How does sensor-based variable rate N application differ from uniform N rate?: Lessons learned from corn on-farm studies in Alabama

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Adoption of sensor-based variable rate nitrogen (N) by corn producers in the Southeast USA is still in progress. Questions related to the accuracy of the sensors assessing N status, significant yield differences with uniform N application, and N savings are often raised among producers.

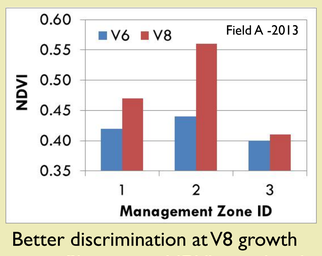
In the Midwest, the variable-rate sidedress N application using active-light crop-canopy remote sensors is usually conducted between V8 to V11 growth stages. Different from the Midwest, delaying N sidedress application to the V8 or later growth stages in Alabama may result in N stress due to sandy soils and high rainfall that characterize the US Coastal Plain region. Therefore, the use of crop canopy sensors for variable rate nitrogen (VRN) application in corn production across the southeastern USA implies assessment of corn N status and growth differences as early as the V6 growth stage.

Objective: Evaluate differences between sensor-based variable rate and uniform rate N application (@V6 and V8 growth stages), and to evaluate the on-the-go performance of the rate controller by comparing differences between the prescribed N rate and the as-applied N rate.

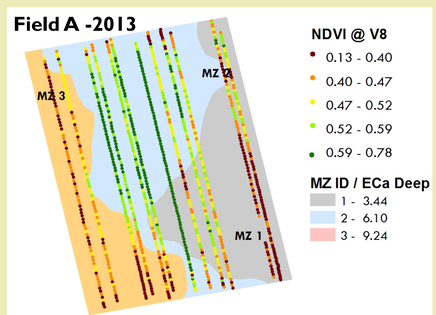
Materials and Methods: On-farm tests have been conducted since 2011 in central Alabama. Data from two fields (Field A – 2013 and Field B -2014) is presented. Treatments evaluated were: two VRN treatments using the Great Plains Oklahoma algorithm vr. 1.3, consisting of N applied at V6 and V8 growth stages, and an uniform rate treatment (producer N rate). Every treatment consisted of six rows spanning the length of the field replicated six (2013) to 12 times (2014). A GreenSeeker RT200® system mounted on a Hagie Sprayer was used to collect the canopy reflectance data with the RT200 providing the target N to a Raven VIPER Pro®.

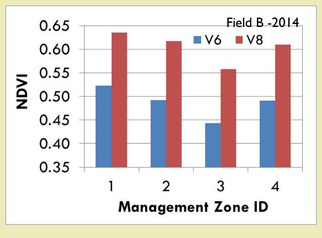
Did the variability in growth and leaf N status follow the within-field soil ECa changes?

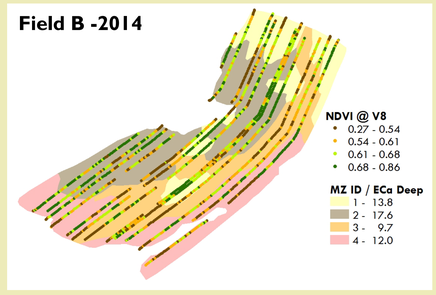
Below are GreenSeeker NDVI maps collected at the V8 corn growth stage. For some fields, the NDVI data at the V8 growth stage better discriminated within-field differences in growth and N status than the NDVI data at V6 stage.



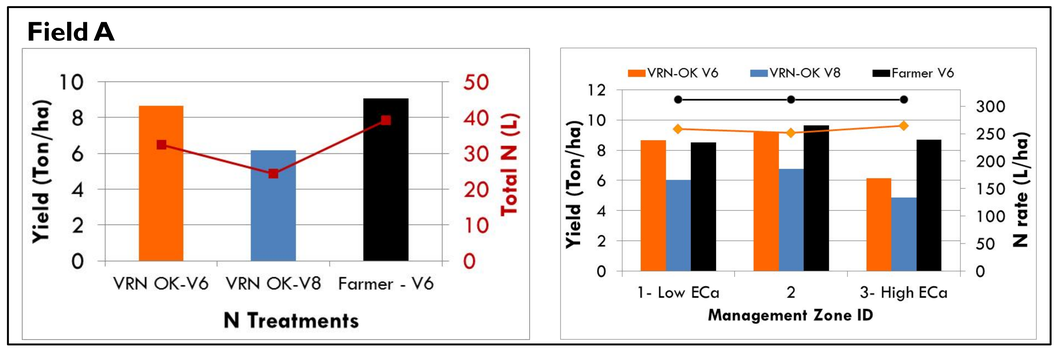
Better discrimination at V8 growth stage. Changes on NDVI correlated with soil textural (Soil Eca) management zones.

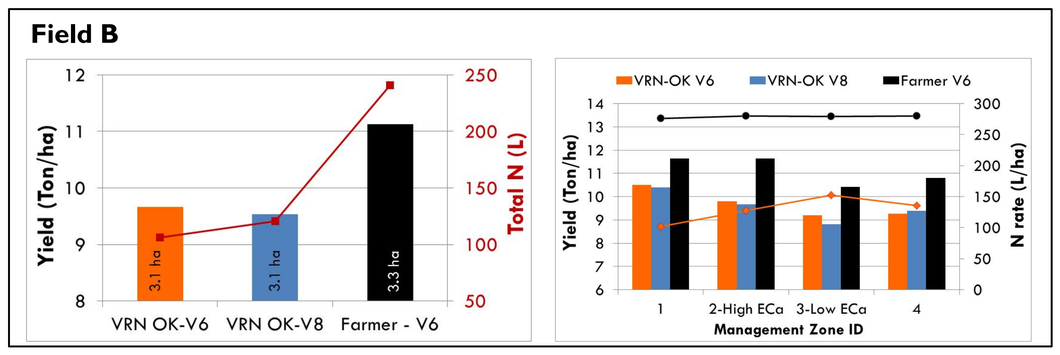






Yield and N Rate Differences by Treatment/Replication

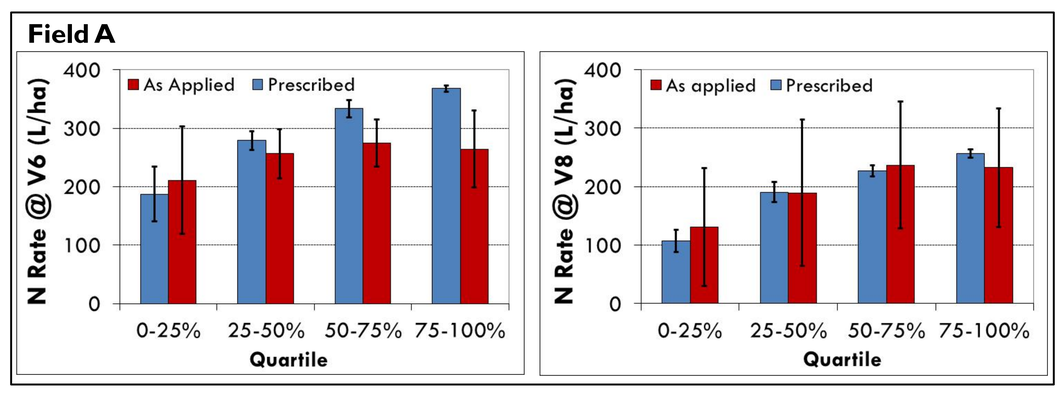


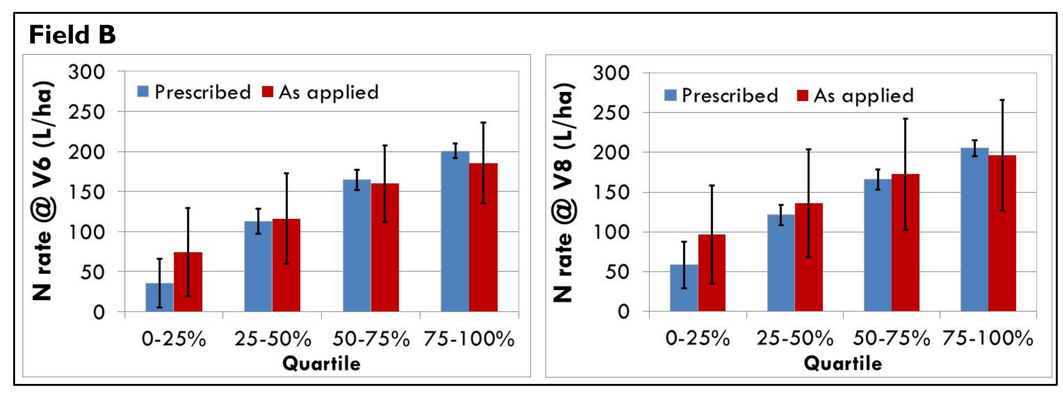


Field A. Yield differences between the treatments were observed. Similar yield was observed between Uniform and VRN-V6, with less N applied by the VRN-V6 treatment. Yield differences by zones were observed on the VRN-V6 treatment. Even though zone 3 had a high yield potential, the VRN algorithm did not prescribed a high rate, perhaps because the NDVI @V6 was the lowest.

Field B. Both VRN treatments had lower yield (lower N rate) compared to the Uniform N rate. The lower prescribed VRN, almost half of the Uniform N rate, could be attributed to the NUE value chosen during application (NUE=0.65). The N rate changes between the zones -VRN treatment - were not sufficient to increase yield close to the uniform N rate treatment.

Evaluation of the rate controller performance





Evaluation of the rate controller performance, comparison of the prescribed versus as-applied N rates, involved grouping the data into rate quartiles (<25th, 25th - 50th, 50th - 75th, >75th percentile). Overall for both fields, data indicated that at low rates (rate values in the lower quartile, 25th percentile), the as-applied rate was higher than the prescribed rate. In contrast, at high rates (rate values in the upper quartile, 75th percentile), the as-applied rate was lower than the prescribed rate. These differences were more evident when high N rates were applied , as the case of Field A – V6 growth stage.
Small differences existed between the rates located in the 50th percentile of the distribution. Even though these differences existed, data showed that the as-applied rate did follow the general prescribed rate trend.

Revenue Analysis

Field A -2013	Revenue		
Treatment	Zone ID		
	1	2	3
VRN OK-V6	$635.41	$673.38	$450.63
Farmer - V6	$626.30	$707.48	$637.78
	Product Costs		
VRN OK-V6	$49.74	$48.37	$50.88
Farmer - V6	$59.94	$59.94	$59.94
	Returns above N Costs		
VRN OK-V6	$585.68	$625.01	$399.75
Farmer - V6	$566.36	$647.54	$577.84
Difference (VRN - Control)	$19.32	-$22.53	-$178.08

The economic analysis showed that VRN was only profitable on zone 1, but significant losses were observed from zone 3.

Conclusions

- The potential benefits derived from VRN should be considered field by field. Significant within-field variability (e.g., soils, terrain) could result into benefits from using VRN, the contrary might occur for uniform fields.

- Data from field A indicated that the sensor-based algorithms will work better if other ancillary data (e.g., soil Eca) is used to determine the within-field N rates.

- Sensitivity analyses should be conducted to evaluate the impact NUE value (input for the VR algorithm) has on the prescribed N rate.