Sensor-based sidedressing for cotton

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Objective:
Develop reliable sensor interpretations as a basis for on-the-go variable-rate N sidedressing of cotton.
   a. Determine sensor model and height that gives the best prediction of sidedress N need.
   b. Determine the best growth stage for sensor-based sidedressing.
   c. Develop recommendation equations to convert sensor readings to N rates.
   d. Test the system in production cotton fields.

Accomplishments for 2009:
- Three N rate and timing experiments were carried out to:
  o Add to the sensor interpretation equations that we have already developed
  o Help answer the question of whether delaying in-season N to the early flower stage will reduce yield.
  o Help answer the question of whether having no N preplant will reduce yield when fertilizing at mid-square or early flower stages.
- Three field-scale demonstrations of variable-rate N based on crop sensors were carried out.
  o Two with the Greenseeker sensor and one with the Crop Circle sensor.
  o Results are only available from one of these demonstrations so far. In that field (shown below), use of sensors produced nearly $50/acre advantage over the producer’s uniform N rate.

2009 cotton demonstration field comparing sensor-based variable-rate N with a constant N rate chosen by the producer (aqua color), both applied at the mid-square growth stage. Sensors reduced N rate by 17 lb N/acre, and increased lint yield by 69 lb/acre, giving a $49 per acre advantage to sensor-based N in this field. Cost of sensors and management time are not included in this estimate. Micronaire and fiber length were greater with sensor-based N rates. We interpret this as being due to delayed maturity with the higher N rates with the constant-rate treatment.
Accomplishments 2007-2009
- We showed that Greenseeker, Crop Circle, and Cropscan sensors are all capable of predicting how much N is needed for in-season application to cotton. All gave predictions of approximately equal accuracy.
- All three sensors performed best at mid-square and early flower (but NOT early square) growth stages from a height of 20 inches above the canopy.
- Recommendation equations that we developed (for 20-inch height only) are:
  - **Crop Circle**:
    - N rate = (178 x relative Vis/NIR) - 156
    - or N rate = 573 - (549 x relative NDVI)
  - **Cropscan**:
    - N rate = (266 x relative Vis/NIR) - 245
    - or N rate = 691 - (673 x relative NDVI)
  - **Greenseeker**:
    - N rate = (122 x relative Vis/NIR) - 95
    - or N rate = 759 - (732 x relative NDVI)
- Vis = visible wavelength, we used green for Cropscan, yellow for Crop Circle, red for Greenseeker
- NIR = near-infrared wavelength
- NDVI = normalized difference vegetative index, calculated from Vis and NIR
- relative Vis/NIR = (Vis/NIR to be fertilized)/(Vis/NIR from area with high N rate)
- relative NDVI = (NDVI to be fertilized)/(NDVI from area with high N rate)
- These equations give N rates in lb N/acre and can be used on-the-go to translate sensor measurements to N rates.
- We discovered that sensor readings on a single cotton plant do not stay the same all day long. This is a problem because the N rate needed by the plant DOES stay the same all day long.
  - These problems were worst with the Greenseeker sensor. The company is working to address this problem.
  - Plants wetting and drying is one reason for changing sensor values.
  - Other reasons are not known yet but may be due to either the plant changing (wilting leaves at mid-day, for example) or due to temperature or light sensitivity of sensors.
  - The solution to this problem is to frequently re-check the sensor readings from the high-N reference area. N rates are calculated by comparison to readings from this area. Changes in plant or sensor status during the day will be reflected in the values measured from the high-N reference area.
  - We have demonstrated at field scale that frequent re-checking of the high-N reference area can be accomplished by applying the high-N area crosswise to the rows. The applicator will then cross it each time it goes the length of the field. It can be programmed to know the location of the high-N area and to re-measure it each time the applicator crosses it.
  - Several producers have tried this approach successfully.
  - One producer applied crosswise high-N reference strips to all of his fields using an airplane. This process took only a few hours.