ABSTRACT

This study was conducted to assess the nutritive quality of Elephant grass (Pennisetum purpureum Schumach) varieties in a mixed sward with Cook Stylo (Stylosanthes guianensis) fertilized with manure. The 3 × 9 factorial experiment was laid out in a split plot design. The treatments were three manure types (swine, poultry, and control) nine levels of grass/legume mixture with three replicates. The results showed that there were significant (P < 0.05) differences in most of the growth parameters of the grasses and legumes measured, irrespective of the intercrop and manure types. Fiber content of the plants increased (P < 0.05) with the intercrop. Swine fertilized plants had the highest DM, CP, EE (96.70%, 10.43%, 7.52%, 10.96%), respectively. Sole S. guianensis fertilized with swine manure had (P <0.05) highest CP content (17.10%) with the intercrop of Green local var. of P. purpureum intercropped with S. guianensis had (P <0.05) highest CP content (8.63%) than other mixtures. The mixture of green local var. of P. purpureum with S. guianensis produced the highest EE value (9.00%) out of the intercropped plants. Swine fertilized intercrop green local had the highest NDF content (67.67%) and ADF had the highest (P <0.05) value when Abeokuta 1 var. of P. purpureum was planted solely (36.67%) for ADL, the value ranged from 9.33% in sole Stylosanthes guianensis to 5.22% when Purple var. P. purpureum was intercropped with Stylosanthes guianensis.

In conclusion, swine manure increased CP content of the mixed sward and the mixture of P. purpureum and Stylosanthes guianensis increased the EE content.

INTRODUCTION

The nutritive quality of fodder plants especially grasses varies with the varieties, the botanical composition of the swards and the soil nutrient status which can be improved upon with application fertilizer especially organic fertilizer that have slow release of nutrients. Sustainable livestock production is highly dependent on the availability of quality feed and forage resources. Napier grass, also known as elephant, is one of the most important tropical forage crops. It is widely used in cut and carry feeding systems (Lukuyu et al., 2012; Kabirizi et al., 2015) and is of growing importance in other agricultural systems.

Elephant grass (Pennisetum purpureum (Schumach) is a deep-rooted high yielding perennial bunch grass that is native to Africa (Boonman, 1993). It grows in tropical and subtropical regions with a wide range of annual moisture from 750 to 2,500 mm rainfall and in altitudes ranging from sea level to over 2100 m, but frost appears to limit its cultivation above this altitude (Skerman and Riveros, 1990). It is the most popular perennial fodder recommended for the intensively managed smallholder crop-livestock farming systems in Africa, where 80% of the national milk output is produced. This is because it can withstand considerable periods of drought (Butt et al., 1993), produces greater dry matter (DM) yields than other tropical grasses (Skerman and Riveros, 1990; Boonman, 1997), and is of high nutritive value for dairy cattle particularly when supplemented with high quality feeds such as legumes (Nyambati et al., 2003). Napier grass on average contains 20% DM, 7 to 10% CP, 70% NDF, 45% ADF (Gwayumba et al., 2002; Islam et al., 2003).
The importance of herbaceous forage legumes in increasing herbage production of grasses and quality of feed produced has been recognized (Mureithi et al., 1995). Including a legume in fodder grasses production would not only provide a nitrogen source to promote grass growth but enhance the quality of feed. Legumes benefit grasses by contributing nitrogen to the soil through atmospheric fixation, decay of dead root nodules or mineralization of shed leaves. The inclusion of a legume in Napier grass-based diet has shown to improve animal performance in terms of milk production because of their high nutrient contents (Muenga et al., 1992). All plants depend on soil for their supply of nutrients and grazing ruminant animals obtain the majority of their nutrient from plant growing on such soil. Fertilizers are needed to improve soil chemical and biological properties, and this reflects on the phytounutrient contents and palatability of herbage plants (Alalade et al., 2013). Livestock farmers, many of whom are also crop producers prefer to use the little fertilizer available to them to boost grain yield rather than for pasture production (Nweze and Ezelfeanyi, 2010).

MATERIALS AND METHODS

The field experiment was carried out at the Teaching and Research Farm Unit of the Directorate of University Farms (DUFARMS), while the laboratory analysis was carried out at the laboratory of the Department of Pasture and Range Management, Federal University of Agriculture, Abeokuta (FUNAAB), Ogun State, Nigeria. The study was laid out in a factorial arrangement in a split plot design with experimental three manure types (swine, poultry and control), and nine levels of grass/legume mixture (S. guianensis + Pennisetum purpureum var. green local, sole Pennisetum purpureum var. green local, S. guianensis + Pennisetum purpureum var. purple, sole Pennisetum purpureum var. purple, S. guianensis + Pennisetum purpureum var. Abeokuta 1, sole Pennisetum purpureum var. Abeokuta 1, S. guianensis + Pennisetum purpureum var. Abeokuta 2, sole Pennisetum purpureum var. Abeokuta 2 and sole S. guianensis).

Proximate composition (dry matter, crude protein, ether extract and ash) were determined according to A.O.A.C. (1995) while non-fiber carbohydrate was calculated as NFC = 100 - (CP + Ash + EE + NDF). Fiber fraction (Neutral detergent fiber (NDF), Acid detergent fiber (ADF) and Acid Detergent Lignin (ADL) were determined with the procedure of Van Soest et al., (1991). Cellulose content was taken as the difference between ADF and ADL while hemicellulose content was calculated as the difference between NDF and ADF. Data collected were subjected to Two-Way Analysis of Variance and the treatment means were separated using Duncan's Multiple Range Test using SAS (1999) package.

RESULTS AND DISCUSSION

The effect of manure type and intercrop on proximate composition was significant (P <0.05) (Table 1).

Table 1: Effect of Manure Types and Intercrop on the Proximate Composition (%) of Four Varieties of P. purpureum/S. guianensis Mixed Sward.

<table>
<thead>
<tr>
<th>Manure</th>
<th>DM</th>
<th>CP</th>
<th>EE</th>
<th>ASH</th>
<th>NFC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swine</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poultry</td>
<td>96.00b</td>
<td>9.57c</td>
<td>6.63b</td>
<td>10.30b</td>
<td>11.80b</td>
</tr>
<tr>
<td>Control</td>
<td>95.19c</td>
<td>8.83b</td>
<td>6.00b</td>
<td>9.59c</td>
<td>14.76c</td>
</tr>
<tr>
<td>SEM</td>
<td>0.25</td>
<td>0.42</td>
<td>0.37</td>
<td>0.34</td>
<td>0.53</td>
</tr>
<tr>
<td><strong>Intercrop</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green local + S. guianensis</td>
<td>96.78ab</td>
<td>8.63d</td>
<td>8.33a</td>
<td>8.33c</td>
<td>9.59a</td>
</tr>
<tr>
<td>Purple + S. guianensis</td>
<td>96.65b</td>
<td>8.53e</td>
<td>7.11c</td>
<td>8.33c</td>
<td>11.36bc</td>
</tr>
<tr>
<td>Abeokuta 1 + S. guianensis</td>
<td>96.44b</td>
<td>8.48e</td>
<td>7.44c</td>
<td>9.00c</td>
<td>10.19c</td>
</tr>
<tr>
<td>Abeokuta 2 + S. guianensis</td>
<td>97.11ab</td>
<td>8.43a</td>
<td>7.11c</td>
<td>8.44c</td>
<td>9.79c</td>
</tr>
<tr>
<td>Green local</td>
<td>94.89c</td>
<td>9.11c</td>
<td>5.00c</td>
<td>12.11a</td>
<td>13.11ab</td>
</tr>
<tr>
<td>Purple</td>
<td>94.44c</td>
<td>9.07c</td>
<td>5.22c</td>
<td>11.56bc</td>
<td>13.04bc</td>
</tr>
<tr>
<td>Abeokuta 1</td>
<td>95.22c</td>
<td>9.08c</td>
<td>5.00c</td>
<td>11.00c</td>
<td>13.59bc</td>
</tr>
<tr>
<td>Abeokuta 2</td>
<td>94.89c</td>
<td>9.67b</td>
<td>4.89c</td>
<td>11.78b</td>
<td>13.22bc</td>
</tr>
<tr>
<td>Stylosanthes guianensis</td>
<td>97.44a</td>
<td>15.49a</td>
<td>10.33a</td>
<td>12.00a</td>
<td>10.07a</td>
</tr>
<tr>
<td>SEM</td>
<td>0.34</td>
<td>0.24</td>
<td>0.30</td>
<td>0.32</td>
<td>1.81</td>
</tr>
</tbody>
</table>

abc: Means in same column with different superscript are significantly (p<0.05) different
SEM= Standard Error of Mean
CP= Crude protein
DM= Dry matter
EE= Ether extract
NFC= Non-fiber carbohydrate
In this study, swine fertilized plants had higher DM, CP, EE, and ash value, the opposite was observed for NFC which was low in swine but was higher than all other four factors in control. The trend was also noticeable in intercrop with green local variety of *P. purpureum* having higher value EE but lower in NFC. The chemical constituents of forage usually indicate the level at which consumption and utilization would yield a positive animal output. In the present study, the CP content of the *S. guianensis* was higher than the range (4-8%) reported by Muraina et al. (2013), when same legume was harvested on natural pasture; this might be due to the stage of growth of the plant at harvest which was at 8 WAP.

Furthermore, the crude protein content of grasses as affected by manures in this study ranged between 8.83-10.43% which was above the required level for maintenance in ruminant animals. These values were also above the minimum range of 6.50-8.0% prescribed for optimum performance of tropical ruminant animals (Minson, 1981). The higher CP recorded for grasses fertilized with cattle and swine manure might be attributed to high carbon: nitrogen ratio which suggests that mineralization takes place at different rates between manures of different animal species (Dele, 2012).

The CP contents results were higher than the recommended requirement (6%) for ruminant animals in the tropics (NRC, 1984; Humpherys, 1991), minimum level (7%) required for optimum rumen functions (Van Soest, 1994) and 8% suggested for ruminal functions (Norton, 1994). The crude protein (CP) content of the intercropped in this study as affected by manure types fell within the range of 15.49% reported by Dele (2012) for *Panicum maximum* and *P. purpureum* when different manure were applied but was lower than sole planted grass which can be attributed to the low level of available P in the soil for the uptake of both plants and this was also corroborated by Tambara et al. (2017) who recorded that black oat had a higher average CP level than the rye grass mixture of black oat and Ryegrass and a consortia of Rye grass, forage peanut and red clover. It is also within the range of 6.48-14.45 reported by Muraina et al. (2015) for Stylosanthes species sown into natural pasture for ruminant feeding. Moreno, the crude protein (CP) content result obtained for the intercropped in this study after 8 weeks of planting was also in line with the report of Ajayi et al. (2007).

The *P. purpureum* intercropped with legume had higher crude protein values than the sole. This could be due to the result of beneficiary association of the legume as supported by Njoka-Njuru et al. (2006) that legumes has relatively high nitrogen content in their vegetative matter and also possess the ability to fix atmospheric nitrogen. Grass maturity is usually negatively related to CP content (Norton, 1981). Furthermore, the CP content of grass obtained in this study fell within the range (3-11%) reported for grasses in grazed natural pastures and fodder bank during late dry season and early rainy season (Mani et al., 1992). Ash content of *P. purpureum* were within the range (9-13%) reported for grasses by Mani et al. (1992).

The effect of manure types and intercrop on the fiber composition was significantly different (P <0.05) (Table 2). Neutral detergent fiber (NDF) value significantly (P <0.05) ranged from 50.00% in *S. guianensis* without manure to 69.67% in Abeokuta 1 variety of *P. purpureum* when swine manure was applied. Acid detergent fiber (ADF) recorded 27.33% in purple variety of *P. purpureum* intercropped with *S. guianensis* with swine manure application to 36.67% in *P. purpureum* with swine manure application while the value of acid detergent lignin (ADL) was 3.67% in purple variety of *P. purpureum* intercropped with *S. guianensis* without manure to 9.67% Abeokuta 2 variety of *P. purpureum* without manure application. Meanwhile, hemicellulose content ranged from 18.67% in sole *S. guianensis* without manure application to 39.00% Abeokuta 2 variety of *P. purpureum* intercropped with *S. guianensis* when swine manure was applied, the cellulose ranged from 20.33% in mono-cropped *S. guianensis* without manure to 31.00% in *P. purpureum* with swine manure was applied.

The NDF contents of *P. purpureum* and *S. guianensis* studied in this research were within the range reported for grasses (40-65.5%) and Stylosanthes (62-72%) (Mani et al., 1992) Roughages with NDF content of 45-65% and below 45% are generally considered as medium and high-quality feeds, respectively (Singh and Oosting, 1992). The NDF contents of these pasture components were higher than the range of medially rated feeds (Singh and Oosting, 1992). Thus, the NDF contents of *P. purpureum, Stylosanthes* and intercropped revealed that they would be poorly digested, since increase in NDF content has been associated with decrease in digestibility and hence feed intake (Van Soest, 1994; McDonald et al., 2002).

The NDF and ADF values of the grasses followed reversed followed pattern as in the CP with the NDF and ADF values. *P. purpureum* var. Abeokuta 1 intercropped with legume had the highest value and

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sole legume had the lowest (52.11%) for NDF and *P. purpureum* purple variety intercropped with stylo had the lowest value (28.89%). It was also recorded that ADF value of sole *P. purpureum* was lower than what was reported by Ojo et al. (2013) and this was lower than the intercropped. The less value recorded for ADF for the intercropped was in line with Njoka-Njuru et al. (2006) that intercropped legumes benefit the associating grasses by improving the CP content, thereby reducing the fiber content.

The ADF values obtained were slightly lower than that reported by Dele (2012) with respect to the effect of manure type. Acid Detergent Lignin was lower in value compared to what was reported by Olanite et al. (2013) which implies that the indigestible portion of the grasses was slightly lower. The ADF values of grasses were within ranges reported by Olanite (2002). The ADF values of sole *P. purpureum* was higher than that of the intercropped across manure types and this shows that the sole is less digestible compared to the intercrop by animals.

The ADL content from the results of this research for all plants and the intercrops were lower than the values reported by Babyle et al. (2007) for Napier grass. This may be due to differences in the harvest age or cutting-back of the sward which in this was at 8 WAP and would have reduced lignification and thereby aids digestibility and utilization. Hemicellulose values of grasses in the intercropped showed similar trend as the ADL and that the intercropping was more digestible than the sole. The fiber contents recorded in this study are within the range that can be degraded by ruminant animals as reported by Anele et al. (2008). Sole leguminous forages had lower NDF and ADF contents than sole grasses. This may be attributed to the fact that the amounts of cell wall constituents (NDF and ADF) in legumes are not as large as those of grasses. The proportion of cell wall constituents in grasses is larger than in legumes and also lignified quickly (Buxton 1996). This study confirms that intake and digestibility could be enhanced by the inclusion of legumes in sole grass forages.

**CONCLUSION**

The *P. purpureum* intercropped with *Stylosanthes guianensis* have higher crude protein than the sole, this could be attributed to the result of beneficiary effect of association of the legume plants with grasses. The results further indicate that there was significant gain in CP and reduced ADF and lignin with the application of swine manure into the mixed swards.

**Table 2:** Effect of Manure Type and Intercrop on the Fiber Composition (%) of Four Varieties of *P. purpureum* / *S. guianensis* Mixed Sward.

<table>
<thead>
<tr>
<th>Manure</th>
<th>NDF</th>
<th>ADF</th>
<th>ADL</th>
<th>Hemicellulose</th>
<th>Cellulose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swine</td>
<td>63.00&lt;sup&gt;a&lt;/sup&gt;</td>
<td>32.15</td>
<td>7.30</td>
<td>30.85&lt;sup&gt;a&lt;/sup&gt;</td>
<td>24.85</td>
</tr>
<tr>
<td>Poultry</td>
<td>61.70&lt;sup&gt;b&lt;/sup&gt;</td>
<td>32.44</td>
<td>6.96</td>
<td>29.41&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.33</td>
</tr>
<tr>
<td>Control</td>
<td>60.62&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.15</td>
<td>7.22</td>
<td>28.37&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.22</td>
</tr>
<tr>
<td>SEM</td>
<td>0.89</td>
<td>0.49</td>
<td>0.39</td>
<td>1.09</td>
<td>0.61</td>
</tr>
<tr>
<td><strong>Intercrop/Sole</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green local + <em>S. guianensis</em></td>
<td>65.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.56&lt;sup&gt;c&lt;/sup&gt;</td>
<td>6.33&lt;sup&gt;d&lt;/sup&gt;</td>
<td>33.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.22&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Purple + <em>S. guianensis</em></td>
<td>64.67&lt;sup&gt;c&lt;/sup&gt;</td>
<td>28.89&lt;sup&gt;c&lt;/sup&gt;</td>
<td>5.22&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td>23.67&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Abeckula 1 + <em>S. guianensis</em></td>
<td>64.89&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.11&lt;sup&gt;d&lt;/sup&gt;</td>
<td>5.89&lt;sup&gt;d&lt;/sup&gt;</td>
<td>33.22&lt;sup&gt;b&lt;/sup&gt;</td>
<td>25.22&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Abeckula 2 + <em>S. guianensis</em></td>
<td>66.22&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32.00&lt;sup&gt;d&lt;/sup&gt;</td>
<td>6.33&lt;sup&gt;d&lt;/sup&gt;</td>
<td>34.22&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.67&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Green local</td>
<td>60.67&lt;sup&gt;c&lt;/sup&gt;</td>
<td>33.22&lt;sup&gt;c&lt;/sup&gt;</td>
<td>8.00&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>27.44&lt;sup&gt;a&lt;/sup&gt;</td>
<td>25.22&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Purple</td>
<td>61.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>34.11&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>8.00&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>27.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26.11&lt;sup&gt;bc&lt;/sup&gt;</td>
</tr>
<tr>
<td>Abeckula 1</td>
<td>61.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>35.44&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.11&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>25.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>28.33&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Abeckula 2</td>
<td>60.44&lt;sup&gt;c&lt;/sup&gt;</td>
<td>33.00&lt;sup&gt;cd&lt;/sup&gt;</td>
<td>8.22&lt;sup&gt;b&lt;/sup&gt;</td>
<td>27.44&lt;sup&gt;b&lt;/sup&gt;</td>
<td>24.78&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td><em>Stylosanthes guianensis</em></td>
<td>52.11&lt;sup&gt;c&lt;/sup&gt;</td>
<td>31.33&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>20.78&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.00&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>SEM</td>
<td>0.79</td>
<td>0.64</td>
<td>0.57</td>
<td>1.08</td>
<td>0.93</td>
</tr>
</tbody>
</table>

<sup>a,b,c,d</sup>: Means in same column for each factor with different superscript are significantly (p<0.05) different

SEM= Standard Error of Mean
NDF= Neutral Detergent Fibre
ADF= Acid Detergent Fibre
ADL= Acid Detergent Lignin
REFERENCES


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**SUGGESTED CITATION**