Herbage and livestock responses in N-fertilized and grass-legume grazing systems

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Introduction

Perennial, warm-season grasses are the backbone of most beef cattle operations in the southeastern United States. Bahiagrass (Paspalum notatum) is among the predominant grasses in the region. Forage shortages usually occur with winter dormancy of perennial grasses. Overseeding cool-season annual grasses into bahiagrass pastures can alleviate feeding costs and improve animal performance. Implementing forage legumes into grazing systems adds a further benefit, but adoption is limited. Strip-planting rhizoma peanut (Arachis glabrata) into bahiagrass pastures is a feasible practice for including legumes into warm-season pastures.

Objective was to evaluate plant and animal responses of N-fertilized and grass-legume grazing systems under continuous stocking during the cool and warm-seasons across 4yrs.

Hypothesis was that replacing N fertilizers with forage legumes would maintain forage productivity over time.

Methods

4-yr grazing experiment conducted from Jan. to Oct. of 2016-2019 at North Florida Research and Education Center located in Marianna, FL. Cool-season months were considered Jan. to early May, whereas warm-season months were considered late May to Oct. of each year.

Treatments consisted of three grazing systems including warm-season perennial forages in summer and overseeded with cool-season annuals in the winter (Table 1).

Pastures were continuously stocked using grazing stock rate, and put-and-take animals to adjust herbage allowance every 14 d.

Target herbage allowance:
- Cool season: 1.0 kg DM kg-1 BW
- Warm season: 1.5 kg DM kg-1 BW

Two Angus crossbred steers were considered testers and remained on each pasture throughout the experiment each year.

Bodyweights were collected every 21 d to estimate average daily gain (ADG).

Gain per area (GPA) was estimated based on animal unit grazing days and ADG.

Herbage mass and nutritive value was quantified every 14 d.

Pasture botanical composition evaluated once per season.

Forage-hungled samples were collected every 14 d to estimate crude protein and in vitro-digestible organic matter (IVDOM) concentrations, and δ13C.

All response variables were analyzed using PROC GLIMMIX from SAS.

Pasture was considered experimental unit for all variables.

For responses including ADG, GPA, and stocking rate, fixed effects included treatments, evaluation period, and their interactions.

Random effects included year, block, and their interactions.

All other herbage responses were considered repeated measures.

Table 1. Grazing systems during cool and warm seasons.

<table>
<thead>
<tr>
<th>Grazing System</th>
<th>Cool Season</th>
<th>Warm Season</th>
<th>Cool Season</th>
<th>Warm Season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>Oat, Rye</td>
<td>Oat, Rye</td>
<td>Oat, Rye</td>
<td>Oat, Rye</td>
</tr>
<tr>
<td>Legume</td>
<td>-</td>
<td>Red, B140,</td>
<td>Red, B140,</td>
<td>Red, B140,</td>
</tr>
<tr>
<td>-</td>
<td>cargo1, B140</td>
<td>cargo1, B140</td>
<td>cargo1, B140</td>
<td>cargo1, B140</td>
</tr>
<tr>
<td>N-fertilizer</td>
<td>112</td>
<td>112</td>
<td>34</td>
<td>34</td>
</tr>
</tbody>
</table>

Figures 1 and 2

Figure 1. Beef steers grazing rhizoma peanut-bahiagrass (left) during the warm season, and grass-clover (right) during the cool season.

Figure 2. Treatment × evaluation date interactions (P < 0.05) for herbage mass during the cool season (A) and warm season (B). Evaluation numbers indicate evaluation date. For the cool season they are as follows: 1- early Jan; 2- late Jan; 3- early Feb.; 4- late Feb.; 5- early March; 6- late March; 7- early April; 8- late April; 9- early May. For the warm season, they are as follows: 10- Late May; 11- Early June; 12- Late June; 13- Early July; 14- Late July; 15- Early August; 16- Late August; 17- Early September; 18- Late September; 19- Early October; 20- Late October. Error bars denote standard errors. * Indicates significant differences within evaluations (P ≤ 0.05) according to LSD.

Results

Overseeding bahiagrass pastures with grasses and clovers is an effective practice for providing forage resources during cool-season months.

Inclusion of clovers into cool-season grass pastures improved forage distribution and sustained nutritive value similar to that of N-fertilized grass.

Clover growth peaked later into the cool season, as N-fertilized grass growth declined.

During the cool season, stocking rates and GPA were similar across treatments despite Grass+N receiving additional 78 kg N ha-1.

During the cool season, stocking rates were greater for Grass+N, however GPA did not differ across treatments.

Nitrogen fertilization management did not affect bahiagrass CP or IVDOM concentrations.

Inclusion of rhiemna peanut increased steer ADG by 74% during the warm season, compared to bahiagrass monocultures, even with N fertilizer application.

Rhiemna peanut composed 32% of the pasture botanical composition and 45% of cattle diet (based on δ13C).

Nitrogen fertilizer inputs were reduced from 224 (Grass+N) to 34 kg N ha-1 yr-1 (Grass+Clover+RP).

Discussion & Implications

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Take Home Message

Year-round grazing systems including clovers during the cool season and rhiemna peanut during the warm season, have equal or greater performance than N-fertilized grass systems and can potentially increase economic returns since less money is spent on N-fertilizer inputs.

Table 2. Average daily gain (ADG), gain per area (GPA), and stocking rate (AU ha-1) in Grass+Clover, Grass+N, and Grass+Clover+RP pastures during cool and warm seasons from 2016-2019, and the whole-year average.

<table>
<thead>
<tr>
<th>Treatment*</th>
<th>Grass+Clover</th>
<th>Grass+N</th>
<th>Grass+Clover+RP</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cool Season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADG, kg</td>
<td>0.91</td>
<td>0.83</td>
<td>0.80</td>
<td>0.08</td>
<td>0.47</td>
</tr>
<tr>
<td>GPA, kg ha-1</td>
<td>288</td>
<td>285</td>
<td>273</td>
<td>39.5</td>
<td>0.90</td>
</tr>
<tr>
<td>Stocking rate, AU ha-1</td>
<td>2.8</td>
<td>3.0</td>
<td>2.9</td>
<td>0.30</td>
<td>0.59</td>
</tr>
<tr>
<td>Warm Season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADG, kg d-1</td>
<td>0.33 B</td>
<td>0.36 B</td>
<td>0.61 A</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>GPA, kg ha-1</td>
<td>278 B</td>
<td>335 AB</td>
<td>397 A</td>
<td>67.8</td>
<td>0.04</td>
</tr>
<tr>
<td>Stocking rate, AU ha-1</td>
<td>5.6 B</td>
<td>6.3 A</td>
<td>4.3 C</td>
<td>0.48</td>
<td>0.003</td>
</tr>
<tr>
<td>Cool + Warm Season</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADG, kg d-1</td>
<td>0.56</td>
<td>0.5</td>
<td>0.69</td>
<td>0.07</td>
<td>0.18</td>
</tr>
<tr>
<td>GPA, kg ha-1</td>
<td>565</td>
<td>620</td>
<td>669</td>
<td>103</td>
<td>0.46</td>
</tr>
<tr>
<td>Stocking rate, AU ha-1</td>
<td>4.4 A</td>
<td>4.9 A</td>
<td>3.7 B</td>
<td>0.34</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Grass:N: bahiagrass, overseeded with rye and oat during the cool season; Grass+Clover: bahiagrass, overseeded with rye-oat-clover during the cool season; Grass+Clover+RP: bahiagrass-rhiemna peanut mixture overseeded with rye-oat-clover during the cool season. *Animal unit (AU); 1 AU=350 kg bodyweight. *Means followed by the same letter within a row do not differ (P ≥ 0.05) according to LSD.