SUMMARY
Orchardgrass, meadow fescue, tall fescue (endophyte-free), and Kentucky bluegrass should be planted in Midwest U.S. horse pastures to maximize horse preference, forage persistence and yield.

INTRODUCTION
In the Midwest and Eastern U.S., cool-season grasses are the foundation of productive pastures. Horses are known to be selective grazers, and the grazing habits of horses may limit the productivity and survival of some pasture species. Horses can graze plant species to a shorter height because they have prehensile lips and a tongue that pulls grass into the mouth (Archer, 1980).

Forage yield and persistence are important criteria when selecting grasses for productive pastures, especially for highly selective livestock like horses. However, many forage grasses are not evaluated under horse grazing or throughout the entire grazing season. The objectives of this research were to evaluate forage yield and persistence, and horse preference of cool-season grasses while grazed by horses.

HOW THE RESEARCH WAS CONDUCTED
Four adult horses grazed ‘Barolex’ tall fescue, ‘Hidden Valley’ meadow fescue, ‘Everett’ quackgrass, ‘Agassiz’ smooth bromegrass, ‘Fleet’ and ‘Paddock’ meadow bromegrass, ‘Marathon’ reed canarygrass, ‘Survivor’ perennial ryegrass, ‘Winneton’ timothy, ‘Ginger’ Kentucky bluegrass, ‘Garrison’ creeping foxtail, and ‘Baridana’ orchardgrass. Horses grazed the research area for three consecutive days (8 hours per day) each month from May to October in 2010 and May to September in 2011 (Figure 1).

Grasses were evaluated for maturity and percent ground cover (persistence), measured for yield and quality, and then grazed by horses when most tall growing grasses reached 8 inches. Following grazing, manure was removed, and remaining forage was mowed to 3 inches and allowed to re-grow.

Preference was estimated by visually comparing height and mass of the grass before and after each grazing event. Before each grazing event, grasses were visually assessed for percent ground cover on a scale of 0 (bare ground) to 100 (100% ground cover of desired species) to assess stand persistence.

Grasses were fertilized with 50 pounds of nitrogen in early April and again in mid-June, and a spring application of a selective broadleaf herbicide was applied to control broadleaf weeds each year.

RESULTS AND DISCUSSION
Weather
During the 2010 (April through October) and 2011 (May through September) grazing seasons,
monthly air temperatures were near historical average. averages; however, more rainfall was recorded during both grazing seasons compared to the historical However, drought conditions in late September and October of 2011 limited grass regrowth and prevented grazing in October 2011.

**Forage Persistence (ground cover)**
Kentucky bluegrass, meadow fescue, orchardgrass, and tall fescue were the most persistent grasses with ≥78% ground cover after two years of rotational grazing by horses (Table 1; Figures 2 and 3).

Meadow bromegrass, perennial ryegrass, and quackgrass had moderate levels of ground cover ranging from 40 to 61%, and creeping foxtail, reed canarygrass, smooth bromegrass and timothy were among the less persistent grasses, with ground covers ≤24% after two year of rotational grazing by horses (Table 1).

Researchers agree that reed canarygrass, smooth bromegrass and timothy will not persist well if cut or grazed during the stem elongation phase (Vogel et al., 1996), due to depletion of carbohydrate root reserves and removal of shoots and tillers that contribute to re-growth (Marten and Hovin, 1980). Compared to more persistent species like orchardgrass, Kentucky bluegrass, meadow fescue, and tall fescue that have culmless vegetative shoots; reed canarygrass, smooth bromegrass, and timothy have culmed shoots and continue to elongate in re-growth cycles (Reynolds and Smith, 1962).

Current equine grazing recommendations include initiating grazing of tall, cool-season grass pastures at a height of 6 to 8 inches. This recommendation will likely result in reed canarygrass, smooth bromegrass, and timothy being at the stem elongation stage at the start of each rotational grazing period, making these plants particularly vulnerable to carbohydrate depletion and poor persistence. Grazing initiation should either be managed to avoid the stem elongation stage in these species, or these grasses should not be included in grazing systems.

**Table 1. Persistence (% ground cover), preference (% removal) and yield of 11 different grass species rotationally grazed by horses in 2010 and 2011.**

<table>
<thead>
<tr>
<th>Specie</th>
<th>Ground Cover</th>
<th>Horse Preference</th>
<th>Yield (2-yr avg)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td>Tons/A</td>
</tr>
<tr>
<td>Creeping Foxtail</td>
<td>2</td>
<td>45</td>
<td>2.9</td>
</tr>
<tr>
<td>Kentucky Bluegrass</td>
<td>90</td>
<td>78</td>
<td>4.0</td>
</tr>
<tr>
<td>Meadow Bromegrass</td>
<td>42</td>
<td>38</td>
<td>4.0</td>
</tr>
<tr>
<td>Meadow Fescue</td>
<td>78</td>
<td>67</td>
<td>4.4</td>
</tr>
<tr>
<td>Orchardgrass</td>
<td>79</td>
<td>47</td>
<td>5.4</td>
</tr>
<tr>
<td>Perennial Ryegrass</td>
<td>61</td>
<td>64</td>
<td>3.8</td>
</tr>
<tr>
<td>Quackgrass</td>
<td>40</td>
<td>61</td>
<td>3.9</td>
</tr>
<tr>
<td>Reed Canarygrass</td>
<td>24</td>
<td>50</td>
<td>3.9</td>
</tr>
<tr>
<td>Smooth Bromegrass</td>
<td>14</td>
<td>61</td>
<td>3.3</td>
</tr>
<tr>
<td>Tall Fescue</td>
<td>79</td>
<td>59</td>
<td>4.5</td>
</tr>
<tr>
<td>Timothy</td>
<td>24</td>
<td>80</td>
<td>3.4</td>
</tr>
</tbody>
</table>


**Horse Preference (forage removal)**
The most preferred grasses were Kentucky bluegrass, meadow fescue, and timothy with post-grazing grass removals ranging from 67 to 80% (Figure 2). Grasses that tended to be more moderately preferred included quackgrass, tall fescue, perennial ryegrass, and smooth bromegrass, with post-grazing grass removals ranging from 59 to 64% (Figure 3). Meadow bromegrass, creeping foxtail, reed canarygrass, and orchardgrass were the least preferred grasses, with post-grazing removals ≤50% (Table 1; Figure 4).

To maximize forage use, grasses with similar preference ratings should be planted in horse pastures. A mixture that results in uniform grazing should maximize forage use and minimize pasture maintenance and associated expenses.
Figure 2. Timothy (a preferred grass) before (left) and after (right) grazing.

Figure 3. Reed Canarygrass (a moderately preferred grass) before (left) and after (right) grazing.

Figure 4. Meadow Bromegrass (a least preferred grass) before (left) and after (right) grazing.

Yield
Orchardgrass, tall fescue, meadow fescue and Kentucky bluegrass were the highest yielding grasses, averaging 4.0 to 5.4 tons/acre annually (Table 1). This was not surprising as these same four grasses were also the most persistent under horse grazing.

Quackgrass, perennial ryegrass, reed canarygrass and meadow bromegrass yielded moderately well, while creeping foxtail, smooth bromegrass, and timothy were the lowest yielding grasses (Table 1).

Most cool-season grasses experience a reduction in production during the traditionally warmer and drier summer months which has been termed the ‘summer slump’ (Riesterer et al., 2000). However, in both 2010 and 2011, the majority of yield for most grasses occurred during summer, with summer months contributing 40 to 83%, respectively, of the total yield. In a pasture system, grasses are frequently grazed and managed to remain in a vegetative stage, allowing for similar growth rates throughout the season. This management scheme, combined with above average rainfall observed in the spring and summer of both years of our study, likely explains the increase in production observed during the summer months and the lack of a ‘summer slump’.

Forage Nutritive Value
Perennial ryegrass, quackgrass, and smooth bromegrass had higher concentrations of crude protein (CP), while Kentucky bluegrass, orchardgrass, creeping foxtail, and timothy tended to have lower CP concentrations. Although few grasses had consistently high or low neutral detergent fiber (NDF) concentrations, quackgrass tended to have lower NDF values compared to higher amounts found in creeping foxtail and smooth bromegrass. Perennial ryegrass and meadow fescue tended to have greater neutral detergent fiber digestibility (NDFD) concentrations, while creeping foxtail and Kentucky bluegrass were lower. Overall, creeping foxtail was the lowest quality cool-season grass, with low CP and NDFD amounts, and high NDF values. Concentrations of non-structural carbohydrate (NSC) were similar among the grasses in spring and fall. During the
summer, timothy, Kentucky bluegrass, meadow fescue, and perennial ryegrass had higher amounts of NSC, while meadow bromegrass, orchardgrass, and reed canarygrass were lower.

Horses are known to be selective grazers, however, little is known about what drives horse preference in a pasture system. In the current study, NSC concentration was positively correlated to horse preference, while there was a trend for NDFD concentration to be positively correlated with preference, and NDF concentration to be negatively correlated to horse preference in 2010. Crude protein and maturity were not correlated to horse preference. However, in 2011, no forage nutritive values or maturities were correlated to horse. Although it is widely accepted that horse (and other livestock) prefer forage that are lower in fiber (NDF) and high in carbohydrates (NSC), the lack of consistent correlation between forage nutritive value and horse preferences in 2011 highlights the fact that horse preference is a complicated issue.

**Conclusions**

Under horse grazing, orchardgrass, meadow fescue, tall fescue, and Kentucky bluegrass were the most persistent and highest yielding grasses, while smooth bromegrass, creeping foxtail, and timothy were the least persistent and lowest yielding grasses. Kentucky bluegrass, timothy, and meadow fescue were the most preferred grasses, while meadow bromegrass, creeping foxtail, reed canarygrass, and orchardgrass were less preferred.

Contrary to existing recommendations, reed canarygrass, smooth bromegrass, and timothy should not be included in equine grazing systems.

Orchardgrass, meadow fescue, tall fescue (endophyte-free), and Kentucky bluegrass should be planted in Midwest U.S. horse pastures as they strike a balance between forage persistence, yield, quality, and horse preference.

**Literature Cited:**


**Manuscript Citations:**


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**Reviewers:**

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