Enhanced Efficiency Phosphorus Application for a Corn-Soybean Rotation

Investigators:
Kelly Nelson, Div. of Plant Sci., Univ. of MO, Novelty; Bruce Burdick, Div. of Plant Sci., Univ. of MO, Albany; David Dunn, Div. of Plant Sci. Univ. of MO, Portageville; Peter Motavalli, Dep. of Soil, Environ., and Atmos. Sci., Univ. of MO, Columbia; Manjula Nathan, Div. of Plant Sci., Univ. of MO, Columbia; Peter Scharf, Div. of Plant Sci., Univ. of MO, Columbia; and Gene Stevens, Div. of Plant Sci. Univ. of MO, Portageville.

Objectives and Relevance:
Phosphorus (P) is an essential plant nutrient because it is a structural element in nucleic acids (DNA and RNA), serves as an energy transfer element (ATP), and serves a critical role in cellular regulation, and carbon partitioning. Plants take up P as as inorganic ions (H$_2$PO$_4^-$ and HPO$_4^{2-}$) in the soil solution. In the soil, P is bound to clay particles and farmers may experience loss when soil particles are eroded into surface waters. Phosphorus leaching is generally considered very low unless the soil is coarse-textured or artificial drainage is present. The availability of P is usually affected by precipitation reactions which depend on the soil pH. Low pH soils, which are typical in Missouri, may cause P to react with Fe and Al which precipitate P and make P unavailable for plant uptake. At high pH (>8), precipitation of calcium phosphate compounds can also reduce P availability.

Fertilizer costs have challenged farmers to evaluate application rates and consider enhanced efficiency P applications or treatments. AVAIL® (Specialty Fertilizer Products, Leawood, KS) is a new stabilizer product for granular phosphate fertilizers including MAP, DAP, and other phosphate fertilizers. It was designed to reduce the impact of metals in the soil around the fertilizer granule on plant uptake, phosphate fixation, and allow phosphorus to be more available to the plant. This product primarily binds with calcium, iron, manganese, and aluminum to prevent precipitation of phosphorus. When applied to single crops, Blevins (2009) reported a 19 to 22 bu/acre increase in corn grain yields when AVAIL was added to MAP at 20 lbs P$_2$O$_5$/acre and applied as a broadcast or banded treatment while Dunn (2009) reported increased Bray-P1 phosphorus availability and a 4 bu yield increase in soybean after applying 50 lbs P$_2$O$_5$ with AVAIL. Similarly, rice yields increased 8 bu/acre when reduced rates of triple super phosphate were applied (25 lbs P$_2$O$_5$) with AVAIL. In addition, banded applications of P may also increase P efficiency (Minor et al., 1993). Phosphorus placement in the rooting zone of moist soil was suggested to improve efficiency if farmers desired to apply reduced rates. Strip till applications may limit P loss if soil particles were eroded into surface waters. Limited research has evaluated AVAIL and strip-till applications of phosphorus in a corn and soybean rotation in Missouri. These enhanced efficiency fertilizer technologies may synergistically benefit P use efficiency in Missouri.

The objectives of this research are to:
1. evaluate the effect of P placement, rate, and P stabilizer on grain yield and P uptake in a corn-soybean rotation, and
2. determine the effect of P source, P stabilizer, and ag lime on grain yield and P uptake in a corn-soybean rotation.
Procedures:
- A two-year rotational crop study will utilize P fertilizer applications for corn and evaluate the subsequent impact on soybean yield and/or uptake.
- The study will be arranged as a randomized complete block design with four replications at each site.
- Research to accomplish Objective 1 will be conducted at Novelty and Albany.
  - Strip-till equipment is currently available at both locations.
  - Treatments will include a factorial arrangement of application placement (surface broadcast or strip-till), MAP rate (0, ½ recommended rate, and recommended rate), and the presence or absence of AVAIL.
  - Potash will be included in all treatments as recommended.
  - A balance of ammonium nitrate fertilizer will be included for all treatments to balance the N contribution of MAP in the recommended rate treatment.
  - Tissue and grain P uptake will be determined at both locations for both crops.
- Research to accomplish Objective 2 will be conducted at Portageville and Novelty.
  - Treatments will include a factorial arrangement of a P source (non-treated control and a broadcast application of DAP or TSP (triple super phosphate)), presence or absence of AVAIL, and broadcast surface application ofag lime (0 and recommended rate).
  - Incorporation following application will be left to the discretion of the individual researcher at each site.
  - Tissue and grain P uptake will be determined at both locations.
- Soils will be initially characterized for soil organic C, pH (0.01 M CaCl₂), and exchangeable K, Ca and Mg at each site. Soil test P (Bray P1) concentrations will be determined prior to application from each replication at each site. Soil test P will be determined following soybean harvest at each treatment for objective 1 while soil test P and pH will also be determined for each treatment for objective 2.

Current Status and Importance of Research:
Several strategies exist for increasing soil P availability for plant growth including selection of the P fertilizer source and the method of application. Use of AVAIL may improve efficiency of applied P fertilizer, but its effectiveness has not been tested with different application methods or under different soil pH in Missouri. This research will help farmers determine the cost-effectiveness of stabilized P fertilizer when applied at recommended and ½ recommended rates as well as the impact of P fertilizer placement and soil pH on corn and soybean grain yields and plant P nutrition.

Expected Economic Impact of the Project:
If increased yields from enhanced efficiency P applications could increase average annual state corn yields 20 bu/acre and soybean yields 4 bu/acre with a 10% rate of adoption, This may add up to $39 million to the economy of Missouri.
Timetable:

2010
March  Soil sampling
April   Corn planting for the 2010/2011 trials
July    Tissue sampling
September  Harvest and grain sample for P for corn
December Submission of annual report

2011
March  Soil sampling
April/May  Soybean planting in 2010 trial
April   Corn planting for the 2011/2012 trials
July    Tissue sampling
September  Harvest and grain sample P for corn and soybean
Oct/Nov Soil sample from all treatments following soybean harvest
December Submission of annual report

2012
March  Soil sampling
April/May  Soybean planting
July    Tissue sampling
September  Harvest and grain sample P for soybean
Oct/Nov  Soil sample from all treatments following soybean harvest
December Submission of final report

Strategy for Application/Transfer of Knowledge:
Transfer of knowledge will be mainly via written and oral educational programs, including press releases, newsletter articles, radio interviews, television interviews, and conferences. On-site field days will provide a forum for farmers and agriculture professionals to learn about on-going research results.

References:
### Proposed Budget:

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**Budget narrative:**

*Salaries and fringe benefits:* Funds are requested for partial support of a research technical support and/or graduate research assistant.

*Presentations, publications, and documentation:* This will help defray cost of publication and documentation of results and conclusions as well as assist travel and board for presentation of results.

*Other Direct Costs:* Covers cost of analysis, sample containers, fertilizer, seed, plot preparation, planting, weed control harvesting, flags, and other field supplies and operations.
RESUME. OF KELLY A. NELSON

Research Agronomist and Associate Professor
Division of Plant Sciences
Greenley Memorial Research Center Tel: (660) 739-4410
University of Missouri Fax: (660) 739-4500
P.O. Box 126, Hwy 156 E Email: nelsonke@missouri.edu
Novelty, MO 63460 http://aes.missouri.edu/greenley/research/index.htm

EDUCATION
- B.S. Plant Science, Dep. of Agronomy, Univ. of Missouri (1995)

APPOINTMENTS
- Research Agronomist & Associate Professor, Univ. of Missouri, Novelty, MO (2007-present)
- Research Agronomist & Assistant Professor, Univ. of Missouri, Novelty, MO (2000-2006)
- Teaching Assistant, Michigan State Univ., East Lansing, MI (1996)

OTHER EXPERIENCE
- Research Technician, Ciba Crop Protection, Lee's Summit, MO (1994)
- Integrated Pest Management, Gypsy Moth Technician, Univ. of Missouri, Columbia, MO (1992)

HONORS AND AWARDS
- ASABE Blue Ribbon Award, Circular Publication, Questions and answers about drainage water management for the Midwest, American Society of Agricultural and Biological Engineers (2007)
- Junior Faculty Award, Gamma Sigma Delta, Honor Society of Agriculture (2005)

SCHOLARLY SOCIETIES
- Sigma Xi
- Gamma Sigma Delta
- Honor Society of Phi Kappa Phi
- Golden Key National Honor Society
- Phi Eta Sigma Honor Society

PROFESSIONAL ORGANIZATIONS
- American Society of Agronomy
- Crop Science Society of America
- Weed Science Society of America
- North Central Weed Science Society of America
SERVICE

- North Central Regional Drainage Committee (NCR-207) (2003-present); Secretary 2008-2009; Chair 2009-2010
- Missouri Agriculture Leaders of Tomorrow Class XIII (ALOT) (2008-present)
- Missouri Livestock Symposium Committee (2001-present)
- Manuscript reviewer for eight peer-reviewed journals (2000-present)
- North Central Weed Science Society (1996-present); Membership Committee Chair (2006-2008)
- Weed Science Society of America (1996-present); Extension Committee(2001-2003)
- Missouri Wind Resources (2006-present)

PUBLICATIONS:


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 USA

Telephone: (573) 884-3212
FAX: (573) 884-5070
E-mail: motavallip@missouri.edu

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


PROFESSIONAL ORGANIZATIONS:

Soil Science Society of America
American Society of Agronomy

SELECTED AWARDS AND FELLOWSHIPS:

2000 - present Adjunct Assistant Professor, Division of Plant Sciences, Univ. of Missouri
2001 - 2006 Member of Editorial Board, Journal of Plant Nutrition
2002 - 2003 New Faculty Teaching Scholar, University of Missouri
2003 Junior Faculty Research Award, Gamma Sigma Delta
2003 Chair of USDA Regional Committee on Soil Organic Matter (NCR 59)
2004 Outstanding Teaching Award, CAFNR, Univ. of Missouri
2004 Chair of Environmental Quality Division (A-5), Amer. Soc. of Agronomy
2008 Associate Editor, Soil Science Society of America Journal
2009 Maxine Christopher Shutz Award for Distinguished Teaching, University of Missouri
Resume of Bruce Burdick

Professional Experience

University of Missouri 2001-2007

Superintendent, Hundley Whaley Research Center, Albany, MO 2003-2007

Responsible for the management of the center research and operations. Serves as the principal investigator on research projects on the center. Projects have included soil fertility, seed traits, variety testing, herbicide testing, and other corn and soybean agronomic studies.

Research Associate / Project Manager 2001-2003

Designed implemented and monitored field trials evaluating yield and other agronomic traits of potential transgenic corn lines. Located and secured cooperators and subcontractors throughout the United States to conduct studies. Monitored status of each site throughout the year.


Senior Field Biologist, 1995-2000
Senior Technical Development Representative 1990-1995
Senior Market Development Representative, 1985-1990
Market Development Representative, 1981-1985

Provided technical support and training in $40 million five state Midwest sales region. Generated new product research and development, together with discovery and expansion of new marketing areas for existing product line. Selected activities included data analysis and summarization, technical information writing, technical presentations to growers and industry professionals, complaint and contract research negotiations, field trial design and implementation, small plot research and large scale sales demonstrations.
Resume of Manjula V. Nathan
Division of Plant Sciences, University of Missouri
23 Mumford Hall, Columbia, MO 65211
Email: nathanm@missouri.edu WEB: http://soilplantlab.missouri.edu/soil
Tel.: (573) 882-3250 (work), FAX.: (573) 884-4288

Education
Ph.D. in Agronomy (1989), South Dakota State University
Major: Agronomy - Soil Fertility Minor: Chemistry
M.Phil. in Agric. (1981), Post Graduate Institute of Agriculture
University of Peradeniya, Sri Lanka
Major: Soil Chemistry Minor: Statistics
B.S. (Hons.) in Agric. (1978), University of Peradeniya, Sri Lanka
Major: Agronomy Specialization: Soil Science

Work Experience
2007 - to date: Extension Associate Professor/ Director of Soil Testing & Plant Diagnostic Laboratories – University of Missouri, Columbia, MO
1994- to 2007 Extension Assistant Professor/ Director of Soil Testing & Plant Diagnostic Laboratories – University of Missouri, Columbia, MO.
1992- 1994: Associate Soil Scientist - Land Reclamation Research Center, North Dakota State University, Mandan, ND.
1990 - 1992: Postdoctoral Associate - Dept. of Soil Science, University of Minnesota, St. Paul, MN.

Honors and Awards
- 2007: Promoted from Assistant to Associate Professor, University of Missouri

Professional Service and Activities
- National Science Foundation Graduate Fellowship Panel Chair for Division of Plant & Animal Sciences (2005)
- Chair and State representative for NCR -13 Committee on Soil Testing and Plant Analysis (Chair: 2002 – 2004; Secretary: 1999; State Rep: 1996 - to date)
- Soil Testing and Plant Analysis Committee of SSSA - S 877 (2003 – to date)
- North American Proficiency Testing Program Oversight Committee of SSSA – S 890 (2002 to date)
- Editorial Board for Communications in Soil Science and Plant Analysis Journal (2002 to date)

Membership and Affiliations
American Society of Agronomy
Soil Science Society of America
Soil Testing and Plant Analysis Council
Sigma Delta Epsilon
Gamma Sigma Delta
AOAC International

National, Regional and State Assignments
- National Science Foundation Graduate Fellowship Panel Chair for Division of Plant & Animal Sciences (2005)
- Chair and State representative for NCR -13 Committee on Soil Testing and Plant Analysis (Chair: 2002 – 2004; Secretary: 1999; State Rep: 1996 - to date)
Publications

Refereed


Book chapters:


Abstracts:


Miscellaneous Publications:


Extension Presentations and Publications

Field Days Presentations:


Program Implementation Experience and In Service Training


Workshops, Conferences, Short Courses and Certified Crop Advisor Training:


Extension Guides and Fact Sheets:


Resume of WILLIAM E. (GENE) STEVENS

EDUCATION

Mississippi State University  PhD  1992  Agronomy
University of Tennessee-Knoxville  M.S.  1982  Plant and Soil Science
Union University  B.S.  1979  Biology and Journalism

EMPLOYMENT AND PROFESSIONAL EXPERIENCE

1994-Present  Crop Production Specialist, Plant Science Div., University of MO, Columbia, MO
1990-1994  Soil Scientist, Agronomy, MS State University/Crop Simulation, Starkville, MS.
1984-1990  Research Associate, North MS Branch Expt. Station, Holly Springs, MS

SERVICE AND AWARDS

2002-Present  Rice Technical Work Group, Executive Committee
2002-Present  MU-CAFNR, Chairman, Professional Track Faculty Committee
2006-Present  MU-Plant Science Division, Promotion and Tenure Committee
2007  Co-chair Southern Plant Nutrition Planning Committee
2006  Pyeontaek, South Korea Agricultural Assessment Team
2001  Innovation in Agribusiness Award, Monsanto Company
1998  Conservation Partnership Award, Natural Resource Conservation Service

PUBLICATIONS DURING THE LAST FIVE YEARS


DAVID J. (Dave) DUNN
University of Missouri
Portageville, MO 63873
Delta Center, P. O. Box 160
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
Responsibilities:
1) Communicate to public the role of an integrated soil fertility program in crop production and environmental protection.
2) Provide relevant and understandable soil and plant analysis results to customers.
3) Maintain quality control of laboratory results while ensuring that results are available to customers in timely manner.
4) Supervise and train administrative and support staff, develop and implement annual working budget, maintain and purchase supplies and equipment as needed.
5) Develop and administer a soil fertility research program.
6) Provide research assistance to other multidisciplinary University of Missouri staff

Iowa State University, Ames, Iowa
Responsibilities:
1) Supervise and train student hourly workers.
2) Maintain equipment and purchase consumable supplies as needed.
3) Maintain quality control of laboratory results.
4) Communicate soil test results to customers.
5) Provide research assistance to other multidisciplinary Iowa State University staff, includes training of graduate students in use of analytical instruments.
Iowa State University, Ames, Iowa
Responsibilities: 1) Supervise and train temporary and student workers.
2) Maintain equipment and purchase consumable supplies.
3) Maintain quality control of laboratory results.
4) Maintain records of laboratory results for compliance with local, state and federal environmental laws.

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:

Dunn, D, and G Stevens. 2007, Phosphorus Management in a Dry-seed, Delayed Flood Production System in Missouri, Better Crops International, (in press)


http://www.plantmanagementnetwork.org/pub/cm/research/2005/boron/


http://www.plantmanagementnetwork.org/pub/cm/research/2005/tillage/


Agricultural Bulletins and Extension Publications:


Crop Management Computer Programs:


Invited Presentations:

Peter Clifton Scharf

Education

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<tr>
<td>Ph.D.</td>
<td>May 1993</td>
<td>Virginia Polytechnic Inst. and State University</td>
<td>Crop &amp; Soil Environmental Sciences</td>
</tr>
<tr>
<td>M.S.</td>
<td>July 1988</td>
<td>Virginia Polytechnic Inst. and State University</td>
<td>Agronomy</td>
</tr>
<tr>
<td>B.S.</td>
<td>August 1982</td>
<td>University of Wisconsin</td>
<td>Biochemistry, Genetics</td>
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Professional Experience

2002 to present  
Associate Professor in the Agronomy Department of the University of Missouri. Responsible for applied research and extension in the area of nutrient management.

1995 to 2002  
Assistant Professor in the Agronomy Department of the University of Missouri.

Areas of Interest

• field-specific, soil-specific, and variable-rate fertilizer recommendations
• minimizing environmental impacts of agricultural practices
• optimizing crop management

Skills

• ability to communicate effectively, to cooperate with others, and to manage projects and people
• outstanding laboratory, field, project design, and data analysis skills
• excellent natural science background

Sample Research Publications


Sample Extension Publications

