Developing a Nitrogen Fertilization Strategy for Corn Following Cover Crops

Investigators:  Bruce Burdick, Superintendent, U of MO Hundley-Whaley Research Center  
Peter Scharf, Professor, Plant Sciences Division, University of Missouri

Project Objective
This project addresses the New Stakeholder Topic of Interest “Effects of starter (pop-up fertilizer) on corn.”

Our goal in this project is to develop economical and effective strategies for fertilizing corn following fall seeded cover crops established after soybean harvest without hurting the yield of a following corn crop. Experiments will be carried out at two locations, Columbia and Albany.

Cereal rye is an economical and effective cover crop, but may reduce the yield of a following corn crop. In a field-scale strip trial conducted in 2015, a 30-bushel yield penalty to the corn crop was observed. In another 2015 field, there was limited effect of cereal rye on corn yield (Scharf, ongoing research). In general, cereal rye has a limited negative effect on the yield of a subsequent soybean crop, and is an excellent choice when soybeans will be grown in the next rotation.

Our goal with cereal rye is to observe whether combinations of cover crop planting date, termination date, starter N (in-furrow), or extra sidedress N can be managed to eliminate the yield penalty to corn. Wheat and a cover crop blend (to be determined but will include radish and/or turnip) will be evaluated as alternatives to cereal rye.

The reason why cereal rye reduces corn yield is not well understood, nor is the reason why the effect is inconsistent. It is widely repeated that chemicals released from the dead/dying rye are toxic to germinating corn, and that waiting at least two weeks after spraying cereal rye to plant corn will avoid this effect. However, ongoing research indicated a 25 bushel yield penalty for corn after rye even when the corn was planted 4 weeks after spraying rye. The rye was relatively large when it was sprayed. Research results in Albany have shown slight yield penalties for later rye kill, except when rye is terminated late by rolling—yield penalties are large in that case.

One factor for the yield decrease may be nitrogen. Some experts recommend using starter N when planting corn into rye. In past experiments, treatments with low N rates were hurt far more by rye than treatments with higher N rates. No starter N was used in the above studies. Other studies suggest nitrogen rates must be increased to offset the loss of available N. We hope to find that the corn yield penalty due to a rye cover can be eliminated with optimal termination date and either in-furrow N, higher N rate or N timing. Alternatively, if wheat can provide the needed cover without the yield penalty to corn, it would be a great alternative to rye.
Procedures
Planned treatments for this project are:

Cover crops:
1. Cereal Rye
2. Wheat
3. Blend including radish and/or turnip
4. No cover crop

Planting date/method:
1. Broadcast into standing soybeans around Labor Day
2. Drilled after soybean harvest

Termination Date:
1. Early season Rye < 6 inches tall (vegetative)
2. Mid season Rye = 12-15 inches (Bolting)
3. Late season Rye > 24” (Reproductive)

N management:
Blanket applications of 60 lb N/acre broadcast preplant and 100 lb N/acre side dressed when corn is 12 to 18 inches tall.
Mid and late termination dates will include with and without N fertilizer applied in-furrow.
To check for possible N limitation, the later 2 rye and wheat termination dates with in-furrow N will be sidedressed with the normal N rate (100) and a high N rate (150).

Overall:
4 covers x 2 planting methods/dates x 3 termination dates = 24 treatments
Added treatments with/without in-furrow N = 4 treatments
Added treatments with extra N = 4 treatments
= 32 treatments total

Four or five replications will be used to evaluate the treatments.

Importance of Research Area / Economic Impact
Missouri is primarily a soybean state. We have nearly twice as many soybean acres as corn, our next-most-important row crop. Soybean is a good fit for Missouri’s soils, but many of these soils are not able to store enough water for good corn production in a dry summer. Unfortunately, intensive soybean production is also a threat to Missouri’s soils, since residue is light and doesn’t provide adequate protection from erosion.
Research in central Missouri has shown a yield penalty of 2.9 bushels of corn/acre and 0.7 bushels of soybean per acre for every inch of topsoil lost due to erosion. On one carefully studied field, nearly 8 inches of topsoil has been lost since agriculture began, resulting in a loss of nearly $90/acre/year of production in a corn-soybean rotation.
Cover crops are the most effective way to stop soil erosion. Erosion can take away in a day the amount of organic matter that will take 100 years to replace. Cover crops may build soil organic
matter, but far more important is their ability to prevent the loss of organic matter we already have.

Cereal rye is an excellent cover crop because it is relatively inexpensive, grows vigorously in the fall, covers the soil to reduce raindrop impact, and has fibrous roots to help hold soil in place. It works well to prevent erosion following soybean harvest in fields that will be planted back to soybean. Unfortunately, rye may cause a yield reduction in a following corn crop. A need exists to either find other inexpensive, effective cover crops that can follow soybean harvest without hurting the following corn crop, or to find ways to manage rye to eliminate or reduce its effect on corn yield. Planting date, termination date, and N management for corn are all factors that may influence whether cereal rye hurts corn yield.

**Timetable**

**Year 1**
- May 2016: Establish bulk soybeans
- September 2016: Overseed cover crops into soybean residue
- March - April 2017: Terminate cover crop
- April 2017: Soil sample available N, plant corn, apply preplant N
- May – June 2017: Sidedress N
- June - July 2017: Soil sample available N
- September – October 2017: Harvest
- December 2017: Summarize results, develop reports

**Year 2**
Same schedule as Year 1

**Strategy for application/transfer of knowledge**
- Written and oral (presentation) educational materials will be developed to promote understanding and application of results.
- Written materials will include newsletter articles, press releases, web page, and farm press articles.
- Presentations will be used in Extension meetings and conferences, sent to regional Extension Agronomists for their use, and shared with anyone who requests them.
- Summary results to be included in annual report and website.

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<th>Budget</th>
<th>Year 1</th>
<th>Year 2</th>
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<td>Research Specialist Albany 25%</td>
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<td>Research Specialist Columbia 25%</td>
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<td><strong>Total</strong></td>
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<td><strong>$64,930</strong></td>
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</table>
Bruce Burdick

Education
MS, Agronomy, 1978 University of Missouri, Dept. of Agronomy
BS, Biological Sciences, cum laude, departmental honors, 1975 University of Missouri

Professional Experience

University of Missouri 2001-2015
Research Associate / Superintendent 2003-2015
Hundley Whaley Research Center, Albany, MO
Responsible for the management of the center research and operations. Serves as the principal investigator and collaborator on research projects at the center. Projects have included soil fertility, seed traits, variety testing, herbicide testing, precision applications, cover crops 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 a 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.
Peter Clifton Scharf
Professor and Nutrient Management Specialist
Plant Sciences Division
210 Waters Hall
University of Missouri
Columbia, MO 65211

2015 serving as Past Chair, Soil Fertility and Plant Nutrition Division, Soil Science Society of America

Research and Extension education interests
- developing, evaluating, and promoting tools to predict crop N needs, including variable-rate N management
- evaluating N management alternatives including source and timing
- long-term protection of the soil resource
- minimizing environmental impacts of agricultural nutrients
- economic comparisons of production alternatives

Education

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


Selected Recent Extension Publications

Scharf, Peter. 2015. Managing Nitrogen in Crop Production. American Society of Agronomy, Madison, WI.


Spend wisely now to avoid late-season troubles. Agriculture.com, June 3, 2015. Using information from Peter Scharf.


Hein, Treena. 2015. Improving late nitrogen application. Top Crop Manager, April 2015. Using information from Peter Scharf.


