# PRODUCTIVITY AND NUTRITIVE VALUE OF *UROCHLOA BRIZANTHA* UNDER WATER SATURATION LEVELS

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## ABSTRACT

Water availability in the soil can alter the productive and qualitative characteristics of pasture, but the magnitude of the response can be different between cultivars. The aim was to assess the productivity and quality of *Urochloa brizantha* cultivars subjected to different water saturation levels. The experimental design was in randomized blocks in a 4x5 factorial scheme, with four cultivars, Marandu, Xaraés, Piatã, and Paiaguás, and five levels of water saturation: 20, 40, 60, 80, and 100% of the maximum water retention capacity in the soil, with four replications. The grasses were sown directly into pots. After 30 days, the uniformization cut was carried out, and the water saturation levels were applied. The plant material was collected 40 days after the uniformization cut. The aerial part's dry mass and the grasses' bromatological characteristics were assessed. The data was submitted to analysis of variance and regression analysis for the water saturation levels and Tukey's test for the cultivars at 5% probability. The cultivars Marandu and Xaraés obtained the highest dry mass of the aerial part with average yields of 17.90 and 17.04 g pot$^{-1}$, respectively. The maximum contents were obtained at levels of water saturation of 28.21%, 43.09%, 43.44%, and 45.06% with 11.14%, 9.21, 9.84%, and 8.59% crude protein, respectively, for the Marandu, Xaraés, Piatã, and Paiaguás cultivars. Higher water saturation levels lead to a decrease in the crude protein content and an increase in the NDF and ADF contents.
**Keywords:** animal nutrition; bromatological composition; forage; soil water

# PRODUTIVIDADE E VALOR NUTRITIVO DE CULTIVARES DE *UROCHLOA BRIZANTHA* SOB NÍVEIS DE SATURAÇÃO HÍDRICA

## RESUMO

A disponibilidade hídrica no solo pode alterar as características produtivas e qualitativas do pasto, entretanto, a magnitude da resposta pode ser diferente entre cultivares. Diante disso, objetivou-se avaliar a produtividade e qualidade de cultivares *Urochloa brizantha* submetidos a diferentes níveis de saturação hídrica. O experimento foi realizado em casa de vegetação com vasos de 8 dm³ de solo, utilizando como substrato o Cambissolo. O delineamento experimental foi em blocos casualizados em esquema fatorial 4x5, sendo quatro cultivares: Marandu, Xaraés, Piatã e Paiaguás e cinco níveis de saturação hídrica (NSH): 20; 40; 60; 80 e 100% da capacidade máxima de retenção de água no solo, com quatro repetições. Os capins foram semeados diretamente nos vasos. Após 30 dias foi realizado o corte de uniformização e aplicado os níveis de saturação hídrica. 40 dias após o corte de uniformização, foi coletado o material vegetal para determinação da massa seca da parte aérea e das características bromatológicas. Os dados foram submetidos à análise de variância e de regressão para os níveis de saturação hídrica e teste Tukey para as cultivares a 5% de probabilidade. As cultivares Marandu, Xaraés tiveram maior massa seca da parte aérea com produção média de 17,90 e 17,04g vaso$^{-1}$, respectivamente. Os teores máximos de PB foram obtidos nos NSH de: 28,21; 43,09; 43,44 e 45,06% com 11,14; 9,21; 9,84 e 8,59%, respectivamente para as cultivares Marandu, Xaraés, Piatã e Paiaguás. Os maiores níveis de saturação hídrica promovem diminuição no teor de PB e aumento nos teores de FDN e FDA
**Palavras-chave**: água do solo; composição bromatológica; forrageira; nutrição animal
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## INTRODUCTION

Brazil is the largest meat supplier in the world, playing an essential role in food security, guaranteeing high-quality beef for export to more than 150 countries (ABIEC, 2023). Due to lower costs, 93 and 95% of this production are based on extensive pastures (GUIMARÃES et al., 2023), but with an occupancy rate of 0.9 UA $ha^{-1}$ (ABIEC, 2023).

Atlas (2022) estimates that approximately 177 million hectares are used for pasture in Brazil, and around 80 million of these hectares are dedicated to growing *Urochloa (*syn. *Brachiaria*) species (RAPOSO et al., 2023). This genus is preferred by livestock farmers since its production accounts for 72.2% of forage seed production areas (GUIMARÃES et al., 2023).

Water availability in the soil is a determining factor in the morphophysiological variables of *Urochloa* grass (SANTOS et al., 2022). The plant's tolerance to water deficit will depend on its intensity and severity. A water deficit may involve morphological changes such as a reduction in leaf area and the aerial part/root ratio (Marcos et al., 2018), reducing production and even the survival of grasses.

On the other hand, the use of organic waste, due to its bio fertilizing potential, has increased over the years (MAGALHÃES; WEBER, 2021). This practice can increase soil fertility and water retention (Santos de Assis et al., 2021). In addition, the use of swine manure could become a common practice due to the reduction in costs, especially in agribusiness hub regions such as Mato Grosso, which produces grains and livestock close to industrial pig farming centers (SANTOS de ASSIS et al., 2021).

It was therefore hypothesized that the development of *U. brizantha* cultivars under the application of swine manure responds differently to the level of water saturation and that there is a level that establishes better production and quality indicators. With this in mind, the aim was to evaluate the production and quality of the cultivars Marandu, Xaraés, Piatã, and Paiaguás in soil subjected to different water saturation levels. It was therefore hypothesized that the development of *U. brizantha* cultivars under the application of swine manure responds differently to the level of water saturation and that there is a level that establishes better production and quality indicators. With this in mind, the aim was to evaluate the production and quality of the cultivars Marandu, Xaraés, Piatã, and Paiaguás in soil subjected to different water saturation levels.

## MATERIAL AND METHODS

The experiment was conducted in a greenhouse at the Federal University of Mato Grosso, Campus Cuiabá, MT. The experimental design was in randomized blocks, arranged in a 4x5 factorial scheme: four cultivars of *Urochloa brizantha (*Marandu, Xaraés, Piatã, and Paiaguás), and five levels of water saturation (WSL): 20; 40; 60; 80 and 100% of the maximum water retention capacity in the soil, with four replications.

The soil used as a substrate was a Cambissolo identified according to the Brazilian Soil Classification System (SANTOS et al., 2018). The soil was sampled in the 0 to 20 cm layer, which was taken to dry in a forced air circulation oven at 60ºC for 24 hours. After drying, it was sieved and prepared for granulometric and chemical characterization following the methodology of Teixeira (2017) (Table 1).

**Table 1**. Chemical and granulometric characteristics of the soil at a depth of 0-20cm

| pH $CaCl_2$ | P | K | Ca+Mg | Al | H+Al | SB(1) | CEC(2) | V(3) | OM(4) | Sand | Silt | Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | --mg $dm^{-3}$-- | | ------------$cmol_c$ $dm^{-3}$ ----------- | | | | | ----------------%---------------- | | | | |
| 4.36 | 42.27 | 2.21 | 1.80 | 0.16 | 3.39 | 1.80 | 5.19 | 35.40 | 2.38 | 86.10 | 6.9 | 7.0 |

(1)sum of bases, (2)Cation Exchange Capacity, base saturation(3), organic matter(4)

The dose of lime was determined using the base saturation method (V=45%) with the incorporation of limestone filler, following the recommendation of Ribeiro et al. (1999). It was applied to soil previously fertilized with swine wastewater, allowing it to react and come into contact with the soil. The treatments with the different water regimes were then applied.

Plastic pots with a capacity of 8 dm³ were used, lined internally with plastic bags to retain the water. The seeds were sown directly into the pot. Thinning was carried out 30 days after sowing, leaving five plants per pot.

Fertilization was carried out according to Ribeiro et al. (1999), using 490 mL of swine wastewater (0.14% N; 0.11% $K_2O$; 0.05% $P_2O_5$) in each pot 20 days after soil correction. To reach 100 kg $ha^{-1}$ of $K_2O$ and N, potassium chloride and urea were used to complement the organic fertilizer, which corresponded to 0.66 and 0.86 g $dm^{-3}$, respectively, diluted in water, in two applications, one before and the other 15 days after the uniformity cut. There was no need for phosphate fertilization.

The uniformization cut occurred six days after thinning, above 20 cm from the ground. The water saturation levels were then applied. Irrigation was carried out daily using the gravimetric method by weighing each pot in order to maintain water regimes based on the soil's field capacity:

Irrigation = (WSL + pot + dry soil + plastic bag) - weight obtained.

At 40 days after applying the treatments, the green mass of the aerial part was cut off and dried in a forced ventilation oven at 60˚C until constant weight to obtain the dry mass of the aerial part (DMAP).

The concentration of total nitrogen was determined using the Kjeldahl method, and the result was multiplied by a conversion factor of 6.25 to obtain the crude protein (CP) content in the plant (SILVA; QUEIROZ, 2004). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) contents were determined using the Van Soest method (1967).

The data was submitted to analysis of variance, regression analysis for the levels of water saturation and Tukey's test for the cultivars at 5% probability, using Sisvar 2006 software.

## RESULTS AND DISCUSSION

There was no interaction (p>0.05) between cultivars and water saturation levels on the dry mass of the aerial part (DMAP). There was an increasing linear effect (P<0.0001) of WSL on DMAP with a maximum production of 22.03 g $pot^{-1}$. Marandu and Xaraés obtained the highest DMAP with average yields of 17.90 and 17.04 g $pot^{-1}$, respectively (Table 2).

**Table 2.** Dry mass of aerial part (g $pot^{-1}$) of the cultivars Marandu, Xaraés, Piatã and Paiaguás under soil water saturation levels (WSL)

| **Soil water saturation levels (%)** | **WSL x Cultivar** |
|---|---|

| Cultivar | 20 | 40 | 60 | 80 | 100 | Mean | |
|---|---|---|---|---|---|---|---|
| Marandu | 11.67 | 14.14 | 16.17 | 21.8 | 25.71 | $17.90^{a}$ | 0.1923 |
| Xaraés | 13.47 | 13.55 | 15.06 | 22.9 | 20.24 | $17.04^{a}$ | 0.1923 |
| Piatã | 11.26 | 12.77 | 13.35 | 18.47 | 19.41 | $15.05^{b}$ | 0.1923 |
| Paiaguás | 10.96 | 12.58 | 15.58 | 21.28 | 20.91 | $16.26^{ab}$ | 0.1923 |
| WSL | 11.84 | 13.27 | 15.04 | 21.11 | 21.57 | - | <0.0001 |
| **CV (%) 13.97** | | | | | | | |

Means followed by the same letter in the same column do not differ by the Tukey test at 5% probability. **: significant at 1% probability ($p < 0.01$).

There was an increase in DMAP production of 24, 49, 73, and 98% for the WSL 40, 60, 80, and 100%, respectively, compared to the WSL of 20%. These results were corroborated by Santos et al. (2012) when evaluating *U. brizantha* cultivars (Marandu, Xaraés, and Piatã) under four water regimes (25, 50, 75 and 100%), which showed the sensitivity of the cultivars to water deficit conditions. However, these cultivars have a deep root system as an adaptation mechanism for plants tolerant to water stress (SANTOS et al., 2013).

The gradual increase in the DMAP of the cultivars, as water availability in the soil increased, can be attributed to the greater use of nutrients by the available water, promoting greater production of forage biomass (POMPEU et al., 2018). In addition, water becomes important during photosynthesis, acting in the supply of electrons through its hydrolysis (SLAMA et al., 2015) and maintenance of plant turgor, which allows cell elongation. In contrast, water deficit causes a reduction in growth rate, stomata closure, and photosynthetic inhibition (KOETZ et al., 2017).

The difference in DMAP production between the cultivars can be attributed to the variation in genotypes within the same species. According to Braz et al. (2017), even if the characteristics are genetically defined, they are influenced by factors such as luminosity, temperature, water availability, and soil fertility, especially when there is a water deficit or surplus, where metabolic and structural processes affect the development of forage plants (DUARTE et al., 2019).

There was an interaction ($p<0.05$) between the cultivars and the WSL on the CP content, with a quadratic effect (Table 3). The maximum contents were obtained in the WSL of 28.21%, 43.09%, 43.44%, and 45.06%, with 11.14%, 9.21, 9.84%, and 8.59% of CP, respectively, for the Marandu, Xaraés, Piatã and Paiaguás cultivars (Figure 1).

There was no interaction ($p>0.05$) between the cultivars and the WSL regarding NDF. There was a quadratic effect ($P<0.0001$) for NDF with a minimum content of 60.27% with 27.03% WSL. The Xaraés cultivar had the highest NDF content (Table 3).

There was an interaction ($p<0.05$) between the cultivars and the WSL on ADF (Table 3). Marandu grass had a quadratic effect and the lowest ADF content (43.84%) at the WSL of 28.90% (Figure 2). Meanwhile, Piatã and Paiaguás grass showed an increasing linear effect.

**Table 3**. Crude protein, neutral and acid detergent fiber of Marandu, Xaraés, Piatã and Paiaguás cultivars under soil water saturation levels

| Soil water saturation levels (%) | WSL x Cultivar |
|---|---|

| Cultivar | 20 | 40 | 60 | 80 | 100 | Mean | |
|---|---|---|---|---|---|---|---|
| **CP (%)** | | | | | | | |
| Marandu | $10.57^{a}$ | $10.59^{a}$ | $9.08^{a}$ | $7.71^{a}$ | $5.74^{a}$ | 8.74 | 0.0124 |
| Xaraés | $8.54^{b}$ | $9.13^{ab}$ | $9.30^{a}$ | $6.88^{a}$ | $5.61^{a}$ | 7.89 | 0.0001 |
| Piatã | $9.13^{ab}$ | $10.18^{a}$ | $9.40^{a}$ | $8.00^{a}$ | $6.72^{a}$ | 8.68 | 0.0008 |
| Paiaguás | $8.18^{b}$ | $8.35^{b}$ | $8.53^{a}$ | $7.75^{a}$ | $6.18^{a}$ | 7.80 | 0.0042 |
| Média | 9.10 | 9.56 | 9.08 | 7.58 | 6.06 | - | - |
| CV (%) | | | 9.59 | | | | |
| **NDF (%)** | | | | | | | |
| Marandu | 59.43 | 58.14 | 57.49 | 65.42 | 66.54 | $61.40^{b}$ | 0.3201 |
| Xaraés | 65.32 | 63.06 | 63.92 | 65.30 | 67.08 | $64.57^{a}$ | 0.3201 |
| Piatã | 60.50 | 59.49 | 60.95 | 63.84 | 64.58 | $61.87^{b}$ | 0.3201 |
| Paiaguás | 59.19 | 59.12 | 61.46 | 65.18 | 66.90 | $62.37^{b}$ | 0.3201 |
| Média | 60.66 | 59.95 | 60.95 | 64.94 | 66.28 | - | <0.0001 |
| CV (%) | | | 4.06 | | | | |
| **ADF (%)** | | | | | | | |
| Marandu | $44.43^{b}$ | $43.28^{b}$ | $44.69^{b}$ | $49.43^{a}$ | $51.03^{a}$ | 46.57 | 0.0068 |
| Xaraés | 48.18 | 47.42 | 48.25 | 49.93 | 49.46 | 48.65 | 0.9174 |
| Piatã | $42.55_{b}$ | $45.24^{ab}$ | $45.83^{ab}$ | $50.22^{a}$ | $50.84^{a}$ | 46.94 | 0.0622 |
| Paiaguás | $44.59^{b}$ | $45.36^{ab}$ | $46.21^{ab}$ | $49.81^{a}$ | $52.52^{a}$ | 47.70 | <0.0001 |
| Média | 44.94 | 45.33 | 46.24 | 49.85 | 50.96 | - | - |
| CV (%) | | | 3.54 | | | | |

Means followed by the same letter in the same column do not differ by the Tukey test at 5% probability. ns: not significant at 5%; **: significant at 1% probability.

The decrease in CP from 40% WSL onwards can be attributed to the dilution effect due to higher MSPA production. Alencar et al. (2010), when assessing the nutritional value of tropical grasses at different times of the year, also observed a decrease in the CP content with the more excellent dry mass production of the Marandu and Xaraés cultivars at times of more significant water availability. In addition, the advancement of the plant's phenological stage increases the proportion and thickness of the thatch about the leaves, decreasing the CP content due to the greater complexation of nitrogen compounds with the lignocellulosic fraction of the cell wall (GARCEZ et al., 2020).

CP contents above 7% were found in all cultivars up to WSL 80% (Figure 1). According to Van Soest (1994), CP levels lower than 7% in grasses cause suppression of fiber digestion to the detriment of incipient levels of N for rumen microorganisms to use in their growth, which decreases the animal's voluntary consumption.

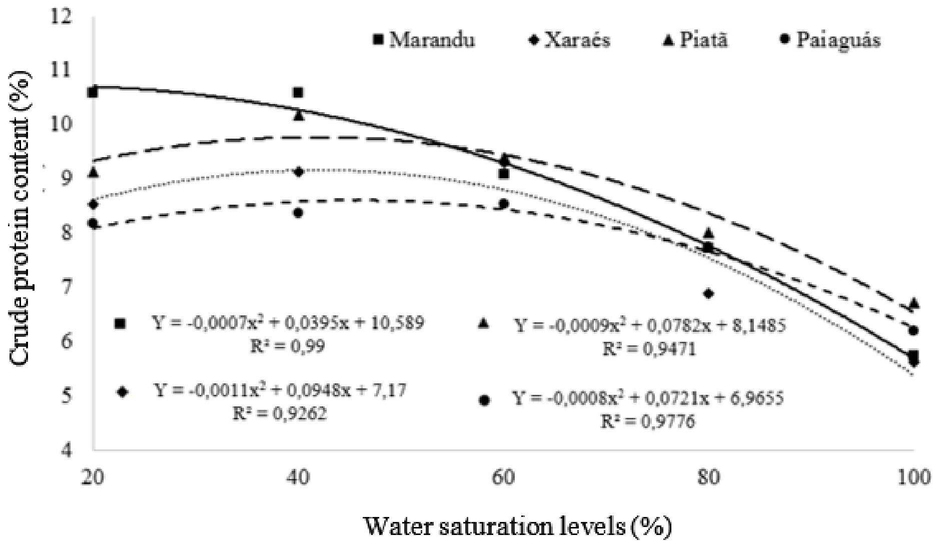


**Figure 1**: Crude protein content of Marandu, Xaraés, Piatã and Paiaguás cultivars under soil water saturation levels

Compared to the other cultivars, the higher NDF content of the Xaraés cultivar can be explained by the characteristic of the grass expressing rapid thatch elongation and a lower proportion of leaf blade under water stress conditions. This fact is also corroborated by studies by Santos et al. (2021), who showed high thatch elongation during the deferment period, and Alencar et al. (2014), who also observed higher NDF levels due to the rapid elongation of the grass leaf in the spring/summer season, with a greater share of the cell wall constituent and, consequently, NDF.

In contrast, under ideal water conditions, Duarte et al. (2019) observed that the brachiaria grass renewed its leaves more quickly due to better use of the available resources. The anatomical changes to the leaves and stalks contributed to its survival, especially under conditions of waterlogging stress.

According to Van Soest (1994), the NDF content of forage plants should be less than or equal to 60% so as not to impair the voluntary consumption of dry matter by the animals. Thus, the 63.92% NDF content obtained with the 80% WSL can be considered attractive for grazing management in pasture production systems, as it is within the recommended range for fibrous components.

The increase in the levels of NDF and ADF as water availability in the soil increased may be due to a change in the plant's morphological composition (Table 2). Kroth et al. (2015) evaluated the cultivars Marandu, Xaraés, and Piatã under waterlogged and water deficit conditions and found a lower leaf/stalk ratio when subjected to waterlogged conditions. Thus, with a lower proportion of leaves and a higher proportion of stalks, fibrous tissues accumulate in the dry matter.

Bearing in mind that in this study, a single cut was made 40 days after the uniformization cut, the increase in the levels of NDF and ADF can be inferred to the greater height and elongation of the stalks, which, although they increase dry matter production, have tissues with a lower nutritional value compared to the leaves.

In addition to increasing the concentration of lignin added to cellulose and hemicellulose, this causes nutrient complexation and makes it impossible for rumen microorganisms to adhere to and digest the fiber (SILVA; QUEIROZ, 2004), which compromises consumption and animal performance (Figure 2).

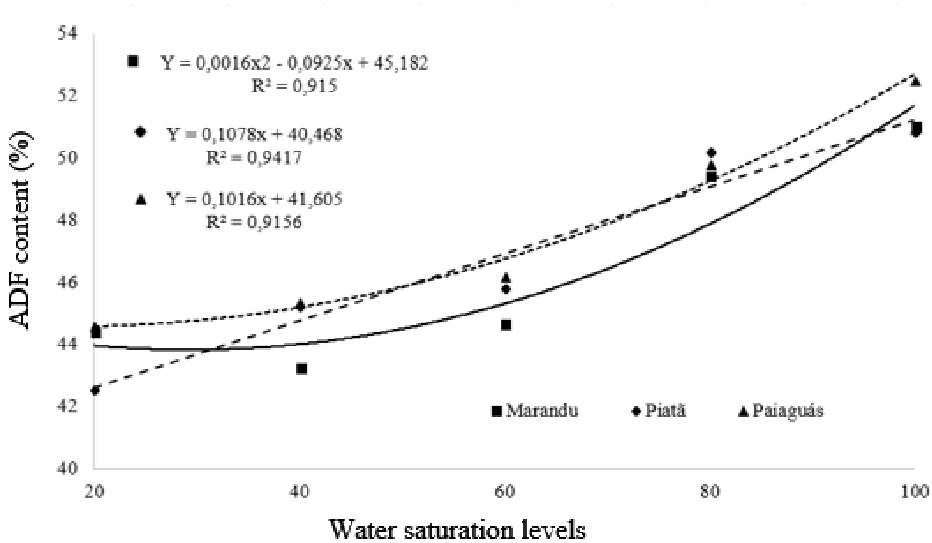


**Figure 2**: ADF content of Marandu, Piatã and Paiaguás cultivars under soil water saturation levels.

## CONCLUSION

The Marandu and Xaraés cultivars have the highest average dry mass of the aerial part, without compromising on crude protein and acid detergent fiber, compared to the Piatã cultivar. However, Xaraés had the highest neutral detergent fiber. Higher water saturation levels lead to a decrease in the crude protein content and an increase in the acid detergent fiber content.

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