Adaptation Trial of Improved Perennial Grass Varieties/Accessions at the Highland of Guji zone, Bore, Ethiopia

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This study was conducted with an objective of adapting, see the yield, quality and recommend improved perennial grass accessions to the highland of Guji Zone, Ethiopia in a randomized complete block design (RCBD) with three blocks. Accessions were (Phalaris aquatica Sirossa, Phalaris aquatica Sirocco, ILCA 14983, ILCA 14984 and variety X (Holeta local). Broadcasting method for Phalaris and 0.5meter between plant and 1meter between row spacing for Napier grass was applied at planting time each plot measuring 4meter x 6meter. Yield parameters were analyzed using statistical analysis software (SAS) and the means of quality parameters were compared with standards. Accordingly, Napier variety X was significant in survival rate, number of shoot, date of first harvest and harvesting frequency at (P<0.05) and highest in crude protein (CP) content. ILCA 14983 were also significant in survival rate and number of shoot and has highest in vitro dry matter digestibility (DOMD). Phalaris aquatica Sirossa was significant in green forage yield and has highest in vitro dry matter digestibility (DOMD). Generally, considering most parameters, Variety X and ILCA 14983 from Napier grass, Phalaris aquatica Sirossa from Phalaris were selected and recommended to the area and has to be evaluated under farmers' conditions.

Key words: forage, Napier, perennial, survival, yield

INTRODUCTION

Despite the large number of livestock resources the country own, its productivity is extremely low. The major constraint to such low productivity is shortage of livestock feeds in terms of quantity and quality, especially during the dry season (Ahmed et al., 2010). Feed supply from natural pasture fluctuates following seasonal dynamics of rainfall (Solomon et al., 2008). Despite, these problems, ruminants continue to depend primarily on forages from natural pastures and crop residues.

There are grass forage varieties which are adapted to different agro ecology of the country. These are divided as annuals and perennials in life forms. Napier grass (Pennisetum purpureum) and Phalaris are among perennial grasses which are adapted to the high land of country (Kediret et al., 2007). Napier grass (Pennisetum purpureum) has become by far the most important species due to its wide ecological range of adaptation (from sea level to over 2,000 meters), high yield and ease of propagation and management (Ordoño, 2006; ILRI, 2010a; ILRI, 2013). The grass is propagated vegetatively by using stem cuttings, root splits or shoot tips which usually vary across agro ecologies (Getnet and Gezahagn, 2012). This grass can provide a continual supply of green forage throughout the year and best fits to all intensive small scale farming systems (Alemayehu, 1997). However, their yield performances vary across testing environments.

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Removing or reducing nutritional constraints leads to dramatic improvement in livestock production and productivity. Dynamic changes have been made in the areas of feed evaluation, nutrient requirement and feeding systems (Seyoum et al., n.d.). Several environmental, genetic and genotype by environment interaction aspects are expected to influence chemical composition and nutritive value. Compositional data information on digestibility and estimated metabolizable energy offers opportunity to formulation of least cost ration.

There is no any animal feed technology which is tested in the study area (Guji zone) and no information on forage nutritional quality due to the remoteness of the area and Bore Agricultural Research was established recently. Therefore, this experiment was conducted with the objectives of adapting, see the yield, quality and recommend improved perennial grass (Phalaris and Napier grass (Pennisetium Purpureum)) varieties/accessions to the area so as to address farmers in high quality and large quantity of forages.

**MATERIALS AND METHODS**

**Description of the Study Area**

The experiment was carried out at Bore Agricultural Research Center, which is one of the recently established Research Centers of the Oromia Agricultural Research Institute (OARI) in Bore district, Guji Zone of Oromia. Bore district is located at 385 km to the south from Addis Ababa and 220 km from the Guji Zone capital city (Negele) with geographical location of 557°23” to 626°52” N latitudes and 3825°51” to 3856°21” E longitudes, South-eastern Oromia. It has moist humid and sub humid moisture condition, with relatively longer growing season. The annual rain fall is about 1400-1800mm and the annual temperatures of the district ranged from 10.1 to 20°C. The major soil types are Nitosols (red basaltic soils) and Orthic Aerosols (Yazachew and Kasahun, 2011).

Bore Agricultural Research station is located at 7km from Bore district which is geographically located at 624°37” N latitude and 3834°76” E longitudes. The research site represents highlands of Guji Zone with an altitude of 2736m.a.s.l.receiving high rainfall characterized by bimodal distribution. The first rainy season extends from April to October and the second season starts late November and ends at the beginning of March. The soil type of the site is mostly black soil.

**Experimental Design and Conduction of the Experiment**

The trial was arranged in randomized complete block design (RCBD). There were three blocks each containing 2 plots of Phalaris accessions (Phalaris aquatica Sirossa and Phalaris aquatica Sirocco) resulting to six plots in total in 2010 summer season, 3 plots of Napier grass accessions (ILCA14983, ILCA 14984 and variety X (Holeta local)) resulting to nine plots in total with each plot measuring 4m x 6m at 2011 summer season. Distance between plots and replication were 1m and 1.5m respectively. Plots in each block were randomly assigned to each treatment. Broad casting method and 100kg DAP and 100kg UREA per hectare were applied for treatments of Phalaris aquatica Sirossa and Phalaris aquatica Sirocco. Row method and 0.5m between plant and 1m between row spacing (Tessema et al., 2002a) were applied at planting time for treatments of Napier grass (ILCA14983, ILCA 14984 and variety X (Holeta local)).

The nutrient analysis was conducted at Adami Tulu Agricultural Research Center and Holeta Agricultural Research Center Laboratory. Composite samples of Napier grass (ILCA14983, ILCA 14984 and variety X (Holeta local)) samples were taken at 1.5m height of the forage. Composite samples of Phalaris (Phalaris aquatica Sirossa and Phalaris aquatica Sirocco) were collected in green stage at 50% flowering. Samples were dried at 65°C in a forced draft oven for 72 hrs. Samples were grounded using a willy mill and allowed to pass through 1mm screen, run in duplicates and Dry matter, Ash, CP, NDF, ADF, ADL (lignin) and DOMD (In vitro dry matter Digestibility) were determined by Near Infrared Reflectance (NIR) analysis and Hemicellulose was calculated by subtracting the ADF from the NDF content while cellulose was determined by subtracting the ADL from the ADF content and data are carefully collected.

**Data Collected**

Date of emergency, survival rate, number of shoot/plant, plant height, date of first harvest, green forage yield and harvesting frequency of Napier grass and date of emergency, date of 50% flowering, date first harvest, plant height and green forage yield of Phalaris and chemical composition data were carefully collected for all accessions/varieties at consecutive years.

**Statistical Analysis**

Data on agronomic parameters and yield was analyzed by using SAS computer soft ware (SAS, 2002 version 9.1) and GLM model was used at 5% significance level. Means of chemical composition analysis were compared with standards.

**RESULT AND DISCUSSION**

**Yield and Yield Components**

**Napier grass (Pennisetum purpureum)**

The analysis of variance (Table 1) shows that some varieties have significant difference in survival rate,
The result of chemical analysis (Table 4) revealed that Phalaris aquatica Sirossa was significant in green forage yield and both are statistically the same in plant height.

**Chemical composition**

**Napier grass (Pennisetum purpureum)**

From the analyzed Napier grass (Table 3) variety X was highest in Crude Protein (CP), Neutral Detergent Fiber (NDF) and Acid Detergent Lignin (ADL) and less in Ash and Dry matter Percentage (DM%) and Organic Matter (OM) content. ILCA 14983 was highest in Ash, Acid detergent Fiber (ADF) and *in vitro* dry matter Digestibility (DOMD) and less in CP content. ILCA 14984 was highest in DM% and OM and less in NDF, ADF and ADL content and *Phalaris aquatica Sirossa* was highest in DOMD when compared to each other.

The CP content of all the tested Napier grass (Table 3) accessions (ILCA 14983, ILCA 14984 and Variety X) was below the average CP content of any feed (10.6) and the CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of any feed (10.6) and the CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the average CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982).

Table 1. Agronomic and yield parameters as influenced by Napier grass accessions/variety

<table>
<thead>
<tr>
<th>Accessions/Variety</th>
<th>Date of emergence</th>
<th>Survival rate</th>
<th>No of shoot/plant</th>
<th>Plant height in cm</th>
<th>Green yield in ton/ha</th>
<th>Date of first harvest</th>
<th>Harvesting frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILCA 14983</td>
<td>18.00</td>
<td>65.87ab</td>
<td>23.12ab</td>
<td>113.33a</td>
<td>37.93a</td>
<td>205.00b</td>
<td>2.00b</td>
</tr>
<tr>
<td>ILCA 14984</td>
<td>18.00</td>
<td>47.62b</td>
<td>14.44b</td>
<td>66.44a</td>
<td>13.00a</td>
<td>215.00a</td>
<td>2.00b</td>
</tr>
<tr>
<td>Variety X</td>
<td>18.00</td>
<td>84.13a</td>
<td>32.44a</td>
<td>121.11a</td>
<td>77.20a</td>
<td>170.00c</td>
<td>4.00c</td>
</tr>
<tr>
<td>SEM</td>
<td>0</td>
<td>14.97371</td>
<td>8.076510</td>
<td>29.71176</td>
<td>44.37181</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*a,b* Means in a column within the same category having different superscripts differ (P<0.05); cm = Cent Meter; DM = Dry Matter; ha = hectare and SEM = Standard Error of Means

Table 2. Agronomic and yield parameters as influenced by Phalaris accessions

<table>
<thead>
<tr>
<th>Accessions</th>
<th>Date of emergence</th>
<th>Date of flowering</th>
<th>Date of first harvest</th>
<th>Plant height in cm</th>
<th>Green forage yield tone/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalaris aquatica Sirossa</td>
<td>9.00</td>
<td>75.00</td>
<td>94.00</td>
<td>204.33</td>
<td>36.80b</td>
</tr>
<tr>
<td>Phalaris aquatica Sirossa</td>
<td>9.00</td>
<td>75.00</td>
<td>94.00</td>
<td>209.00</td>
<td>58.80b</td>
</tr>
<tr>
<td>SEM</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>12.33559</td>
<td>0</td>
</tr>
</tbody>
</table>

*a,b* Means in a column within the same category having different superscripts differ (P<0.05); cm = Cent Meter; DM = Dry Matter; ha = hectare and SEM = Standard Error of Means

Table 3. Chemical composition and digestibility as influenced by Napier grass accessions

<table>
<thead>
<tr>
<th>Accessions</th>
<th>DM %</th>
<th>Ash</th>
<th>OM</th>
<th>CP</th>
<th>NDF</th>
<th>ADL</th>
<th>ADF</th>
<th>ADL</th>
<th>DOMD</th>
<th>Cellulose</th>
<th>Hemi-cellulose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILCA 14983</td>
<td>93.18</td>
<td>9.05</td>
<td>84.12</td>
<td>3.79</td>
<td>70.16</td>
<td>50.27</td>
<td>9.49</td>
<td>53.42</td>
<td>40.78</td>
<td>19.89</td>
<td></td>
</tr>
<tr>
<td>ILCA 14984</td>
<td>93.80</td>
<td>8.50</td>
<td>85.33</td>
<td>3.90</td>
<td>70.12</td>
<td>48.23</td>
<td>8.78</td>
<td>52.41</td>
<td>39.45</td>
<td>21.89</td>
<td></td>
</tr>
<tr>
<td>Variety X</td>
<td>90.40</td>
<td>6.48</td>
<td>83.92</td>
<td>7.68</td>
<td>79.65</td>
<td>48.65</td>
<td>11.31</td>
<td>45.75</td>
<td>37.34</td>
<td>31.00</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>92.460</td>
<td>8.01</td>
<td>84.456</td>
<td>5.123</td>
<td>73.31</td>
<td>49.05</td>
<td>9.86</td>
<td>50.526</td>
<td>39.19</td>
<td>24.26</td>
<td></td>
</tr>
</tbody>
</table>

ADF = Acid Detergent Fiber; ADL = Acid Detergent Lignin; CP = Crude Protein; CV = Coefficient of Variation; DM = Dry matter; DOMD = *in vitro* dry matter Digestibility; LSD = Least Significant difference; NDF = Neutral Detergent Fiber and OM = Organic Matter

The result of chemical analysis (Table 4) revealed that *Phalaris aquatica Sirossa* was highest in OM, CP, NDF, ADF and ADL content and *Phalaris aquatica Sirossa* was highest in DOMD when compared to each other.

The CP content of all the tested Napier grass (Table 3) accessions (ILCA 14983, ILCA 14984 and Variety X) was below the average CP content of any feed (10.6) and the CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982). This level of CP is below the recommended minimum level of CP in the diet of ruminants for optimum rumen function (Van Soest, 1994). The result is also less than the CP content of obtained by (Tessema, 2005) in north east Ethiopia which was (12.2, 12.4 and 13.2) respectively. NDF content of all accessions/varieties was greater than the average NDF content of feed which is 56.2 and also higher than the result obtained by (Tessema, 2005) which was (53.5, 54.7 and 58.2) respectively. DOMD content of all accessions/varieties was above the average DOMD content of a feed (50.3) except Variety X and below energy supplement feeds which is 82.2 and less than that of obtained by (Tessema, 2005) which was (65.2, 64.7 and 57.5) respectively. The difference is may be due to environmental factors (soil and temperature), harvesting stage, application of fertilizers and three years composite sample of the previous study and method of analysis employed. The CP content of all the tested Phalaris (Table 4) accessions was also less than the average CP content of any feed (10.6) and the CP content of young herbage to be as high as 14 to 16% (Van Soest, 1982).
Table 4. Chemical composition and digestibility as influenced by Phalaris accessions

<table>
<thead>
<tr>
<th>Accessions</th>
<th>DM%</th>
<th>Ash</th>
<th>OM</th>
<th>CP</th>
<th>NDF</th>
<th>ADF</th>
<th>ADL</th>
<th>DOMD</th>
<th>Cellulose</th>
<th>Hemi-cellulose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phalaris aquatica Sirocco</td>
<td>93.10</td>
<td>12.23</td>
<td>93.10</td>
<td>4.92</td>
<td>80.87</td>
<td>73.58</td>
<td>34.18</td>
<td>40.49</td>
<td>39.40</td>
<td>7.29</td>
</tr>
<tr>
<td>Phalaris aquatica Sirossa</td>
<td>92.82</td>
<td>10.63</td>
<td>82.19</td>
<td>4.27</td>
<td>72.83</td>
<td>38.58</td>
<td>30.93</td>
<td>59.83</td>
<td>7.65</td>
<td>34.25</td>
</tr>
<tr>
<td>Mean</td>
<td>92.96</td>
<td>11.43</td>
<td>87.65</td>
<td>4.59</td>
<td>74.87</td>
<td>56.08</td>
<td>32.55</td>
<td>50.16</td>
<td>23.53</td>
<td>18.79</td>
</tr>
</tbody>
</table>

ADF= Acid Detergent Fiber; ADL= Acid Detergent Lignin; CP= Crude Protein; CV= Coefficient of Variation; DM= Dry matter; DOMD= In vitro dry matter Digestibility; LSD= Least Significant difference; NDF= Neutral Detergent Fiber and OM= Organic Matter

Roughage diets with NDF content of 45-65 and below 45% were generally considered as medium and high quality feeds, respectively (Singh and Oosting, 1992). However, the NDF content of all accessions of Napier grass and Phalaris was higher than 65% which classifies the feeds under poor condition and ranged above the 66.2% average value reported for tropical grasses (Van Soest, 1994). Therefore, some improvement mechanisms should have to be employed. Roughages with less than 40% ADF is categorized as high quality and those with greater than 40% as poor quality (Kellemens and Church, 1998), and the ADF value of Napier grass and Phalaris accessions/varieties in the present study was greater than 40% except *Phalaris aquatica Sirossa* which was (38.58%). This indicates that there has to be an enhancement of the feeding value of the grass through different agronomic techniques and application of fertilizer. All accessions/varieties of Napier grass and Phalaris ADL (limits DM intake) value was above 10% which is in a bad range (Reed et al., 1986) except *ILCA 14984 and ILCA 14983* which classifies the forage under good range of quality. The cellulose content of the tested forages was above the tropical grasses, which is 31.9% except *Phalaris aquatica Sirossa* (7.93) and hemi-cellulose content of less than tropical grasses, 35.4%, which classifies them as good quality as noted by Moore and Hatfield (1994).

The DOMD value of all tested forage accessions/varieties for the current study was in the range of the digestibility of tropical grasses which lies between 50 to 60% (Ow and Jaysuria, 1989) which is considered to be quality except for Napier Variety X (45.45) and *Phalaris aquatica Sirocco* (40.49%). DOMD content of all the tested forages with the exception of these two accessions/varieties were above the average content of any feed which is 50.3%, but less than the DOMD content of energy supplement feeds which are 82.2%. The increase in digestibility also will lead to increased feed intake as digestibility and feed intake are positively correlated (Van Soest, 1982).

CONCLUSION

Access to new and improved agricultural technologies especially that of forage is highly limited in Guji zone of Oromia, most probably due to the remoteness from the center and in accessibility of the area. That is why Bore Agricultural Research Center paved the way to adapt and recommend new accessions/varieties of forages to the area. Based on the results obtained from the adaptation and nutritional quality analysis improved perennial forage grass accessions, Variety X and *ILCA 14983* from Napier grass, *Phalaris aquatica Sirossa* from Phalaris were selected and recommended to the highland of the Guji zone. Therefore, those accessions have to be evaluated under farmers’ conditions so as to prove further their best performing ability.

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REFERENCE


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