Title: Use of Pre-plant or Foliar-Applied Potassium Chloride with Fungicides to Improve Soybean Response and Disease Resistance

Investigators: Peter Motavalli, Soil, Environmental and Atmos. Sciences, Univ. of Missouri
Kelly Nelson, Division of Plant Sciences, Univ. of Missouri, Greenley Center
Gene Stevens, Division of Plant Sciences, Univ. of Missouri, Delta Center
David Dunn, Soil and Plant Testing Laboratory, Univ. of Missouri, Delta Center

Objectives and Relevance:
An increased occurrence of K deficiency in soybeans and the potential widespread onset of Asian rust (SBR) (Phakopsora pachyrhiza) in soybeans have stimulated interest in new management practices that may improve K nutrition and lower disease incidence. In 2004, SBR was reported in nine states including Louisiana, other Gulf-coast and southeastern states, and Missouri (APHIS, 2005). Yield loss estimates for this fungal disease range from 10 to 80% in areas where rust is established and could result in economic losses between $640 to $1,341 million the first year of infestation (Sweets et al., 2004). Since current soybean varieties grown in the U.S. have little or no resistance to SBR, a primary method of controlling the spread of the disease has been use of fungicides. Currently, four families of fungicides are available for SBR management: triazoles, strobilurins, chloronitriles, and carboxamides. In addition, extensive research has established a link between plant nutrition and disease incidence including the disease suppressing effects of K, Cl, Mn, B and P (Fixen et al, 2004). Therefore, combining K, Cl and other nutrients either as a pre-plant or foliar application with a fungicide may enhance disease control. Recent research by Bradley and Sweets (2005) in Missouri indicates that several fungicides can be tank mixed with glyphosate without significant injury or reduction in yields of soybeans, but the limited penetration of the combined spray into the plant canopy may reduce potential SBR control. Nelson et al. (2004) has also established the KCl and several other K fertilizer sources can be combined with glyphosate without reducing weed control or causing significant foliar injury. This “weed and feed” system could also serve as an example for a system that combines disease control and nutrient management. The possible benefits of this approach include reduction in application costs, improved disease suppression and nutrient response, and flexibility in management response to environmental conditions during the growing season.

The proposed objectives of this study are:

1. Determine soybean yield response, disease incidence and K and Cl tissue concentrations from application of KCl alone or in combination with several fungicides.
2. Examine the effects of application timing of KCl or the fungicides on crop response and disease incidence.
3. Evaluate the cost-effectiveness of applying KCl with fungicides for soybean production.

Procedures:
This study will evaluate the effects of either pre-plant or foliar-applied KCl fertilizer sources and rates of application on glyphosate-resistant soybean response and weed control.
Two-year field trials will be established at the MU Greenley Center in Northeast Missouri and at the MU Delta Center in Southeast Missouri on soils with medium to low soil test K. Roundup-Ready® soybeans will be no-till planted at 180,000 seeds/acre in 15 inch rows.

The study will be arranged as a randomized complete block design with four replications. Treatments will consist of a control, a recommended pre-plant rate of KCl based on soil test, or a foliar application of 16 lb K/acre (as KCl) in a factorial arrangement combined with and without fungicide applications of 6 oz/acre of pyraclostrobin (Headline®), 6.4 oz/acre of azoxystrobin (Quadris®) or 6.4 oz/acre Quadris® + 2.6 oz/acre of Warrior® (lambda-cyhalothrin insecticide) applied either at V4 or R4 growth stages. Both Headline® and Quadris® are strobilurin fungicides.

Changes in soil test K in the plow layer due to treatment application will be determined by sampling at the beginning and end of the growing season. Foliar injury will be rated 3, 7, and 28 days after foliar application and differences in maturity will be determined. Treatments will be evaluated for the incidence of diseases, such as Septoria, Frogeye leaf spot, sudden death syndrome, and other diseases. Leaf samples taken at initial bloom will be used to determine crop K and Cl status in treated and non-treated plants. Soybeans will be harvested and data analyzed to determine the influence of the treatments on crop response and grain yield.

To determine the cost-effectiveness of the pre-plant and foliar KCl and foliar fungicide treatments, gross margins will be calculated as the [(grain yield * market price) – cost of fertilizer in the presence and absence of the fungicide] to determine the practical use of KCl in a disease control and feed soybean production system.

Current Status and Importance of Research:

Nelson et al (2005 and unpublished data) have done extensive research in Missouri examining combining K fertilizer sources with post-emergence glyphosate applications and its effects on weed control and soybean K nutrition and crop performance. This research approach has been suggested as a model for examination of the interactive effects of combining plant nutrient amendments with fungicide applications in response to the threat of Asian soybean rust (Motavalli and Nelson, 2005). Increasing occurrence of K deficiencies in soybeans and the potential threat of rapid spread of Asian rust makes research into development of cost-effective management alternatives for farmers a high priority. This practice of combining a K or Cl source with fungicides has the potential to further enhance disease control while also allowing for an in-season cost-effective response to possible K deficiency due to changing management or climatic conditions. Through the coordination of the Potash and Phosphate Institute, several universities are currently cooperating on sharing research information related to the effects of plant nutrition on soybean rust and Missouri’s participation in this network would enhance our possible response to further spread of the disease.

Timetable for Proposed Research:
April, 2006 Characterize field sites in Southeast and Northeast Missouri
Establish K fertilizer/fungicide field experiments
Plant soybeans in experiments
April-Sept., 2006  
Sample and analyze soil and plant tissue  
Apply foliar K and fungicide treatments
Sept./Oct, 2006  
Harvest experiments and analyze soil and plant tissue samples
November, 2006  
Analyze research results
December, 2006  
Submit annual progress report
April-Nov. 2007  
Same as 2006 for field experiments
December 2007  
Submit final report

**Strategy for Application/Transfer of Knowledge:**  
The information developed from this research will assist Missouri soybean farmers to make informed decisions on how pre-plant or foliar KCl may be combined with fungicides to improve soybean performance and reduce disease incidence. This information will be incorporated into research and extension publications, workshops and annual field days to provide additional information to farmers and agricultural professionals on effective K fertilizer management practices.

**References:**
### Proposed Budget:

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<th>CATEGORIES</th>
<th>YEAR ONE</th>
<th>YEAR TWO</th>
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**Justification:**

Salaries and Fringe Benefits: Funds are requested for support of 3 months time of two technicians working at the Greenley Center and the Delta Center and for an undergraduate student worker ($7.50/hr). Fringe benefits for each technician is 30% of their salary.

Travel: Covers cost of travel of PI to Greenley Agronomy Center and Delta Center field sites and Univ. of Missouri at Columbia at 40.5¢/mile.

Laboratory Reagents and Supplies: Covers cost of laboratory reagents, sample containers, and other materials used in soil and plant tissue analyses.

Field: Cost of fertilizer, seed, plot preparation, planting, weed control and harvesting, soil samplers, flags, pots and other field supplies and operations.

Soil and Plant Tissue Analyses: the University of Missouri Soil and Plant Testing Laboratory will characterize soil samples for soil pH, soil organic matter, extractable P, K, and exchangeable Ca and Mg taken at the beginning and end of the first growing season and also at the end of the second growing season: (64 samples x $5.70/sample x 3 samplings = $1,094).
Resume of PETER P. MOTAVALLI

Associate Professor, Soil Nutrient Management
Dept. of Soil, Environmental and Atmospheric Sci.
School of Natural Resources
University of Missouri-Columbia
302 ABNR Bldg.
Columbia, MO 65211

EDUCATION:

Ph.D., 1989, Soil Fertility and Plant Nutrition Cornell University, Ithaca, NY
M.S., 1984, Soil Fertility and Plant Nutrition University of Wisconsin, Madison, WI
B.S., 1982, Agronomy University of Wisconsin, Madison, WI
B.S.F.S., 1978, Foreign Service Georgetown University, Washington, DC

RESEARCH, EXTENSION AND TEACHING EXPERIENCE:

University of Missouri, Columbia, MO (Mar., 1999 – present). Associate Professor of Soil Nutrient Management in the Dept. of Soil, Environmental and Atmospheric Sci., School of Natural Resources.

University of Guam, Mangilao, GU (Aug., 1994 – Mar., 1999). Associate Professor of Soil Science in the Agricultural Experiment Station, College of Agriculture and Life Sciences.


SELECTED PUBLICATIONS

Articles in Journals:


Extension Publications:


PROFESSIONAL ORGANIZATIONS:

Soil Science Society of America
American Society of Agronomy
Ecological Society of America

AWARDS AND FELLOWSHIPS:

1978 - Phi Beta Kappa
1978 - 1979 Fulbright-Hays Fellowship, Khartoum, Sudan
1998 Faculty Award for Excellence in Research, University of Guam
2003 Junior Faculty Research Award, Gamma Sigma Delta, Univ. of Missouri
Resume of KELLY A. NELSON

University of Missouri Greenley Research Center  
P.O. Box 126, Hwy 156 E  
Novelty, MO 63460  
Phone:  660-739-4410 or 660-216-8394  Fax: 660-739-4500  
E-mail: nelsonke@missouri.edu

EDUCATION:
Ph.D. Weed Science, Dep. of Crop and Soil Sci., Michigan State University, May 2000
M.S. Weed Science, Dep. of Crop and Soil Sci., Michigan State University, May 1997
B.S. Plant Science, Dep. of Agronomy, University of Missouri-Columbia, May 1995

PROFESSIONAL EXPERIENCE:
University of Missouri, Novelty, MO.  June, 2000 to present.  Research Agronomist and Assistant Professor.

PUBLICATIONS:
Refereed Publications


**Professional Activities:**
American Society of Agronomy
Crop Science Society of America
Weed Science Society of America
North Central Weed Science Society of America
Resume of WILLIAM E. (GENE) STEVENS

Associate Professor
Department of Agronomy
University of Missouri-Delta Research Center
Portageville, MO 63873
Phone: (573) 379-5431
Fax: (573) 379-5875
Email: stevensw@missouri.edu

EDUCATION

Degree: Ph.D., Agronomy, 1992
Institution: Mississippi State University
Professor: Dr. Jac J. Varco

Degree: M.S., Plant and Soil Science, 1982
Institution: University of Tennessee-Knoxville
Professor: Dr. Donald D. Tyler

Degree: B.S., Biology, 1979
Institution: Union University

EMPLOYMENT AND EXPERIENCE

1994 – Present University of Missouri-Delta Research Center Portageville, MO
Associate Professor

Extension: (70%)
• Educate clientele groups on practices to improve soil management
• Help farmers increase efficiencies of fertilizers and irrigation

Research: (30%)
• Develop innovative cropping systems
• Evaluate new technologies for monitoring crop nutrients and pests

1990- 1994 Mississippi State Univ./USDA Crop Simulation Lab Starkville, MS
Extension Soil Specialist

Extension: (100%)
• Provided technical support to cotton farmers across the United States using the GOSSYM cotton management program
• Served as liaison between state soil extension specialists and researchers developing crop simulation models
1984- 1990 North Mississippi Branch Experiment Station Holly Springs, MS

**Research Associate**

Research (100%)

- Conducted conservation tillage experiments for reducing soil erosion
- Coordinated research with agronomists at other stations and campus

1981- 1994 Stevens Farm Somerville, TN

**Farmer**

- Worked for father growing corn, cotton, and soybeans
- Developed nutrient management plans for the family farm

**AWARDS**

2001 Innovation in Agribusiness Award, presented by Monsanto Company

1998 Natural Resource and Conservation Service Partnership Award

**UNITED STATES PATENT**


**COMPUTER PROGRAMS DEVELOPED**


**PROFESSIONAL SERVICE**

2003 Chairman, University of Missouri College of Agriculture, Food, and Natural Resources Professional-Track Faculty Committee

2000 Chairman, Soil Management and Plant Nutrition Committee, Beltwide Cotton Conference, Anaheim, California

1995- 1999 Farm Supervisor at Missouri Rice Research Farm

1997-2001 Editor of Missouri Rice Outlook and Research Updates
REFEREED RESEARCH PUBLICATIONS:


D. Dunn, G. Stevens, M. Aide, and J. Horn. 2002. Effect of soil pH and zinc on rice cultivars in Missouri. Trans. Missouri Acad. of Sci. pg.33-36


Resume of DAVID J. (Dave) DUNN

University of Missouri
Delta Center, P. O. Box 160
Portageville, MO 63873
Phone (573) 379-5431
dunnd@missouri.edu

EDUCATION:

Degree: M.S. Geology (with emphasis in soils development) 1985
Institution: Iowa State University
Professor: Dr. Carl F. Vondra

Degree: B.S. Geology, 1980
Institution: Iowa State University

PROFESSIONAL EXPERIENCE:

Supervisor: Soil Testing Lab 1997-present
University of Missouri-Delta Center, Portageville, Missouri

Iowa State University, Ames, Iowa

Iowa State University, Ames, Iowa

PROFESSIONAL SERVICE:

1998- present University of Missouri Soil Testing Lab Advisory Committee.

1997- present University of Missouri Soil Test Recommendations Review Committee.

1997- present University of Missouri Soil Fertility Working Group.

1999-2001 Editor of Missouri Rice Research Update.

PROFESSIONAL SOCIETY MEMBERSHIPS:

American Society of Agronomy
Soil Science Society of America
Rice Technical Work Group
**RECENT PUBLICATIONS:**

**Refereed Publications:**


D. Dunn, G. Stevens, M. Aide, and J. Horn. 2002. Effect of soil pH and zinc on rice cultivars in Missouri. Trans. Missouri Acad. of Sci. pg.33-36


Dunn, D., B. Phipps, G. Stevens, and A. Phillips. 2001 Effect of CaSO\textsubscript{4} (gypsum) on cotton lint yields, soil fertility, and physical properties of heavy clay soils in Missouri. Proc. Missouri Acad. of Sci. 35:1-5.

**Agricultural Bulletins:**

**Crop Management Computer Programs:**


**Invited Workshops:**