Biomass Yield and Nutritive Value of Ten Napier Grass (Pennisetum purpureum) Accessions at Areka, Southern Ethiopia

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Abstract: An experiment was conducted to evaluatethe biomass yield and nutritive value of tenaccessions of Napier grass (Pennisetumpurpureum) at Areka Agricultural Research Center. The accessions evaluated were Acc. No. 16817, 16791, 16794, 16913, 16815, 16783, 15743, 16902, 16819 and local check in a Randomized Complete Block Design (RCBD) with three replications each. The biomass yield, height and leaf:stem ratio were measured every 2 months of plant growth and chemical composition and organic matter (OM) digestibility were analyzed after 18 months. The results indicated that leaf to stem ratio of accession No. 16902 was (p<0.05) higher than acc. No 16783, local, 16794, 16791, 16819 but similar to acc No.16817, 16913, 15743, 16815. DM yield of the acc No. 16815 (17.90 t/ha) and local (16.68 t/ha) were (p<0.05) higher than accessions No.16794 (6.95t/ha) and 16819 (10.62t/ha) but similar to accessions No. 16913(13.86t/ha), 15743 (11.98 t/ha), 16902(11.95t/ha), 16783 (12.32t/ha), 16817 (13.87 t/ha) and 16791(12.56 t/ha). The crude protein, OM, neutral detergent fiber, acid detergent fiber, lignin and organic matter digestibility were not different (p>0.05) among accessions. It was concluded that the accessions No. 16913, 16815, 16902, 15743 and 16817 were found promising to be scaled up or out along with the previously adapted local accessions under climatic conditions similar to Areka.

Key words: Napier grass Accession · Dry matter · Nutritive values · In vitro digestibility · Southern Ethiopia

INTRODUCTION

Livestock production is an integral part of the subsistence crop-livestock mixed farming systems of Ethiopia. The major constraint that influences the productivity of livestock is shortage of feed both in quantity and quality [1]. The major feed resources for livestock come from natural pasture and crop residue [2]. However, they are poor in quality and provide inadequate protein, energy, vitamins and minerals [3].

Nevertheless, the feed supply to animals can be improved by cultivation of tropically adapted forage species, which give reasonable yield under drought and unstable climatic conditions. One of such forages is the Napier (Pennisetumpurpureum) grass. It is a tall perennial grass and well adapted to an altitude up to 2500m and Rainfall 600-1000mm [4]. Napiergrass is an adaptable, vigorous, highly productive and withstands considerable periods of drought. It rapidly recovers from stagnation of growth with the onset of rains after extended dry periods [5]. Napier grass is palatable and could be fed fresh, as silage or directly grazed on the field [6, 7].

Structural cell wall carbohydrates of Napier grass increase rapidly whereas crude protein (CP) content and digestibility decreases rapidly with advance in maturity [8]. There are varietal differences in the proportion of botanical fractions and chemical composition [9, 10]. The proportion of leaf fractions is positively correlated to the concentration of plant CP and digestible energy [9] and in turn determines the intake and animal performance [11, 9]. Scaling up of options of proven accessions are needed to widen the genetic diversity of the Napier grass since some cultivars have shown better resistance than others in the outbreak of new diseases [12]. The objective of this study was to evaluate the biomass yield and nutritive value of nine imported accessions and one local variety of Napier grass.
MATERIALS AND METHODS

Study Site: The experiment was conducted at Areka Agricultural Research Center, ManteDubo sub-research site. The site is located at a distance of about 300km south of the capital, Addis Ababa and at an altitude of 1711 masl and situated at N07'06.4312'E037'41.688'. The rainfall is bimodal and ranges between 1201 and 1600mm with highest from July to September. The mean annual temperature ranges between 22 and 24°C.

Source of Planting Material and Experimental Design: Nine imported and one local accessions of Napier(Pennisetum purpureum) grass were brought from Ethiopian Institute of Agricultural Research, Debrezeit Agricultural Research Center and planted at Areka Agricultural Research Center for performance evaluation. The Napier accessions (treatments) were 16817, 16791, 16794, 16813, 16815, 16783, 16743, 16902, 16819 and local check with Randomized Complete Block Design (RCBD) with three replications each. Local check was the previously released and widely adopted at farmer’s conditions and used as a control to compare the performance of other accessions in the study area. A single plot of 4 x 3m (12m²) containing 4 rows, each row 0.75m apart and plant spaced 0.25m within rows. The spaces between plots were 1.5m and the total area of experiment was 15 x 43.5m (652.5m²). Therefore, a total of thirty (30) plots each measuring 12m² were used for the planting.

Land Preparation and Planting: A total area of 15 x 43.5m (652.5m²) plot was ploughed and harrowed with a tractor. The field was divided in to thirty (30) plots with each plot measuring 12m². The parent plants were cut into stems with three nodes per cutting for planting. The cuttings were planted20cm deep at an angle of about 40°C. Plant population per plot were 64 (4m/0.25m*4 row) and plant population per accessions were 192 (64 plants *3 reps).

Dry Matter Yield Determination: An area of 8m²(2x4m) was randomly selected and harvested with a sickle at a height of 20cm above the ground. The total harvest per plot of fresh forage was weight and about 500g of sub samples taken from each plot and chopped in short lengths (2-4cm) for dry matter determination using AOAC [13] procedure. This involves drying in an oven at 102°C overnight. The DM yield of each accession at each plot was calculated on dry matter basis by multiplying the percentage dry weight of the sub-samples from the whole fraction to the fresh weight of the respective accessions at each plot per 8m² and converted to hectares.

Height and Leaf to Steam Ratio (LTSR) Determination: The height of plant at each plot was measured by measuring all the samples harvested for DM yield determination and the average height of all the plants was taken as a height of plant at each plot. LTSR of Napier accessions at each plot was measured by the fraction of weight of leaf of plants sampled for herbage yield determination to the weight of stem of plants sampled for herbage yield determination.

Chemical Analysis: Forage samples of each accession, prepared following the procedure of AOAC (2000), were dried at 60°C for 48 hours. The samples were sent to the Holeta Agricultural Research Center for laboratory analysis. Accordingly, the CP, organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin and organic matter digestibility (OMD) values were analyzed.

Statistical Analysis: Data collected were subjected to Analysis of variance (ANOVA) using the General Linear Model procedure of SPSS version 16 (2006). Where F-tests declared significance at P<0.05, means were separated using Duncan multiple range test.

RESULTS AND DISCUSSION

Effect of Accession on Biomass Yield: The DM yield of the accessions No. 16815 and local were higher (p<0.05) than the accession No.16794 and 16819 but similar to the accession No.16783, 16902, 16817, 15743, 16817 and 16791 (Table 1). The mean DM yield of Napier accessions in the present study at 2 months age (12.77 tonsDM/ha) was lower than the previous findings of which is 41.05tDM/ha at 4 months age [14] which might be due to the proportional increment of dry matter yield with advance in age of cutting [15]. The high dry matter recorded for accession16815, local, 16902, 16817, 16791, 15743, 16913 and 16783 suggested that these accessions are competent with local accession and less moisture is present in the grass and will therefore reduce the rate at which the grass deteriorate when stored [14].
Table 1: Effect of accession on DM yield (ton/ha), leaf to steam ratio and height (m) of ten Napier accessions at 2 months of age

<table>
<thead>
<tr>
<th>Items</th>
<th>Local 16783</th>
<th>16902</th>
<th>16794</th>
<th>16817</th>
<th>16913</th>
<th>16791</th>
<th>16819</th>
<th>15743</th>
<th>16815</th>
<th>Mean</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTSR</td>
<td>0.54abc</td>
<td>0.53ab</td>
<td>1.01a</td>
<td>0.57bc</td>
<td>0.65bc</td>
<td>0.31c</td>
<td>0.52ab</td>
<td>0.69abc</td>
<td>0.74a</td>
<td>0.62</td>
<td>0.04</td>
</tr>
<tr>
<td>DM yield</td>
<td>16.7bc</td>
<td>12.3bc</td>
<td>12.0bc</td>
<td>6.95bc</td>
<td>13.9bc</td>
<td>13.9bc</td>
<td>12.6bc</td>
<td>10.62bc</td>
<td>12.0bc</td>
<td>17.9</td>
<td>12.77</td>
</tr>
<tr>
<td>Height</td>
<td>1.00</td>
<td>1.20</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.30</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
<td>1.10</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Mean with different superscript in the same row are significantly different at p<0.05.

Table 2: The chemical composition (%) of ten pooled Napier accessions at full maturity (about 18 month’s age)

<table>
<thead>
<tr>
<th>Accession</th>
<th>DM</th>
<th>OM</th>
<th>NDF</th>
<th>ADF</th>
<th>Lignin</th>
<th>CP</th>
<th>OMD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>93.2</td>
<td>91.0</td>
<td>81.7</td>
<td>42.2</td>
<td>8.00</td>
<td>4.86</td>
<td>39.0</td>
</tr>
<tr>
<td>16902</td>
<td>91.9</td>
<td>89.8</td>
<td>80.4</td>
<td>41.5</td>
<td>8.09</td>
<td>6.66</td>
<td>40.0</td>
</tr>
<tr>
<td>16783</td>
<td>92.8</td>
<td>90.2</td>
<td>83.4</td>
<td>44.8</td>
<td>8.37</td>
<td>4.57</td>
<td>40.0</td>
</tr>
<tr>
<td>16794</td>
<td>92.9</td>
<td>90.1</td>
<td>83.6</td>
<td>43.5</td>
<td>8.04</td>
<td>4.23</td>
<td>36.0</td>
</tr>
<tr>
<td>16817</td>
<td>92.0</td>
<td>89.8</td>
<td>81.0</td>
<td>43.8</td>
<td>8.80</td>
<td>5.62</td>
<td>42.0</td>
</tr>
<tr>
<td>16913</td>
<td>93.0</td>
<td>88.9</td>
<td>78.6</td>
<td>42.7</td>
<td>7.83</td>
<td>6.47</td>
<td>43.0</td>
</tr>
<tr>
<td>16791</td>
<td>93.6</td>
<td>90.0</td>
<td>81.0</td>
<td>44.5</td>
<td>8.27</td>
<td>5.30</td>
<td>40.0</td>
</tr>
<tr>
<td>16819</td>
<td>93.1</td>
<td>88.9</td>
<td>81.9</td>
<td>43.9</td>
<td>8.30</td>
<td>4.46</td>
<td>41.0</td>
</tr>
<tr>
<td>15743</td>
<td>93.1</td>
<td>90.1</td>
<td>79.8</td>
<td>41.5</td>
<td>8.01</td>
<td>5.63</td>
<td>39.0</td>
</tr>
<tr>
<td>16815</td>
<td>92.7</td>
<td>87.8</td>
<td>79.0</td>
<td>41.4</td>
<td>7.86</td>
<td>6.36</td>
<td>41.0</td>
</tr>
<tr>
<td>Mean</td>
<td>92.8</td>
<td>89.7</td>
<td>81.0</td>
<td>42.9</td>
<td>8.16</td>
<td>5.42</td>
<td>40.0</td>
</tr>
<tr>
<td>SE</td>
<td>0.13</td>
<td>0.28</td>
<td>0.70</td>
<td>0.51</td>
<td>0.10</td>
<td>0.24</td>
<td>1.37</td>
</tr>
</tbody>
</table>

Effects of Accession on Leaf to Stem Ratio and Plant Height: The LTSR of Napier accession 16902 was higher (p<0.05) than Napier accessions 16783, local, 16794, 16791, 16819 but similar to accessions 16817, 16913, 15743 and 16815 indicating that accessions 16902, 16817, 16913, 15743 and 16815 contained higher nutrients than others and the performance of animals is closely related to the amount of leaf in the diet because leaf is generally of higher nutritive value than stem [16]. The LTSR of accession No16815 was higher (p<0.05) than accession 16791. In the present study, the LTSR ranging from 0.31 (accession 16791) to 1.01 (accession 16902) were different from the range of ratios reported by Elkana et al. [17] who reported that 1.7 to 3.1 might be due to varietal differences of Napier grass. Accession 16791 recorded the lowest (0.31) LTSR but the tallest (1.3) of all the accessions were similar to the trend reported from western Kenya [17].

The height of Napier grass was similar (p>0.05) among accessions at 2 months of age (Table 1). In the present study, the minimum height of 1m was found in the accession No. 16902, local, 16794, 16817, 16913, 16819, 15743 and 16815 while the maximum height of 1.3 m was found in accession No. 16783 and 16791 which indicated that at 2 months of age all Napier accessions attained the optimum plant harvesting stage (1-1.5m) for forage [4].

Chemical Composition: The chemical composition of 10 Napier accessions are presented in Table 2. The CP, OM, NDF, ADF, lignin and OMD were not different (p>0.05) among accessions.

The overall mean in CP and OMD obtained at 18 months age in the present study (5.42 and 40.04%), respectively, however, are much lower than the mean values at 2 to 4 months reported previously (10.77 and 62.5%), respectively, as reported by Taye et al. [15]. This might be due to the Napier grass considered in this study is high in CP and OMD that decreases rapidly with advance in maturity [8]. We found the highest CP (6.66%) in Napier accession No. 16902 while the lowest CP (4.23%) in accession No. 16794. However, the CP content of all the Napier accessions in the present study was below the minimum level (7%) required for optimum rumen function [8]. This might be due to the grasses were harvested relatively at old age. Therefore, under practical production settings Napier grass harvest at 18 months age requires higher supplementation to support reasonable productivity of animals than Napier grass harvest at earlier stages of growth.

The overall mean in OMD obtained at 18 months of age in the present study (40.04%), however, is much lower than the mean values at 2 to 4 months reported previously (62.5%) by Taye et al. [15] was might be due
The higher crude protein and organic matter digestibility constituent of forage plants are better in quality than the same forage plants with lower crude protein and organic matter digestibility constituents. Therefore, Napier grass with better crude protein and digestibility content ranked as the better performed accession. Therefore, Napier accessions No. 16913, 16902, 16815, 16817 and 15743 were ranked 1st, 2nd, 3rd, 4th and 5th, respectively and outperformed than local and accessions No.16791, 16819, 16783 and 16794 in terms of CP content and OMD.

**Correlation Studies:** The ADF was positively correlated with OM (0.43*) and NDF (0.78**) (Table 4). As it would expected, the ADL (lignin) was positively correlated with NDF (0.51*) and ADF (0.73**). On the other hand, the CP content was negatively correlated with NDF (0.43*) while its correlation with OM, ADF and ADL was negative and weak. CP, OMD and LTSR were positively correlated and that means the accession with higher leaf to stem ratio, usually had the higher CP content and OMD and in turn determines the intake and animal performance [11, 9]. The negative correlation between cell wall components (ADF and NDF) and *in vitro* digestibility was reported previously in similar agro-ecological areas [20]. It is also in line with other reports [8] who reported reduced digestibility of roughages with higher fiber contents.
CONCLUSIONS

The Napier accession No. 16913, 16815, 16902, 15743 and 16817 outperformed local accessions in terms of leaf to steam ratio and ranked better in CP and OMD and they are similar to local accession in terms of dry matter yield. Therefore, Napier accessions No. 16913, 16815 and 16902 are better options to be scaled up/out with the previously adapted local accession under the existing climatic conditions of Areka.

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REFERENCES


