

Project Title: Fertilizing Summer-Annual Grasses for Forage Production

Investigator: Robert L. Kallenbach

Objectives and relevance of project: Summer-annual grasses are becoming more popular each year, especially forage varieties of crabgrass and dwarf, brown mid-rib sorghum sudangrass. These grasses provide high-quality forage for summer grazing and/or stored forage. However, we have almost no information about how to fertilize these grasses for optimum economic production. This is especially true for nitrogen fertilizer. Although these grasses represent a great opportunity for forage/livestock producers at present, there is little data for solid agronomic recommendations.

The **overall objective** is to develop research-based recommendations that help industry personnel and farmers properly fertilize summer annual grasses. Specific objectives are:

Objective 1: Determine the optimum economic N rates for crabgrass, dwarf brown mid-rib (BMR) sorghum-sudangrass hybrids, non-dwarf sorghum-sudangrass hybrids and pearl millet.

Objective 2: Determine if split application of nitrogen fertilizers provides a significant advantage compared to larger single applications.

Objective 3: Determine the influence of N application rates on nitrate accumulation and/or prussic acid concentrations in forage.

Procedures:

Treatments: This experiment has 40 treatments; five forage entries and eight N rates x timing applications. The five forage entries are 'Red River' crabgrass, 'Big-n-Quick' crabgrass, 'Summer Dream' dwarf BMR sorghum x sudangrass, 'Nutri+BMR' sorghum-sudangrass and 'Tifleaf III' pearl millet. The eight nitrogen treatments are described in the table below.

Treatment	Annual N rate	No. of Applications	Notes
	lb/acre	#	
1	0	-	Control
2	50	1	Applied in late May
3	100	1	Applied in late May
4	100	2	1/2 in late May, 1/2 late June
5	150	3	1/3 late May, 1/3 late June, 1/3 late July
6	150	1	Applied in late May
7	300	3	1/3 late May, 1/3 late June, 1/3 late July
8	300	2	1/2 in late May, 1/2 late June

Cultural practices: Stands of each annual forage will be established in late April or early May at the Southwest Center, near Mt. Vernon, MO and at the Forage Systems Research Center near Linneus, MO. Existing perennial forage will be sprayed with glyphosate approximately 1 month prior to planting and again 3 to 7 days before planting. Both sites will be planted using a Truax no-till drill. The seeding rates (PLS) for each species will be as follows; crabgrass 4 lb/acre,

sorghum-sudangrass 40 lb/acre, and pearl millet 30 lb/acre. Soil P and K will be maintained at levels recommended by the University of Missouri Soil Testing Laboratory.

Design: Each treatment will be replicated four times in a randomized complete block design in a split-block arrangement. Forage entries will be main plots and nitrogen treatments sub-plots. Individual main plots will be 50 ft. x 35 ft.

Measurements:

Forage yield and growth rates. Growth rate of forage will be measured weekly using a rising plate meter for crabgrass and a falling disk meter (FDM) for the other forage species. Mechanical forage harvest for an individual treatment will occur when forage reaches the following thresholds: 18 RPM units for crabgrass, 60 FDM units for the other species. For those unfamiliar with disk meter measurements, this would equate to approximately 8 inches in height for crabgrass and 30 inches of height for the other species. While more time consuming, this "harvest when it is ready" methodology more accurately reflects the use of forage in pasture-based systems. When a mechanical harvest is triggered, forage yield will be determined by clipping a 3-ft. x 30-ft. strip to a 2 inch stubble height in each plot.

Forage nutritive value [crude protein, neutral detergent fiber (NDF), and NDF digestibility (DNDF)] 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, NDF, and DNDF will be measured using near-infrared reflectance spectroscopy.

Forage toxicity. Prussic acid and nitrates in summer annual forages will be measured at each harvest from wet (green) tissue. For prussic acid, the method of Blaedel (1971) will be used. For nitrates, NO₃-N content will be determined by ion chromatography (IC7000S; Yokogawa Analytical Systems, Tokyo, Japan) after extraction with distilled water.

Current Status/importance of research area: One of the greatest limitations to livestock production in Missouri is the lack of acceptable quality forage from cool-season grasses during the summer months. To meet this need, producers often use annual warm-season grasses to provide high-quality forage during summer. Among those being used most frequently are crabgrass and BMR types of sorghum-sudangrass.

Despite its reputation as a weed, crabgrass is among the highest quality forages in summer (Dalrymple, 1999). Preliminary research from our lab shows that stocker calves can gain over 2.0 lb/hd/d when grazing well-managed crabgrass. This would compare to 1.2 lb/hd/d from bermudagrass or 0.8 lb/hd/d from tall fescue. Research conducted at the Noble Foundation in Oklahoma, as well as farmer experience, shows similar results. Additionally, research from Oklahoma (Dalrymple, 1999) and Virginia (Teutsch et al., 2005) show that crabgrass is responsive to N fertilization, though the responses under Midwestern conditions is unknown.

Another development in annual warm-season grasses are "dwarf" types of brown mid-rib (BMR) sorghum-sudangrass. These new types not only have the BMR genes that improve forage digestibility but also have much shorter stem internodes. This dwarf trait results in plants having a greater leaf to stem ratio that improves both palatability and forage quality. While many studies

have examined nitrogen fertilizer use on sorghum-sudangrass hybrids, almost no work has been conducted with the new dwarf BMR types.

Expected economic impact of the project: Crabgrass and BMR sorghum-sudangrass have over the past few years become an important economic component of forage-livestock systems. The largest factor driving the increased use of these forages 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 summer annual forage production could 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 \$16 million dollars annually.

Timetable for proposed research: This study will begin in spring of 2011 and end in December of 2013 (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	3/15/11
No-till plant forage at the Southwest Center and at the Forage Systems Research 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.

References:

- Blaedel, W.J., D.B. Easty, L. Anderson and T.R. Farrell. 1971. Potentiometric determination of cyanide with an ion selective electrode. *Anal. Chem.* 43:890–894.
- Dalrymple, R. L. 1999. Crabgrass: A synopsis. Pages 1-5 in: Crabgrass for Forage: Management from the 1990s. NF-FO-99-18. The Noble Foundation, Ardmore, OK.
- Teutsch, C.D., Fike, J.H., Groover, G.E., and Tilson, W.M. 2005. Nitrogen fertilization rate and application timing effects on the yield of crabgrass. *Online*. Forage and Grazinglands doi:10.1094/FG-2005-0518-01-RS.

Budget:

Year 1

Salary and Benefits

Research Specialist (20% of \$48,000)	\$ 9,600
<u>Benefits for Research Specialist</u>	<u>\$ 3,072</u>
Total Salary and Benefits	\$ 12,672

Operating Expenses

Fertilizer, bags, repair parts for harvester and other field supplies	\$ 1,500
NIR charges for forage quality analysis (1280 samples @ \$4 each)	\$ 3,840
Wet chemistry for NIR calibration (90 samples @ \$10.50 each)	\$ 945
Prussic acid and nitrate analysis	\$ 1,250
<u>Travel to research locations (mileage, lodging, and meals for 8 trips/yr)</u>	<u>\$ 1,600</u>
Total Operating Expenses	\$ 9,135

Equipment

<u>None requested</u>	<u>\$ 0</u>
Total Equipment	\$ 0

Total Proposal Request for Year #1 ***\$21,807***

Year 2

Salary and Benefits

Research Specialist (20% of \$48,000)	\$ 9,600
<u>Benefits for Research Specialist</u>	<u>\$ 3,072</u>
Total Salary and Benefits	\$ 12,672

Operating Expenses

Fertilizer, bags, repair parts for harvester and other field supplies	\$ 1,500
NIR charges for forage quality analysis (1280 samples @ \$4 each)	\$ 3,840
Wet chemistry for NIR calibration (90 samples @ \$10.50 each)	\$ 945
Prussic acid and nitrate analysis	\$ 1,250
<u>Travel to research locations (mileage, lodging, and meals for 8 trips/yr)</u>	<u>\$ 1,600</u>
Total Operating Expenses	\$ 9,135

Equipment

<u>None requested</u>	<u>\$ 0</u>
Total Equipment	\$ 0

Total Proposal Request for Year #2 ***\$21,807***

Year 3**Salary and Benefits**

Research Specialist (20% of \$48,000)	\$ 9,600
<u>Benefits for Research Specialist</u>	<u>\$ 3,072</u>
Total Salary and Benefits	\$ 12,672

Operating Expenses

Fertilizer, bags, repair parts for harvester and other field supplies	\$ 1,500
NIR charges for forage quality analysis (1280 samples @ \$4 each)	\$ 3,840
Wet chemistry for NIR calibration (90 samples @ \$10.50 each)	\$ 945
Prussic acid and nitrate analysis	\$ 1,250
Travel to research locations (mileage, lodging, and meals for 8 trips/yr)	\$ 1,600
<u>Publication charges</u>	<u>\$ 850</u>
Total Operating Expenses	\$ 9,985

Equipment

<u>None requested</u>	<u>\$ 0</u>
Total Equipment	\$ 0

Total Proposal Request for Year #3 **\$22,657**

Grand Total for three years **\$66,271**

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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 Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. (60% Extension – 25% Research – 15% Service). Sep. 2004 to Sep 2009.
Assistant Professor/State Extension Specialist – Forage Crops. University of Missouri – Columbia. (60% Extension – 25% Research – 15% Service). Jan. 1998 to Sep. 2004.
Field Crops Advisor. University of California - Cooperative Extension. Oct. 1994 to Dec. 1997.

Professional Service, Honors and Awards (Since 2004):

- 2010 Grasslander of the Year. (*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 specialists working together on innovative outreach programming.*)
- 2007: Donald W. Fancher Provost Award for Outstanding Achievement in Extension and Continuing Education.
- 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

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

Research Activities:

Refereed Journal Articles	45
Book Chapters	2
Proceedings and Abstracts	101

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 2006):

- 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., H.E. Garrett and R.L. Kallenbach. 2010. Agroforestry and grass buffer effects on water quality in grazed pastures. *Agroforest. Syst. In Press.*
- 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.
- 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.
- 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.
- Curtis, L.E., and R.L. Kallenbach. 2007. Endophyte infection level of tall fescue stockpiled for winter grazing does not alter the gain of calves nursing lactating beef cows. *J. Anim. Sci.* 85:2346-2353.
- Casler, M.D., K.P. Vogel, C.M. Taliaferro, N.J. Ehlke, J.D. Berdahl, E.C. Brummer, R.L. Kallenbach, C.P. West, and R.B. Mitchell. 2007. Latitudinal and longitudinal adaptation of switchgrass populations. *Crop Sci.* 47:2249-2260.

- Smith, L.B., and R.L. Kallenbach. 2006. Overseeding annual ryegrass and cereal rye into soybean as part of a multifunctional cropping system: I. Grain crop yields, winter annual weed cover, and residue after planting. *Forage and Grazinglands* doi:10.1094/FG-2006-0907-01-RS.
- Smith, L. B., and R.L. Kallenbach. 2006. Overseeding annual ryegrass and cereal rye into soybean as part of a multifunctional cropping system: II. Forage yield and nutritive value. *Forage and Grazinglands* doi:10.1094/FG-2006-0907-02-RS.
- Kallenbach, R. L., C.A. Roberts, T.R. Lock, D.H. Keisler, M.R. Ellersieck, and G.E. Rottinghaus. 2006. Performance of steers fed ammoniated straw from tall fescue seed fields. *Forage and Grazinglands* doi:10.1094/FG-2006-0113-01-RS.
- Kallenbach, R.L., M.S. Kerley, and G.J. Bishop-Hurley. 2006. Forage accumulation, quality and livestock production from an annual ryegrass and cereal rye mixture in a pine-walnut silvopasture. *Agroforest. Syst.* 66:43-53.

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 University 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 University Press, Ames, IA.