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STOVER YIELD AND CHEMICAL COMPOSITION IN SOME SORGHUM VARIETIES IN GADARIF STATE, SUDAN

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ABSTRACT

An experiment was conducted at the faculty of Agricultural and Environmental Sciences farm, University of Gadarif, Gadarif State, Sudan to evaluate dry matter yield and nutritive value of the stover of four local sorghum varieties (Bashier, Zahratelgadambalia, Butana and Arfagadamac). Dry matter yield, morphological traits and chemical composition were determined. There were significant ($P < 0.05$) differences in dry matter yield and other morphological traits among varieties. Zahratelgadambalia had the highest dry matter yield (2520 kg/fed) and was 100%, 31% and 19% higher than Bashier, Butana and Arfagadamac varieties, respectively. It also had the highest stem height, stem weight and least in stem thickness. Arfagadamac was next to Zahratelgadambalia in dry matter yield and had the highest stem thickness. Butana was less productive than Zahratelgadambalia and Arfagadamac, but not significantly. Bashier was inferior to all varieties in dry matter yield and had the highest leaf: stem. Dry matter yield had a highly significant positive correlation with plant height (0.999) and positive correlation with stem weight (0.553), number of leaves/ plant and leaves weight. There were significant variations in chemical composition among sorghum varieties. Acid detergent fibre (ADF) was 46.4- 70.0%, neutral detergent fibre (NDF) was 59.9 - 79.3% and lignin was 9.2-13.5%. Butana variety stover had the least NDF and ADF among the four varieties. This indicated it was better in chemical composition and expected to be better in nutritive value unless other factors were not involved like anti nutritional factors.

Keywords: Sorghum varieties, Stover, Dry matter yield, Morphological traits, Fibre fraction, Sudan.

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Contribution/ Originality

This study is one of very few studies which have investigated the nutritive value and dry matter yield of local sorghum varieties in Gadarif State, the most important region for sorghum production in Sudan. It contributes to the existing literature in the analysis of correlation between morphological traits and dry matter yield.

1. INTRODUCTION

Gadarif State is in the Butana plain in eastern Sudan and is one of the main rain fed agriculture areas in the country. Sorghum, millet and sesame are important crops in the state. Crops and animal production are very important in the state and are generally integrated. Animal production role is increasing in the state due to high livestock population, reputed breeds and closeness to main markets in the country and abroad. Adequate nutrition is essential for optimum animal production [1]. Nutrition is one of the main constraints for animal production in Gadarif State as animals are mainly reared in traditional systems based on rangeland which deteriorated for many factors including reduced area due to haphazard agricultural expansion [2, 3], reduced rainfall, successive droughts and poor management. In addition seasonal variations in rainfall were associated with seasonal variations in feeds quantity and quality and serious feeds shortages and effects on animals' health and performance, especially in the dry season [4] as in the tropics [5, 6]. Crop residues are cheap and abundant in the state and used to fill the nutritional gap in the dry season [4]. However, they generally have low nutritive value due to high CF and low CP, digestibility and feed intake and hence animals performance.

Sorghum (*Sorghum bicolor*(L.)Moench) is an important crop in Sudan and the country ranked 8th in world sorghum grain production producing 3.5 million Metric Tons [7]. It is the main crop in the state and about 5-6 million feddans (2.1-2.52 ha) are cultivated annually. Grain and stover yield are important traits for improving rabi sorghum varieties and hybrids in India [8]. It is claimed that limited adoption of improved sorghum varieties was mainly due to crop residues lower nutritive value and farmers believe that improved cultivars stover yield and quality are lower than local cultivars [9]. Grain yield was higher in improved cultivars and stover yield was similar or higher than local cultivars [10]. In addition *in vitro* digestibility was higher in improved cultivars than the local ones. There were significant differences among cultivars in grain and stover yield, digestibility, CP and minerals in Botswana [11]. Sorghum varieties varied significantly ($p < 0.01$) in fresh and DM yields [12]. Highly significant genotype-dependent variation was found in sorghum grain and stover yield and fodder value [13]. Grain yield and stover quality were not inversely related and high grain and stover yields seem to be compatible traits. There were variations in cellulose, lignin and NDF, rumen degradation, digestibility and feed intake among sorghum stover whole plant, stem and leaves and were different from Lablab in Nigeria [14]. There may be significant differences among sorghum cultivars in the stover concentration of structural and nonstructural carbohydrates and relative proportions of cellulose, hemicellulose and lignin [15]. In addition there is increasing interest in bioenergy and converting lignocellulosic biomass to energy products via enzymatic or thermochemical

conversion [16]. Many sorghum varieties are used in Gadarif State and the main ones in traditional Feterita are Arfagadamac, Abdalla Mustafa and Korkol. Some sorghum varieties such as Bashier, Butana, Zahratelgdambalia and Arfagadamac produce huge amounts of residues. It is important to conduct comparative studies to evaluate different cultivars. Asma Hamed [4] studied Arfagadamac stover nutritive value and effects on goat performance in Gadarif State. There is no available information on many sorghum varieties stover yield, nutritive value, fibre fraction, plants morphological characteristics and their correlation with dry matter yield in Gadarif State, Consequently, this study was conducted to determine sorghum varieties stover yield, fibre fraction, morphological traits and their correlations in four sorghum varieties in Gadarif State.

2. MATERIALS AND METHODS

2.1. Study Area

The experiment was conducted in the animal production farm, Faculty of Agricultural and Environmental Sciences, Gadarif University in Gadarif, Gadarif State, Sudan. Gadarif lies in the eastern part of Sudan at latitudes 12° 40'-15° 45' N and longitudes 33° 34'-37°1' E. Mean maximum temperature is 40.7 ° C in April. Autumn extends from July to October and average annual rainfall is 602 mm. Many crops are cultivated in the area including sorghum, sesame and millet.

2.1.1. Stover Sampling, Yield and Morphological Traits

Sorghum stover was collected from four sorghum varieties grown in the farm in 2010 autumn including Bashier, Zahratelgadambalia, Butana and Arfagadamac. They were laid in a completely randomized design (CRD) with three replicates. The field was divided into three plots for each variety and ten samples were collected at random from each plot using a 1m² sampler for dry mater yield estimation. Sorghum stover was cut at the ground level. Three plants were selected at random from each plot to collect data on plant height (cm), number of leaves, stem thickness (cm), stem dry weight, leaves weight and leaf: stem.

2.2. Laboratory Analysis

Samples of sorghum stover were prepared for laboratory analysis by milling through 2mm screen. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin were determined according to Goering and Van Soest [17].

2.3. Statistical Analysis

Data were analyzed by analysis of variance for a completely randomized design using MSTAT procedure [18]. The means were compared using least significant differences (LSD). Simple correlation coefficients were estimated.

3. RESULTS

3.1. Morphological Traits and DM Yield

Table 1 shows sorghum varieties stover morphological traits and DM yield in Gadarif State.

Plants height, stem thickness, leaves weight, stem weight, number of leaves /plant, leaf stem and DM yield varied significantly ($P < 0.05$) among sorghum varieties. Zahratelgadambalia was significantly ($P < 0.001$) the highest plant and Butana was the shortest one. Stem thickness was highest in Arfagadamac and was significantly ($P < 0.01$) lowest in Zahratelgadambalia. Leaves weight was significantly ($P < 0.05$) higher in Bashier and lowest in Arfagadamac with no significant differences between Bashier and Zahratelgadambalia. Stem weight was significantly ($P < 0.001$) higher in Zahratelgadambalia and lowest in Butana. Number of leaves/plant was significantly ($P < 0.05$) higher in Arfagadamac than Butana and Bashier, but not significantly different from Zahratelgadambalia. Leaf: stem varied significantly ($P < 0.001$) among varieties. and was highest in Bashier and least in Zahratelgadambalia.

Sorghum varieties varied significantly ($P < 0.05$) in DM yield and was highest in Zahratelgadambalia and lowest in Bashier. Zahratelgadambalia DM yield was 100%, 31% and 19% higher than Bashier, Butana and Arfagadamac varieties, respectively.

3.2. Correlations between Morphological Traits and Dry Matter Yield

The correlation coefficients between morphological traits and dry matter yield are shown in table 2. Dry matter yield had highly significant positive correlation with plant height and positive correlation with stem weight, number of leaves/ plant and leaves weight. Highly significant negative correlation was observed between DM yield and leaf: stem. There was a negative and non significant correlation between DM yield and stem thickness among the varieties under study.

3.3. Fibre Fractions

Table 3 shows fibre fractions in sorghum varieties stover in Gadarif State.:

There were significant ($P < 0.05$) variations among sorghum varieties in stover ADF, NDF, Lignin, cellulose and hemicelluloses. Acid detergent fibre and NDF were highest in Arfagadamac and lowest in Butana. Lignin was highest in Zahratelgadambalia and lowest in Arfagadamac. Cellulose was highest in Arfagadamac and lowest in Butana. Hemicellulose was highest in Bashier and lowest in Zahratelgadambalia.

4. DISCUSSION

4.1. Morphological Traits and DM Yield

The significant differences among sorghum varieties in stover morphological traits including plant height, stem thickness, leaves weight, stem weight, number of leaves/plant and leaf: stem were mainly genetical. Similar results were found by many workers [10, 19].

The variations among sorghum varieties in DM yield were mainly genetical. Similar variations in sorghum varieties stover yield were reported by many workers [11, 12, 20].

4.2. Correlations between Morphological Traits and Dry Matter Yield

The significant positive correlations between DM yield and plant height, stem weight, number of leaves/ plant and weight of leaves were similar to that reported in Napier grass [21]. Dry matter yield was also highly positively correlated with stem fresh weight, number of leaves, plant height and stem thickness [21]. Significant correlations between plant height and green fodder yield and indirect effect on dry fodder yield were also reported by Lyanar Vijyakumar and Fazlullahkhan [22]. Significant correlations were also found among sorghum morphological traits with stover yield in Nigeria [23]. The positive correlation between plant height in green fodder and DM yield and positive correlation between green fodder yield and DM yield was also reported for pearl millet [24]. Leaf number had significant positive correlation with plant height and stover weight [23]. Plant height had significant positive correlation with leaf number and stover weight and negatively correlated with total grain yield. Stover weight had significant positive correlation with leaf number, leaf length and plant height.

4.3. Fibre Fractions

The significant variations among sorghum varieties stover in ADF, NDF, lignin, cellulose and hemicelluloses were mainly genetical. Similar variations in stover structural carbohydrates were reported in sorghum varieties in Texas, USA [20]. Neutral detergent fibre, ADF and lignin in sorghum stover were within the range reported by many authors [4, 25, 26]. Butana variety stover had the least NDF and ADF and was expected to have better nutritive value. Sorghum stover in Nigeria had higher NDF than the varieties in Gadarif State, except Arfadamac. Lignin was higher than Zahratelgadambalia and Butana varieties [14]. Cellulose was higher than Zahratelgadambalia and Bashier.

5. CONCLUSIONS

Sorghum varieties differed in DM yield and fibre fractions. Dry matter yield was highest in Zahratelgadambalia and lowest in Basheir. Dry matter yield had highly significant positive correlation with plant height and positive correlations with stem weight, number of leaves/plant and weight of leaves. Butana had the highest CP (6%) and lowest crude fibre (25.0%) and Arfadamac had the highest CF (37.0%).

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Table-1. Different sorghum varieties stover morphological traits and dry matter yield in Gadarif State, Sudan.

Varieties/ Parameters	Height (cm)	Stem thickness(cm)	Leaves weight (g)	Stem Weight(g)	Leaves / plant	Leaf:stem	DM yield (kg/fed)
Bashier	84.78 ^c	4.30 ^b	11.13 ^a	22.17 ^b	3.33 ^c	0.504 ^a	1260 ^b
Zahratelgadambalia	136.7 ^a	3.28 ^c	10.17 ^{Ab}	40.1 ^a	4.33 ^{ab}	0.254 ^d	2520 ^a
Butana	70.7 ^c	4.67 ^b	9.63 ^b	21.3 ^b	4.10 ^{bc}	0.459 ^b	1918 ^{ab}
Arfagadamac	095.0 ^b	5.63 ^a	8.77 ^b	21.9 ^b	5.05 ^a	0.403 ^c	2114 ^a
C.V	8.17	10.42	7.97	3.52	11.83	5.01	22.44
S.E.	7.67	0.28	0.23	2.40	0.22	0.03	174.6

Means with different superscripts in the same column are significantly ($p < 0.05$) different.
SE= Standard error of the mean; C.V= Coefficient of variation. Feddan=0.42 ha

Table-2. The correlation coefficients among stover morphological traits and with dry matter yield in different sorghum varieties in Gadarif State, Sudan.

Parameters	PH	ST	SW	NL/P	WL	LSR	DMY
PH	-	-0.70	0.512	0.94	0.087	-0.995*	0.999**
ST		-	-0.972*	-0.902	0.650	0.771	-0.734
SW			-	0.774	-0.811	-0.599	0.553
NL/P				-	-0.258	-0.97*	0.955
WL					-	0.017	0.039
LSR						-	-0.998**
DMY							-

*= Significant at P<0.05; **= Highly significant at P<0.01

PH= Plant height; ST= Stem thickness; SW= Stem weight; NL/P= Number of leaves / plant, WL = weight of leaves; LSR= Leaf: stem; DMY= Dry matter yield

Table-3. Fibre fractions in different sorghum varieties stover in Gadarif State, Sudan.

Parameter	Bashier	Sorghum varieties Zahratelgadambalia	Butana	Arfadamac	S.E.	C.V
ADF	51.0 ^c	67.4 ^b	46.4 ^d	70.0 ^a	3.07	0.02
NDF	64.8 ^c	74.6 ^b	59.9 ^d	79.3 ^a	2.32	0.02
Lignin	10.9 ^c	13.5 ^a	11.3 ^b	9.2 ^d	0.46	0.08
Cellulose	40.2 ^c	53.9 ^b	35.1 ^d	60.7 ^a	3.11	0.01
Hemicellulose	13.8 ^a	07.2 ^d	13.5 ^b	09.3 ^c	0.84	0.15

NDF= Neutral detergent fibre ; ADF= Acid detergent fibre; S.E.= Standard error of mean; C.V= Coefficient of variation.

Means with different superscripts in the same row are significantly different at p<0.05;

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