Sensor-based variable rate N: Long-term performance in corn and cotton

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Objective:
The objective of this project is to evaluate long-term performance of sensor-based variable N rate recommendations for corn and cotton. Sensor-based N management is compared with typical producer N management and with other N rate decision systems.

Accomplishments for 2012:
• Two small-plot corn experiments were conducted as planned at Bradford Farm near Columbia.
• Unfortunately, the planned cotton experiment was not conducted in 2012 due to miscommunication. The corn experiment will be extended for an extra year to make up for this omission.

Sensor-based variable rate N: Long-term performance in corn

Experiment 1: Long-term impact of nitrogen rate recommendation systems
• 2012 is the 6th year of this study, with each plot getting the same N timing and N rate decision system every year.
  o Four of the treatments are fixed preplant N rates: 0, 100, 140, and 180 lb N/ac
  o The 140 lb N/acre rate is the MRTN (Maximum Return to Nitrogen) rate for Missouri and is also the Univ. of Missouri N rec for 135 bushel corn with 2.8% soil organic matter
  o A fifth preplant N treatment has the 140 lb N/acre rate as a base, with soil nitrate credits subtracted based on a 2-foot soil nitrate sample
  o Three treatments have N applied sidedress; rates are based on:
    ▪ Sidedress soil nitrate test (Iowa State University interpretation)
    ▪ Chlorophyll meter (University of Missouri interpretation)
    ▪ Crop Circle 210 canopy sensor (University of Missouri interpretation)
  o All treatments are surface-applied ammonium nitrate
• This experiment is conducted in continuous no-till corn to magnify the effects of any problems related to N management.
• Extreme drought occurred in this experiment in 2012.
  o Three irrigations totaling 3.6 inches were applied with a linear-move irrigation system in July to avoid complete crop failure.
• Even so, all treatment mean yields were 82 bu/acre or less due to water limitation.
• Yield differences between treatments were minimized due to this water limitation.
• Yields for the eight N system treatments are shown in the table on the next page.
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<td>79</td>
<td>392</td>
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<td>Crop Circle sensor V7</td>
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<td>721</td>
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<td>Average rate = 144</td>
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<td>Sidedress soil test V7</td>
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<td>116</td>
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<td>475</td>
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<td>100</td>
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<tr>
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<td>0</td>
<td>34</td>
<td>218</td>
<td>0</td>
<td>45</td>
<td>287</td>
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</table>

1 Growth stage V7 is about knee high corn
2 Yields are different from one another (90% confidence) if they are more than 5 bushels apart
3 2011 data was not included due to insufficient stand count and uniformity

- Six of the N treatments yielded between 76 and 82 bushels with N rates between 116 and 180 lb N/acre. Because water availability limited yields so severely, most N timing & rate combinations appeared to deliver enough N to the crop to maximize yield within the constraint of limited water.
- Only the 0 and 100 lb N/acre rates clearly yielded less than the other treatments. Although the 100 lb N rate would seem to be enough to produce 80 bushels like the other treatments, N delivery from soil to roots is inefficient when soil is dry.
- **Treatments in the table above are ordered based on profitability for the period 2007-2012.**
- **For this period, the two systems based on crop color to guide sidedress N rate out-performed the best preplant system (180 lb N rate) by about $250/acre.**
  - They produced 35-40 bushels more corn with 10-30 lb less N than the 180 lb N/acre preplant treatment.
  - This was mainly due to serious N loss with preplant N applications during the wet springs of 2008-2010.
- The color-based systems for choosing sidedress N rate also out-performed the soil test system for choosing sidedress N rate by $40-50/acre.
  - This was due to under-recommendation by the sidedress soil test system in 2007 and 2010, resulting in lower yields.
- **Based on results from 2007-2012, long-term performance of sensor-based variable-rate N in corn appears to be good.**
Experiment 2: Effect of pre-plant nitrogen on sensor-based N rate performance

Experiment 2 is designed to complement Experiment 1 and address concerns that sidedress systems with no N applied preplant may cost yield.

- 2012 is the second year for this experiment.
- Three of the four treatments in Experiment 2 are shared with Experiment 1.
- The key treatment is 50 lb N/ac applied preplant, followed by sidedress N at rates diagnosed by the Crop Circle sensor.
  - Results from this treatment can be compared to pre-plant N management (140 and 180 lb N rates) and sensor-based sidedress with no N pre-plant to evaluate its relative performance.
  - Any N stress experienced with the sidedress-only sensor-based treatments should be avoided.

It is right next to Experiment 1, so soils and weather are very similar. Seed, herbicide, planting date, and application dates are identical to Experiment 1. Experiment 2 received the same supplemental irrigation (total about 3.6 inches) as Experiment 1.

Despite irrigation, yields were strongly water-limited and treatment mean yields did not exceed 79 bushels/acre.

One of the concerns with sidedress N management with no N applied pre-plant is that the crop development will be slowed. In years with a July drought, slower development could push reproductive stages farther into the drought, causing additional yield loss.

Sidedress-only N management did not cause yield loss despite drought stress and the potential for slower development to push reproductive growth into a more stressful time.

Over the 3 years of this study, there has been no indication that sensor-based N rate recommendations perform better with preplant N than without.

Over 3 years, sensor-based N management out-yielded the best preplant N management by about 8 bushels and gave about $85/acre higher profit (see table below). This is due to higher yields with sensor-based N management than preplant N management in 2010. Yield differences between treatments were minimal or non-existent in 2011 & 2012. Average N savings over the 3-year period were 40 and 55 lb N/acre for the two sensor-based N systems while still producing higher yield than the most profitable preplant N system.
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<td>V8</td>
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<td>50 lbs./N + Crop Circle sensor</td>
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¹ Growth stage V6-V7 is about knee high corn, Growth stage V8-V10 is about thigh to waist high corn.

² A different N rate was applied in each of 6 replications for this treatment. It is feasible to use this sensor to change N rate automatically while fertilizing a field, and we felt that this ability would be most accurately reflected by diagnosing N rate for each plot separately.

³ Gross calculated using $6.40/bu. corn price, $0.71/lb. N cost as estimates of average corn prices and N cost during these years.