Fertilization of Tifton 85 with Swine Liquid Manure

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Abstract

The objective was to verify the possibility of supplying the nutritional requirement of Tifton 85 grass with swine liquid manure in an intensive management system. The experiment was carried out in a randomized block design, with four treatments of swine liquid manure doses: 0, 70, 140 and 210 $m^3 \cdot ha^{-1}$, divided into seven applications and a treatment of mineral fertilization of 200 kg of nitrogen $ha^{-1} \cdot year^{-1}$. Samples of the collected plant material were weighed to obtain fresh mass taken for drying and then ground for bromatological determination. The dry mass production data were obtained by dry matter accumulation during the cuts and averages were made for the variables; plant height, crude protein, NDF, ADF, neutral detergent insoluble protein (NDIP) and acid detergent insoluble protein (ADIP). The data were subjected to variance analysis, performing regression for swine liquid manure doses and averages test (Dunnett test) to compare the doses with the mineral fertilization. Higher plant heights, dry mass production, crude protein content, neutral detergent insoluble protein content and lower neutral detergent fiber content in Tifton 85 grass were observed with mineral fertilization. In the variables, acid detergent fiber and acid detergent insoluble protein there was no difference (P = 0.05) between the mineral fertilization and the swine liquid manure doses. There was a linear increase (P = 0.05) of swine liquid manure doses only in dry matter production. Swine liquid manure doses up to 210 $m^3 \cdot ha^{-1} \cdot year^{-1}$ do not meet the entire nutritional requirement of Tifton 85 grass, recommending the evaluation of higher swine liquid manure doses or complementation with mineral fertilization.

Keywords

Bromatology, *Cynodon* spp., Organic Fertilization, Waste Reuse

1. Introduction

Swine farming is considered a potentially polluting activity due to the waste production generated, which consist of animals feces, leftover ration, urine, excess water from drinkers and water used in the hygiene of the stalls [1].

Therefore there is great concern in making the rational disposal of these residues in the environment, so that there is no compromise of soil, plants and water resources [2]. One of the causes of pasture degradation is the fertilization absence, the use of swine liquid manure as a source of nutrients is an alternative to be used [3] [4].

The swine liquid manure contains in its composition, organic matter, nitrogen, phosphorus, potassium, calcium, sodium, magnesium, manganese, iron, zinc and copper [5] [6]. Typically, it contains from 70% to 80% of total N as ammonium, which is an available form of N for plants [7].

The application of swine liquid manure increases the supply of N [8] and P [6] to soil, in order to promote plant growth and enhance the leaf/stem ratio [1].

Therefore, fertilization with swine liquid manure may be a viable option [9] [10] [11] [12] in case the soil adsorption capacity and the need for crops are respected [13] mainly among tropical grasses cultivated with high yield, such as *Cynodon* spp. cv. Tifton 85.

It is verified that there is variability in the recommendation, in studies by [14] [15], on the effect of fertilization of Tifton 85 grass, whose values ranged from 200 to 500 $m^3 \cdot ha^{-1} \cdot year^{-1}$ of swine liquid manure, respectively.

Faced with this variability, the objective of this study was to evaluate whether or not the swine liquid manure replaces the mineral fertilization of Tifton 85 grass in an intensive system.

2. Material and Methods

2.1. Description of the Study Area

The experiment was carried out at the Experimental station of the Rio Verde Foundation (13˚00'02"S and 55˚58'15"O), located in Lucas do Rio Verde municipality, Mato Grosso state. The soil of the region is classified as Oxisol, according to the classification of [16].

The region climate, according to the Köppen classification, is of the type Aw, tropical rainy, hot and humid, with a prolonged dry season and wet season of seven months, between October and April (**Figure 1**).

The swine liquid manure used came from the swine sector of the Federal Institute of Mato Grosso, Campus São Vicente-MT, coming from a stabilization pond.

2.2. Treatments and Experimental Design

The experimental design was randomized blocks with five treatments. The treatments consisted of four doses of swine liquid manure (0, 70, 140 and 210 $m^3 \cdot ha^{-1}$

per cut) and a mineral fertilization to meet 100% of the culture requirement, adopting the doses of 200, 70 and 400 kg·ha^{-1} of nitrogen, phosphorus and potassium, respectively, in two production cycles. Four blocks were delineated in plowed and meshed area, with five plots of 55 m^2 (11.0 × 5.0 m) in each block, separated by plots and between blocks of 1 m.

The first cycle corresponded to months March, April and May of 2014; The second cycle: October 2014 to January 2015. The swine liquid manure doses applied were seven cuts of 0, 10, 20, 30 m^3·ha^{-1}·year^{-1}. The experimental area was occupied in the previous crop with soybean crop, which left residue for the subsequent crop.

The swine liquid manure was manually applied with 10 litre capacity-watering rooms, in the volumes recommended for each treatment shortly after the cuts. To avoid possible contamination of the plots, by surface runoff, was placed on the sides of each portion PVC plates forming a protection barrier due to a soil slope.

Soil samples were collected in two depths (0 to 10 and 10 to 20 cm) for the determination of the chemical analysis (**Table 1**) according to methodologies recommended by authors [17].

The swine liquid manure was stored in open ponds, being under the incidence and variation of the rains (**Figure 1**), which may have caused some dilution, this way, a sample was collected monthly to analyze its chemical composition. The sample was refrigerated and stored for macronutrient analysis. The average

Table 1. Soil fertility chemical analysis of the experimental area at different depths from 0 to 10 and 10 to 20 cm.

Depth	pH	Al	H + Al	Ca	Mg	$T_{pH7,0}$	V	M	OM	K	P
(cm)	($CaCl_2$)		($cmol_c \cdot dm^{-3}$)				(%)			($mg \cdot dm^{-3}$)	
0-10	4.91	0.24	17.60	2.32	2.24	22.17	20.61	4.98	5.56	4.07	21.8
10-20	4.70	0.40	14.10	1.30	1.30	16.71	15.61	13.28	5.27	2.79	3.70

pH—acidity; OM—organic matter; P—phosphorus; K—potassium; Ca—calcium; Mg—magnesium; H + Al—Hydrogen plus aluminum; T—cationic exchange capacity; V—base saturation.

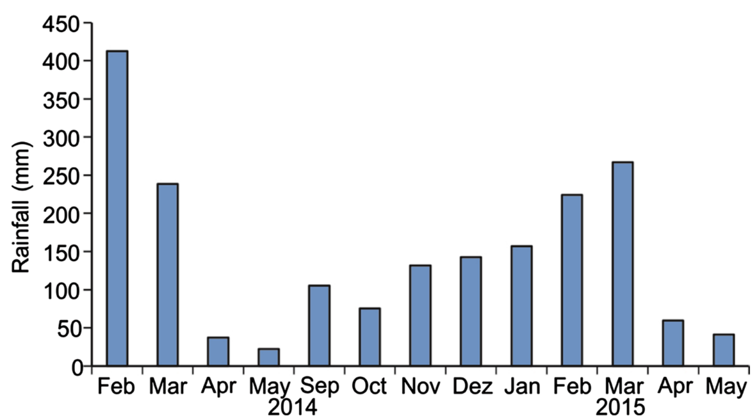

Figure 1. Rainfall in the experimental period at Fundação Rio Verde (Lucas do Rio Verde).

chemical composition of the swine liquid manure consisted of: Total N: 3500 $mg \cdot L^{-1}$; P: 1617.66 $mg \cdot L^{-1}$; K: 461.34 $mg \cdot L^{-1}$; Ca: 2994.8 $mg \cdot L^{-1}$; Mg: 1084 $mg \cdot L^{-1}$; S: 1179 $mg \cdot L^{-1}$. With the nitrogen content, the volume of swine liquid manure to be applied in each cut was calculated.

The planting of Tifton 85 grass seedlings was carried out in January 2014, after 30 days, a uniformity cut at 15 cm of residue height was performed. In March 2014, the first measurements of the plant height were performed at 10 sites per plot, and three forage samples were collected from each plot at the residue height (15 cm) using a square of 0.5×0.5 m.

2.3. Soil Sampling, Preparation and Analysis

Samples of the collected plant material were weighed to obtain fresh mass and packaged in paper bags, duly identified and taken for drying in air circulation incubator, at temperature of 60˚C to constant weight. The dry material was then grinded into a Willey mill and properly stored with identification for further determination of the bromatological composition.

The N content was determined by the Kjeldahl method as the authors [18]. For the determination of the fibrous fraction, the methods described by the author [19], which divides the sample components into neutral detergent insoluble fiber (NDF) and acid detergent insoluble fiber (ADF).

The dry mass production data were obtained by dry matter accumulation during the cuts and averages were made for the variables; plant height, crude protein, NDF, ADF, neutral detergent insoluble protein (NDIP) and acid detergent insoluble protein (ADIP).

2.4. Statistical Analysis

The data were subjected to variance analysis, performing regression for swine liquid manure doses and averages test (Dunnett test) to compare the doses with the mineral fertilization.

3. Results and Discussion

When comparing the mineral fertilization with swine liquid manure doses by Dunnett means test ($P = 0.05$), higher plant height, dry mass production, crude protein content, NDIP content and lower NDF content in Tifton 85 grass were observed in mineral fertilization (**Figure 2**). For the ADF and ADIP variables there was no significant difference between the swine liquid manure doses and mineral fertilization (**Table 2**).

The mineral fertilization complied with the requirements of Tifton 85 grass, providing higher plant height (55.27 cm) and higher dry mass production (30.52 $kg \cdot ha^{-1}$) (**Figure 2**). The levels of NPK, in the swine liquid manure volume, were not sufficient to meet the nutrient requirement, because Tifton 85 grass is highly demanding in relation to fertility and inadequate supply can cause the reduction of forage production, nutritive value and nutrient concentrations [20].

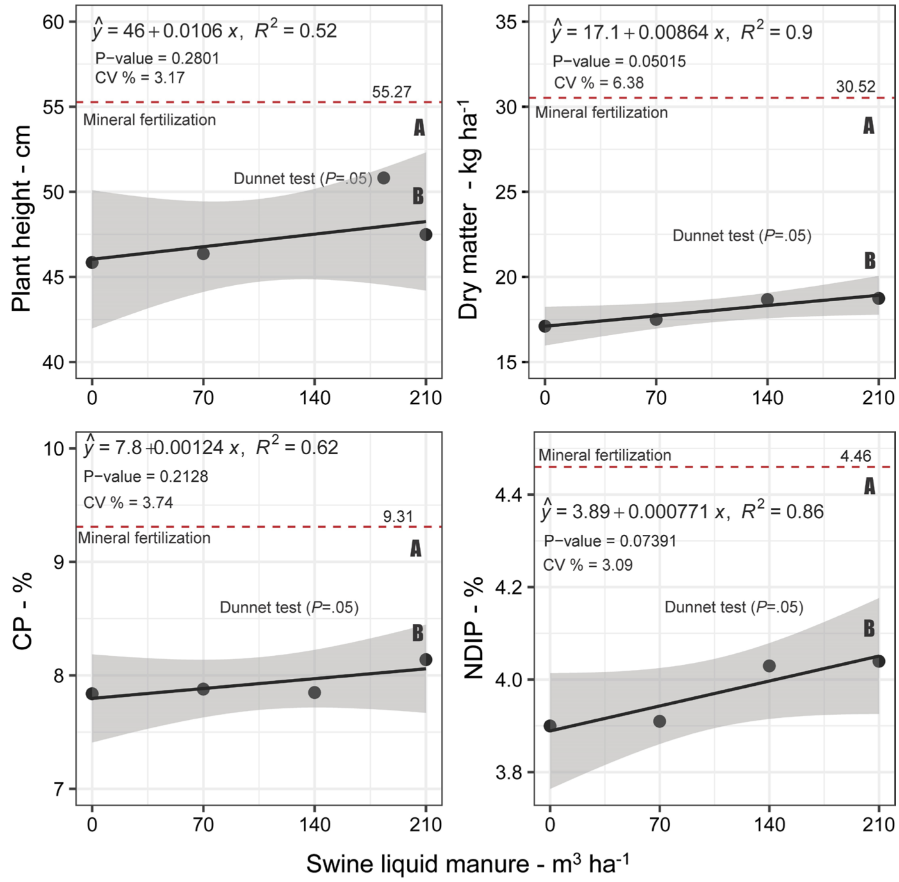

Figure 2. Production and bromatological composition of Tifton 85 grass fertilizing with different swine liquid manure doses and mineral fertilization in two production cycles. Red dashed line-mineral fertilization with 200, 70 and 400 kg·ha^{-1} of nitrogen, phosphorus and potassium, respectively. Means followed by the same letter do not differ from each other by the Dunnet test ($P < 0.05$). CP (%)—Crude protein; NDIP (%)—Neutral detergent insoluble protein.

The lowest crude protein content in the swine liquid manure doses compared to mineral fertilization (**Figure 2**) may be related to variations in the nutrient concentration of the slurry, since the doses were fixed in volumes. However, in the highest swine liquid manure dose the crude protein content was above 8%, considered the minimum percentage sufficient for an adequate microbial ruminants activity [21].

Only in the mineral fertilization, the NDF contents (**Table 2**) were close to those that the author [19] established, that is, that lower or equal levels of 65%, do not impair the forage intake by the animals and guarantee the ruminal microorganisms greater utilization of the dietary nutrients consumed by the animal, providing better performance. The highest NDF levels (67.17% to 67.90%) is a particularity presented in Tifton Grass 85 [22] [23].

However the authors [24] cite that even this forage with values greater than 65% is possible to have good digestibility, because the cellular compounds have fewer ester-type bonds involving ferulic acid, a compound phenolic digestibility

Table 2. Production and bromatological composition of Tifton 85 grass fertilizing with swine liquid manure doses and mineral fertilization in two production cycles.

Variables	Swine liquid manure doses ($m^3 \cdot ha^{-1}$)				Mineral fertilizer*	CV (%)
	0	70	140	210		
NDF (%)	67.41^b	67.17^b	67.90^b	67.76^b	65.76^a	0.86
ADF (%)	33.93^a	33.71^a	33.86^a	34.01^a	33.86^a	1.05
ADIP (%)	0.78^a	0.75^a	0.83^a	0.75^a	0.78^a	8.06

NDF (%)—Neutral detergent insoluble fiber; ADF (%)—Acid detergent insoluble fiber; ADIP (%)—Acid detergent insoluble protein; *Mineral fertilizer—200, 70 and 400 $kg \cdot ha^{-1}$ of nitrogen, phosphorus and potassium, respectively. Medium followed by the same letter in line do not differ by Dunnett test.

inhibitor. The highest levels of NDF are related to higher plant height observed.

There was no significant difference between the levels of acid detergent fiber (ADF) between the swine liquid manure doses and mineral fertilization (**Table 2**). The ADF contents are within the ideal range, as fodder with levels around 30% of ADF or less are more digestible [18].

The contents of PIDN were close to those observed by the authors [25] at 28 days of interval between the cuttings for the production of Tifton 85 grass (**Figure 2**). While the ADIP levels were lower than those observed by the same author (**Table 2**). The results show the need for studies with higher doses of swine liquid manure for Tifton 85 grass, considering the values obtained are below the values observed in the mineral fertilization.

For the swine liquid manure doses, there was a significant effect on the dry matter production variable (**Figure 2**). There was an increasing linear effect ($P > 0.05$) of the mineral fertilizer dose on dry matter production (**Figure 2**). Similar results were verified by authors [26] [27] in the dry mass production of pasture, in which they verified the linear growth according to the swine liquid manure doses.

According to authors [7] swine waste doses (500 $kg \cdot ha^{-1} \cdot year^{-1}$) that did not reach the plateau of dry matter production, it allows, according to the authors, quadruplicate the daily dose of forage production, without the reduction in agronomic efficiency.

The estimated dry matter production was 18.928.25 $kg \cdot ha^{-1} \cdot year^{-1}$, obtained with the application of 210 $m^3 \cdot ha^{-1} \cdot year^{-1}$ of swine liquid manure, with an increment of 9.60%, when compared to the treatment without swine liquid manure.

Close results were obtained by authors [27] who worked with four swine liquid manure treated doses and, with and without irrigation, obtaining an estimated yield of 19.535.5 kg DM $ha^{-1} \cdot year^{-1}$ at the dose of 210 $m^3 \cdot ha^{-1}$ of swine liquid manure, when in the presence of irrigation. However, this value may vary according to the stocking rate used, justing the magnitude of response to nitrogen fertilization in the different cuts [8].

4. Conclusions

The application of swine liquid manure has its use justified by the increase in dry mass production of Tifton 85 grass. There was a significant increase with the use of the manure in relation to its non-use.

Swine liquid manure doses up to 210 $m^3 \cdot ha^{-1}$ do not supply the entire nutritional requirement of Tifton 85 grass, recommending the evaluation of higher swine liquid manure doses.

Due to the increasing linear effect in the dry matter production, the maximum dose used in the present experiment may be increased, but there is a need for studies on environmental impacts.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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