Effect of Maturity at Harvest on Chemical Composition, Tannin Concentration, Digestibility and Yield of Velvetbean (Mucuna pruriens)

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Mucuna nutritive value increased with maturity but the ideal maturity at harvest for optimizing the yield and nutritive value was approximately 110 d after planting.

SUMMARY
Velvetbean is a relatively cheap source of supplemental protein for ruminants fed low quality forages. However, there is little published information on the maturity stages at which the nutritive value of velvetbean is optimized. This study evaluated the chemical composition, tannin concentration and digestibility of velvetbean harvested at 77, 90, 110, and 123 DAP at the BRU. Dry matter, NDF, ADF, and lignin concentration increased (P<0.001) with maturity but CP concentration did not. The CP concentration of velvetbean ranged from 13 to 16% and that of leaves was 9 to 26%, stems 8 to 13% and pods 10 to 20%. Total tannin concentration was highest (P<0.001) at 110 DAP (6%) followed by 123 DAP, and samples harvested at 90 DAP had the lowest concentration (3%). Pods had the highest tannin concentration (9%). In conclusion, velvetbean should be harvested at approximately 110 DAP to optimize nutritive value and yield.

INTRODUCTION
Velvetbean was widely grown in Florida for fodder and as a green manure source until cheap fertilizers became available in the 1950s. It can still provide a relatively cheap dietary protein source (seeds, 25-35% CP; whole plant, 14-19% CP) for ruminants fed low quality forages. However, velvetbean contains lignin, which limits digestibility, and certain anti-nutritional factors such as tannins. Tannins are naturally occurring compounds that bind proteins and other nutrients. This can be beneficial if the tannin concentration is low (<3%) as the bound proteins essentially become rumen bypass protein which is very valuable. However high tannin (>6%) concentrations can limit protein digestibility in the animal. Most of the previous research on velvetbean has focused on feeding the seed to livestock, and relatively little attention has been paid to the potential of the foliage as fodder. Some recent studies have shown the potential of velvetbean foliage hay as a protein supplement for ruminants fed low quality forages. However, most of these studies have evaluated velvetbean at specific growth stages and there is insufficient information on the ideal maturity at harvest for optimizing the nutritive value of velvetbean.

PROCEDURE
The experiment was carried out at the BRU. Velvetbean was planted and harvested at 77, 90, 110, and 123 DAP. The foliage was then weighed and separated into leaves, stems and pods. Whole plant botanical fractions at each maturity stage were oven dried at 55°C for 72 h for DM determination. The samples were ground to pass through a 1 mm sieve and analyzed for chemical composition, tannin concentration, and IVDMD determination. In vitro dry matter digestibility was determined using the Tilley and Terry two stage technique that involves 48 h fermentation in rumen fluid followed by a hydrochloric acid-pepsin digestion that simulates digestion in the abomasum.

RESULTS
Velvetbean DM yield was 2.3 t/ac at 70 DAP, 2.3 t/ac at 90 DAP, 3.5 t/ac at 110 DAP, and 3.7 t/ac at 123 DAP (Figure 1). The chemical composition of velvetbean harvested at the four maturity stages is presented in Table 1. The highest DM concentration occurred in velvetbean harvested at 123 DAP. The CP concentration of the plants was not affected by maturity at harvest. This may be due to the fact the CP concentration of the leaves declined with maturity while that of the pods increased (Figure 2). Nevertheless, plants harvested at 110 and 123 DAP had numerically higher CP values.

While the NDF, ADF, and lignin concentration of velvetbean increased after the first harvest, there were no differences among the NDF values at 90, 110, and 123 DAP (Table 1). Velvetbean harvested at 90 DAP had the highest ADF and lignin concentrations. Lignin concentration was lowest at 110 DAP, while ADF concentration was lower at 110 and 123 DAP, than at earlier maturity stages. The NDF and ADF concentrations were consistently higher in stems followed by leaves, and pods had the lowest concentrations (Figures 3 and 4).

The highest IVDMD was observed at 110 DAP when velvetbean had the lowest lignin concentration (Table 1). In contrast, digestibility was lowest at 90 DAP when lignin concentration was highest (16%). Although velvetbean harvested at 123 DAP had comparable CP and NDF concentrations to that at 110 DAP, it had lower IVDMD values due to a higher lignin concentration. Velvetbean pods were more digestible than leaves and stems at all maturity stages and the digestibility of pods increased with maturity (Figure 6). This study shows that the nutritive value of velvetbean is optimized when it is harvested 110 DAP.

In conclusion, velvetbean nutritive value increased with maturity but the ideal maturity at harvest for optimizing yield and nutritive value was 110 DAP.
(110 – 123 DAP) during which the CP and NDF concentration of the foliage remain relatively unchanged.

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Table 1. Chemical composition, tannin concentration, and IVDMD of velvetbean harvested at four maturity stages.

<table>
<thead>
<tr>
<th>Nutrient (%)</th>
<th>77</th>
<th>90</th>
<th>110</th>
<th>123</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>DM</td>
<td>18.0a</td>
<td>19.6a</td>
<td>26.0b</td>
<td>42.2c</td>
<td>***</td>
</tr>
<tr>
<td>CP</td>
<td>13.1a</td>
<td>13.1a</td>
<td>15.8a</td>
<td>15.9a</td>
<td>NS</td>
</tr>
<tr>
<td>NDF</td>
<td>31.0a</td>
<td>46.0b</td>
<td>44.6b</td>
<td>48.5b</td>
<td>***</td>
</tr>
<tr>
<td>ADF</td>
<td>22.7a</td>
<td>39.8c</td>
<td>32.6b</td>
<td>36.4ab</td>
<td>***</td>
</tr>
<tr>
<td>Lignin</td>
<td>7.5a</td>
<td>15.6c</td>
<td>11.7b</td>
<td>14.1c</td>
<td>***</td>
</tr>
<tr>
<td>Tannin</td>
<td>3.7ab</td>
<td>3.0a</td>
<td>5.6c</td>
<td>4.4bc</td>
<td>***</td>
</tr>
<tr>
<td>IVDMD</td>
<td>51.8bc</td>
<td>39.0a</td>
<td>54.9c</td>
<td>49.0b</td>
<td>***</td>
</tr>
</tbody>
</table>

Means within a row followed by different superscripts differ; ***, P<0.0001; NS=Not Significant.

Figure 1. Velvetbean DM biomass yield at four maturity stages. Error bars denote the 5% confidence interval.

Figure 2. Crude protein concentration (% DM) of velvetbean botanical fractions. Error bars denote the 5% confidence interval.
Figure 3. Neutral detergent fiber concentration (% DM) of velvetbean botanical fractions. Error bars denote the 5% confidence interval.

Figure 4. Acid detergent fiber concentration (% DM) of Velvetbean botanical fractions. Error bars denote the 5% confidence interval.

Figure 5. Tannin concentration (% DM) of velvetbean botanical fractions. Error bars denote the 5% confidence interval.
Figure 6. In-vitro dry matter digestibility (%) of velvetbean botanical fractions. Error bars denote the 5% confidence interval.