Effect of age of regrowth on yield and herbage quality of *Panicum coloratum* under sub humid climatic conditions of Ethiopia

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The effect of stage of harvest on dry matter (DM) yield and herbage nutritive value of *Panicum coloratum* under sub humid climatic conditions of western Ethiopia was evaluated. Three harvesting stage treatments (8, 10 and 12 weeks of regrowth age) were assessed. The herbage DM yield (P<0.05); and leaf (P<0.05) and stem component DM yields (P<0.01); and leaf to stem ratio (P<0.001) values were significantly affected by the age of regrowth. Herbage and stem component DM yields; and stand density exhibited an increasing trend with age of regrowth. Mean herbage DM yield ranged from 11.04±0.91tha⁻¹ to 14.71±0.91tha⁻¹. The crude protein (CP) content was 8.28±0.34 and 8.43±0.34% for the 8 and 10 weeks treatments, respectively, while it declined to 6.27±0.34% for samples harvested at 12 weeks of age. Mean values of neutral detergent fibre (NDF) were generally high for all harvesting treatments, the values ranging from 74.02±0.85 to 77.50±0.85%. The in vitro DM digestibility (IVDMD) values ranged from 46.92% for the 12 weeks to 53.65% for the 8 week harvests. The calcium concentration ranged from 0.38±0.05% for the 10 weeks treatment to 0.51±0.05% for that of 10 weeks. Similarly, phosphorus content varied from 0.13±0.005 to 0.15±0.005% and no clear trend was observed with stage of maturity. It was recommended that the grass be harvested at 8 weeks of regrowth age for optimal yield and quality.

**Key words:** Dry matter yield, leaf to stem ratio, crude protein, neutral detergent fibre, in vitro dry matter digestibility, calcium, potassium.

**INTRODUCTION**

*Panicum coloratum* is one of the grass species recommended for production in sub humid tropical areas of the western zones of Ethiopia. Its herbage production potential and nutritional quality was reported to be influenced, among other factors, by stand age at harvest (Bogdan, 1977). The effect of stand age on yield and quality of grasses has been a subject of various experiments (Daniel, 1990). The yield and nutritional values of forages was reported to decrease by the proceeding development of the crop during the growing season (Steen, 1992). In view of that the crude protein (CP) and dry matter digestibility decreases leading to impairment of animal performance. During the maturing process, concentration of minerals does also vary. Vona et al. (1984), for example, have reported calcium levels to increase with maturity and Daniel (1990), on the other hand, has observed inconsistent trends in calcium concentration for pure stands of *Chloris gayana* and
Medicago sativa. Similarly Vona et al. (1984) have reported the concentration of phosphorus to decline considerably with advancing maturity.

Information on yield and nutritive value of P. coloratum as influenced by stage of harvest is not available though the species was recommended for use based on prior appraisal of dry matter (DM) yield potential under germplasm evaluation programs in western subhumid areas of Oromia, Ethiopia. This study, therefore, was undertaken to evaluate the effect of stage of harvest on DM yield and herbage quality of the grass species under sub humid tropical climatic conditions in western Oromia, Ethiopia.

MATERIALS AND METHODS

The study was conducted at the Bako Agricultural Research Center (BARC) during the long rainy season of 1999. The study area is located at 09°6` N latitude and 37°09` E longitude; about 260km west of Addis Ababa with an altitude of 1650 m above sea level (IAR, 1991). The area experiences one main rainy season, extending from May to September and the mean annual rainfall is about 1280 mm with a peak in July and mean annual temperature is 20°C, with a mean minimum and maximum temperature of 13 and 27°C, respectively.

Stand establishment

Seeds of P. coloratum were planted on well prepared seed beds at a seed rate of 10 kg/ha in early weeks of 1 June 1999. The seeds were drilled in rows of 4 m long with 30 cm inter-row spacing, with plot size of 12m² (4 × 3 m), each plot consisting of 10 rows. The plots were arranged in completely randomized block design (CRBD) with four replications. Before drilling the seeds, a starter fertilizer was applied at a rate of 100 kg/ha in the form of diammonium phosphate (DAP), 46% P₂O₅ and 18% N and worked in to the upper soil layer using hand rakes to enhance vigorous growth of the seedlings and improve their resistance to weed suppression. Weeding was practiced by hoeing and hand weeding during the seedling establishment stage, and subsequently as needed. After the seedlings were well established, the above ground biomass was uniformly cut at about 4-5 cm height from ground level on August 1, 1999, and the cut biomass was raked out of the plots. This was done with the aim to enhance stand uniformity for the subsequent regrowth harvesting stage study. Then three regrowth age treatments: harvesting after 8 (T1), 10 (T2) and 12 weeks (T3) were imposed on the plots for subsequent evaluation of yield and quality traits.

Data collection procedures

For DM yield determination, two randomly selected middle rows were harvested and the fresh weight of each plot was recorded in the field just after mowing using a field balance. Sub-samples of each treatment were dried in an oven at 60°C for 72 h to determine the DM percent. Dry samples of each treatment (for the four replication of each treatment) were maintained for laboratory analyses after grinding to pass through 1 mm sieve in a Willey mill. Separate samples randomly selected from the remaining intact rows were further harvested for determination of leaf to stem ratio.

Chemical analysis of feed samples

Dry matter and ash content was determined using the procedures described by the Association of Official Analytical Chemists (A.O.A.C., 1980). Nitrogen was determined using the Kjeldhal procedure and crude protein (CP) was calculated by multiplying percent N by the factor 6.25. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) contents were determined according to Van Soest and Robertson (1985). Hemicellulose was determined by subtracting ADF from NDF and cellulose by subtracting lignin from ADF. Calcium was determined using the atomic absorption spectrophotometer (Perkin-Elmer, 1982). Concentration of phosphorus was determined by the autoanalyzer (Chemlab, 1978). A modified two stage in vitro Tilley and Terry technique (1963) was used to determine in vitro DM digestibility.

Data analysis

Data was subjected to analysis of variance using the GLM procedure of SAS, with harvesting stage treatment as independent variable in the model. Treatment differences were declared significant at p≤0.05.

RESULTS AND DISCUSSION

The analysis of variance results for the various herbage traits (means±SE) is presented in Table 1. Stage of harvest significantly affected herbage (P<0.05), leaf (P<0.05) and stem DM yields (P<0.01); and leaf to stem ratio (P<0.001). On the contrary, the effect of stage of harvest was not significant for harvestable stand density (P>0.05). Herbage and stem DM yields; and stand density tended to exhibit an increasing trend with maturity and this is in agreement with findings of other authors (Daniel, 1996; Teshome et al., 1994; Aschalew et al., 1995). Leaf yield was highest at 12 weeks of age with lopsided patterns of response with advancing maturity and similar pattern was also observed for leaf to stem ratio.

Results from the analysis of variance for chemical composition and in vitro DM digestibility are given in Table 2. Harvesting stage significantly affected CP

Two samples of 25 × 30 cm area were harvested and stored in a plastic bag and the herbage samples were separated into leaf and stem components on a neat canvas sheet under shade. The leaf sheath component was lumped with the stem component and hence the stem proportion is composed of these two plant parts. The fresh mass of the components were weighed using an electronic balance and composite samples for each component were oven dried at 60°C for 72 h and the DM content and then the DM yield of the two fractions were determined. The leaf to stem ratio was determined by taking the ratio of leaf DM yield to stem DM. Stand density at harvest was determined by counting the number of plants from a sampling area of 0.6 m². These sampling units were randomly selected and permanently marked using wooden stakes during the early age of the pasture. At herbage harvest for DM yield determination, all plants within the marked units were mowed and tiller counts were made.
Table 1. Effect of stages of harvest on herbage DM yield (t/ha; mean ± SE; n=4), leaf yield (t/ha; mean ± SE; n=4), stem yield (t/ha; mean ± SE; n=4), harvestable stand density (number of tillers/0.6 m²) and leaf to stem ratio of *Panicum coloratum*.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Stages of harvest</th>
<th>SE (n=4)</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Herbage DM yield</td>
<td>11.04&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.84&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.71&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Leaf yield</td>
<td>3.59&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>2.56&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.69&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Stem yield</td>
<td>4.94&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.11&lt;sup&gt;b&lt;/sup&gt;</td>
<td>9.51&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Stand density</td>
<td>436.4</td>
<td>449</td>
<td>477.6</td>
</tr>
<tr>
<td>Leaf to stem ratio</td>
<td>0.74&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.49&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.51&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

* = significant at 0.05; ** = significant at 0.01; *** = significant at 0.001; NS = not significant; #means within row followed by common letter do not significantly vary; SE, standard error of the mean.

Table 2. The chemical composition (% of DM; mean ± SE; n=4) and in vitro dry matter digestibility (% DM; mean ± SE; n=4) of *Panicum coloratum* harvested at different stages of harvest.

<table>
<thead>
<tr>
<th>Components</th>
<th>Stages of harvest (weeks)</th>
<th>SE</th>
<th>Significance level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Dry matter (%)</td>
<td>92.64&lt;sup&gt;ab&lt;/sup&gt;F</td>
<td>91.54&lt;sup&gt;c&lt;/sup&gt;</td>
<td>91.83&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Ash</td>
<td>8.24</td>
<td>7.88</td>
<td>7.3</td>
</tr>
<tr>
<td>CP</td>
<td>8.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.43±&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.27&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>NDF</td>
<td>77.50&lt;sup&gt;a&lt;/sup&gt;</td>
<td>74.02&lt;sup&gt;b&lt;/sup&gt;</td>
<td>76.81&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>ADF</td>
<td>48.47</td>
<td>45.34</td>
<td>48.65</td>
</tr>
<tr>
<td>Lignin</td>
<td>7.24</td>
<td>5.61</td>
<td>6.32</td>
</tr>
<tr>
<td>Cellulose</td>
<td>41.23</td>
<td>39.73</td>
<td>42.33</td>
</tr>
<tr>
<td>Hemicellulose</td>
<td>29.03</td>
<td>28.68</td>
<td>28.16</td>
</tr>
<tr>
<td>IVDMD</td>
<td>53.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>53.16&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.92&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Calcium</td>
<td>0.51</td>
<td>0.38</td>
<td>0.48</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.14</td>
<td>0.15</td>
<td>0.13</td>
</tr>
</tbody>
</table>

* = significant at 5 %; ** = significant at 1 %; *** = significant at 0.1 %; <sup>F</sup>means within rows followed by common letters are not significantly different; SE, standard error.

(P<0.01), NDF (P<0.05) and IVDMD (P<0.01). On the other hand, treatment effect was not significant (P>0.05) for ADF, P, cellulose, hemi-cellulose, lignin and calcium. The CP values ranged from 6.27±0.34 to 8.43±0.34%. The values for samples harvested at 12 weeks were significantly low and this is in agreement with reports (Daniel, 1990, 1996; Teshome et al., 1994). Similarly, late harvesting was reported to significantly reduce CP concentrations of herbage species (Tinnimit and Thomas, 1976; Vona et al., 1984; Teshome et al., 1994; Daniel, 1996). Adugna and Said (1994) and Vansoest (1982) have reported the minimum level of CP required for optimal rumen function to be 7.5%. Herbage harvesting at 12 weeks was observed to result in fall of protein below the values reported to be optimal in the present study implying the need for supplemental protein sources.

The herbage NDF values varied from 74.02±0.85 to 77.5±0.85% with no consistent trend with advancing age. The NDF values for 8 and 12 weekly harvests were statistically at par, while NDF value for 10 week harvest was significantly low. In concurrence with observation in the present study, NDF values without a well established trend with stage of maturity was also reported for Guinea and Merker grass hays (Arroyo-Aguilu et al., 1980). Values of NDF greater than 60% is known to result in decreased voluntary feed intake, increased rumination time and decreased efficiency of conversion of metabolizable energy to net energy (Shirley, 1986; Reed and Goe, 1989). The effect of harvesting stage on other cell wall constituents were generally not significant (P>0.05) with trends that are inconsistent. The lack of consistency in hemicellulose content of tropical grass species with stage of maturity for Guinea and Pangola grasses has also been observed by Shenkute (1972).

The same study also reported an increase hemicellulose...
with age in Congo and Elephant grasses and insignificant reduction with age in Star grass. The IVDMD concentrations of samples varied from 46.92% for the 12 week treatment to 53.65% for the 8 week ones. Moore and Mott (1973) and Mugeriwa et al. (1978) have reported that digestibility values higher than 65% indicate a better forage quality and that below this to result in reduced intake due to decrease in feed digestibility. The values obtained in the present study were far lower than these critical levels.

Herbage phosphorus concentration ranged from 0.13±0.005 to 0.15±0.005 and no clear trend was observed with stage of maturity. The inconsistency observed here is similar to observations reported by Fleming (1973) and Vona et al. (1984). The phosphorus values recorded in the present study are lower than the ranges reported to be adequate for maintenance in beef (NRC, 1984), dairy (NRC, 1981), sheep (NRC, 1975) and goats (NRC, 1981). The highest calcium concentration was obtained for the 8 week samples and this is in agreement with the reports of Daniel (1996) who found higher calcium values at the earlier stage of harvest in Rhodes grass. A lactating cow weighing 400 kg and producing 18 kg of milk daily requires a calcium concentration in feed DM of 0.43% (Fleming, 1973; NRC, 1978). Except for the samples harvested at 10 weeks of age, calcium contents that can satisfy this demand was obtained in this study.

Conclusion

*Panicum coloratum* is one of the recommended grass species for wider production in western Ethiopia. The present study evaluated its yield and quality performance under varying stages of harvest. With advancing maturity, herbage yield, stem component yield and stand density tended rise. Harvesting stage effects on CP, NDF an IVDMD was significant. Though there was no obvious trend of decline in CP concentration with increasing stages of harvest, the earlier harvested sample had a relatively higher CP compared to the samples harvested at 12 weeks. The *in vitro* DMD showed a consistently declining trend with stage of maturity. It was recommended that the grass be harvested at 8 weeks of regrowth after uniformity cut is made.

REFERENCES


