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Response of two Brachiaria species to swine manure application rates: effect on biomass yield, nutritive quality and acceptability by WAD sheep

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Abstract

Rising inorganic fertilizer prices have led to *return to the use of organic nutrient sources to reduce cost and improve pasture productivity. The present study determined the* response of *Brachiaria ruziziensis* and *Brachiaria mulato* II to swine manure application rates: effect on biomass yield, nutritive quality and acceptability by WAD sheep. *The experiment was a 3 × 2 factorial arrangement laid out as a split-plot design with three* swine manure application rates (0, 5, 10 t ha^{-1}) as the main plot and two Brachiaria species (*B. ruziziensis and B. mulato* II) as the sub-plot *replicated three times. Growth parameters were determined at 2, 4, 6 and 8 weeks after sowing, while dry matter yield was determined at 8 weeks after sowing. Chemical composition and in vitro gas production of the harvested grass samples were conducted and the acceptability of the forage material by WAD sheep was also determined. Results showed that B. ruziziensis* was morphologically taller than *B. mulato* II at all weeks of growth. The heights of the plants significantly ($P < 0.05$) increased with increasing manure application rate at all weeks of growth. A significantly ($P < 0.05$) higher dry matter yield was recorded for *B. ruziziensis* than in *B. mulato* (6.24 vs. 4.16 t ha^{-1}). Dry matter yield of the plants increased as the rate of manure application increased. The crude protein content of both grasses increased significantly (P<0.05) as the level of manure inclusion increased. The *highest significant (P<0.05) (14.00* ml/200mg DM*) gas volume produced was recorded for B. ruziziensis fertilized with 10* t ha^{-1} *of manure while the least gas volume (7.50* ml/200mg DM) was recorded for *B. mulato* unfertilized at 24 hours of incubation. *Brachiaria ruziziensis* fertilized with 5 t ha^{-1} of swine manure was most preferred by the sheep. *In conclusion, herbage yield increased as the swine manure application rate increased, also chemical composition and acceptability by sheep was higher in B. ruzuziensis than with B. mulato II.*

Keywords: Acceptability, Brachiaria species, chemical composition, dry matter yield, swine manure

Introduction

Ruminants production has been faced with the limitation of high quality and quantity forage due to prolonged annual dry season that negatively affects plant's performance. In order to mitigate poor ruminant nutrition problems, Olanite (2002) and Ojo *et al.* (2015a) suggested that the use of sown and purposely managed pastures could help raise ruminant productivity. *Brachiaria species* are low-growing decumbent perennial grasses with an aggressive growth habit that provides a dense ground cover able to suppress weeds; however, as with most tropical grasses, they are characterized by low productivity and can benefit from manure sources to improve their productivity (Ojo *et al*., 2015b). The utilization of manure, beyond improving the physico-chemical properties of generally nutrient deficient tropical soils, also has economical advantages as it serves to reduce the cost of synthetic fertilizers (Van Wieringen *et al.,* 2005).

The nutritive value of these Brachiaria species, compositional changes that occurs in the plant as a result of different manure fertilizer rates, their acceptability by ruminants and subsequently, their digestibility using *in vitro* techniques need to be reassessed, to evaluate and revalidate the nutritive value and improvement potential of these forage grasses (Babayemi *et al*., 2006). The objective of this study was to evaluate the growth, yield and nutritive quality of *Brachiaria ruziziensis* and *Brachiaria mulato II* as affected by swine manure application rates and their acceptability by West African dwarf sheep.

Materials and methods

This study was carried out at the Federal University of Agriculture, Abeokuta, Nigeria on latitude 7^0 13 49.46 N and longitude $3^0$26 11.98 E.

The experimental land area was ploughed twice and allowed to rest for a period of two weeks before harrowing. A plot measuring 510 m^2 was mapped out after harrowing. Prior to sowing, soil samples were randomly collected from the plots at the depth of 0 - 15 cm to determine the physico-chemical properties of the soil. Analysis of the soil from the site indicated that it was sandy silt with pH of 6.75; organic carbon 1.27 %, available phosphorus 30.40 mg kg^{-1}, potassium 0.79 cmol/kg, calcium 3.36 cmol/kg, magnesium 2.42 cmol/kg, sodium 1.51 cmol/kg and total nitrogen 0.11%.

Swine manure was collected from the piggery unit of the Directorate of University Farms situated within the University premises and chemical analysis of the manure indicated that it contained calcium (4.76 %), magnesium (2.40 %), potassium (1.92 %), sodium (2.07 %), nitrogen (0.34 %) and phosphorus (12070 mg kg^{-1}). The manure was applied at three levels i.e. 0 t ha^{-1} which represents the control plot, 5 t ha^{-1} and 10 t ha^{-1}. Application was done by manually raking them into the soil of individual plots according to treatment in a single application. The plots were allowed a period of two weeks for mineralization of the manure, which was followed by weeding to keep the plots weed free as much as possible before sowing the grass. Seeds of the grasses sourced from the National Animal Production Research Institute, were drilled in rows at a spacing of 1.0 m intervals with a seed rate of 20 kg ha^{-1} in August 2017. The inter-plot and intra-plot spaces were kept weed-free as much as possible throughout the experimental period by manual weeding. Growth data on the grasses - plant height, number of leaves and number of tillers - were recorded at 2, 4, 6 and 8 weeks after sowing of the grasses following procedures as described by Ojo *et al.* (2014). After collection of growth data at eight weeks, fresh biomass yield of the grasses were recorded by harvesting the grass material on each plot at 10 cm above ground level. Subsequently, sub samples weighing 500 g of each of the harvested grasses were collected, oven dried at 65 ^oC until a constant weight was attained, and used to calculate the dry matter percentage. Dry matter yield was calculated as the percentage of dry matter multiplied by the fresh weight harvested from each plot, and extrapolated to tonnes/ha. After dry matter yield estimation, the dried grass samples were milled using a hammer mill, and allowed to pass through a 1 mm sieve screen for chemical analysis. The dry matter, crude protein, ether extract and Ash contents were determined following standard procedures as described by AOAC (2000), while the NDF, ADF and ADL contents were determined following the procedure described by Van Soest *et al*. (1991); hemicellulose was taken as the difference between NDF and ADF, while cellulose was taken as the difference between ADF and ADL. The *in vitro* gas production was determined following the procedure of

Menke and Steingass (1988) by using 100 ml glass syringes fitted with plungers for 24-hour with 200 mg of each samples replicated six times. Following the termination of the 24 hours *in vitro* gas volume readings, organic matter digestibility and metabolizable energy were calculated using the equations as described by Menke and Steingass (1988), while short-chain fatty acids was calculated according to Getachew *et al*. (2000).

After the chemical analysis were conducted, Eighteen *West African dwarf rams with age ranging from 12 - 13 months, and weight ranging from 10 – 15 kg were used for the study. There were six treatment groups of three animals each which were* tagged for easy identification*. The animals were dewormed and dipped to destroy both internal and external parasites before the experiment. The pens were disinfected before being used.* Grasses were harvested from the experimental site and a known grass weight of approximately 1 kg was randomly offered to the animals in the feeding troughs. The *grasses were* introduced on cafeteria basis to the animals in eight different feeding troughs with two troughs being empty to avoid border bias, this allowed the animals' free access to each of the diets in the trough. The positioning of the grasses were rotated daily to prevent bias by the animals taking a particular part of the pen as the position for a particular type of forage. Grasses were offered before the animals were allowed to graze or offered any feed for the day. The feeding troughs were withdrawn after 30 minutes and the left-over were weighed and recorded to determine the intake per 30 minutes. This was repeated for five consecutive days. The grasses were offered at 08.00hr and withdrawn by 08.30hr. The preference for the grasses was calculated as the percentage of the grass consumed with relative to grass offered for five days.

$$\% \text{ Consumption} = \frac{\text{Grass offered} - \text{Grass remnant}}{\text{Grass offered}} \times 100$$

Experimental design and statistical analysis

The experiment was a laid out as a 3 × 2 factorial arrangement laid out in a split plot design comprising of 3 levels of swine manure application rate (0, 5 and 10 t ha^{-1}) as the main plot and two Brachiaria species (*B. ruziziensis* and *B. mulato* II) as the sub-plot. Blocking was used to account variations in the soil. Each treatment was replicated three times, and each block served as a replicate. All data obtained were analysed as a two-way analysis of variance using the SPSS 20 statistical package.

Results and discussion

There were significant ($P < 0.05$) morphological differences in the height of the grass species with the different rate of manure application at all weeks (Table 1). *Brachiaria ruziziensis* with or without manure application was morphologically taller than *B. mulato* II at all weeks of growth. The heights of the plants significantly ($P < 0.05$) increased as the rate of manure applied increased at all weeks of growth. Similarly, there was a significant ($P < 0.05$) exponential increase in the number of leaves and number of tillers produced by the plants as the rate of manure applied increased at all weeks of growth for both plants.

The morphological differences observed on the evaluated grasses - *B. ruziziensis* and *B. mulato* II in the present study, might be due to the genetic factors of the genera (Hani *et al*., 2006). The reason for the progressive increase in the heights of the plants as the rate of manure applied increased, could be due to a higher amount of available nutrients from higher rate of manure application. Sahoo and Panda (2001) and Amanullah *et al*. (2009) also observed that plants were taller when higher rates of organic fertilizer were applied compared to those left unfertilized. The narrative could also explain the increase in the number of leaves recorded for both grasses as the rate of manure applied increased. The higher number of leaves recorded in the present study as the rate of manure applied serves the advantage for increasing the plant's ability to trap sunlight for photosynthesis which increases the competitive ability of the plant for sunlight resources, and is usually also indicative of better quality and the likelihood of a higher intake (Omaliko, 1980). The exponential increase in the number of tillers produced by grasses as the rate of manure applied increased agrees with reports of Ramivez Ariles (1993) that fertilization boost tiller production in grasses.

Table 1: Effects of manure application rates on the growth characteristics of two Brachiaria species

		Weeks after planting			
		2	4	6	8
Species	**Manure (t ha^{-1})**	**Plant height (cm)**			
B. mulato II	0	17.67^{c}	29.34^{d}	40.91^{d}	52.04^{d}
	5	23.23^{c}	35.01^{d}	46.34^{d}	57.75^{d}
	10	32.50^{abc}	44.29^{cd}	56.00^{cd}	67.17^{cd}
B. ruziziensis	0	30.50^{bc}	55.87^{bc}	67.27^{bc}	78.45^{bc}
	5	43.47^{ab}	64.33^{ab}	75.75^{ab}	86.86^{ab}
	10	49.50^{a}	72.53^{a}	84.28^{a}	95.33^{a}
SEM		4.88	6.97	6.95	6.94
		Number of leaves			
B. mulato II	0	3.50^{b}	3.95^{b}	5.90^{b}	7.86^{b}
	5	4.67^{a}	4.87^{ab}	6.70^{ab}	8.65^{ab}
	10	5.00^{a}	7.33^{a}	9.34^{a}	11.46^{a}
B. ruziziensis	0	5.00^{a}	5.00^{ab}	6.98^{ab}	8.82^{ab}
	5	4.00^{ab}	4.33^{b}	6.27^{b}	8.35^{b}
	10	4.33^{ab}	5.33^{ab}	7.14^{ab}	9.21^{ab}
SEM		0.21	0.66	0.73	0.74
		Number of tillers			
B. mulato II	0	4.67^{cd}	7.81^{c}	11.67^{b}	14.92^{c}
	5	7.00^{c}	7.67^{c}	11.50^{b}	15.51^{c}
	10	18.00^{a}	19.78^{a}	18.59^{ab}	23.04^{ab}
B. ruziziensis	0	8.67^{c}	10.67^{ab}	12.39^{b}	16.06^{c}
	5	11.00^{bc}	14.00^{ab}	14.92^{b}	19.34^{bc}
	10	12.00^{ab}	15.33^{ab}	23.30^{a}	27.27^{a}
SEM		2.92	1.90	1.96	1.86

^{ab}: means on the same column with different superscript differ significantly (P < 0.05); SEM: Standard error of mean

Plants that received 10 t ha^{-1} of manure produced the highest dry matter yield, although *B. ruziziensis* fertilized with 10 t ha^{-1} of manure had a significantly ($P < 0.05$) higher yield (6.24 ha^{-1}) than *B. mulato* II (4.16 ha^{-1}) fertilized at the same rate (Table 2). The resulting higher yield recorded in the present study at higher manure rates had been reported in earlier studies by Olanite (2002) and Ojo *et al*. (2015b). The present observation might be the results of better root development from increased nutrient levels because of the higher manure rates which may have provided a better habitat for the activity of beneficial soil and plant microbes that might have helped improve the growth and consequently the yield of the plants (Ayub *et al*., 2012). This observation implies a linear increase in yield of plants with higher nutrient availability, which is in line with the reports by Kering *et al*. (2012) who also observed increased yield in heavy fertilized soils.

Table 2: Effect of Manure application rate on the dry matter yield of two Bracharia species

Species	Manure (t ha^{-1})	Dry matter yield (t ha^{-1})
B. mulato II	0	2.36^{d}
	5	2.49^{d}
	10	4.16^{b}
B. ruziziensis	0	3.07^{c}
	5	3.79^{b}
	10	6.24^{a}
SEM		2.92

^{ab}: means on the same column with different superscript differ significantly (P < 0.05); SEM: Standard error of mean

There were no significant (P > 0.05) changes in the dry matter and ether extract contents of the plants with the manure application rate; however, there was a significant (P < 0.05) improvement in the crude protein content as a result of the applied manure (Table 3). Grasses on the control plots has significantly (P > 0.05) lesser crude protein content than their fertilized counterparts, although, the differences in the crude protein content recorded for plants fertilized with 5 and 10 t ha^{-1} of manure was not significant (P > 0.05). There were no significant (P > 0.05) changes in the Ash content of *B. ruziziensis* as a result of the applied manure; however, *B. mulato* on control plots had significantly (P > 0.05) lower Ash content than those that were fertilized. There was an observed decline in the NDF and ADF content of both grasses as the manure application rate increased. The ADL content recorded for *B. mulato* declined as the manure application rate increased, while the no significant (P > 0.05) ADL changes was recorded for *B. ruziziensis*.

The increase in crude protein content with the application of manure as observed in the present study could be due to the presence of more nutrients in the soil. The increase in available nutrients could have increased microbial activities in the soil which may have led to increase in the rooting depths of the plants as a result of loosening of the soil structure which also improves soil aeration. This might have increased the quality of the forage since plants are able to tap and uptake nutrients easily (Dwyer *et al*., 1988). The CP recorded in this study surpassed the threshold of 60 g/kg required by rumen microbes to build their body protein (Van Soest, 1994). The higher content of ash in the plants fertilized with manure in the present study implies that the application of manure might have made essential soil nutrients available to the grasses. This is in agreement with the report by Fisher and Baker (1996) that manure application supplies nitrogen and mineral nutrient to plants through senescence and decay of leaves and rooting materials of the plants. The observed increase in ash content with manure application in the present study is in line with the findings of Little *et al*. (1989) that Ash content increases with manure application. The manure might have made more nutrients available for plant uptake. The decrease in fibre constituents of the plants in the present study with manure application might be due to the increased uptake of essential nutrients made available by the manure used in the present study. The nutrient in the fertilizer taken up by the plants might have reduced the rate of fibre build up which agrees with the reports of Cox *et al*. (1998) that fibre content decreases with fertilizer application. Similarly, Cox and Cherney (2001) reported that the NDF fractions decreased by using more fertilizer.

Table 4 shows the effects of manure application on the in vitro gas production of *B. ruzizensis* and *B. mulato.* The volume of gas produced increased as the manure application rate increased. Gas volume ranged from 7.50 ml/200mg DM recorded

Table 3: Effects of manure application rates on the chemical composition of two Brachiaria species

		chemical composition (g/kg)								
Species	**Manure ($t\ ha^{-1}$)**	**DM**	**CP**	**EE**	**Ash**	**NDF**	**ADF**	**ADL**	**Hemicellulose**	**Cellulose**
B. ruziziensis	0	95.54	7.78^{b}	10.35	13.37^{a}	61.50^{a}	40.74^{a}	3.86^{a}	20.76^{a}	36.88^{a}
	5	97.05	8.33^{a}	10.04	13.65^{a}	59.42^{a}	38.93^{a}	3.70^{a}	20.49^{a}	35.23^{a}
	10	96.30	8.87^{a}	9.73	13.92^{a}	57.33^{b}	37.11^{b}	3.53^{a}	20.22^{a}	33.58^{b}
B. mulato II	0	97.01	7.76^{b}	9.81	12.44^{b}	58.00^{ab}	38.13^{ab}	3.61^{a}	19.87^{a}	34.52^{ab}
	5	96.06	8.34^{a}	9.95	13.20^{a}	50.00^{c}	32.84^{c}	3.12^{b}	17.16^{b}	29.73^{c}
	10	95.11	8.91^{a}	10.08	13.95^{a}	42.00^{d}	27.55^{d}	2.62^{c}	14.45^{c}	24.94^{d}
SEM		2.03	1.17	0.52	0.37	6.3	4.17	0.4	2.14	3.77

^{ab}: means on the same column with different superscript differ significantly ($P < 0.05$); SEM: Standard error of mean
DM: Dry matter, CP: Crude protein, EE: Ether extract, NDF: Neutral detergent fibre, ADF: Acid detergent fibre
ADL: Acid detergent lignin

Table 4: Effects of manure application rates on the *in vitro* gas production (ml/200mg DM) of two Brachiaria species

Species	Manure (t ha^{-1})	3	6	9	12	15	18	21	24	OMD %	SCFA –	ME MJ/kg
		ml/200mg DM										
B. mulato II	0	0.00^{c}	0.00^{d}	2.00^{b}	2.00^{c}	3.00^{d}	4.00^{d}	4.00^{e}	5.00^{d}	30.92^{d}	0.06^{d}	2.95^{c}
	5	0.50^{b}	1.00^{c}	2.00^{b}	3.00^{bc}	4.00^{cd}	5.50^{c}	6.00^{d}	7.50^{c}	33.89^{c}	0.12^{c}	3.30^{b}
	10	1.00^{ab}	2.00^{b}	2.00^{b}	4.00^{b}	5.00^{c}	7.00^{b}	8.00^{c}	10.00^{b}	36.86^{b}	0.18^{b}	3.64^{ab}
B. ruziziensis	0	1.00^{ab}	2.00^{b}	4.00^{a}	6.00^{a}	8.00^{b}	8.00^{b}	10.00^{b}	11.00^{b}	36.86^{b}	0.20^{ab}	3.77^{a}
	5	1.17^{a}	2.34^{a}	4.34^{a}	6.34^{a}	8.67^{ab}	9.34^{a}	11.00^{a}	12.50^{a}	38.62^{a}	0.24^{a}	3.98^{a}
	10	1.33^{a}	2.67^{a}	4.67^{a}	6.67^{a}	9.33^{a}	10.67^{a}	12.00^{a}	14.00^{a}	40.38^{a}	0.27^{a}	4.18^{a}
SEM		0.83	0.44	1.17	1.43	2.83	2.92	3.50	4.25	1.43	0.04	0.78

[ab]: means on the same column with different superscript differ significantly ($P < 0.05$); SEM: Standard error of mean

as the least value for unfertilized *B. mulato*, while the highest gas volume *14.00* ml/200mg DM was recorded for *B. ruziziensis fertilized with 10* t ha^{-1} *of manure.* Degradability of forages in the rumen of ruminants has been reported to be positively correlated with the gas volume produced (Fievez *et al*., 2005). Invariably, the lesser fibre content of the fertilized plants implies that more substrate may have been made available to the rumen microbes for degradation, which may be the reason for the higher volume of gas produced and the resulting higher digestibility. This present results is in agreement with the report of earlier study conducted by Fievez *et al*. (2005).

Figure 1 shows the mean dry matter intake by WAD Sheep that consumed the brachiaria species fertilized at different manure application rates. Consumption of *B. mulato* by the animals was improved by manure application; however, preference for *B. ruziziensis* fertilized with 10 t ha^{-1} of manure was lower than the unfertilized, and those fertilized with 5 t ha^{-1}. This may not be unconnected to the higher presence of stem materials from the higher DM yield obtained from the same treatment, since stems are noted to contain a higher fraction of structural constituents than leaves (Gierus *et al*., 2012).

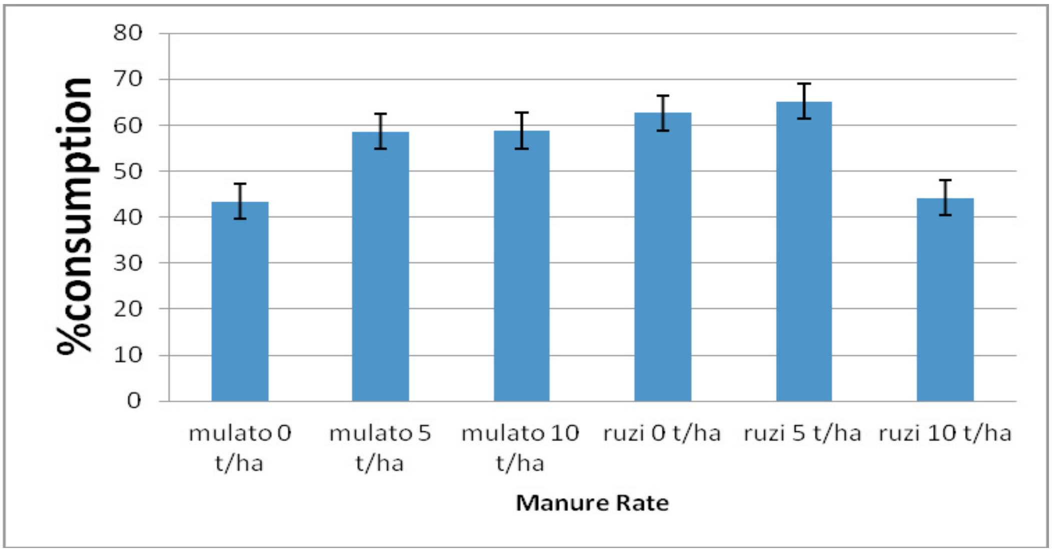

Figure 1: Influence of manure application rates on Mean dry matter intake (MDI) (kg DM) of two Brachiaria species by WAD Sheep

Conclusions

Brachiaria ruziziensis morphologically and nutrition wise had better growth rate, dry matter yield and chemical composition than *Brachiaria mulato* II. Plant height, yield and nutrient of the plants increased with increasing rate of manure application. This could be due to higher mineralization rate of swine manure which enabled the grass to absorb sufficient nutrients for its growth and improved its quality.

Recommendation

Based on the result of this study, *Brachiaria ruziziensis* was the better performing species and higher rate of manure application will improve the growth, yield and nutritive quality of the Brachiaria species.

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