Project Title: The influence of nitrogen rate and pasture composition on the toxicity, quality and yield of stockpiled tall fescue

Investigators: Robert L. Kallenbach and Robert L. McGraw

Objectives and relevance of project: More than one-third of Missouri’s 60,000 beef producers use stockpiled tall fescue to extend the grazing season. However, less than half the producers who stockpile tall fescue apply N in late summer to encourage fall growth. While previous research has shown the benefits of a late-summer N application, producers are reluctant to fertilize in late summer and frequently raise three questions about it. These questions are: 1) How should I adjust my N rate for stockpiling if I have a mixed tall fescue/red clover versus a pure stand of tall fescue? 2) Does applying N in late summer affect the clover component in my mixed sward the next spring? and 3) Does applying N in late summer change the toxicity (ergovaline concentration) of endophyte infected tall fescue? Although late-summer N applications to tall fescue pastures represents a great opportunity for both the fertilizer and beef industries, at present, there is little data to answer these questions.

The overall objective is to develop research-based recommendations that help industry personnel and farmers properly fertilize tall fescue for stockpile grazing. Specific objectives are:

Objective 1: Determine the optimum N rate (late-summer N application) for tall fescue/red clover versus pure tall fescue pastures used for stockpile forage.

Objective 2: Determine if a late-summer N application affects the persistence and productivity of red clover in mixed tall fescue/red clover pastures the following spring.

Objective 3: Determine the influence of a late-summer N application on the ergovaline content of tall fescue and tall fescue/red clover pastures used for stockpile forage.

Procedures:

Treatments: This experiment has 10 treatments; five N rates (0, 50, 100, 150 and 300 lb/acre) and two pasture types (tall fescue with or without red clover).

Cultural practices: This study will be conducted on an established tall fescue/red clover pasture at the Forage Systems Research Center (FSRC) near Linneus, MO. At present, the stand is approximately 30% red clover and 70% tall fescue. For the pure tall fescue pastures, the clover component will be killed in early spring by spraying 2-4D and Remedy herbicides. For the mixed tall fescue/red clover treatments, additional red clover seed will be frost seeded each year to maintain approximately 30% red clover. Soil P and K will be maintained at levels recommended by the University of Missouri Soil Testing Laboratory. The forage in all treatments will be clipped to a 3-inch stubble height in early August prior to starting the study. After clipping, the N fertilizer treatments will be applied in mid-August.

Design: Each of the ten treatments will be replicated six times in a randomized complete block design in a split-split block arrangement. Nitrogen rates will be main plots, sward type (pure tall fescue or mixed tall fescue/red clover) will be subplots and harvest dates sub-subplots. Individual main plots will be 100 ft. x 50 ft.
Measurements:

Forage yield will be measured on the 15th of November, December, January, February and March from uncut portions (sub-subplots) in each plot. In addition, yield will be measured from all sub-subplots in May and July to study the residual effects of N applications and winter harvest dates. Forage yield will be determined by clipping a 3-ft. x 30-ft. strip in each plot.

Forage quality and toxicity {crude protein, acid detergent fiber (ADF), neutral detergent fiber (NDF) and ergovaline} will be measured at the same time as forage yield. Samples will be freeze-dried before being ground to pass a 1-mm screen. Crude protein, ADF and NDF will be measured using NIRS. Ergovaline will be determined using the procedures of Hill et al. (1993).

Botanical composition of the tall fescue/red clover treatments will be measured at each forage harvest using NIRS.

Red clover plant density of the tall fescue/red clover treatments will be determined in August and April each year. Red clover plant density will be determined by counting the number of plants in six, 1.0-ft.² frames in each sub-subplot.

Total soil nitrogen to a depth of 40 in. will be determined prior to application of N and in March, each year. Samples will be split into three sections: 0-10 in, 10-20 in. and 20-40 in.

Current Status/importance of research area: Tall fescue grows on more than 12 million acres and provides forage for more than 4 million beef cattle in Missouri. It is by far the most popular forage with beef producers because it persists well on infertile, poorly drained, sloped, and/or unmanaged pastures. It has few serious pests and persists longer than other cool-season grasses.

Perhaps the greatest attribute of tall fescue is, that with proper fertilization, its autumn growth can be accumulated for deferred grazing (stockpile grazing). Stockpile grazing allows producers to extend the grazing season into winter and thereby cut winter feeding costs. A well-managed stockpile program can reduce winter feeding costs by more than 70%.

Research conducted by Kroth et al. (1977), Collins and Balasko (1981), and Gerrish et al. (1994) have shown that applying 60 to 100 lb/acre of N in August increases the yield and quality of stockpiled tall fescue in December. While this research laid a solid foundation about N fertilization of tall fescue for stockpiling, three important areas not addressed by this research are:

1. **This research was conducted on pure stands of tall fescue, yet many livestock producers have mixed stands of red clover and tall fescue.** Research conducted by Gerrish et al. (1994) showed that N carryover on stockpiled tall fescue was possible; however, the influence of N carryover on the legume component of pastures the following spring has not been measured.

2. **Forage sampling ceased in mid- to late-December.** Many livestock producers graze stockpiled tall fescue in from December through March but there is little published data to describe the forage quality of stockpiled tall fescue through the coldest part of winter.

3. **Tall fescue toxicity was not measured.** Recent research from our lab shows that endophyte-infected tall fescue retains significant levels of ergovaline into winter. For graziers who utilize stockpiled tall fescue, this explains the symptoms of fescue toxicosis found in winter such as fescue foot or frostbitten extremities. To our knowledge there is no data describing how N rate affects the ergovaline content of stockpiled tall fescue.
**Timetable for proposed research:** This study will begin in August of 2002 and end in December of 2005 (Three years of study). The table below gives a brief summary of the project's activities. (* indicates task to be done on an annual basis throughout the three-year study)

<table>
<thead>
<tr>
<th>Task Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed 5 lb/a of red clover on appropriate plots to maintain grass/legume mix.</td>
<td>3/1/02*</td>
</tr>
<tr>
<td>Spray pure TF plots with herbicide to kill any volunteer legumes</td>
<td>4/9/02*</td>
</tr>
<tr>
<td>Clip pasture to a 2 to 3 inch stubble.</td>
<td>7/29/02</td>
</tr>
<tr>
<td>Count the legume plants in six, 1.0 ft.$^2$ quadrats in each plot</td>
<td>8/12/02*</td>
</tr>
<tr>
<td>Take soil core samples to a 40-inch depth for soil nitrogen.</td>
<td>8/13/02*</td>
</tr>
<tr>
<td>Apply N fertilizer. Treatments are 0, 50, 100, 150 and 300 lb/acre of actual N.</td>
<td>8/14/02*</td>
</tr>
<tr>
<td>Harvest appropriate sub-subplots for forage yield and retain subsamples for forage quality and ergovaline analysis</td>
<td>11/15/02, 12/15/02, 1/15/03, 2/15/03 and 3/15/03*</td>
</tr>
<tr>
<td>Take soil cores from each sub-plot to determine residual soil N.</td>
<td>3/19/03*</td>
</tr>
<tr>
<td>Count the legume plants in six, 1.0 ft.$^2$ quadrats in &quot;clover&quot; plots</td>
<td>4/2/03*</td>
</tr>
<tr>
<td>Analyze samples taken to date for forage quality and ergovaline content</td>
<td>8/30/03*</td>
</tr>
<tr>
<td>Harvest all sub-subplots for forage yield and retain subsamples for forage quality and ergovaline analysis. (This should measure the residual effects)</td>
<td>5/19/03 and 7/24/03*</td>
</tr>
<tr>
<td>Analyze latest results &amp; report findings to Fertilizer/Ag Lime Advisory Council</td>
<td>12/15/02*</td>
</tr>
<tr>
<td>Incorporate latest findings into soil testing reports, grazing school curriculum and winter-pasture workshops. Work with popular press on articles.</td>
<td>10/2005</td>
</tr>
<tr>
<td>Prepare updated MU guidesheet on fertilization of tall fescue for stockpile</td>
<td>11/2005</td>
</tr>
<tr>
<td>Prepare and submit article on this research to a peer-reviewed journal</td>
<td>12/2005</td>
</tr>
</tbody>
</table>

**Application/transfer of knowledge:** We will transfer our results in four ways. First, we will incorporate the results and recommendations from this study into the curriculum of the Missouri Grazing Schools and the annual Winter Grazing Workshops at Linneus and Mt. Vernon. Second, we will work with the Soil Fertility Working Group and the University of Missouri Soil Testing Laboratory to refine the recommendations printed on soil testing results. Third, we will publish a new guidesheet on stockpiling tall fescue that incorporates the latest findings from this research. Finally, we will prepare articles to be published in statewide and national magazines such as Missouri Ruralist, Graze, Stockman Grass Farmer and scientific (peer-reviewed) journals.

**References:**


Budget:

**Year 1**

**Salary and Benefits**

- Research Specialist (25% of $30,000) $ 7,500
- Benefits for Research Specialist $ 1,875
- Total Salary and Benefits $ 9,375

**Operating Expenses**

- Fertilizer, bags, repair parts for harvester and other field supplies $ 1,000
- NIR charges for forage quality and ergovaline analysis (900 samples @ $1 each) $ 900
- Forage quality wet chemistry for NIR calibration (90 samples @ $10.50 each) $ 945
- Ergovaline analysis (wet chem. for NIR calibration 90 samples @ $25 each) $ 2,250
- Soil N analysis (366 samples @ $8 each) $ 2,928
- Travel to FSRC (mileage, lodging, and meals for 8 trips per year) $ 1,100
- Total Operating Expenses $ 9,123

**Equipment**

- None requested $ 0
- Total Equipment $ 0

**Total Proposal Request for Year #1** $18,498

**Year 2**

**Salary and Benefits**

- Research Specialist (25% of $31,500) $ 7,875
- Benefits for Research Specialist $ 1,969
- Total Salary and Benefits $ 9,844

**Operating Expenses**

- Fertilizer, bags, repair parts for harvester and other field supplies $ 1,000
- NIR charges for forage quality and ergovaline analysis (900 samples @ $1 each) $ 900
- Forage quality wet chemistry for NIR calibration (45 samples @ $11 each) $ 495
- Ergovaline analysis (wet chem. for NIR calibration 45 samples @ $25 each) $ 1,125
- Soil N analysis (366 samples @ $8 each) $ 2,928
- Travel to FSRC (mileage, lodging, and meals for 8 trips per year) $ 1,100
- Total Operating Expenses $ 7,548

**Equipment**

- None requested $ 0
- Total Equipment $ 0

**Total Proposal Request for Year #2** $17,392
### Year 3

#### Salary and Benefits
- Research Specialist (25% of $33,075) $8,269
- Benefits for Research Specialist $2,067
- Total Salary and Benefits $10,336

#### Operating Expenses
- Fertilizer, bags, repair parts for harvester and other field supplies $1,000
- NIR charges for forage quality and ergovaline analysis (900 samples @ $1 each) $900
- Forage quality wet chemistry for NIR calibration (45 samples @ $11 each) $495
- Ergovaline analysis (wet chem. for NIR calibration 45 samples @ $25 each) $1,125
- Soil N analysis (366 samples @ $8 each) $2,928
- Travel to FSRC (mileage, lodging, and meals for 8 trips per year) $1,100
- Total Operating Expenses $7,548

#### Equipment
- None requested $0
- Total Equipment $0

---

**Total Proposal Request for Year #3** $17,884

**Grand Total for three years** $53,774
Resume for
Robert L. Kallenbach

Office
Dept of Agronomy – 214 Waters Hall
University of Missouri
Columbia, MO 65211
Phone (573) 882-2001
email: kallenbachr@missouri.edu

Home
5203 Forest Glen
Columbia, MO 65203
Phone (573) 446-6834

EDUCATION:
Ph.D., Agronomy, with an emphasis in statistics. 1994. Texas Tech University, Lubbock TX.
B.S., Agronomy. 1989. Southwest Missouri State University, Springfield, MO.

PROFESSIONAL EMPLOYMENT AND RESEARCH EXPERIENCE:
Jan. 1998 to present. Assistant Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. (70% Extension – 30% Research)
Responsibilities: Project leader for research and extension education projects on forage crops for Missouri. Current research focuses on developing improved winter-feeding systems for beef and dairy cattle. Specific projects include winter-annual forage evaluations, improving winter grazing of tall fescue, adaptation of rhizomatous birdsfoot trefoil for winter grazing, alfalfa management strategies to lower hay production costs, and preventing grass tetany in grazing livestock. Coordinate extension education programs on “pasture-based dairy production” and “winter-feeding systems for beef cattle”. Train and advise graduate students. Obtain outside funding for agricultural research and extension education projects. Manage university grant accounts. Provide educational support to hay, livestock, and forage producers statewide.

Responsibilities: Principal investigator and project leader for agricultural research and extension projects for the Palo Verde and Imperial valleys of California. Research and educational projects included irrigation management for alfalfa, cutting strategies to control weed invasions in alfalfa, alfalfa variety evaluations, and efficient nitrogen management for sudangrass hay.

PROFESSIONAL HONORS AND AWARDS:
2001: Provost's Award for Creative Extension Programming by New Faculty
1997: Certificate of Meritorious Service to the University of California and Riverside County
1994: Texas Tech University nominee for the Gerald O. Mott Meritorious Graduate Student Award in Crop Science
Selected Outstanding Ph.D. Student by Gamma Sigma Delta Agricultural Honor Society
1993: Selected Graduate Student Representative to the College of Agricultural Sciences and Natural Resources Deans' Advisory Committee
1991: Selected as DeKalb Outstanding Student in Agronomy
1989: Elected to Delta Tau Alpha National Honor Society
MEMBERSHIP IN PROFESSIONAL SOCIETIES:
Missouri Forage and Grassland Council
American Forage and Grassland Council
American Society of Agronomy
Crop Science Society of America
Gamma Sigma Delta Honor Society of Agriculture

SELECTED PUBLICATIONS:

Refereed Journal Articles:


Technical Reports:


Official Extension Publications:


Resume for
Robert L. McGraw

Office

Department of Agronomy
208 Waters Hall
University of Missouri
Ph: 573-882-6608
Columbia, MO 65211
E-mail: McgrawR@missouri.edu

Education


Employment

1990-Present Associate Professor, University of Missouri-Columbia
1986-1990 Assistant Professor, University of Missouri-Columbia
1980-1986 Research Agronomist, USDA-ARS, University of Minnesota
1975-1979 Graduate Research Assistant, University of Florida
1971-1975 First Lieutenant USAF, Communications Systems Officer

Honors

Phi Kappa Phi - National Honorary Society
Kappa Delta Pi - The Honor Society in Education
Gamma Sigma Delta - The Honor Society in Agriculture
Sigma Xi - The Honor Society of Scientists

Membership in Professional Societies

Association for Temperate Agroforestry
American Society of Agronomy
Crop Science Society of America
American Forage and Grassland Council
Missouri Forage and Grassland Council
The International Herbage Seed Production Research Group
Selected Publications (Total publications exceed 140 with over 50 refereed)


