Sensor-based Topdressing for Winter Wheat
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Objective:
- Develop reliable sensor interpretations as a basis for on-the-go variable-rate N topdressing of winter wheat.

Accomplishments for 2011:
- Three nitrogen rate experiments were carried out in conjunction with sensor measurements at the pre-jointing growth stage.
- As with 2009, N applications at greenup were not very effective.
  - Yield with all N applied at greenup was, on average, 9 bushels/acre less than when all N was applied a month later at the pre-joint stage (see table below).
  - Optimal N rate was higher (average 29 lb N/acre) at greenup than at pre-joint despite producing lower yields.
  - For N applications split between greenup and pre-joint, every 30 lb N/acre reduced optimal N rate applied at prejoint by 9 lb N/acre. This suggests that N applied at greenup was about 1/3 as effective as N applied at pre-joint.

<table>
<thead>
<tr>
<th>Experiment</th>
<th>optimal yield with all N applied at:</th>
<th>optimal N rate with all N applied at:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Greenup</td>
<td>pre-joint</td>
</tr>
<tr>
<td>1</td>
<td>58</td>
<td>68</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>51</td>
<td>64</td>
</tr>
</tbody>
</table>

- Applying all N pre-joint worked fine in these experiments
  - There was weak evidence that split spring applications may have given higher profit in 2 of the 3 experiments, but if so it wasn’t much higher
  - Yield response to different N rates at the prejoint stage is shown in the graphs below
● The most profitable N rates were higher than in 2009 and in most previous Missouri experiments on N rate for wheat (see table).
  ○ 101 lb N/acre average optimal N rate at pre-joint
  ○ 77 lb N/acre average optimal pre-joint N rate in 2009
  ○ but 120+ lb N/acre for all 3 experiments when applied at greenup

● There was probably not enough variability in optimal N rate (from 87 to 120) to justify use of precision agriculture techniques to diagnose and apply the correct N rate.
  ○ Using a rate of 100 lb N/acre would have given $6/acre less profit than applying the exact optimal N rate to each experiment.

● However, applying the average optimal N rate from 2009 (77 lb N/acre) would have reduced profit by an average of $18/acre for the three 2011 experiments. Correctly diagnosing this need for higher N rates in our 2011 experiments would have value.

● Part of this higher N need may be due to previous crop. Experiments 1 and 3 followed corn and had higher optimal N rates than Experiment 2, which followed soybean. In 2009, all experiments followed soybean.

● A range of crop appearances and N sufficiencies at the pre-jointing stage was created by applying either 0, 30, or 60 lb N/acre at greenup. Each of these greenup N rates was followed by a complete range of N rates and by sensor measurements at the pre-jointing stage.

● Each experiment thus produces three data points of sensor value and optimal N rate:
  ○ One with no N applied at greenup
  ○ One with 30 lb N/acre applied at greenup
  ○ One with 60 lb N/acre applied at greenup

● The relationship between readings from the CropSpec sensor and optimal N rate for the three 2011 experiments is shown in the graph below.
• NDVI is the Normalized Difference Vegetative Index, an index that has widely been used to quantify the amount and health of vegetation.

• The CropSpec sensor is a new sensor designed by TopCon that is in the pilot stages of commercialization. It was not available, or in this study, in 2009. In 2011, it did a considerably better job of discerning N need than the Greenseeker sensor.

• Relative sensor reading is the average sensor reading for a given greenup N rate (0, 30, or 60) divided by the average sensor reading taken from the high-N plot. A value of 1 indicates that the two plots looked the same. The farther this value is from 1, the more difference there is in appearance between the two N rates, which is inferred to be due to N limitation on growth at the lower N rate.

• The equation for the line in the graph above could potentially be used to translate sensor values to N rates in the future. However, there is reason to believe that this line could change as more data is added.
  • Especially in experiments 1 and 2, the greenup N applications (30 or 60 lb N/acre) changed the sensor measurements quite a bit by the pre-joint stage, but had minimal effect on the optimal N rate to apply then. This can be seen in the graph above.
  • In experiment 2, the plots with greenup N = 60 looked almost exactly like the plots with greenup N = 120. Thus relative green = 1.0. Despite this excellent appearance, the crop still needed about 65 lb N/acre.
  • Although a wheat crop that looks excellent may still need more N for optimal yield, it should be less (and usually will be less) than 65 lb N/acre.
  • The sensors were ‘fooled’ into thinking that the wheat that got greenup N looked better and thus needed less N, when in fact it still needed quite a lot.
  • Sensors may only be useful for pre-joint N applications when no N has been applied at the greenup stage.

• Sensor readings were also taken on these experiments using the Crop Circle 210 and OptRx sensors. However, we used a new device to record these sensor readings and had a lot of problems with it. We believe that we have finally retrieved all of the data taken with these sensors, but have not yet had time to analyze them.

**Budget for 2012:**
We plan to conduct these experiments again in 2012 due to the failure of our wheat crop establishment in 2009-2010. Wheat is planted and looking good. We are not requesting any additional funds, we have funds remaining in this account that will cover these expenses.