhang et al., 2023). These results show the direct effect of the increase in root volume as well as root dry mass of plants, which contributes to the greater synthesis of photoassimilates in the leaves. It occurs because, with root growth, there is a greater area of contact and exploration for nutrient absorption (Taiz et al., 2021). It reinforces the importance of sources that efficiently provide these nutrients to plant roots, such as wood ash used in the formulation of organomineral fertilizer.

When compared to BRS Piatã, the Marandu cultivar was superior in terms of shoot dry mass productivity, root volume, and root dry mass. However, it had a lower SPAD index, which is justified by the dilution effect of chlorophyll with greater distribution in total leaf mass. This result is associated with the plant's greater efficiency in converting available resources into root growth, which indicates greater exploitation of soil volume, absorption capacity, and physiological support for biomass accumulation in the shoot (Taiz et al., 2021).

Materials and Methods

Experimental site

The experiment was conducted from June to October 2023 in a greenhouse at the Federal University of Rondonópolis (UFR), located in the municipality of Rondonópolis, Mato Grosso, Brazil (16º27'49" S; 54º34'46" W; 290 m altitude). The region's climate is classified as tropical Aw according to the Köppen-Geiger classification, characterized by dry winters and rainy summers (Aparecido et al., 2020).

Soil characterization

The soil was collected in the 0-0.2 m layer in a Cerrado area and classified as Latossolo Vermelho (Santos et al., 2018), equivalent to Ferralsol according to the WRB 2022 (IUSS Working Group WRB, 2022). The initial physical and chemical properties of the soil are shown in Table 1.

Liming was carried out with dolomitic limestone (86% PRNT), incubated for 30 days before applying the treatments, to raise base saturation from 13.5% to 25%, a value corresponding to half the usual recommendation for tropical forage grasses (Jayme et al., 2022).

Experimental design

The experimental design employed randomized blocks in a 6 x 2 factorial scheme, with six doses of organomineral fertilizer (0, 5, 10, 15, 20 and 25 g kg^{-1}) and two cultivars of *Urochloa brizantha* (BRS Piatã and Marandu), each with four replicates, resulting in a total of 48 experimental units.

Formulation and application of organomineral fertilizer

The organomineral fertilizer was produced by mixing wood ash from the burning of *Eucalyptus sp*. wood with mineral sources, according to the methodology proposed by (Oliveira et al., 2023), which also served as the basis for defining the doses applied. The wood ash was collected from local industry in the municipality of Rondonópolis and characterized in terms of its corrective and fertilizing potential (Table 2).

After the incubation period with limestone, the organomineral fertilizer was incorporated into the soil homogeneously, according to the dose corresponding to each treatment.

Experimental setup

The experimental units consisted of plastic pots with a volume of 2 L and a diameter of 15 cm, containing eight holes at the base for drainage. Each pot was filled with 1.5 kg of corrected and fertilized soil, as specified in the experimental design.

The cultivars used were *Urochloa brizantha* cv. BRS Piatã and cv. Marandu is sown separately according to the treatment. In each pot, 20 seeds of the respective cultivar were distributed at a depth of 2 cm. At 5, 10, and 15 days after emergence (DAE), thinning was performed, keeping three plants per pot.

Nitrogen fertilization was common to all treatments, using urea (45% N) as the source. The recommendation used was 200 mg kg^{-1} (Bonfim-Silva et al., 2011), applied at 15, 30, and 60 days after emergence (DAE). In each phase, the dose was divided into two applications of 100 mg kg^{-1}, totaling 200 mg kg^{-1} per phase. Each application of 100 mg kg^{-1} corresponded to 1.11 g pot^{-1} of urea, dissolved in 50 mL of water and applied close to the soil, with an interval of seven days between applications.

Irrigation was controlled by the gravimetric method, with daily weighing of the pots. Water replacement was performed to maintain soil moisture at 60% of the pot's water retention capacity, as described in the methodology of Bonfim-Silva et al. (2011).

Variables analyzed

The evaluations were carried out at 30, 60, and 90 days after plant emergence. The variables analyzed included soil pH, determined from samples collected from each experimental unit using a 0.01 mol L^{-1} $CaCl_2$ solution in a 1:2.5 ratio (soil/$CaCl_2$), with measurements performed using a digital bench pH meter calibrated with pH 4.0 and 7.0 standards. The SPAD index was used as an indirect estimate of leaf chlorophyll content, with readings obtained using a SPAD-502 chlorophyll meter (Soil Plant Analysis Development, Minolta®) on the +1 or +2 leaves of each plant. Shoot dry mass productivity (SDMP) was evaluated by cutting the shoots with scissors at 5 cm above soil level at 30 and 60 days after emergence (DAE), and flush with the soil at 90 DAE. The plant material was placed in paper bags, dried in a forced-air oven at 65 °C for 72 hours, and weighed on a semi-analytical balance with a precision of 0.01 g. Root volume (RV) was determined by the volume displacement method, using a 1000 mL graduated cylinder containing a known volume of water in which the roots of each pot were fully immersed; the displaced volume was recorded as root volume and expressed in milliliters. Root dry mass

(RDM) was obtained after volume measurement; the roots were dried on paper towels, placed in paper bags, oven-dried at 65 °C for 72 hours until constant weight, and weighed on a semi-analytical balance.

Statistical analysis

The data were submitted to a normality test to verify whether the errors followed a normal distribution. Subsequently, the data were submitted for analysis of variance ($p \leq 0.05$). For the quantitative factor (doses), regression analysis was used; for the qualitative factor (cultivars), the Tukey test was used ($p \leq 0.05$). The analyses were performed using SISVAR statistical software version 5.8 (Ferreira, 2019).

Conclusions

The application of organomineral fertilizer based on wood ash promoted significant improvements in soil chemistry, with an increase of more than 50% in pH at a dose of 25 g kg^{-1}. The Marandu cultivar showed higher agronomic performance, with increases of 45% in shoot dry mass productivity and 46.6% in root dry mass compared to the Piatã cultivar. The highest biomass yields were achieved with doses between 17 and 21 g kg^{-1} of organomineral fertilizer. The organomineral fertilizer demonstrated potential as an alternative to synthetic fertilizers, as it combines acidity correction, essential nutrient supply, and agroindustrial waste recovery. The organomineral fertilizer tested contributes to the sustainable management of tropical grasses and meets the principles of the Sustainable Development Goals (SDGs), especially SDGs 2, 12, and 13.

Data Availability Statement: All the data reported here are available from the authors upon request.

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