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Bromatological composition of sorghum, millet plant and midget-guandu at different cut times in intercropping and monoculture

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ABSTRACT. To determine the chemical composition of intercropping and monoculture cultivars of sorghum, millet and midget-guandu, we determined the production of dry matter (DM), ashes, gross fiber, ethereal extract, gross protein (GP), nutritious digestive total, and extractive without oxygen. The experimental design used was completely random blocks with four repetitions split into 18 treatments: monoculture sorghum, monoculture midget-guandu, monoculture millet, intercropping sorghum and midget-guandu, millet and midget-guandu and millet and sorghum, with cutting times at 30, 60 and 90 days after sowing (DAS). Millet had the highest production of dry biomass at 30 and 60 DAS in monoculture and intercropping. The highest DM was obtained by intercropping (90 DAS). Sorghum intercropping had the highest crude protein at 30 DAS, and the midget-guandu promoted increased crude protein at intercropping.

Keywords: consortium of cultures, productivity, legume, grass.

Composição bromatológica do sorgo, milheto e guandu-anão em diferentes épocas de corte em consórcio e monocultivo

RESUMO. Com objetivo de determinar a composição bromatológica dos cultivares de sorgo, milheto e guandu, consorciados e solteiros, determinou-se produção de matéria seca (MS), cinzas, fibra bruta, extrato etéreo, proteína bruta (PB), nutrientes digestivos totais e extrativos não nitrogenados. Utilizou-se delineamento experimental em blocos completos ao acaso, com quatro repetições, com parcelas subdivididas em 18 tratamentos: sorgo solteiro, guandu solteiro, milheto solteiro, sorgo e guandu consorciados, milheto e guandu consorciados e milheto e sorgo consorciados, com épocas de corte nos estágios de 30, 60 e 90 dias após a semeadura (DAS). O milheto apresentou a maior produção de MS aos 30 e 60 DAS no monocultivo e em consórcio. Os maiores valores de MS foram obtidos no consórcio (90 DAS). Os consórcios de sorgo apresentaram maiores valores de proteína bruta aos 30 DAS e o guandu-anão promoveu aumento de proteína bruta no cultivo consorciado.

Palavras-chave: culturas consorciadas, produtividade, leguminosas, gramíneas.

Introduction

No-tillage (NT) systems have begun to be adopted in various regions in Brazil, but with little knowledge of the cover crops that are able to produce the amount of dry matter (DM) sufficient for the system and thus to maintain or increase the soil fertility and productivity of crops. Therefore, it is necessary to determine the correct way to implement the system, studying the cultivation of grasses and legumes as cover crops.

Low natural soil fertility, a limiting factor in the productivity and sustainability of tropical pastures (TIRITAN et al., 2008), can promote nutrient deficiency, especially of nitrogen (N). An increase in the supply of N can be obtained by increasing the organic matter (OM) content in the soil by gradually releasing N mineralization and introducing microorganisms to the soil (SANTOS et al., 2011), through the application of N fertilizer or the use of legumes in association with grasses or through atmospheric N fixation. N fixed by legumes increases the quality of the diet (PACIULLO et al., 2003) and benefits livestock (EUCLIDES et al., 1998). The contribution is made indirectly by the transfer of fixed N to grass, which increases the carrying capacity of pasture and extends its productive capacity (VIERA VARGAS et al., 1995). Another advantage of legumes is their lower seasonal variation in nutritional value compared with grasses (KLUSMANN, 1988).

The intercropping of legumes and grass species, provided they are compatible in terms of plant development, is of great benefit to production systems through outputs such as increase in biomass production, biological fixation of atmospheric N and quality of forage for animal feed. According to Giacomini et al. (2004), to protect the soil and add N, the consortium between plant species coverage should provide an output of DM whose C/N ratio is intermediate with that of species isolated in cultures, providing a longer period of ground cover and synchronization between the supply and demand of N by crops.

Amado et al. (2000) experimented with cover crops in the autumn / winter cultivation period to identify the best combinations of species and proportions of seeds for the implementation of intercropping. They attested to the efficiency of the cultivation of winter grasses and legumes at supplying N immobilization or less for the main crop coupled with the durability of the straw layer on the surface of the NT.

Cover crops can also be used in animal feed, especially when grown in the fall / winter, coinciding with the shortage of pasture. According to Mello and Nornberg (2004), crop–livestock integration is a practice that has contributed to the economic viability of farms and the NT system. Thus, the cultivation of cover crops with high biomass production and tolerance to water stress is essential to enable the rotation of crops in NT and reform the areas of pasture.

Crop areas support livestock through food production, whether in the form of grain, silage or hay as forage available for grazing; they increase the efficiency of land use; they permit the sale of animals in the off-season; and they provide a better distribution of income during the year. Therefore, species with rapid growth and intense regrowth are favored because they may be used as fodder as a first stage and, after regrowth, in the form of straw for the NT system in the subsequent summer season (ALVARENGA et al., 2003).

According to Heinrichs et al. (2001), the main advantages of intercropping cover crops compared with cultivation alone, are the greater accumulation of nutrients and yield of DM, depletion of the available soil N by the grass in intercropping and the stimulation of N_2 fixation by legumes. Additionally, the presence of grasses and legumes in the mix adds to the soil biomass, with a C/N ratio intermediate to that of isolated cultivated grasses, while providing protection and a supply of soil N to the crops in succession.

Sorghum has been grown especially in regions where droughts occur frequently, limiting the production of fodder. In addition, after harvesting of the original crop, the sorghum plant root system remains alive, allowing regrowth at adequate temperatures and soil moisture (BOTELHO et al., 2010). According to Scheffer-Basso et al. (2004), another summer forage crop that can fill gaps in cultivation is autumn millet, which originated from Africa and is widespread throughout the country. In this context, midget-guandu (*Cajanus cajan*), which is adapted to the tropical environment and able to fix atmospheric N, can be used to cover the soil and for crops for forage or for grain production (SILVEIRA et al., 2005).

Much of the meat and milk production in Brazil is based on the use of pasture, with very low levels of animal productivity as a consequence of the quality of forage species used, low soil fertility and inadequate management of pastures. Thus, there is a need for studies that contribute to reversing this situation. This study aimed to evaluate the effect of both intercropping and of monoculture crops of sorghum, millet and midget-guandu in the production of dry biomass content and the behavior of crude fiber (CF), crude protein (CP), total digestive nutrients (TDNs) and non-nitrogen extract (NNE).

Material and methods

The experiment was conducted in the agricultural area of the Universidade do Oeste Paulista - Unoeste in Presidente Prudente city, São Paulo state, from February to May in the 2006 agriculture year. The climate, according to the Köppen classification, is CWA, having a tropical rainy season and a well-defined hot climate from September to March and dry winter conditions with mild temperatures from April to August.

The experimental area soil was classified as dystrophic (EMBRAPA, 2006), with a wavy soft relief and good drainage. The experimental area had been cultivated for over ten years with conventional tillage, with corn in summer and fallow in winter. Samples were collected for the characterization of chemical attributes (RAIJ et al., 2001) and granulometric analysis (EMBRAPA, 1997) at a depth of 0 to 20 cm with the following results: pH ($CaCl_2$ 1 mol L^{-1}) 5.9; 18 g dm^{-3} OM; 16 mg dm^{-3} P_{resin}; 27 $mmol_c$ dm^{-3} H+Al; 1.2 $mmol_c$ dm^{-3} K; 38 $mmol_c$ dm^{-3} Ca; 12 $mmol_c$ dm^{-3} Mg; 52 $mmol_c$ dm^{-3} sum of bases (SB); 69 $mmol_c$ dm^{-3} of cation exchange capacity; 74% base saturation (V); 740 g kg^{-1} sand; 80 g kg^{-1} silt; and 180 g kg^{-1} clay.

Each plot consisted of eight plant rows that were 5.0 m long and spaced 0.40 m apart. Monoculture cover crop species were sown in eight rows, and intercropped species were sown in alternate rows.

A randomized complete block design was adopted with four replicates in a split-plot with 18 treatments: monoculture sorghum, monoculture midget-guandu, monoculture millet, intercropping sorghum and midget-guandu, millet and midget-guandu and millet and sorghum, with cutting times at 30, 60 and 90 days after sowing (DAS). The plants contained in a meter length in the four sub-samples per experimental plot were cut close to the soil surface. A distance of 0.5 m was left as a boundary between the times of collection and at the ends of the plots.

Tilling was performed in February, with plowing and harrowing, on the spontaneously occurring vegetation of the area. Then, furrows were dug using a mechanized planter, and 200 kg ha^{-1} of 8-28-16 fertilizer was added with the manual sowing of sorghum (*Sorghum bicolor* x *Sorghum sudanensis* cv. BRS-800), millet (*Penissetum glaucum* cv. BN-2) and midget-guandu (*Cajanus cajan* cv. anão).

At 17 days after sowing, the weeds in the rows of the cover crops were removed by hand. At 30 DAS, further manual weeding was undertaken. The plant stands at four randomly chosen points in the useful area of the plots were quantified as follows: sorghum: 761,000 stems ha^{-1} (± 91,320); midget-guandu: 422,000 stems ha^{-1} (± 33,760); and millet: 1,140,000 stems ha^{-1} (± 159,600). During counting, all structures that characterize stem tillers and/or mother plants were considered. The cuts were made at 30, 60 and 90 DAS.

After cutting, the samples were dried in an oven with forced ventilation at 55°C for 72 hours until constant weight. The samples were then milled in a Wiley type mill and passed through sieves with mesh holes a millimeter wide for the evaluation of DM, mineral matter (MM), CP, ether extract (EE) and CF, according to the techniques of the Association of Official Analytical Chemists, described by Hortws (1975).

The micro-Kjeldahl method was used for the determination of N. The N content was multiplied by a factor of 6.25 to give the CP content, which was corrected for DM. The non-nitrogen extract (NNE) was obtained by calculating NNE = 100 - (% moisture +% CP +% CF +% EE +% MM). Because the TDN was obtained by calculating the total carbohydrate (TC), where TC = 100 - (% CP + EE + 5% * Ashes) and TDN% = CP + CF + 2.25 * EE + TC. Statistical analysis consisted of analysis of variance and a t-test at a 5% significance level to compare the means of the experimental treatments.

Results and discussion

The findings for plant shoot dry biomass over three seasons are evaluated in Table 1. Significant results were found for the different species evaluated in the three seasons. At 30 and 60 days, millet produced the greatest amount of dry matter in both cropping and intercropping with midget-guandu and sorghum. At 90 days, sorghum showed a large increase in DM yield, but the highest yields were obtained in intercropping. According to Neumann et al. (2008), the DM content rises faster in hybrid sorghum, medium or low (if BRS 800), due to the greater participation of panicles in the total dry matter.

Using intercropping, and considering the total output of DM in the consortium at 60 days, the highest value was obtained with the millet+sorghum. At 90 days, the millet+sorghum ratio was reduced, though the millet remained as the main constituent responsible for total DM production in the three periods evaluated. Likewise, Andreola et al. (2000) and Perin et al. (2004) stated that in grass and legume intercropping the grass contributes to relatively high amounts of biomass, which are characterized by a high C/N ratio and which increase the persistence of land cover over time. However, high biomass may cause problems in subsequent cultivation due to the temporary immobilization of N in the process of the biological decomposition of straw.

The results indicate that with respect to DM production for the use of grazing or silage, the behavior of species and associations are very different. The millet at 30 days shows monoculture spot grazing, a feature that was maintained for up to 60 days. Millet intercropped with midget-guandu showed the same behavior as a monoculture millet crop, although in this case 30 days grazing would most likely cause major problems for midget-guandu productivity due to its low dry matter yield.

The sorghum culture showed the highest DM yield at 90 days, both in the monoculture crop and intercropping with midget-guandu and pearl millet. The millet presented its maximum DM production at 60 days in the monoculture cropping system, while the DM yield was higher at 90 days in intercropping with midget-guandu and sorghum, demonstrating the importance of the addition of culture intercropping DM. Therefore, the higher millet DM for silage was 60 days in cropping and 90 days in intercropping (Table 1).

Table 1. Dry matter of plants shoots of the midget-guandu, millet and sorghum at 30, 60 and 90 days after sowing (DAS), in monoculture and intercropping.

Species Coverage	Species 1			Species 2			Total	
	------------------------ (kg ha^{-1}) ---------------------------							
				(30 Days After Sowing - DAS)				
Midget-guandu (monoculture)	-			-			144	b
Millet (monoculture)	-			-			2573	a
Sorghum (monoculture)	-			-			699	b
M.guandu (S1) + Millet (S2)	109	b B	(3%)	3362	a A	(97%)	3471	a
M.guandu (S1) + Sorghum (S2)	305	b A	(35%)	575	b A	(65%)	880	b
Millet (S1) + Sorghum (S2)	3009	a A	(90%)	347	b B	(10%)	3356	a
				(60 Days After Sowing - DAS)				
Midget-guandu (monoculture)	-			-			1397	e
Millet (monoculture)	-			-			6318	c
Sorghum (monoculture)	-			-			4085	d
M.guandu (S1) + Millet (S2)	501	e B	(7%)	7130	bc A	(93%)	7631	ab
M.guandu (S1) + Sorghum (S2)	1003	e B	(21%)	3768	d A	(79%)	4771	d
Millet (S1) + Sorghum (S2)	6894	bc B	(82%)	1538	e C	(18%)	8432	a
				(90 Days After Sowing - DAS)				
Midget-guandu (monoculture)	-			-			3278	d
Millet (monoculture)	-			-			5585	c
Sorghum (monoculture)	-			-			7086	b
M.guandu (S1) + Millet (S2)	1349	e C	(16%)	6902	b B	(84%)	8251	a
M.guandu (S1) + Sorghum (S2)	2785	d C	(30%)	6452	bc B	(70%)	9237	a
Millet (S1) + Sorghum (S2)	6279	bc B	(71%)	2507	d C	(29%)	8786	a
Causes of variation				F calculated values				
Cover crop				83.19**				
Collect time				321.25**				
Culture x Time				9.04**				
Interaction DMS (kg ha^{-1})				1150				
CV (%)				20.98				

S1: Midget-guandu and millet in consortium. S2: millet and sorghum in intercropping. The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability, within each collect time. Lower case letters compare columns and upper letters compare lines. Percentages in parentheses represent the amounts of biomass of each species in relation to total production in intercropping.

The sorghum and midget-guandu intercropping showed low DM production at 30 and 60 days compared with the DM production of millet, so they are not recommended for grazing or cultivation beds (Table 1). Teixeira et al. (2005) evaluated the production of the dry biomass of millet, beans and pork in monoculture cropping and intercropping dwarf pea at 119 days after sowing and observed that the lowest yield was obtained with the midget-guandu monoculture crop. They also noted that for the consortium of millet and beans with pork, the contribution of the species to the production of total dry biomass was very similar, unlike the consortium of millet and midget-guandu where dry millet contributed the most, because millet is a grass with higher DM production potential.

The results for the CP content of the plant shoots in the three seasons are shown in Table 2. Meaningful results were found for the different species evaluated in the three seasons. At 30 days, the sorghum+midget-guandu and sorghum+millet intercropping and the millet and midget-guandu monoculture showed CP contents higher than the millet and midget-guandu intercropping and sorghum monoculture (Table 2). Therefore, at 30 days, millet presenting a high amount of DM and had high levels of CP, so it can be used as cover plants for grazing.

The millet and midget-guandu intercropping had a lower CP content at 30 days than midget-guandu and the millet monoculture, and midget-guandu with sorghum and millet with sorghum, but had higher crude protein content than sorghum monoculture (Table 2). At 60 DAS, the highest CP content was observed in the midget-guandu monoculture, followed by midget-guandu+millet and midget guandu + sorghum intercropping.

A lower protein content was also observed in the monoculture sorghum in comparison with intercropping sorghum and midget-guandu and millet monoculture.

At 90 DAS, the midget-guandu continued to have the highest CP content, followed by millet+midget-guandu and sorghum+midget-guandu intercropping. The midget-guandu and sorghum intercropping had a higher CP content than the sorghum monoculture. A similar situation occurred with the millet. The sorghum monoculture had the lowest CP content.

At 60 and 90 DAS, the midget-guandu monoculture, followed by midget-guandu intercropped with sorghum or millet, always had the highest CP content. This effect, in the presence of midget-guandu (protein source), even resulted in a lower amount of DM, possibly increasing the CP. Thus, midget-guandu crops intercropped with millet and sorghum may be an option for raising CP levels, especially when the object is to produce silage or grazing.

Table 2. Gross protein content measured at 30, 60 and 90 days after sowing of the monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)						
	30		60		90		Average
	(Gross Protein Content, in % DM)						
Midget-guandu	14.19	ab A	14.67	a A	12.15	a B	13.67
Millet	14.64	a A	9.70	c B	7.48	c C	10.61
Sorghum	11.25	c A	8.89	c B	6.24	d C	8.79
M.-guandu + Millet	13.19	b A	11.95	b B	9.16	b C	11.43
M.guandu + Sorghum	15.08	a A	11.09	b B	8.76	b C	11.64
Millet + Sorghum	14.36	a A	9.53	c B	6.39	cd C	10.09
Average	13.79		10.97		8.36		
	F calculated values						
Causes of variation	Gross Protein Content						
Cover crop	32.54**						
Collect time	176.75**						
Culture x Time	6.38**						
CV (%)	7.42						

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

Similarly, the consortium of pasture and legumes improved the CP, neutral detergent fiber and acid detergent fiber according to Schaefer et al. (2010) in experiments with different systems of forage cultures constituted by *Pennisetum americanum*, *Arachis pintoi* and *Stylosanthes guianensis* associated with *Cynodon dactylon* and both isolated species. Vitor et al. (2008), working with legume species intercropped with grasses, also reported that the consortium, in general, presented a greater forage CP concentration compared with signalgrass fertilized with nitrogen.

Millet has been the object of evaluation for use in animal feed (KOLLET et al., 2006; RIBEIRO et al., 2004; ROMAN et al., 2008). In addition to its resistance to drought, high temperatures and acidic soils, millet retains good development in soils with low OM content (GUIMARÃES JÚNIOR et al., 2009) and is promising for many Brazilian soils. The CP content of pearl millet is higher than corn, so there is a reduction in amino acids in the diet. According to Bastos et al. (2002), millet grain has an amino acid content similar to wheat, barley and rice. Data from the NRC (1998) show a CP content of 11.1% for millet and 8.3% for maize. Rostagno et al. (2000) evaluated the chemical composition of pearl millet and maize obtained from experiments performed in Brazil and found higher values of CP (12.08 vs. 8.57%), fat (4.19 vs. 3.46%) and gross energy (3980 vs. 3933 kcal kg^{-1}) for maize. These values are close to those obtained in the experiment and to those obtained by Adeola and Orban (1995) and Lawrence et al. (1995). Gomes et al. (2006), evaluating the CP content of different parts of the sorghum plant at 112 DAS, observed a higher CP content in the panicle (9.72%) compared with the leaves (6.31%) and stems (1.70%).

Table 3 presents the results for the crude fiber (GB) content of the shoots at 60 and 90 days. Significant responses were presented by the different species in the two periods evaluated. At 60 days, midget-guandu, pearl millet and midget-guandu+sorghum had the highest concentrations of crude fiber. At 90 days, the highest GB concentrations were observed in millet+midget-guandu and sorghum+millet. However, the lowest GB concentration was observed in the sorghum monoculture. Midget-guandu and sorghum showed a reduction in GB from 60 to 90 DAS. The results show that the average GB content was similar to that observed 60 and 90 DAS, and the production of monoculture and consortium was satisfactory for the production of forage high in fiber. Similar results were observed for Leonel et al. (2008).

The results of total digestible nutrients (TDN) of the shoots at 60 and 90 DAS are shown in Table 4. Significant responses were found for the different species in the two periods evaluated. At 60 days, midget-guandu, because being a legume, presented the highest TDN concentrations. However, millet was the crop with the lowest TDN concentration. At 90 days, the highest value was also observed for midget-guandu and the lowest for millet + sorghum.

Table 3. Gross fiber (GB) content measured at 60 and 90 days after sowing of the monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)				
	60 dias		90 dias		Average
	(Gross Fiber Content, in % DM)				
Midget-guandu	28.46	abc A	26.70	c B	27.58
Millet	28.62	ab A	29.88	b A	29.25
Sorghum	27.81	bc A	24.56	d B	26.18
M.guandu + Millet	27.14	c B	31.77	a A	29.45
M.guandu + Sorghum	29.44	a A	26.02	c B	27.75
Millet + Sorghum	27.50	bc B	31.55	a B	29.53
Average	28.16		28.42		
Causes of variation	F calculated values				
	Gross Fiber Content				
Cover crop	16.84**				
Collect time	0.95				
Culture x Time	29.81**				
CV (%)	3.28				

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

The results show that from 60 to 90 DAS, midget-guandu also accumulated total digestible nutrients when the plant was at the height of its production, increasing dry matter and nutrient accumulation. For millet, there was a decrease in the TDN concentration from 60 to 90 DAS, indicating the plant was undergoing the process of senescence, decreasing the nutrient ratio to the shoots and thereby decreasing the chemical quality (millet crop intercropping).

Table 4. Total digestive nutrients (TDN) at 60 and 90 days after sowing of monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)				
	60		90		Average
	(TDN Contents in % DM)				
Midget-guandu	56.05	a B	58.09	a A	57.07
Millet	51.93	c A	50.29	c B	51.11
Sorghum	53.41	bc B	55.51	b A	54.46
M.guandu + Millet	54.45	b A	49.12	c B	51.79
M.guandu + Sorghum	53.82	b B	55.48	b A	54.65
Millet + Sorghum	53.55	b A	47.28	d B	50.42
Average	53.87		52.63		
Causes of variation	F calculated values				
	TDN Contents				
Cover crop	42.82**				
Collect time	15.06**				
Culture x Time	23.68**				
CV (%)	2.08				

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

The ethereal extract (EE) results at 60 and 90 DAS are shown in Table 5. There were significant responses in the different species in the two periods evaluated. The midget-guandu and the millet at 60 days in monoculture (no intercropping) had the highest EE percentage. At 90 DAS, the midget-guandu monoculture already presented the highest EE values, which represent higher energy density. With intercropping, the results obtained at 60 DAS with midget-guandu+sorghum were higher than with grass monoculture (sorghum).

Table 5. Ethereal extract (EE) contents at 60 and 90 days after sowing of the monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)				
	60		90		Average
	(EE Contents in % DM)				
Midget-guandu	2.64	ab B	3.52	a A	3.08
Millet	2.21	ab A	2.20	b A	2.20
Sorghum	1.96	b A	2.09	b A	2.03
M.guandu + Millet	2.39	ab A	2.19	b A	2.29
M.guandu + Sorghum	2.69	a A	2.59	b A	2.64
Millet + Sorghum	2.32	ab A	2.02	b A	2.17
Average	2.37		2.43		
Causes of variation	F calculated values				
	EE Contents				
Cover crop	5.44**				
Collect time	0.24^{ns}				
Culture x Time	1.62^{ns}				
CV (%)	19.68				

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

The results of NNE are presented in Table 6. Meaningful results were found for the different species in the two periods evaluated. The sorghum monoculture at 60 DAS did not differ in the production of NNE, but at 90 DAS, the sorghum intercropped with midget-guandu had the highest response in the production of NNE when compared with the consortium or monoculture crops. The MM results at 60 and 90 DAS are shown in Table 7.

Table 6. Non-nitrogen extract contents (NNE) at 60 and 90 days after sowing of the monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)				
	60		90		Average
	(NNE Content in % DM)				
Midget-guandu	46.19	c B	51.47	cd A	48.83
Millet	51.21	b B	53.81	c A	52.51
Sorghum	54.31	a B	61.06	a A	57.68
M.guandu + Millet	50.06	b A	49.87	e A	49.97
M.guandu + Sorghum	50.14	b B	57.22	b A	53.68
Millet + Sorghum	50.11	b A	52.13	cd A	51.12
Average	50.34		54.26		
Causes of variation	F calculated values				
	NNE Contents				
Cover crop	36.12**				
Collect time	83.74**				
Culture x Time	7.63**				
CV (%)	2.84				

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

Table 7. Mineral matter (MM) contents at 60 and 90 days after sowing of the monoculture and intercropping of the midget-guandu, millet and sorghum.

Species Coverage	Days After Sowing (DAS)				
	60		90		Average
	(MM contents in % DM)				
Midget-guandu	8.25	a A	6.22	bc B	7.24
Millet	8.17	a A	6.60	abc B	7.38
Sorghum	6.88	b A	5.90	c B	6.39
M.guandu + Millet	8.76	a A	7.13	ab B	7.94
M.guandu + Sorghum	6.65	b A	5.99	c A	6.32
Millet + Sorghum	8.88	a A	7.36	a B	8.12
Average	7.93		6.53		
Causes of variation	F calculated values				
	MM Contents				
Cover crop	11.23**				
Collect time	57.73**				
Culture x Time	1.19^{ns}				
CV (%)	8.80				

The following averages for the same letter in the line do not differ by the Tukey test at 5% of probability. Lower case letters compare columns and upper letters compare lines. *and **significant at the 5% and 1% level of probability, respectively. ns: not significant.

Significant responses to the different species in the two seasons evaluated were observed. At 60 DAS of monoculture, millet and midget-guandu had a higher response to the production of minerals. At 90 DAS, sorghum + millet and midget-guandu+millet intercropping and millet monoculture showed higher results than midget+sorghum intercropping and sorghum monoculture in MM production. The percentage of ash (DM) did not differ between species and the collection times. Such distinctions may be related to the method of nutrient uptake, both as best in the rooting soil volume used, as in the increased capacity of cultivars to exploit mineral nutrients in this experiment. The way as the phosphate fertilizer was located in the phosphate fertilizer court system may have provided better utilization of this nutrient, which is extremely important for the establishment of roots, favoring the uptake of nutrients by the plant and enriching the forage with nutrients, expressed as ash in DM.

Conclusion

Millet had the highest production of dry biomass at 30 and 60 DAS with monoculture and intercropping. The highest DM were obtained with intercropping (90 DAS). Sorghum intercropping had the highest crude protein at 30 DAS, and midget-guandu promoted increased crude protein with intercropping.

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