Sensor-based Topdressing for Winter Wheat

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Objective:

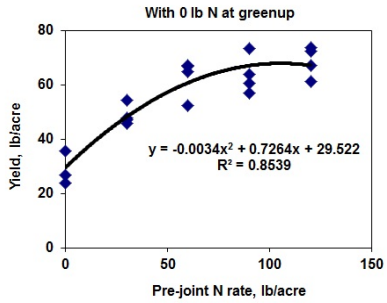
- Develop reliable sensor interpretations as a basis for on-the-go variable-rate N topdressing of winter wheat.

Accomplishments for 2011:

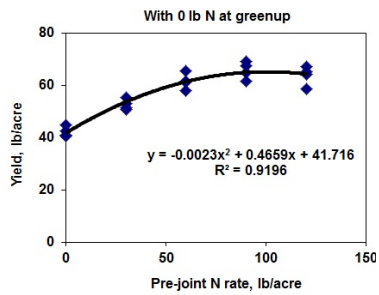
- Three nitrogen rate experiments were carried out in conjunction with sensor measurements at the pre-jointing growth stage.
- As with 2009, **N applications at greenup were not very effective**.
  - Yield with all N applied at greenup was, on average, 9 bushels/acre less than when all N was applied 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.

Experiment	optimal yield with all N applied at:		optimal N rate with all N applied at:	
	Greenup	pre-joint	Greenup	pre-joint
1	58	68	120	96
2	60	65	120	87
3	51	64	120	120

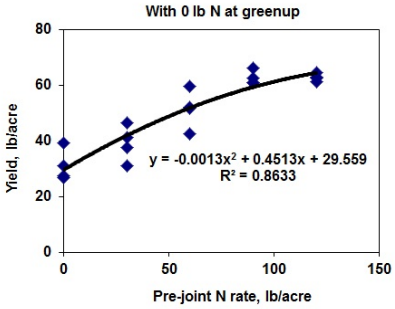
- **Applying all N pre-joint worked fine in these experiments**
  - There was weak evidence that split spring applications may have given higher profit in 2 of the 3 experiments, but if so it wasn't much higher
  - Yield response to different N rates at the prejoint stage is shown in the graphs below



Experiment 1



Experiment 2



Experiment 3

- 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.

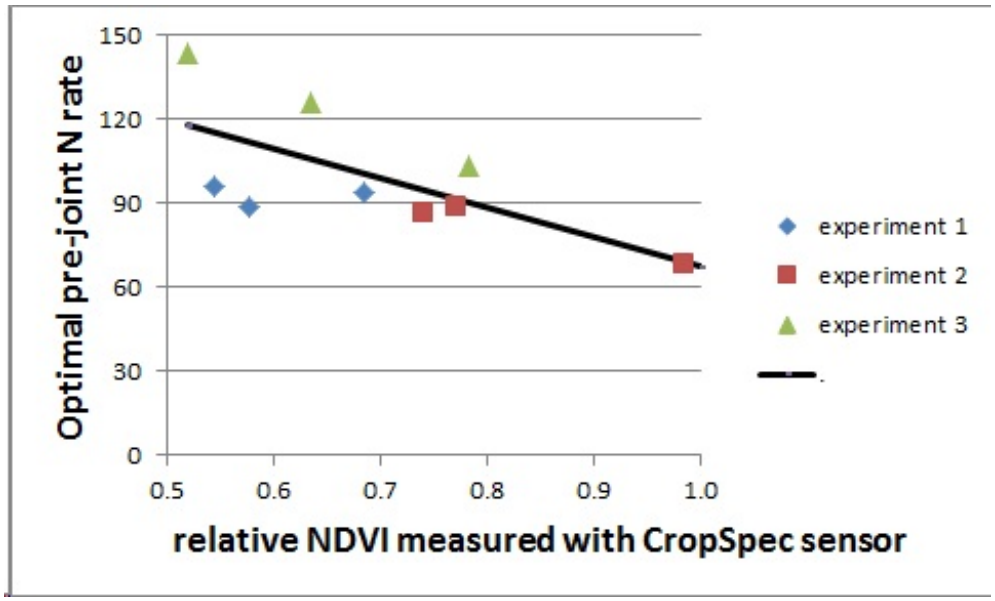
- However, applying the average optimal N rate from 2009 (77 lb N/acre) would have reduced profit by an average of $18/acre for the three 2011 experiments. Correctly diagnosing this need for higher N rates in our 2011 experiments would have value.

- 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.