Comparative Litter Quality and Recalcitrance Among Native Grasses and the Invasive, Non-indigenous KR Bluestem (*Bothriochloa ischaemum*)

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Background

- Decomposition
  - Nutrient availability is altered following the change in litter quantity and quality due to invasion, causing a positive feedback for invasion (Evans et al. 2001, Allison & Vitousek 2004, Ehrenfeld 2003)

- Fire cycles
  - An increase in fire frequency and alteration in natural disturbance regimes has been observed in invasion studies (Evans et al. 2001, Vasquez et al. 2008, Gabbard & Fowler 2007)

- Competition for resources
  - Litter chemistry effects have been determined to be more influential for N cycling. Native grasses that have been determined to have diverse litter qualities would have a competitive advantage in restoration (Majors, Rour and
KR Bluestem (hereafter referred to as KR)

Perennial, C4 bunchgrass
Originated in southern Europe and Asia (Allred, 1983)
Introduced in 1930’s for rangeland improvement, erosion control, and revegetation (USDA, Gabbard & Fowler, 2007)
Observed to have a detrimental impact on native plant diversity and has a high probability of future spread (Gabbard & Fowler, 2007)

- Impact on indicator species including rodents (Sammon, 2006), and birds (Hickman et al., 2006)
KR Distribution in the U.S.
Observations – Texas Hill Country

- KR is commonly found in disturbed areas and open habitats with long history of grazing.
- Native species are predominately located in shaded areas.
- KR generally found in monocultures in rangelands and appears to have increased litter quantity and, thus, fuel load.
Hypothesis

- Following invasion, the rate of decomposition and nutrient release is slower in KR dominated areas.
- Mechanism? - Lower quality litter, as measured by C and N and lignin.
Experimental Design

- **Species**
  - KR Bluestem (*Bothriochloa ischaemum*)
  - Little Bluestem (*Schizachyrium scoparium*)
  - Sideoats Grama (*Bouteloua curtipendula*)
  - Switchgrass (*Panicum virgatum*)

Litter collected from 3 roadside populations/species.

Litter divided into leaves and culms

2 g per bag: 1 g leaves, 1 g culms

Fiberglass mesh bags

- Highly resistant to UV
- Small hole size (.01m x .02m) allows for microbes, excludes invertebrates.

- Bag size: 10.16 cm x 15.24 cm
Litterbag Method
Experimental Design Using Litter Bags

Factorial Design:
• x 4 Species
• x 3 Sites
• x 2 Habitats per site (KR-vs. native-species dominated)
• x 5 Collection dates
• x 3 Replicate bags/date

Total # of bags = 360
Sites

- Site
  - All located in Texas Hill County on similar soil types.
  - Protected so that bags could be left in place.
  - KR and native-dominated areas in open habitat to control for effects of canopy cover.
Site Characteristics

Three sites

Crownridge Natural Area (San Antonio, TX)

Davidson Ranch (Kendalia, TX)

Luna Rosa Ranch (Medina, TX)
### Site Characteristics - Soils

<table>
<thead>
<tr>
<th>pH</th>
<th>Mg (lbs/A)</th>
<th>total nitrate (%)</th>
<th>Fe (ppm)</th>
<th>total ammonium (%)</th>
<th>P (lbs/A)</th>
<th>Zn (ppm)</th>
<th>P-H2O</th>
<th>K (lbs/A)</th>
<th>B (ppm)</th>
<th>sand</th>
<th>SO4 (lbs/A)</th>
<th>Cu (ppm)</th>
<th>silt</th>
<th>Ca (lbs/A)</th>
<th>Organic Matter (%)</th>
<th>clay</th>
</tr>
</thead>
<tbody>
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Found NO significant differences among sites or between habitat for soil nutrient or texture analyses.
Response Variables

- **Site and Habitat Characterization**
  - Vegetation
  - Biomass
  - SoilFoodWeb
- **Litter Quality**
  - Initial C, N, and lignin
- **Biomass Loss with ash-free corrections**
KR Cover x Site x Habitat

<table>
<thead>
<tr>
<th>Source</th>
<th>F</th>
<th>P</th>
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<tbody>
<tr>
<td>Model</td>
<td>43.7295</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Site</td>
<td>0.3685</td>
<td>0.6948</td>
</tr>
<tr>
<td>Habitat (Site)</td>
<td>72.6368</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

**KR Cover x Site x Habitat**

- **CR**: p = 0.0001
- **K**: p = 0.0050
- **LR**: p = 0.0001

**KR Cover x Habitat (all sites)**

- Native: 30% ± 10%
- KR: 70% ± 10%
Biomass x Habitat

Site and Habitat = N.S.
SoilFood Web Analysis x Habitat

MANOVA Site and Habitat = N.S.
Litter Quality x Species

%N of Composite Sample

% Lignin of Composite Sample

C:N of Composite Sample

Lignin:N of Composite Sample
## MANOVA/Repeated Measures for Biomass Loss in Leaves, Culms and Total

<table>
<thead>
<tr>
<th>Factor</th>
<th>percent remaining leaves</th>
<th>percent remaining culms</th>
<th>percent remaining combined biomass</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>p</td>
<td>x Time</td>
</tr>
<tr>
<td>Site</td>
<td>0.560</td>
<td>0.574</td>
<td>n.s.</td>
</tr>
<tr>
<td>Habitat</td>
<td>0.110</td>
<td>0.738</td>
<td>n.s.</td>
</tr>
<tr>
<td>Species</td>
<td>13.380</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
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<tr>
<td>Site x Habitat</td>
<td>0.180</td>
<td>0.832</td>
<td>n.s.</td>
</tr>
<tr>
<td>Site x Species</td>
<td>1.410</td>
<td>0.232</td>
<td>n.s.</td>
</tr>
<tr>
<td>Habitat x Species</td>
<td>0.130</td>
<td>0.942</td>
<td>n.s.</td>
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<tr>
<td>Site x Habitat x Species</td>
<td>0.780</td>
<td>0.587</td>
<td>n.s.</td>
</tr>
<tr>
<td>Time</td>
<td>177.22</td>
<td>&lt;0.0001</td>
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</tbody>
</table>

Wilks' Lambdas reported
LEAF Biomass Loss x Species

Species Contrast Over Time

CULM Biomass Loss x Species

Species Contrast Over Time

TOTAL Biomass Loss x Species

Species Contrast Over Time

Conclusions

• No significant differences for the following:
  – Soil food web and nutrients and texture (sites or habitats).
  – Litter biomass accumulation (sites or habitats).
  – Initial C, N, or lignin composition among species.

• Significant differences in KR cover between habitats.
  • KR Bluestem does not appear to be any more recalcitrant than the native species in this study.
  • Little bluestem appears to have the highest recalcitrance. Perhaps useful for management where carbon (CO₂) sequestration is a goal.
Further Study

- **Observational study**
  - Comparing litter accumulation in the present sites and habitats.

- **Soil Microbial Community Analysis**
  - Utilizing PCR techniques to identify the diversity of microorganisms present.
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