

**Project Title:** Evaluation of Micronutrient Packages for Cool-season grass Pastures

**Investigator:** Robert L. Kallenbach

**Objectives and relevance of project:** Several new fertilizer products are being offered to forage producers. Although some of these products have no real scientific basis (raw milk, sea salt, etc.), there are several new products that legitimately could alleviate secondary or micronutrient deficiencies. Fertilization with secondary and micro-nutrients has not been widely recommended or practiced in Missouri, but interest in these nutrients has increased as feed prices have jumped. Offered by several well-established fertilizer companies, producers and fertilizer dealers are naturally curious as to the effectiveness of these products on pastures. At present, there is little independent research data examining the use of these products on cool-season grass pastures.

The **overall objective** is to develop research-based recommendations that help industry personnel and farmers determine if fertilization with commercially available secondary and/or micro-nutrient packages improves cool-season grass pasture growth. Specific objectives are:

*Objective 1:* Determine if adding a commercially-available secondary or micro-nutrient product to an existing fertilizer program improves the growth response of cool-season grass pastures.

*Objective 2:* Determine if these products change forage palatability or utilization by livestock.

*Objective 3:* Determine if these products change forage nutritive value.

**Procedures:**

*Treatments:* This experiment tests 12 unique fertilizer products on cool-season grass pastures. The products to be tested are listed in the table below.

Product	Supplier	Analysis/Active Ingredients
MicroEssentials SZ	Mosaic	12-40-0-10S-1Zn
MicroEssentials S15	Mosaic	13-33-0-15S
CropPlex BLACK	United Suppliers	6-20-0-0.7Zn + Humic acid
Tracite Complex	Helena	Cu and Zn (4-4)
Bio-Forge	Stoller	N,N'-diformyl urea and K-hydroxide
Humic 20	United Suppliers	Humic acid
Black Label Zn	Loveland	6-20-0-0.7Zn
LoKomotive	Loveland	2-0-25 (K-acetate)
PMax	Rosens	Copoly-[(3-carboxypropionamide)(2-(carboxymethyl)acetamide)]
Lignin Magnesium	AgXplore	S-Mg-Mn (6-4-7)
Lignin Manganese	AgXplore	S and Mn (4-5)
MicroScience	AgXplore	B-Mn-Mo-Zn (0.5-3-0.001-1)
Control	-	-

Each product will be tested under both a low and a high yield scenario. In the low yield scenario, 50 lb/acre of N will be applied in spring as a basic fertility treatment and then the products listed above will be applied at the manufacturers recommended rate. For the high yield scenario, N-P-K will be

applied according to soil testing information with a yield goal of 5 tons per acre. After fertilizer application in spring (March) the products listed above will be applied at the manufacturers recommended rate. This low/high yield scenario comparison should indicate if the use of these new products is more likely to be beneficial at higher production levels or if it is beneficial at all production levels. Finally, check treatments where no fertilizer is applied will be included. In total there will be 27 treatment combinations tested [12 fertilizer products x 2 yield scenarios = 24 treatment plus 3 controls (low yield, high yield, and no fertilizer)].

*Cultural practices:* This study will be conducted on established tall fescue pastures at the Southwest Missouri Research Center near Mt. Vernon, MO. Basic fertility for the high and low yield scenarios will be applied in mid-March. Timing and rate of treatment fertility packages will be in accordance with the manufacturer recommendations.

*Design:* Treatments in both experiments will be replicated four times in a randomized complete block design. Individual plots will be 10 ft. x 35 ft.

*Measurements:*

Forage yield and growth rates. Pasture yield will be measured weekly using an ultra-sonic feed reader and growth rates computed using week-over-week comparisons. Readings will begin in mid-April and end after two grazing cycles (see below). The ultra-sonic reader will be calibrated by mechanically harvesting forage from dedicated yield strips. As an aside, typical  $R^2$  values for ultra-sonic vs. mechanically harvested forage exceed 0.90.

Animal palatability and utilization.

In order to best test the products for pasture use, we propose to test under grazing conditions. Once the pasture reaches the ideal height for grazing (7 to 10 inches), livestock will be introduced at a temporal stocking rate of 50 to 60 hd/acre. At this stocking rate, forage should be grazed to a 2-3 inch stubble within 24 hours. To assess palatability of the forage, a representative set of livestock will be fitted with GPS collars. The GPS collars track and record livestock location every second (1 Hz). Each recording or “fix” during the grazing period will be associated with an individual plot. Previous research from our lab shows that these fixes correlate well with grazing time, and thus animal preference for forage. We propose to test (graze) the pasture over two growth cycles (approximately 28 days apart) to provide a more accurate data set for the treatments.

Forage nutritive value [crude protein, neutral detergent fiber (NDF), and NDF digestibility (DNDF)] will be measured just prior to each grazing event. Forage from 25 to 30 locations within each plot will be hand collected. Samples will be dried at 55°C before being ground to pass a 1-mm screen. Crude protein, NDF, and DNDF will be measured using near-infrared reflectance spectroscopy.

**Current Status/importance of research area:** Cool-season grass pastures grow on more than 12 million acres and provide forage for more than 3.5 million beef cattle in Missouri. These grasses, primarily tall fescue, are popular with beef producers because they persist on infertile, poorly drained, sloped, and/or unmanaged areas.

Traditionally, pastures have received limited fertility inputs. However, as available pasture acres contract (as a result of expanding corn and soybean acreage) the impetus to maximize forage production and utilization grows. As a result, both producers and fertilizer dealers are considering

fertility programs once thought of as only applicable to row crop agriculture. New to the market are several products that claim to improve forage yield and/or utilization by animals. Offered by several well-established fertilizer suppliers, (Helena, Mosaic, United Suppliers, Rosens, Stoller, AgXplore) producers and fertilizer dealers are naturally curious as to the effectiveness of these products on pastures. At present, there is little independent research data examining the use of these products on cool-season grass pastures.

**Expected economic impact of the project:** The largest factor driving the increased interest in fertilizing forage acres more efficiently is high grain (feed) prices. While great for crop farmers, higher feed-grain prices have, in effect, made the value of forage greater. Economic analyses show that a 15% increase in forage production would increase the net value of livestock sold by \$40 per head in Missouri. If just 20% of beef producers used this practice, the net value of feeder calves sold in Missouri would increase by \$13 million dollars annually.

**Timetable for proposed research:** This study will begin in spring of 2013 and end in December of 2015 (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)

Spray existing perennial forage in plot areas with glyphosate	3/15/13
No-till plant forage at the Southwest Center	*Late April or Early May
Take plate meter readings to guide forage harvests	*Weekly from 1 June until frost.
Apply appropriate nitrogen fertilizer treatments (see table on page 1 for details)	*May, June, July
Harvest appropriate plots for forage yield and retain subsamples for forage quality, prussic acid, and nitrate analysis	*Variable based on plant growth - expect 3 to 5 harvests per yr.
Analyze latest results & report findings to Fertilizer/Ag Lime Advisory Council	*December
Incorporate results into soil testing reports, grazing school materials and forage conferences. Work with press on articles.	October 2013 through December 2014
Submit manuscript on this research to a peer-reviewed journal	March 2014

**Application/transfer of knowledge:** We will transfer our results in three ways. First, we will incorporate the results and recommendations from this study into the curriculum of the Missouri Grazing Schools and the annual Forage Conferences held across the state. 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. 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.

**Budget:****YEAR 1****Salary and Benefits**

Research Specialist (20% of \$57,000)	\$11,400
Benefits for Research Specialist	\$3,648
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Total Salary and Benefits	\$15,048

**Operating Expenses**

Fertilizer, bags, repair parts for harvester and other field supplies	\$3,740
NIR charges for forage quality analysis (216 samples @ \$5 each)	\$1,080
Wet chemistry for NIR calibration (60 samples @ \$24 each)	\$1,440
Travel to research location (mileage, lodging, and meals for 8 trips/yr)	\$1,600
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Total Operating Expenses	\$7,860

**Equipment**

Sonic Sensor equipment and software	\$3,600
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Total Equipment	\$3,600

***Total Proposal Request for Year #1*** \$26,508

**YEAR 2****Salary and Benefits**

Research Specialist (20% of \$58,710)	\$11,742
Benefits for Research Specialist	\$3,757
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Total Salary and Benefits	\$15,499

**Operating Expenses**

Fertilizer, bags, repair parts for harvester and other field supplies	\$3,740
NIR charges for forage quality analysis (216 samples @ \$5 each)	\$1,080
Wet chemistry for NIR calibration (60 samples @ \$24 each)	\$1,440
Travel to research location (mileage, lodging, and meals for 8 trips/yr)	\$1,600
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Total Operating Expenses	\$7,860

**Equipment**

None requested	\$0
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Total Equipment	\$0

***Total Proposal Request for Year #2*** \$23,359

**YEAR 3****Salary and Benefits**

Research Specialist (20% of \$60,471)	\$12,094
Benefits for Research Specialist	\$3,870
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Total Salary and Benefits	\$15,964

**Operating Expenses**

Fertilizer, bags, repair parts for harvester and other field supplies	\$3,740
NIR charges for forage quality analysis (216 samples @ \$5 each)	\$1,080
Wet chemistry for NIR calibration (60 samples @ \$24 each)	\$1,440
Travel to research location (mileage, lodging, and meals for 8 trips/yr)	\$1,600
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Total Operating Expenses	\$7,860

**Equipment**

None requested	\$0
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Total Equipment	\$0

***Total Proposal Request for Year #3*** \$23,824

**GRAND TOTAL REQUEST** \$73,692

# Robert L. Kallenbach

Professor and State Extension Specialist  
Division of Plant Sciences – 108 Waters Hall  
University of Missouri  
Columbia, MO 65211

Phone (573) 884-2213  
Fax (573) 882-1467  
email: kallenbachr@missouri.edu

## Education:

Ph.D., Agronomy, with an emphasis in statistics. 1994. Texas Tech University, Lubbock TX.  
M.S., Agronomy. 1992. University of Missouri-Columbia, Columbia, MO.  
B.S., Agronomy. 1989. Southwest Missouri State University, Springfield, MO.

## Professional Employment and Experience (Since 1994):

Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. (60% Extension – 25% Research – 15% Service). Sep. 2009 to Present.  
Associate/Associate Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. Jan. 1998 to Sep. 2009.  
Field Crops Advisor. University of California - Cooperative Extension. Oct. 1994 to Dec. 1997.

## Professional Service, Honors and Awards (Since 2004):

- 2011: C. Brice Ratchford Fellow. (*Fellowship given to one person in the MU-system annually*)
- 2010: Missouri Grasslander - Agency. (*Statewide award given by the Missouri Forage and Grassland Council to one agency person each year*)
- 2009: University of Missouri "Teamwork Extension Award". (*System wide award given to a group of faculty and regional specialists working together on innovative outreach programming.*)
- 2007: Donald W. Fancher Provost Award for Outstanding Achievement in Extension and Continuing Education. (*Campus-wide award given to one faculty member at the University of Missouri each year.*)
- 2004: Young Crop Scientist award presented by the Crop Science Society of America (*International award given to one scientist under 37 years of age annually*)
- 2004: J.W. Burch State Specialist Award for Outstanding Statewide Program Leadership
- 2004: Gamma Sigma Delta Honor Society award for Excellence in Extension Education

## Membership in Professional Societies:

American Society of Agronomy, 1990 to present  
Crop Science Society of America, 1990 to present  
American Forage and Grassland Council, 1990 to present  
Missouri Forage and Grassland Council, 1998 to present  
Gamma Sigma Delta Honor Society of Agriculture, initiated in 1988

## Research Activities:

Refereed Journal Articles	57
Book Chapters	2
Proceedings and Abstracts	121
Grants Dollars Awarded	\$6,837,267

## Extension Education:

Extension Manuals and Guides	34
Workshops and Short Courses taught	118
Extension education meetings and classes taught	302

## Selected publications

### Refereed Journal Articles (Since 2008):

- Kallenbach, R.L., R.J. Crawford, Jr., M.D. Massie, M.S. Kerley, and N.J. Bailey. 2012. Integrating bermudagrass into tall fescue-based pasture systems for stocker cattle. *J. Anim. Sci.* 90:387-394.
- Dierking, R.M., and R.L. Kallenbach. 2012. Mediterranean and continental tall fescue: II. Effects of cold, nonfreezing temperatures on leaf extension, proline, fructan, and abscisic acid. *Crop Sci.* 52:460-469.
- Dierking, R.M., C.A. Young, and R.L. Kallenbach. 2012. Mediterranean and continental tall fescue: I. Effects of endophyte status on leaf extension, proline, mono- and disaccharides, fructan, and freezing survivability. *Crop Sci.* 52:451-459.
- Houx, J.H., III, R.L. McGraw, H.E. Garrett, R.L. Kallenbach, F.B. Fritschi, and M.A. Gold. 2012. Temperate silvopasture tree establishment and growth as influenced by forage species and cultural management practices. *J. Agric. Sci.* 4:20-30.
- Kumar, S., S.H. Anderson, R.P. Udawatta, and R.L. Kallenbach. 2012. Water infiltration influenced by agroforestry and grass buffers for a grazed pasture system. *Agroforest. Syst.* 84:325-335.
- Lee, D.K., E. Aberle, C. Chen, J. Egenolf, K. Harmony, G. Kakani, R.L. Kallenbach, and J.C. Castro. 2012. Nitrogen and harvest management of conservation reserve program (CRP) grassland for sustainable biomass feedstock production. *GCB Bioenergy.* (doi: 10.1111/j.1757-1707.2012.01177).
- Roberts, C.A., R.L. Kallenbach, G.E. Rottinghaus, and N.S. Hill. 2011. Ergovaline and ergot alkaloid concentrations change in conserved tall fescue forage. Online. *Forage and Grazinglands* doi:10.1094/FG-2011-1013-01-RS.
- Rogers, W.M., C.A. Roberts, J.G. Andrae, D.K. Davis, G.E. Rottinghaus, N.S. Hill, R.L. Kallenbach, and D.E. Spiers. 2011. Seasonal fluctuation of ergovaline and total ergot alkaloid concentrations in tall fescue regrowth. *Crop Sci.* 51:1291-1296.
- Udawatta, R.P., H.E. Garrett, and R.L. Kallenbach. 2011. Agroforestry buffers for non point source pollution reductions from agricultural watersheds. *J. Environ. Qual.* 40:800-806.
- Rogers, W.M., C.A. Roberts, R.L. Kallenbach, G.E. Rottinghaus, N.S. Hill, W.E. McClain, and D.G. Blevins. 2010. Poultry litter and its chemical equivalent can affect ergot alkaloid concentrations in tall fescue. Online. *Forage and Grazinglands* doi:10.1094/FG-2009-0129-01-RS.
- Kallenbach, R.L., E.B. Venable, M.S. Kerley, and N.J. Bailey. 2010. Stockpiled tall fescue and livestock performance in an early stage Midwest silvopasture system. *Agroforest. Syst.* 80:379-384.
- Bailey, N.J. and R.L. Kallenbach. 2010. Economic favorability of feeding distillers dried grains with solubles and round-bale silage to stocker cattle. *Profess. Anim. Sci.* 26:375-379.
- Udawatta, R.P., H.E. Garrett, and R.L. Kallenbach. 2010. Agroforestry and grass buffer effects on water quality in grazed pastures. *Agroforest. Syst.* 79:81-87.
- Bradley, K.W., R.L. Kallenbach, and C.A. Roberts. 2010. Influence of seeding rate and herbicide treatments on weed control, yield, and quality of spring-seeded glyphosate-resistant alfalfa. *Agron. J.* 102:751-758.
- Dierking, R.M., R.L. Kallenbach, and I.U. Grün. 2010. Effect of forage species on fatty acid content and performance of pasture finished steers. *Meat Sci.* 85:597-605.
- Bailey, N.J. and R.L. Kallenbach. 2010. Comparison of three tall fescue-based stocker systems. *J. Anim. Sci.* 88:1880-1890.
- Dierking, R.M., R.L. Kallenbach, and C.A. Roberts. 2010. Fatty acid profiles of orchardgrass, tall fescue, perennial ryegrass, and alfalfa. *Crop Sci.* 50:391-402.
- Meyer, A.M., M.S. Kerley, R.L. Kallenbach, and T.L. Perkins. 2009. Comparison of grazing stockpiled tall fescue versus feeding hay with or without supplementation for gestating and lactating beef cows during winter. *Profess. Anim. Sci.* 25:449-458
- Bruce, B.R., R.L. Kallenbach, K.W. Bradley, and B.D. Fuqua. 2009. Using a pre-plant herbicide does not increase forage production when cereal rye is interseeded into bermudagrass in the southern temperate-humid zone. *Agron. J.* 101:1175-1181.
- Angima, S.D., R.L. Kallenbach, W.W. Riggs. 2009. Optimizing hay yield under lower nitrogen rates for selected warm-season forages. *J. Integrative Biosci.* 7:1-6.
- Roberts, C.A., R.L. Kallenbach, N.S. Hill, G.E. Rottinghaus, and T. J. Evans. 2009. Ergot alkaloid concentrations in tall fescue hay during production and storage. *Crop Sci.* 49:1496-1502.
- Angima, S.D., R.L. Kallenbach, and W.W. Riggs. 2009. Forage yield of selected cool-season grasses in response to varying rates of nitrogen. Online. *Forage and Grazinglands* doi:10.1094/FG-2009-0129-01-RS.
- Dierking, R.M., R.L. Kallenbach, M.S. Kerley, C.A. Roberts, and T.R. Lock. 2008. Yield and nutritive value of 'Spring Green' festulolium and 'Jessup' endophyte-free tall fescue stockpiled for winter pasture. *Crop Sci.* 48:2463-2469.
- Meyer, A.M., M.S. Kerley, and R.L. Kallenbach. 2008. The effect of residual feed intake classification on forage intake by grazing beef cows. *J. Anim. Sci.* 86:2670-2679.
- Curtis, L.E., R.L. Kallenbach, and C.A. Roberts. 2008. Allocating forage to fall-calving cow-calf pairs strip-grazing stockpiled tall fescue. *J. Anim. Sci.* 86:780-789.

### Book Chapters:

- Casler, M.D. and R.L. Kallenbach. 2007. Cool-season grasses for humid areas. *In* R.F. Barnes, C.J. Nelson, K.J. Moore and M. Collins (ed.) *Forages Vol II: The science of grassland agriculture*, 6th ed. Iowa State Univ. Press, Ames, IA.
- Cherney, J.H. and R.L. Kallenbach. 2007. Forage systems for the temperate humid zone. *In* R.F. Barnes, C.J. Nelson, K.J. Moore and M. Collins (ed.) *Forages Vol II: The science of grassland agriculture*, 6th ed. Iowa State Univ. Press, Ames, IA.