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Nitrogen fertilization strategies for xaraes and tifton 85 grasses irrigated in the dry season[1]

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ABSTRACT - An experiment was carried out to assess rates and nitrogen fertilization strategies on the forage yield using irrigation to supply the water deficit during the dry season. The grasses *Cynodon* spp cv. tifton 85 and *Brachiaria brizantha* cv. Xaraés were cultivated with nitrogen (N) at levels of 200 and 400 kg/ha according to strategies: 1) half dose applied during the rainy season (RS) and half during the dry season (DS); 2) 1/3 during the RS and 2/3 during the DS; 3) 2/3 during the RS and 1/3 during the DS; 4) all doses applied during the DS. In each season the dose was divided in three applications. Eleven harvests were conducted: six in the RS and five in the DS. When 2/3 of N was applied in the DS, forage yield in this period was statistically equivalent to those obtained in the RS in three of the five harvests for both 200 and 400 kg/ha of N. With 100% of N applied in the DS, the yield of four of five cuts of forage was similar to that obtained in the RS for both rates of N. The strategy of applying more N in the DS rather than in the RS was effective, keeping the yield steadily throughout the year. The application of 100% of the dose of 200 kg/ha N and 2/3 of the dose of 400 kg/ha N both in the dry period, under irrigation, promote uniform productions per harvest throughout the year.

Key Words: *Brachiaria brizantha*, *Cynodon* spp, nitrogen, pasture irrigation

Introduction

The uniform distribution of the forage production throughout the year is much desirable, once the seasonality of production is one of the factors that most interfere with the adoption of appropriate pasture management practices (Rolim, 1994). The challenge is to increase the forage utilization period, reducing production seasonality and the costs with forage conservation.

Several factors of pasture production can be worked on in order to minimize seasonality; among them is nitrogen fertilization and irrigation. Nitrogen (N) is one of the most required nutrients by plants, and its utilization affects forage production and nutritional value. The manipulation of doses and times of N application can lead to response from tropical forages and reduce production seasonality. Thus, Hennessy et al. (2008) verified that alteration in the N application pattern from spring to summer increases the forage supply in the fall and accumulates reserves for the winter. Euclides et al. (2007) recommend the application of N at the end of the rainy season, for production of forage for the winter.

The irrigation of pasture in the dry period can boost the effects of N application to reduce seasonality of forage production. However, studies conducted in the southeast region of Brazil have indicated the absence of response to irrigation during the dry period at forage production (Alvim et al., 1997; Lopes et al., 2005), which is a fact attributed to the effects of climate factors on seasonality. In the southeast region, there are microregions of low altitude where the minimum temperatures during the winter are more elevated, which allows the cultivation of tropical forage if the water deficiency is corrected.

This study, with irrigated pastures in the dry season, aimed to evaluate the strategy of N application which best fits the context approached. Ribeiro et al. (2009) and Vilela et al. (2004a, 2004b) applied nitrogen at the same dose throughout the rainy and dry seasons. Balieiro Neto et al. (2007) and Mistura et al. (2006) applied nitrogen fertilization in the rainy period, in spite of the irrigation in the dry season, which can reduce the response potential of irrigation and intensify the effect of seasonality.

The objective was to evaluate doses and strategies of nitrogen fertilization in two tropical grasses in order

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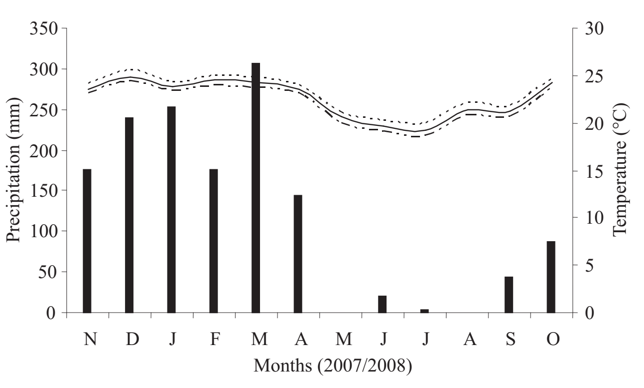
to promote better balance at the distribution of forage production throughout the year by utilizing irrigation for correction of the water deficit in the dry period.

Material and Methods

The experiment was conducted at the Experimental Farm of Leopoldina, belonging to the company EPAMIG, located at 21°28'17" South latitude, 42°43'30" West longitude and 184 meters altitude, during the period from September 2007 to October 2008. The climate in Leopoldina is humid tropical of Aw type, according to the Köppen classification (Antunes, 1986). The region has (megathermal) humid tropical climate of the savannah, with dry winter and rainy summer, whose temperature in the coldest month is above 18 ºC (Antunes, 1986; Figure 1).

The experiment was set on a plain terrain (terrace), where the soil presented the following chemical characteristics from 0 to 20 cm: pH 4.8; P and K 2.5 and 40 mg/dm^3; Ca, Mg, Al, H+Al, SB, CEC (t) and CEC (T) 0.5; 0.3; 0.6; 4.46; 0.90; 1.50 and 5.36 cmol$_c$/dm^3; base saturation (V) and aluminum saturation (m) 17 and 40%; organic matter 1.75 dag/kg; Zn, Fe, Mn, Cu and B, 2.0; 275.6; 33,8; 1.6 and 0.24 mg/dm^3, respectively. Application of limestone at 2.8 t/ha (CFSMG, 1999) was necessary, with half performed before plowing and the other before two harrowing sessions, which were performed in October 2006. The correction of acidity and phosphate and potassium fertilization for the establishment and maintenance of pastures were performed according to recommendation of (CFSMG, 1999) for a high technological level. Urea, single superphosphate and potassium chloride were used as N, P and K sources, respectively. The irrigation control was done with an irrigameter (Oliveira et al., 2008). Soil samples were obtained for the determination of wilting point, field capacity and soil density. Tests for the outflow of the irrigation equipment were conducted, and based on the soil, equipment and culture parameters, water depth and irrigation frequency were set according to the parameters of the irrigameter.



Precipitation data obtained at COPASA Water Company, in Leopoldina, and temperature data obtained at Small Hydropower Ormeo Junqueira Botelho, in Muriaé, Minas Gerais.

Figure 1 - Climatic variables during the experiment.

The experimental design was in randomized blocks with subdivided plots. Species were allocated in the plots; two nitrogen doses were combined with four strategies of nitrogen fertilization application (2 × 4 factorial arrangement) in the subplots and harvests in the subplots, with three replicates. Forage grasses *Cynodon* spp cv. tifton 85 and *Brachiaria brizantha* cv. Xaraés subjected to 200 and 400 kg/ha nitrogen were studied. Doses were split over the year according to the following strategies: 1) half the dose in the rainy period and the other half in the dry period; 2) one-third of the dose in the rainy period and two-thirds in the dry period; 3) two-thirds of the dose in the rainy period and one-third in the dry period; 4) total dose applied in the dry period. Strategies 1, 2 and 3 were divided into six applications and 4 into three applications. There were eleven harvests: six in the rainy period and five in the dry period. The experimental unit had 81 m^2, with width and length of nine meters.

The tifton 85 seedlings were obtained at the Experimental Farm Santa Rita, belonging to EPAMIG, in Prudente de Morais, planted on November 29 and 30, 2006. Before opening of the furrows, the area was broadcast with 110 kg/ha P_2O_5 and 60 kg/ha K_2O (CFSMG, 1999). Next, furrows were opened at about 0.5 m apart from each other; a seedlings patch was inserted at every 50 cm, covered with ground and stomped for compression. Approximately 2,500 kg/ha seedlings were used. On 12/05/06, seeding of xaraes grass was performed with 10 kg/ha viable seeds thrown over the area; then an old-tire roller was driven around the area for slight compaction over seeds. Fertilization was the same utilized for tifton 85. In January/07 it rained 646 mm, and because the experimental area is flat and presents little outflow of the excess water, there was soil flooding, which lasted throughout all the month of January until mid-September. This caused intense competition of typical weeds of moist areas which could not be hoed due to excessive moisture.

Only from the second fortnight did rainfall decrease, so there was the possibility to work on the area. As the infestation of weeds was too large and the hoeing hard, first the area was hoed, and when the grass was finally regrown the terrain was cleaned. Mowing was performed on 02/28/07 at 10 cm above the ground. Tifton grass presented excellent regrowth and xaraes grass presented slow regrowth, without any conditions to cover the area, which required new seeding, which was done in pits, without eliminating the plants already established.

There were 11 harvest cycles: six in the rainy period and five in the drought. The management of the pasture simulated a rotational system, around three days of variable grazing and rest, which occurred simultaneously in the plots, done by a group of cows and/or heifers. Before each grazing session, forage availability was obtained through the harvesting of the forage contained within a sampler frame of 1.0 × 1.0 m, harvested 10 cm above ground for the two grasses. After the area to be harvested was delimited, three measurements of pasture height and the visual estimate of the soil cover were taken by two assessors before and after grazing. After they were harvested, before and after grazing, samples were weighed and sampled for fractioning into leaf blade and stem + sheath. Samples were taken to oven at 65 ºC for 72 hours for pre-drying. The data obtained were submitted to variance analysis and means were compared by the Student-Newman-Keuls test (α = 0.05).

Results and Discussion

The harvest × species × dose/strategy of nitrogen application interaction was not significant for most of the variables. Both xaraes and tifton 85 grasses responded equally to doses and strategies of N application, except for cover and percentage of leaf blades at pre-grazing. Species, dose/strategy of N application and harvest were significant (P<0.05) for most of the dependent variables, as well as for the harvest × species and harvest × dose/strategy interactions (Table 1).

The effects of species on the pre and post-grazing heights stem from the morphological and structural characteristics of the species studied (Table 2). At pre-grazing, xaraes grass presented more elevated height and percentage of leaf blade, whereas tifton 85 grass showed greater soil cover. At pre-grazing, there was no difference in forage mass availability, but the differences from before grazing at the sward height, leaf blade percentage and mass remained.

The fact that the xaraes grass presents caespitous growth makes tussocks that can reach 1.6 m height produce vigorous stalks with long and lanceolate leaves, which reach up to 60 cm length and 2.5 width, resulting in a high ratio of leaves in the mass (Valle et al., 2010). Tifton 85 grass, in turn, a hybrid of the genus *Cynodon* spp. whose plants are rhizomatous and stoloniferous, does not originate tussocks (Hill et al., 1993) and usually presents greater proportion of stalks in the mass than xaraes grass. These traits made the tifton 85 grass have higher availability of forage mass than

Table 1 - Probability values by the F test of variance analysis

Source of variation	Variables								
	PrHt	PrCv	PrDM	Prbld	%Prbld	PoHt	PoDM	%Pobld	Pobld
Species	<0.001	<0.001	0.018	<0.001	<0.001	0.004	0.508	<0.001	<0.001
Dose/strategy	<0.001	<0.001	0.015	<0.001	0.008	0.005	0.268	0.001	0.039
Spe×dose/stra	0.152	0.338	0.797	0.213	0.386	0.049	0.535	0.067	0.287
Harvest	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Harvest×species	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.015	0.041	<0.001
Harvest×dose/stra	<0.001	<0.001	0.056	<0.001	<0.001	0.592	0.259	0.397	0.614
Harv×spe×dose/stra	0.951	0.026	0.314	0.079	0.039	0.895	0.906	0.359	0.506
CV (%)	13.49	7.73	28.62	23.74	15.81	13.67	32.27	30.53	42.24

PrHt - pre-grazing height; PrCv - pre-grazing cover; PrDM - pre-grazing dry forage mass; Prbld - pre-grazing leaf blade dry forage mass; %Prbld - percentage of pre-grazing leaf blade; PoHt - post-grazing height; PoDM - post-grazing dry forage mass; Pobld - pre-grazing leaf blade dry forage mass; %Pobld - percentage of post-grazing leaf blade.

Table 2 - Mean values per harvest of structural and production variables of xaraes and tifton 85 grasses pre and post-grazing and probability by the F test

Variable	Grazing/Species					
	Pre-grazing			Post-grazing		
	Xaraes	Tifton 85	P value	Xaraes	Tifton 85	P value
Sward height (cm)	52.98	38.64	<0.001	31.80	25.86	0.004
Cover (%)	78.14	91.32	<0.001	-	-	-
DM/cut (kg/ha)	4.376	4.747	0.018	2939	2809	0.508
LBDM/cut (kg/ha)	2.352	1.918	<0.001	780	529	<0.001
% Leaf blade	56.36	40.47	<0.001	28.42	20.20	<0.001

DM - forage dry mass; LBDM - leaf blade dry matter.

xaraes grass, although with lower leaf blade, at pre-grazing. Despite their contrasting morphological characteristics, both species were included in this study for meeting two premises: Xaraes grass had been recently launched by EMBRAPA, in 2003 (Valle et al., 2004) and stood out in an assay under irrigation (Alencar et al., 2009a) involving tropical grasses; tifton 85 grass was tested in several experiments under irrigation (Marcelino et al., 2003; Aguiar et al., 2006; Balieiro Neto et al., 2007) and could serve as a reference species due to the greater number of studies. In spite of the morphological differences, both grasses responded equally to doses and strategies of nitrogen application in forage dry mass production at pre-grazing.

The comparison of productions obtained in this study with those of others is not valid by the method of forage removal through grazing, but leaf blade dry forage mass reached high annual availability, of 25,872 kg/ha in xaraes grass, against 21,098 kg/ha in tifton 85 grass, at the 11 evaluations. Average per harvest similar to this experiment was obtained by Balieiro Neto et al. (2007) with tifton 85 grass irrigated under grazing with rotational stocking, who obtained average 2,249 kg/ha green leaf dry forage mass (blade + leaf sheath) at pre-grazing in eight assessments during the seasons of summer/fall/winter. Aguiar et al (2006), on tifton 85 pasture irrigated under grazing, obtained average pre and post-grazing forage masses of 7,948 and 3,386 kg/ha, respectively. Pre-grazing mass was quite superior to those obtained in this study, but at post-grazing, it was close.

Treatments receiving the greatest fractions of N doses during the rainy period presented higher values for the variables, especially at pre-grazing (Table 3). This result was expected, once environmental conditions during the spring/summer generate better conditions for the development of grasses and better responses to the increase in N doses. One must consider that the data presented are means obtained throughout the 11 assessments done in the two grasses, when the total N dose was applied. In xaraes grass irrigated and fertilized throughout the year with proportional doses of N, Cunha et al. (2010) also obtained greater height and cover in the spring/summer seasons.

In the case of total pre-grazing dry forage mass, although the variance analysis presented (Table 1) significant effect ($P<0.05$), at the test of mean there was no effect of doses/strategies of N application. The lack of effect for doses 200 and 400 kg/ha N was not expected, but can be explained by the evaluation methodology of the experiment. The forage removal to start new growth in this experiment was done by grazing. In this management, the removal of forage from the plots by grazing left a residue of non-consumed stems, which were reassessed at the following sampling, yielding a residual effect at the estimation of total forage dry mass production by the cut at 10 cm from the ground. The effects of N doses on the availability of leaf blade at pre-grazing were clear, with average 1,926 and 2,344 kg/ha for doses 200 and 400 kg/ha N, an increase of 22%. Leaf blade mass at post-grazing, in turn, did not present difference between doses and strategy of N application. In this case, grazing removed the treatments in a different manner, making there be no differences between the residues (Table 3). Thus, the effects of N doses on the disappearance of leaf blade forage mass between pre- and post-grazing were even higher, of 1,265 and 1,696 kg/ha for doses 200 and 400 kg/ha N, respectively, with an increase of 34%.

For the morphological, structural and production variables, disregarding species and doses/strategies of fertilization, the results were much variable. This is a result from the effects of doses/strategies which varied throughout the year, affecting each harvesting individually (Table 4).

Overall, greater accumulation of total dry forage mass and leaf blade mass were observed during the rainy period, although the difference between the two seasons was not

Table 3 - Mean values of structural and production variables following the dose/strategy of nitrogen application in xaraes and tifton 85 grasses

Variable	Nitrogen dose (kg/ha)/Application strategy							
	200				400			
	50/50*	33/67	67/33	0/100	50/50	33/67	67/33	0/100
Pre. sward height (cm)	42.1c	45.5b	46.7ab	40.5c	48.3ab	48.5ab	49.9ab	45.0b
Pre. cover (%)	81.4cd	83.8bcd	81.7cd	79.9d	87.6abc	89.4abc	90.5ab	83.5bcd
Pre. total DM/cut (kg/ha)	4.227a	4.301a	4.562a	4.090a	4.899a	4.582a	4.896a	4.934a
% Pre. leaf blade	45.2b	47.5ab	45.6ab	47.9ab	50.6ab	51.4ab	51.8a	47.5ab
Pre. blade DM/cut (kg/ha)	1.860d	1.990cd	2.013cd	1.843d	2.418ab	2.324ab	2.470a	2.163bc
Post. sward height (cm)	27.4b	29.9ab	29.6ab	27.1b	29.6ab	28.4ab	30.3a	28.4ab
Post. total DM/cut (kg/ha)	2874							
% Post. leaf blade	23.8abc	24.4abc	26.5a	25.0abc	24.1abc	22.9bc	25.8ab	21.9c
Post. blade DM/cut (kg/ha)	642a	674a	739a	590a	587a	663a	741a	601a

Means followed by the same lowercase letter in the row do not differ ($P<0.05$) from each other by the SNK test.
DM - dry forage mass; Pre. - pre-grazing height; Post. - post-grazing.
* % of N applied in the rainy and dry seasons, respectively.

high. On average, 70% of the forage mass obtained during the rain could be produced in the dry period (5.120 × 3.892 kg/ha). Since the dry forage mass is subjected to the effects of residual post-grazing mass, it may not accurately reflect the intended purpose of uniform forage production throughout the year. When considering the leaf blade forage dry mass, the production in the dry period reached 85% of the rainy period (2.272 × 1.971 kg/ha). One must consider that the data from Table 4 do not incorporate the effect of dose/strategies of N application, since they are average data of this variable and of species over the harvesting sessions.

Alencar et al. (2009a) and Cunha et al. (2012) obtained dry mass productivity in the fall/winter seasons equivalent to 76% of that produced in the spring/summer in the West region of Minas Gerais. Oliveira Filho et al. (2011) obtained approximately 80% of the production of spring/summer during the fall/winter in Gurupi, Tocantins. These experiments were conducted in locals of low latitude and altitude: 18° 47' and 223 m for Governador Valadares, Minas Gerais, and 11° 45' and 287 m in Gurupi, Tocantins, respectively. According to Alencar et al. (2009b), the winter temperature in these regions is higher than 15 ºC and under conditions of average winter annual temperatures superior to this value, pasture growth rate is not very reduced.

In the first evaluations of the experiment during the rainy period, there was no difference between species, or there was higher production of dry forage mass of xaraes grass on the average of doses/strategies of N application in relation to tifton 85 (Table 5). From the six cutting, tifton 85 produced more dry forage mass than xaraes grass.

In the case of leaf blade availability, the advantage was always of xaraes grass in almost all harvesting sessions, except for the ninth one, which was performed in August. The advantage in the accumulation of leaf blades in xaraes grass is due to its greater percentage in the dry forage mass (Table 2). One must consider that the stem in tifton 85, due to its stoloniferous growth, thinness and small leaves must contribute in greater amounts to the animal diet than the stem of xaraes grass. Thus, the greater total dry forage mass accumulation of tifton 85 in relation to xaraes grass in the dry period may represent an advantage to increase the forage availability in this sense. In the case of tifton 85, the morphological and structural characteristics of the sward limit the capacity of cattle to select only the leaf blades.

The comparison between species is a strategy adopted in many studies aiming to determine the forage grasses best suited to that pasture manage system. Under irrigation in the dry period, one could regard the greater potential

Table 4 - Mean values by species and dose/strategy of nitrogen application of structural and production variables according to harvest

Variable	Harvested months (2007/2008)										
	Rainy						Dry				
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct
Pre. sward height (cm)	43.3e	39.0f	66.0a	62.1b	47.8d	44.0e	35.9g	31.5h	37.6fg	45.2e	51.7c
Pre. cover (%)	82.8c	83.7bc	86.6ab	84.5bc	83.1bc	79.5d	89.0a	78.3d	88.7a	89.3a	86.6ab
Pre. total DM/cut (kg/ha)	5.494b	5.972ab	6.404a	4.626c	4.586c	3.637de	3.786de	3.431e	3.756de	4.278cd	4.207cd
Pre. blade DM/cut (kg/ha)	2.650b	2.145cd	2.952a	2.330c	2.052d	1.501e	1.951d	1.249f	1.976d	2.354c	2.326c
% Pre. leaf blade	49.6cd	37.2f	47.0de	50.2cd	45.3e	44.0e	53.2bc	37.0f	55.0ab	56.4ab	57.8a
Post. sward height (cm)	27.1e	29.1cd	37.0a	32.7b	30.3c	29.6cd	23.4g	24.8fg	26.2ef	29.4cd	27.6de
Post. total DM/cut (kg/ha)	3.694b	5.234a	3.476bc	3.201c	3.624bc	2.721d	2.016e	1.909e	1.654e	1.669e	2.417d
Post. blade DM/cut (kg/ha)	886a	740bc	911a	613cd	821ab	593d	405e	527de	523de	521de	662cd
% Post. leaf blade	24.3bc	13.8e	26.3b	19.1d	22.7cd	21.7cd	20.4cd	27.7b	31.3a	31.9a	28.1b

Means followed by the same lowercase letter in the row do not differ (P<0.05) from each other by the SNK test.
DM - dry forage mass; Pre. - pre-grazing height; Post. - post-grazing.

Table 5 - Total forage mass and leaf blade dry mass, by cutting, before grazing during the rainy and dry seasons under irrigation

Variable	Season of the year/harvested month (2007/2008)										
	Rainy						Dry				
	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Aug	Sep	Oct
	Total dry forage mass (kg/ha)										
Xaraes grass	5.427bA	6.435aA	6.961aA	4.780cA	4.501cA	3.131dB	3.493dA	3.387dA	2.821dB	3.672dB	3.530dB
Tifton 85 grass	5.561aA	5.508aB	5.846aB	4.472bA	4.671bA	4.143cA	4.078cA	3.476cA	4.691bA	4.885bA	4.884bA
	Leaf blade dry forage mass (kg/ha)										
Xaraes grass	2.836aA	2.637bA	3.575aA	2.700bA	2.298cA	1.698dA	2.066cA	1.448eA	1.777dB	2.300cA	2.534bA
Tifton 85 grass	2.465aB	1.653cB	2.330aB	1.960bB	1.805bB	1.303dB	1.835bA	1.050dB	2.176aA	2.409aA	2.117aB

Means followed by the same lowercase letter in the row do not differ (P<0.05) from each other by the SNK test.

of response of tifton 85, considering its selection for the subtropical condition and the harsher winters in the United States than in central Brazil (Hill et al., 1993). However, there was not a clear difference that could point one of the species as the most indicated. Other studies comparing tropical forage grasses irrigated in the dry period did not indicate the advantages of one plant over the other (Alencar et al., 2009a; Aguiar et al., 2005). In the study of Aguiar et al. (2005), tifton 85 grass presented response to irrigation, unlike the Tanzania and Mombasa grasses, which did not respond. Considering only the result obtained under irrigation, none of the three grasses showed difference of production. Rassini (2004), in turn, in a study with six irrigated tropical grasses which included coastcross grass, obtained best response from elephant grass and the worst with coastcross grass.

Nitrogen (N) fertilization in the fall/winter produced effects on the forage availability throughout the year under irrigation (Table 6). With 200 kg/ha N per year, the application of 67% N in the dry season promoted production equivalent to the highest ones obtained in the rainy period in three of the five evaluations conducted. With 100% of the N applied in the dry season, four of the five cuts were similar to the highest productions in the rain (Table 6). At the dose of 400 kg/ha N per year, similar results were obtained, with three and four harvest sessions of dry period producing similarly to the highest productions of rain, resulting from the application of 67 and 100% of the N, respectively.

In an overview of the data, one can see that the responses to nitrogen fertilization were higher in the rainy period. The treatment with application of 67% N kept the leaf blade mass availability higher in the rain, regardless of the dose applied. The concentration of nitrogen fertilization during the dry period increased the production in relation to the other treatments receiving part of the N in the rain, but was not capable of compensating the lower production in the rain. Similar pattern was verified by Hennessy et al. (2008), dislocating part of the nitrogen fertilization of the spring to summer in temperate conditions. The responses in forage production and N absorption were better with the application of N in the spring. In spite of the lower response to N application in the dry period, it is estimated that this may not be a problem, once the N non-absorbed in the dry season will be used in the following rainy period and, since in the irrigation there is control of the water depth applied, there are no risks of N leaching even at high doses. Primavesi et al. (2006) affirm that the application of N doses of up to 500 kg/ha split in up to five times does not present risk of leaching of nitrate to the groundwater, even during the rainy period.

Brazil presents very different regions as for the effects of the climatic factors on seasonality and pasture production, and in each region, locations with quite contrasting climatic conditions in function, especially of latitude and altitude, are found. The North and Northeast regions, close to the equator, present smaller temperature variations during the year and the seasonality of production occurs mainly in function of irregularity of rainfall. In regions of more elevated latitude such as the South and part of the South and Midwest, the main climatic factor responsible for seasonality

Table 6 - Effect of the dose/strategy of nitrogen application interaction and harvested months during the rainy and dry seasons under irrigation on the leaf blade dry mass

Harvested months	Nitrogen dose (kg/ha)/Strategy of application							
	200				400			
	50/50*	33/67	67/33	0/100	50/50	33/67	67/33	0/100
	Rainy (kg/ha)							
November	2.615Ab	2.464Ab	3.094Aa	1.999Ac	3.091Ba	2.524Ab	3.381Aa	2.035Bc
December	1.901Ba	1.945Aa	2.190Ba	1.860Aa	2.292Ca	2.065Ba	2.531Ba	2.379Aa
January	3.064Ab	2.667Ac	3.204Ab	1.750Ad	3.862Aa	3.111Ab	3.344Ab	2.616Ac
February	2.080Bc	2.296Ab	2.300Bb	1.788Ac	2.532Cb	2.570Ab	3.353Aa	1.722Bc
March	1.918Bb	1.736Bb	2.217Ba	2.078Aa	2.342Ca	2.163Ba	2.548Ba	1.410Cb
April	1.284Ca	1.560Ba	1.655Ca	1.163Ba	1.626Ca	1.601Ba	1.972Ca	1.146Ca
Subtotal	12.862	12.668	14.660	10.638	15.745	14.034	17.129	11.308
	Dry (kg/ha)							
May	1.473Ca	2.007Aa	1.716Ca	1.850Aa	2.093Ca	2.129Ba	1.873Ca	2.463Aa
June	1.013Ca	1.035Ca	1.001Da	1.141Ba	1.469Da	1.615Ba	1.233Da	1.486Ca
August	1.549Cb	1.663Bb	1.240Db	2.016Ab	2.213Ca	2.753Aa	1.849Cb	2.529Aa
September	1.712Bb	2.260Aa	1.849Cb	2.501Aa	2.621Ca	2.401Aa	2.477Ba	3.014Aa
October	1.854Bb	2.261Ab	1.675Cb	2.130Ab	2.458Ca	2.629Aa	2.608Ba	2.990Aa
Subtotal	7.601	9.226	7.481	9.638	10.854	11.527	10.040	12.482

Means followed by the same lowercase letter in the row and uppercase letters in the column do not differ from each other by the SNK test ($P<0.05$).
* % of N applied in the rainy and dry seasons, respectively.

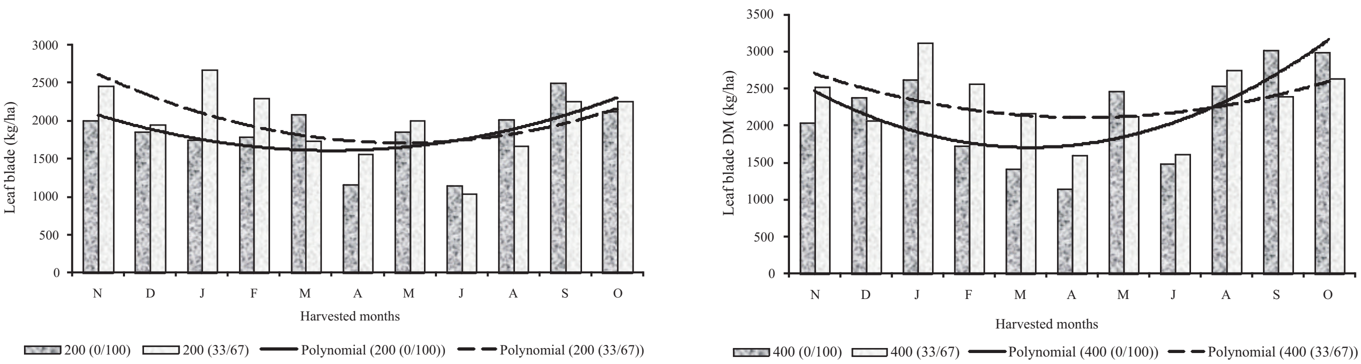


Figure 2 - Lines of tendency of leaf blade forage mass availability during rainy and dry periods under irrigation (2007/2008), with fertilization of 200 kg/ha and 400 kg nitrogen fully applied in the dry period or with 33% in the rainy period.

of forage production is the low temperature observed in the winter. However, even in regions of higher latitude, there are microregions of low altitudes in which the minimum temperatures during the winter are more elevated, allowing the cultivation of tropical forages if the water deficiency is corrected. Thus, one cannot generalize about the climatic limitations to forage growth only in function of the region. The most righteous is to analyze the climatic data of the location, especially the variation of minimum temperatures during the year, in order to verify the potential of response that one can expect with the use of irrigation.

On the climatologic data obtained at PCH Muriaé, the lowest mean minimum temperature was observed in July: 18.6 ºC (Figure 1). Considering the fertilization strategy, just for the availability of the leaf blade fraction, the opportunity of manipulating the distribution of forage production throughout the year utilizing irrigation in regions of climate similar to that of the region studied is clear. In systems that propose to utilize irrigation for correction of the water deficit during the dry period, the fertilization strategy can be an important tool for the forage producer.

The analysis of the lines of tendency clearly indicates the recommendation of applying 100% of the dose in the dry period in the case of fertilization with 200 kg/ha N and 67% of the dose in the dry period with fertilization of 400 kg/ha N when aiming at more balance in the forage production throughout the year (Figure 2). Although the results were obtained in an exploratory assay, in small portions, involving a dry and a rainy period, the responses obtained point to good potential of the irrigation technology in the dry period of the year.

The application of 400 kg/ha N in the dry period, be it in full or partially, also provoked an inversion in the capacity of leaf blade accumulation between the rainy and dry periods, with advantage to the dry period of the year. The average availability of leaf blades in the harvest sessions of the rainy period was of 1,885 kg/ha against the 2,496 kg/ha obtained in the dry period. This can be a desirable situation to intensify smaller areas and work with high stocking rates. Since irrigation demands high investment, the exploitation of the maximum potential of production in the dry season can be advantageous. As these independent variables did not interact with the species, both xaraes and tifton 85 grasses can be utilized. Besides the forage availability, one must consider the average interval in between grazing sessions, which was 30.8 days in the rainy period, against 38.2 days in the dry period. The pasture needed a time interval for a 25% higher growth in the dry period to reach grazing conditions.

Depending on the region, the pasture irrigation systems which are not uninstalled in the rainy period can be utilized strategically in the spring and summer, correcting the bad distribution of rainfall in the period, especially at the occurrence of Indian summer. The technical and economic adequacy of the pasture irrigation in the dry season, according to the prevailing environmental conditions of the region is necessary, hence the possibility of elaborating a map of climatic adequacy for the state of Minas Gerais, concerning different geographic references such as latitude, longitude and altitude which delimitate the regions with potential of response to pasture irrigation during the rainy period of the year.

Conclusions

The nitrogen fertilization strategy alters the curve of forage distribution of xaraes and tifton 85 grasses under irrigation in the dry period throughout the year. The concentration of total or partial nitrogen fertilization in the dry period allows the maintenance of the pasture in xaraes and tifton 85 grasses under irrigation without big alterations in pasture support capacity.

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