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Characterization of tillers of piata palisade grass deferred in the fall with varying heights and deferment periods

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ABSTRACT. This study was conducted to evaluate the tiller population density and its structural characteristics in *Brachiaria brizantha* cv. Piata subjected to deferment periods (65, 85 and 105 days) and initial sward heights for deferment (20, 30 and 40 cm). A completely randomized block design was used in a split-plot scheme with three replications. The population density of vegetative basal and total tillers was influenced by the interaction between periods and initial heights of deferment, with lower values in the period of 85 days associated with the initial height of 40 cm and the period of 105 days associated with initial heights of 30 and 40 cm. The length of the stem and leaf blade of vegetative basal tillers increased with the raise in the deferment periods. Initial deferring heights had little effect on the structural characteristics of the tillers. The concomitant use of tall plants and long deferring periods reduces tillering of piata palisade grass. To optimize the tillering and structure of the deferred pasture in the region of Viçosa, piata palisade grass should be deferred with an initial height from 20 to 40 cm in early May and remain deferred for 65 days.

Keywords: *Brachiaria brizantha*, pasture management, structural characteristics, tillering, tiller population density.

Caracterização de perfilhos de capim-piatã diferido no outono com alturas e períodos de diferimento variáveis

RESUMO. Este trabalho foi conduzido para avaliar a densidade populacional de perfilhos e as características estruturais de perfilhos em *Brachiaria brizantha* cv. Piatã submetida a períodos de diferimento (65, 85 e 105 dias) e alturas iniciais do dossel para o diferimento (20, 30 e 40 cm). Utilizou-se o delineamento experimental de blocos completos casualizados, em esquema de parcelas subdivididas com três repetições. A densidade populacional de perfilhos basais vegetativos e totais foi influenciada pela interação entre períodos e alturas iniciais de diferimento, com menores valores no período de 85 dias associado à altura inicial de 40 cm e no período de 105 dias associado às alturas de 30 e 40 cm. O comprimento de colmo e da lâmina foliar dos perfilhos basais vegetativos aumentou com o aumento nos períodos de diferimento. As alturas iniciais de diferimento tiveram pouco efeito sobre as características estruturais dos perfilhos. O emprego concomitante de plantas altas e longos períodos de diferimento reduz o perfilhamento do capim-piatã. Para otimizar o perfilhamento e a estrutura do pasto diferido na região de Viçosa, MG, o capim-piatã deve ser diferido com altura inicial de 20 a 40 cm, no início de maio e permanecer diferido por 65 dias.

Palavras-chave: *Brachiaria brizantha*, manejo da pastagem, características estruturais, perfilhamento, densidade populacional de perfilhos.

Introduction

The tiller is the basic growth unit of forage grasses, with development based on the successive differentiation of phytometers at different development stages from the same apical meristem (VALENTINE; MATTHEW, 1999). Thus, if the apical meristem is removed by cutting or grazing, there is usually death of tillers, and a new tiller may emerge to replace them.

In this context, pasture height at the beginning of the deferment period may affect the population of tillers on pasture. Pastures deferred at elevated heights in the beginning of the fall usually have a greater number of tillers with a remaining apical meristem and, in such condition, photoassimilates are preferentially reallocated for the development and maintenance of the existing tillers (ROBSON et al., 1988). The larger leaf area of pastures deferred higher causes more shading at the bottom of plants and inhibition of the appearance of new tillers (SANTOS et al., 2009a). This can determine, at the end of the deferment period, a tiller population comprised mainly of older tillers, resulting in a response pattern contrary to the one that normally occurs on pastures deferred at lower initial height.

The period in which the pasture remains deferred also promotes alterations in tillering and the morphological characteristics of each tiller. In fact, longer deferment periods result in a pasture with a higher number of reproductive and dead tillers, in relation to vegetative tillers (SANTOS et al., 2009a); the latter are usually in a more advanced development stage. The development of reproductive tillers may limit the nutritional value and damage the structure of the deferred pasture (SANTOS et al., 2008), negatively affecting the intake and performance of animals grazing.

Therefore, this study was conducted to evaluate, in the winter, the population density and, in the fall, the morphologic characteristics of tillers on deferred piata grass at different heights and deferment periods, generating subsides that may aid in recommendations that are more efficient and adequate to the deferment of piata grass pastures.

Material and methods

The experiment was conducted in the period from March 20 to July 02, 2010, in the Forage Sector of the Department of Animal Science of Universidade Federal de Viçosa, located in Viçosa, Minas Gerais State, Brazil. The approximate geographic coordinates of the experiment site are 20º45' South latitude, 42º51' West longitude and altitude of 651 m.

The climate of the region of Viçosa, according to the Köppen classification, is of Cwa type, with annual precipitation around 1,340 mm and mean relative air humidity of 80%. Mean maximum and minimum temperatures are 22.1 and 15ºC. The climatic data recorded during the experimental period were obtained at the meteorological station of the Department of Agricultural Engineering of UFV, located about 500 m away from the experimental area (Table 1).

Table 1. Monthly means of the average daily temperature, insolation, total monthly precipitation and total monthly evaporation from March 2010 to July 2010.

Month	Average air temperature (°C)	Insolation (hours day^{-1})	Precipitation (mm)	Evaporation (mm)
March/2010	22.9	6.2	184.8	121.7
April/2010	20.4	6.5	28.1	103.4
May/2010	18.4	5.7	35.4	76.0
June/2010	15.3	6.7	0.9	73.6
July/2010	17.3	6.4	0.0	84.9

An area of approximately 155 m^2 of *B. brizantha* cv. Piatã (piata grass), established in December 2009 in a sandy-clayey textured Red-Yellow Argisol (EMBRAPA, 2006) was utilized in this experiment. Soil samples were taken with the aid of Dutch auger (0-20 cm), and the results from the chemical analysis were: pH in H_2O: 5.2; P: 1.2 mg dm^{-3} (Melich 1) and K: 22.0 mg dm^{-3}; Ca^{2+}: 2.5; Mg^{2+}: 0.5 and Al^{3+}: 0.1 cmol$_c$ dm^{-3} (KCl 1 mol L^{-1}). The area utilized had gone through correction process in previous experiments, and a little presence of exchangeable aluminum and pH values within the range considered satisfactory for the grass studied were found (CFSEMG, 1999), so there was no need for liming. Phosphorus was applied at 50 kg ha.$^{-1}$, in the form of single superphosphate; potassium, at 60 kg ha.$^{-1}$, in the form of potassium chloride; and nitrogen was applied at 75 kg ha.$^{-1}$, in the form of ammonium sulfate - all in a single dose. Fertilization was performed always in the beginning of every deferment period, in the evening. After fertilization, plots were wet so as to elevate soil humidity and reduce the possible losses of nitrogen by volatilization.

Combinations between deferment periods, randomized to the plots, and initial sward heights, randomized to the subplots, were assessed. The deferment periods were 65, 85 and 105 days, and the initial heights at the beginning of the deferment period were 20, 30 and 40 cm. The design adopted was of completely randomized blocks in an arrangement of subdivided plots with three replications. The criterion utilized for the definition of blocks was the variation of relief of the experimental area. Each block was subdivided, with the aid of wooden stakes, in three subplots (17.3 m^2), to which the deferment periods were drawn. Each plot, in turn, was subdivided in three subplots, with floor area of 5.7 m^2, to which initial deferment heights were drawn.

The dates of the beginning of deferment were: March 20, April 10 and May 1, 2010. On these days, the piata grass was lowered by mechanic cutting to the respective heights (20, 30 and 40 cm), moment at which fertilization was carried out. All the area remained deferred until July 2, 2010, date considered appropriate for the beginning of the period of utilization of deferred pastures in the region of Viçosa (SANTOS et al. 2009b). On this date, all the response variables were evaluated.

Tiller population density was determined by a single counting of the number of tillers at three points per plot, which represented the average condition of the sward. All live tillers within a 0.40 m sided square were counted. These tillers were identified as basal, aerial, vegetative, reproductive and dead. The tiller was considered basal when it originated from basal buds, located close to or touching the soil surface. Aerial tillers corresponded to those originated from lateral buds on the main basal tiller. Live tillers which had visible inflorescence were classified as reproductive; live tillers which did not have visible inflorescence were denominated vegetative; and those whose stem was completely necrotized were classified as dead.

The structural characteristics of tillers were assessed in tem tillers harvested close to the soil, in each category, per experimental unit. The lengths of pseudostems and leaf blade, as well as the number of live and dead tillers, were quantified in these tillers. The length of the pseudostem was measured from the soil to the ligule of the oldest completely expanded leaf. The length of the leaf blade was verified by measuring the distance between the ligule to the apex of the leaf blade. Live leaves consisted of expanding and expanded leaves. Only the leaves which had more than 50% of the leaf blade under senescence were classified as dead.

The experimental data were analyzed through (SAEG, 2003) Sistema para Análises Estatísticas e Genéticas, version 8.1. For each trait, variance analysis was performed, and when the interaction between the factors was not significant, the marginal means between the levels of the primary (deferment period) and secondary (initial pasture height) factors were compared. When the interaction between the factors was significant, the levels of one factor were compared separately for each level of the other factor. The means of factors were compared by Tukey's test at significance level of up to 5% probability of type I error.

For the periods of 85 and 65 days of deferment, no reproductive basal tillers were found in all the subplots with initial heights of 30 and 40, which was the reason why no statistical analysis was proceeded for this category of tillers in such conditions. For the deferment period of 105 days, reproductive basal tillers were found in all subplots corresponding to the heights evaluated, which enabled the performance of statistical analysis to evaluate this tiller category, in this period. For the initial height of 20 cm, reproductive basal tillers were found in all periods assessed, so statistical analysis was conducted to evaluate the structural characteristics of this tiller category, at this height.

Results and discussion

The population density of total (total live tillers in all categories) and vegetative basal tillers were affected ($p < 0.05$) by the interaction between deferment periods and heights of the piata grass in the beginning of deferment (Table 2). The deferment periods did not affect the population of vegetative basal tillers. This was an unexpected result, once the increase in the deferment period usually brings about development of a big part of the vegetative tillers on reproductive tillers, following the normal phonological cycle of the grass (SANTOS et al., 2010).

Table 2. Population density of total and vegetative basal tillers on brachiaria grass in different deferment periods.

Initial sward height (cm)	Deferment period (days)		
	65	85	105
	Vegetative basal tiller m^{-2}		
20	702 aA	669 aA	1.031 aA
30	825 aA	973 aA	677 aB
40	621 aA	513 aB	600 aB
	Total tillers* m^{-2}		
20	1.056 aA	975 aB	1.135 aA
30	1.158 abA	1.356 aA	861 bB
40	1.113 aA	704 bB	808 bB

*Total live tillers in all categories. Means followed by the same lowercase letter in the row and uppercase letter in the column do not differ by Tukey's test ($p > 0.05$).

Significant reduction ($p < 0.05$) was observed in the number of vegetative basal tillers in the areas deferred for 85 days associated with initial height of 40 cm and in the areas deferred for 105 days with initial heights of 30 and 40 cm. In the areas deferred for 85 days, the piata grass at initial height of 40 cm presented greater residual leaf area in the beginning of the deferment period, when compared with plants managed at 20 and 30 cm (2.74 versus 1.96 and 2.33, respectively). Similarly, when deferred for 105 days, plants of 30 and 40 cm had larger residual leaf area in the beginning of deferment, in relation to those of 20 cm (1.95 and 2.21 versus 1.30, respectively). This might have reduced the light penetration in the sward, inhibiting the appearance and development of new basal tillers, and consequently, the population density of vegetative basal tillers (SBRISSIA; DA SILVA, 2008). In addition, when the piata grass was deferred at 30 and 40 cm, there was greater ($p < 0.05$) number of dead basal tillers at the end of the deferment period (Table 4), which also might have contributed to decrease in the population density of vegetative basal tillers (Table 2).

As for total tiller population density, higher values ($p < 0.05$) occurred in plants deferred for 85 days and at 30 cm. For plants deferred at 40 cm, greater total tiller population density occurred ($p < 0.05$) when they remained deferred for 65 days, in comparison with the other periods. In 105 days of deferment, there was lower ($p < 0.05$) total tiller population density in the piata grass at 30 and 40 cm, when compared with that at 20 cm (Table 2). These results can be explained by the greater residual leaf area of higher plants at the beginning of the deferment period, which reduces the light incidence on the lower part of the sward, and consequently limits tillering, as previously discussed.

The adoption of a longer deferment period, as well as the more elevated height of the plant in the beginning of deferment, resulted in lower number of tillers in piata grass plants, i.e., the two management strategies evaluated in this study presented the same effect on the number of tillers of piata grass. From this piece of information, these strategies can be employed concomitantly so as to optimize tillering on deferred pastures. This would be possible through the use of lower plant heights in the beginning of long deferment periods, or, contrarily, through deferment of higher plants for shorter periods.

In all deferment periods, there was more contribution of vegetative basal tillers in the constitution of the total tiller population, but with decrease in their contribution as the periods were shortened (Figure 1).

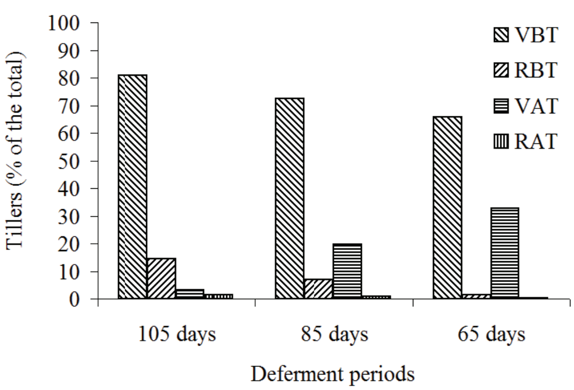

Figure 1. Contribution of each tiller category in the total tiller population density at the end of each deferment period. VBT - vegetative basal tiller; RBT - reproductive basal tiller; VAT - vegetative aerial tiller; RAT - reproductive aerial tiller.

The contribution of reproductive basal tillers was greater in the deferment period of 105 days and reduced as the periods were reduced. In contrast, the contribution of vegetative aerial tillers was lower in the period of 105 days and increased as the deferment periods decreased. In all periods, the contribution of reproductive aerial tillers was too little, for it is possible that there was not enough time for these tillers to reach the reproductive stage. The little contribution of reproductive tillers is interesting, once, when this stage is reached, there is decrease in the nutritional value of the plant.

As observed for the deferment periods, vegetative basal tillers had greater contribution in the total tiller population, although it was followed by the contribution of vegetative aerial tillers. Overall, the contribution of the tiller categories did not differ between the initial deferment heights (Figure 2).

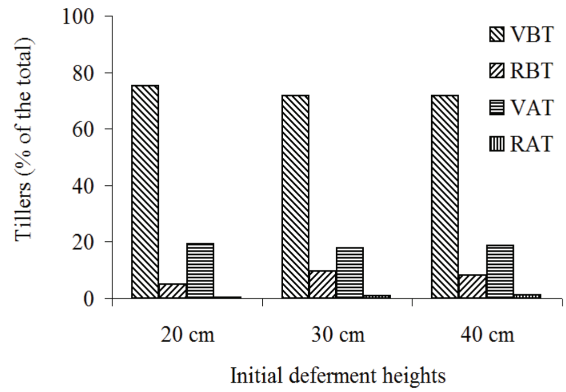

Figure 2. Contribution of each tiller category in the total tiller population density at the end of each deferment period, for the heights evaluated. VBT - vegetative basal tiller; RBT - reproductive basal tiller; VAT - vegetative aerial tiller; RAT - reproductive aerial tiller.

The longer deferment period promoted enough time for development and differentiation of tillers, so the number of reproductive basal tillers increased ($p < 0.05$) at such condition (Table 3).

Table 3. Number of tillers per category and their structural characteristics on piata grass in different deferment periods.

Characteristic	Deferment period (days)		
	65	85	105
NRBT	16 c	71 b	123 a
NDBT	356 a	211 b	158 b
NVAT	375 a	213 b	29 c
LSVB	17.7 c	25.3 b	36.6 a
LLBVB	14.9 c	22.3 b	27.6 a
LSDB	23.8 c	44.5 b	61.8 a
NDLDB	5.0 b	5.3 b	7.1 a

NRBT: number of reproductive basal tillers (tillers m^{-2}); NDBT: number of dead basal tillers (tillers m^{-2}); NVAT: number of vegetative aerial tillers (tillers m^{-2}); LSVB: length of the stem of the vegetative basal tiller (cm); LLBVB: length of the leaf blade of the vegetative basal tiller (cm); LSDB: length of the stem of the dead basal tiller (cm); NDLDB: number of dead leaves on the dead basal tiller. Means followed by the same letter in the row do not differ by Tukey's test ($p > 0.05$).

The development of reproductive tillers may limit the nutritional value and damage the structure of the deferred pastures (SANTOS et al., 2008); however, on pastures subjected to adversities of climate and/or management, the higher production of seeds from pasture flowering can be advantageous and favor the natural recovery of pastures after adversity periods. Thus, the duration of the deferment period, as a method of controlling flowering, has to be contextualized.

As for the number of dead basal tillers, higher values ($p < 0.05$) occurred in plants deferred for 65 days, in comparison with the other periods assessed (Table 3). This might have occurred because of the climatic conditions unfavorable to the forage plant from May (Table 1), when the deferment of the areas which would be deferred for 65 days began.

For the number of vegetative aerial tillers, there was increase ($p < 0.05$) in its values as the deferment periods reduced, with highest value for the areas deferred for 65 days (Table 3). The development of lateral meristems, which originates aerial tillers, is limited by the apical dominance that comes about as a consequence of the presence of auxin in the meristematic zone (TAIZ; ZEIGER, 2004). Furthermore, the elevated content of auxin in the apical buds aids the maintenance of high levels of abscicic acid (ABA) in the lateral buds, inhibiting their growth (TAIZ; ZEIGER, 2002). Considering that plants were under free growth before the beginning of deferment, the dates of the beginning of each deferment period (March 20, April 10 and May 1st, 2010, for the periods of 105, 85 and 65 days, respectively) promoted distinct growth periods to plants. Therefore, it is possible that the longer growth period, to plants deferred for 65 days, enabled more elevation of the apical meristem in relation to the other periods. Thus, on May 1st, when the sward was lowered, in the areas which remained deferred for 65 days, there was possibly more elimination of the apical meristem, eliminating the apical dominance of auxin. This way, the removal of the apical meristem promotes increase of auxin in the lateral meristems, decrease in ABA and increase in the transport of nutrients and cytokinins from the roots to the lateral meristems (TAIZ; ZEIGER, 2004), promoting their development, and resulting in a higher number of vegetative aerial tillers.

The lengths of stems of vegetative basal and dead tillers were superior ($p < 0.05$) in plants deferred for 105 days, intermediate in those deferred for 85 days, and inferior in plants with 65 days of deferment (Table 3). The longer deferment period propitiated more time for the plant to utilize the resources of the environment for its growth and development, increasing the LAI and consequently shading onto the sward. At this condition, there is more competition for light between tillers, making plants enhance the elongation of internodes, and consequently the length of stems (CARNEVALLI et al., 2006), in order to position the new leaves in the least shaded parts of the swards.

The same response pattern occurred for the leaf blade length of vegetative basal tillers. Its value was higher ($p < 0.05$) in plants deferred for a longer time, when compared with those managed for short periods of time (Table 3). Increase in the length of the stems in plants under longer deferment periods extended the course of elongating leaves in the pseudostem, resulting in longer new expanded leaf blades (DURU; DUCROCQ, 2000).

The number of dead leaves on the dead basal tillers (NDLDB) was lower ($p < 0.05$) in plants deferred for 65 and 85 days and higher ($p < 0.05$) in those deferred for 105 days (Table 3). Longer deferment period provides more time for the development of plants, which increases the size and number of emerged leaves per tiller. When the tiller dies, it is natural that it has a higher number of dead tillers.

In the reproductive basal tillers, evaluated only in plants deferred at 20 cm, there was effect ($p < 0.05$) of the deferment periods only for stem length, which was greater in plants under longer deferment periods (41.9, 65.2 and 68.5 cm in plants at 65, 85 and 105 days of deferment, respectively). For these tillers, the NLL and the LDL were of 3.3 and 3.9 leaves/tiller, respectively, and the leaf blade length was of 12.0 cm.

Some structural characteristics of the tillers from the deferred piata grass were not affected ($p > 0.05$) by the deferment periods, the number of reproductive aerial (7.7 tillers m^{-2}, on average) and dead (15.3 tillers m^{-2}, on average) tillers and the number of live (4.0, on average) and dead (1.5, on average) leaves per vegetative tiller.

On the other hand, the height of the piata grass in the beginning of the deferment period did not affect the following response variables: number of reproductive basal tillers (70 tillers m^{-2}, on average); number of vegetative aerial (219 tillers m^{-2}, on average), reproductive (8 tillers m^2/on average) and dead (15 tillers m^{-2}, on average) tillers; lengths of the stem (26.1 cm, on average) and leaf blade (21.6 cm, on average) of the vegetative basal tillers; and number of live (4, on average) and dead (1.5, on average) leaves per vegetative basal tiller.

The number of dead basal tillers was higher ($p < 0.05$) in plants of initial height of 30 cm, intermediate in those of 40 cm and lower in plants of 20 cm (Table 4). In plants of 30 and 40 cm, the residual leaf area may have been larger than in those of 20 cm, which might have contributed to the increase in the death of basal tillers, once increase in the shading of the sward triggers senescence and death of the shaded organs of plants (HODGSON et al., 1981), such as younger and smaller tillers.

The length of the stem of the dead tiller was superior ($p < 0.05$) in plants managed at greater heights in the beginning of the deferment period (Table 4). These results can be explained, once plants of higher initial heights reached the critical leaf area index quickly, which stimulates stem elongation (CARNEVALLI et al., 2006). Therefore, when tillers die, they are characterized by a greater stem length. The same response pattern was expected for the vegetative tiller, which did not occur because of the high coefficient of variation verified for this variable (39%).

Table 4. Number of tillers per category and their structural characteristics on piata grass at initial deferment heights.

Characteristic	Initial sward height (cm)		
	20	30	40
NDBT	174 b	317 a	235 ab
LSDB	31.6 c	45.8 b	52.6 a
NDLDB	5.4 b	6.0 a	6.2 a

NDBT: number of dead basal tillers (tiller m^{-2}); LSDB: length of the stem of the dead basal tiller (cm); NDLDB: number of dead leaves of the dead basal tiller. Means followed by the same lowercase letter in the row do not differ by Tukey's test ($p > 0.05$).

The number of dead leaves of the dead basal tillers (DLDDB) was also higher ($p < 0.05$) in plants deferred at 30 and 40 cm than in those at 20 cm (Table 4). It is possible that plants deferred at 30 and 40 cm presented greater leaf area index and shading in the sward. As a consequence, there was greater senescence of the shaded leaves, which explains the higher DLDDB in these conditions. It is worth remarking that the same response pattern was expected for the number of dead leaves of the vegetative basal tiller (NDLVB), but this did not happen. Dead leaf blades possibly came off the tiller during its development or during the handling of plants at the moment of evaluation. This might have been the cause of the absence of effect of plant height on NDLVB.

For reproductive basal tillers, assessed only in the piata grass deferred for 105 days, stem length (SLRB) and the number of live leaves (NLLRB) were not affected ($p > 0.05$) by the initial deferment height. Thus, the average SLRB was 80.0, and mean NLLRB was 3.5 leaves $tiller^{-1}$. In this period, the number of dead leaves per reproductive basal tiller (NDLRB) was higher ($p < 0.05$) in plants deferred at 30 cm (5.8 leaves $tiller^{-1}$), and lower in those deferred at 20 cm (4.2 leaves $tiller^{-1}$) and 40 cm (4.7 leaves $tiller^{-1}$). Initial deferment heights also affected ($p < 0.05$) the length of the leaf blade of plants deferred for 105 days; greater values were observed in plants of 40 cm (17.5 cm) in comparison with those of 20 cm (11.7 cm) and 30 cm (14.1 cm). Leaf blade length is a plastic characteristic responsive to the severity of defoliation (BRISKE, 1996), and its higher values are associated with the higher defoliation height, in function of the elevated length of the leaf sheath (GRANT et al., 1981). In fact, in higher cuttings, the distance to be traveled by expanding leaves inside the cartridge formed by the sheaths of leaves is longer, resulting in greater length of the new leaf blade (DURU; DUCROCQ, 2000).

Overall, the adoption of longer periods and higher initial heights of plants managed in deferment conditions have limiting effects on the tillering of piata grass. In addition, the use of higher levels of such factors also brings about alterations in the morphology of individual tillers, which may compromise the structure of the deferred pasture. In this sense, it is not recommended to utilize elevated levels of these factors along with deferred pastures. Furthermore, it is also appropriate to conduct new scientific studies aiming to verify the effects of the deferment period and plant height on the structure of the pasture and their reflexes on the performance of grazing animals.

Conclusion

The simultaneous use of tall plants and long deferment periods reduce the tillering of piata grass. To optimize tillering and structure of the deferred pasture in the region of Viçosa, Minas Gerais State, piata grass should be deferred at initial height of 20 to 40 cm, in the beginning of May, and remain deferred for 65 days. Other possibilities are deferment in mid-April, with initial height of 30 cm and 85 days of deferment, and deferment in mid-May, with initial height of 20 cm and 105 days of deferment.

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