Effects of poultry manure and nitrogen rates from two production systems on dry matter yield, and nutritive value of Columbus grass (*Sorghum almum)*

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Abstract

The experiment was conducted at screen house of Centre for Dry land Agriculture, Bayero University Kano, in the year 2016. The objective of the study was to determine the effects of poultry manure and nitrogen rates from battery cage and deep litter systems on dry matter yield, morphological characteristics and forage quality of Columbus grass (Sorghum almum). Sorghum almum seeds were sown in 32 plastic containers (dimensions 26 cm height, 28 cm top width and 20cm base width) perforated at the bottom containing 12 kg mixture of sandy and loamy soil in ratio of 1:3. The treatments consisted of poultry manure from two production systems (Battery cage and Deep litter) and nitrogen rates (50, 60, 70 and 80 kgN/ha) in a 2×4 factorial combined in a completely randomized design. Parameters measured were dry matter yield, number of tillers and stem diameter at the late boot stage of Sorghum almum, in addition, forage quality parameters (CP, ADF, NDF, digestible dry matter (DDM) dry matter intake as a percentage of body weight (DMI) and relative feed value (RFV)) were also evaluated. The results revealed no significant ($p>0.05$) difference between battery cage and deep litter fertilized Sorghum almum but deep litter fertilized Sorghum almum had numerically higher dry matter yield (5062.30 kg/ha) than battery cage (4400.40 kg/ha) Number of tillers and stem diameter were found to be significantly greater ($p<0.05$) in Deep litter (2.56 and5.70mm respectively) compared to Battery cage (1.13 and 5.08mm respectively). Both dry matter yield and stem diameter of Sorghum almum were significantly ($p<0.05$) highest at 80 kg N/ha. Crude protein was observed to be significant ($p<0.05$) in Sorghum almum fertilized with poultry manure from deep litter (11.35 %) compared with battery cage (10.05 %). The CP value was observed to increase with increased nitrogen rate with the highest value recorded at 80 kg N/ha (11.11 %). Dry matter intake (as a percentage of body weight) was equally greater ($p<0.05$) in Sorghum almum fertilized with deep litter (2.63%) compared to battery cage (2.49%). The value for NDF was significantly higher in sorghum almum fertilized with battery cage, while that of ADF was greater in deep litter. it can be concluded that, Sorghum almum fertilized with manure from deep litter system produced better yield and nutritive value.

Key words: *Sorghum almum*, Dry matter yield, production system, digestible dry matter Dry matter intake

Introduction

Pasture is a major agricultural resource supporting both intensive and extensive livestock production. One of the problems confronting animal production in Nigeria, more especially in the arid and semi-arid zones is wide variability in the availability and quality of feed for production of ruminant livestock over the feeding/grazing period attributable to climatic variation (Hopkins, 2000). At peak dry season, with the depletion of crop residue and forage supply from native range land coupled with over grazing and bush fire, the consequences are inadequate supply of feed in term of quantity and quality with attendant loss in body weight, low milk yield and poor reproductive performance of livestock (FAO, 1983).

Numerous research efforts have been made in the area of pasture grasses evaluation in Nigeria in the past decades with grasses, such as *Panicum maximum, Pennisetum purpureum, Andropogon gayanus, Andropogon. tectorum, Cynodon nlemfuensis, Cynodon. dactylon,* assuming prominence in forage research and livestock production (Ademosun, 1973). Most of these grasses usually occur as components of natural vegetation that constitute the grazing resource to ruminant animals in the country (Mohammed-Saleem, 1994). One grass whose potential has not been sufficiently exploited in Nigeria is columbus grass (*Sorghum almum*). *Sorghum almum* is a fast growing and high-yielding forage grass. In Australia, it is usually grown in pure stands but also thrives in mixtures with other grasses such as *Megathyrsus maximus*, *Cenchrus ciliaris* or *Chloris gayana* (Bogdan, 1977). Such pastures first benefit from the fast-growing Columbus grass and later from the other perennial species (Cook *et al.,* 2005). Columbus grass responds well to additional N, P and K fertilizers and generally yields 4-12 t DM/ha, sometimes up to 20 t DM/ha (Cook *et al.,* 2005). Seeds yield ranges from 0.3-1.6 t/ha (Cook *et al*., 2005). Excessive use of chemical fertilizers adversely affects the soil, causing depletion of organic carbon, reducing micro-flora and earthworms, increasing acidity and alkalinity and making the soil harder. Excess fertilizers contaminate water, which harms fish and other fauna. Production of chemical fertilizers also damages the environment and increases the cost of production. In this situation, the best option lies in the complementary use of bio-fertilizers and/or organic manures in a suitable proportion with fertilizers.

Manure is organic matter used as a fertilizer in agriculture; it contributes to the fertility of the soil by adding organic matter and nutrients such as nitrogen, potassium and phosphorus. According to Urquiaga and Zapata (2000), alternative sources of nitrogen such as animal waste (slurry, urine, etc.), manure, green fertilizer, vegetable compost and agricultural industry residues, are having special importance in recent years due to the high costs of inorganic fertilizers. As grasses are lovers of nitrogen, one of the factors that may constitute a set back to the production of *Sorghum almum* is the high cost of fertilizer nitrogen and farmers acceptability of having to grow forages with expensive fertilizer. Dry matter yield is not the only factor determining the productivity of livestock, the nutritive value of the pasture is equally very important. Hence, the experiment aims at evaluating the dry matter yield and nutritive value of *Sorghum almum* treated with poultry manure from two production systems (battery cage and deep litter.

Materials and methods

Experimental location

The experiment was conducted at the screen house of the Centre for Dry land Agriculture (CDA), Bayero University, Kano in the year 2016. Kano lies between longitude 9º 31' and 12º 30'North, and latitude 9° 30´ and 8° and 42´ East in the Sudan savannah ecological zone of Nigeria. The zone is characterized by two distinct seasons, wet season (May-September) and dry season (October-April. Mean annual rainfall ranges from 500-1000mm while mean temperature from 21-39°C (KNARDA 2001). The soil used for the experiment had the following characteristics (pH=6.47, N=0.08 %, P=22.53 ppm and K=0.03cmol/kg)

Sowing Operation and Field Culture

Seeds of *Sorghum almum* were collected

from the laboratory of the Department of Animal Science, Faculty of Agriculture, Bayero University Kano. Thirty two (32) plastic containers perforated at the base to avoid water logging, with dimension (26 cm height, 28 cm top width and 20 cm base width) were used for the experiment. Twelve kg of soil consisting of a mixture of soil and sand in 3:1 ratio was put in each of the containers. Thirty seeds of *Sorghum almum* were sown in each of the pots on 19th May, 2016. Seedlings were later thinned to 5 plants per pot. Organic manure from two production systems (battery cage and deep litter) were applied at sowing at the rate of 50, 60, 70 and 80 kg N/ha. The plants were irrigated every other day throughout the duration of the experiment.

Treatment and Experimental Design

The experiment was 2*4 Factorial arrangements in a Completely Randomized Design. The factors were manures from 2 poultry production systems (battery cage and deep litter) and 4 rates of poultry manure (50, 60, 70 and 80 kg N/ha)

Harvesting

Harvesting was carried out on 4th August, 2016 which coincided with late boot stage of *Sorghum almum*. Prior to harvest, number of tillers in each pot was counted followed by measurement of stem diameter using vernier caliper. Harvesting involved cutting the plants in each pot at 5cm stubble height above the soil level and then weighed to determine the fresh weight. The samples were then oven dried at 65^{o}C for 72 hours, after which they were weighed again to determine the yield on dry matter basis.

Chemical analysis

The oven-dried samples were ground to pass through 2mm sieve. Analysis of crude protein (CP) was carried out using Kjeldahl method. Percentage nitrogen (N) was first determined and then multiplied by a factor of 6.25. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were determined according the procedure described by Van Soest *et al.* (1991).

Other quality parameters were calculated as follows:

Dry matter intake (DMI)= 120/ % NDF, Digestible Dry matter (DDM)=88.9-(%ADF*0.779)

Relative feed value (RFV)=(%DDM*%DMI)/1.29 (Horrock and Vallentine, 1999)

Data Analysis

The data collected were subjected to analysis of variance (ANOVA) using SAS 2009 (version 9.2). Differences among means were separated by Duncan Multiple Range Test (Duncan, 1995).

Results

Dry Matter and Morphological Characteristics of Sorghum almum (Columbus Grass)

Table 1 shows the main effects of poultry manure and nitrogen rates from battery cage and deep litter systems on dry matter yield and morphological characteristics of Columbus grass (*Sorghum almum*). Poultry manure from the two production systems (battery cage and deep litter) were not significantly ($p>0.05$) different in terms of dry matter yield. However, in absolute terms, dry matter yield tended to be higher in *Sorghum almum* treated with poultry manure from deep litter system. Number of tillers and stem diameter were significantly greater ($p<0.05$) in *Sorghum almum* treated with poultry manure from deep litter system (2.5 and 5.7 mm respectively) compared to Battery cage (1.13 and 5.08 mm respectively). In the same connection dry matter yield and stem diameter of *Sorghum almum* were significantly ($p<0.05$) affected by the rate of poultry manure nitrogen. The highest dry matter yield (5521 kg/ha) and stem diameter (5.73 mm) were obtained at an application rate of 80 kgN/ha compared to other rates

Table 1 : Main effects of poultry manure and nitrogen rates from two production systems on dry matter yield and morphological characteristics of Columbus grass

Poutry manure	Dry matter yield (Kg/ha)	Number of tillers	Stem diameter (mm)
Battery cage	4400.4	1.13[b]	5.08[b]
Deep litter	5062.3	2.56[a]	5.70[a]
P value	0.1624	0.0363	0.0001
Rates (kg N/ha)			
50	4893.1[ab]	2.75	5.37[ab]
60	4762.7[ab]	1.00	5.26[b]
70	3748.5[b]	1.38	5.22[b]
80	5521[a]	2.25	5.73[a]
P value	0.0407	0,2317	0.0500

Means with different superscripts within the same column are significantly different (p<0.05)

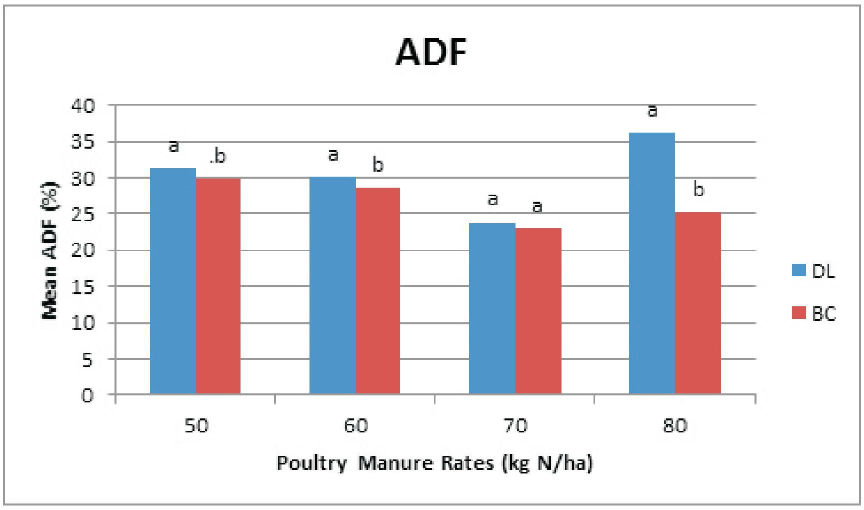
Proximate components of *Sorghum almum*

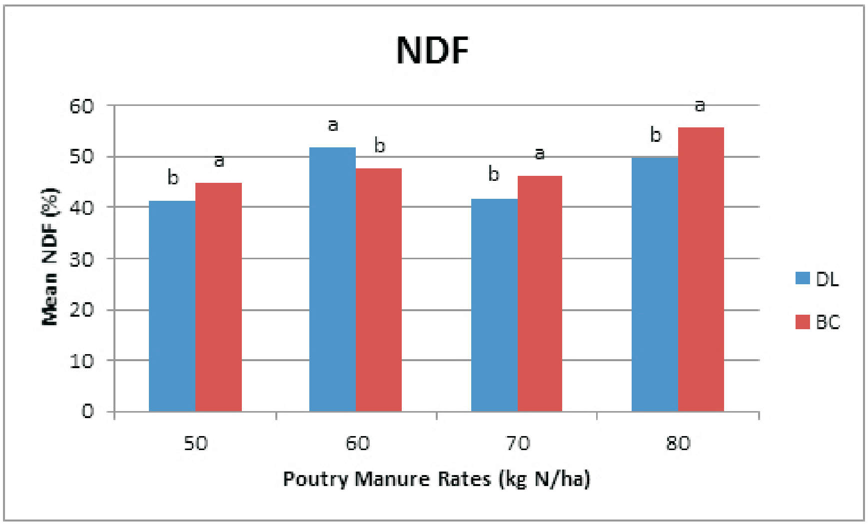
Table 2 shows main effects of poultry manure and nitrogen rates from deep litter and battery cage on proximate composition of *Sorghum almum* (Columbus grass). *Sorghum almum* treated with poultry manure from deep litter recorded significantly higher ($p<0.05$) crude protein (CP) (11.35 %) and acid detergent fiber (ADF) (30.36 %). However, the neutral detergent fiber (NDF) value in *Sorghum almum* treated with deep litter was significantly ($p<0.05$) lower (46.15%) than that of battery cage (48.49 %). Poultry manure nitrogen rates significantly affected the composition of CP, ADF and NDF in *Sorghum almum.* The composition of CP, ADF and NDF were significantly the highest at 80 kgN/ha compared to other rates except at 70 kgN/ha in the case of CP found to be significantly at par with 80 kgN/ha, similarly in the case of ADF at 50 kgN/ha. Interaction between poultry manure and rates was highly significant in the case of ADF and NDF. *Sorghum almum* fertilized with manure from deep litter had the highest ADF at all application rates, however, significant differences ($p<0.05$) were only observed at 50, 60 and 80 kg N/ha (Fig 1.). As for NDF, *Sorghum almum* fertilized with manure from battery cage recorded significantly greater ($p<0.05$) NDF at 50, 70 and 80 kg N/ha except at 60 kg N/ha where the reverse was the case (Fig 2.)

Table 2: Main effects of poultry manure and nitrogen rates from deep litter and battery cage and their interaction on proximate composition of Columbus grass

Poultry manure	CP (%)	ADF (%)	NDF (%)
Battery cage	10.05[b]	26.61[b]	48.49[a]
Deep litter	11.35[a]	30.36[a]	46.15[b]
P value	0.0001	0.0001	0.0001
Rate (kg N/ha)			
50	10.15[c]	30.58[a]	43.06[d]
60	10.69[b]	29.34[b]	49.54[b]
70	10.87[ab]	23.38[c]	43.98[c]
80	11.11[a]	30.64[a]	52.71[a]
P value	0.0001	0.0001	0.0001
Interaction			
Poultry manure x rate	Ns	**	**

Means with different superscripts within the same column are significantly different (p<0.05) . Ns-Not Significant





Dry matter intake dry matter digestibility and Relative feed value of Sorghum almum

Table 3 shows main effects of poultry manure and nitrogen rates from deep litter and battery cage on digestible dry matter (DDM), dry matter intake (DMI) and relative feed value (RFV). *Sorghum almum* treated with battery cage recorded significantly higher ($p<0.05$) digestible dry matter (68.17 %). The reverse was the case with regard to DMI (Deep litter, 2.63 % of body weight and battery cage, 2.49 % of body weight). However no significant difference was observed in terms of relative feed value irrespective of the source of poultry manure. Poultry manure nitrogen rates were significantly different in respect of DDM, DMI and RFV. In the case of DDM, 70 kgN/ha recorded significantly higher ($p<0.05$) value compared to other rates whereas DMI was significantly greater ($p<0.05$) at 50 kgN/ha in comparism with other rates. In the same vein 70 kgN/ha recorded the highest ($p<0.05$) relative feed value.

Table 3 : Main effects of poultry manure and nitrogen rates from deep litter and battery cage on digestible dry matter, dry matter intake and relative feed value

Poultry manure	Digestible dry matter DDM (%)	Dry matter intake DMI (%body weight)	Relative feed value (RFV)
Deep litter	65.25[b]	2.63[a]	133.25
Battery cage	68.17[a]	2.49[b]	131.61
P value	0.0001	0.0001	0.076
Rates (kgN/ha)			
50	65.08[c]	2.79[a]	140.79[b]
60	66.05[b]	2.43[c]	124.32[c]
70	70.69[a]	2.74[b]	149.87[a]
80	65.03[c]	2.28[d]	114.73[d]
P value	0.0001	0.0001	0.0001

Discussion

Responses of *Sorghum almum* to poultry manure were observed to vary according to the poultry production systems and rates of N application, as indicated in Table 1. The higher value in absolute terms recorded by deep litter treated *Sorghum almum* in terms of dry matter yield and the significantly greater number of tillers and stem diameter agree with the finding of Wilkinson, (1979) who reported that poultry manure from deep litter system is generally considered to be the most valuable animal manure for fertilizer purpose, owing to its relatively low moisture and high macronutrients content. While poultry manure without bedding (such as that of Battery cage) has a higher proportion of N as ammoniacal-N which is subject to loss via ammonia volatilization (Sims *et al*., 1989). This partly explains the comparatively lower values recorded in most of the parameters measured in respect of *Sorghum almum* treated with poultry manure from the battery cage system. The highest dry matter yield obtained at an application rate of 80kgN/ha compared to other rates, concurs with the report of Abusuar and El-Zalia (2010) who reported that as the rate of poultry manure increases, both fresh and dry yields of forage sorghum [*Sorghum bicolor* (L) Moench] also increased. The not too impressive performance recorded in *Sorghum almum* treated with 70kg N/ha may be due to insect pest that affected some of the plants in the treatment. The significantly greater crude protein recorded by *Sorghum almum* treated with poultry manure from deep litter (DL) may be explained in the context of the manure's ability to absorb nutrient and minimize the tendency of the manure nitrogen to volatilize courtesy of some of the constituents such as bedding materials feathers and wasted feed. In the same vein the significantly higher acid detergent fiber (ADF) in *Sorghum almum* fertilized with deep litter manure may be linked to the fact that the deep litter manure contains other constituent such as bedding material that could increase the fiber content (Wilkinson, 1979). The significantly lower digestible dry matter observed in *Sorghum almum* treated with manure from deep litter compared to battery cage could be due to its relatively higher ADF as digestible dry matter is negatively related to ADF while the significantly higher dry matter intake as a percentage of body weight observed in *Sorghum almum* treated with deep litter may be explain in the context of its comparatively lower NDF, lower NDF connotes higher dry matter intake. By and large crude protein and total fiber (NDF) were significantly higher and lower in *Sorghum almum* treated with deep litter, hence the seemingly higher relative feed value recorded by deep litter against battery cage.

Conclusion

From the results obtained it can be concluded that, in producing *Sorghum almum* with poultry manure, the manure from deep litter system produced better yield and nutritive value.

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