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Effect of chicken manure on yield, quality and HCN concentration of two forage Sorghum (*Sorghum bicolor* (L) Moench) cultivars

Awad O. Abusuwar[1] and Hala A. El Zilal[2]

[1]Department of Agronomy, Faculty of Agriculture, University of Khartoum, Sudan,
[2]Department of Range Sciences, University of Sudan for Science and Technology, Khartoum, Sudan. Corresponding E-mail: abusuwar@yahoo.com

ABSTRACT

An experiment was conducted for two successive years (2000-2001) in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum in Shambat to investigate the response of two forage sorghum cultivars to different rates of chicken manure in two different seasons (summer and winter). The treatments consisted of four chicken manure levels (0, 2.5, 5.5 and 7.0 tons/ ha.), two cultivars of forage sorghum (Abu Sabein and Pioneer) and two sowing dates (winter and summer). Treatments were arranged in a split-split plot design with four replications. The parameters measured included fresh and dry matter yields and proximate analysis to determine the nutritive value and the HCN concentration of the forage. Results showed that chicken manure rates had a significant effect on yield and nutritive value of the forage produced during both seasons throughout the experimental period. The maximum forage fresh yield of 33.21 tons/ha was recorded for the highest rate of chicken manure applied (7.5 tons/ha) compared to 17.71 tons/ha for the control during the first year. On the other hand maximum dry forage yield of 16 tons/ha was recorded for the same treatment compared to 11.42 tons/ha for the control during the same period. In both years no significant effects of cultivars on forage yield, except for dry matter production in the second year. Summer sowing significantly outyieded winter sowing throughout the experimental period. Chicken manure application significantly improved forage quality in terms of crude protein and crude fiber, with highest protein and lowest fiber recorded for the highest dose of chicken manure applied compared to the control. Summer planting resulted in a significantly higher P and Ca compared to winter planting. Pioneer significantly exceeded Abu Sabein in Mg content through out the experimental period. Prussic acid contents were significantly increased by chicken manure treatment. Abu Sabein (Sorghum bicolor (L.) Moench) had greater contents of prussic acid than Pioneer cultivar and all prussic acid content of Pioneer cultivar did not reach the toxic level (>204 ppm) during the two seasons.

Keywords: Organic fertilizer, forage sorghum yield, forage sorghum quality, prussic acid

INTRODUCTION

Sudan has a huge animal wealth that is estimated to be about 130 million heads of different animal classes. There is a feed gap to cope with this huge animal wealth as indicated by different studies (AOAD, 2003a; AOAD, 2003b). This necessitated expanding irrigated forages vertically and horizontally to bridge this feed gab. Fertilization of forage crops to increase productivity and improve quality is of equal importance. With the rise in prices of chemical fertilizers beyond the capability of farmers, organic fertilizers seem to be more appealing.

Among the organic fertilizers available in large quantities in Sudan is chicken manure. Cooke (1982) reported that fresh poultry droppings contain twice as much as farmyard manure. They are much richer in phosphorus and contain as much potassium as farmyard manure. Compost of droppings and straw are richer in NPK than farmyard manure. He also reported that wheat grain yield, grain quality and straw yield were promoted by the rate of chicken manure and the point of profitable grain yield corresponded to the manural rate of 8.25 tons/ha. Nitrogen and phosphorus uptake, as a function of chicken manure application rate, increased progressively with the increase in manural rate (Magid *et al*, 1998; Postma *et al*, 1998; Hue and Sobieszczyk, 1999). Great concern by herders is given when animals are fed with Sorghum forage as it contains variable amount of the poisonous compound glycoside. Glycoside is found in a number of plants as secondary chemical compound from which the poisonous hydrogen cyanide is released as

result of their exposure to certain enzymes. However, due to different activities inside the cells such as maturation or exposure to sodification or crop cutting or browsing by animals , those two enzymes come into contact and react with glycoside to form the first compound (β-glycosidase) and through partial oxidation hydrogen cyanide gas is released and this reaction is known as cynogenisis (Khair, 1999). Glycoside compounds occur in about 750 types (varieties) of forage plants. Some examples included *Sorghum bicolor*, *Sorghum sudanense*, *Lotus* spp, *Trifolium repens*, *Bracharia mutica*, *Sorghum halpense*, and *Ipomia* spp. Other forages which contain glycoside include *Panicum repense* and *Amorphophallus campanultus* (Brigit et. al, 1982, and Khair, 1999).

Hydrocyanic acid content in sorghum is heritable and subjected to modification through selection and breeding, as well as by climate ,stage of maturity, stunting of plant, type of soil and fertilizer (Khatri et . al.1997).

Little research work on chicken manure as a biofertilizer in forages has been carried in Sudan. Therefore the objectives of this research were to investigate chicken manure as biofertilizer and to evaluate its effect on forage quality, productivity and the HCN contents of the two forage cultivars.

MATERIALS AND METHODS

An experiment was carried out during the years 2000 to 2001 in the Demonstration Farm of the Faculty of Agriculture, University of Khartoum in Shambat, Sudan. The treatments consisted of four levels of chicken manure (0, 2.5, 5.5 and 7.5 tons/ha.), two sowing seasons (summer and winter) and two cultivars of forage sorghum (Abu Sabein and Pioneer) laid out in a split-split plot design replicated four times. Seasons were assigned to the main plots, cultivars to the sub-plots and manure rates to the sub-sub plots. The manure was incorporated into the soil, watered twice before planting to insure complete decomposition. Seeding rates were 20 and 25 kg/feddan for Pioneer and Abu Sabein, respectively. Plot size was 3X4 m for each experimental unit. Planting was done in July for summer season and in November for winter planting.

At harvest one meter was harvested from the two inner middle ridges to determine fresh and dry forage yields. Sub-samples from the dry weights were ground for proximate analysis to determine forage nutritive value. Crude protein was determined by the micro-kjeldahl method (Pearson, 1970); whereas crude fiber was determined according to the method of AOAC (1984). Phosphorus content was determined according to Pearson (1970); while Ca and Mg were determined according to the method described by Chapman and Patt (1961).

Ten plants were randomly taken from each treatment. They were weighed and milled in a pressure machine. The extracted juice was filtered through centrifuge model 305 at 5000 rounds per minute. Then the spectrophotometer was used to determine the absorption of the juice at wave length ƛ 293 nm. Then the glycoside concentration was calculated according to the formula described by The British Pharmacopeias (1980) which is adapted by Babiker Khalid 2000 (Faculty of Pharmacy, University of Khartoum).

Absorption =concentration of glycoside X path width (1cm) X absorbability (1.3)
The HCN content was then calculated according to the formula: Standard volume (10.5) →1.03 HCN
The glycoside concentration→ X HCN
Glycoside concentration X 1.03 X1000

$$\text{HCN content} = \frac{\text{Glycoside concentration X 1.03 X100}}{10.5}$$

The collected data were analyzed according to the statistical procedure described by Gomez and Gomez (1984) and the computer package MSTAT-C. Means were separated using the Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Chicken manure rates significantly affected forage fresh and dry yields throughout the experimental period (Table 1). As the rate of manure increased both fresh and dry yields increased. The maximum fresh forage and dry matter produced were recorded under the highest rate of manure applied. The highest doze of chicken manure (7.5 tons/ha.) applied increased forge fresh yield by 138% and dry matter yield by 200% in year 2001. Several researchers (Magid *et al*, 1998; Postma *et al*, 1998; Hue and Sobieszczyk,1999) reported that nitrogen and phosphorus uptake, as a function of chicken manure application rate, increased progressively with increasing manural rates. It is worth mentioning here that the chicken manure used in the experiment contained 8.5% Ca, 3.1%Mg, 5.0% K, .84% N, and 0.93%P that would help the crop in obtaining its required nutrients in addition to the improvement of soil physical conditions, particularly in heavy clay soils where the experiment was conducted.

Pioneer out yielded Abu Sabein throughout the experimental period; however significant differences in dry matter production were recorded during year 2001 only.

With respect to effect of seasons on forage productivity, winter planting significantly out yielded summer planting during year 2000 and the opposite was true during year 2001. This is probably due to the fact that during year 2000, winter temperatures were wormer than winter temperatures of 2001.

Regarding the effects of treatments on forage quality, chicken manure significantly improved forage quality, as it resulted in higher crude protein and lower crude fiber (Table 2). The percent Ca, Mg, and P in plant tissue were also improved significantly by manure additions. This is expected as the chemical analysis of the manure indicated higher contents of these elements. Similar findings were also reported by Magid *et al* (1998), Postma *et al,* (1998) and Hue and Sobieszczyk (1999).

Analysis of variance showed significant differences among cultivar and fertilizer rates on HCN content in both seasons (Tables 3 and 4). Pioneer was significantly lower in HCN content compared to Abu Sabein in both seasons and the amount of the acid decreased in the second summer season (Table 4). In all counts for the two cultivars the concentration was higher during the first count then it decreases as the plant advances in maturity. This drop in HCN content as the plant ages may be attributed to the fact that the prussic acid content in green plants decreases as maturity approaches. This is also reported by Kallah *et al.,* (1977) and by Khair (1999).

Another explanation for lower HCN content in Pioneer forage may be the fact that HCN content in sorghum is a heritable character and subject to modification by selection and breeding as well as by climate (Franzke, 1947). Moreover, Pioneer is a sorghum hybrid and is expected to have good quality characters, among which are a lower HCN content.

In both seasons, as the rate of manure increased, the HCN concentration in plant tissue significantly increased together with fresh and dry yields. It is worth mentioning here that the highest HCN content did not reach the toxic level (≥ 204 ppm).

It can be concluded from the results of this study that chicken manure application significantly increased forage productivity and improved forage quality in forage sorghum cultivars Abu Sabein and Pioneer. Summer sowing increased forage productivity and improved quality in cereal forages than winter sowing.

The pioneer cultivar seemed more nutritious than Abu Sabein in most of the parameters measured during the course of the study. Moreover, the HCN concentration in plant tissue increases as the dose of chicken manure increases; however this increase in HCN content did not reach the toxic level with the highest doze of chicken manure used (7.5 tons/ha.). Moreover, the Pioneer hybrid was significantly lower in HCN content compared to Abu Sabein in both seasons.

Table 1. Effects of Chicken Manure Rates, Cultivars and Season on Fresh and Dry Matter Yields of Two Forage Sorghum Cultivars (Abu Sabein and Pioneer)

Treatments	**Year 2000**		**Year 2001**	
(t/ha.)	Fresh yield(T/Ha)	Dry yield(T/Ha)	Fresh yield(T/Ha)	Dry yield(T/Ha
0.0	17.71a	11.42d	13.35d	3.92d
2.5	22.28c	11.14c	19.78c	7.41c
5.5	27.57b	13.57b	23.92b	9.78b
7.5	33.21a	16.0a	30.71a	12.0a
SE±	0.06	0.05	0.07	0.04
Pioneer	25.28a	12.35a	22.0a	8.00a
Abu Sabein	25.14a	12.07a	21.85a	7.42b
SE±	0.26	0.36	0.20	0.17
Summer	24.2b	10.85b	32.85a	10.64a
Winter	26.2a	13.64a	10.00a	05.78b
SE±	6.40	0.15	0.25	0.05
CV%	6.40	11.7	8.7	15.2
(t/ha.)	Fresh yield(T/Ha)	Dry yield(T/Ha)	Fresh yield(T/Ha)	8.00a

Means followed by the same letter(s) in a given column are not significantly different at P=.05, using the Duncan's Multiple Range Test.

Table 2. Effects of Chicken Manure Rates, Cultivars and Season on Quality of Two Forage Sorghum Cultivars (Abu Sabein and Pioneer)

Treatments	Year 2000					Year 2001				
	CP%	CF%	Ca%	P%	Mg%	CP%	CF%	Ca%	P%	Mg%
(control) 0 t/ha	4.61d	28.8d	0.27ab	0.06a	0.52b	6.4c	30.9a	0.31d	0.15b	0.43d
2.50 t/ha	5.05c	27.7b	0.28a	0.06a	0.55b	8.4b	30.1b	0.32c	0.19a	0.49c
5.50 t/ha	5.52b	26.7c	0.24c	0.07a	0.74a	9.2a	28.6c	0.34b	0.16b	0.61b
7.50 t/ha	5.94a	26.4c	0.24c	0.07a	0.61a	9.5a	28.4c	0.38a	0.18a	0.92a
SE±	0.03	0.10	0.01	0.001	0.04	0.25	0.21	0.007	0.06	0.02
Pioneer	4.52b	27.03b	0.75a	0.07a	0.69a	8.8a	29.1a	0.35a	0.18a	0.71a
Abu Sabein	6.04a	27.75a	0.26b	0.07a	0.52b	7.9b	29.1a	0.37a	0.16b	0.52b
SE±	0.07	0.22	0.01	0.006	0.03	0.007	0.75	0.007	0.05	0.04
Summer	5.78a	25.7b	0.23b	0.08a	0.61a	9.3a	29.2a	0.39a	0.19a	0.62a
Winter	4.78b	29.0a	0.28a	0.05a	0.06b	7.4b	29.6a	0.34b	0.15b	0.61a
SE±	0.08	0.27	0.006	0.01	0.02	1.18	0.54	0.03	0.05	0.05
CV%	2.4	1.5	5.2	9.2	8.7	5.5	2.6	3.6	10.5	10.6

Means followed by the same letter(s) in a given column are not significantly different at P=.05,

Table 3. Effect of Chicken Manure and Cultivar on HCN contents (ppm) at different sampling dates during the summer of 1999/2000 season.

Treatments	1st sampling	2nd sampling	3rd sampling	4th sampling	5th sampling	6th sampling
N0 (control)	299.9d	180.6d	158.8d	143.5d	107.1d	91.8d
2.5 tons (1M)	235.5c	183.1c	162.7c	148.3c	114.1c	92.2c
5.5 tons (2M)	251.6b	194.2b	174.2b	160.9b	117.6b	93.3b
7.5 tons (3M)	314.1a	199.9a	183.3a	170.0a	123.8a	94.6a
SE	0.27	0.33	0.07	0.32	0.11	0.04
Pioneer	196.4b	158.5b	140.4b	128.0b	79.6b	79.7b
Abu Sabein	315.5a	220.3a	199.1a	183.2a	151.7a	106.3a
SE	0.30	0.42	0.12	0.11	0.08	0.06

Means followed by the same letter(s) in a given column are not significantly different at 0.05 level using the Duncan's Multiple Range Test

Table 4. Effect of Chicken Manure and Cultivar on HCN contents (ppm) at different sampling dates during the summer of 2000/2001 season.

Treatments	1st sampling	2nd sampling	3rd sampling	4th sampling	5th sampling	6th sampling
N0 (control)	221.0d	189.6d	155.3d	148.3d	115.8d	112.7d
2.5 tons (1M)	244.1c	177.2c	166.8c	160.0c	118.0c	113.2c
5.5 tons (2M)	245.7b	186.5b	176.5b	170.1b	119.7b	116.6b
7.5 tons (3M)	252.1a	190.1a	180.1a	172.9a	137.9a	120.0a
SE	0.17	0.12	0.12	0.09	0.09	0.12
Pioneer	192.2b	166. 4b	153.4b	146.5b	115.7b	104.6b
Abu Sabein	288.6a	195.0a	186.2a	179.3a	130.0a	126.7a
SE	0.07	0.13	0.06	0.03	0.08	0.30

Means followed by the same letter(s) in a given column are not Significantly different at 0.05 level using the Duncan's Multiple Range Test.

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