

Increasing Phosphorus and Magnesium Concentrations in Stockpiled Tall Fescue

Missouri Fertilizer and Lime Council

Grant Proposal

Investigator: Dale G. Blevins, Professor of Agronomy, University of Missouri

Objective: To determine if high rates of phosphorus fertilization on both low P and adequate P soils will result in leaf P and Mg concentrations in stockpiled tall fescue that meet the nutrient requirements for grazing beef cows in winter and early spring. This research is important for the Missouri fertilizer and lime industry because of the potential acreage involved. Missouri is second in the nation, after Texas, in feeder calf production and is number one in tall fescue production (2002 Missouri Farm Facts). There are over 10 million acres of tall fescue in the state, and much of it is on low phosphorus soils. In our previous work on grass tetany, we found that tall fescue pastures treated with phosphorus fertilizer had higher leaf magnesium concentration than leaves from untreated soil (Reinbott and Blevins, 1997). Many people are recommending that cattle producers stockpile tall fescue for winter grazing, since it is much more economical than making hay. However, there is very little information available on the nutrient quality of stockpiled tall fescue.

Problem: This new project is based on results of our current study, where stockpiled tall fescue on a low P soil treated with 12.5 or 25 lbs P/acre had leaf P and Mg concentrations during winter and early spring that dropped below levels recommended for the diets of beef cows. Therefore diets of beef cows grazing stockpiled tall fescue may need to be supplemented with grain, alfalfa hay or mineral blocks to provide P and Mg in the diet. Another approach is to determine if higher levels of soil or fertilizer P will bust the P and Mg levels in the leaves of tall fescue entering winter, such that the leaf levels will remain above the levels recommended for beef cow diets during winter and early spring.

Procedures: During summer 2003, several sites at the University of Missouri Southwest Research Center near Mt. Vernon will be selected for good tall fescue stands, and soil from these areas will be sampled and tested for phosphorus and other macronutrient elements. Two sites, one with low soil P (<10 lbs/acre) and one with over 40 lbs P/acre will be selected for this study. The plot areas will be mowed and the forage will be removed during the third week in August. Plots will be 10' x 25' with 5' alleys, and at each site plots will be treated with 0, 50, 100 or 200 lbs P/acre. Each treatment will be replicated six times. From mid-October through mid-April, two different types of samples will be harvested from each plot. One sample will consist of 20 of the most recently collared leaves, and the second type of sample will be four grab samples combined within each plot. In the previous study, 20 of the most recently collared leaves were harvested, and this type of sampling will be maintained for comparison, and the grab samples will be added to reflect the harvest of a grazing cow. All samples will be placed in a drying oven. Dried samples will be ground and digested in nitric acid in a microwave digestion system (CEM Corp.). Digested samples will be filtered, diluted and

K will be determined by flame ionization, Mg and Ca by atomic absorption, and P by colorimetric analysis. Data will be analyzed by SAS and graphs will be prepared by plotting leaf macronutrient concentrations versus month of the year and phosphate treatments (as in Fig. 1).

Current status/importance of research area: In searching the literature, I found only one study on macronutrient concentration in stockpiled tall fescue, and although this West Virginia study was on nitrogen fertilization rates, levels of P and Mg in the forage dropped during the winter months (Collins and Balasko, 1981). Our current results also show that as stockpiled tall fescue plants entered the winter months, leaf P, Mg and K concentrations plummeted (Fig. 1). However, leaf Ca concentrations remained level during the fall and winter months, and this was not surprising since Ca is an immobile element in plants. The P, Mg and K are mobile inside the plant and are often remobilized in perennial plants, for example in alfalfa they are removed from leaves and remobilized to the crown area over winter. Nutrient remobilization in the perennial tall fescue has neither been suggested nor studied previously, to my knowledge. Remobilization of P, Mg and K in tall fescue is the best explanation for the results presented in the West Virginia study and in our current study. Although leaf K concentrations decline during winter, the levels did not fall below the nutritional requirements of grazing beef cows (Nutritional Requirements, National Academy of Science 2002). However, the leaf levels of P and Mg did fall below required levels, therefore cattle producers must take this into consideration when animals are grazing stockpiled tall fescue. The question then becomes, with higher soil P levels and/or will higher rates of P fertilization, can P and Mg concentrations of tall fescue forage be maintained at levels that meet the requirements of grazing beef cows during the winter and early spring?

Timetable for proposed research: In early July 2003, soil will be sampled at several tall fescue sites at the Southwest Center. Samples will be analyzed at the University of Missouri Soil Testing Laboratory. One site that tests below 10 lbs P/acre and another site that tests over 40 lbs P/acre will be selected for this study. During the third week in August the tall fescue will be cut and the forage removed. Plot areas will be marked, flagged and P fertilization treatments will be applied. During mid-October and each month thereafter until May, leaf samples will be harvested, dried, digested and nutrient analyzes will be conducted. In late May 2004, hay will be harvested, yields measured and hay samples will be dried, weighed, ground and analyzed. On the third week in August, hay samples will be removed, dried, weighed, ground and analyzed. After this 2004 harvest, P fertilization treatments will be applied, as in 2003. Sampling and harvests will be continued monthly as in 2003. Data will be analyzed, and P and Mg concentrations in leaves will be compared with the nutrient requirements of grazing beef cows. During summer 2005, results from this two-year study will be prepared for publication in a refereed journal.

Strategy for application and transfer of knowledge: The results of this study will be presented at Southwest Center Field Days, and presented at several meetings of the Missouri Cattlemen's Association. The results also will be presented a several county Cattlemen's Association meetings, and Forage meetings in the state. Results of this study

will be presented at annual meetings of the American Society of Agronomy, and published in a refereed journal.

Budget:

<u>Category</u>	<u>Year 1</u>	<u>Year 2</u>
Salary		
Research Assistant (50%)	\$16,000	\$17,000
Benefits	4,000	4,250
Supplies (fertilizer, chemicals, DI H ₂ O, beakers, pipets)	2,000	2,000
<u>Travel to Mt. Vernon</u>	<u>1,000</u>	<u>1,000</u>
Total	\$23,000	\$24,250

Literature cited (Our publications after 1996 are listed in my CV):

Collins, M. and J.A. Balasko. 1981. Effects of N fertilization and cutting on stockpiled tall fescue: Forage quality. *Agron. J.* 73:821-826.

Resume:

Dale G. Blevins - Professor of Agronomy

Present Address

1-87 Agriculture Building
Department of Agronomy
University of Missouri
Columbia, MO 65211

phone 573 882-4819
fax 573 882-1469
email blevinsd@missouri.edu

Education

B.S. in Chemistry, Southwest Missouri State University, 1965
M.S. in Soils (Plant Nutrition), University of Missouri, 1967
Ph.D. in Plant Physiology, University of Kentucky, 1972

Experience

1985 - present, Professor, Agronomy Department, U. Missouri, Columbia
1980 – 1985 Associate Professor, Agronomy Department, U. Missouri, Columbia
1978 - 1980 Assistant Professor, Agronomy Department, U. Missouri, Columbia
1974 - 1977 Assistant Professor, Botany Dept., U. Maryland, College Park
1972 - 1974 Postdoctoral Research Associate, Department of Botany and Plant Pathology, Oregon State University, Corvallis

Awards

1982 Gamma Sigma Delta Superior Research Award for Junior Faculty in Agriculture
1983 Amer. Soybean Assoc./ ICI International Soybean
 Researchers Recognition Award
1983 Gamma Sigma Delta Superior Graduate Teaching Award

1992 Fellow of the American Society of Agronomy
1992 Fellow of the Crop Science of America
1992 Distinguished Faculty Award, UMC Alumni
1993 Kemper Teaching Award, UMC

Ph.D. Dissertations Completed

E. W. Triplett. 1981. Agronomy Department, UMC. Title: Soybean Nodule Xanthine Dehydrogenase: Purification, Properties and Role in Ureide Metabolism. Professor of Plant Physiology in the Agronomy Department at the University of Wisconsin.

E. J. Grabau. 1985. Agronomy Department, UMC. Title: Effects of Phosphate on Leaf Senescence and Yield, Methionine on Seed Protein Quality and Planting Rate on Harvestability of Soybeans. Professor of Agronomy and Director of the Teaching and Learning Center at the University of Kentucky. Co-Advised with Harry Minor.

M. J. Lauer. 1989. Agronomy Department, UMC. USDA National Needs Fellow. Title: Soybeans (*Glycine max*) Response to Varying Phosphate Nutrition. Presently employed by Pioneer Seed Co., Johnston, IA.

M. K. Schon. 1989. Agronomy Department, UMC. USDA National Needs Fellow. Title: Physiological Roles of Boron in Higher Plants. Director of Science Communications at Epcot Center, Walt Disney World, Orlando, Florida.

R. C. Dobert. 1990. Agronomy Department, UMC. USDA National Needs Fellow. Title: Gibberellins and the *Rhizobium*-Legume Symbiosis. Currently at Monsanto in St. Louis, MO.

M.E. LeNoble. 1993. Agronomy Department, UMC. Title: Boron Ameliorates Root Growth Inhibition by Aluminum in Alfalfa and Squash. Currently research associate with Dr. Robert Sharp at UMC.

B.B. Stone. 2001. Biological Sciences, UMC. Title: Boron Deficiency Blocks Squash Root Growth and Magnesium Uptake. Post-doctoral student in Biological Sciences at UMC, and teaching General Biology.

B.M. Waters. 2002. Agronomy Department, UMC. Title: Iron Nutrition in Plants and Yeast: Studies on the FRO1 gene of *Pisum sativum* and the FET4 gene of *Sacharomyces cerevisiae*. In July 2002, Brian was appointed Assistant Professor of Biology at McMurry University in Abilene, Texas. Co-advised with Dr. David Eide.

Selected Publications (last five years)

Reinbott, T.M. and D.G. Blevins. 1997. Phosphorus and magnesium fertilization interaction with soil phosphorus level: Tall fescue yield and mineral element content. *J. Production Agriculture* 10: 260-265.

Reinbott, T.M., D.G. Blevins and M.K. Schon. 1997. Content of boron and other elements in main stem and branch leaves and seed of soybean. *J. Plant Nutrition* 20: 831-843.

Blevins, D.G. and T.M. Reinbott. 1998. Impact of phosphorus nutrition on magnesium, calcium and water status of plants. *Current Topics in Plant Physiology: An American Society of Plant Physiologists Series*. 19: 197-206.

Blevins D.G. and K.M. Lukaszewski. 1998. Boron in plant structure and function. *Annual Review of Plant Physiology and Plant Molecular Biology* 49: 481-500.

Markwell, J. and D.G. Blevins. 1999. The Minolta Spad-502 leaf chlorophyll meter: An exciting new tool for education in the plant sciences. *The American Biology Teacher* 61: 672-676.

Reinbott, T. M. and D.G. Blevins. 1999. Phosphorus nutritional effects on root hydraulic conductance, xylem water flow and flux of magnesium and calcium in squash plants. *Plant and Soil* 209: 263-273.

Waters, B.M. and D.G. Blevins. 2000. Ethylene production, cluster root formation and localization of iron (III) reducing capacity in Fe deficient squash roots. *Plant and Soil* 225: 21-31.

Smith, G.J., W.J. Wiebold, T.L. Niblack, P.C. Scharf and D.G. Blevins. 2000. Yield components of soybean plants infected with soybean cyst nematode and sprayed with foliar applications of boron and magnesium. *J. Plant Nutrition* 23: 827-834.

Smith, G.J., W.J. Wiebold, T.L. Niblack, P.C. Scharf and D.G. Blevins. 2001. Macronutrient concentrations of soybean infected with soybean cyst nematode. *Plant and Soil* 235: 21-26.

Lock, T.R., R.L. Kallenbach, D.G. Blevins., T.M. Reinbott, G.J. Bishop-Hurley, R.J. Crawford, Jr. and M.D. Massie. 2001. Soil phosphorus may be important to beef herd health and performance. *Better Crops with Plant Food* 85: 4-8.

Waters, B.M., D.G. Blevins and D.J. Eide. 2002. Characterization of FRO1, a pea (*Pisum sativum*) ferric-chelate reductase involved in root Fe uptake and tissue Fe distribution. *Plant Physiol.* 129: 1-10.

Lock, T.R., R.L. Kallenbach, D.G. Blevins, T.M. Reinbott and G.J. Bishop-Hurley. 2002. Adequate soil phosphorus decreases the grass tetany potential of tall fescue pasture. Online. *Crop Management* doi:10.1094/CM-2002-0809-01-RS.