VARIABLE RATE COTTON FERTILIZATION DEVELOPMENT IN THE COASTAL PLAIN

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ABSTRACT

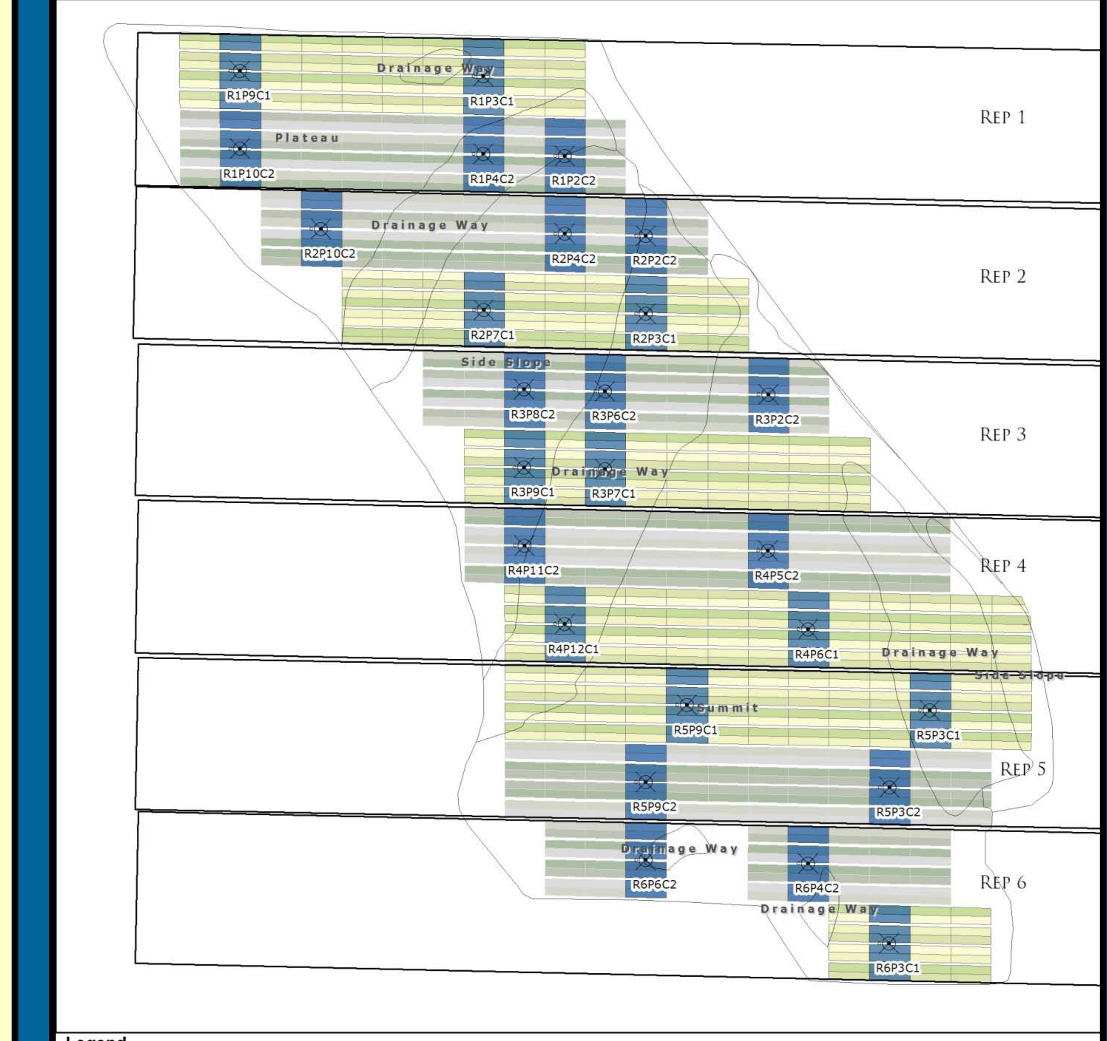
Previous research has shown that cotton yields can vary across the landscape based on the management system utilized; however, typical N fertilizer rates for cotton are applied uniformly across the field. The relationship is complicated by how cotton responds to different amounts of N, particularly excess N. Sensor technology previously utilized in other crops can potentially quantify cotton N status and relate sensor output to an N recommendation that will vary across the field and simultaneously improve cotton yields and profitability. An experimental site was established in a 9 ha. field in the Coastal Plain consisting of Typic and Aquic Paleudults that had management systems in place for 9 years. A split plot design was utilized with main plots consisting of two soil management systems (conventional-CT and conservation-NT) and split plots of 4 N rates (0, 45, 90, 134 kg/ha) with six replications of 3.7-m. strip-transects (4-row widths) across the field that intersect management zones. At pre-determined sampling points (3.7 x 18.3 m grids stratified within each management zone) 25 upper most mature leaves will be collected along with SPAD meter readings, plant heights, sensor measurements, and 1 m of whole plant biomass from the same pre-determined locations across landscape positions around 1st square and mid-bloom. Seed cotton yield was determined across the field with a combine equipped with GPS and yield monitor.

OBJECTIVE

Relate N status of cotton to sensor based readings across the landscape to identify a relationship for variable N rate application.

INTRODUCTION

- Typical N fertilizer rates for cotton are applied uniformly across the field, but the variability of many cotton fields may result in over-application or under-application of this expensive input.
- Under-application of N may result in yield loss, while over-application can result in excessive vegetative growth that also decreases yield and increases susceptibility to insect damage and disease pressure. Crop maturity may also be delayed.
- Cotton yields can vary across the landscape; therefore, the amount of N required to maximize cotton yields across the landscape should also vary.
- The relationship is complicated by how cotton responds to different amounts of N, as previously described. To maximize profitability, cotton N rates should vary across the landscape as well as across crop years.
- Sensor technology can potentially quantify in-season crop N status and relate sensor output to an N recommendation, but relationships between sensor readings and plant N status need to be identified to determine the proper N levels to apply that will maximize profit.



EV Smith Planting and Nutrient Plan with Smart Cells

MATERIAL AND METHODS

- An experimental site was established (~9 ha) near Central AL in the Coastal Plain (EV Smith Research Center).
- A split plot design with main plots consisting of two tillage systems (conventional-CT and conservation-NT) and split plots of 4 N rates (0, 45, 90, 134 kg/ha) with six replications in strips (4-row widths) traversing the field and intersecting landscape positions.
- At 1st square, prior to N application, and from pre-determined sampling points (3.7 x 18.3 m grid) various data was collected: SPAD readings from 25 upper most mature leaves (leaves also used for leaf N analysis), plant height, 1 m of whole plant biomass, and NDVI readings from landscape positions.
- Planting, sensing, and harvest dates with climate data are shown in Table 1. Results correspond only to the NT system and first sensing date.

Table 1. Planting, sensing, and harvest dates including growing degree days and rainfall for the 2008 and 2009 cotton growing seasons.

	Growing season			
	2008		2009	
	1st Sensor Reading	2nd Sensor Reading	1st Sensor Reading	2nd Sensor Reading
Planting	5-13-08		6-2-09	
Sensing Date	6-19-08	7-31-08	7-9-09	7-16-09
Growing Degree Days	655	1527	766.5	910
Cumulative Rainfall, mm	75.4	227.3	121.9	145.8
Harvest	10-15-08		11-6-09	
Total Rainfall, mm	520.0		679.2	

RESULTS AND DISCUSSION

- The 2008 and 2009 growing season were different based on rainfall and growing degree accumulation (Table 1). These growing seasons illustrate how climate can affect cotton growth, based on much larger plants observed early in the 2009 season.
- Pearson correlation coefficients (r) are presented for all measurements collected at 1st square during the 2008 and 2009 growing seasons across the entire 9 ha field (Table 2).
- Plant height had the highest correlation with NDVI measurements across both growing seasons, but plant height and NDVI correlated poorly with lint yields and leaf N % (Table 2).
- We hypothesized that landscape zones determined by soil survey mapping, landscape characteristics, and soil EC data would reduce field variability and improve correlation between NDVI and plant parameters.
- In 2008, correlation improved between leaf N % and NDVI and lint yield and NDVI across the sideslope and summit zones compared to correlation across the entire field. No improvements between these variables were observed in 2009 (Fig. 1).

CONCLUSIONS

- Relationships between plant N status and NDVI measurements were weak at 1st square, prior to N application. These relationships were improved for select variables within landscape zones, but not in 2009, a year characterized by rapid early season growth attributed to excessive rainfall.
- NDVI correlations with different plant parameters were not consistent across years. Reducing variability by comparing within landscape zones did not improve relationships with NDVI measurements.
- Future research will determine if observed relationships are consistent across tillage systems and how sensor-based, variable rate N application could be used for cotton production in the Coastal Plain.

Table 2. Pearson correlation coefficients (r) between sensor readings and plant parameters across the entire field. Red values are significant (P < 0.10).

	2008								2009							
	SPAD	NDVI	Lint Yield	Height	Leaf N	Leaf wt.	Plant biomass	Plant N	SPAD	NDVI	Lint Yield	Height	Leaf N	Leaf wt.	Plant biomass	Plant N
NDVI	-0.2054								-0.4916							
Lint yield	0.2762	0.1630							0.1726	0.0020						
Height	-0.2929	0.8876	0.0128						-0.5199	0.5597	-0.3211					
Leaf N	-0.6318	-0.3242	-0.3598	-0.2636					-0.2971	-0.1568	-0.0858	0.2326				
Leaf wt.	0.2469	0.6848	0.2540	0.7052	-0.7184				0.7632	-0.2234	0.0752	-0.1687	-0.2802			
Plant biomass	0.0313	-0.0679	0.1277	-0.0593	-0.0463	0.0837			-0.2635	-0.4669	-0.0567	0.5591	-0.0896	0.0316		
Plant N	-0.0964	0.1076	-0.0513	0.0776	0.1769	-0.0215	-0.1195		-0.0683	0.0576	-0.5693	0.2943	0.0519	0.0086	-0.0151	
Plant uptake	0.0238	-0.0526	0.1294	-0.0451	-0.0424	0.0899	0.9943	-0.0324	-0.2936	0.4921	-0.1871	0.6009	-0.0797	0.0153	0.9696	0.2134

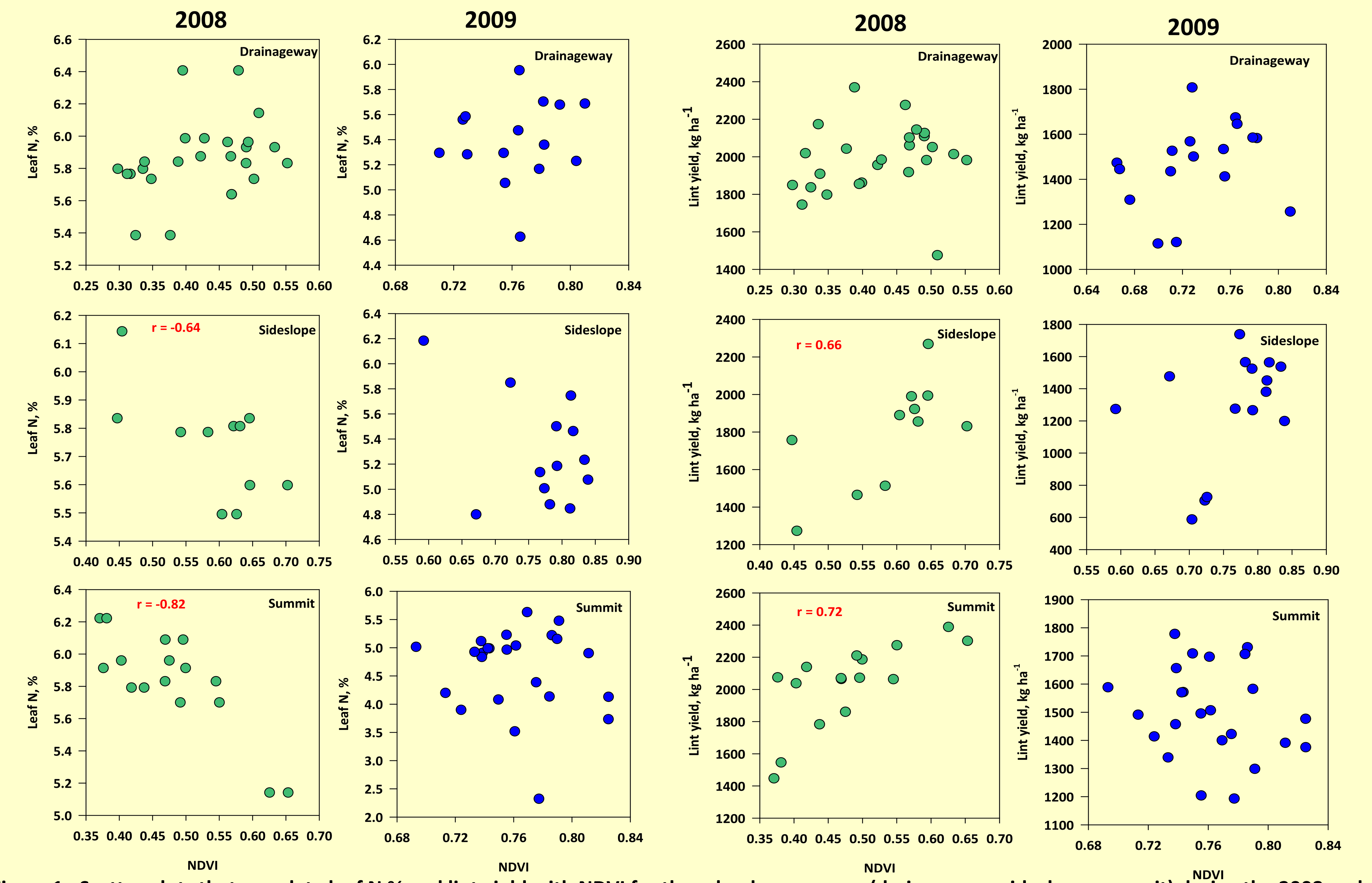


Figure 1. Scatter plots that correlate leaf N % and lint yield with NDVI for three landscape zones (drainageway, sideslope, summit) during the 2008 and 2009 growing seasons.