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Tiller population density in deferred *Urochroa decumbens* pasture and strategies for nitrogen fertilization

Fábio Andrade Teixeira[1*], Paulo Bonomo[2], Aureliano José Vieira Pires[1], Fabiano Ferreira Silva[1], George Abreu Filho[3] and Pablo Teixeira Viana[3]

*[1]Departamento de Tecnologia Rural e Animal, Universidade Estadual do Sudoeste da Bahia, Estrada do Bem Querer, km 4, Cx. Postal 95, 45083-900, Vitória da Conquista, Bahia, Brazil. [2]Departamento de Estudos Básicos e Instrumentais, Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Bahia, Brazil. [3]Programa de Pós-graduação em Zootecnia, Universidade Estadual do Sudoeste da Bahia, Vitória da Conquista, Bahia, Brazil. *Author for correspondence. E-mail: ftxzoo@yahoo.com.br*

ABSTRACT. The objective of this work was to evaluate the tiller population density in *Urochroa decumbens* pasture deferred for 95 and 140 days, aiming to determine the best strategy for nitrogen fertilization. Four fertilization strategies at the beginning and end of summer (0-0, 100-0, 50-50, 0-100 kg ha^{-1} of N) were studied, respectively, with four repetitions. For the pastures deferred for 95 days, the population densities of vegetative tillers were greater ($p < 0.05$) for the strategy 0-100. At the end of the deferment period, the weight of the vegetative tillers per hectare was greater for the strategy 0-100, followed by the strategy 50-50. The densities of vegetative tillers, evaluated in the pastures deferred for 140 days, were greater ($p < 0.05$) for the fertilization strategies 0-100 and divided 50-50. At the end of the deferment period, greater density ($p < 0.05$) of dead tillers was verified for the fertilization strategy 0-100, not proving effect ($p < 0.05$) in post-grazing. The strategy of application of 100 kg ha^{-1} at the end of summer, followed by the strategy of 50 kg ha^{-1} of nitrogen divided between the beginning and end of summer, promoted a positive influence on the tiller population density in pastures deferred for 140 days.

Keywords: density, deferment, grazing, tiller, urea.

Densidade populacional de perfilhos em pastagem de *Urochroa decumbens* diferida e estratégias de adubação nitrogenada

RESUMO. O objetivo deste trabalho foi avaliar a densidade populacional de perfilhos de pastos de *Urochroa decumbens* diferidos por 95 e 140 dias, visando determinar a estratégia mais adequada de adubação nitrogenada. Foram estudadas quatro estratégias de adubação no início e no final do verão (0-0, 100-0, 50-50, 0-100 kg ha^{-1} de N), respectivamente, com quatro repetições. Para os pastos diferidos por 95 dias, as densidades populacionais de perfilhos vegetativos foram maiores ($p < 0,05$) para a estratégia 0-100. O peso de perfilhos vegetativos por ha, no final do período de diferimento, foi maior para a estratégia 0-100, seguida da estratégia 50-50. As densidades de perfilhos vegetativos, avaliadas nos pastos diferidos por 140 dias, foram maiores ($p < 0,05$) para as estratégias de adubação 0-100 e parcelados 50-50. No final do período de diferimento, constatou-se maior ($p < 0,05$) densidade de perfilhos mortos para a estratégia de adubação 0-100, não constatando efeito ($p < 0,05$) no pós-pastejo. A estratégia de aplicação de 100 kg ha^{-1} no final do verão, seguida da estratégia de 50 kg ha^{-1} de nitrogênio parcelado no início e final do verão, promove influência positiva sobre a densidade populacional de perfilhos em pastos diferidos por 140 dias.

Palavras-chave: densidade, diferimento, pastagem, perfilho, ureia.

Introduction

An aggregation of different tillers organized by growth origin, age, stage of development and hierarchy constitutes the plants of a pasture. Therefore, the formation of new tillers assists the establishment and the perenniality of forage gramineae, assisting in the protection of the soil, weed control, and principally increasing the production of forage.

The characterization of individual tillers in pastures permits the discernment of the effects of the management actions utilized in the pastures, and recommendation of those that are most efficient. In the tropical environment, there are few studies that involve tiller population density. In this sense, these studies could help to understand and determine alternatives for pasture management that do not compromise pasture persistence, and favor the optimization of production processes and utilization of forage produced.

The profiling of gramineae contributes to the adaptation to the management strategies, guaranteeing the balance between forage demand and its availability to the animals. In this way, the number of tillers can be utilized as an indicator of vigor or persistence of the grass in the pasture. The deferment of pastures, even though it is a practice that increases the production of dry forage material, may promote a reduction in the number of tillers during the recuperation period, due to the growing competition for light among the tillers. On the other hand, nitrogen fertilization in deferred pastures would have the additional advantage of stimulating the tillering of the gramineae (FAGUNDES et al., 2006), compensating for the negative effect of the recuperation period on the tiller population density.

Strategies for application of nitrogen fertilization may modify the tiller population density of in *U. decumbens* pastures deferred for different periods, and in post-grazing. Based on this hypothesis, the objective of this work was to evaluate the tiller population density of *U. decumbens* pastures deferred for 95 and 140 days, aiming to determine the best strategy for nitrogen fertilization.

Material and methods

The experiment was conducted in the Cattle Breeding Sector of the *Universidade Estadual do Sudoeste da Bahia* (UESB), Itapetinga campus, in the southeastern region of the state of Bahia, located at 15º18'14" southern latitude and 40º12'10" western longitude, at an altitude of 268 meters (m), during the period from November 2008 to November 2009.

The climate of the region is the "Cw" type, humid and subhumid mesothermal, hot with dry winters, under the Köppen classification. The summer is hot and encompasses the months from October to March, while the dry season is cold, without rain, during the months from May to October (25% of annual precipitation). The average annual precipitation is 892 mm and the average annual temperature is 27ºC. A pluviometer and a maximum and minimum thermometer installed close to the experimental area were used for the collection of the data for rainfall and temperature (Table 1), during the experimental period. The soil of the experimental area is hypereutrophic, Chernozem soil (SANTANA et al., 2002), with a sandy texture and with slightly wavy relief.

Two experimental trials were installed in the area, one to evaluate pastures deferred for a period of 95 days and the other for 140 days. The experimental delineation adopted was that of actualized blocks with four treatments and four repetitions. The treatments were distributed randomly in four blocks (pickets) of 441 m^2, fenced with electrified wire, divided into four parcels of 100 m^2 (10 x 10 m), deducting the 1 m wide border. The experiment was installed in a well-established pasture of *U. decumbens*, formed in 1993 with seeds. On November 27, 2008 a uniform grazing was realized, and soon after the demarcation of the parcel areas, and finally the collection of soil samples at a depth of 0 to 20 cm. The results of the chemical analyses were: water pH = 5.6; available P = 7.5 mg dm^{-3}; K = 0.5 $cmol_c$ dm^{-3}; Ca = 1.8 and Mg = 1.1 $cmol_c$ dm^{-3}; Al= 0.1 and H^+ = 2.2 $cmol_c$ dm^{-3}; V= 60%; CTC= 5.8 $cmol_c$ dm^{-3}. Considering the base saturation values of the soil analysis, there was no need for acidity correction. The application of K was also unnecessary, as based on the results of the soil analysis (CANTARUTTI et al., 1999). Although the P content was considered low (CANTARUTTI et al, 1999), it was decided to not perform phosphate fertilization, considering that the practice of deferment is normally utilized in systems with low technology. Generally, these production systems do not use any fertilizers in pastures, therefore the objective of this study was to evaluate only nitrogen fertilization in the first year of application.

Table 1. Monthly averages of the daily mean and minimum monthly temperature, historic rainfall index, and rainfall index of the experimental period.

Month/Year	Average Temperature (°C)	Minimum temperature (°C)	Historic rainfall index (mm)	experimental rainfall index (mm)
November/2008	26.4	21.0	131.8	113.4
December/2008	26.8	21.0	124.7	189.3
January/2009	27.6	20.0	75.6	78.4
February/2009	28.0	20.0	82.4	5.6
March/2009	28.9	20.0	136.5	83.4
April/2009	27.6	21.0	75.2	112.4
May/2009	25.2	17.0	46.0	17.8
June/2009	23.9	16.0	27.6	41.1
July/2009	26.0	15.0	46.0	6.1
August/2009	25.9	16.0	33.0	70.4
September/2009	26.8	16.0	21.2	41.2
October/2009	28.5	18.0	60.4	145.9
November/2009	30.5	19.0	131.8	13.8

Strategies for nitrogen fertilization at the beginning and end of summer were studied, the treatments of which were randomly distributed in the blocks and consisted of: 0-0 (control) - no fertilization; 100-0 - 100 kg ha^{-1} of N applied at the beginning of summer; 50-50 - parceled 50 kg ha^{-1} of N at the beginning and end of summer; 0-100 - 100 kg ha^{-1} of N applied at the end of summer. Nitrogen fertilization in the form of urea was applied at the end of November 2008, for the treatment 100-0 and the first dose of the 50-50 treatment, characterizing the beginning of summer and in February of 2009 the 0-100 treatments were applied, with the second dose of the 50-50 treatment at the end of the summer.

During the period from November 2008 to February 2009, the pickets were managed under intermittent capacity with a rest period of 28 days, utilizing Holland/Zebu calves with average body weight of 150 kg, adopting the *mob-grazing* technique, with groups of calves for rapid defoliation, simulating a grazing scenario which assured, among other treatments, a post-grazing height of around 15 cm. Before the recuperation period, the pastures were intensively utilized, decreased to a height of 10 cm and after the last parcel of nitrogen fertilization in February, the pastures were put into recuperation until June 24, 2009, completing a period of 140 days.

The evaluation of the tiller population density was realized in two distinct periods: the end of the deferment period (February to June) and post-grazing (June to September 2009). In each period a sample of plants from each parcel was collected, with an area of .25 x .25 m, totaling an area of .0625 m^2. After the cutting, the samples were taking to the laboratory for separation and counting of the total number of reproductive and dead vegetative basal tillers.

The data were evaluated through variance analysis, in a mathematical model with the fixed effects of treatment and block. The SAEG program (RIBEIRO JUNIOR., 2001) was utilized for the statistical analyses, applying the Duncan test at a level of 5% significance.

Results and discussion

The population densities of vegetative tillers, evaluated after 95 days of deferment and post-grazing or after the grazing were greater ($p < 0.05$) for the treatment fertilized with 100 kg ha^{-1} of N at the end of the summer (0-100) (Table 2). These results may be attributed to the effects of N which is one of the nutrients with greater dynamic in the system, readily available in the form of nitrogen and ammonia, resulting from the greater dose and application of the fertilizer in the interval closest to the recuperation period of the pasture.

Santos et al. (2009a), characterizing tillers in deferred *U. decumbens* pastures fertilized with nitrogen, reported a change in the number of vegetative tillers with fertilization on the pastures deferred for 116 days, concluding that the stimulation from the nitrogen fertilization was compensated by the long duration of the deferment period of the pasture. On the other hand, in the pastures deferred for 73 days there was an increase of 145% in the vegetative tiller density, with the increase of the nitrogen dose from 0 to 129 kg ha^{-1}. These results corroborate with the present study, with a deferment period 20 days longer (95 days), and for which was observed an increase of 77% of vegetative tillers in relation to the control treatment with the dose of 100-100 kg ha^{-1} of N.

One of the processes responsible for the increase of forage the production with nitrogen fertilization is the increase in the tillering capacity, which depends on the leaf area index (LAI) in which the pasture is maintained. Thus, pastures deferred for a shorter period, and therefore with lower LAI have greater potential for response from the nitrogen on the tillering (SANTOS et al., 2009a). According to

Table 2. Tiller population density in pastures of Urochroa decumbens deferred 95 days under four nitrogen fertilization strategies at the end of the deferment period and post grazing.

Tillers	Fertilization				Mean	CV (%)
	0 - 0	0 - 100	50 - 50	100 - 0		
	End of the deferment period (June)					
Vegetative m^{-2}	744c	1320a	1089b	1132b	1071	8.3
Dead m^{-2}	213.8	95.5	170.5	167.8	162	43.6
Weight / Vegetative tiller (g)	4.1	4.2	4.5	3.1	4.0	26.0
Vegetative tiller weight (kg ha^{-1})	2245b	3495a	3360a	2303b	2851	19.8
	Post grazing (September)					
Vegetative m^{-2}	680b	964a	792b	736b	793	9.4
Dead m^{-2}	156b	302a	284a	241ab	246	24.8
Weight / Vegetative tiller (g)	2.3	1.8	2.0	1.8	2.0	16.2
Vegetative tiller weight (kg ha^{-1})	941ab	1079a	929ab	756b	926	12.1

Means followed by small distinct letters on the line differ by Duncan test ($p < 0.05$).

the same authors, the reduction of the number of vegetative tillers in deferred pastures may compromise the persistence of the pasture in case the deferment is repeated, in the same area, during various, consecutive years.

There was an average reduction of 35% of the vegetative tiller population density from the end of the deferment period in relation to the post-grazing period. This decrease was reflected in the increase of the average density of dead tillers from the end of the deferment period in relation to the post-grazing period, from 162 to 246 dead tillers m^2. At the end of the deferment period, no effect ($p < 0.05$) from the fertilization strategy was observed among the dead tillers; however, a lower value was found for the pasture that did not receive nitrogen fertilization (Table 2). This was expected, because the trampling by the animals intensified with the continuous load, and the unfavorable conditions for new sprouts probably promoted the death of the tillers. Moreira et al. (2009), evaluating the tillering of *U. decumbens*, observed that the population of dead tillers in April was greater than the other evolution months in the first year, and in March and April in the second year. The authors also verified that the population of the dead tillers increased significantly according to the nitrogen doses, only in the first year, estimating a population of 295 and 829 tillers m^{-2} for the doses of 75 and 300 kg ha^{-1} of N, results higher than those reported in the present study with application of kg ha^{-1} of N. Results in the literature demonstrate that the nitrogen appears to work in an indirect way on tiller the death in the pasture (AUDA et al., 1966), since it stimulates the turnover of materials, increasing the appearance and death not only of tillers, but also of leaves (MOREIRA et al., 2009).

The effect ($p < 0.05$) of the strategies of nitrogen fertilization on the weight by vegetative tiller were not verified, with an average of 4 and 2 g vegetative tiller at the end of the deferment and post-grazing period, respectively. The weight of the vegetative tillers per hectare, at the end of the deferment period, was greater for the fertilized treatments with 100 kg ha^{-1} of N at the end of summer (0-100) and parceled with 50 kg ha^{-1} of N at the beginning and end of the summer (50-50) (Table 2). Santos et al. (2009a) verified that the deferment period ($p < 0.05$) and the nitrogen fertilization ($p < 0.01$) linearly influenced the weight of all of categories of tillers of capim braquiária.

Probably, pastures deferred for a longer amount of time remain with more time with LAI higher than critical LAI, accentuating the process of leaf senescence located on the lower layer of the pasture, as well as the process of straightening of the stem. The straightening of the stem added to the greater number of leaves per tiller, resulted in a greater weight of the live tillers in the pastures with 95 days of deferment. In addition to this, the increase of the availability of nitrogen in the soil may interfere in the morphological responses of the forage plant, such as photosynthetic activity, mobilization of reserves after defoliation and expansion rhythm of the foliar area (TAIZ; ZEIGER, 2009). Therefore, the greater availability of nitrogen in the soil, when applied close to the deferment period, possibly resulted in greater accumulation of biomass per tiller, characterized by a greater number of phytomers, greater foliar expansion, straightening and thickening of nodes and internodes (SANTOS et al., 2009a).

Management practices which assure high rates of reproduction of tillers during the growth season are essential for the maintenance and increase of the tiller population density during the year. This affirmation corroborates with the results found by Fagundes et al. (2006) that evaluated the structural characteristics of capim braquiária in pastures fertilized with nitrogen in the four seasons of the year. According to the authors, the greater number of tillers per plant will result in greater soil coverage by the forage plant. Therefore, nitrogen fertilization in addition to increasing the production of dry material also evicts degradation of the soil, impact from rain and exposure to the sun.

For the pastures deferred for 140 days, the effect of ($p > 0.05$) was verified on the population density of vegetative tillers and tillers per hectare in all periods. However, for dead tillers and weight by vegetative tiller, the effect ($p > 0.05$) was verified only in the period after deferment. The population density of vegetative tillers, evaluated after deferment and in the post grazing, were greater ($p < 0.05$) for the fertilization strategies with 100 kg ha^{-1} of N applied at the end (0-100), and parceled at the beginning and end of summer (50-50) (Table 3). In spite of the long deferment period, 140 days utilized in this study, the nitrogen fertilization utilized increased ($p < 0.05$) the population density of vegetative tillers.

The results obtained in this study had the same tendency as those obtained by Santos et al. (2009b), who obtained 800 and 864 vegetative tillers m^{-2} in the absence of nitrogen fertilization and with 120 kg ha^{-1} of N, respectively. The authors concluded that the stimulation from the nitrogen fertilization was compensated by the long duration of the deferment period of the pasture (116 days), corroborating with the results of this study, which was also verified the same tendency.

Table 3. Tiller population density Urochroa decumbens pastures deferred for 140 days under four strategies of nitrogen fertilization after deferment and post-grazing.

Tillers	Fertilization				Mean	CV (%)
	0 - 0	0 - 100	50 - 50	100 - 0		
	After deferment (June)					
Vegetative m^{-2}	660c	1056a	1016a	876b	902	6.9
Dead m^{-2}	56b	316a	72b	64b	127	27.0
Weight / Vegetative tiller (g)	6.1a	4.2b	4.5b	4.1b	4.7	14.1
Vegetative tiller weight (kg ha^{-1})	2465ab	2800a	2840a	2192b	2574	10.7
	Post grazing (September)					
Vegetative m^{-2}	838b	1096a	938ab	874b	936	11.8
Dead m^{-2}	320.9a	319.8a	255.3a	291.9a	297	31.4
Weight / Vegetative tiller (g)	3.0a	3.0a	3.5a	2.7a	3.1	24.4
Vegetative tiller weight (kg ha^{-1})	1325c	1950a	1775ab	1406bc	1614	14.3

Means followed by distinct lowercase letters on the line differ by Duncan test ($p < 0.05$).

There was no effect ($p < 0.05$) from the fertilization strategy on the density of dead tillers in post-grazing, registering an average of 297 tillers m^{-2}. At the end of the deferment period, greater density ($p < 0.05$) of dead tillers was verified for the fertilization strategy of 100 kg ha^{-1} of N applied at the end of summer (0-100), highlighting a growth of 464% in relation to the pastures which were not fertilized (Table 3). This growth in tillers death with nitrogen fertilization soon after deferment may possibly be attributed to the long period of deferment, combined with the unfavorable climate conditions for regrowth. Moreira et al (2009), evaluating the tillering of *U. decumbens*, reported a positive linear effect between the nitrogen doses and the number of dead tillers in the first year. Utilizing the equation $\hat{Y} = 117.66 + 2.371*N$; $R^2 = 0.95$, suggested by the authors, a density of 355 dead tillers per m^2 was calculated, a value close to the 316 dead tillers m^{-2}, reported in the present study with application of 100 kg ha^{-1} of N. These results brought the authors to deduce that the nitrogen possibly works in an indirect manner on the death of tillers in the pasture (AUDA et al., 1966), since it stimulates the turnover of material, increasing appearance as much as mortality not only of tillers, but also of leaves (MOREIRA et al., 2009).

There was no effect ($p < 0.05$) of the fertilization strategy on the weight by vegetative tiller before the deferment, registering an average of 4.7 and 3.1 g $tiller^{-1}$, respectively (Table 3). Weights of vegetative tillers per ha were greater for the application strategies of N at the end (0-100), and parceled at the beginning and end of summer (50-50) (Table 3). These results reflect the stimulation of nitrogen fertilization, close to the deferment, on greater tillering and principally on the weight of the tillers. In a general manner, in deferred pastures less-intensive grazing occurs and, in this way, the tiller density diminishes. Sbrissia et al. (2001) discussed at length the law of size compensation/density proposed by Matthew et al. (1995), which defines that the greater intensity of grazing (less height of the pasture) reflects a greater number of lighter tillers, while lower intensity of grazing generates a fewer number of heavier tillers.

The effect of nitrogen fertilization on the straightening of the stem resulted in a greater weight of the live tillers in the pastures with 140 days of deferment. The increase in the availability of nitrogen in the soil interferes in the morphophysiological responses of the forage plant, such as photosynthetic activity, mobilization of reserves after defoliation and rhythm of foliar area expansion (TAIZ; ZEIGER, 2009). Thus, the greater availability of N in the soil, when applied close to the deferment period, possibly resulted in greater accumulation of biomass per tiller, according to Santos et al. (2009a) as characterized by a greater number of phytomers and a more advanced level of individual development of the vegetative tillers.

Conclusion

Nitrogen fertilization at the end of summer favors tiller population density, in addition to assuring high rates of reproduction of tillers during the growth season in *U. decumbens* pastures deferred for 90 days. The strategies of nitrogen application parceled at the beginning and end of summer, and applications only at the end of summer, favored greater population density of vegetative tillers for the pastures deferred for 140 days. This aspect, added to the high number of dead tillers, is of fundamental importance for coverage and protection of the soil. Independent of the fertilization strategy, the practice of deferment may contribute to the recuperation of degraded areas and perenniality of pastures.

References

AUDA, H.; BLASER, R. E.; BROWN, R. H. Tillering and carbohydrate contents of orchardgrass as influenced by environmental factors. **Crop Science**, v. 6, n. 2, p. 139-143, 1966.

CANTARUTTI, R. B.; MARTINS, C. E.; CARVALHO, M. M.; FONSECA, D. M.; ARRUDA, M. L.; VILELA, H.; OLIVEIRA, F. T. T. **Pastagens**. In: RIBEIRO, A. C.; GUIMARÃES, P. T. G.; ALVAREZ, V. V. H. (Ed.). Recomendações para uso de corretivos e fertilizantes em Minas Gerais. 5ª aproximação. Viçosa: Cfsemg/UFV, 1999. p. 13-20.

FAGUNDES, J. L.; FONSECA, D. M.; MISTURA, C.; MORAIS, R. V.; VITOR, C. M. T.; GOMIDE, J. A.; NASCIMENTO JUNIOR, D.; CASAGRANDE, D. R.; COSTA, L. T. Características morfogênicas e estruturais do capim braquiária em pastagem adubada com nitrogênio avaliada nas quatro estações do ano. **Revista Brasileira de Zootecnia**, v. 35, n. 1, p. 21-29, 2006.

MATTHEW, C.; LEMAIRE, G.; SACKVILLE HAMILTON, N. R; HERNANDEZ-GARAY, A. A modified self-thinning equation do describe size/density relationships for defoliated swards. **Annals of Botany**, v. 1, n. 76. p. 579-587, 1995.

MOREIRA, L. M.; MARTUSCELLO, J. A.; FONSECA, D. M.; MISTURA, C.; MORAIS, R. V.; RIBEIRO JÚNIOR, J. I. Perfilhamento, acúmulo de forragem e composição bromatológica do capim braquiária adubado com nitrogênio. **Revista Brasileira de Zootecnia**, v. 38, n. 9, p. 1675-1684, 2009.

RIBEIRO JUNIOR, J. I. **Análises estatísticas no SAEG** (Sistema para análises estatísticas). Viçosa: UFV, 2001.

SANTANA, S. O.; SANTOS, R. D.; GOMES, I. A.; JESUS, R. M.; ARAUJO, Q. R.; MENDONÇA, J. R.; CALDERANO, S. B.; FARIA FILHO, A. F. **Solos da região Sudeste da Bahia**: atualização da legenda de acordo com o sistema brasileiro de classificação de solos Ilhéus: Ceplac. Rio de Janeiro: Embrapa Solos, 2002. (Boletim de Pesquisa e Desenvolvimento, n. 16).

SANTOS, M. E. R.; FONSECA, D. M.; BALBINO, E. M.; MONNERAT, J. P. I. S.; SILVA, S. P. Caracterização dos perfilhos em pastos de capim braquiária diferidos e adubados com nitrogênio. **Revista Brasileira de Zootecnia**, v. 38, n. 4, p. 643-649, 2009a.

SANTOS, M. E. R.; FONSECA, D. M.; EUCLIDES, V. P. B.; NASCIMENTO JÚNIOR, D.; QUEIROZ, A. C.; RIBEIRO JÚNIOR, J. I. Características estruturais e índice de tombamento de *Urochroa decumbens* cv. Basilisk em pastagens diferidas. **Revista Brasileira de Zootecnia**, v. 38, n. 4, p. 626-634, 2009b.

SBRISSIA, A. F.; SILVA, S. C.; CARVALHO, C. A. B.; CARNEVALLI, R. A.; FAGUNDES, J. L.; PINTO, L. F. M.; PEDREIRA, C. G. S. Tiller size/population density compensation in Coastcross grazed swards. **Scientia Agricola**, v. 58, n. 4, p. 655-665, 2001.

TAIZ, L.; ZEIGER, E. **Fisiologia vegetal**. 4. ed. Porto Alegre: Artmed, 2009.

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