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Productivity and quality of Mombasa grass under fertilization with pig deep-litter and NPK

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ABSTRACT: The use of pig deep-litter (PDL) in pasture fertilization can be an important alternative from an environmental and economic point of view. This study was conducted to evaluate the fertilization with PDL exclusively or in association with mineral fertilizers on the quality and productivity of *Panicum maximum* cv. Mombasa. The experiment was carried out in Ipameri, GO, Brazil. The design was a randomized block design in a 2 x 5 factorial scheme with four repetitions, in plots of 24 m^2. The doses of PDL (0; 5; 10; 15 and 20 Mg ha^{-1}) were tested, with or without fertilization with NPK (50 kg ha^{-1} of P_2O_5, 10 kg ha^{-1} of K_2O and 10 kg ha^{-1} of N). The organic fertilizer was applied broadcast at the planting of the pasture, and the mineral fertilizers were split and applied at planting and as topdressing. Dry mass, crude protein, acid detergent fiber and neutral detergent fiber were evaluated. PDL doses associated with mineral fertilization led to linear increases from 52 to 282% in the analyzed variables and better bromatological composition. PDL application is beneficial to the production of pastures, and increasing applications up to the PDL dose of 20 Mg ha^{-1} associated with mineral fertilization promoted better quantitative and qualitative results. With exclusive fertilization with PDL, the gains in quality and productivity were more modest.

Key words: *Panicum maximum*, crude protein, neutral detergent fiber, acid detergent fiber

Produtividade e qualidade do capim Mombaça sob adubação com cama sobreposta de suínos e NPK

RESUMO: O uso de cama sobreposta de suínos (CSS) na adubação de pastagens pode ser uma importante alternativa do ponto de vista ambiental e econômico. Com o objetivo de avaliar a adubação com CSS de forma exclusiva ou associada a fertilizantes minerais, na qualidade e produtividade de *Panicum maximum* cv. Mombaça, foi conduzido um experimento em condições de campo, em Ipameri, GO. O delineamento foi em blocos ao acaso em esquema fatorial 2 x 5 com quatro repetições, em parcelas de 24 m^2. Foram testadas as doses de CSS (0; 5; 10; 15 e 20 Mg ha^{-1}), com ou sem adubação com NPK (50 kg ha^{-1} de P_2O_5, 10 kg ha^{-1} de K_2O e 10 kg ha^{-1} de N). O adubo orgânico foi aplicado a lanço na implantação da pastagem, e os fertilizantes minerais parcelados no plantio e em cobertura. Foram avaliadas a massa seca, proteína bruta, fibra em detergente ácido e fibra em detergente neutro. As doses de CSS associadas à adubação mineral apresentaram incrementos lineares de 52 a 282% nas variáveis avaliadas, e melhor composição bromatológica. A aplicação de CSS é benéfica à produção de pastagens e as aplicações crescentes até à dose de 20 Mg ha^{-1} de CSS associadas à adubação mineral apresentaram melhores resultados quantitativos e qualitativos. Com a adubação exclusiva com CSS os ganhos de qualidade e produtividade do capim Mombaça são menores.

Palavras-chave: *Panicum maximum*, proteína bruta, fibra em detergente neutro, fibra em detergente ácido

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Introduction

In Brazil, pasture is the main food source for most of the cattle herd, mainly because it provides lower production cost. The system is characterized by extractivism, where the adoption of technologies and intensive use in capital is restricted to a small set of producers (Barcellos et al., 2008). According to Carvalho et al. (2017), it is estimated that 80% of the 50-60 million hectares of pasture cultivated in the Central region of Brazil are in some state of degradation.

In the Cerrado, the introduction of selected forage plants enabled significant gains in the animal stocking rate compared to native species (Martha Júnior & Vilela, 2002). Mombasa grass (*Panicum maximum* cv. Mombasa) is considered one of the most productive tropical forage species available to livestock farmers. However, in situations of low fertility, production is reduced, as the forage is demanding in terms of soil fertility (Freitas et al., 2007).

Pasture fertilization is often considered to be unfeasible for producers. Thus, the use of organic waste such as those from pig farming can be a good alternative as a source of nutrients (Cardoso et al., 2015), besides reducing environmental impacts (Rizzoni et al., 2012).

The deep-litter pig production system is still recent in Brazil and has the advantages of greater comfort to animals, lower stress in the intensive production system and low costs of implementation and operation of the system, reducing the need for complementary structures, such as ponds for waste treatment (Homem et al., 2015). In this system, the animals are raised in facilities whose floor is formed by wood shavings, straw or rice husk, where the waste goes through the "in situ" composting process.

Organic fertilizers contain highly variable concentrations and rates of nutrient release in the soil, and for pig deep-litter (PDL) there are still no indices of availability (IA) of the main nutrients, such as nitrogen, phosphorus and potassium (Hentz et al., 2008). As the PDL system is recent, little is known about the quantities to be used in crops, exclusively or associated with NPK fertilization. The hypothesis of this study is that fertilization with PDL associated with mineral fertilizers has a synergistic effect on the quality and productivity of Mombasa grass.

This study aimed to evaluate the effect of PDL, exclusively or associated with mineral fertilizers, on the productive and qualitative characteristics of *Panicum maximum* cv. Mombasa.

Material and Methods

The experiment was carried out under field conditions in the experimental area of the Universidade Estadual de Goiás - Campus of Ipameri, located on the GO 330 highway, km 241, Brazil (17º 42' 54" S, 48º 8' 36" W and altitude of 803 m), in the period from December 2015 to May 2016, in the edaphoclimatic region of Southeastern Goiás, Brazil, in Oxisol. The experimental period comprised the planting and maintenance of the pasture of *Panicum maximum* cv. Mombasa.

The climate of the region, according to the Köppen's classification, is semi-humid tropical (Aw), with high temperatures, with annual averages from 20 to 24º C, summer rains from 1300 to 1700 mm and dry winter. The climatic conditions observed along the experimental period are shown in Figure 1.

The experimental design used was in randomized blocks, in a 2 x 5 factorial scheme, with four replicates. The first factor corresponded to mineral fertilization with NPK (without and with). The second factor consisted of pig deep-litter (PDL) doses of 0, 5, 10, 15 and 20 Mg ha^{-1}, with 48.36% moisture, distributed throughout the area and incorporated into the soil in the 0-5 cm layer 10 days before sowing the grass. Mineral fertilization with NPK was applied based on soil analysis and according to the recommendations of Cantarutti et al. (1999), for pasture of high technological level.

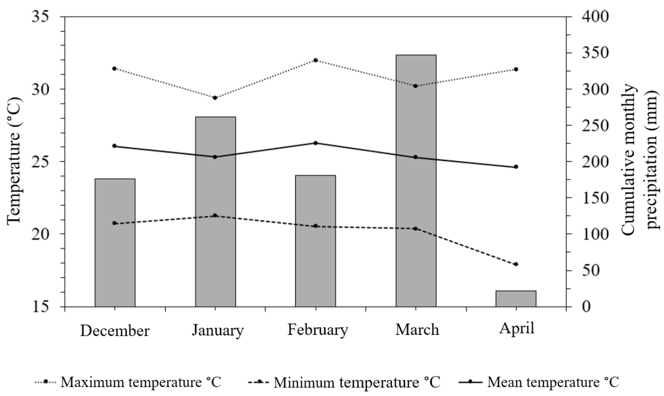
PDL was acquired at Grão Dourado farm, in the municipality of Ipameri, GO, Brazil, which has breeding, weaning and finishing phases of pigs. The bedding removed from the facilities is the result of the mixture of beddings of all rearing stages. The carbonaceous material used to make the bedding was rice straw. In its analysis, the following parameters were determined: dry mass = 51.64%; N = 15.6 g kg^{-1}; P_2O_5 = 43.0 g kg^{-1} and K_2O =21.5 g kg^{-1}.

Soil sampling was performed in the area before installing the experiment, in the layer from 0 to 20 cm for chemical characterization. The results obtained were: pH - 4.6; P (Mehlich 1) - 1.5 mg dm^{-3}; K - 39.0 mg dm^{-3}; H+Al - 1.5 cmol$_c$ dm^{-3}; Al^{3+} - 0.4 cmol$_c$ dm^{-3}; Ca - 1.3 cmol$_c$ dm^{-3}; Mg - 0.54 cmol$_c$ dm^{-3}; OM - 18.0 g dm^{-3}; CEC - 3.42 cmol$_c$ dm^{-3}, clay content - 250 g kg^{-1} and base saturation - 56.06%.

Soil tillage for the experiment was performed by means of three harrowing operations. Basal fertilization consisted of 50 kg ha^{-1} of P_2O_5, 10 kg ha^{-1} of K_2O and 10 kg ha^{-1} of N, using as source triple superphosphate, potassium chloride and urea, respectively, based on soil analysis and according to the recommendations of Cantarutti et al. (1999), considering pastures of high technological level. Liming was not performed because the base saturation of the soil was above the recommended level for the species.

Broadcast manual sowing was performed in 6 x 4 m plots, with a total area of 24 m² each, incorporating the seeds to the soil with a closed leveling harrow. The amount used was 20 kg ha^{-1} of coated seeds of *Panicum maximum* cultivar Mombasa, which had 96.12% purity and cultural value of 80%.

Topdressing fertilization was performed when the grass covered 60% of the soil, at 42 days after seedling emergence (DAE), using 50 kg ha^{-1} of N and 50 kg ha^{-1} of K_2O, using urea and



Source: INMET (2016)

Figure 1. Cumulative monthly precipitation and temperatures recorded from December 2015 to May 2016

KCl as sources, respectively. Topdressing nitrogen fertilization was repeated after each cutting, in applications of 50 kg ha^{-1} of N, using urea as source of N, at 64, 95 and 133 DAE. After the fourth cutting (173 DAE), no nitrogen fertilization was performed due to lack of rainfall. Grass height was considered for each cutting, which was performed when it reached 90 cm.

The samples were collected using a 1 m^2 frame randomly thrown in the plot, then the sample was cut respecting the height of the grass, leaving a residue of 45 cm.

The analysis of dry mass production (DM) was determined based on the mass of the aerial part (stems + leaves) of the obtained sample. After weighing, the material was chopped and homogenized, and 100-g subsamples were dried in a forced air circulation oven at 65 °C until reaching constant weight, thus determining the water content, correcting the fresh mass (FM).

Then, the dry subsamples were ground in a Wiley-type mill to perform the other analyses. For forage quality analysis, the contents of crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) were considered according to procedures described by Rodrigues (2010). N was determined by the Kjeldahl method and was used for crude protein calculation, multiplying by factor 6.25 (Silva & Queiroz, 2006).

The obtained data were subjected to analysis of variance by F test. Effects of NPK fertilization were compared by the Scott-Knott test at $p \leq 0.05$ while PDL doses were evaluated by regression analysis. Statistical calculations were performed using the software program Sisvar 5.3 (Ferreira, 2011).

Results and Discussion

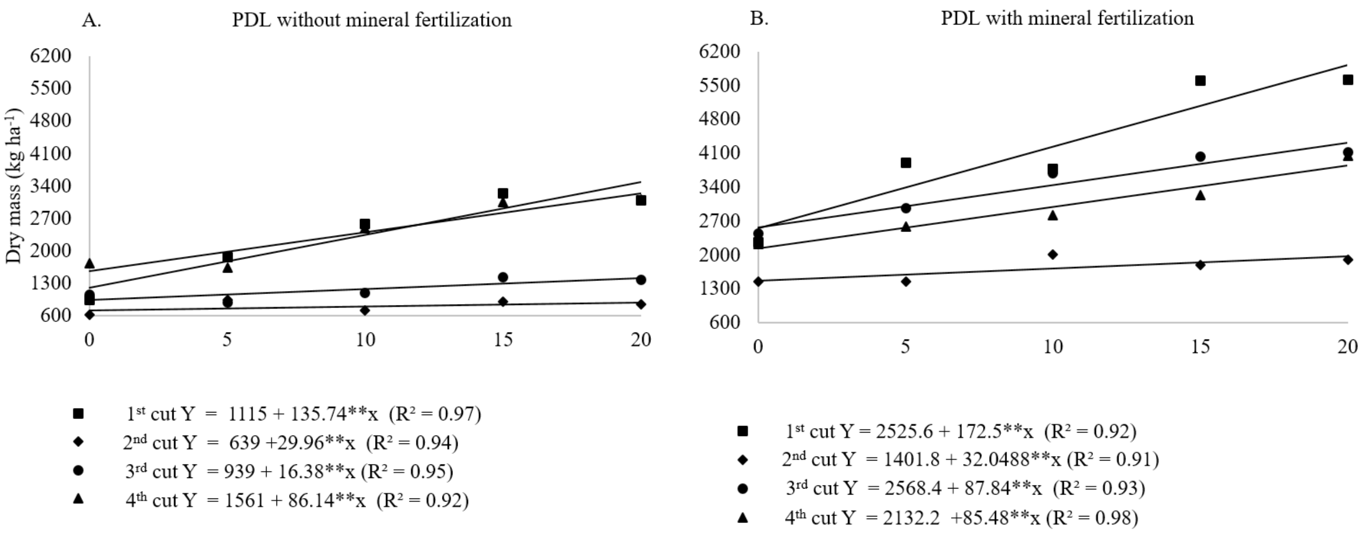
The F test was significant at $p \leq 0.01$ for the variables DM, CP, NDF, ADF and FTMS, for the effects of mineral fertilization, for PDL doses, as well as for the interaction between both, in all cuttings and in the total, except for the MF x PDL interaction for NDF in the 1st and 4th cuts and ADF in the 1st and 3rd cuts, which had no significant effect. ADF in the 2nd cutting was also not significantly affected by MF (Table 1). These results show that both MF and PDL fertilization interfere with Mombasa productivity and quality.

Table 1. Summary of the analysis of variance for dry mass (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total dry mass productivity (TDMP), for *Panicum maximum* cv. Mombasa

Source of variation	DF	Mean squares			
		DM	CP	NDF	ADF
		1st cutting			
MF	1	36903370.5062**	27.1590**	12.3432**	39.2040**
PDL doses	4	10870925.1312**	11.5474**	11.9680**	9.0504**
MF x PDL	4	808863.9437**	0.4352**	0.3211 ns	0.2412 ns
Residual	27	21774.4414	0.0290	0.4016	0.4026
CV (%)	-	4.8	2.06	0.88	1.55
LSD	-	95.74	0.11	0.41	0.41
		2nd cutting			
MF	1	845388.0520**	24.1647**	41.6976**	0.0656 ns
PDL doses	4	311213.0375**	12.7976**	11.0439**	0.8962*
MF x PDL	4	40660.8375**	0.6656**	85.0185**	23.2522**
Residual	27	1562.1102	0.0119	0.4505	0.2639
CV (%)	-	3.13	1.32	0.95	1.21
LSD	-	25.64	0.07	0.43	0.33
		3rd cutting			
MF	1	53107202.5000**	16.9000**	310.8062**	72.5764**
PDL doses	4	1804420.9375**	4.2504**	71.7501**	37.3921**
MF x PDL	4	497157.1875**	0.6132**	8.5647**	0.9428 ns
Residual	27	21346.6667	0.0064	9.1975	0.4657
CV (%)	-	6.37	1.03	0.85	1.92
LSD	-	94.80	0.051	0.38	0.44
		4th cutting			
MF	1	7695675.6250**	22.1563**	40.6426**	825.7357**
PDL doses	4	13502158.7500**	24.6018**	9.2228**	20.9077**
MF x PDL	4	553658.7500**	0.5274**	0.4470ns	1.6762**
Residual	27	850984.3750	0.6840	0.3934	0.3531
CV (%)	-	6.20	1.99	0.84	1.28
LSD	-	115.19	0.10	0.41	0.38
		TDMP			
MF	1	126504705.6250**	-	-	-
PDL doses	4	42324295.9375**	-	-	-
MF x PDL	4	1073822.8125*	-	-	-
Residual	27	279799.5138	-	-	-
CV (%)	-	4.51	-	-	-
LSD	-	343.21	-	-	-

ns, ** - Not significant and significant at $p \leq 0.01$ by F test; MF - Mineral fertilization; PDL - Pig deep-litter, DF - Degrees of freedom; CV - Coefficient of variation; LSD - Least square difference

The dry mass of Mombasa grass showed linear fits ($p \leq 0.01$) as a function of PDL doses, in all cuttings, in the absence or in the presence of mineral fertilization (Figure 2).



** Significant at $p \leq 0.01$ by F test

Figure 2. Dry mass productivity of Mombasa grass as a function of pig deep-litter doses (PDL) without (A) and with (B) mineral fertilization

In the first cut, it was found that the fertilization with PDL, when compared to the treatment that did not receive any fertilization, led to a 243.48% increase in dry mass productivity (DM), for the application of 20 Mg ha^{-1} of PDL (Figure 2A). Application of mineral fertilizer together with PDL enabled a 136.6% increase in DM compared to the treatment that received only mineral fertilization (Figure 2B). When comparing the productivity gains of organic fertilization with those of mineral fertilization, the second leads to a smaller increment, but its productivity is 2145.80 kg ha^{-1} higher than that with PDL fertilization at dose of 20 Mg ha^{-1}. Thus, it is possible to affirm that the highest dose of PDL associated with mineral fertilization leads to the highest DM productivity.

In the second cut, the increment found in organic fertilization at the dose of 20 Mg ha^{-1}, compared to the treatment that did not receive any fertilization, was equal to 93.77%, and for fertilization with PDL associated with mineral fertilization, the increase in comparison to the treatment that received only mineral fertilization was 45.73%. Despite the difference between the increase gain, the treatment with associated fertilization led to 804.58 kg ha^{-1} more in comparison to the PDL dose of 20 Mg ha^{-1}. The DM productivity of the second cutting was lower than that of the others (Figure 2), which may be directly related to the lower volume of rainfall in this period.

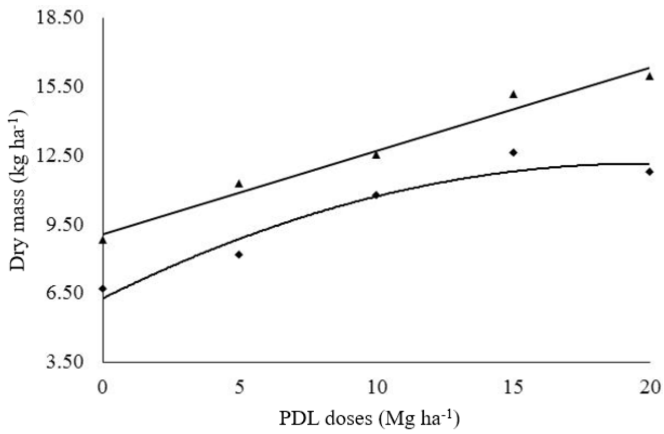
In the third and fourth cuts, there were increments of 34.89 and 110.36%, respectively, in organic fertilization with 20 Mg ha^{-1} compared to the treatment that did not receive any fertilization, and for fertilization associated with 20 Mg ha^{-1} of PDL and mineral fertilization the increments in comparison to the treatment that received only mineral fertilization were 68.40 and 80.18%, respectively. The treatment with associated fertilization in the third cutting promoted 3058.60 kg ha^{-1} more DM production than the dose of 20 Mg ha^{-1} of organic fertilization and, the fourth cutting, led to 558.00 kg ha^{-1} more in comparison to the dose of 20 Mg ha^{-1} of organic fertilization.

According to Araújo et al. (2008), the highest values of DM production observed for treatments produced from animal residues can be explained because manures promoted better chemical conditions in the soil, providing nutrients for a more efficient absorption by the root system, and virtually the essential nutrients are in their mineralized form.

Barnabé et al. (2007), evaluating the fertigation of *Brachiaria brizantha* cv. Marandu with liquid swine manure, observed that the application of 150 m^3 ha^{-1} (highest dose) led to the highest productivity, as in the present study. Data found in the study conducted by Orrico Junior et al. (2012), using biofertilizer from cattle and pig manure for Piatã grass fertilization, also indicated better results with the highest doses of biofertilizer, up to the N dose of 300 kg ha^{-1}.

In an overall analysis comparing the fertilizations in the sum of the cuttings, it can be observed that the best results were obtained with the doses of pig deep-litter (PDL) plus mineral fertilization (MF) (Figure 3).

For treatments that received only PDL in the sum of the four cuttings, there was a quadratic behavior, reaching a maximum point with PDL dose of 19.72 Mg ha^{-1}, producing 12.14 Mg ha^{-1} of DM. The associated fertilization of PDL plus mineral fertilization with NPK led to a 80.55% increase compared to the control, producing 16.34 Mg ha^{-1} of DM in comparison to the treatment that received only mineral fertilization.



** Significant at $p \leq 0.01$ by F test

Figure 3. Total dry mass productivity of Mombasa grass as a function of the doses of pig deep-litter (PDL), with and without mineral fertilization (MF), referring to the average of the four cuttings

Mazza et al. (2009), studying nitrogen fertilization in the productivity and chemical composition of Mombasa grass, observed that nitrogen fertilization increased up to 30 times the dry mass production in comparison to the control (without nitrogen fertilization) in the treatment with highest dose (510 kg of N ha^{-1}).

According to Lopes et al. (2013), the behavior shown by the forage production confirms the importance of nitrogen for biomass increment in intensively managed forages. For the PDL dose of 20 Mg ha^{-1} associated with mineral fertilization, 321 kg ha^{-1} of N were applied, of which 161 kg ha^{-1} were through PDL and 160 kg ha^{-1} at planting and as topdressing using urea as source.

Therefore, the obtained results (Figure 3) are consistent with Araújo et al. (2011), who highlighted that the use of manure as the only source of N is insufficient for the plant to express its full genetic potential, since there is no amount of N readily available.

However, as the fits were linear it means that the PDL doses applied were not sufficient for the forage to reach its maximum production potential in the four cuttings evaluated.

The highest crude protein (CP) contents were obtained using PDL doses of 15 and 20 Mg ha^{-1} plus mineral fertilization, and the CP contents were above 9% (Table 2). For each dose, with MF, CP was statistically higher, due to the higher doses of N, since the higher the dose of PDL, the larger the amount of N available. According to Freitas et al. (2007), this probably occurred because of the greater presence of free amino acids, which maintain N in their structure, and small peptides in plant tissue in response to the higher N supply in the soil.

Marques et al. (2016), studying times of N application in Massai grass in greenhouse, found a linear increase in the average crude protein content with the increase in N doses.

Similar results were found by Barnabé et al. (2007), who evaluated *Brachiaria brizantha* cv. Marandu fertilized with liquid swine manure and observed higher contents, using

Table 2. Crude protein (CP, %) of *Panicum maximum* cv. Mombasa, as a function of mineral fertilization (MF) for different dose of pig deep-litter (PDL)

PDL ($Mg\ ha^{-1}$)	1st cutting		2nd cutting		3rd cutting		4th cutting	
	Without MF	With MF	Without MF	With MF	Without MF	With MF	Without MF	With MF
	CP (%)							
0	6.07 b	7.54 a	6.08 b	7.51 a	5.86 b	7.81 a	6.02 b	7.80 a
5	6.34 b	8.50 a	6.34 b	8.53 a	6.21 b	8.06 a	6.70 b	7.96 a
10	7.06 b	9.19 a	7.06 b	9.19 a	7.30 b	8.23 a	7.35 b	9.05 a
15	8.82 b	9.97 a	8.98 b	9.96 a	7.85 b	8.63 a	7.81 b	9.32 a
20	8.88 b	10.21 a	9.19 b	10.24 a	8.08 b	9.08 a	8.44 b	9.64 a
CV (%)	2.06		1.32		1.03		1.99	

Means followed by the same letter in the row for each cutting do not differ at $p \leq 0.05$ by Scott-Knott test; CV - Coefficient of variation

the doses of 100 and 150 $m^3\ ha^{-1}$ of manure and chemical fertilization.

According to Soest (1994), when the CP contents of forage crops are less than 7%, there is a reduction in their digestion due to inadequate N contents for rumen microorganisms, decreasing their population and, consequently, reducing digestibility and dry mass intake. Thus, higher CP content is necessary to meet the protein requirements of the animal organism. Based on the statement, it can be seen that Mombasa grass would satisfactorily meet the minimum requirements of ruminants with PDL doses plus mineral fertilization.

Regarding the regression evaluation for the interaction between mineral fertilization and pig deep-litter, there was a linear behavior, showing that with increase in PDL doses, there is also an increment in crude protein contents (Figures 4A and B).

Simonetti et al. (2016), analyzing the productivity of Mombasa grass under different doses of biofertilizers, found that the highest doses of biofertilizer (200 $m^3\ ha^{-1}$) led to differences between the other treatments, evidencing its influence on forage quality for protein content.

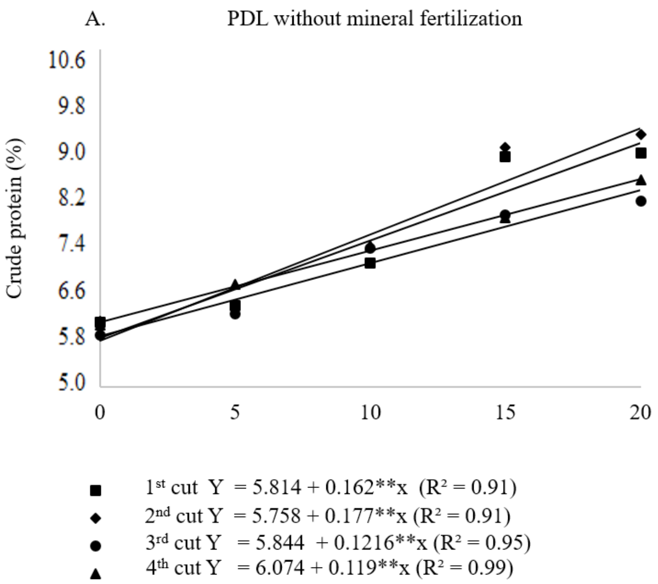
According to Barnabé et al. (2007), nitrogen fertilization through the supply of N readily available to plants has shown significant influence on several quantitative and qualitative variables inherent to pasture management. Generally, nitrogen is absorbed by the plant and joins the carbon chains to form the amino acids, increasing the CP content of the forages.

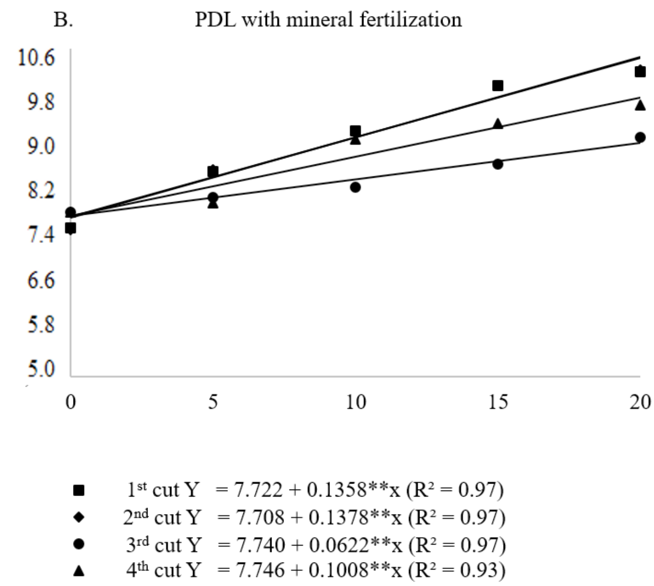
The NDF contents in the first cutting ranged from 69.9 to 74.26%, and in the associated fertilization with PDL plus mineral fertilization, NDF values were always higher than those found under PDL without mineral fertilization (Table 3).

In the second cutting, the NDF contents ranged from 66.01 to 75.97% and were higher without MF at the PDL doses from 0 to 10 $Mg\ ha^{-1}$ (Table 3). In the third cutting, the values varied from 64.75 to 73.75%, and PDL led to lower values of NDF compared to PDL + MF. In the fourth cutting, the values were between 71.85 and 76.33%, and at all doses there were lower values for NDF without mineral fertilization.

NDF indicates the total amount of fiber within the bulkage, which relates it to consumption. Thus, the lower the content of NDF, the higher the dry mass intake. NDF contents vary according to plant species and vegetative stage. NDF measures all the fiber or volume component (bulkage) - hemicellulose, cellulose and lignin, being useful to estimate voluntary consumption (Rodrigues, 2010).

Food NDF content represents the fraction of non-soluble fiber in neutral detergent and can be used by technicians and producers of ruminant animals for balancing diets with adequate dietary fiber contents (Simonetti et al., 2016). In general, both the quality and quantity of dietary fiber present





** Significant at $p \leq 0.01$ by F test

Figure 4. Crude protein (CP) contents of Mombasa grass as a function of pig deep-litter doses without (A) and with (B) mineral fertilization (MF), referring to the averages of the four cuts

Table 3. Contents of neutral detergent fiber (NDF %) and acid detergent fiber (ADF %) of *Panicum maximum* cv. Mombasa, as a function of fertilization with pig deep-litter, with or without mineral fertilization (MF)

PDL (Mg ha^{-1})	1st cutting		2nd cutting		3rd cutting		4th cutting	
	Without MF	With MF	Without MF	With MF	Without MF	With MF	Without MF	With MF
				NDF (%)				
0	72.60b	74.26a	75.97a	72.22b	67.28b	73.75a	74.77b	76.33a
5	72.12b	73.06a	74.62a	71.26b	66.26b	72.90a	73.96b	76.03a
10	71.32b	72.69a	73.49a	70.85b	65.97b	71.41a	73.06b	75.80a
15	70.83b	71.75a	67.97a	68.11a	64.95b	70.19a	72.71b	74.34a
20	69.90b	70.55a	66.60a	66.01a	64.75b	68.83a	71.85b	73.95a
CV (%)	0.88		0.95		0.84		0.85	
				ADF (%)				
0	43.52a	41.12b	44.08a	40.09b	39.67a	35.97b	53.22a	43.77b
5	42.48a	40.76b	43.22a	41.15b	38.16a	35.91b	52.79a	42.70b
10	41.87a	39.80b	42.75a	42.45a	36.76a	34.83b	51.06a	41.95b
15	41.25a	39.08b	41.86b	43.95a	35.83a	32.85b	49.31a	41.75b
20	40.47a	38.47b	40.27b	44.94a	33.72a	31.11b	49.10a	39.92b
CV (%)	1.55		1.21		1.92		1.28	

Means followed by the same letter in the row for each cutting do not differ at $p \leq 0.05$ by Scott-Knott test; CV - Coefficient of variation

in forage plants are key variables that can influence the DM intake by animals.

In studies with different grazing heights, Rego et al. (2003) found NDF values from 58 to 72% for leaves and from 77 to 83% for stems. Euclides (1995), studying several cultivars of *Panicum maximum*, concluded that NDF contents lower than 55% are rare, higher than 65% are common in new tissues and contents between 75 and 80% are found in materials of advanced maturity. These results are in line with the observed in this study, in which the fourth cutting showed higher values of NDF, since the material was in an advanced state of maturity and with scarcity of rain.

The average levels of acid detergent fiber (ADF) ranged from 43.52 to 38.47%, and at all doses lower values were found without mineral fertilization. (Table 3). In second cutting, the contents ranged from 40.27 to 44.94%. Without mineral fertilization, the ADF contents were higher at the PDL doses 0 and 5 Mg ha^{-1} and lower at the PDL doses of 15 and 20 Mg ha^{-1}. In third cutting, the values ranged from 31.11 to 39.67%, and at all doses the ADF contents were lower without mineral fertilization. In the fourth cutting, the values ranged from 53.22 to 39.92%, and continued with lower values at all doses of PDL without MF (Table 3). These results are higher than those reported by Medeiros et al. (2007), who found mean values of 28.80% when evaluating *Brachiaria brizantha* cv. Marandu fertigated with liquid swine manure.

ADF indicates digestibility, that is, the amount of fiber that is not digestible since it contains the highest proportion of lignin, an indigestible fraction of fiber. ADF is an indicator of energy value: the lower the ADF, the higher the energy value. ADF measures the most indigestible components, cellulose and lignin (Rodrigues, 2010).

Freitas et al. (2007) found the lowest contents of NDF (66.09%) and ADF (32.15%) in the grass subjected to fertilization with 150 m^3 ha^{-1} year^{-1} of liquid swine manures, hence suggesting that the highest doses of biofertilizers can improve the bromatological conditions of the grass.

Conclusion

Applications of pig deep-litter up to the dose of 20 Mg ha^{-1} associated with mineral fertilization promoted higher dry mass productivity, increasing the contents of crude protein (CP) and decreasing the contents of neutral detergent fiber (NDF) and acid detergent fiber (ADF).

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