Tall Fescue Mixtures with Birdsfoot Trefoil or Alfalfa improve Forage Production, Beef Steer Gains, and Economic Returns

INTRODUCTION AND OBJECTIVE

- High fertilizer prices and environmental stewardship have increased interest in grass-legume mixed pastures.
- Grasses need nitrogen to produce sufficient forage—generally 112 to 168 kg/ha N per year in the western U.S.
- There has been a drastic increase in cost of N fertilizer.
- Low-levels of condensed tannins in birdsfoot trefoil are reported to increase ruminal nitrogen utilization and may improve livestock performance.
- Past grass-legume research was not indicative of the irrigated, rotationally stocked pastures common in the western U.S.
- Therefore the objectives of this experiment were:
  - Determine and compare relative livestock performance, economic return, and herbage mass and nutritive value of tall fescue with or without N-fertilizer to tall fescue binary mixtures with alfalfa or birdsfoot trefoil.

MATERIALS AND METHODS

Pastures and Plant Materials:

- Treatments: Tall fescue + N fertilizer (TF+N, 168 kg/ha), tall fescue unfertilized (TF-N), tall fescue + alfalfa (TF+ALF), and tall fescue + Birdsfoot trefoil (TF+BFT).
  - Seeding rate: Monoculture, 18 kg ha⁻¹; Binary mix, 11 kg ha⁻¹ TF and 7 kg ha⁻¹ legume (resulted in 30% legume in herbage mass).
  - RCB design (3 reps) with 0.4 ha pastures divided into four 0.1 ha paddocks.
  - Irrigated: 3.8 cm every 7 days during grazing season.

Grazing and herbage Data:

- Grazed for 112 days (mid-May to Mid-September) in 2012 and 2013.
- Rotational Stocking: 7-day grazing period per paddock, 28-day rotation cycle (21 day rest period).
- Three Angus-cross steers per pasture — starting weight was 381 kg in 2012 and 304 kg in 2013.
- Put-and-take stocking: addition of mature cows in spring and removal of steers to overflow pasture in summer based upon available herbage.
- Steers weighed at end of every 28-day rotation cycle.
- Four 0.25-m² samples collected from paddocks just prior to grazing to determine stocking rate and herbage mass and nutritive value.

RESULTS

Table 1. Livestock weight gain.

<table>
<thead>
<tr>
<th>TRMT</th>
<th>Day 1 (begin)</th>
<th>Day 112 (end)</th>
<th>Cumulative average daily gain (ADG; kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TF+BFT</td>
<td>342.2 A</td>
<td>425.4 A</td>
<td>1.30 A 0.84 A 0.82 A 0.73 A</td>
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<tr>
<td>TF+ALF</td>
<td>340.1 A</td>
<td>415.3 A</td>
<td>1.50 A 0.93 A 0.78 A 0.67 B</td>
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<tr>
<td>TF+N</td>
<td>346.2 A</td>
<td>414.7 A</td>
<td>1.17 A 0.76 A 0.65 B 0.61 C</td>
</tr>
<tr>
<td>TF-N</td>
<td>339.1 A</td>
<td>383.8 B</td>
<td>0.94 B 0.61 B 0.50 C 0.40 D</td>
</tr>
</tbody>
</table>

Means: Trmt*:YR P < 0.0271 YR P < 0.0001 Trmt*YR P < 0.0001

Table 2. Herbage mass and nutritive value.

<table>
<thead>
<tr>
<th>TRMT</th>
<th>CP</th>
<th>IVTD</th>
<th>NDF</th>
<th>NDFD</th>
<th>NFC</th>
<th>NEm</th>
<th>NEg</th>
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<tbody>
<tr>
<td>TF+BFT</td>
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<tr>
<td>TF+ALF</td>
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<tr>
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<tr>
<td>TF-N</td>
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</tbody>
</table>

Mean S.E.: 99 5.3 9.1 7.9 11.4 6.7 0.02 0.02

Trmt T P-value: 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001

Table 3. Economic analysis.

<table>
<thead>
<tr>
<th>TRMT</th>
<th>Initial value</th>
<th>Final value</th>
<th>Added value</th>
<th>Stocking rate</th>
<th>Added value</th>
<th>Net Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>TF+BFT</td>
<td>957 A 1126 A 169 A</td>
<td>1528 A 1197 A</td>
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<tr>
<td>TF+ALF</td>
<td>961 A 1101 A 139 B</td>
<td>1174 B 846 B</td>
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<tr>
<td>TF+N</td>
<td>962 A 1105 A 143 AB</td>
<td>1175 B 494 C</td>
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<tr>
<td>TF-N</td>
<td>958 A 1042 B 84 C</td>
<td>446 C 96 D</td>
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<td></td>
</tr>
</tbody>
</table>

Mean S.E.: 10 14 10 0.3 85 85

Trmt P-value: 0.9522 0.0001 0.0001 0.0001 0.0001 0.0001

YR P-value: 0.0001 0.0001 0.0001 0.0001 0.0001 0.0001

Trmt*YR P-value: 0.0472 0.1285 0.8116 0.0001 0.5206 0.5206

CONCLUSIONS

- There were few significant Treatment by Year interactions for livestock performance; Treatment by Year interactions for forage traits were mostly due to magnitude and not rank change.
- Overall, TF+BFT had the highest rate of steer weight gain (Table 1).
- Rate of weight gain was greatest for all treatments during the first 28 days of grazing (Fig 1).
- The decrease in rate of weight gain (from rotation-1 to rotation-2) corresponded with a decrease in NEg (Fig 2).
- TF+Legume mixtures always had greater NEg than the TF monocultures (Tables 2, Fig 2).
- Herbage mass was slightly less for TF-legume mixtures than the TF+N, but substantially greater than TF-N (Table 2).
- TF+BFT pastures had the highest economic net return, more than doubling the net return of TF-N (Table 3).
  - The net return of $1197 ha⁻¹ for TF+BFT is comparable or better than common field crops in the region ($464, $780, and $1608 for grain corn, wheat, and alfalfa, respectively).
  - These results indicate that adding N via fertilizer or legume increases steer weight gains, herbage mass, nutritive value, and net return compared to no N fertilizer on tall fescue.
- TF+Legume mixtures result in greater steer weight gains and economic net return compared to TF+N or TF-N.
- TF+Legume mixtures can be substituted for TF+N to address environmental concerns (N-leaching, run-off) without reducing production.
- TF+BFT results in the greatest ADG (Table 1) and Net Return (Table 3) without the risk of bloat.
- Grass-legume mixtures with greater nutritive energy mid-grazing-season may further increase livestock gains and economic return.