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Concentration and moment of niacin application on *Urochloa brizantha* in relation to nitrogen fertilization

Concentração e momento de aplicação de niacina em Urochloa brizantha em relação à adubação nitrogenada

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ABSTRACT

The present study aimed to evaluate the effect of applying different concentrations of niacin, at different times in relation to nitrogen fertilization, on the characteristics of *Urochloa brizantha*. The treatments consisted of applying three concentrations of niacin (0, 100, and 200 mg L^{-1}) and three different moments (two days before, together, and two days after nitrogen fertilization). It was found that there was variation in response, mainly concerning the moment of application of the vitamins, in which the joint and subsequent application of fertilization generally exceeded the application performed previously, and of both concentrations used (100 and 200 mg L^{-1}), in relation to the control without vitamin application. In this way, the application of niacin at a concentration of 100 mg L^{-1}, carried out jointly or after nitrogen fertilization, provides better conditions for developing and producing dry matter of *Urochloa brizantha* due to the presence of nitrogen.

KEYWORDS: tropical grasses; vitamin B3; plant protection; forage production; nutrient uptake.

RESUMO

O presente estudo teve como objetivo avaliar o efeito da aplicação de diferentes concentrações de niacina, em momentos distintos em relação à adubação nitrogenada, sobre as características de *Urochloa brizantha*. Os tratamentos foram compostos pela aplicação de três concentrações de niacina (0, 100 e 200 mg L^{-1}) e três momentos distintos (dois dias antes, juntamente e dois dias após a adubação nitrogenada). Verificou-se que houve variação de resposta, principalmente em relação ao momento de aplicação das vitaminas, em que as aplicações conjunta e posterior à adubação superaram, de maneira geral, a aplicação realizada anteriormente, e de ambas as concentrações utilizadas (100 e 200 mg L^{-1}), em relação ao controle sem vitamina. Desta maneira, a aplicação de niacina em concentração de 100 mg L^{-1}, realizada de maneira conjunta ou posterior à adubação nitrogenada, propicia melhores condições para o desenvolvimento e a produção de matéria seca de *Urochloa brizantha*, devido à presença do nitrogênio.

PALAVRAS-CHAVE: gramíneas tropicais; vitamina B3; proteção de plantas; produção de forragens; absorção de nutrientes.

The demand for food produced with less environmental impact has increased the importance of optimizing beef production systems. This optimization is related to obtaining higher productivity in smaller areas, which in turn is intrinsically related to the increase in quality and the offer of pastures to animals. This factor has outstanding economic importance worldwide, mainly in emerging countries (CARDOSO et al. 2020).

As with other species of forage grasses, those belonging to the *Urochloa* genus are highly responsive to nitrogen fertilization, not only in terms of productivity but also with a direct relationship with the bromatological quality of the plants and the way of grazing management (RODRIGUES et al. 2017, TEIXEIRA et al. 2018). However, the participation of nitrogen as an indispensable input in animal protein production results in need for investments to purchase this nutrient, and, mainly in intensive production systems, these investments can result in large part of the total production costs (COSTA et al. 2015).

Several studies have envisioned an improvement in the use of nitrogen applied to the cattle production system, mainly using environmentally friendly techniques that maintain adequate economic return (BAZAME et al. 2020). Among these, nitrogen-fixing bacteria stand out, which significantly improves the photosynthetic system (VENDRUSCOLO et al. 2021), increasing the production of dry matter and the quality of the forage produced (LEITE et al. 2019). Also, there is the use of other products with the potential to increase the productivity of grasses, such as the B vitamins (VENDRUSCOLO et al. 2019b).

Among the vitamins currently studied for application in agriculture, promising results have been observed for the use of niacin (COLLA et al. 2021). This vitamin is present in the constitution will of coenzymes NADH and NADPH, which are associated with the reduction of enzymatic oxidation reactions in living cells. So naturally, nicotinamide concentration can increase in plants after situations that cause oxidative stress and induction of defensive metabolism (BERGLUND & OHLSSON 1995, VENDRUSCOLO et al. 2019a).

The participation of niacin in vital processes in plant tissues can also be optimized by its exogenous application, providing increases in cell elongation and expansion, improvement of productive characteristics in the face of adverse environmental conditions, such as water deficit and soil salinity, and accumulation energy and nutritional reserves (ABDELHAMID et al. 2013, EL-BASSIOUNY et al. 2014, VENDRUSCOLO & SELEGUINI 2020). Thus, there is potential to optimize the absorption of nutrients applied to production systems, such as nitrogen.

However, despite the potential mentioned above, no studies point to a better time of application or concentration of niacin, aiming at the maximum use of nitrogen fertilization. Therefore, the present study aimed to evaluate the effect of applying different concentrations of niacin, at different times in relation to nitrogen fertilization, on the characteristics of *Urochloa brizantha.*

The study was conducted in the municipality of Cassilândia, State of Mato Grosso do Sul, Brazil (latitude: 19° 05' 30.50", longitude: 51° 5' 55.64", and altitude: 510 m). The experiment site has an Aw climate, according to the Köppen-Geiger classification, characterized as a tropical climate with a rainy season from October to April and a dry period between May to September.

The soil used was classified as Neossolo Quartzarênico and presented the following chemical characteristics: Organic matter = 10,0 g kg^{-1}; pH ($CaCl_2$) = 4,7; P (resin) = 12,0 mg dm^{-3}; K = 1,60 $mmol_c$ dm^{-3}; Ca = 34 $mmol_c$ dm^{-3}; Mg = 11,0 $mmol_c$ dm^{-3}; H+Al = 23 $mmol_c$ dm^{-3}; Al = 0,0 $cmol_c$ dm^{-3}; cation exchange capacity = 69 $mmol_c$ dm^{-3}; base saturation = 67,0%.

The experiment was carried out in a randomized block design, in a 3 x 3 factorial scheme, with 5 replications. The nine treatments used in the study consisted of applying three concentrations of niacin (0, 100, and 200 mg L^{-1}) and three different moments (two days before, together, and two days after nitrogen fertilization). The experimental units were composed of 10 L pots, in which four plants were grown.

After conditioning the soil in the pots, a dose equivalent to 200 kg ha^{-1} of phosphorus was incorporated. The sowing of *Urochloa brizantha* (cv. MG5) was carried out 30 days after applying phosphate fertilizer, depositing ten seeds per pot at a depth of 0.5 cm. The plants were thinned, leaving four per pot, which were conducted until the time of the evaluations. No application of insecticides or fungicides was necessary, however, spontaneous plants were removed manually, and irrigation was carried out in order to maintain moisture in the field capacity.

For the application of niacin, a manual spray was used, in a volume of syrup equivalent to 200 L ha^{-1}, while nitrogen was applied to the soil in a dose corresponding to 250 mg dm^{-3} (CABRAL et al. 2013) and having ammonium sulfate (21% N) as a source, 22 days after sowing. After applying the nitrogen fertilizer, irrigation was carried out with an amount equivalent to 10 mm.

At 45 days after sowing, the plants were evaluated for height, number of tillers, number of leaves, mass of fresh weight, mass of dry weight and relative chlorophyll content. For that procedures the following steps were adopted. First, the height of the individual plants was measured with a graduated ruler, from the ground level up to the maximum height of the canopy. After, the relative chlorophyll content was obtained by measuring with a manual chlorophyll meter. Finally, the fresh weight was obtained immediately after harvesting the plants, and weighing them on a digital scale. For the dry weight, they were weighed in packages of 200 g containing fresh matter, which was conditioned in an oven with forced air change at a temperature of 65 °C until a constant weight was observed. The data obtained for each variable were subjected to variance analysis and compared with the LSD test at 5% probability.

It was found that the concentrations of niacin did not affect the variables analyzed (Table 1), except for plant height.

Table 1. Average fresh weight (FW), dry matter (DW), number of leaves (NL), relative chlorophyll content (RCC) and number of tillers of *U. brizantha* plants treated with different concentrations of niacin.

Concentration mg L^{-1}	FW g $plant^{-1}$	DM g $plant^{-1}$	NL -	RCC -	NT -
0	41.33	6.28	22.53	19.78	7.13
100	43.33	6.81	22.80	20.51	7.00
200	42.00	6.27	22.23	20.11	6.57
CV%	25.90	20.28	19.25	15.33	27.33
LSD	9.76	1.17	3.87	2.76	1.68

CV% = coefficient of variation; LSD = least significant difference.

It was found that the joint application of niacin with N provided greater accumulation of fresh weight and dry weight of plants, without any significant difference for the application of the vitamin before N, for the accumulation of fresh weight (Figures 1A and 1B). However, for the relative chlorophyll content (Figure 1C) and the number of tillers (Figure 1D), the superiority of the applications after and before fertilization was verified, respectively, both not differing from the joint application.

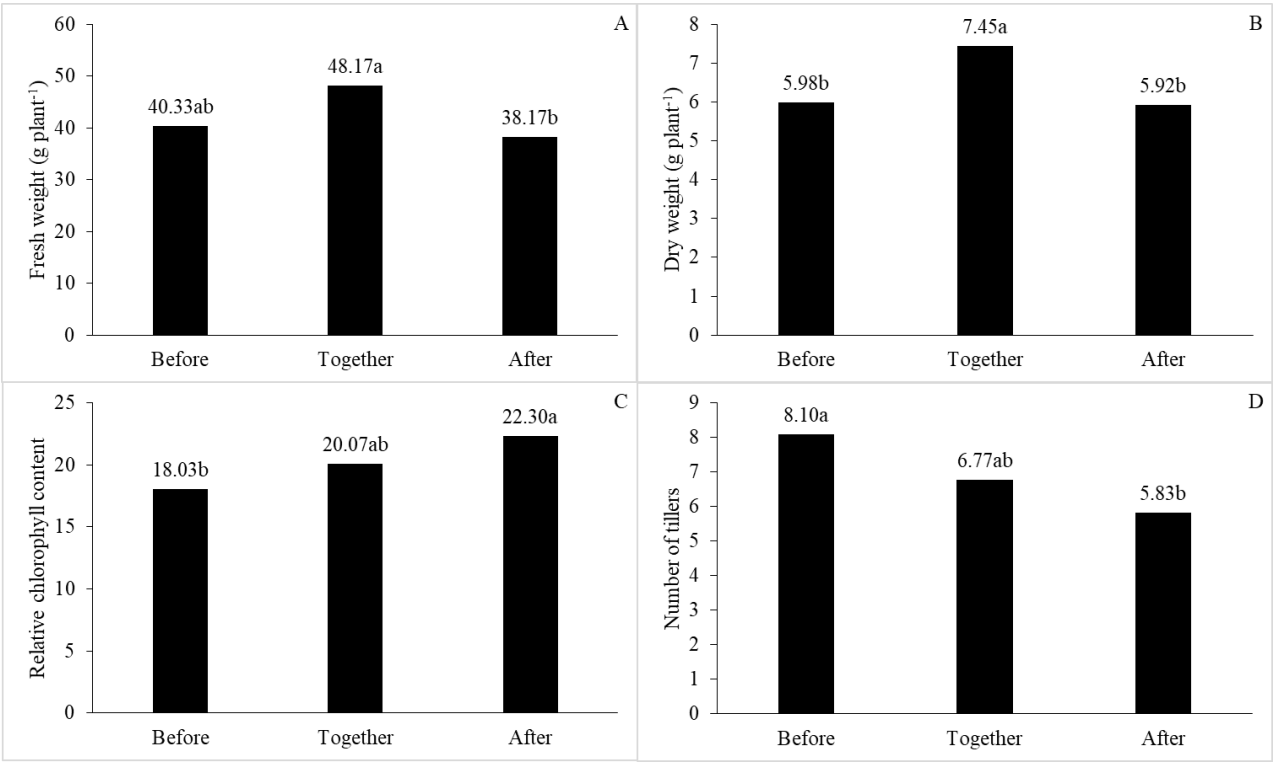

Figure 1. Fresh weight (A), dry weight (B), relative chlorophyll content (C), and the number of tillers (D) of *U. brizantha* treated with niacin at different times in relation to nitrogen fertilization. Averages followed by the same letter do not differ by LSD test at 5% probability.

For the plant height and the response to the moment of application, the effect of the concentrations used was also observed (Figure 2). The application of the vitamin both together and after nitrogen fertilization, in concentrations of 100 and 200 mg L^{-1}, respectivelly, provided significant increases in this characteristic.

The results obtained in the present study point out to marked importance of the moment of application of the vitamin, overlapping the relevance of the concentration. This is evident when observing the response of plants to height development, in which there is equality between the concentrations of niacin used (Figure 2). It is also noteworthy that, although there were no statistically significant differences between vitamin concentrations for most variables (Table 1), a trend of behavior similar to that observed for plant height can be seen, in which there are slight superiority of the values when the concentration of 100 mg L^{-1} is used.

Similar effects were obtained in a study with upland rice when it was found that the effect of niacin varies little with the change of the applied concentration, especially regarding the vegetative growth of plants, however overcoming the treatment without the application of vitamin (VENDRUSCOLO et al. 2020). This positive response in relation to the presence of niacin is due to the action of this vitamin in the production of

phytohormones (HASSANEIN et al. 2009), the constitution of coenzymes and as a signal of stress factors, improving the response capacity of plants, including greater absorption of nutrients (ABDELHAMID et al. 2013, EL-BASSIOUNY et al. 2014, VENDRUSCOLO & SELEGUINI 2020).

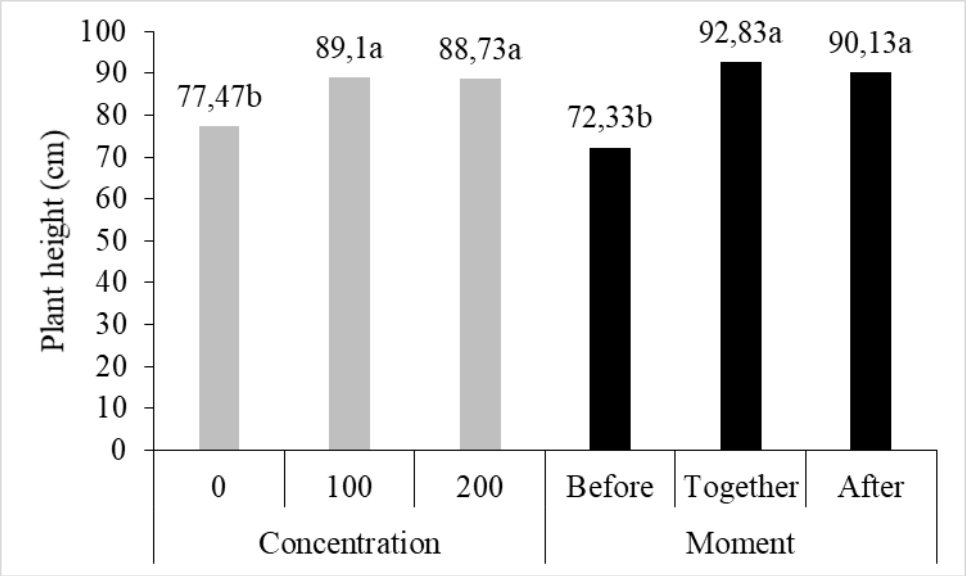

Figure 2. Height of *U. brizantha* plants treated with different concentrations of niacin at different times in relation to nitrogen fertilization. Averages followed by the same letter do not differ by LSD test at 5% probability.

Concerning the time of application of niacin, as verified for all variables, in general, the application was superior simultaneously with nitrogen fertilization, or equality with this time of application, when applications were superior before or after the fertilizer application. This effect may be related to the response time of plants to the exogenous application of B vitamins. In this sense, it was found that the greatest response to the application of vitamin B1 occurred after 60 minutes in vine plants, decreasing in intensity afterward, but with the effects remaining throughout the days after application (BOUBAKRI et al. 2012).

Based on the effect observed with the joint application or after nitrogen fertilization, as verified for the plant height variable, it is possible to infer that the efficiency of the application of the vitamin is related to the availability of nitrogen at the time of application, resulting in greater gains for *Urochloa brizantha.* Even for the variable number of tillers, in which the treatment applied prior to fertilization resulted in increments due to the promotion of cellular activity (HASSANEIN et al. 2009), the difference for the joint application was not found.

In view of the founds, we can conclude that applying niacin at a concentration of 100 mg L^{-1}, carried out together or after nitrogen fertilization, provides better conditions for developing and producing dry weight of *Urochloa brizantha*, due to the presence of nitrogen. Therefore, in addition to being considered a biostimulating element, promoting plant development, the application of niacin can be used as a technique for improving the development of *Urochloa brizantha*. Therefore, the current approach is encouraged to be evaluated in other forage species.

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