



Using GreenSeeker® to Drive Variable Rate Application of Nitrogen, PGRs and Defoliants on Cotton

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Research Partners

University of Georgia

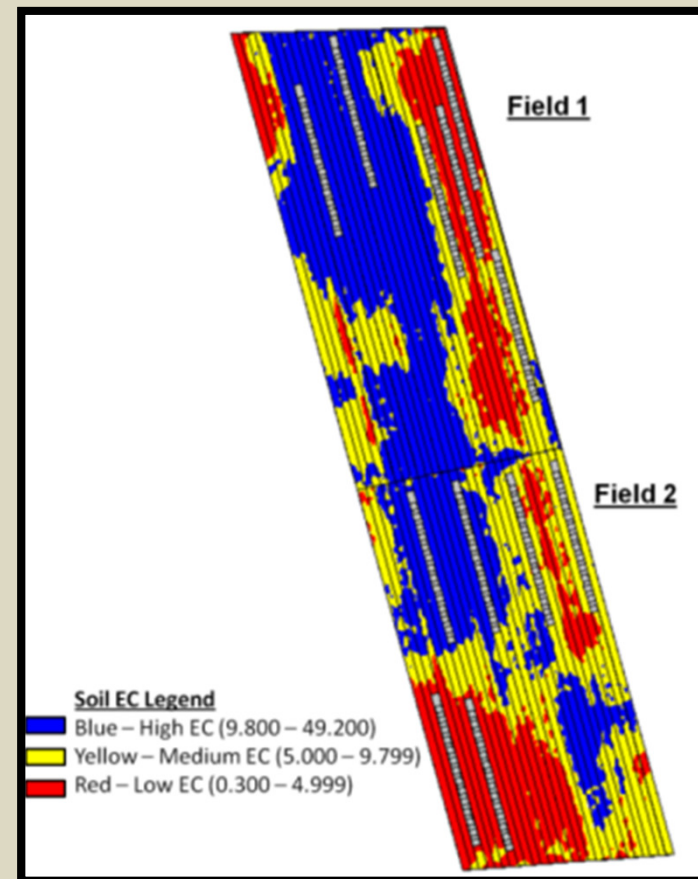
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- Mr. Herman Henry
- Mr. Rodney Hill
- Mr. Calvin Perry
- Dr. Glen Ritchie
- Ms. Heather Savelle
- Mr. Sergio Villagran

Financial Support

- Georgia Cotton Commission
- Cotton, Inc.



Why VRA in Georgia Cotton?

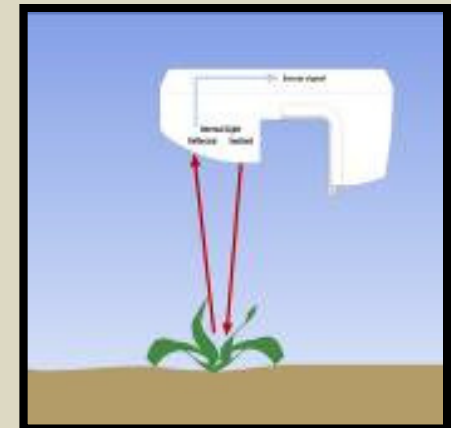


GreenSeeker®

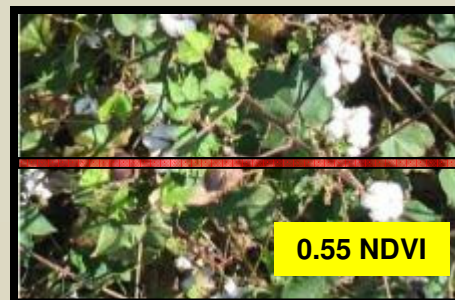
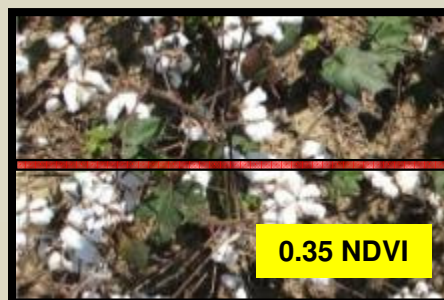
- Generates light at two wavelengths
 - Red and NIR
 - measures the light reflected from the plants
- Reflectance used to calculate NDVI
- NDVI = Normalized Difference Vegetative Index
 - Most common Vegetative Index



$$NDVI = \frac{NIR_{\text{reflectance}} - Red_{\text{reflectance}}}{NIR_{\text{reflectance}} + Red_{\text{reflectance}}}$$



GreenSeeker® Sensors “look” straight over row/crop and
NDVI values change based upon size and vigor of crop.



Photos courtesy of Ted Mayfield

NDVI Mapping



- GreenSeeker® RT200 six-sensor system
- Trimble® DGPS



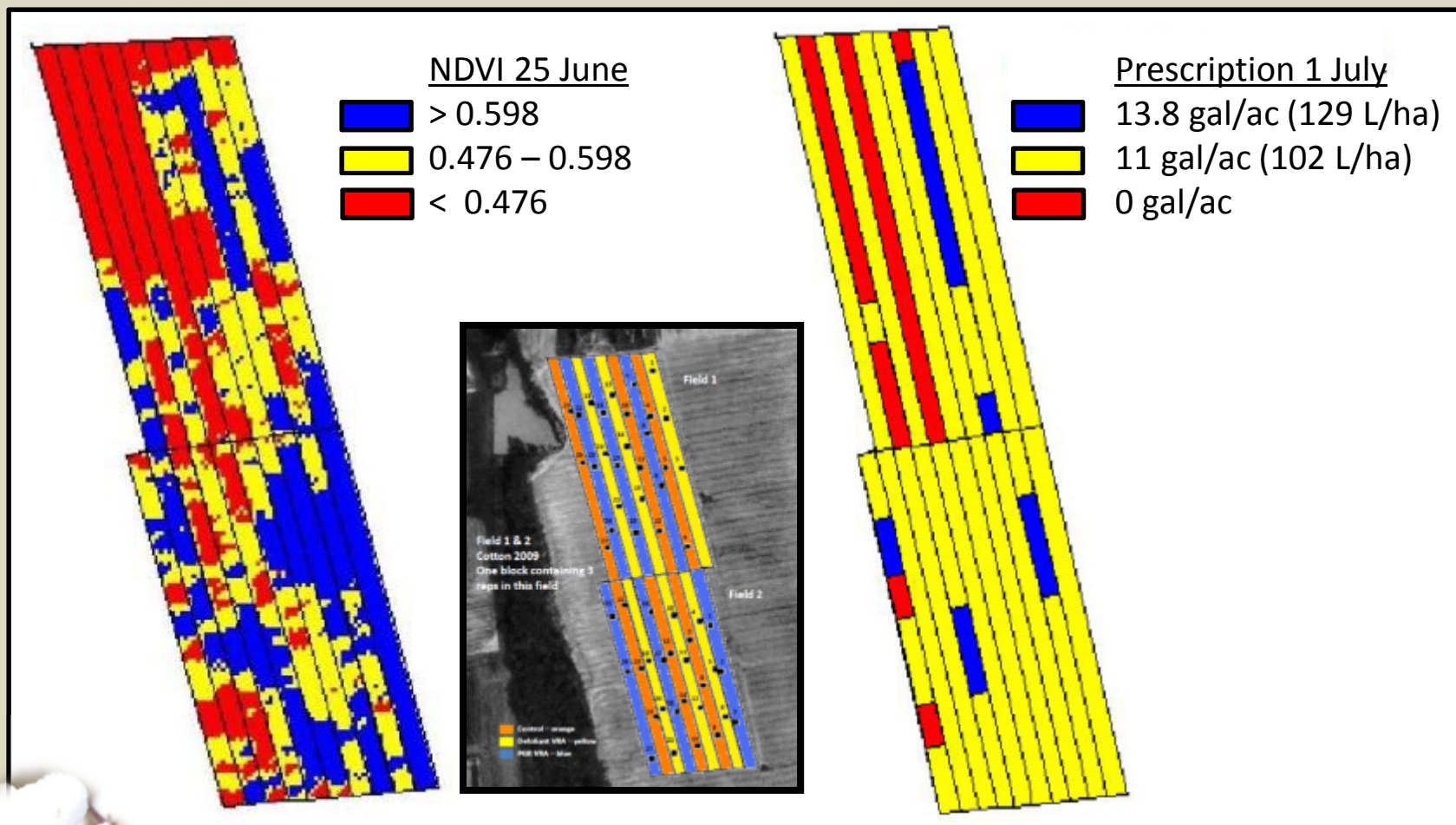
VRA of PGRs and Defoliant



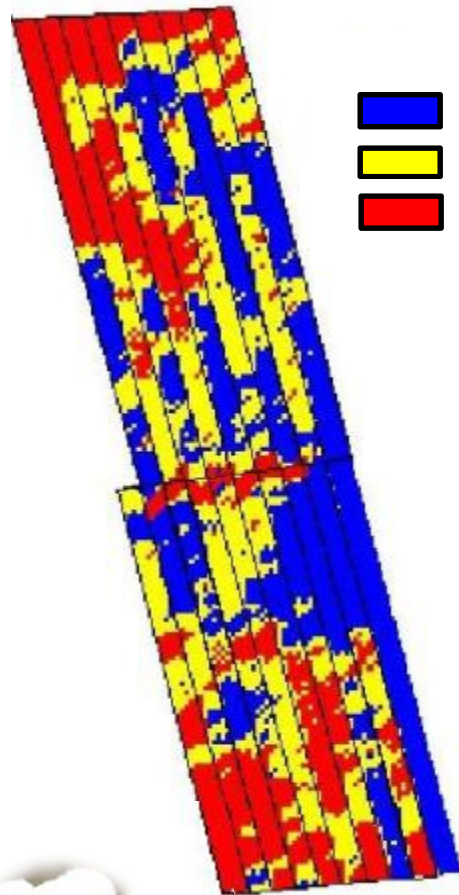
- MidTech Legacy[®] variable rate controller
- Trimble[®] DGPS



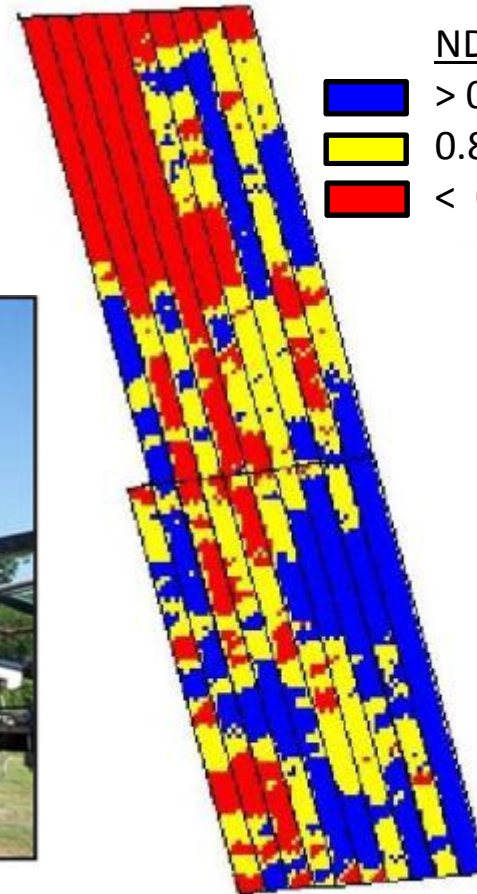
PGR NDVI Maps



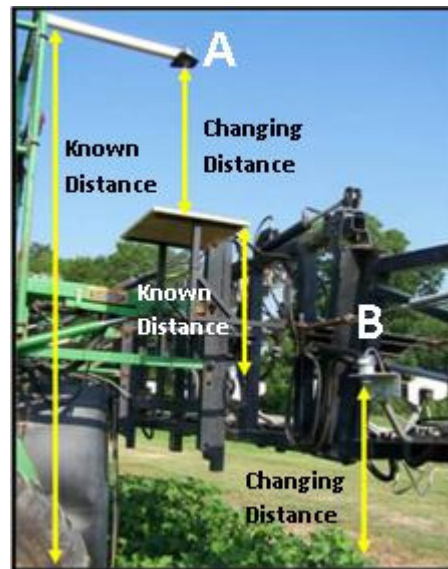
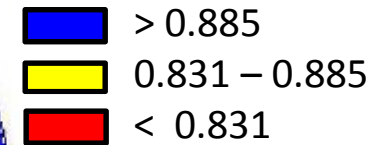
PGR NDVI Maps



Plant Height (m)



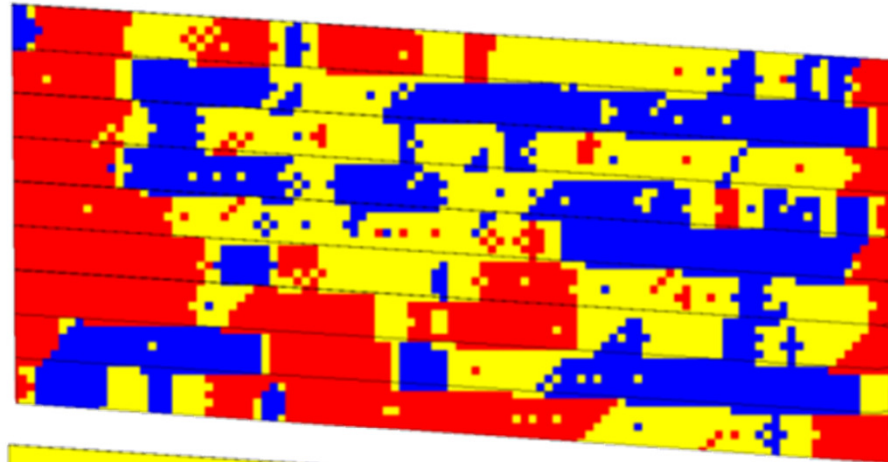
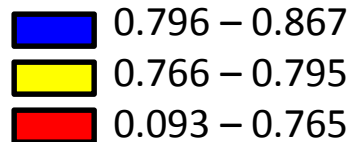
NDVI 10 August



Defoliant Prescription Maps

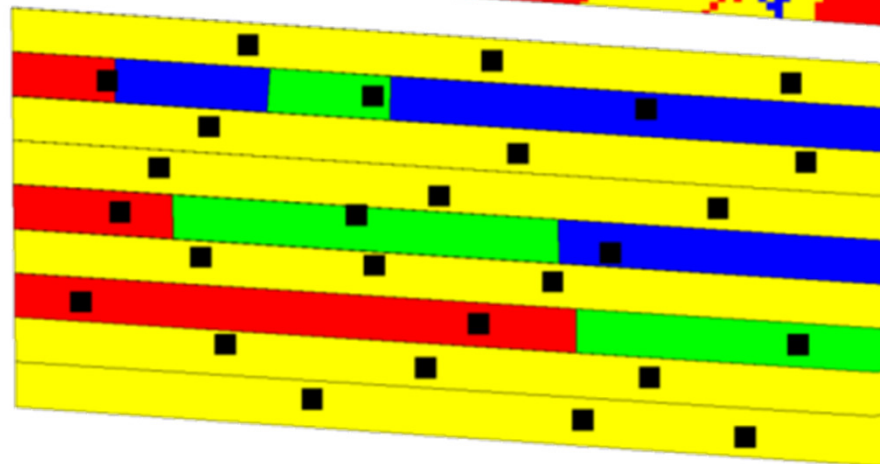
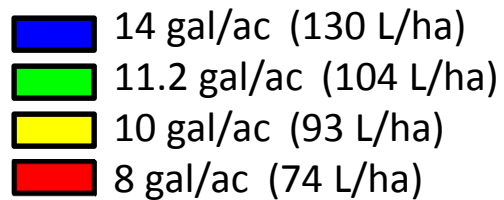
Field 3 NDVI 22 Sept 09

NDVI Legend



Field 3 Defoliant Rx Map
01 Oct 09

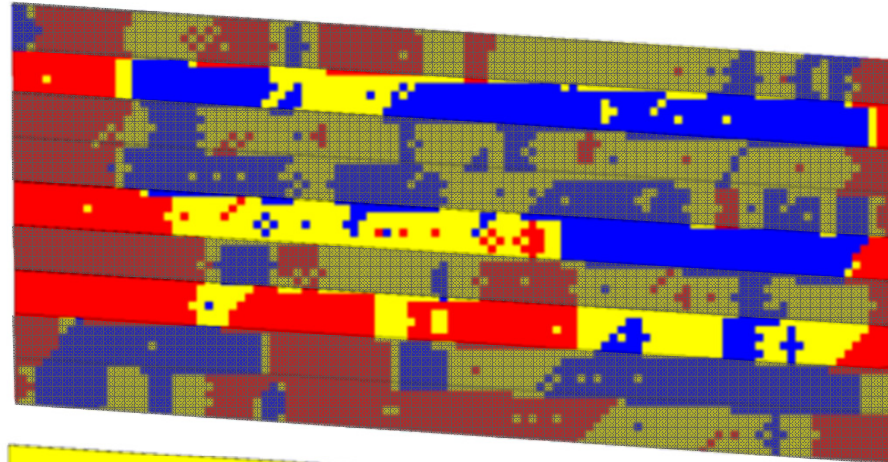
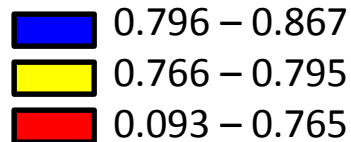
Defoliant Rx Rates



NDVI & Prescription Maps

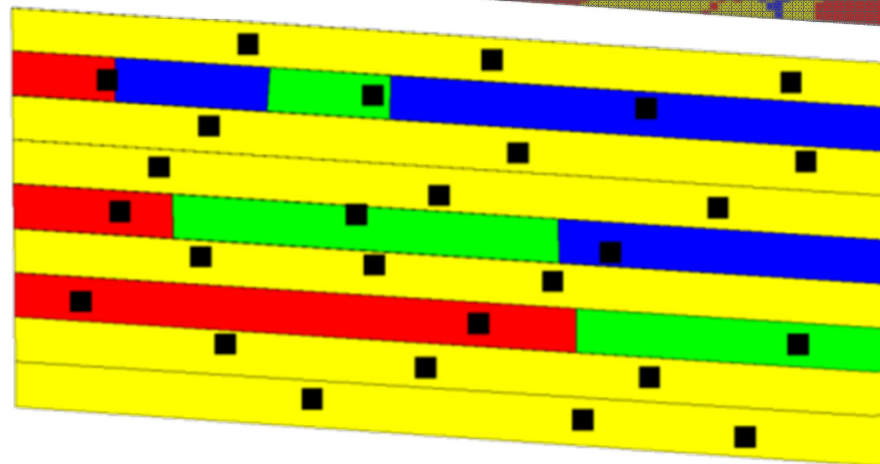
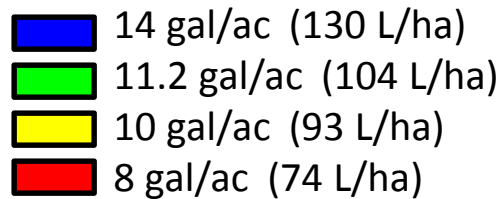
Field 3 NDVI 22 Sept 09

NDVI Legend



Field 3 Defoliant Rx Map
01 Oct 09

Defoliant Rx Rates



PGR Comparisons – Uniform vs VRA

Difference in Volume Used:

- July 1: 14% less/acre
- July 24: 6.5% less/acre
- August 11: 1% less/acre
- **Season Total: 7% less/acre**



PGR Cost Difference per Acre:

Field 1&2:

- Uniform rate: \$1.62/ac (\$4/ha)
- VRA rate: \$1.48/acre (\$3.7/ha)
- **Uniform - VRA: +\$0.14/ac (\$0.35/ha)**

Field 3:

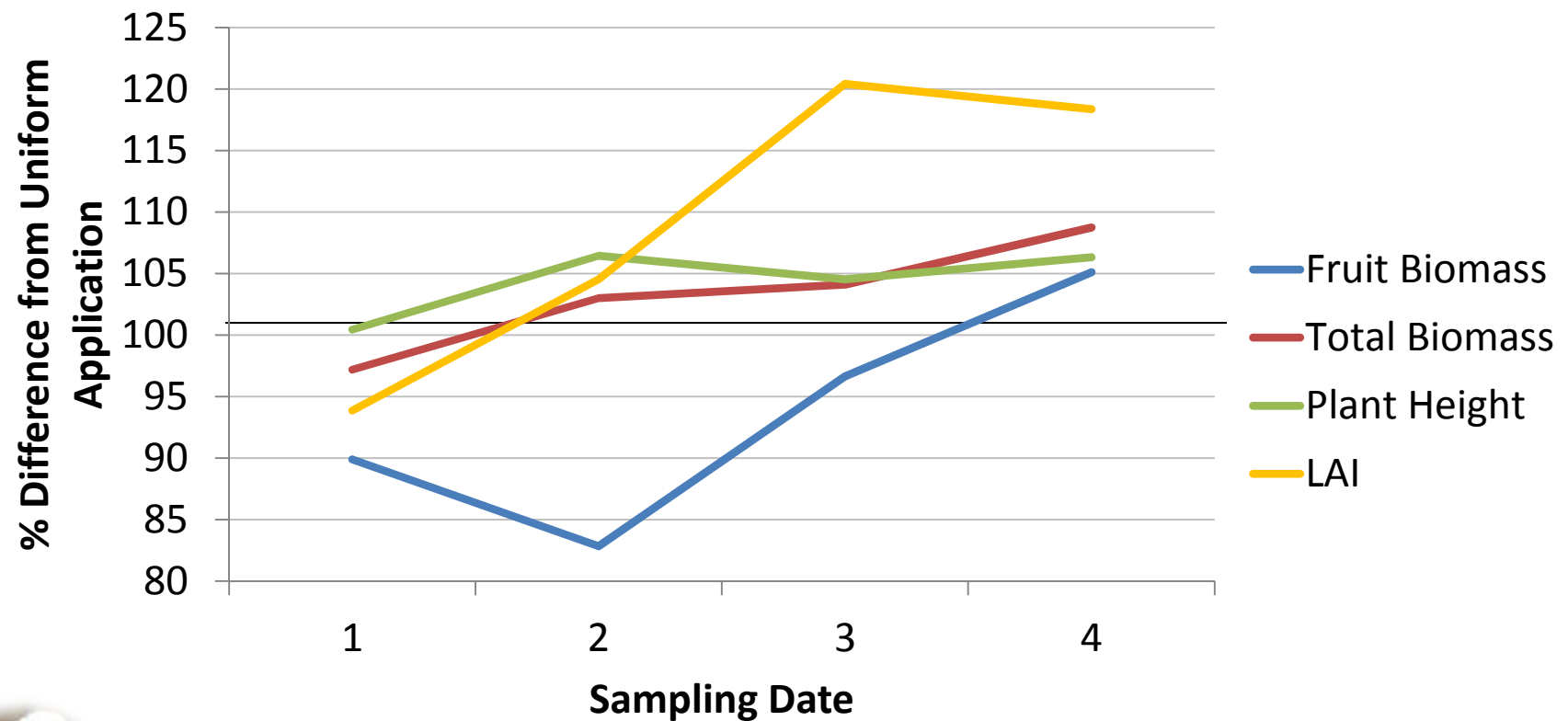
- Uniform rate: \$1.62/ac (\$4/ha)
- VRA rate: \$1.53/ac (\$3.8/ha)
- **Uniform - VRA: +\$0.10/ac (\$0.25/ha)**

Average Difference: +\$0.12/ac (\$0.30/ac)

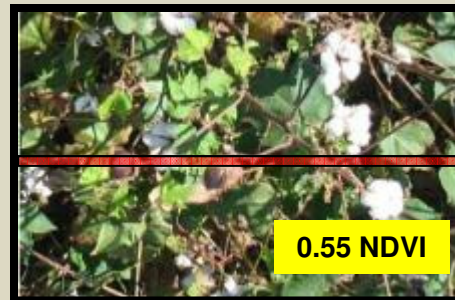
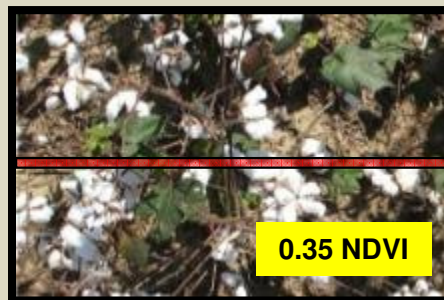
* + indicates net gain as a result of using VRA

PGR Results

Plant Growth Parameters: VRA Compared to Uniform

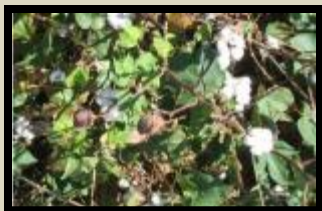


GreenSeeker® Sensors “look” straight over row/crop and
NDVI values change based upon size and vigor of crop.



Photos courtesy of Ted Mayfield

Defoliation Formulations



<u>Uniform Rate</u>	Prep	Dropp	Folex
Fields 1, 2, 3	32 (oz/ac)	2 (oz/ac)	6 (oz/ac)



<u>Fields 1&2</u>	Prep (oz/ac)	Dropp (oz/ac)	Folex (oz/ac)
High (100%) 14 gal/ac	32	2.4	10
Med (71.4%) 10 gal/ac	22.9	1.7	7.1
Low (57.1%) 8 gal/ac	18.3	1.4	5.7

<u>Field 3</u>	Prep (oz/ac)	Dropp (oz/ac)	Folex (oz/ac)
High (100%) 14 gal/ac	32	2	8
Med (80%) 11.2 gal/ac	25.6	1.6	6.4
Low (57.1%) 8 gal/ac	18.3	1.1	4.6



Defoliation Results

Plant Growth Parameters: PGR vs. Uniform

- LAI
 - Uniform rate: 98% reduction
 - VRA: 96% reduction
- Leaf Biomass
 - Uniform rate: 97.8% reduction
 - VRA: 95% reduction
- Boll Opening

Field	% Bolls Opened Between Defoliation and Harvest (14 days)			
	VRA Prep Application Rate			Uniform Prep Rate
	High	Medium	Low	
Field 1	-	71%	70%	82%
Field 2	55%	80%	44%	83%
Field 3	62%	42%	70%	66%



Defoliation Cost Comparison

Product	Uniform Application (\$/ac)	VRA Application (\$/ac)		Difference (Uniform - VRA) (\$/ac)	
		Field 1&2	Field 3	Field 1&2	Field 3
Dropp	\$2.70	\$2.28	\$2.15	+\$0.42*	+\$0.55
Folex	\$2.87	\$3.42	\$3.08	-\$0.55	-\$0.21
Prep	\$6.19	\$4.44	\$4.98	+\$1.75	+\$1.21

* + indicates net gain as a result of using VRA

Difference in Volume of Product Used

Dropp: 17% less/acre
 Folex: 15% more/acre
 Prep: 25% less/acre

Difference in Cost (Uniform – VRA)

Fields 1&2: +\$1.62/ac (\$4/ha)
 Field 3: +\$1.55/ac (\$3.8/ha)
 Average: +\$1.58/ac (\$6.2/ha)



Cost Comparison

Products	Difference in Cost (VRA – Uniform) (\$/ac)	
	Field 1&2	Field 3
PGR	+\$0.14	+\$0.10
Defoliants	+\$1.62	+\$1.55
TOTAL	+\$1.76	+\$1.65

Production Application:

- Average Difference = +\$1.71/ac
- Savings on 2000 acres = \$3420
- Cost of GreenSeeker = \$15,000

**Pay for Technology
in less than 5 years**

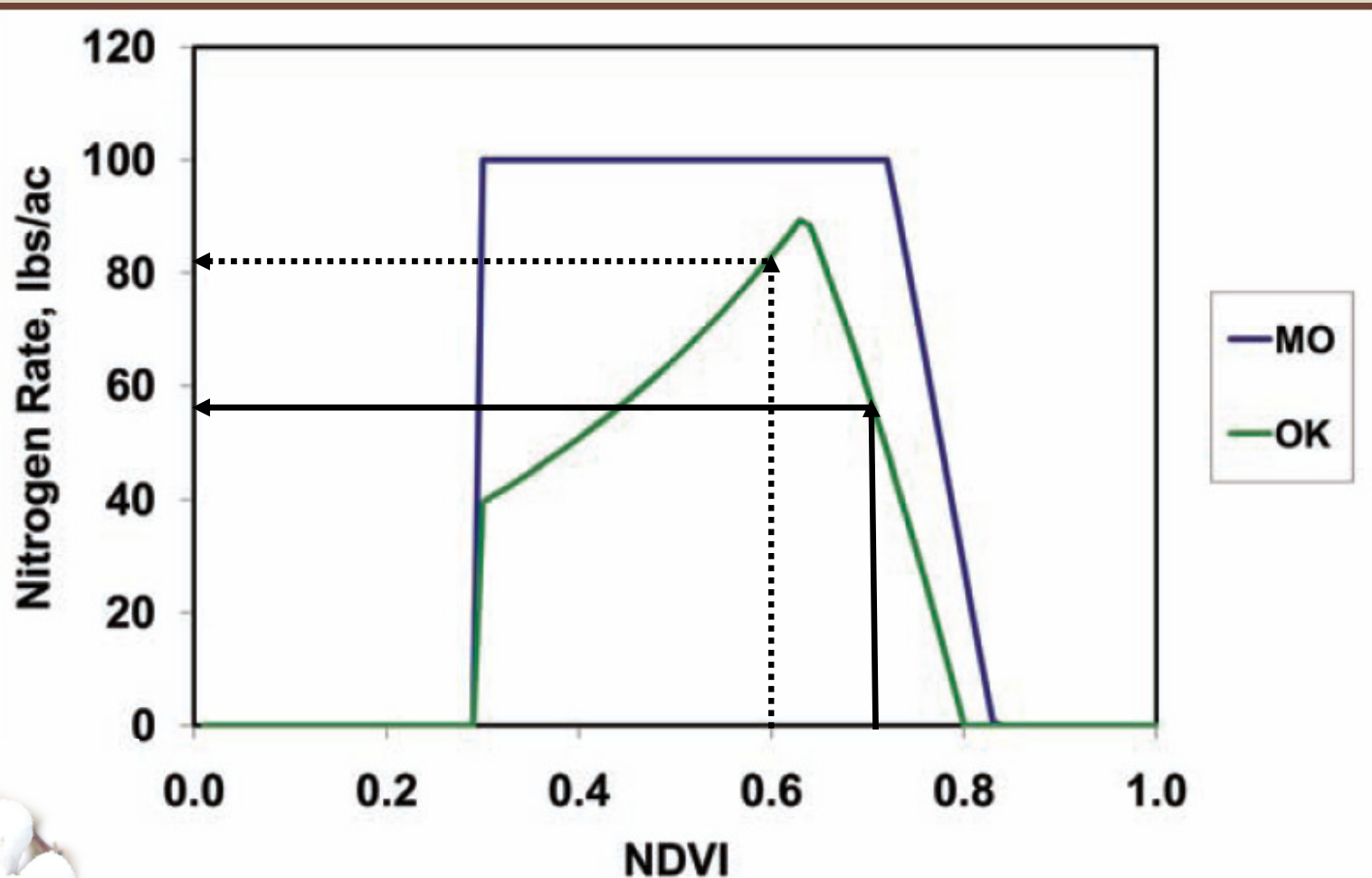


Nitrogen Use in Georgia

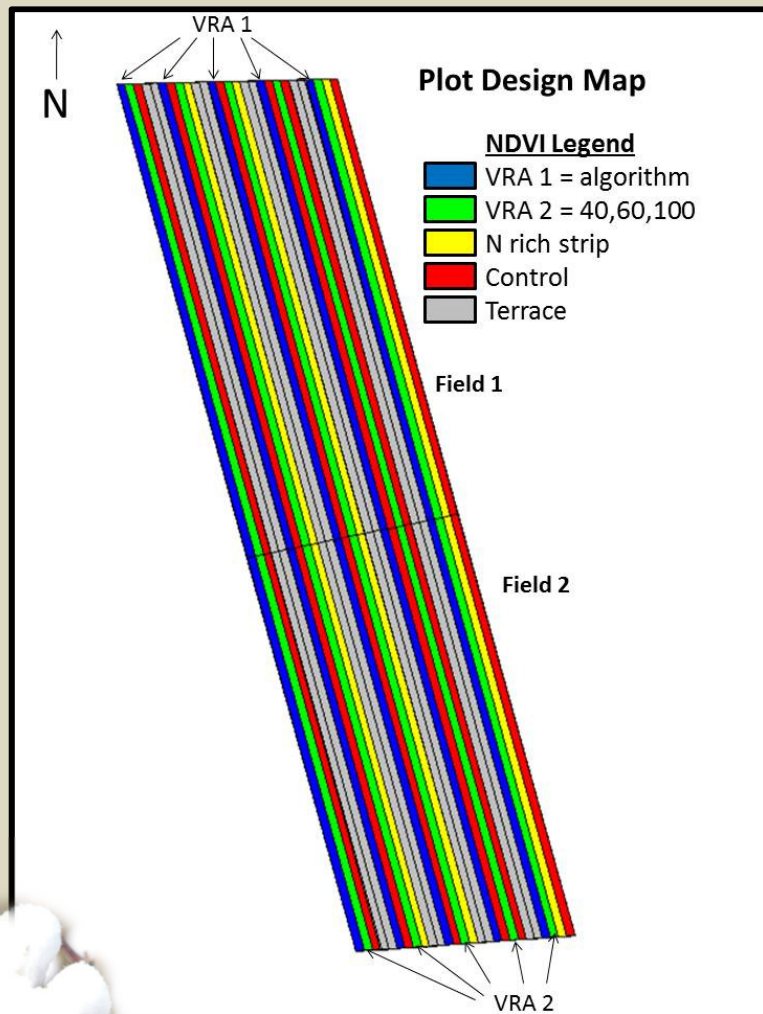
- Most important fertilizer used in cotton
- Most difficult to manage
- Low rates → reduce yield and quality
- Excessive N → rank growth, boll rot, delayed maturity, poor quality and yield
- Recommended in GA: 105 lb/ac (117 kg/ha)
 - 25 lb/ac at pre-plant or at planting (28 kg/ha)
 - 80 lb/ac side-dress (90 kg/ha)



OK State / Clemson Algorithm

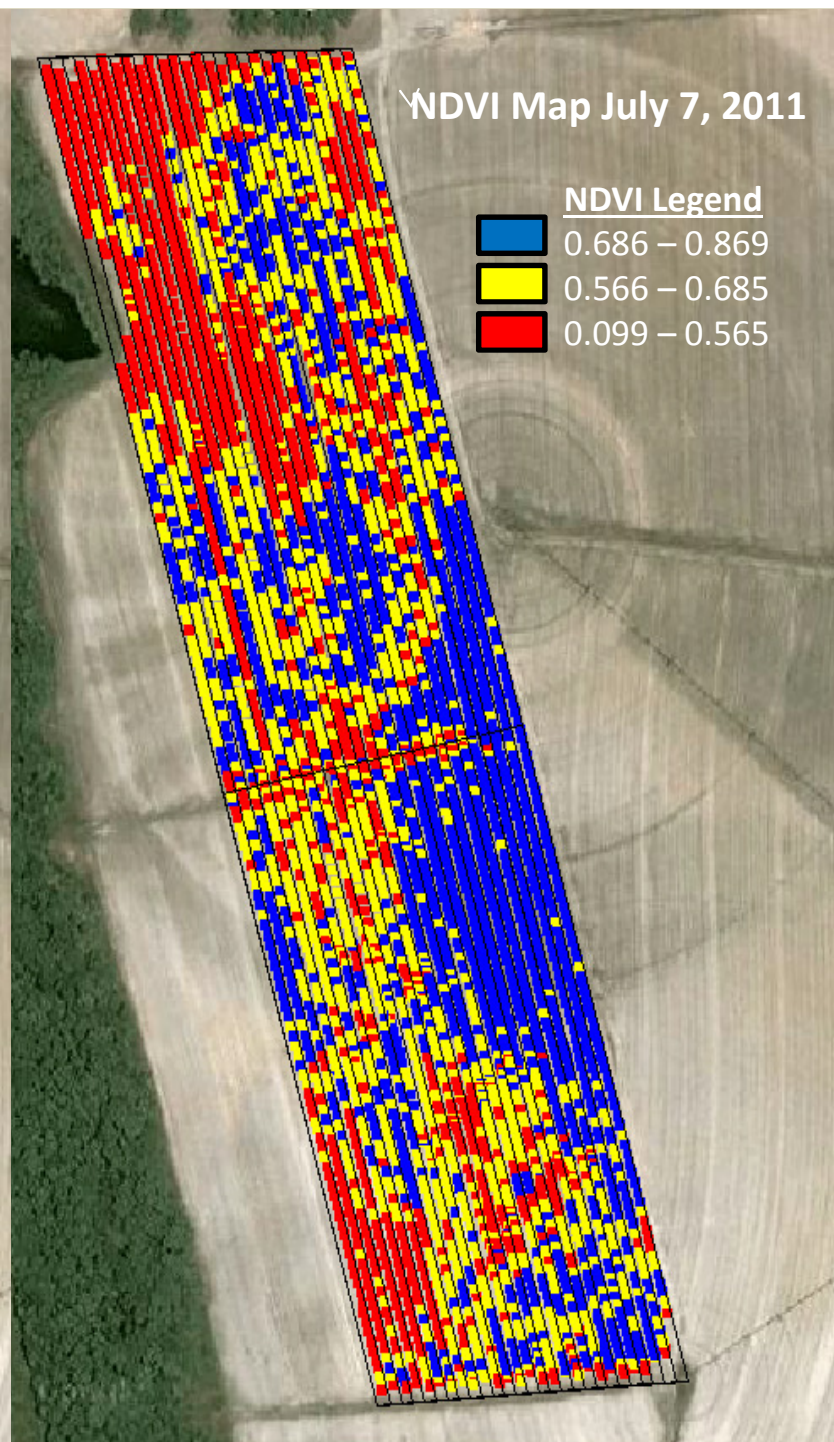
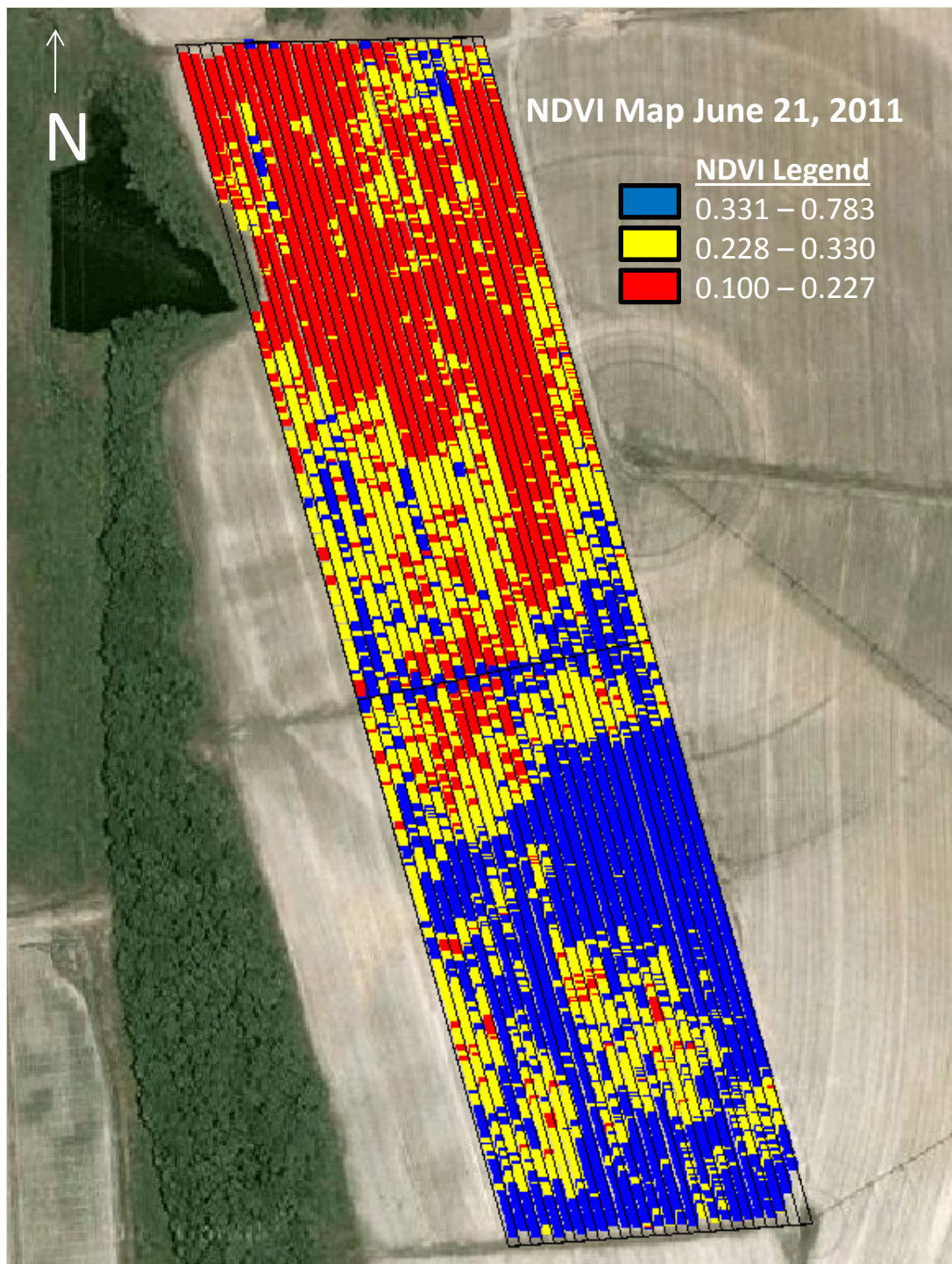


N-Rich Strips



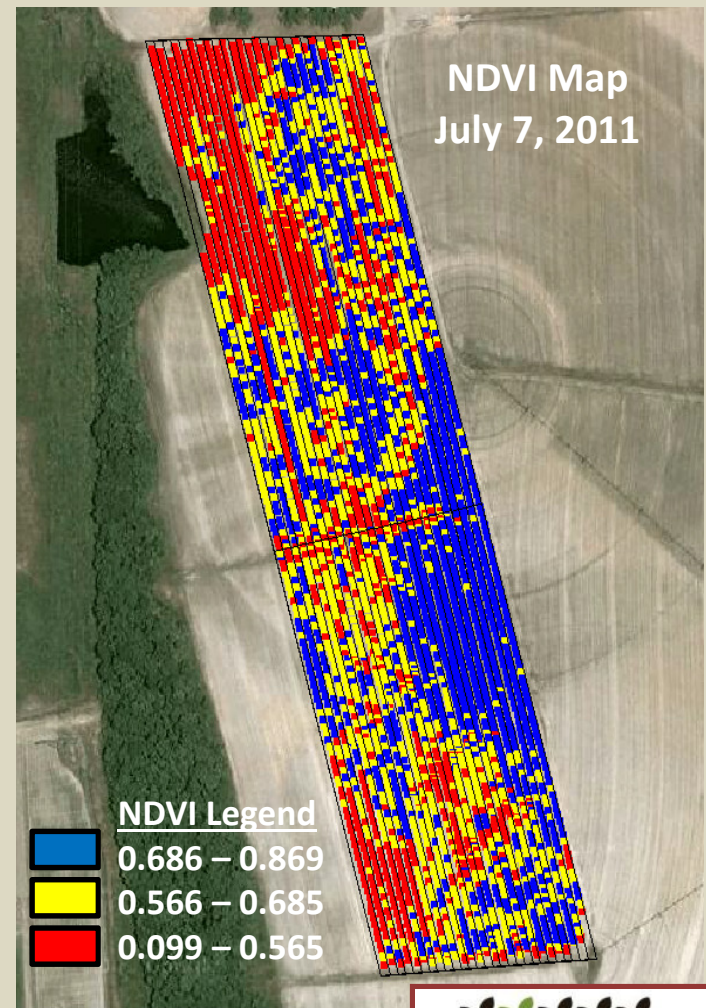
- 105 lb N/ac applied
08 June 2011
- 28% liquid N



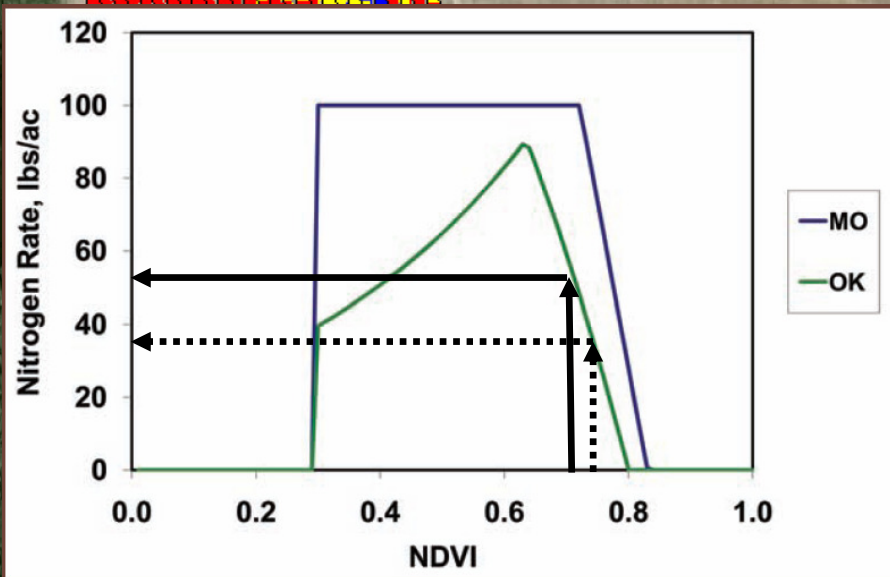


Prescription Maps

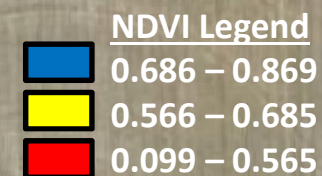
- Based on 07 July NDVI map
 - Use NDVI to assess yield potential
 - N-rich strips not effective
- Two VRA treatments
 - OK State / Clemson algorithm applied to each field
 - User-selected rates



N



NDVI Map July 7, 2011



Field 1

Field 2

NDVI Zone	Field 1		Field 2	
	Side-Dress (lb N/ac)	NDVI	Side-Dress (lb N/ac)	NDVI
High	51.8	0.721	32.7 (40) ²	0.765
Medium	77.7	0.602	57.4	0.653
Low	44.2	0.459	41.7	0.494

Applying Side-Dress N



- Capstan® variable rate system driven by an Ag Leader® Insight variable rate controller



OK State / Clemson Algorithm

VRA Treatment 1 (5 strips in each field)

NDVI Zone	Field 1		Field 2	
	Side-Dress N Rate		Side-Dress N Rate	
	(lb/ac)	(gal/ac) ¹	(lb/ac)	(gal/ac)
High	51.8	17.3	32.7 (40) ²	13.4
Medium	77.7	25.9	57.4	19.1
Low	44.2	14.7	41.7	13.9
Control	85	28.3	85	28.3

¹ 28% liquid N

² Algorithm calculated 32.7 lb N/ac but we overrode and applied 40 lb N/ac



User Selected Rates

VRA Treatment 2 (5 strips in each field)

NDVI Zone	Field 1		Field 2	
	Side-Dress N Rate		Side-Dress N Rate	
	(lb/ac)	(gal/ac) ¹	(lb/ac)	(gal/ac)
High	100	33.4	100	33.4
Medium	60	20	60	20
Low	40	13.4	40	13.4
Control	85	28.3	85	28.3

¹ 28% liquid N



2011 Results

- No significant differences in tissue sample N concentration prior to side-dress application
- Strips harvested with 4-row cotton picker equipped with Ag Leader yield monitor
- Significant differences in yields of treatments



2011 Yield Results

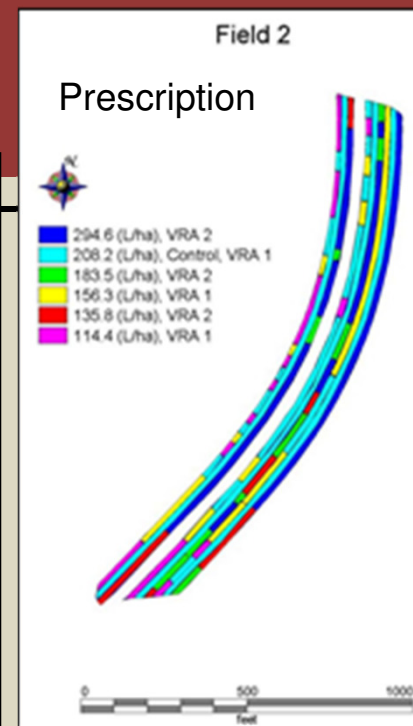
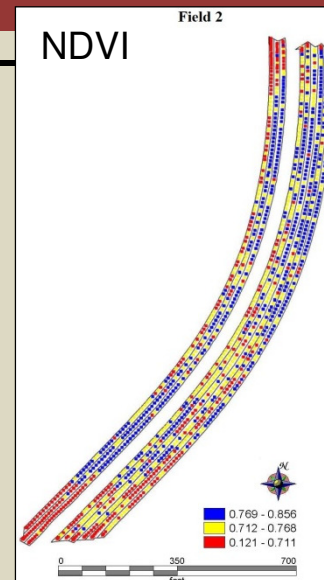
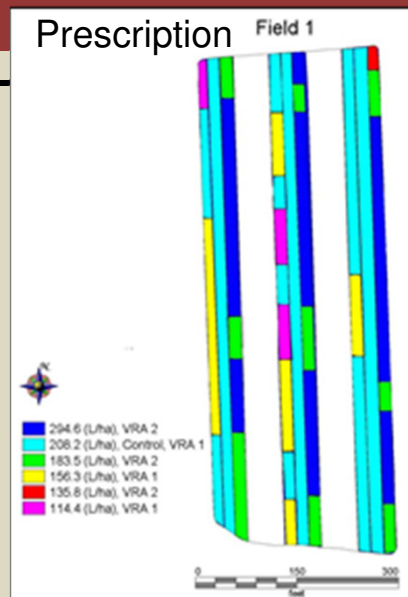
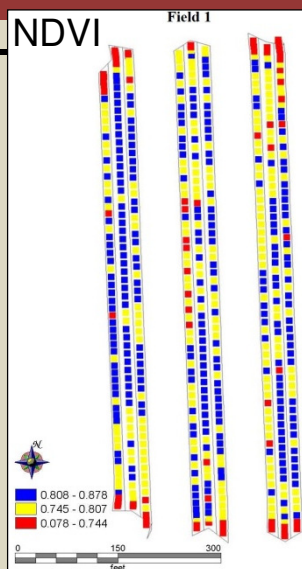
NDVI Zone	Field 1		Field 2	
	Side-Dress N Rate	Average Yield	Side-Dress N Rate	Average Yield
	(lb/ac)	(lb/ac)	(lb/ac)	(lb/ac)
VRA 1	44, 78, 52 ¹	3031	42, 57, 40 ¹	3032
VRA 2	40, 60, 100 ¹	2920	40, 60, 100 ¹	3330
Control	85	2849	85	3361
N-Rich	85 ²	2782	85 ²	3309

¹ Rates for Low, Medium, High NDVI zones. N applied July 7.

² Applied June 8.



2012 Results



Treatment	Yield (lb/ac)	Soil ECa (mS/m)		NDVI	As Applied N (gal/ac)	Return ¹ (\$/ac)	Difference ² (\$/ac)
		0-30 cm	0-90 cm				
Fld 1 VRA1	3078	9.40	21.39	0.738	22.0	874	+48
Fld 1 Control	2940	8.37	14.28	0.756	25.2	826	-
Fld 1 VRA2	3125	10.88	18.19	0.762	28.9	873	+47
Fld 2 VRA1	2593	6.33	12.51	0.714	19.9	340	+71
Fld 2 Control	2752	7.98	16.28	0.729	25.3	269	-
Fld 2 VRA2	2499	5.84	12.81	0.710	26.6	164	-105

¹ Return = Yield × Lint Price – N Cost; ² Difference = Control - VRA



Conclusions

- VRA on cotton has great potential for improving efficiency
- N-rich strips do not work in Georgia because of pre-plant fertilizer
- Non-uniform management can distort NDVI data leading to inaccurate prescriptions

