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DOSES AND SOURCES OF NITROGEN ON YIELD AND BROMATOLOGICAL COMPOSITION OF *XARAÉS* GRASS

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ABSTRACT

This study evaluated the effect of nitrogen sources and doses on dry matter yield and bromatological composition of *xaraés* grass throughout the year. The experiment was carried out at the Agronomy Faculty of Rio Verde University from October 2008 to January 2010. The experiment consisted of a randomized complete block design in a 2 x 4 factorial arrangement with measures repeated in time, and four replications. We tested two nitrogen sources (ammonium sulfate and urea) and four nitrogen levels (0, 200, 400 and 600 kg ha^{-1}). The evaluations were conducted on the same plots throughout the year and during all four seasons (autumn, winter, spring, and summer). The results demonstrated that the maximum grass production of dry matter and crude protein of *xaraés* grass for the sources of urea and ammonium sulfate were estimated at doses of 500 and 472 kg ha^{-1} and 407 and 396 kg N ha^{-1}, respectively. And for TDN level the maximum dose was 404.74 kg ha^{-1} N, for the source of ammonium sulfate. This result indicates that, regardless of the source, the application of increasing doses of up to 400 kg ha^{-1} of nitrogen in *xaraés* grass is sufficient to maintain a high dry matter production, associated with the nutritional value of the forage. The source ammonium sulfate demonstrated higher efficacy for *xaraés* grass dry matter production in the seasons evaluated, however additional studies are needed to evaluate the economical feasibility of its use.

KEYWORDS: Ammonium sulphate; *Brachiaria brizantha*; urea; year season.

DOSES E FONTES DE NITROGÊNIO NA PRODUÇÃO E COMPOSIÇÃO BROMATOLÓGICA DO CAPIM-XARAÉS

RESUMO

O objetivo do trabalho foi avaliar o efeito de doses e fontes de nitrogênio na produção de massa seca e composição bromatológica do capim-xaraés em diferentes estações do ano. O experimento foi conduzido no Campus da Faculdade de Agronomia da Universidade de Rio Verde, no período de outubro de 2008 a janeiro de 2010. O delineamento experimental utilizado foi em blocos completos ao acaso, em esquema fatorial 2 x 4, com medidas repetidas no tempo, com quatro repetições. Foram testadas duas fontes de nitrogênio (sulfato de amônio e uréia) e quatro doses de nitrogênio (0, 200, 400 e 600 kg ha^{-1}). As avaliações foram realizadas durante o ano, nas estações de outono, inverno, primavera e verão, nas mesmas parcelas. Os resultados demonstraram que a máxima produção de massa seca e teores de PB do capim-xaraés nas fontes de ureia e sulfato de amônio foram estimados nas doses de 500 e 472 kg ha^{-1} e de 407 e 396 kg ha^{-1} de N, respectivamente. E para os teores de NDT a dose máxima foi de 404,74 kg ha^{-1} de N, na fonte de sulfato de amônio. Esse resultado indica que independente da fonte nitrogenada, a aplicação de doses crescentes de até 400 kg ha^{-1} de nitrogênio no capim-xaraés é suficiente para manter uma alta produção de massa seca, associada ao valor nutritivo da forragem. A fonte de sulfato de amônio mostrou maior eficiência na produção de massa seca do capim-xaraés nas estações analisadas.

PALAVRAS-CHAVE: *Brachiaria brizantha*; estações do ano; sulfato de amônio; ureia.

INTRODUCTION

The genus *Brachiaria* lies among the most important tropical forages in Brazil. *Brachiaria brizantha* is one of the most important species for forage production, and within this species, *xaraés* presents several advantages in relation to other cultivars, such as greater sprouting velocity, and greater yield, assuring a high support capacity and higher yield per area (FLORES et al., 2008). However, because it is a recently released cultivar, little information is available about its soil fertility requirements.

FAGUNDES et al. (2006) reported that low nutrient availability certainly is one of the factors that seriously affect forage yield and quality. Thus, nutrient supply, in adequate amounts and proportions, especially nitrogen, takes a fundamental role in the production process of forage grasses, since soil nitrogen, from organic matter mineralization, is not sufficient to meet the requirements of high yield potential grasses.

The nutrient state of plants is evaluated primarily by chemical analysis of leaf tissue, especially for identification of nutrient deficiencies and estimation of nutrient demand. Nitrogen application increases the protein content in plant dry matter (DM). Since proteins are synthesized from amino acids, increases in nitrogen supply reduce soluble carbohydrates. Large accumulation of nitrogen products and proteins cause a dilution in the cell wall fraction, increasing digestibility (COSTA et al., 2008). Studies indicate that the use of nitrogen fertilizers in forage grasses, besides increasing dry matter production (RODRIGUES et al., 2005), also improves forage quality, increasing crude protein (CP) and total digestible nutrients (TDN) contents, and decreasing neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin contents, thus improving digestibility (CECATO et al., 2004; MISTURA et al., 2007; BENETT et al., 2008; MARANHÃO et al., 2009 e COSTA et al., 2010).

Therefore, this study evaluated the effect of nitrogen sources and doses on dry matter yield and chemical-bromatological composition of *xaraés* grasses throughout the year stations.

MATERIAL AND METHODS

The experiment was carried out at the Agronomy Faculty of Rio Verde University, located in the farm Fontes do Saber, at 748 m above sea level, 17° 48’ S and 50° 55’ W, from October 2008 to January 2010. The forage grass area used was about 500 m^2, each experimental unit measured 16 m^2 and the evaluated area 6 m^2.

The experiment consisted of a randomized complete block design in a 2 x 4 factorial arrangement with measures repeated in time, with four replications. We tested two nitrogen sources (ammonium sulfate and urea) and four nitrogen levels (0, 200, 400 and 600 kg ha^{-1}). The evaluations were conducted on the same plots throughout the year and during all four seasons (autumn, winter, spring and summer).

The soil was classified as a distroferric Red Latosol (EMBRAPA, 2006), and its average chemical and physical attributes, before treatments, are shown in Table 1.

The area was prepared by eliminating competing plants with glyphosate and, subsequently, by harrowing. Before sowing the grass, 910 kg ha^{-1} lime was applied to increase base saturation to 45%, 80 kg ha^{-1} P_2O_5, 60 kg ha^{-1} K_2O and 20 kg ha^{-1} FTE BR-12, using the sources super simple phosphate, potassium chloride, and fritted micronutrients, respectively. Sowing of *Brachiaria brizantha* cv. *xaraés* was done with 9 kg of pure viable seeds per hectare.

Nitrogen fertilization (treatments) was done 45 days after sowing, after a standardized cut at the height of 20 cm in all plots. Nitrogen fertilization was split in four seasons, after each evaluation cut of the forage grass. The fertilizations were done in December, January, February and March, considering an interval of 30 days.

The evaluations of dry matter yield and nutritional value were done in the rainy and dry seasons. Two 1 m^2 samples were randomly collected in each plot, using a harvesting knife. Harvest was done in the Summer (January/2009; February/2009 and March/2009); Autumn (April/2009 and May/2009); Winter (July/2009 and September/2009) and Spring (October/2009 and December/2009).

After each evaluation harvest, a standardized cut was done in the whole experimental area, at the same height of the evaluated plants (20 cm), and the material was removed from the area.

The collected material was placed in plastic bags and sent to the laboratory, where a 500 g sample was removed and dried in a forced air oven at 58 to 65ºC until constant weight was achieved. Subsequently, the samples were ground through a 1 mm screen in a Wiley mill and stored in plastic bags until laboratory analysis.

Table 1. Soil chemical and physical attributes before treatment application

Characteristics	Depth (cm)	
	0-20	20-40
pH ($CaCl_2$)	4.4	4.3
Al^{3+} ($cmol_c$ dm^{-3})	0.45	0.55
P-Mehlich-1 (mg dm^{-3})	2.07	0.65
K^+ ($cmol_c$ dm^{-3})	0.17	0.10
Ca^{2+} ($cmol_c$ dm^{-3})	1.36	1.09
Mg^{2+} ($cmol_c$ dm^{-3})	0.73	0.49
H + Al ($cmol_c$ dm^{-3})	4.8	4.2
CTC ($cmol_c$ dm^{-3})	7.05	5.89
SO_4^{-2} (mg dm^{-3})	9.8	7.6
V (%)	32.0	28.5
m (%)	16.6	24.6
Cu (mg dm^{-3})	3.7	3.6
Zn (mg dm^{-3})	1.8	0.5
Fe (mg dm^{-3})	83.2	106.0
Mn (mg dm^{-3})	58.7	35.8
Organic matter (g dm^{-3})	21.6	20.1
Clay (g kg^{-1})	600	610
Silt (g kg^{-1})	50	50
Sand (g kg^{-1})	350	340

The bromatological analyses were done in the Bromatological Lab of the Animal Science Department of Rio Verde University, to determine dry matter (DM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF), using the method described by SILVA & QUEIROZ (2002). The total digestible nutrient (TDN) was obtained using the formula: TDN = 105.2 - 0.68 * (% NDF), proposed by CHANDLER (1990).

Temperature and rainfall were monitored daily during the experimental period, and their averages are presented in Figure 1.

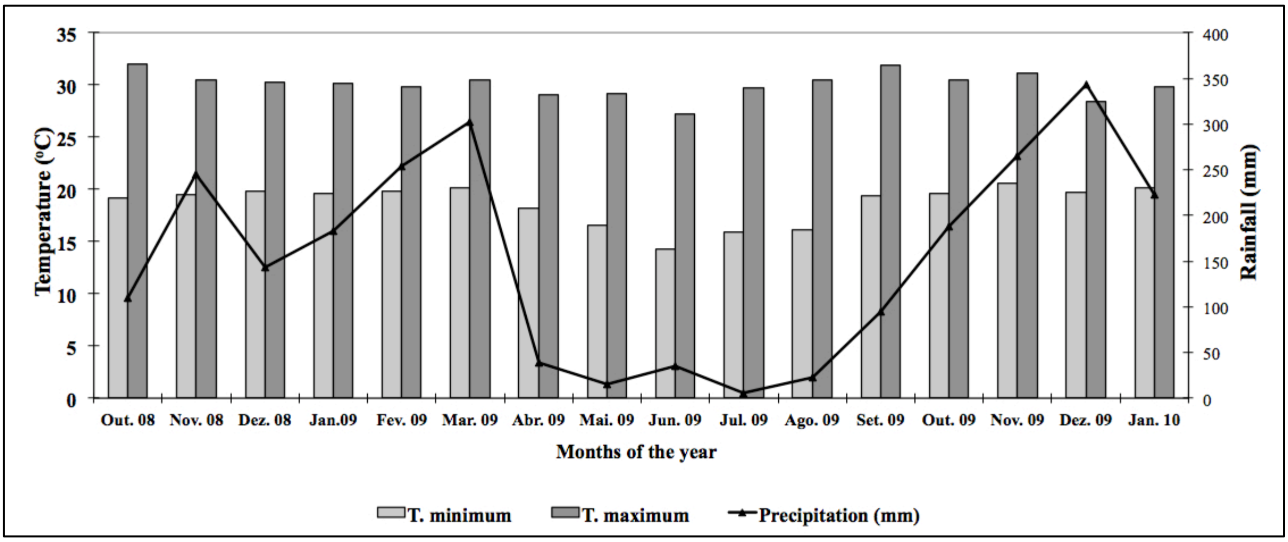

Figure 1. Maximum and minimum temperatures (°C) and rainfall (mm) observed from October 2008 to January 2010, in Rio Verde-GO.

The data were subjected to analysis of variance with significance level of 5% probability and depending on the significance of the variables were adjusted by regression equations. Analyses were performed by a split-plot model in time, as the adequacy of linear models of Gauss-Markov, using the software SISVAR (FERREIRA, 2000).

RESULTS AND DISCUSSION

Dry matter production by *xaraés* grass was affected ($P<0.05$) by the interaction of nitrogen sources and doses in all seasons of the year. A quadratic regression adjustment ($P<0.05$) for yield as a function of nitrogen doses for both sources can be observed in Figure 2. In general the production increased until the dose of 400 kg ha^{-1} in all seasons, with sharp responses in relation to the lack of nitrogen (control). MARTUSCELLO et al. (2009) reported that nitrogen supply is one of the major management factors that control different growth processes in plants.

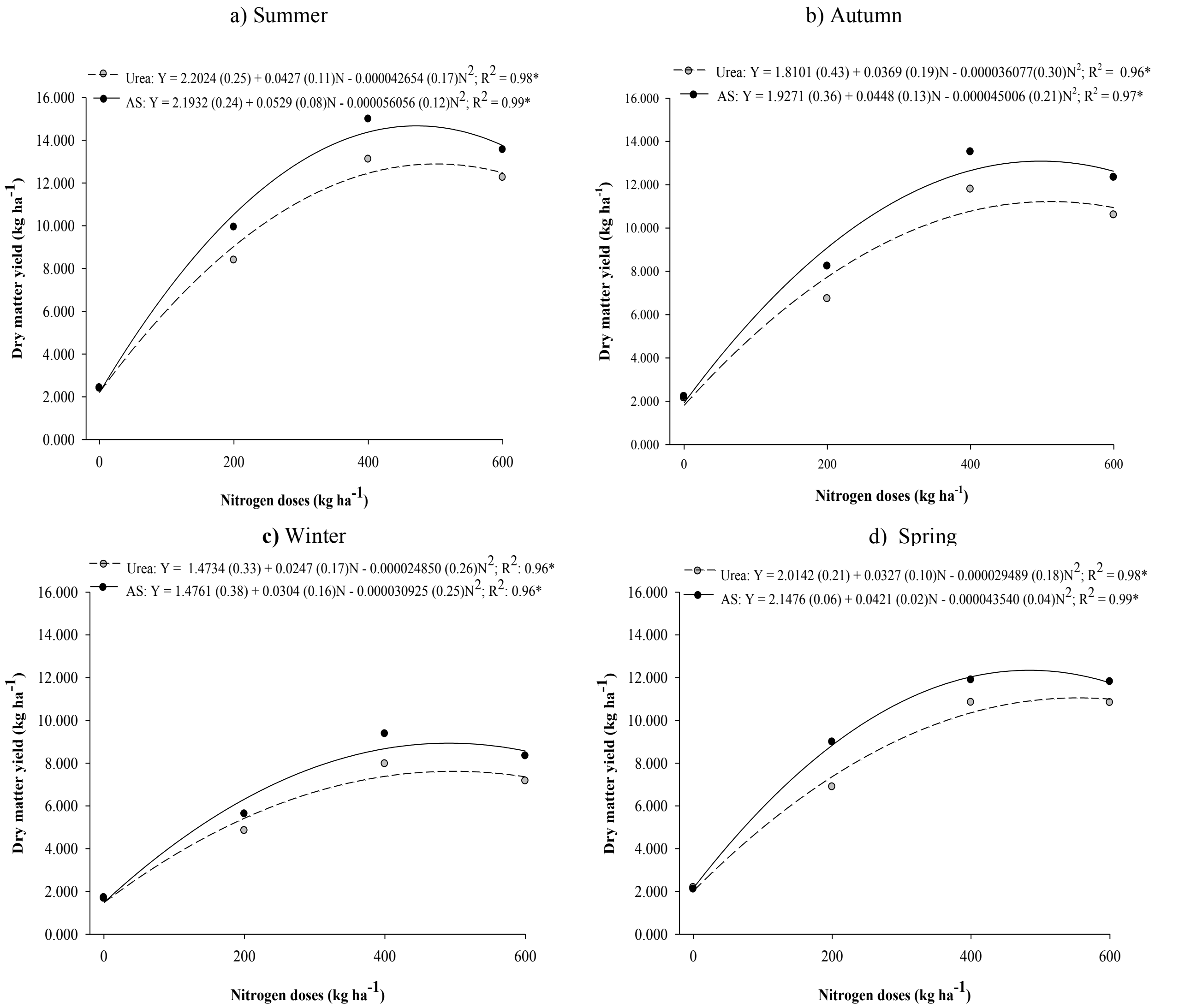

Figure 2. Dry matter yield of *xaraés* grass under nitrogen doses and sources in different seasons of the year. Number in parenthesis corresponds to the significance parameters of regression equations. *significant at 5%.

Xaraés grass was quite responsive to nitrogen fertilization. However, decreases in dry matter production were observed after the maximum responses estimated as 500 and 472 kg ha^{-1} N as urea and ammonium sulfate, respectively, in the summer and 511 and 497 kg ha^{-1} N as urea and ammonium sulfate, respectively, in the autumn. Similar results were obtained by BENETT et al. (2008) for *marandu* grass, with yield decrease at the dose 600 kg ha^{-1}.

Ammonium sulfate was a better nitrogen source for increasing yield, in all seasons. The lower yield obtained with urea can be explained as a function of its transformations in the soil, since nitrogen fertilization was done by spreading over the grass, which resulted in greater nitrogen losses by ammonia volatilization (OLIVEIRA et al., 2007), thus limiting the grass responses to nitrogen, impairing dry matter production. MARTHA JÚNIOR et al. (2004) explained that under high temperatures, lack of rainfall immediately after fertilization and high water evaporation rates from the soil, volatilization losses can reach up to 80% of the nitrogen applied as urea, compromising the yield of the forage plant. Another factor that could have contributed for greater dry matter yield of the sulfate source would be the presence of sulfur. BONFIM-DA-SILVA & MONTEIRO (2006) reported that areas that received large amounts of nitrogen fertilizers demand the supply of sulfur to maximize the forage response, especially in degraded areas, with low levels of organic matter, where, usually, the levels of sulfur-sulfate have low availability in the soil.

Yield evaluation throughout the year indicated that higher dry matter yields were obtained in the summer, followed by the autumn (Figure 2). Weather conditions (rainfall and temperature) were more favorable for grass growth in these seasons (Figure 1), affecting the forage grass development. PEDREIRA et al. (2009) explained that environment variables, such as lighting, temperature, and water status, can affect forage tillering and be as important as hormone factors for the development of buds and tiller stimulation to maintain yield.

COSTA et al. (2010), studied different sources and doses of nitrogen for recovery of *marandu* grass, and found that the dry matter yield under ammonium sulfate at the dose of 300 kg ha^{-1} was 18% greater than under urea. PRIMAVESI et al. (2006), analyzing two sources (ammonium nitrate and urea) and four doses of nitrogen (0, 200, 400 and 800 kg ha^{-1}) in *marandu* grass, found that the forage grass yield under ammonium nitrate was greater than under urea, reaching values of 13.070 and 12.328 kg ha^{-1}, respectively, in the maximum doses.

Even in the winter, with little rainfall, we observed *xaraés* grass development. Dry matter yield obtained in this season at the dose of 400 kg ha^{-1}, with the source ammonium sulfate, was equivalent to 59, 44 and 26% of the yield obtained in summer, autumn and spring, respectively. One of the factors that favored the best *xaraés* grass development in this period was splitting nitrogen fertilization, with the last one applied at the end of March. These results demonstrated the importance of fertilization at the end of the rainy season, thus minimizing the seasonality effect of forage production. Another factor favoring forage development in this period was the greatest sprouting ability of *xaraés* grass, demonstrating that even under water deficit, this forage grass can grow. FLORES et al. (2008) reported that *xaraés* grass have advantages over other *Brachiaria* cultivars, such as greater sprouting velocity and forage yield.

A significant effect of the interaction ($P<0.05$) of nitrogen sources and doses was observed in the summer and autumn, for the CP contents (Figure 3), with quadratic equation adjustments. The greatest contents obtained in the summer were found for the doses 407 and 396 kg ha^{-1} N from urea and ammonium sulfate, respectively. At the dose of 400 kg ha^{-1} N, the CP content under the source ammonium sulfate was 6.6% greater than under urea in the summer and 5.2% in the autumn. A study of nitrogen sources and doses on forage yield and quality of *marandu* grass, by BENETT et al. (2008), indicated that the average of CP contents varied from 10.6% in the control treatment to 17.6% at the greatest nitrogen dose (600 kg ha^{-1}).

In winter and spring only the nitrogen doses had effect on CP. In these seasons, the CP contents, as a function of nitrogen doses adjusted by a quadratic equation, with maximum estimated at 443.98 and 427.65 kg ha^{-1} N for winter and spring, respectively (Figure 3). A study of nitrogen and phosphorus doses in signalgrass, by MAGALHÃES et al. (2007), showed that only nitrogen affected the contents of CP, with an increase of 22.5% at the dose 100 kg ha^{-1} nitrogen, in comparison to the non fertilized control. An increase of CP contents under nitrogen doses was also observed by CECATO et al. (2004), MISTURA et al. (2007) and MARANHÃO et al. (2009).

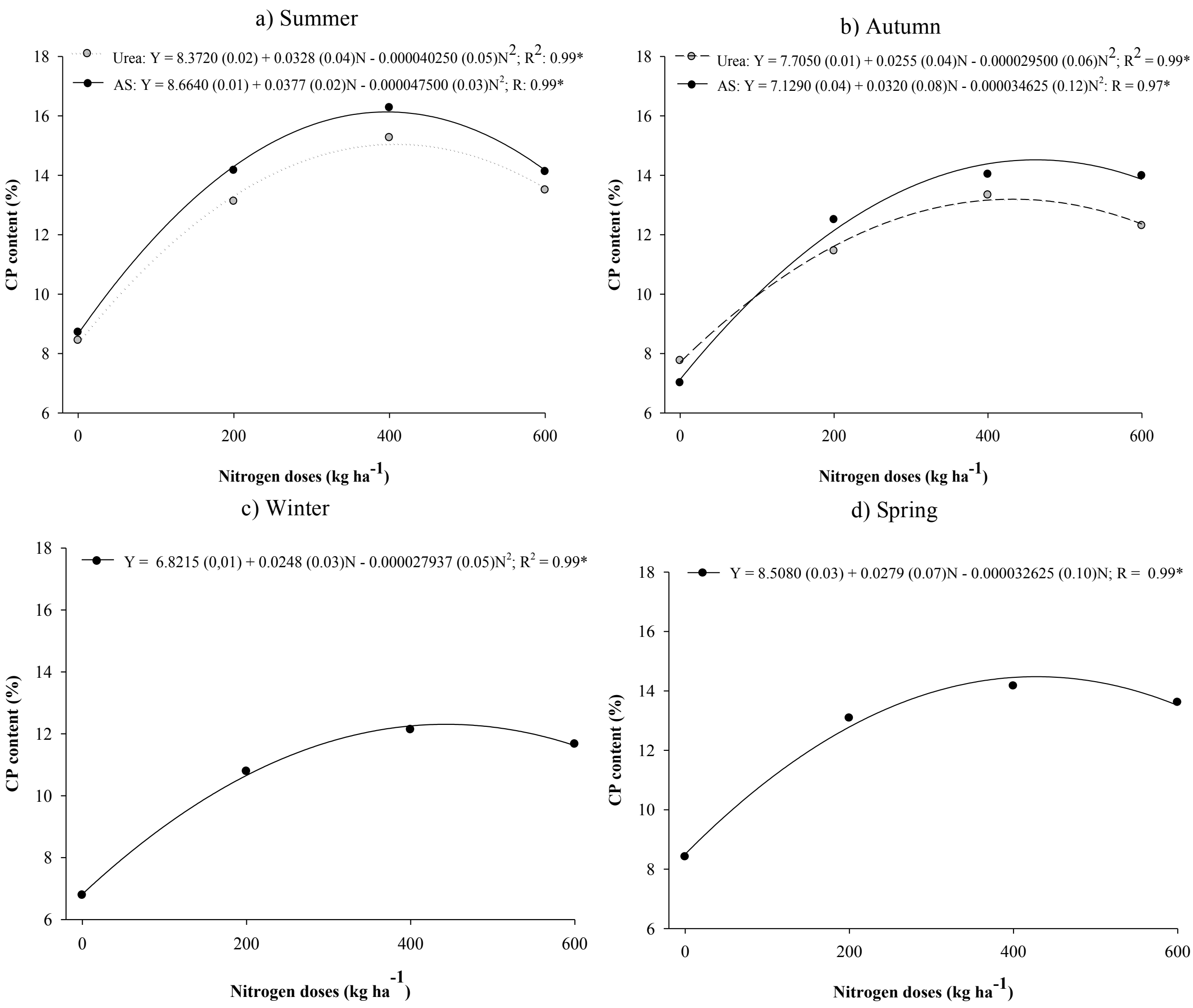

Figure 3. *Xaraés* grass CP contents under nitrogen sources and doses in different seasons of the year. Number in parenthesis corresponds to the significance parameters of regression equations. *significant at 5%.

An important aspect to be considered in this study is the response ability of *xaraés* grass to nitrogen fertilization, increasing the CP content to adequate values for the development of the forage plant. Excepting winter, even in the treatment with no nitrogen fertilization, the CP contents were above the critical level of 7% (COSTA et al., 2010), which is limiting for cattle consumption, in different periods. In the summer, the CP contents at the dose 400 kg ha^{-1} reached 16.3% under the source ammonium sulfate and 15.3% under urea.

The CP content varied through the seasons of the year. The highest levels were found in the summer, followed by autumn and spring. These greater contents can be explained due to the favorable climate conditions for *xaraés* grass growth and development. In contrast, in winter, the conditions of temperature and rainfall (Figure 1) were limiting for plant development, slowing growth and the formation of new tillers, which led to pasture aging, thus decreasing nutritional quality, since harvest was done in 64-days cycle, and not 32-days, such as in the other seasons, as a response to forage production seasonality. MITCHELL et al. (1998) reported that grazing can be used as a tool to open the forage canopy and stimulate the appearance of new tillers, with greater quality, if environment factors, such as temperature, humidity and lighting are adequate.

Another important variable expressing forage quality is NDF, comprising structural carbohydrates, which are largely used by ruminants, especially cellulose and hemicellulose (VAN SOEST, 1994). Nitrogen sources and doses affected

(P<0.05) NDF contents only in the autumn. There was a decrease in NDF contents until the dose 400 kg ha^{-1}, with subsequent increases in both sources, but greater with ammonium sulfate (Figure 4). Studies of nitrogen sources and doses for the recovery of *marandu* grass, by COSTA et al. (2010), indicated that only the doses affected NDF contents, reducing contents as nitrogen levels increased. Similar results were also obtained by MISTURA et al. (2007) and BENETT et al. (2008).

Greater contents of NDF were observed in winter. This increase is a consequence of cell wall constituents increase, which occurs with the advance of plant age (64 days), possibly due to the reduction in leaf blades and increase in stem proportion, thus increasing the fiber components (COSTA et al., 2007). This fact is associated to unfavorable climate conditions in winter, with low rainfall (Figure 1).

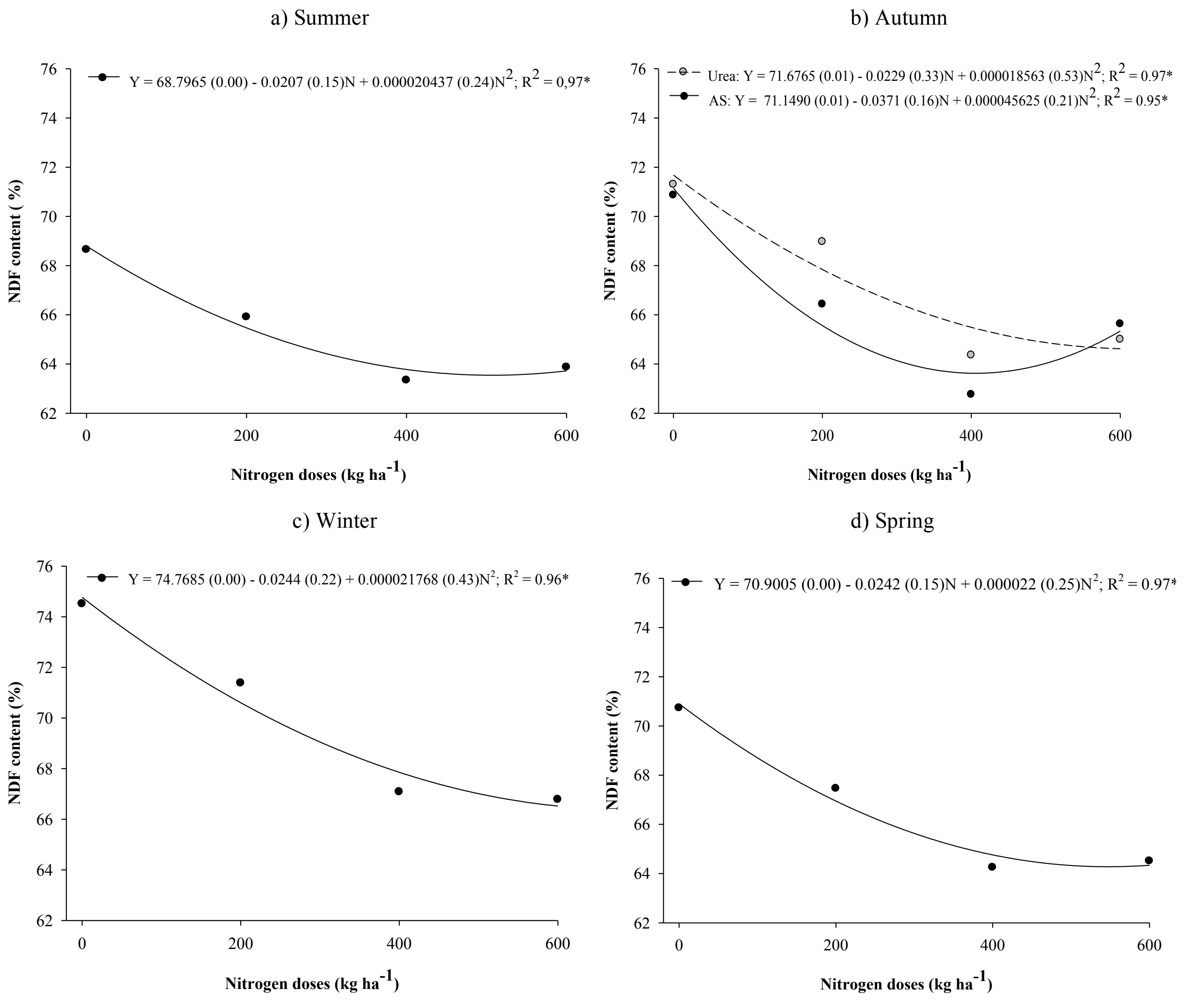

Figure 4. *Xaraés* grass NDF contents under nitrogen sources and doses in different seasons of the year. Number in parenthesis corresponds to the significance parameters of regression equations. *significant at 5%.

Only the nitrogen doses affected NDF contents in the summer, winter and spring. Similarly to what happened in the autumn, a sharp decrease in NDF contents was observed with increasing nitrogen doses, until 506, 560, and 548 kg ha^{-1}, respectively. This NDF reduction is relevant to improve forage nutritional value and the increased consumption of dry matter by the animals, since NDF content is an important parameter for defining forage quality, as well as for limiting the intake ability of the animals (COSTA et al., 2010). CECATO et al. (2004) reported that the increase of nitrogen components demands a compensating decrease in cell wall, thus reducing NDF and ADF contents.

Only the nitrogen doses affected ADF contents, in all periods analyzed, showing a linear decrease ($P<0.05$) in the autumn and a quadratic decrease ($P<0.05$) in the summer, winter and spring, with increasing nitrogen doses (Figure 5). This decrease is considered important, since the ADF content is used to evaluate feed digestibility. High ADF contents in the forage decrease dry matter digestibility, compromising animal yield. No significant decrease in ADF contents was observed beyond the dose 400 kg ha^{-1}, which was similar to the dose 600 kg ha^{-1}, in winter and spring.

In an evaluation of *marandu* grass bromatological composition, under nitrogen doses, CECATO et al. (2004), found ADF contents of 37.0 and 39.0% in the non fertilized treatment and 35.5 and 35.0% under 600 kg ha^{-1}, in the summer and winter, respectively. Such results were greater than those found in this study. However, MARANHÃO et al. (2009), studying nitrogen doses (0, 75, 150 and 225 mg dm^{-3}) in *marandu* grass, found lower NDF contents, varying from 34.5 and 25.0% for the control and maximum nitrogen dose, respectively. These authors also explain that nitrogen fertilization favors ADF reduction by the greater participation of soluble constituents and CP.

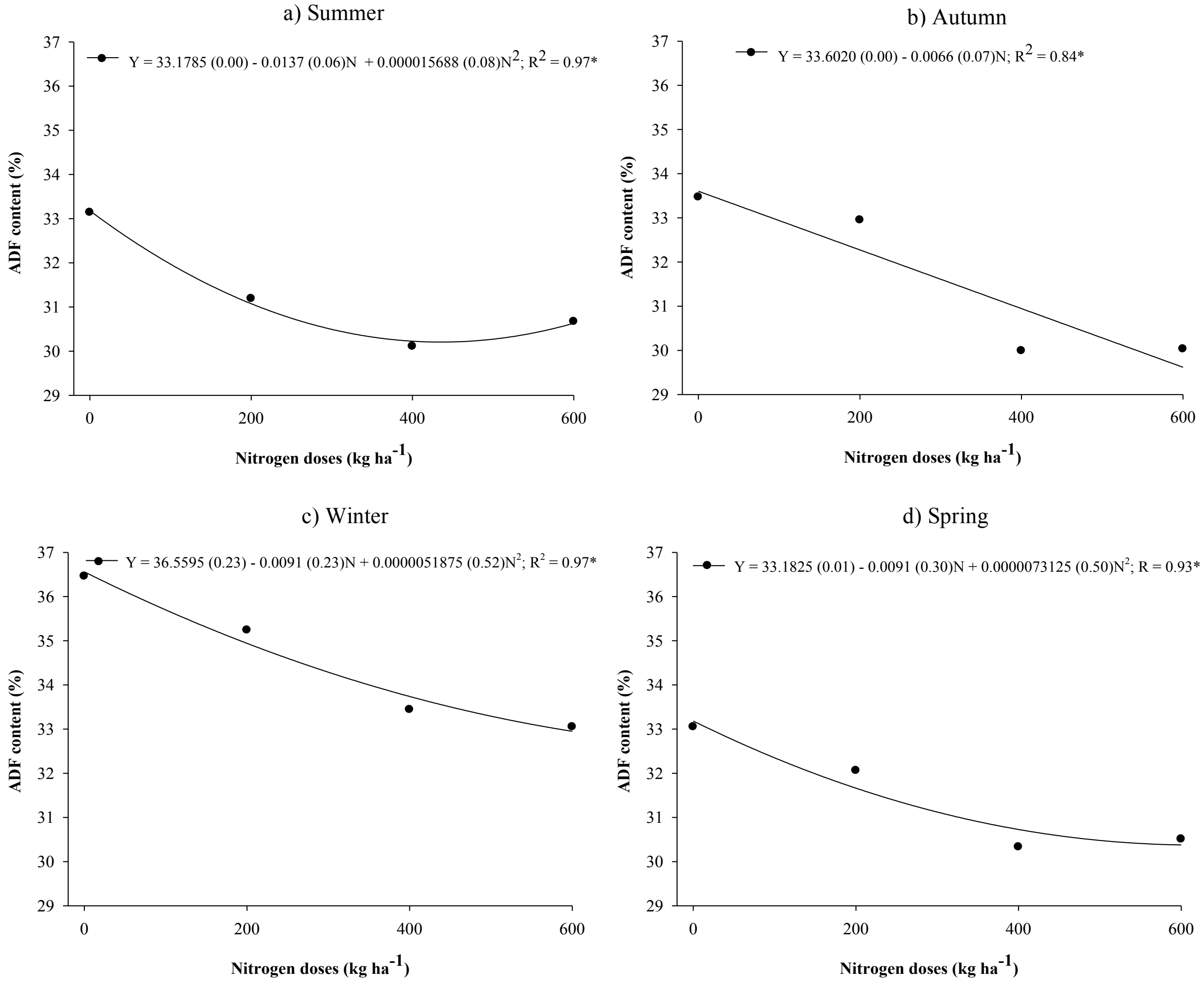

Figure 5. *Xaraés* grass ADF contents under nitrogen sources and doses in different seasons of the year. Number in parenthesis corresponds to the significance parameters of regression equations. *significant at 5%.

Interaction ($P<0.05$) between nitrogen sources and doses for TDN contents was observed only in the autumn. TDN contents for the source ammonium sulfate reached the maximum point at 404.74 kg ha^{-1} N (Figure 6). Subsequently, a decrease in TDN content was observed. CAPPELLE et al. (2001) reported that estimates of feed and diet energy values are important for high yield animals, especially dairy cattle, which require a large amount of energy. Diets deficient in energy reduce milk production, cause excessive weight loss, reproduction problems and can decrease resistance against diseases. In contrast, during summer, winter and spring, only the nitrogen doses affected TDN contents. A quadratic effect ($P<0.05$) was observed for the nitrogen doses, and the greatest contents obtained were at 400 kg ha^{-1}. No significant differences were observed above this dose for TDN contents.

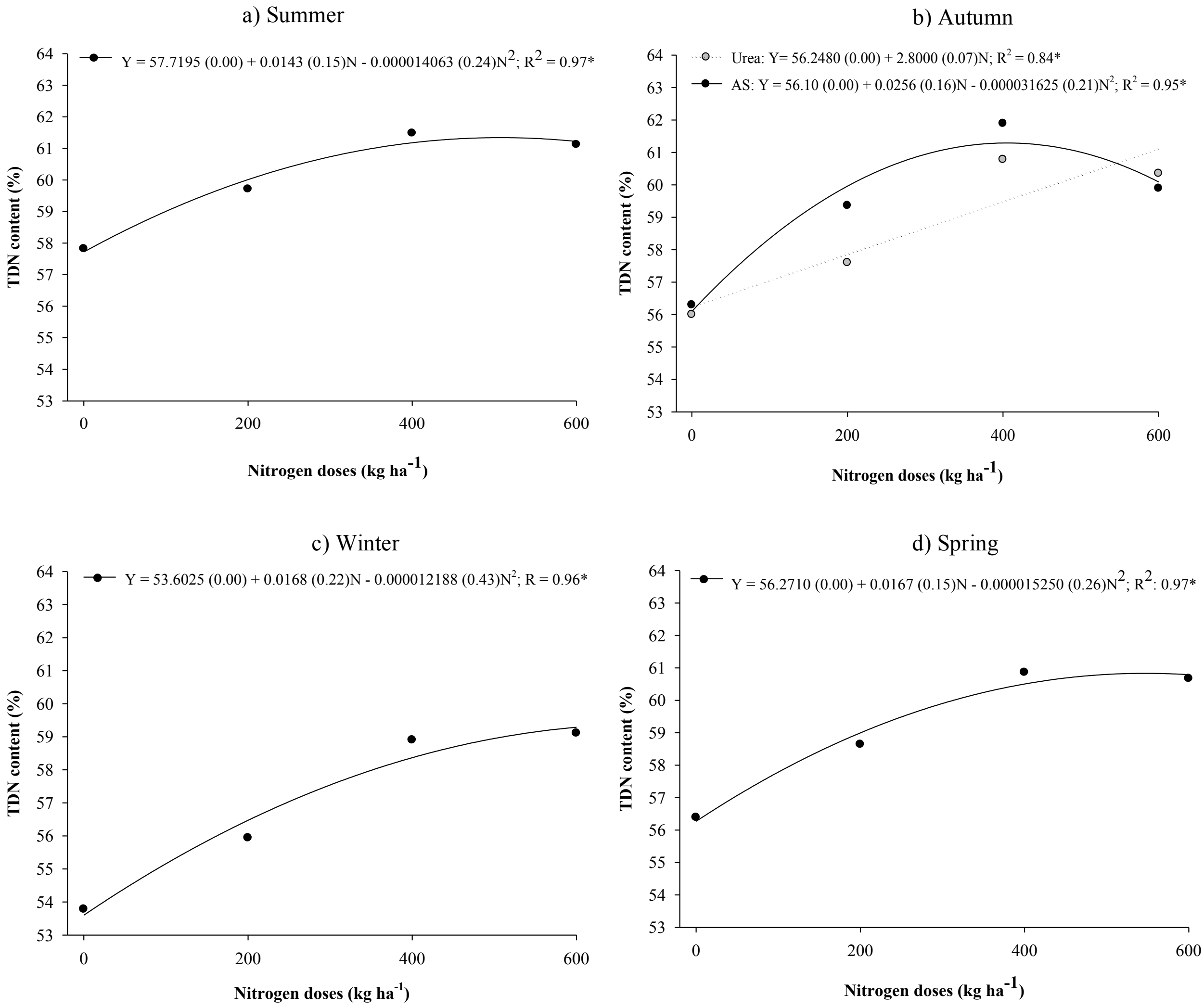

Figure 6. *Xaraés* grass TDN contents under nitrogen sources and doses in different seasons of the year. Number in parenthesis corresponds to the significance parameters of regression equations. *significant at 5%.

VAN SOEST (1994) explained that several factors, such as plant species, temperature, light intensity, water availability, latitude, maturity, type of harvest and associated forages affect the chemical composition and, consequently, feed energy availability.

BENET et al. (2008) found that as nitrogen doses increased, considerable increases were observed in the average TDN contents from the first to the third harvest, with average values varying from 54.63% for the control to 56.72% for the dose 600 kg ha^{-1} nitrogen. The TDN results obtained in that study were lower than those found in the present study for all evaluated seasons.

CONCLUSIONS

The sources of urea and ammonium sulfate were estimated at doses of 500 and 472 kg ha^{-1} and 407 and 396 kg N ha^{-1}, respectively, for the maximum production of dry matter and crude protein of *xaraés* grass. And for TDN level the maximum dose was 404.74 kg ha^{-1} N, for the ammonium sulfate source. This result indicates that regardless of the source, the application of increasing doses of up to 400 kg ha^{-1} of nitrogen to *xaraés* grass is sufficient to maintain a high dry matter production, associated with the nutritional value of the forage.

The source ammonium sulfate demonstrated higher efficacy for *xaraés* grass dry matter production in the seasons evaluated, however additional studies are needed to evaluate the economical feasibility of its use.

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