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Yield and nutritional value of sorghum genotype silages using *Azospirillum brasilense* in the northern region of the state of Minas Gerais

Produtividade e valor nutricional das silagens de genótipos de sorgo com uso de *Azospirillum brasilense* na região norte de Minas Gerais

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Highlights

Biomass sorghum showed higher dry matter yield compared to Volumax.
Azospirillum brasilense reduces chemical fertilization in sorghum crop.
There was no difference between sorghum hybrids for dry matter digestibility.

Abstract

Sorghum is a crop of great interest in animal feed in semiarid regions. The environment and nitrogen fertilization can influence its productive potential and nutritional quality. This study aimed to evaluate sorghum biomass genotypes associated or not with *Azospirillum brasilense* managed at different sowing sites on the yield and nutritional value of silage. We evaluated 3 sorghum genotypes combined with 3 fertilization strategies using urea, *Azospirillum brasilense* and the urea/*A brasilense* combination in two planting sites (Janaúba, MG, and Montes Claros, MG). A randomized block design was carried out in a 3 x 3 x 2 factorial arrangement of 3 genotypes, 3 fertilization strategies and 2 sowing sites. *Azospirillum brasilense* foliar spraying was carried out using a costal (Backpack) atomizer and for silage production, PVC silos with

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weight and length of 50 cm and 10 cm in diameter were used. There was no triple interaction between the studied variables. There were differences between genotypes and between sites for agronomic traits. Statistical differences were detected between genotypes and sites for chemical composition, and sorghum forage on digestibility evaluations. The region of Montes Claros has greater forage production and the region of Janaúba has better quality of silage. Biomass sorghum genotypes have higher forage production and the Volumax genotype has better silage quality.

Key words: Biological nitrogen fixation. Fertilization. Forage. *Sorghum bicolor.*

Resumo

O sorgo é uma cultura de grande interesse na alimentação animal em regiões semiáridas. O ambiente e a adubação nitrogenada podem influenciar seu potencial produtivo e qualidade nutricional. Este trabalho teve como objetivo avaliar genótipos de biomassa de sorgo associados ou não ao Azospirillum brasilense manejados em diferentes locais de semeadura sobre a produtividade e valor nutricional da silagem. Foram avaliados três genótipos de sorgo associados e três estratégias de adubação utilizando ureia, Azospirillum brasilense e a associação ureia/A. brasilense em dois locais de plantio (Janaúba, MG e Montes Claros, MG). O delineamento foi em blocos casualizados em esquema fatorial 3 x 3 x 2, com 3 genótipos, 3 estratégias de adubação e 2 locais de semeadura. A pulverização foliar de Azospirillum brasilense foi feita com o auxílio de um atomizador costal e para a produção de silagem foram utilizados silos de PVC com peso conhecido e comprimento de 50 cm e 10 cm de diâmetro. Não houve interação tripla entre as variáveis estudadas. Houve diferenças entre genótipos e entre locais para características agronômicas. Também foram observadas diferenças estatísticas entre os genótipos e locais estudados para a composição química e forrageira de sorgo nas avaliações de digestibilidade. A região de Montes Claros possui maior produção de forragem e a região de Janaúba possui melhor qualidade de silagem. Os genótipos de sorgo biomassa apresentam maior produção de forragem e o genótipo Volumax apresenta melhor qualidade de silagem.

Palavras-chave: Fixação biológica de nitrogênio. Adubação. Forragem. *Sorghum bicolor.*

Introduction

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the most widely used crops in the world as feed for animals, and humans (Vanamala et al., 2018; Mundia et al., 2019; Souza et al., 2021). The annual dry mass (DM) yield ranges from 10 to 50 t ha^{-1} (Qu et al., 2014; Castro et al., 2015; L. G. F. de Almeida et al., 2019), with good nutritional value (Ramos et al., 2021; Queiroz et al., 2021; Queiroz et al., 2022). According to Parrella et al. (2010), biomass sorghum is a promising material because of its high energy yield per hectare. Due to adaptation mechanisms and good concentrations of soluble carbohydrates, biomass sorghum can be supplied as silage in ruminant feed (Veriato et al., 2018; Souza et al., 2021; Queiroz et al., 2022).

Due to its deep root system, capable of extracting nutrients and moisture from the soil, the sorghum crop has stood out for its ability to grow in conditions of water stress and high temperature, such as in the semiarid region.

The performance of genotypes more adapted to the region favors the best development of the crop, and the use of genotypes sensitive and insensitive to photoperiod must be taken into account when choosing the sowing time (May et al., 2015).

In Brazil, in order to reduce animal feed costs, especially in intensive production systems, the search for forages with high potential for mass production per unit area and good nutritional value (i.e., total digestible nutrients and digestibility above 50%) has been intensified by many researchers (Monção et al., 2019, 2020; Ribas et al., 2021). The Brazilian Agricultural Research Corporation, together with other public and private institutions, has joined efforts for genetic improvement of sorghum to obtain genotypes with higher yield in different Brazilian regions. Some productivity results under tropical conditions are reported by Castro et al. (2015), and L. G. F. de Almeida et al. (2019) while the nutritional value was studied by Ramos et al. (2021), Queiroz et al. (2021), and Souza et al. (2021). However, information on productivity of biomass sorghum genotypes for silage production in the semiarid is still scarce. Furthermore, proper management of nitrogen fertilization can contribute to forage yield under adverse weather conditions.

Urea has been widely used as a source of nitrogen (N) in agriculture. However, the acquisition cost has increased production. Alternative sources of N for agriculture have been evaluated, including the use of diazotrophic bacteria such as *Azospirillum brasilense* that fix atmospheric N in the soil (Andrade et al., 2019). Bacteria of the genus *Azospirillum* can contribute to the efficient use of nutrients, increasing absorption (Uptake) and concentration of nitrogen (N) and other mineral elements in plants (Dobbelaere et al., 2002; Moutia et al., 2010). However, there are gaps in knowledge about productivity and nutritional value of different sorghum genotypes with the use of *Azospirillum brasilense.* It is expected a beneficial association of this bacterium in the production of biomass sorghum genotypes, especially in regions with climatic instability due to the lower efficiency of mineral fertilization.

Based on the above, the objective was to evaluate sorghum biomass genotypes associated or not with *Azospirillum brasilense* managed at different sowing sites on the yield, and nutritional value of silage.

Material and Methods

The experiment was conducted in two locations: UNIMONTES Experimental Farm, municipality of Janaúba, state of Minas Gerais (geographical coordinates: 15 ° 52'38 "S, 43 ° 20'05" W) and at the Federal University of Minas Gerais, municipality of Montes Claros, state of Minas Gerais (geographical coordinates: 19° 52' 8.72" S, 43° 57' 58.97" W). According to Köppen and Geiger (1928), the climate in Janaúba and Montes Claros is BSh and Aw, respectively, with well-defined summer rains and dry periods in the winter. Average annual rainfall varies from 800 mm to 1,200 mm, with an average annual temperature of 24-28 °C. The climate is tropical mesothermal, almost megathermal, due to the altitude, sub-humid and semiarid, with uneven rainfall, causing long periods of drought (Köppen & Geiger, 1928). The climate data during the experimental period in the two sites are presented in Figures 1 and 2. In both sites, the experiments were carried out in rainfed areas.

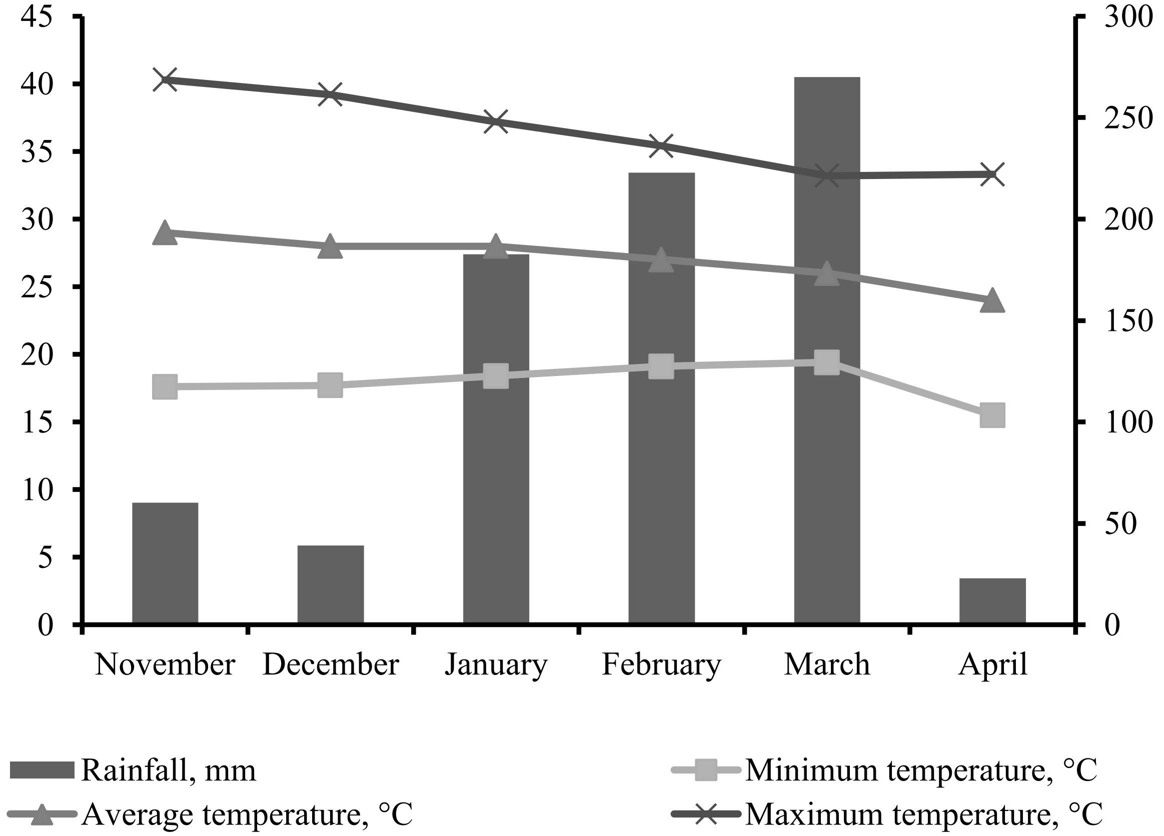

Figure 1. Climatic data during the experimental period in the municipality of Janaúba.
Source: Instituto Nacional de Metereologia [INMET] (2021).

In Janaúba, soil of the experimental area is classified as Eutrophic Red Latosol with an epieutrophic character in the superficial layer with clayey texture (Empresa Brasileira de Pesquisa Agropecuária [EMBRAPA], 2014). The chemical properties of this soil, in samples taken from the 0-20 cm layer are: pH in H_2O 6.1; MO 2.6 dag kg^{-1}; P, K and Na in $Mehlich^{-1}$ of 3.8; 120, and 0.1 mg dm^{-3}, respectively; Ca, Mg and Al extracted in KCl 1mol L^{-1} with values of 4.7; 1.9 and 0.0 cmol dm^{-3}, respectively; and H+Al with 2.9 cmol and dm^{-3}; T = 9.9 cmolc.dm^{-3}; V = 70%. The soil in Montes Claros is a typical eutrophic red-yellow argisol (EMBRAPA, 2014). Here, samples from the 0-20 cm layer show: pH in H_2O 5.2; MO 3.37 dag kg^{-1}; P and K $Mehlich^{-1}$ of 6.14; 275 mg dm^{-3}, respectively. Ca, Mg and Al extracted in KCl 1 mol L^{-1} with values of 4.10; 2.17; 0.14 cmol dm^{-3}, respectively; and H+Al with 2.37 cmol dm^{-3}; T=9.35 cmolc.dm^{-3}; V=75%.

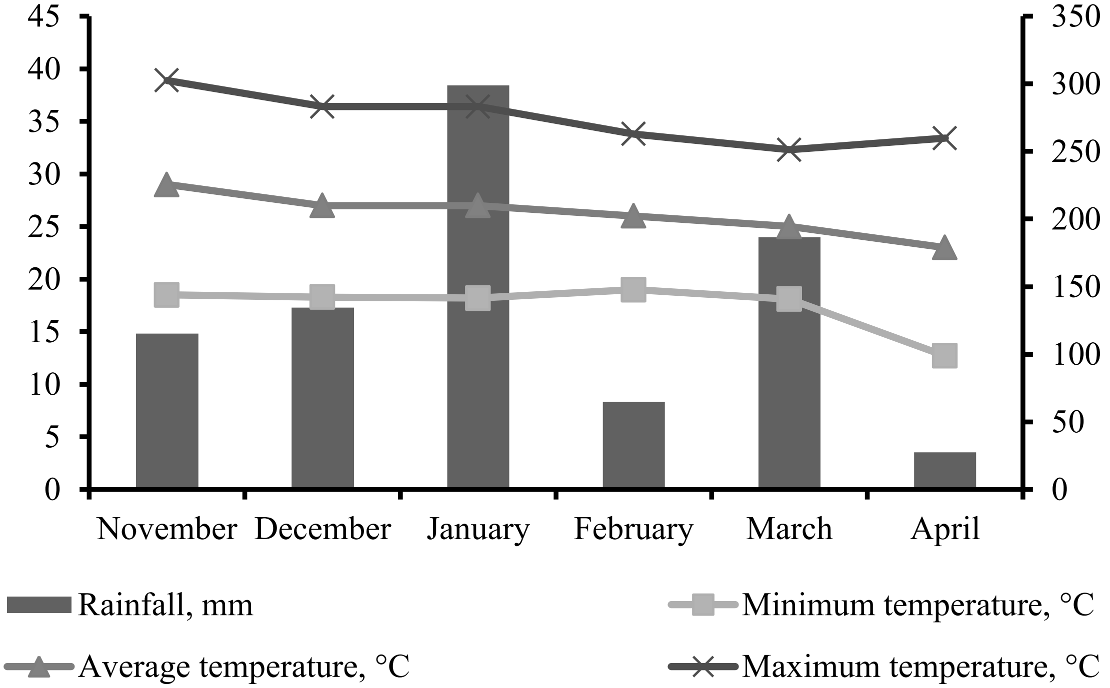

Figure 2. Climatic data during the experimental period in the municipality of Montes Claros. Source: Instituto Nacional de Metereologia [INMET] (2021).

Three sorghum genotypes were tested, one control widely used in the region as silage, belonging to Agroceres (Volumax) and two experimental genotypes from EMBRAPA (201813B and 201814B), previously selected for biomass and energy production.

The three sorghum genotypes combined with three fertilization strategies using urea, *Azospirillum brasilense* and the urea/*A. brasilense* association were evaluated in two planting sites (Janaúba, MG and Montes Claros, MG). A randomized block design in a 3 x 3 x 2 factorial arrangement was used, with 3 genotypes, 3 fertilization strategies, and 2 sowing sites. The variation between different plots was the blocking factor, with 3 repetitions per site. The useful area of each experimental unit was four rows of 3 meters per plot, with the two central rows considered useful for collection.

Sorghum was sown using seeds donated by the producing companies in 2019. One plowing and two harrowing were carried out with conventional soil preparation, before sowing; 250 kg ha^{-1} of NPK fertilizer (04-30-10) was applied to the seed furrow. Weed and insect control were carried out by applying herbicides and insecticides based on atrazine and deltamethrin, respectively, using a sprayer attached to the tractor.

In both planting sites, genotypes were sown manually using twice the seeds, at a depth of 0.03 m, with rows spaced 0.70 m apart. Subsequently, thinning was carried out, leaving a population of 110 thousand plants ha^{-1}. Nitrogen fertilization with urea was carried out 30 days after sowing, with a single application of 100 kg ha^{-1} broadcast between rows of the plots.

Azospirillum brasilense was sprayed four days after nitrogen fertilization, for not interfering with the nitrogen fertilizer, and the doses were diluted in water to a volume of 200 liters ha^{-1} syrup (200 liters of water to 20 liters of solution. Foliar spraying was performed using a costal (Backpack) CO_2 atomizer, until the plant running was observed . *A. brasilense* Ab-V5 and Ab-V6 were used at a concentration of 2 x 10^8 CFU mL^{-1}.

Flowering was determined by the number of days between the sowing date and the 50% panicle stage of each plot. Plant height was measured from the insertion of the upper panicle to the ground, measuring, in meters, 5 plants per plot in the useful area, after flowering. After obtaining the green weight of all plants in the useful area, eight randomly selected plants were collected to be crushed and homogenized in a forage grinder. Then, a 300 g sample was pre-dried in a forced air oven at 55 °C to constant weight, to determine the percentage of dry matter in the forage. The dry matter yield was estimated through the green weight of the plots multiplied by the dry matter percentage. The average weight was transformed into t ha-¹.

Part of the collected plants, after crushing and homogenization, was sent for silage production. To this end, experimental polyvinyl chloride (PVC) silos of known weight, 50 cm long and 10 cm in diameter, were used. The bottom of the silos was added with a layer of 10 cm dry sand (500 g), and after complete forage homogenization, the resulting material was deposited in the silos and compacted with a wooden plunger. Silos were stored at room temperature in the facilities of the UNIMONTES Food Analysis Laboratory and opening after a period of 60 days.

Samples were ground in a knife mill with a 1 mm diameter sieve for chemical composition analysis and another part was ground with a 2 mm diameter sieve for *in vitro* incubation, to assess digestibility of the forage and silage. Samples were analyzed for dry matter content (INCT-CA G-001/1 and G-003/1), crude protein (INCT-CA N-001/1), neutral detergent fiber (INCT-CA F- 002/1), lignin (INCT-CA F-007/1), indigestible neutral detergent fiber (iNDF) (INCT-CA F-008/1) and non-fiber carbohydrates, following the recommendations described in Detmann et al. (2012). The content of total digestible nutrients (TDN) was estimated according to the National Research Council [NRC] (2001).

The in vitro digestibility of dry matter and neutral detergent fiber was determined according to Tilley and Terry (1963) in a Tecnal® *in vitro* incubator (TE-150), using non-woven fabric (100 g/m^2) for making the incubation bag (7.5 x 7.5 cm), according to Valente et al. (2011). Ruminal fluid from two fistulated animals was used, this fluid was mixed in the same proportion, 2/liter rumen inoculum per bovine. All animal care and handling procedures were approved by the Animal Care and Use Committee of the State University of Montes Claros, Brazil (protocol 24 CEBEA-Unimontes 173/2018).

Data were tested by analysis of variance using the SISVAR GLM procedure, version 5.6 (D. F. Ferreira, 2014). The UNIVARIATE procedure was used to detect outliers or influencing values and to check the normality of the residuals. When significant by the F-test, the means of sorghum genotypes, N fertilization strategies and planting sites and interactions were compared by the Scott-Knott test. For all statistical procedures, α = 0.05 was set as the maximum tolerable limit for type I error.

Results and Discussion

For all structural and production characteristics evaluated, there was a significant effect of genotypes (P<0.01) and genotypes x sites interaction (P<0.01). There was also an effect of the site for the production of green mass (P<0.01). Thus, there was no effect of double interactions (Genotype x Fertilizer and Site x Fertilizer), and triple interaction between treatments (Genotype x Fertilizer x site) for all variables.

The different results of studies on *Azospirilum* spp. are associated with soil and climate interactions and interactions with soil microbiology. Fukami et al. (2016) observed an increase in maize plants inoculated with *Azospirillum brasilense* via the foliar. A 29% increase in maize production was found due to inoculation with *Azospirillum* in the Brazilian Cerrado (A. S. Ferreira et al., 2013). Benefits of diazotrophic bacteria on plants have already been demonstrated by several researchers, but their use can be interfered with, in certain situations, by the form *Azospirillum brasilense* bacteria freely associate with the plant, either in the rhizosphere or inside the tissues, which leads to susceptibility to the environment (Gyaneshwar et al., 2002); another factor that can influence is the genotype in which the symbiosis with the bacteria occurs (Iniguez et al., 2004) it has also been noted that soil properties may be related to the lack of interaction with the inoculation (Dobbelaere et al., 2002).

As for flowering (Table 1), Volumax sorghum showed lower values in both sites, compared to the two biomass sorghum genotypes. When comparing the same characteristic in different sites, the 201814B biomass sorghum showed a significant difference, with a higher value in Janaúba. When evaluating height (m), green mass production (t ha^{-1}) and dry matter production (t ha^{-1}), there was a significant difference between genotypes, in the two planting sites, the Volumax sorghum had the lowest averages. In the comparison between sites, there was a higher production of green and dry matter (t ha^{-1}) in Janaúba. The sorghum crop, depending on the genotype, planting time and growing region, can vary in production, due to sensitivity to photoperiod. Pereira et al. (2012) and May et al. (2013), with biomass sorghum genotypes, observed flowering 100 days after planting, presenting genotypes with an average of up to 169 days for flowering. Because the experiment was conducted in rainfed conditions, the late development of the genotypes can be explained, as observed in days before flowering, by the low rainfall percentage (Figure 1 and 2) in the most critical phases of the crop. According to Menezes et al. (2015) and Batista et al. (2017), the interaction between genotypes and environments directly influences the phenotypic performance of the drought tolerance trait in sorghum.

Table 1
Average values for flowering (days), plant height (m), green mass yield (t ha^{-1}) and dry mass yield (t ha^{-1}) of sorghum genotypes grown in different sites

Item	Site	Sorghum genotypes			SEM
		Volumax	201813B	201814B	
Flowering	Janaúba	127.33 Ab	146.00 Aa	148.11 Aa	1.94
	Montes Claros	127.77 Ac	151.11 Aa	139.00 Bb	
Height	Janaúba	1.66 Ac	3.79 Ab	4.07 Aa	0.07
	Montes Claros	1.86 Ab	3.67 Aa	3.88 Aa	
Green mass yield	Janaúba	26.16 Ab	40.01 Aa	38.15 Aa	2.19
	Montes Claros	11.28 Bb	40.53 Aa	35.93 Aa	
Dry matter yield	Janaúba	6.20 Ab	10.79 Ba	10.78 Ba	0.70
	Montes Claros	3.33 Bb	13.28 Aa	13.82 Aa	

Means followed by different lowercases, in the same row, and uppercases, in the same column, within each characteristic, are significantly different by Scott-Knott test ($P<0.05$). SEM - standard error of the mean.

Plant height is a significant variable, especially when the purpose is animal feed and grain production. The tall size of the sorghum plant possibly reveals greater biomass production, due to the increase in the percentage of stalk (stem) and leaf blade, characterizing a foraging behavior (Perazzo et al., 2013).

Structural and yield traits of Volumax sorghum were inferior to the other genotypes in all parameters observed (Table 1). This was expected because this cultivar had a shorter cycle due to a lower accumulation of dry matter during its development, unlike biomass sorghum that was selected by seed producing companies for greater increments of dry matter. According to J. E. Almeida et al. (2014), later genotypes have a longer cycle and tend to produce in larger amounts.

According to Guimarães et al. (2016), when comparing different sorghum forages in the Brazilian semiarid region, the cultivar Volumax showed productivity in the order of 6.99 t ha^{-1} for dry matter. These results are similar to those found herein for the same cultivar. Another study carried out in the semiarid conditions of the state of Paraíba, reported dry matter values for Volumax between 11.94 t ha^{-1}, and 3.34 t ha^{-1}, with yield affected by climatic conditions prevailing at the time of cultivation (Perazzo et al., 2017). Fortes et al. (2018) compared sorghum biomass genotypes under the soil and climate conditions of the state of Tocantins and obtained a low average dry matter yield of 8.13 t ha^{-1}, due to the low water potential.

In addition to high yield, sorghum genotypes indicated for silage production must have good forage quality. For all traits related to the nutritional quality of forage (Table 2), there was a significant effect only of the genotypes for lignin ($P<0.01$), total carbohydrates ($P<0.01$) and non-fiber carbohydrates ($P<0.01$), in addition to the sites (Table 3) for dry matter (P<0.01), crude protein (P<0.01), NDF (P<0.01) and lignin (P<0.01). The management of fertilization as well as interactions with this treatment did not influence any nutritional characteristics.

Table 2
Average dry matter, crude protein, neutral detergent fiber, neutral detergent fiber corrected for ash and protein (NDFap), lignin, total carbohydrate, non-fiber carbohydrate, total digestible nutrients, *in vitro* dry matter digestibility, in vitro neutral detergent fiber digestibility of sorghum forages as a function of genotypes

Item (% as fed)	Sorghum genotypes			SEM
	Volumax	201813B	201814B	
Dry matter	29.67 a	27.18 a	28.22 a	1.59
Crude protein	5.93 a	5.8 a	5.01 a	0.35
Neutral detergent fiber	59.97 a	58.28 a	59.2 a	0.80
NDFap	55.50a	53.94a	54.79a	0.89
Lignin	11.10 a	9.87 b	10.09 b	0.42
Total carbohydrate	82.99 b	85.19 a	85.84 a	0.53
Non-fiber carbohydrates	23.01 b	26.91 a	26.64 a	0.98
Total digestible nutrients	49.48 a	50.62 a	49.87 a	0.57
in vitro dry matter digestibility	46.79 a	53.7 a	50.85 a	3.51
in vitro neutral detergent fiber digestibility	41.74 a	50.23 a	47.15 a	3.45

Means followed by different lowercases, in the same row, are significantly different by Scott-Knott test (P<0.05). SEM - standard error of the mean.

There was a statistical difference between genotypes for lignin where the forage sorghum Volumax had a higher average compared to the other two genotypes, but for total carbohydrates and non-fiber carbohydrates, the Volumax genotype had lower averages compared to the others. Sorghum genotypes have a high diversity in terms of cell wall content, especially in relation to lignin (EMBRAPA, 2014). Buso et al. (2018) found an average NDF content of 59.07% and reported that this value is within the ideal range for ensiling, similar values were obtained in the present study.

Table 3

Average dry matter, crude protein, neutral detergent fiber, lignin, total carbohydrate, non-fiber carbohydrate, total digestible nutrients, in vitro dry matter digestibility, *in vitro* neutral detergent fiber digestibility of sorghum forages as a function of planting sites

Item (% as fed)	Planting sites		SEM
	Janaúba	Montes Claros	
Dry matter	24.56 b	32.16 a	1.29
Crude protein	6.69 a	4.47 b	0.28
neutral detergent fiber	68.77 a	59.54 b	0.65
Lignin	5.27 b	6.11 a	0.14
Total carbohydrate	84.51 a	84.84 a	0.44
Non-fiber carbohydrates	15.74 a	15.30 a	0.30
Total digestible nutrients	45.58 a	44.40 a	0.47
in vitro dry matter digestibility	49.62 a	51.28 a	2.87
in vitro neutral detergent fiber digestibility	44.92 a	47.83 a	2.82

Means followed by different lowercases, in the same row, are significantly different by Scott-Knott test (P<0.05). SEM - standard error of the mean.

When comparing the sites regarding the nutritional quality of forage (Table 3), it was observed that in Montes Claros, the forage had higher averages for dry matter and lignin contents, whereas crude protein, neutral detergent fiber corrected for ash and protein had higher averages in Janaúba. According to May et al. (2013), both genotype and harvest time can influence the dry matter content of sorghum biomass. Pereira et al. (2012), with commercial forage genotypes BRS655, and Volumax, obtained dry matter contents of 29.10% and 32.67%.

When making the silage, it is expected the plant maintains its nutritional properties closer to the natural before storage. For all traits related to nutritional quality of silage (Table 4), there was a significant effect of genotypes for almost all traits studied, such as dry matter (P<0.01), crude protein (P<0.01), NDF (P< 0.01), NDFap (P<0.01), total carbohydrates (P<0.01), non-fiber carbohydrates (P<0.01), total digestible nutrients, *in vitro* DM digestibility (P<0.01) and *in vitro* NDF digestibility (P<0.01). Furthermore, there was a significant effect of sites (Table 5) for dry matter (P<0.01), crude protein (P<0.01), total carbohydrates (P<0.01) non-fiber carbohydrates (P<0.01), *in vitro* DM digestibility (P<0.01), and *in vitro* NDF digestibility (P<0.01). Silage of different sorghum genotypes grown in Janaúba showed higher digestibility in relation to the silages produced in Montes Claros. This is justified by the higher dry mass yield and lignin content of sorghum cultivated in Montes Claros. Von Pinho et al. (2007) studied the quality of sorghum silage as a function of the planting season, and obtained 8.2% CP for the dual-purpose sorghum genotypes, and 7.1% CP for forage genotypes.

When evaluating the chemical composition and digestibility of silage comparing the different sorghum genotypes (Table 4), it was observed that the biomass sorghum genotypes had higher averages for dry matter, as well as for total carbohydrates. The Volumax genotype had higher averages for crude protein and total digestible nutrients, and the biomass genotype 201813B had the highest average for neutral detergent fiber, neutral detergent fiber corrected for ash and proteins, in vitro dry matter digestibility and in vitro NDF digestibility. According to Araújo et al. (2012), who obtained contents of 28.8 to 34.5% dry matter in silages of six sorghum genotypes, which are values considered adequate for better compaction and silage preservation. Kaplan et al. (2017), with 41 sorghum genotypes, found crude protein content between 3.44 and 7.03%. Neumann et al. (2019), analyzed chemical aspects of corn silages, evaluating nitrogen doses, and reported NDF ranging from 58.65 to 62.98%.

Table 4

Mean values of dry matter, crude protein, neutral detergent fiber, neutral detergent fiber corrected for ash and protein, total carbohydrates, non-fiber carbohydrates, total digestible nutrients, *in vitro* dry matter digestibility, *in vitro* neutral detergent fiber digestibility of silages of sorghum genotypes

Item (% DM)	Sorghum genotypes			SEM
	Volumax	201813B	201814B	
Dry matter	25.26 b	27.04 a	28.1 a	0.52
Crude protein	7.05 a	4.83 b	4.77 b	0.24
Neutral detergent fiber	57.80 b	64.54 a	60.81 b	1.11
NDFap	53.49 b	59.73 a	56.28 b	0.97
Total carbohydrate	82.53 b	86.58 a	86.74 a	0.53
Non-fiber carbohydrates	24.73	22.04	25.92	1.23
Total digestible nutrients	53.52a	50.23 b	51.26b	0.82
in vitro dry matter digestibility	54.74 b	59.28 a	55.34 b	0.94
in vitro neutral detergent fiber digestibility	48.86b	53.43a	49.24b	0.82

Means followed by different lowercases, in the same row, are significantly different by Scott-Knott test (P<0.05). SEM - standard error of the mean.

Table 5

Mean values of dry matter, crude protein, neutral detergent fiber corrected for ash and protein (NDFap), total carbohydrates, non-fiber carbohydrates, total digestible nutrients, *in vitro* dry matter digestibility, *in vitro* neutral detergent fiber digestibility of sorghum silages in different planting sites

Item (% DM)	Planting sites		SEM
	Janaúba	Montes Claros	
Dry matter	25.55 b	28.04 a	0.43
Crude protein	6.69 a	5.41 b	0.20
Neutral detergent fiber	59.74	62.36	0.90
NDFap	55.29	57.72	0.83
Total carbohydrate	82.89 b	87.67 a	0.42
Non-fiber carbohydrates	27.92 a	20.53 b	1.01
Total digestible nutrients	53.25a	50.09 b	0.67
in vitro dry matter digestibility	60.42a	58.49 b	0.77
in vitro neutral detergent fiber digestibility	54.99 a	54.02 a	0.67

Means followed by different lowercases, in the same row, are significantly different by Scott-Knott test (P<0.05). SEM - standard error of the mean.

Comparing silages of different sorghum genotypes evaluated in two planting sites, in Montes Claros, the variables dry matter, total carbohydrates, and *in vitro* NDF digestibility of the forage showed higher averages in relation to the forage in Janaúba. On the other hand, in Janaúba, forages presented higher averages for crude protein, non-fiber carbohydrates, total digestible nutrients and *in vitro* dry matter digestibility.

Conclusion

Fertilization with *Azospirillum brasilense* has no influence on the production and nutritional quality of silage of sorghum genotypes. The municipality of Montes Claros - MG has the highest forage production and the municipality of Janaúba - MG has the best quality of silage. The 201813B and 201814B sorghum biomass genotypes have higher forage production and Volumax has better nutritional quality silage.

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