Morphogenesis of Tanzania guinea grass under nitrogen doses and plant densities

Thiago Gomes dos Santos Braz[1], Dilermando Miranda da Fonseca[2], Fabrício Paiva de Freitas[1], Janaina Azevedo Martuscello[3], Manoel Eduardo Rozalino Santos[4], Márcia Vitória Santos[1], Vinícius Valim Pereira[1]

[1] Programa de Pós-graduação em Zootecnia/Universidade Federal de Viçosa, Viçosa, MG.
[2] Departamento de Zootecnia/Universidade Federal de Viçosa, Viçosa, MG.
[3] Departamento de Zootecnia/Universidade Federal de Alagoas, Arapiraca, AL.
[4] Departamento de Zootecnia/Universidade Federal de Uberlândia, Uberlândia, MG.

ABSTRACT - The objective of this work was to evaluate effects of nitrogen fertilization and plant density on morphogenesis of Tanzania guinea grass. It was used a random block design with 12 treatments and two replications in a 4×3 factorial arrangement, with four doses of nitrogen (N) (without N application, 80, 160 or 320 kg/ha.year) and three plant densities (9, 25 or 49 plants/m^2). Harvest was performed at 25 cm from the ground when the canopy intercepted 95% of the incident light. Rates of leaf appearance and pseudostem elongation were positively and linearly influenced by nitrogen, whereas phillochron and leaf life span were influenced linearly and negatively. Leaf elongation responded positively to two factors, whereas leaf senescence rate and number of live leaves were not influenced by the factors evaluated. Number of total, basal and aerial tillers were greater at the density of 9 plants/m^2 and at the nitrogen dose of 320 kg/ha.year. Nitrogen increases production of leaves and tillers in Tanzania guinea grass defoliated at 95% of light interception, but high density of plants reduces the number of tiller per bunch.

Key Words: fertilization, light interception, morphogenetic characteristics, structural characteristics, *Panicum maximum*

Introduction

It is estimated that in Brazil, approximately 172 million of hectares are used for pastures (IBGE, 2006), which represents around 22% of the national territory, but most areas used for raising domestic herbivores present productive indexes below to what is desirable. The low productivity is a consequence, mainly, of the adoption of incorrect management strategies, which lead to a low pasture sustainability.

Apart from assuring pasture sustainability, the principal objective of pasture management is to make most of the diet of the animal composed of leaves, nevertheless, many environmental factors (light, temperature, water and nutrients) influence photosynthesis processes, growth dynamics and plant development, and consequently, leaf formation. Thus, under distinct conditions of use, understanding the process of forage development is the first step for defining rational strategies of pasture management (Gomide et al., 2006). This statement highlights the importance of studies on forage grass production dynamics through evaluations of its morphogenetic and structural characteristics.

Nitrogen has great ability on modifying tissue flow in tropical forage grass (Marschner, 1995), resulting in the need for adjustment in the adopted strategies of defoliation management (Fonseca et al., 2008). On the other hand, little is known on the impact of plant density on pasture morphogenesis, particularly when its effect is combined with nitrogen fertilization on pastures managed on the condition of pre-defoliation referent to 95% light interception. Moreover, it is believed that plant density can also influence pasture structure because of the changes on patterns of intra-specific competition for nutrients and light in the canopy.

Therefore, the objective of this work was to evaluate the influence of nitrogen fertilization and the effect of plant density on the morphogenetic and structural traits of Tanzania guinea grass.

Material and Methods

This experiment was carried out in Setor de Forragicultura in the Departamento de Zootecnia at Universidade Federal de Viçosa from November 2007 to March 2008. Viçosa is located in the region of Zona da Mata Mineira at 651 meter

of altitude at 20° 45' 40" S and 42° 51' 40" W. According to the classification of Köppen (1948), the climate in the region of Viçosa is subtropical, Cwa, characterized by a mild and dry winter and well defined dry and rainy seasons. Average pluvial precipitation is 1,340 mm, air relative humidity is 80% and maximum and minimum temperatures are 27.3 and 14.9°C, respectively. During the experimental period, climate data were recorded (Figure 1).

It was used 9 m² (3 × 3 m) plots with guinea grass cultivar Tanzania (*Panicum maximum* Jacq.) plants, established in December 2005. Data on soil analyses, climate conditions, sowing rate and establishing manner referring to the initial phase of plant establishment can be seen in Magalhães (2007). Treatments were arranged in a 4 × 3 factorial arrangement, corresponding to four doses of nitrogen (no N application, 80, 160 or 320 kg/ha.year) and three plant densities (9, 25 or 49 plants/m²), totaling 12 treatments. It was used a completely randomized block design with two replicates. Blocks were established perpendicular to the slope of the area. The soil is classified as paleudult soil (EMBRAPA, 1999), with clay texture. Before the experiment (October 2007), sampling of the soil was carried out at 0-20 cm depth, which presented the following chemical characteristics: pH water (1:2.5 ratio) = 5.88; P-Mehlich^{-1} = 2.25 mg/dm^3; K-Mehlich^{-1} = 47 mg/dm^3; Ca^{2+} = 3.4 cmol$_c$/dm^3; Mg^{2+} = 0.88 cmol$_c$/dm^3; Al^{3+} = 0 cmol$_c$/dm^3; H + Al = 3.59 cmol$_c$/dm^3, V% = 55; m% = 0; and OM = 1.67 dag/kg. According to the results from this analyses, 200 kg/ha of P$_2$O$_5$ were applied as simple superphosphate in the plots of Tanzania guinea grass.
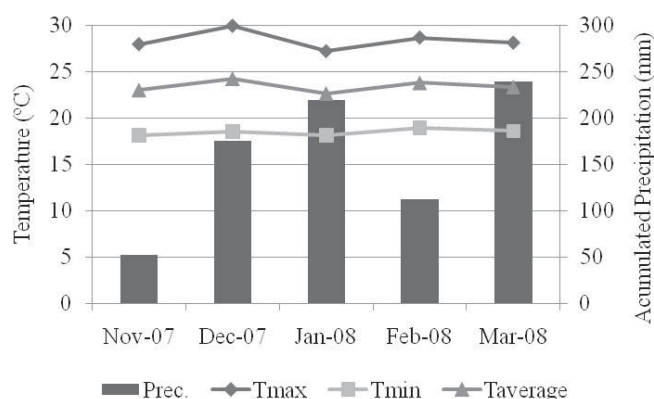

Figure 1 - Monthly accumulated precipitation (Prec.) and maximal temperature (Tmax), average temperature (Taverage) and minimal temperatures (Tmin) recorded during experimental period (Source: Departamento de Engenharia Agrícola/UFV).

Nitrogen doses were split into three applications: the first one right after standardization cutting, carried out in November 4th 2007; the others were done after the second and third cut in each plot (experimental unit). It was also applied 150 kg/ha of K$_2$O in each plot, split in two applications, one right after standardization cutting and the second after the second cutting. Sources of nitrogen and potassium were urea (44% N) and potassium chloride (58% K$_2$O), respectively.

After aerial section standardization cutting, monitoring of light interception (LI) started in the plots by using canopy analyses system SUNSCAN (Delta-T, Cambridge, England). Readings were performed every three days until readings were close to 90%, from which they started to be done daily, until reaching 95% of light interception, when all forage of the plots were cut by using a brush cutter and removed afterwards. Regardless to height of the canopy, cutting was done at 25 cm from the ground level.

Morphogenetic and structural traits were evaluated twice a week by using a millimeter ruler in two tillers per plot which were marked after standardization cutting. Length of expanded leaves was determined by measurement from the leaf tip to its ligule. For expanding leaves, the same procedure was used, but the ligule of the last expanded leaf was considered as measure reference. For senescencing leaves, the length corresponded to the distance from the leaf ligule to the point of advance of senescence. Size of the stem was measured as the distance from the soil surface to the ligule of the youngest completely expanded leaf. From this measures, the following response-variables were calculated: leaf appearance rate (LAR) - leaf/day; phillochron (number of days to appearance of two consecutive leaves) - day; leaf elongation rate (LER) - cm/day; pseudostem elongation rate (PER) - cm/day; leaf life span (LLS) - day; number of live leaves per tiller (NLL) and leaf senescence rate (LSR) - cm/day. Number of basal tiller (NBT), aerial tillers (NAT) and number of total tiller (NTT) per bunch was obtained by identifying and counting two distinct bunch per plot every 28 days.

Data were submitted to analyses of variance and regression by using the model:

$$\hat{Y} = \hat{\beta}_0 + \hat{\beta}_1 \times N + \hat{\beta}_2 \times N^2 + \hat{\beta}_3 \times D + \hat{\beta}_4 \times D^2 + \hat{\beta}_5 \times (N \times D)$$

where N = nitrogen dose and D = plant density.

The other freedom degree related to the treatments was grouped as "lack of fit". The models were selected based on the significance of the parameters previously described, by adopting P=0.05 as the critical level of probability for error Type I. For significance for "lack of fit", the adjustment of the new model was evaluated by including non-contemplated

interactions in this work previously described in order to adjust properly data.

Values of the variables NTT, NBT and NAT were transformed based on neperian logarithm in function of the non-observation of normal distribution (P<0.05).

All the statistical procedures were carried out by using PROC GLM, PROC REG and PROC NLIN procedures implemented in program SAS version 8.2 (Statistical Analysis System, 1999).

Results and Discussion

Leaf appearance rate (LAR) could be represented by the linear regression model and it was positively influenced by nitrogen fertilization (P<0.05), without observed effects of plant density or interaction among those factors (P>0.05; Table 1). In the absence of nitrogen application (N), LAR was 0.16 leaf/day and 0.24 leaf/day at the dose of 320 kg/ha.year N, representing an increase of 50%. Indeed, nitrogen has a central role on forage grass leaf production inasmuch as it is a constituent of amino acids, proteins and fundamental enzymes for carbon fixation (Taiz & Zeiger, 2004) and it is required at great quantities in the zones of cell division (Gastal & Nelson, 1994).

Leaf appearance rate and the increase estimated for this variable by applying 320 kg/ha.year N were similar to the ones reported in literature. However, value of LAR in the absence of nitrogen was rather great, if compared to the results of most of studies on morphogenesis (Garcez Neto et al., 2002; Martuscello et al., 2006; Oliveira et al., 2007). Influence of nitrogen on LAR can be analyzed as the result of combination among many factors as height of sheath, leaf elongation and temperature (Duru & Ducrocq, 2000).

Garcez Neto et al. (2002), in a work with four doses of nitrogen (0, 100, 200 and 400 kg/ha) and three cutting heights (5, 10 or 20 cm) in Mombasa guinea grass, observed increases up to 104% in LAR. On the other hand, Patês et al. (2007), by evaluating the effect of nitrogen and phosphorus application on morphogenesis of Tanzania guinea grass, observed an average increase of 59% for LAR by supplying 100 kg/ha.year.

The effect of nitrogen fertilization on LAR is variably discussed in the literature, probably because of the differences in nitrogen doses and cutting intensities, factors that can be, many times, associated to responses from different cultivars or forage plant species to N supply. According to Oliveira et al. (2007), under high availability of nitrogen, Tanzania guinea grass plants have their increase stimulated with a consequent elongation of internodes, increasing new tissue flow so the new leaf is pushed out of the sheath of the preceding leaf, what can cause increase of LAR.

However, Skinner & Nelson (1995) demonstrated that the higher length of sheath, common in pseudostems of tiller fertilized with high N doses, promotes lower rate of leaf apearance, what can be explained by the greater distance to be completed by the leaf until its emergence.

Phillochron fitted the linear model regression and it was negatively influenced by N application (P<0.05), but it was not influenced (P>0.05) by plant density or by interaction among these factors (Table 1). The values found were 4.44 day.leaf $^{-1}$ at the dose of 320 kg/ha.year N and 7.57 leaf/day at the absence of N supply.

Reduction of phillochron with nitrogen fertilization was due to the positive effect of nitrogen on LAR. Thus, Martuscello et al. (2006) verified, in Massai guinea grass plants, influence by nitrogen fertilization and by defoliation regime on phillochron, which reduced at the highest doses and with the lowest defoliation frequencies. According to these authors, reduction of phillochron with nitrogen fertilization is a result of the effect of N on plant growth, giving greater capacity of regrowth, inasmuch as after defoliation, fast recovery of its photosynthetic apparatus can determine its survival in the vegetal community.

Pseudostem elongation rate (PER) of Tanzania guinea grass can be represented by the linear regression model and it was positively influenced (P<0.05) by nitrogen fertilization, but it was observed no effect (P>0.05) of plant density or of interaction among factors (Table 1). By applying 320 kg/ha.year, PER was 0.21 cm/day, which represents an increase of 133% in relation to the non-supply of N

Table 1 - Leaf appearance rate (LAR), phillochron, pseudostem elongation rate (PER), leaf life span (LS), leaf senescence rate (LSR) and number of live leaves (NLL) in Tanzania guinea grass in function of doses of N (N)

Variable	Equation	R²	CV (%)
LAR (leaves/day)	$\hat{Y} = 0.1604 + 0.000256*N$	0.49	23.3
Phillochron (days/leaf)	$\hat{Y} = 7.57 - 0.00797*N$	0.68	18.9
PER (cm/day)	$\hat{Y} = 0.0920 + 0.000372*N$	0.37	59.2
LLS (days)	$\hat{Y} = 33.24 - 0.03664*N$	0.46	24.5
LSR (cm/day)	$\hat{y} = 0.56$	-	52.3
NLL (leaves)	$\hat{Y} = 4.7$	-	9.1

(0.09 cm/day). Similar results were observed by many authors in in *Panicum maximum* grasses (Lavres Junior et al., 2004; Oliveira et al., 2007; Patês et al., 2007).

Nitrogen is important for forage grass yield because it positively influences characteristics such as size of the leaves and stems and appearance and development of tillers and root system (Lavres Junior & Monteiro, 2003; Rodrigues et al., 2007), which are factors directly related to forage yield. In addition, because of its effects on the sward development, nitrogen can also increase shading of the tillers, which respond to this condition by increasing LAR to expose to the light the most active section of photosynthetic apparatus (the youngest leaves). As forage harvest is done when canopy intercepts 95% of light, as in this experiment, elongation of stems and leaf senescence are reduced because canopy did not exceed the critical leaf area index and consequently, kept itself in non-limiting light conditions (Barbosa et al., 2002; Carnevalli et al., 2006).

Leaf life span (LLS) can be represented by the linear regression model and it was negatively influenced by nitrogen supply (P<0.05). Plant density effects or interaction among these factors were not observed (P>0.05; Table 1). The values found were 21 and 33 days for N dose of 320 kg/ha.year and absence of nutrient supply, respectively. The increase on longevity of leaves of the plants which received less N or did not receive N can be explained by the reduction of leaf appearance rate, which implied in a longer time for plants to reach the maximum number of live leaves, which was 4.7 leaves/tiller (Table 1).

Management of defoliation through LI reduces leaf senescence and accumulation of stem, but this is not an indispensable condition, that is, before canopy reaches 95% of LI, leaf senescence already occurs. Thus, Mazzanti et al. (1994), highlight that, overall, there is a reduction of leaf life span in situations of high availability of nitrogen because of light competition, determined by the increase in leaf elongation rate and because of the greater final size of the leaves.

Martuscello et al. (2006) also observed a linear negative influence of nitrogen fertilization and defoliation frequency on leaf life-span of Massai guinea grass, which ranged from 45 days for plants without nitrogen fertilization harvested with four leaves to 33 days for plants fertilized with 240 kg/ha.year N also harvested with four leaves. Results of LLS on the literature changes a lot, but when plants are evaluated in more competitive environments, as for example plots or pastures, the effect of competition and self-shading becomes more important for this variable, which decreases with the increase of N supply, different from what occurs in

greenhouse conditions. Therefore, Pereira (2009) observed a reduction of LLS during summer and fall/winter seasons in tillers of Marandu palisade grass on pastures fertilized with nitrogen. On the other hand, increase on leaf longevity was observed by Garcez Neto et al. (2002) and Oliveira et al. (2007) in *Panicum maximum* forage fertilized with N in greenhouse.

Leaf elongation rate (LER) fitted the exponential model in function of nitrogen doses and the quadratic model in function of plant density (P<0.05), but it was not evidenced interaction among these factors (P>0.05; Figure 2). Increases promoted by N supply were greater to the ones caused by plant density, suggesting a greater importance of N for leaf yield in Tanzania guinea grass pastures. Therefore, increases promoted with N dose of 320 kg/ha.year in relation to the absence of supply were 103; 96 and 89% for densities of 9, 25 and 49 plants/m^2, respectively, whereas with the increase in plant density from 9 to 49 plants/m^2, increases were 16, 11, 9, and 8%, respectively, for the absence of fertilization and at the doses of 80, 160 and 320 kg/ha.year. Although the effect of plant density on LER was not so sharp, the occurrence of greater LER at greater intensities can be explained by the fact that plants present greater leaf elongation to increase its light interception in canopies.

Leaf elongation rate is one of the most responsive morphogenetic trait to nitrogen fertilization (Garcez Neto et al., 2002; Martuscello et al., 2005, 2006; Oliveira et al., 2007; Patês et al., 2007; Silva et al., 2009). Overall, most authors
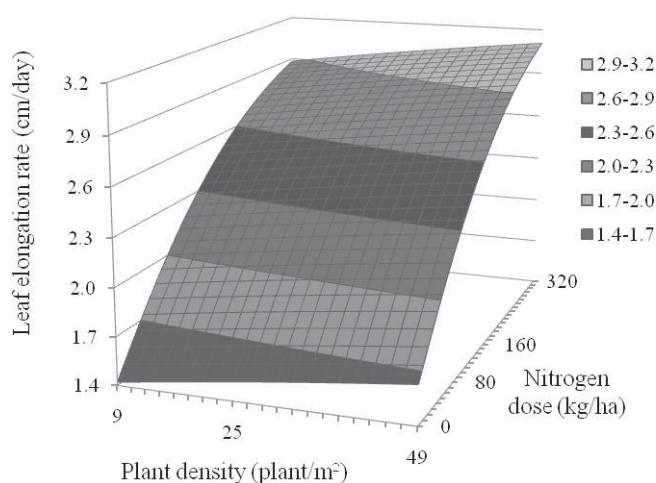
$$\hat{Y} = 1.3612e^{(0.8107(1-e^{(-0.00715N)}))} + 0.00678D - 0.00002D^2 (R^2 = 0.98)$$

Figure 2 - Leaf elongation rate (LER) in Tanzania guinea grass in function of the doses of nitrogen (N) and plant density.

reports a linear and positive response of LER in relation to nitrogen supply. In this context, Martuscello et al. (2006) observed positive linear influence of nitrogen to LER in Tanzania guinea grass grown in a greenhouse, which represented an increase of 64% in elongation of leaves at 240 kg/ha N. The reason for those results is because in addition to being part of the structure of many components essential to plant growth, N has the capacity to stimulate growth of leaves, stem and roots, and its deficiency can reduce cell division and cell expansion as well, directly affecting leaf elongation (Marschner, 1995).

Regarding to leaf senescence rate (LSR), it was not observed any effect (P>0.05) of nitrogen supply, plant density and interaction among factors, whose mean in the treatments was 0.56 cm/day (Table 1). Absence of significant effect of nitrogen doses and of plant density for this variable can be explained by the strategy itself established for these cuts, that is, when canopy reached 95% of LI. The objective of this management is to increase forage net accumulation through maintenance of the pasture with leaf area index below the critical one, therefore reducing forage losses by senescence. On the other hand, high coefficient of variation was observed for this variable (Table 1), which can also have contributed for not detecting effects of nitrogen or plant density. Another factor that can influence LSR in cutting or intermittent pasture systems are variable conditions of temperature, humidity and luminosity which the pasture is submitted to. Indeed, before cutting, the oldest leaves located in the lowest pasture stratum were adapted to the reduced light intensity, which probably results in low photosynthesis rate and high respiration rate. However, because pasture was harvested by grazing or by cutting, those leaves are exposed to high luminosity condition. In this situation, reconstitution of a new leaf area of forage after cutting might have depended on intern cycling of the nutrients (i.e., N redistribution) due to the low capacity of using soil nutrients during the initial stage of regrowth. This certainly determined the occurrence of leaf senescence of Tanzania guinea grass, even under pre-harvest management referring to 95% of LI. Thus, Barbosa et al. (2002) observed average LSR of 1.29 cm/day.tiller in Tanzania guinea grass canopy defoliated with 95% under two post-pasture residuals, a value superior to the one observed in this study. Sousa et al. (2010) also observed the occurrence of leaf senescence in andropogon grass defoliated with 95% of LI which was higher in canopies defoliated with higher intensity.

There was no influence of nitrogen doses, plant density and interaction of these factors on the number of live leaf per tiller (LLT; P>0.05; Table 1), which tends to be steady at the water or nutritional deficits and in pasture variable conditions.

The average number of live leaves was 4.7 leaves/tiller, which was greater than the one observed by Gomide & Gomide (2000) for Tanzania cultivar, which presented a mean value of 3.5 leaves/tiller after 35 days of regrowth. In this sense, Fagundes et al. (2006) did not observe any effect of N on the number of live leaves of signalgrass over the season of the year. However, the absence of nitrogen effect on NLL differs from the results by Garcez Neto et al. (2002) and Martuscello et al. (2006), who observed positive effect of nitrogen under this variable for Mombasa and Massai *P. maximum*, respectively.

For the number of total tillers per bunch (NTT), the exponential model was fitted in function of N doses and the quadratic model was fitted in function of plant density (P<0.05; Figure 3A). The lowest NTT was estimate for the density of 35 plants/m^2, regardless of nitrogen doses. The greatest NTT was observed at the density 9 plants/m^2, suggesting that Tanzania grass pastures established under low sowing densities tend to increase the number of tiller per bunch to occupy vacant spaces. Actually, for most species, greater light intensities, which is a common condition in pastures with lower plant density, favors tillering.

In the absence of nitrogen supply and at the N doses of 80, 160 and 320 kg/ha.year, NTT was respectively 38, 47, 57 and 78 in relation to the density of 9 plants/m^2. For the density 25 plants/m^2, NTT was 29, 36, 44 and 60 for absence of supply and N doses of 80, 160 and 320 kg/ha.year, respectively. This reduction in NTT can be explained by the effect of reducing luminosity and nutrient availability caused by the greater plant density. In relation to the absence of supply, the application of 320 kg/ha.year increased NTT by 107%, what can be explained by the capacity of this nutrient in increase tillering, confirming the importance of nitrogen on perennially of pastures and for forage accumulation.

Lavres Junior et al. (2004) observed a quadratic effect of nitrogen doses for the number of tillers in *P. maximum* Aruana cultivar, and also that the maximum number of tillers after the first cut was estimated for the N dose of 746 kg/ha whereas after the second cutting, the dose which most stimulated tillering was 598 kg/ha, probably because of the own capacity of N in increasing proliferation of the root system which becomes more efficient in extracting the nutrient. A quadratic effect of nitrogen doses on tillering was also observed by Garcez Neto et al. (2002).
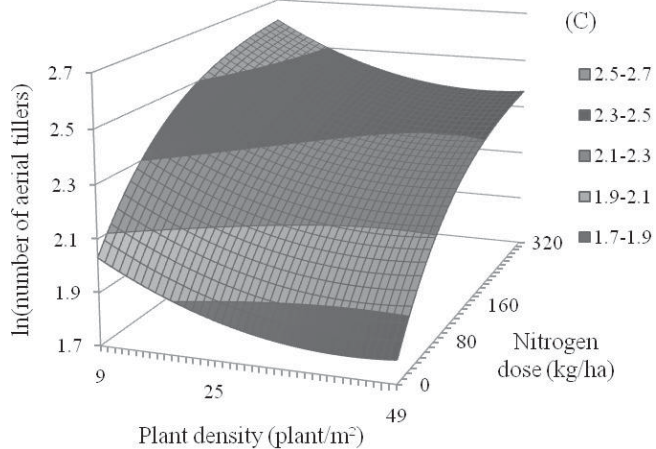
Number of basal tillers per bunch (NBT) also fitted exponential regression model in function of N doses and it fitted the quadratic model in function of plant densities
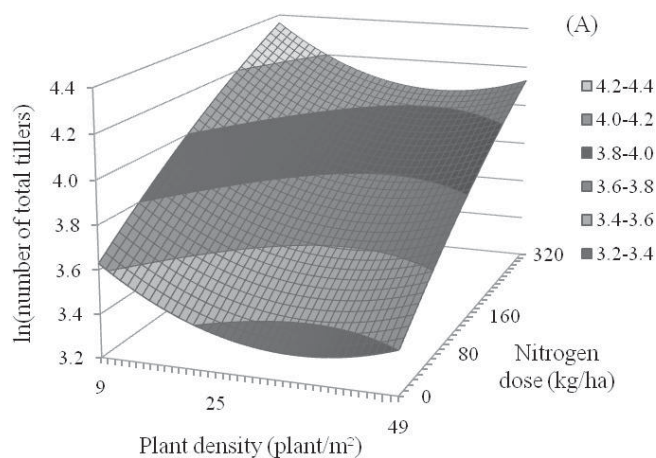
$\hat{Y} = 3.8737e^{(0.3294(1-e^{(-0.00231N)}))} - 0.0311D + 0.000438D^2 (R^2 = 0.99)$
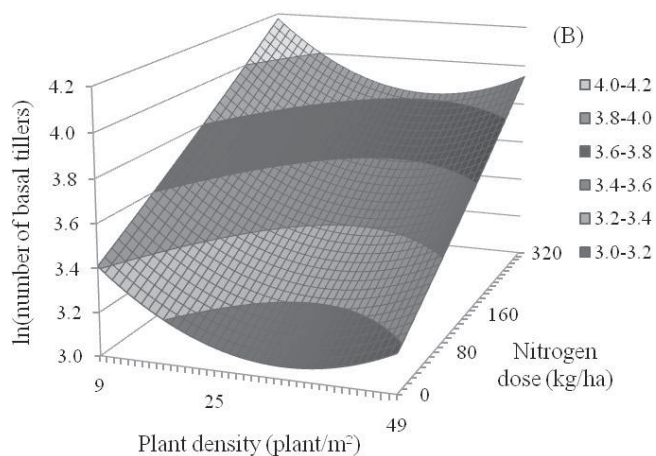
$\hat{Y} = 3.7071e^{(8.2308(1-e^{(-0.000072N)}))} - 0.0381D + 0.000558D^2 (R^2 = 0.99)$

$\hat{Y} = 2.1843e^{(0.2471(1-e^{(-0.00948N)}))} - 0.0189D + 0.000221D^2 (R^2 = 0.96)$

Figure 3 - Number of total (A), basal (B) and aerial (C) tillers per bunch in Tanzania guinea grass in function of the nitrogen doses and plant densities.

(P<0.05), not being detected significant interaction (P>0.05) among these factors (Figure 3B). The response of number of basal tillers to nitrogen fertilization and to plant density was similar to the one of total number, inasmuch as basal tillers were more numerous than aerial tillers. Number of basal tiller was greater at the density 9 plants/m^2 and the smallest at the density 25 plants/m^2 and 49 plants/m^2.

The greater number of basal tillers at the density 9 plants/m^2 suggests that less dense canopy tend to favor basal tillering and therefore the total number of tillers, inasmuch as greater luminosity intensity crosses the aerial section of the plants and it reaches the base of the bunchs.

At the absence of N supply and by supplying 80, 160 and 320 kg/ha.year, it was observed 30, 36, 44 and 65 basal tillers per bunch, respectively, at the density 9 plants/m^2, whereas at the density 25 plants/m^2, it was verified values of 22, 27, 32 and 48 basal tiller per bunch.

Reduction of NBT of density 9 to densities 25 and 49 plants/m^2 was 26 and 7%, respectively. These results show that smaller participation of basal tiller in NTT at the density 25 plants/m^2 and that this one could have been compensated by greater aerial tillering. On the other hand, greater participation of basal tillers at the density 49 plants/m^2 can be explained by the fact that in greater densities, bunch becomes smaller and constituted of less robust tillers with lower capacity of emitting aerial tillers.

The increase in NBT promoted by nitrogen supply of 320 kg/ha.year in relation to the non-supply of the nutrient was approximately of 115% indicating that the effect of nitrogen on basal tillering is sharper than on NTT, whose increase was 107%. This result was probably caused by the nitrogen positive effect on initiation of more developed buds (basal) and by the inhibitory effect of the auxine on the development of higher buds, closer to the apical meristem (Taiz & Zeiger, 2004).

The number of aerial tillers per bunch (NAT) and the NBT as well, were better fitted to the exponential regression model in function of N doses and the quadratic model in function of plant density (P<0.05), but it was not observed any interaction among those factors (P>0.05; Figure 3C). There were more aerial tillers at the density 9 plants/m^2 and at the N dose of 320 kg/ha.year, being smaller the number of aerial tillers estimated for density 43 plants/m^2.

The number and density of aerial tiller are in general little discussed in the literature. Carvalho et al. (2006) did not observe any effect of the grazing intensity on aerial tiller density of elephant grass managed under two residuals in the rotational system (50 and 100 cm), but they did prove the influence of the tiller class and time of evaluation on population density of tillers inasmuch as the number of
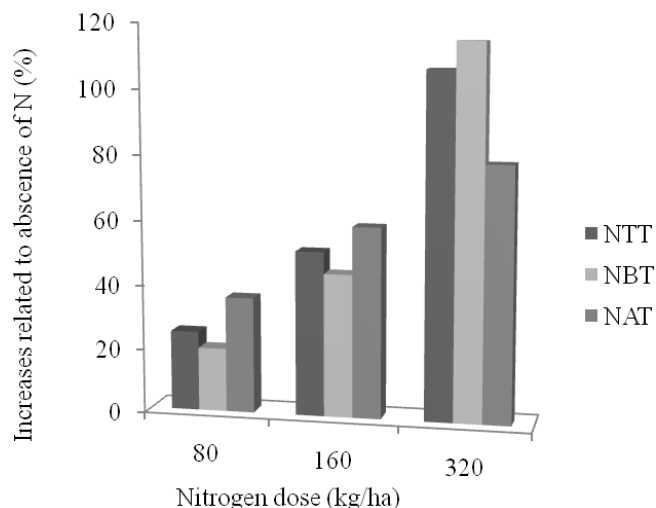
Figure 4 - Increase on the number of total tillers (NTT), number of basal tiller (NBT) and number of aerial tillers (NAT) per bunch in Tanzania grass fertilized with nitrogen in relation to the not-fertilized condition.

basal tiller was greater in the spring and the number of aerial tiller was greater in the summer.

Absence of nitrogen supply resulted in smaller aerial tiller yield and nitrogen fertilization presented lower effect on the number of those tillers when compared to total and basal tillers (Figure 4).

The greater increase on the number of basal tillers by applying 320 kg/ha.year can be caused by the higher frequency of cuttings, resulting in greater exposure of basal buds to the light in addition to the effect of nitrogen on initiation of latent buds.

Conclusions

Nitrogen fertilization increases leaf appearance and elongation and reduces leaf life span and phillochron in Tanzania guinea grass submitted to cutting at 95% light interception condition. Plant density influences positively leaf elongation and reduces number of basal and aerial tiller per bunch in Tanzania guinea grass. Nitrogen promotes increases in the number of basal and aerial tillers in bunches of Tanzania guinea grass, with a sharper effect on the number of basal tillers.

References

BARBOSA, R.A.; NASCIMENTO JR, D.; EUCLIDES, V.P.B. et al. Características morfogênicas e acúmulo de forragem do capim-tanzânia (Panicum maximum Jacq. cv. Tanzânia) em dois resíduos forrageiros pós-pastejo. **Revista Brasileira de Zootecnia**, v.31, n.2, p.583-593, 2002.

CARNEVALLI, R.A.; DA SILVA, S.C.; BUENO, A.A.O. et al. Herbage production and grazing losses in *Panicum maximum* cv. Mombaça under four grazing managements. **Tropical Grassland**s, v.40, p.165-176, 2006.

CARVALHO, C.A.B.; PACIULLO, D.S.C.; ROSSIELLO, R.O.P. et al. Dinâmica do perfilhamento em capim-elefante sob influência da altura do resíduo pós-pastejo. **Pesquisa Agropecuária Brasileira**, v.41, n.1, p.145-152, 2006.

DURU, M.; DUCROCQ, H. Growth and senescence of the successive grass leaves on a tiller. Ontogenic development and effect of temperature. **Annals of Botany**, v.85, p.635-643, 2000.

EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA - EMBRAPA. Centro Nacional de Pesquisa de Solos. **Sistema brasileiro de classificação de solos**. Rio de Janeiro, 1999. 412p.

FAGUNDES, J.A.; FONSECA, D.M.; MISTURA, C. et al. Características morfogênicas e estruturais do capim-braquiária em pastagem adubada com nitrogênio avaliadas nas quatro estações do ano. **Revista Brasileira de Zootecnia**, v.35, n.1, p.21-29, 2006.

FONSECA, D.M.; SANTOS, M.E.R.; MARTUSCELLO, J.A. Adubação de pastagens no Brasil: uma análise crítica. In: SIMPÓSIO SOBRE MANEJO ESTRATÉGICO DA PASTAGEM, 4., 2008, Viçosa, MG. **Anais...** Ubá: Suprema Editora, 2008, v.1, p.295-334.

GARCEZ NETO, A.F.; NASCIMENTO JUNIOR, D.; REGAZZI, A.J. et al. Respostas morfogênicas e estruturais de Panicum maximum cv. Mombaça sob diferentes níveis de adubação nitrogenada e alturas de corte. **Revista Brasileira de Zootecnia**, v.31, n.5, p.1890-1900, 2002.

GASTAL, F.; NELSON, C.J. Nitrogen use whitin the growing leaf blade of tall fescue. **Plant physiology**, v.105, p.191-197. 1994.

GOMIDE, C.A.M.; GOMIDE, J.A.; PACIULLO, D.S.C. Morfogênese como ferramenta para o manejo de pastagens In: REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA DE ZOOTECNIA, 43., 2006, João Pessoa. **Anais...** João Pessoa: SBZ, 2006. p.554-579.

INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE. [2006]. Disponível em: <http://www.sidra.ibge.gov.br/bda/tabela/protabl.asp?c=264&z=t&o=1&i=P> Acesso em: 13/6/2011.

KÖPEN, W. **Climatologia**. Buenos Aires: Gráfica Panamericana, 1948. 478p.

SOUSA, B.M.L.; NASCIMENTO JÚNIOR, D.; DA SILVA, S.C. et al. Morphogenetic and structural characteristics of andropogon grass submitted to different cutting heights. **Revista Brasileira de Zootecnia**, v.39, n.10, p.2141-2147, 2010.

LAVRES JUNIOR, J.; MONTEIRO, F.A. Perfilhamento, área foliar e sistema radicular do capim-mombaça submetido a combinações de doses de nitrogênio e potássio. **Revista Brasileira de Zootecnia**, v.32, n.5, p.1068-1075, 2003.

LAVRES JÚNIOR, J.; FERRAGINE, M.D.C; GERDES, L. et al. Yield components and morphogenesis of aruana grass in response to nitrogen supply. **Scientia Agricola**, v.61, n.6, p.632-639, 2004.

MAGALHÃES, M.A. **Fluxo de Tecidos e produção de capim-tanzânia irrigado sob diferentes densidades de plantas e doses de nitrogênio**. 2007. 94f. Dissertação (Mestrado em Zootecnia) - Universidade Federal de Viçosa, Viçosa, MG.

MARCHNER, H. **Mineral nutrition of higher plants**. 2.ed. London: Academic Press, 1995. 889p.

MARTUSCELLO, J.A.; FONSECA, D.M.; NASCIMENTO JÚNIOR, D. et al. Características morfogênicas e estruturais do capim-xaraés submetido à adubação nitrogenada e desfolhação. **Revista Brasileira de Zootecnia**, v.34, n.5, p.1475-1482, 2005.

MARTUSCELLO, J.A.; FONSECA, D.M.; NASCIMENTO JÚNIOR, D. et al. Características morfogênicas e estruturais de capim-massai submetido a adubação nitrogenada e desfolhação. **Revista Brasileira de Zootecnia**, v.35, n.3, p.665-671, 2006.

MAZZANTI, A.; LEMAIRE, G.; GASTAL, F. The effect of nitrogen fertilisation on the herbage production of tall fescue swards

grazed continuousey with sheep. 1. Herbage growth dynamics. **Grass and Forage Science**, v.49, p.111-120, 1994.

OLIVEIRA, A.B.; PIRES, A.J.V.; MATOS NETO, U. et al. Morfogênese do capim-tanzânia submetido a adubações e intensidades de corte. **Revista Brasileira de Zootecnia**, v.36, n.4, p.1006-1013, 2007.

PATÊS, N.M.S.; PIRES, A.J.V.; SILVA, C.C.F. et al. Características morfogênicas e estruturais do capim-tanzânia submetido a doses de fósforo e nitrogênio. **Revista Brasileira de Zootecnia**, v.36, n.6, p.1736-1741, 2007.

PEREIRA, L.E.T. **Morfogênese e estrutura de pastos de capim-marandu submetidos à lotação contínua e ritmos morfogênicos contrastantes**. 2009. 111f. Dissertação (Mestrado em Agronomia) - Escola Superior de Agricultura "Luiz de Queiroz"/Universidade de São Paulo, Piracicaba.

RODRIGUES, R.C.; MOURÃO, G.B.; VALINOTE, A.C. et al. Reservas orgânicas, relação parte aérea-raiz e C-N e eliminação do meristema apical no capim-xaraés sob doses de nitrogênio e potássio. **Ciência Animal Brasileira**, v.8, n.3, p.505-514, 2007.

SILVA, C.C.F.; BONOMO, P.; PIRES, A.J.V. et al. Características morfogênicas e estruturais de duas espécies de braquiária adubadas com diferentes doses de nitrogênio. **Revista Brasileira de Zootecnia**, v.38, n.4, p.657-661, 2009.

SKINNER, R.H.; NELSON, C.J. Elongation of the grass leaf and its relationship phillochron. **Crop Science**, v.35, n.1, p.4-10, 1995.

TAIZ, L.; ZEIGER, E. **Fisiologia vegetal**. Porto Alegre: Artmed, 2004. 719p.