DOI: 10.5433/1679-0359.2020v41n1p323

Nutritive value of improved populations *Brachiaria ruziziensis*

Valor nutritivo de populações melhoradas de *Brachiaria ruziziensis*

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Abstract

A low number of *Brachiaria ruziziensis (Syn. Urochloa)* cultivars available on the market and a lack of information about its forage potential have made it difficult to expand its cultivated area, and have therefore made it necessary to implement a breeding program for this species. Thus, the objective of this work was to evaluate the nutritional value of ten improved populations of *Brachiaria ruziziensis* (*Syn. Urochloa*) and two controls (*B. ruziziensis* cv. Kennedy and *B. brizantha* cv. Marandu). The experimental design was a randomized block design with three replications in five sections. The data were submitted to analysis of variance in the subdivided plot in which the primary factors were the populations and the secondary cuts. The Tukey test was used at 5% of significance for the comparison of means. The genotypes used came from the third recurrent selection cycle of Embrapa dairy cattle, originating from the interbreeding of clones which had been identified as superior. The height of the cuts was 10 cm in relation to the ground. The material was cut and weighed in the field to obtain the sample weights to determine the nutritional forage value. After drying, the samples were ground in 1 mm sieves for chemical analyzes and in vitro digestibility. The best CP, ADF and NDF levels observed in IV populations (lower levels of ADF and NDF at 93 days of cut interval and lower NDF contents at 35 and 41 days of cut interval), population VI (higher CP content in the interval of 93 days, lower DM content at 64 and 93 days of cut interval, and lower NDF content at 35 and 64 days of cut interval) showed that these populations can be evaluated under grazing even at an advanced maturation stage. The objective of these selections was to evaluate the nutritional value of improved populations of *Brachiaria ruziziensis* (*Syn. Urochloa*) in order to obtain more homogeneous populations for implantation of grazing experiments.

Key words: Animal nutrition. Forage. Vegetable breeding.

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Received: Apr. 15, 2019 - Approved: July 17, 2019

Resumo

O reduzido número de cultivares de *Brachiaria ruziziensis (Syn. Urochloa)* disponíveis no mercado, a ausência de informações sobre seu potencial forrageiro que vem dificultando a expansão de sua área cultivada tornaram necessário a implantação de um programa de melhoramento genético desta espécie. O objetivo do trabalho foi avaliar o valor nutricional de dez populações melhoradas e duas testemunhas *(B. ruziziensis* cv. Kennedy *e B. brizantha* cv. Marandu). O delineamento experimental utilizado foi o de blocos ao acaso com três repetições, em cinco cortes. Os dados foram submetidos à análise de variância conjunta no esquema de parcela subdividida no qual o fator primário foram as populações e o secundário os cortes. Para a comparação das médias utilizou-se o teste de Tukey a 5% de significância. Os genótipos utilizados foram provenientes do terceiro ciclo de seleção recorrente na Embrapa Gado de Leite, originadas do intercruzamento de clones identificados como superiores. A altura dos cortes foi de 10 cm em relação ao solo. O material foi cortado e pesado em campo para obtenção dos pesos das amostras para realização das avaliações do valor nutritivo da forragem. Após a secagem, procedeu-se a moagem das amostras em peneira de 1 mm para realização das análises químicas e digestibilidade *in vitro*. Os melhores teores de PB, FDA e FDN observados nas populações IV (menores teores de FDA e FDN aos 93 dias de intervalo de corte e menores teores de FDN aos 35 e 41 dias de intervalo), população VI (maior teor de PB no intervalo de corte de 93 dias, menor teor de FDA aos 64 e 93 dias de intervalo de corte e menor teor de FDN aos 35 e 64 dias de intervalo de corte) demonstram que mesmo em avançado estágio de maturação essas populações podem ser avaliadas sob pastejo. O objetivo dessas seleções foi avaliar o valor nutricional de populações melhoradas de *Brachiaria ruziziensis (Syn. Urochloa)* visando obter populações mais homogêneas para implantação de experimentos de avaliações sob pastejo.

Palavras-chave: Forragem. Melhoramento vegetal. Nutrição animal.

Introduction

Brachiaria ruziziensis (Syn. Urochloa) presents positive attributes such as high forage quality and nutritive value, response to fertilization, high acceptability (M. E. R Santos et al., 2011), fast establishment with high growth at the beginning of the rainy season, can be used in a consortium with legumes, has concentrated flowering and high seed production (Valle, Macedo, Euclides, Jank, & Resende, 2013).

The small number of *Brachiaria ruziziensis (Syn. Urochloa)* cultivars available on the market and a lack of information on its forage potential have made it difficult to expand its cultivated area, and have therefore made it necessary to implement a breeding program for this species (Souza, Lédo, Koop, Pereira, & Souza, 2009).

The interest in a recurrent selection program is to obtain genetic gains for characteristics of agronomic interest at each new selection cycle (Hallauer, Carena, & Miranda 2010), which expresses the progress of the working population in relation to the performed selection.

The objective of these selections was to evaluate the nutritional value of improved *Brachiaria ruziziensis (Syn. Urochloa)* populations aiming to obtain more homogeneous populations for implanting grazing experiments.

Material and Methods

The experiment was carried out in the Atlantic Forest Biome (Experimental Field of the Embrapa Dairy Cattle in the Municipality of Coronel Pacheco-MG) located in the Zona Mata region of Minas Gerais at 414 m altitude, 21º 35'08'' S and 43º15'04'' W.

The climate of the area is CWA mesothermal according to the Köppen classification, defined as having a temperate rainy season in summer and dry winter between June and September. The average annual rainfall is 1600 mm, while the

average annual temperature is 22.5 °C. (Figures 1 and 2) illustrates the annual mean precipitation and temperature during the experimental period. The soil of the experimental area showed the following characteristics according to Table 1.

The experiment was carried out by seedlings in tubes being propagated by seeds and taken directly to the experimental area. The best plants were selected and cloned to obtain the seedlings for field evaluations.

The experimental design was complete randomized blocks with 12 treatments and three replicates. The treatments consisted of the 10 improved populations of *B. ruziziensis* (*Syn. Urochloa*) and the two controls (*B. ruziziensis* cv. Kennedy and *B. brizantha* cv. Marandu). The experimental plots were 24 m^2, composed of six lines of four meters in length and spaced one meter apart.

Table 1
Results of soil analysis in the experimental area of Coronel Pacheco-MG

Characteristics		Characteristics	
Sand (dag/kg^{-1})	48	H+Al cmol(c) dm^{-3}	4.13
Silt (dag/kg^{-1})	15	Sum of bases cmol(c) dm^{-3}	1.99
Clay (dag/kg^{-1})	37	Effective CEC cmol(c) dm^{-3}	1.99
Ca^{2+}cmol(c)dm^{-3}	1.1	total CEC cmol(c) dm^{-3}	6.12
Mg^{2+}cmol(c) dm^{-3}	0.6	M%	0
Al^{3+} cmol(c) dm^{-3}	0.0	V%	33
K	112	pH mols de H^+	5.1
P mg /dm^3	3.1	O.M.dag/Kg	2.86

The soil was prepared in a conventional system with plowing, harrowing and correction of fertility levels. The seedlings were manually planted in the field in October 2013 in a plantation of three plants/m^2, spaced 1m between rows. First, 100 kg/ha of P_2O_5 were used in the planting fertilization. The fertilization maintenance was performed according to the recommendation of (P. M. Santos, Primavesi, & Bernardi, 2010) using 350 kg/ha of the 08-28-16 (NPK) formula. The total cover fertilization dose was divided into five plots and always performed when the soil presented good humidity. The plots were kept free of invasive plants by cutting the grass and weeding.

Five cuts were made after a uniformity cut in the year 2014. The height of the cuts was 10 cm in relation to the soil. The whole plant cuts were determined by their development, which were evaluated in the field and in greenhouse.

The material was cut and weighed in the field to obtain the sample weights to determine the nutritional forage value. After drying, the samples were ground in 1 mm sieves for chemical analyzes and in vitro digestibility. Chemical analyzes were performed at the Laboratory of Food Analysis of Embrapa Dairy Cattle. The following variables were evaluated: crude protein (CP -%), in vitro dry matter digestibility (IVDMD -%), acid detergent fiber (ADF -%), neutral detergent fiber (NDF), lignin (LIG -%) and ashes (ASH -%). In vitro dry matter digestibility was determined using the method proposed by Tilley and Terry (1963), which occurs in two stages: the first, in which the samples are incubated individually in tubes containing

ruminal inoculum and buffer solution; and the second in which the residue obtained after 48 hours of incubation is subjected to acidic digestion with pepsin (Tilley & Terry, 1963). Measurements were performed on near infrared spectrophotometer equipment (NIRS).

The joint analysis of variance of the five cuts was performed in a split-plot scheme, with the primary factor being the cuts and the secondary factor the populations, as well as the Tukey test to compare the factor means. These statistical procedures were performed using the (SAS program).

Results and Discussion

In the joint analysis of variance, significance was detected for the effect of population x cut interaction for the CP, ADF and NDF levels. Significant differences between the improved populations were detected for the ADF and NDF levels, and between the cuts for all variables. Thus, it is possible to detect differences in the of IVDMD, LIG and ASH contents between the performed cuts, independently of the analyzed improved populations. However, the selection of populations for CP, ADF and NDF contents depends on the time at which the cut was performed (Table 2).

Table 2
Summary of the joint variance analyzes for six variables of nutritional value evaluated in ten populations of *Brachiaria ruziziensis* and two controls in five cuts in the municipality of Coronel Pacheco, Minas Gerais

Variation source	Mean squared					
	CP%	IVDMD%	ADF%	NDF%	LIG%	ASH%
Block	12.30	31.00	10.86	12.67	0.19	2.01
Population	3.95	5.79	21.11*	25.33*	0.28	3.52
Error (a)	1.97	2.49	3.92	4.96	0.13	1.72
Cut	142.38*	120.77*	779.04*	143.55*	39.72*	39.05*
Pop. x Cut	1.22*	4.29	5.06*	3.54*	0.17	0.92
Error (b)	3.47	1.68	3.67	3.80	0.23	3.12
Error (c)	0.75	3.01	2.83	2.32	0.12	0.92
CV% (a)	9.86	2.30	6.24	3.54	12.55	12.07
CV% (b)	13.08	1.89	6.04	3.10	16.70	16.23
CV% (c)	6.06	2.52	5.30	2.42	11.88	8.83

* Significant at 5% significance by the F-test. CP = Crude protein; IVDMD = In vitro dry matter digestibility; ADF = acid detergent fiber; NDF = Neutral detergent fiber; LIG = Lignin; ASH = Ashes; CV% = Coefficient of variation.

The estimates of the CVs% obtained in this work generally ranged from 1.89-1.70%, which evidences the good accuracy of the evaluations and gives high reliability to the obtained results. These values were similar to those found in works with other forage species such as *Panicum* (Lédo et al., 2008), elephant grass (Shimoya, Pereira, Ferreira, Cruz, & Carneiro, 2002) and alfafa (Ferreira, Botrel, Pereira, & Cruz 1999; Souza et al., 2004).

In the cut performed on 07/09/14 with a 64-day interval, the ash content 12.53% was higher than in the other cuts, except for the cut performed on 01/14/14 with a 41-day interval. Although minerals do not provide energy to animals, unsatisfactory amounts in forages in any of the 17 elements considered essential for animals may limit the digestion, absorption and use of dietary components (Norton, 1982). Flores et al. (2013) mentioned

reduced ash levels as a function of the increase in the physiological age of the plant (Table 3).

The in vitro dry matter digestibility levels were similar in the cuts performed on 09/07/14 with a 64-day interval and in the cut performed on 02/19/14 with an interval of 35 days, and higher than the cut done on 10/08/14 with an interval of 93 days. In evaluating the IVDMD levels of Coastcross, Tifton 68 and Tifton 85, Cedeno, Rocha, Pinto, Muniz and Gomide (2003) found IVDMD values of 60.69%, 65.77% and 60.53%, respectively, at the 42-day cut interval, and values of 47%, 30%, 55.49%, 57.41% at 70 days of cut interval, respectively, for the same forages, demonstrating that the evaluated populations showed good quality with digestibility levels above 55% (Leng, 1990). The lower IVDMD content at the 93-day cut interval is due to changes in the chemical composition of forages with advancing physiological age of the plants (Carvalho & Pires, 2008).

Table 3
Means in the cut intervals for in vitro digestibility of dry matter (IVDMD), lignin (LIG) and ashes (ASH) performed ten populations of Brachiaria ruziziensis and two controls were carried out in the municipality of Coronel Pacheco, MG

CUTS	IVDMD%	LIG%	ASH%
1st cut 01/04/14 (41 days)	65.97 bc	4.47a	11.09 ab
2nd cut 02/19/14 (35 days)	70.20 a	1.87 cd	10.54 b
3rd cut 05/05/14 (74 days)	68.91 ab	3.24 b	10.55 b
4th cut 07/09/14 (64 days)	70.58 a	2.71 bc	12.53 a
5th cut 10/08/14 (93 days)	68.29 b	2.05 cd	9.72 b

* Means followed by the same letter in the column do not differ by Tukey test at 5% probability.

The highest lignin content was found in the cut performed on 01/14/14 with a 41-day interval, while the lowest lignin content was found in the cut performed on 05/05/14 with a 74-day interval. Water availability, temperature and radiation are factors which affect the bromatological composition and the energy availability of forage, and a lower light intensity reduces the productivity of tropical grasses and the production of cell wall components such as lignin (Leonel et al., 2009a, 2009b). The highest lignin content found in the cut interval of 41 days is due to the high temperature of the cut period. However, the lower lignin content in the cut performed on 05/05/14 with a 64-day interval is due to the reduced growth of the plants which occurred in the low temperature and low water availability period (GRAPH 2).

The Kennedy cultivar had the highest CP content in the cuts made on 01/14/14 with an interval of 41 days, and 05/05/14 with an interval of 74 days, but the highest CP content of 14.80% was found in the cut on 10/08/14 in the population VI. No differences were observed in CP contents between the populations and cultivars evaluated in the cuts performed on 02/19/14 and 07/19/14 with intervals of 35 and 64 days, respectively. The cuts performed at the 74 and 93-day intervals resulted in higher CP contents (Table 4). Crude protein contents below 7% are limiting to animal production due to lower voluntary consumption, reduced digestibility and negative nitrogen balance (Minson, 1990). The studied populations in this work met the minimum requirements of crude protein required by ruminants in all cut intervals. Light intensity and water availability are the environmental factors which most affect plant growth. However, changes in light intensity are fundamental in the development and production processes (Atroch, Soares, Alvarenga, &

Castro, 2001). The increase in temperature which occurred in the cut interval of 93 days may explain the higher CP content obtained by population VI (Figure 2).

With the exception of the 74-day interval, the Kennedy cultivar had the lowest content of ADF, with similar content to populations V and IX in the 35-day cut interval, populations III to X in the cut performed with an interval of 64 days, and populations IV and VI in the cut performed in the 93-day interval. The cuts performed at the 35, 64 and 93 day intervals resulted in lower ADF levels (Table 5). These levels were below 40% and did not lead to a reduction in consumption and could be classified as highly digestible (Nussio, Manzano, & Pedreira, 1998). In an experiment with *Brachiaria brizantha* cv. MG-5, (Costa et al., 2007) observed ADF levels of 36.00% with a cut interval of 60 days. The harvesting time of the forage, either by cutting or grazing, should be associated with the height or age of the plant and forage harvested with an advanced physiological age has low digestibility and nutritive value (Costa et al., 2007). Changes in temperature and radiation cause changes in the physiology and metabolism of plants, causing lower lignification of the cell wall, decreased metabolic activity of cells and less conversion of photosynthetic products to components of the cell wall (Michael et al., 2008). Lower radiation and temperature was registered during the experimental period and there was also low water availability in the cut performed with an interval of 64 days, which may explain the higher ADF content. There was an increase in solar radiation and temperature in the cutting period with a 93-day interval, which may explain the lower ADF content in relation to the other cuts (Figures 1 and 2).

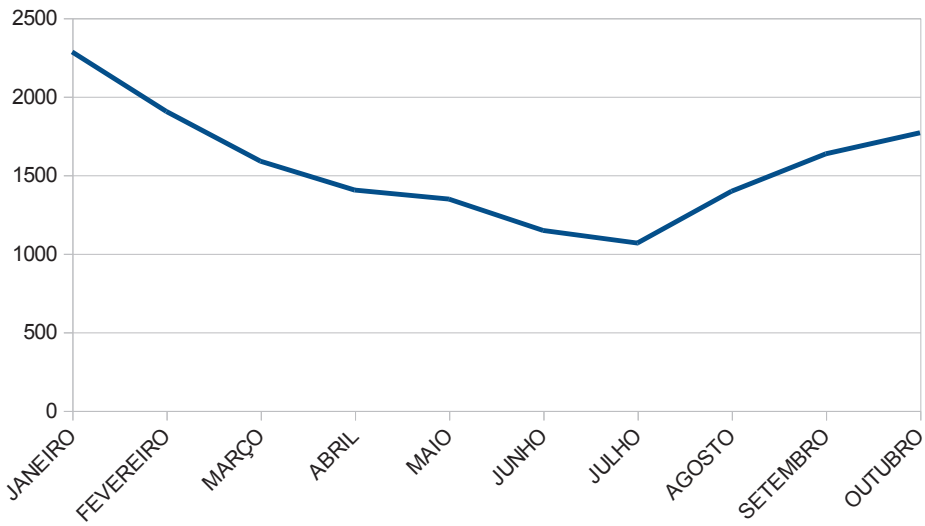

Figure 1. Solar radiation (KJm2) registered from January to October 2014.Source: *Instituto Nacional de Meteorologia - Inmet Estação Meteorológica Automática de Coronel Pacheco/MG Latitude: -21*546728º Longitude: -43.261029º.

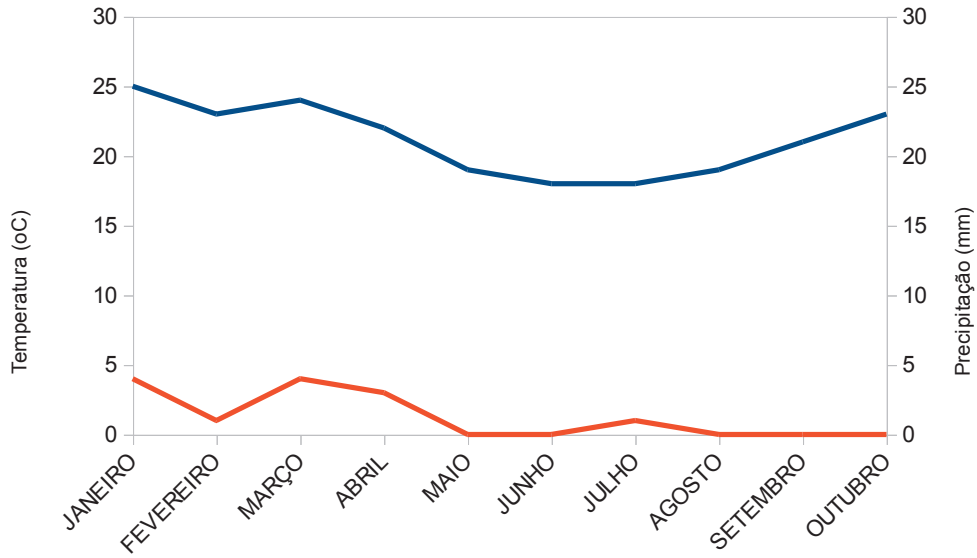

Figure 2. Temperature (ºC) and precipitation (mm) recorded from January to October 2014. Source: *Instituto Nacional de Meteorologia - Inmet Estação Meteorológica Automática de Coronel Pacheco*/MG, Latitude: -21.546728º Longitude: -43.261029º.

Table 4
Means of crude protein (CP%) in percentage obtained in the improved populations and controls in five cuts in the municipality of Coronel Pacheco, MG

Pop.	Cut dates and intervals (month-day-year)				
	01-14-14 (41 days)	02-19-14 (35 days)	05-05-14 (74 days)	07-19-14 (64 days)	10-08-14 (93 days)
I	11.56 abA	15.45 aA	15.31 abA	15.37 aA	12.86 abcB
II	9.92 bA	14.88 aA	15.36 abA	14.77 aA	12.54 abcB
III	10.98 abAB	15.59 aAB	15.38 abAB	16.29 aA	13.66 abcB
IV	12.10 abAB	16.04 aA	16.52 abA	16.29 aAB	14.37 abB
V	10.36 abA	16.52 aA	16.26 abA	15.33 aAB	13.56 abcB
VI	10.06 bA	15.10 aA	15.99 abA	15.66 aA	14.80 aA
VII	11.82 abAB	14.96 aA	16.48 abA	15.82 aA	13.81 abcB
VIII	10.41 abA	15.68 aA	14.66 abA	15.80 aA	12.16 bcB
IX	11.39 abA	15.92 aA	15.65 abA	15.22 aA	14.04 abcA
X	10.68 abA	14.68 aA	16.09 abA	15.89 aA	11.90 cB
Mar.	11.54 abA	14.34 aA	14.29 bA	14.00 aA	13.68 abcA
Ken.	12.49 aA	16.47 aA	6.74 aA	15.68 aA	13.61 abcB

* Means followed by the same letter, uppercase and lowercase in the column, do not differ from each other by the Tukey test at 5% probability. Marandu = *B. brizantha* cv. Marandu; Kennedy = *B. ruziziensis* cv. Kennedy.

Table 5
Means of the Acid detergent fiber (%) in percentages obtained in the improved populations and controls evaluated in five cuts in the municipality of Coronel Pacheco, MG

Pop.	Cut dates and intervals (month-day-year)				
	01-14-14 (41 days)	02-19-14 (35 days)	05-05-14 (74 days)	07-19-14 (64 days)	10-08-14 (93 days)
I	38.40 abA	28.88 bcB	32.18 aB	29.13 abB	31.10 abB
II	38.89 abA	29.16 bcC	33.33 aB	29.35 abC	27.86 abcdC
III	39.93 abA	29.41 abcC	34.84 aB	27.38 bC	27.17 abcdC
IV	38.90 abA	28.67 bcC	32.51 aB	28.00 bC	25.19 dC
V	40.01 abA	27.77 cC	32.51 aB	27.12 bC	26.68 bcdC
VI	42.05 aA	29.89 abcBC	33.29 aB	27.66 bC	26.16 cdC
VII	38.44 abA	28.66 bcC	33.48 aB	27.64 bC	26.94 abcdC
VIII	39.36 abA	28.87 bcC	33.89 aB	28.51 bC	29.63 abcdC
IX	38.16 abA	28.06 cC	33.23 aB	28.12 bC	28.67 abcdC
X	39.56 abA	32.91 abB	31.94 aBC	28.68 bC	30.49 abcC
Mar.	40.23 abA	33.89 aB	34.83 aB	33.68 aB	31.42 aB
Ken.	37.06 bA	27.82 cC	32.40 aB	28.14 bC	25.88 dC

* Means followed by the same letter, uppercase and lowercase in the column, do not differ from each other by the Tukey test at 5% probability. Marandu = *B. brizantha* cv. Marandu; Kennedy = *B. ruziziensis* cv. Kennedy.

In the joint analysis of the NDF means, population IV had the lowest NDF content in the cut intervals of 41 and 93 days. The lowest NDF levels were obtained in populations I to IX and in the Kennedy cultivar in the cut interval of 35 days, and III to X and in the Kennedy cultivar in the cut interval of 64 days. However, a difference between the means in the NDF levels between the populations and the controls was not observed in the 74-day interval (Table 6). The cuts performed at the 64 and 93 day intervals resulted in lower NDF levels. In evaluating *Brachiaria brizantha* Stapf. cv. Marandu, Gerdes, Werner, Colozza, Possenti and Schammass (2000) obtained 72.70% content with a cut interval of 35 days in the summer, and 78.14% in the *Panicum maximum* Jacq. cv. Tanzania^{-1} with the same cut interval and in the same season, all of which were higher than those found in the present study. These mean NDF values were close to the limit proposed by Van Soest (1965), which considers levels above 55-60% of cell wall constituents as limiting forage consumption. These populations showed high NDF digestibility, providing a high potential of DM consumption and a good production of milk and meat when used in grazing (Nussio, Campos, Paziani, & Santos, 2002).

Table 6
Mean values of neutral detergent fiber (NDF) in percentage obtained in the improved populations and controls in five cuts in the municipality of Coronel Pacheco, MG

Pop.	Cut dates and intervals (month-day-year)				
	01-14-14 (41 days)	02-19-14 (35 days)	05-05-14 (74 days)	07-19-14 (64 days)	10-08-14 (93 days)
I	65.44abA	62.88 bA	64.61 aA	62.01 aA	62.96abA
II	66.14abA	63.40 bAB	65.29 aA	61.70 aB	60.57abcB
III	64.99abAB	62.57 bBC	67.21 aA	60.43 bC	62.74abBC
IV	62.44 bAB	61.63 bAB	63.44 aA	59.77 bBC	57.99 cC
V	64.46abA	61.26 bAB	64.10 aA	59.80 bB	58.98 bcB
VI	66.83aA	63.45 bA	65.09 aA	59.57 bB	59.19 bcB
VII	65.17abA	63.22 bAB	63.29 aAB	59.47 bC	60.16abcBC
VIII	65.09abAB	62.61 bABC	65.98 aA	60.79 bC	61.96abcBC
IX	63.82abAB	61.92 bABC	65.29 aA	59.55 bC	60.94abcBC
X	64.27abA	64.11abA	63.45 aAB	60.35 bB	62.02abcAB
Mar.	66.10abAB	67.95aA	66.67 aAB	66.32 aAB	63.72aB
Ken.	63.61abA	61.81 bAB	63.92 aA	60.55 bAB	59.43 bcB

* Means followed by the same letter, uppercase and lowercase in the column, do not differ from each other by the Tukey test at 5% probability. Marandu = *B. brizantha* cv. Marandu; Kennedy = *B. ruziziensis* cv. Kennedy.

The plant age influences the chemical composition of forages, as occurred in the cut interval of 64 days (Carvalho & Pires, 2008). Solar radiation and temperature exert great influence on the growth and productivity of a species (Atroch et al., 2001). There was a gradual increase in solar radiation and temperature in the period between the 64-day interval and the 93-day interval, which may explain the lower NDF content found in this cut interval (Figures 1 and 2).

The best CP, ADF and NDF levels observed in the populations IV (lower ADF and NDF levels at 93 days of cut interval, and lower NDF levels at 35 and 41-day intervals), population VI (higher CP content in the 93-day cut interval and lower NDF levels at 35 and 64-day cut intervals) confirm the statement by Serrão and Simão (1971) that *Brachiaria ruziziensis* is palatable even at an advanced maturation stage and that these populations can be evaluated under grazing.

Conclusion

The improved *Brachiaria ruziziensis* (*Syn. Urochloa*) populations generally obtained better performance than the Marandu cultivar and similar performance to the Kennedy cultivar. The improved populations IV and VI were selected for implanting experiments of grazing evaluations due to presenting the best nutritional values in the performed cuts in both the rainy season and in the dry season.

Acknowledgements

The authors acknowledge the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (*CAPES*) for the awarded grants, the *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (*CNPq*) and the *Fundação de Amparo à Pesquisa do Estado de Minas Gerais* (*FAPEMIG*) for partially financing the study.

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