Comparison of Impregnated Dry Fertilizer with S and Zn to Blends for Corn

Investigators:
Kelly Nelson, Div. of Plant Sci., Univ. of MO, Novelty; Bruce Burdick, Hundley-Whaley Center, Univ. of MO, Albany; Peter Motavalli, Dep. of Soil, Environ., and Atmos. Sci., Univ. of MO, Columbia; and Manjula Nathan, Div. of Plant Sci., Univ. of MO, Columbia.

Objective and Relevance:
High yielding corn and soybean production systems in Missouri have renewed an interest in micronutrient management such as sulfur which is essential for protein formation and Zn which is important for enzymes and metabolic reactions. Yield increases to sulfur applications are more likely to occur during cool, wet springs when mineralization and crop growth are slow as a result of a decrease in atmospheric sulfur deposition. Soil tests in 2010 indicated that over 60% of the samples in upstate Missouri had low (<0.6 ppm) to medium (0.7 to 1.0 ppm) soil test Zn (Nathan, unpublished). Similarly, over 70% of the soil test samples were very low to medium for Bray 1P.

Fertilizer manufacturing has progressed to accommodate more uniform distribution of nutrients in an individual fertilizer granule. Each prill is formulated to contain N, P, S, and/or Zn rather than a blended product that includes individual prills of individual nutrients. In a blend, there may be a certain amount of segregation that may occur which often affects the uniformity of distribution when the blended fertilizer is applied in the field. This poor distribution of applied blended fertilizer may be significant for recommendations of 5 to 10 lbs of Zn/acre. Typically, soluble S sources, such as ammonium sulfate or ammonium thiosulfate, are recommended over elemental S and ZnSO\textsubscript{4} is a common source of Zn.

Impregnated granules where S and Zn are added in layers to the MAP prill allows for a more uniform distribution of fertilizer which allows roots to have a higher probability of contact with the fertilizer granule and may enhance fertilizer efficiency. Mosaic has formulated MES10 (12-40-0-10S) and MESZ (12-40-0-10S-1Zn) with two forms of sulfur (50% sulfate and 50% elemental S). MESZ includes Zn as zinc oxide. These formulations are targeted primarily for corn, soybean, wheat and rice. This combination has been promoted to increase P uptake up to 30%. The availability of Zn to the plant has been promoted as being 10 to 45% greater with the Mosaic product. Preliminary data from Albany and Novelty, Missouri in 2011 demonstrated differences among S and Zn treatments, but these differences were dependent on location (Figure 1).

The objectives of this research are to 1) evaluate P rates of MES10 and MESZ formulations to equivalent blends of MAP, Zn, and S; 2) evaluate ZnSO\textsubscript{4} rates in a blend with MAP or DAP compared to MES10 and MESZ formulations on grain yields and uptake of micronutrients in a corn-soybean rotation; and 3) determine the cost-effectiveness of new formulations compared to blends.

![Figure 1. Corn grain yield response to S and Zn treatments at Albany (LSD = 10) and Novelty (LSD = 13) in 2011. Phosphorus was applied at 70 lbs P\textsubscript{2}O\textsubscript{5}/acre.](image)
**Procedures:**
- Field research will be conducted at two locations (Novelty and Albany).
  - Corn plots will be established in 2013 and followed by soybean in 2014 for objective #1.
  - Additional corn plots will be established in 2014 and followed by soybean in 2015 for objective #1.
  - Objective #2 will only evaluate corn response in 2013 and 2014.
  - The treatments at each site will be arranged as randomized complete block designs with 4 and 5 replications at Albany and Novelty, respectively.

- Objective 1: Evaluate P rates of MES10 and MESZ formulations compared to equivalent blends of MAP, Zn, and S.
  - Treatments:

    | Fertilizer treatment | P$_2$O$_5$ (lbs/a) | Zn (lbs/a) | S rate (lbs/a) |
    |--------------------|-------------------|------------|---------------|
    | MES10              | 70                | 0          | 18            |
    | MES10              | 110               | 0          | 28            |
    | MESZ               | 70                | 1.8        | 18            |
    | MESZ               | 110               | 2.8        | 28            |
    | MAP + N balance    | 70                |            |               |
    | MAP + N balance    | 110               |            |               |
    | MAP + AMS          | 70                |            |               |
    | MAP + AMS          | 110               |            |               |
    | MAP + ZnSO$_4$ + AMS | 70          | 1.8        | 18            |
    | MAP + ZnSO$_4$ + AMS | 110        | 2.8        | 28            |

  5 Nitrogen only controls to balance the N contributions
  Non-treated

  - Soil and ear leaf tissue P, Zn and SO$_4$-S
  - Grain yield

- Objective 2: Evaluate ZnSO$_4$ rates in a blend with MAP or DAP compared to MES10 and MESZ formulations
  - Treatments:

    | Fertilizer treatment | P$_2$O$_5$ (lbs/a) | Zn (lbs/a) | S rate (lbs/a) |
    |--------------------|-------------------|------------|---------------|
    | Non-treated Nitrogen only | 80            | 0          | 20            |
    | MES10              | 80                | 0          | 20            |
    | MESZ               | 80                | 2          | 20            |
    | MAP                | 80                |            |               |
    | MAP + ZnSO$_4$ + AMS | 80          | 2          | Balance S with MES10 |
    | MAP + ZnSO$_4$ + AMS | 80          | 5          | Balance S with MES10 |
    | DAP                | 80                |            |               |
    | DAP + ZnSO$_4$ + AMS | 80          | 2          | Balance S with MES10 |
    | DAP + ZnSO$_4$ + AMS | 80          | 5          | Balance S with MES10 |

  - Soil and ear leaf tissue P, Zn and SO$_4$-S
  - Grain yield

**Current Status and Importance of Research:**

Preliminary research was conducted at Novelty and Albany in 2011. These locations were followed by soybean in 2012. If P uptake can increase up to 30%, this is beneficial for enhancing P
use efficiency. In addition, impregnated Zn would provide a better distribution when compared to a blended application. Research has shown a 3 to 7 bu/acre increase in yield when S and Zn was applied in the MicroEssentials® formulation compared to a blend (http://microessentials.com/knowledge_yieldresults.cfm?crop=Corn#images/yieldtrials/corn_1yr_19loc_sz_dap.jpg); however, no research has reported the subsequent effect on soybean yields.

**Expected Economic Impact of the Project:**
A 10% adoption could add an additional $4.4 to 10 million to the Missouri economy annually. Providing farmers, suppliers, and distributors with options to improve fertilizer application distribution, yield and nutrient use efficiency.

**Timetable:**

**2013**
- Feb.-April         Prepare equipment, sample soil, and apply fertilizer treatments
- April-September  Manage plots and demonstrate at local field day
- September        Harvest corn ear leaf tissue for fertilizer uptake and collect grain samples
- Nov.-Dec.         Analyze results
- December         Submission of annual report

**2014** Repeat 2013 timetable and rotate the 2013 trial into soybean (Objective #1)

**Strategy for Application/Transfer of Knowledge:**
Results of this research will be utilized to demonstrate the beneficial effects of sulfur and zinc impregnated fertilizers on crop production. Dissemination of knowledge will be accomplished through field day events, field day reports, and written and broadcast media outlets. Transfer of knowledge will be mainly via written and oral educational programs, including press releases, newsletter articles, radio interviews, television interviews, and conferences. Furthermore, on-site field days will provide a forum for farmers and agriculture professionals to learn about on-going research activities and current findings.
### Proposed Budget:

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**Budget narrative:**

*Salaries and fringe benefits:* Funds are requested for partial support of a M.S. student or a research specialist.

*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 FOR KELLY A. NELSON

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

EDUCATION AND TRAINING
• M.S. Crop and Soil Sciences, Dep. of Crop and Soil Sci., Michigan State Univ. (1997)
• 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)
• Crop and Livestock Production Assistant, Nelson Farms, Skidmore, MO (1980-1995)

HONORS AND AWARDS
• Citation of Merit, Mizzou Alumni Association of the University of Missouri (2010)
• 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
• Crop Science Society of America
• American Society of Agricultural and Biological Engineers

PATENT
SERVICE
- North Central Regional Drainage Committee (NCR-217) (2003-present); Secretary 2008-2009; Chair 2009-2010
- Missouri Agriculture Leaders of Tomorrow Class XIII (ALOT) (2008-2010)
- Missouri Livestock Symposium Committee (2001-present)
- Manuscript reviewer for twelve 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 Bruce Burdick

Professional Experience

University of Missouri 2001-present

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

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 PETER P. MOTAVALLI

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

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


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 - present Associate Editor, Soil Science Society of America Journal
2009 Maxine Christopher Shutz Award for Distinguished Teaching, University of Missouri

SELECTED RECENT PUBLICATIONS:


Manjula V. Nathan  
Division of Plant Sciences, University of Missouri  
23 Mumford Hall, Columbia, MO 65211  
E-mail: nathanm@missouri.edu Web: http://soilplantlab.missouri.edu/soil  
Tel.: (573) 882-3250 (work), Fax.: (573) 884-4288

Career summary  
**Nutrient management research**  
- Effects of cropping systems on nutrient availability  
- Nutrient management for biofuel crops and long term effects on soil quality  
- Organic fertilizers for sustainable vegetables production  
- Best management systems to improve efficiency of fertilizer use  
- Soil test correlations and calibrations  
- Soil test procedures and analytical methods  
- Land application of agricultural and industrial wastes  
- Agricultural impacts on water quality  
- Reclamation of surface mine lands  

**Extension education and outreach**  
- Promoting soils and plant nutrition, and soil and plant testing as a best management tool  
- Promoting efficient nutrient management and environmental protection through use of soil, plant, manure, and water analysis  
- Instruction in soils, plant nutrition, soil and plant testing, soil test interpretations and nutrient management and related topics for agricultural producers, horticulturists, lawn and landscape managers, vegetables and fruit growers, master gardeners, state and federal agency personnel, and agricultural industry representatives and consultants.

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

**Professional experience**  
**1994 to date:** Extension Associate Professor/ Director of Soil Testing and Plant Diagnostic Laboratories – University of Missouri, Columbia  
**1992 - 1994:** Associate Soil Scientist - Land Reclamation Research Center, North Dakota State University, Mandan  
**1990 - 1992:** Postdoctoral Associate - Department of Soil Science, University of Minnesota, St. Paul  
**1989 - 1990:** Postdoctoral Research Fellow - Department of Agronomy, University of Missouri, Columbia
1985 - 1989: Graduate Research Assistant - Department of Plant Science, South Dakota State University, Brookings

Membership and affiliations
- American Society of Agronomy
- Soil Science Society of America
- Soil Testing and Plant Analysis Council
- AOAC International

Publications
- Refereed: 11
- Abstracts: 24
- Extension publications: 85
- Miscellaneous: 41

National, Regional and State Assignments
- National Science Foundation Graduate Fellowship Panel Chair for Division of Plant & Animal Sciences (2005)
- 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)
- National Science Foundation Graduate Fellowship Panelist (2001 - 2010)
- North American Proficiency Testing Program QA/QC Committee (2000 to date)
- NCR-13 Sub Committee Chair for QA/QC Committee
- Missouri State Representative for NAPT Program (1999 to date)
- Associate Referee for CEC Method Evaluation/Certification for AOAC- 1998
- Official Soil Testing Method Verification Committee of SSSA– S 889 (1996 to date)
- Soil Testing and Plant Analysis Council (1994 to date)
- Coordinator of Missouri Soil Testing Association Accreditation Program (1994 to date)

College of Agriculture, Food and Natural Resources Assignments
- Promotion and Tenure Committee, Division of Plant Sciences (Sept 2008 to date)
- Plant Protection Programs Steering Committee (07/2001 – 7/2005)
- Soil Aggregate Group- Faculty Group that worked on Future of Soil Science Program at MU (2003)
- Sanborn Field Committee (1997-2001)
- Search Committee for Asst. Professor in Nutrient Management, Dept. of Soil and Atmospheric Sciences (1998)
• Soil Testing Advisory Committee (1997 -1999)
• Plant Science Unit Extension Committee (1997-1998)
• Member of the Urban Outreach Group (1997-1998)
• Missouri Precision Agriculture Center (MPAc) Ad hoc/ Steering Committee (1997)
• Search Committee to MPAc Associate Director (1997)
• Chair, Search Committee for Delta Lab Supervisor (1997)
• Peer Review Panel member for MoAES Interdisciplinary Regional Research Projects (1996)
• Lime and Fertilizer Control Faculty Advisory Committee (1995 to date)
• Crop Injury Diagnostic Clinic Planning Committee (1995-2002)
• Agricultural Chemicals Short Course Planning Committee (1995-1997)
• Search Committee for Commercial Agriculture Nutrient Management Specialist Position (1995)
• Soil Fertility Working Group (1994 - to date)

Other/Professional Contributions
  Reviewer for Agronomy and Soil Science Society of America journals (1992 to date)

Selected Publications

Refereed


Note: Last name changed from Vivekanandan to V. Nathan; Maiden name: M. Sivasangaranathan

Book chapters


Abstracts

Nutrient Use Geographic Information System (NuGIS) and Other Applications. North Central, South Eastern and North Eastern Joint Meetings in Soil Testing and Plant Analysis at Madison, WI.


Miscellaneous publications:


Agronomy Miscellaneous Publ. #07-01, College of Agriculture, Food and Natural Resources, University of Missouri. P 100-107.


Field days and other presentations


**Program implementation experience and in-service training**


**Workshops, conferences, short courses and certified crop advisor training**


Media articles

Extension guides and fact sheets

Extension manuals

Newsletters (most recent)