In-Season Precision Applications of Fluid Fertilizer to Optimize Cotton Productivity and Nitrogen Use Efficiency

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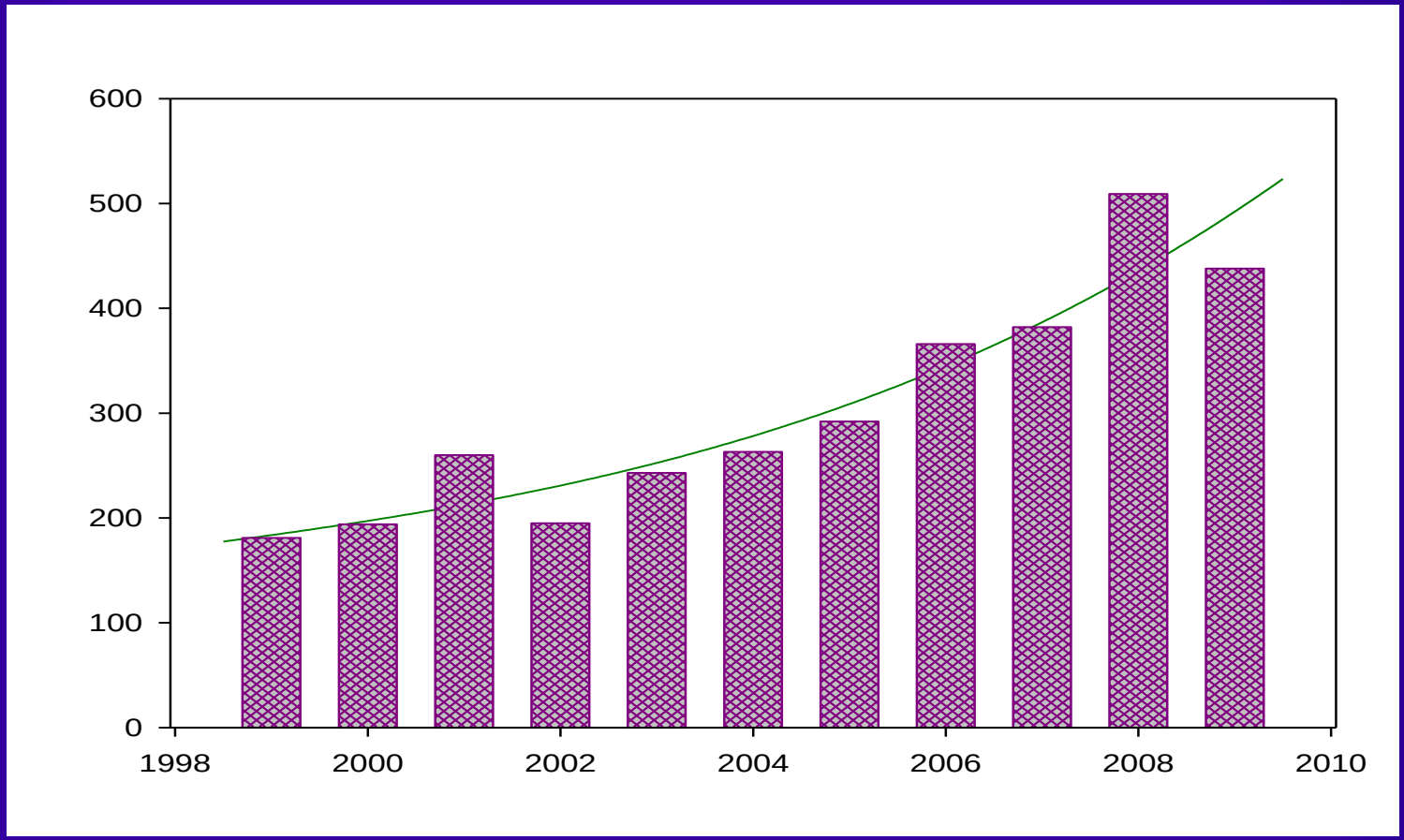
N Management for Cotton in TN

- **Application Rate:**
  - 30-60 lb N/acre on bottom soils
  - 60-80 lb N/acre on upland soils
- **Application Timing:**
  - Preplanting or at planting
- **Application Scale:**
  - Uniform-rate for the entire field
- **N Source:**
  - Ammonium nitrate

Ammonium Nitrate Price in U.S. (1999-2009)



Improvement in Cotton N Management in TN

- **Application Rate:**
  - Higher rate
  - Lower rate
- **Application Timing:**
  - In-season application
- **Application Scale:**
  - Variable-rate within a field
- **N Source:**
  - Fluid N fertilizer

Objectives

- ✓ Determine the optimal N application rates for high-yielding cotton production systems in Tennessee.
- ✓ Assess the spatial variations in lint yield, normalized difference vegetation index (NDVI), leaf N concentration, and soil nitrate within a field.
- ✓ Examine the relationships between lint yield and NDVI and between crop N nutrition and NDVI.
- ✓ Develop algorithms for in-season variable-rate application of fluid N fertilizer, and compare variable-rate N application with uniform-rate N application in terms of N consumption and lint yield.

Experimental Design

- **Location:** Gibson
- **Duration:** 2009-2011
- **Pre plant N:** 40 lb N/a
- **Side dress N:** 0, 40, 80, 120, 160 lb N/a
- **Strip plot:** *40’ × 800’*
- **Design:** Randomized complete block (RCB)
- **Replicate:** 3
- **Sub-plot:** *40’ × 100’*

Sampling and Measurements

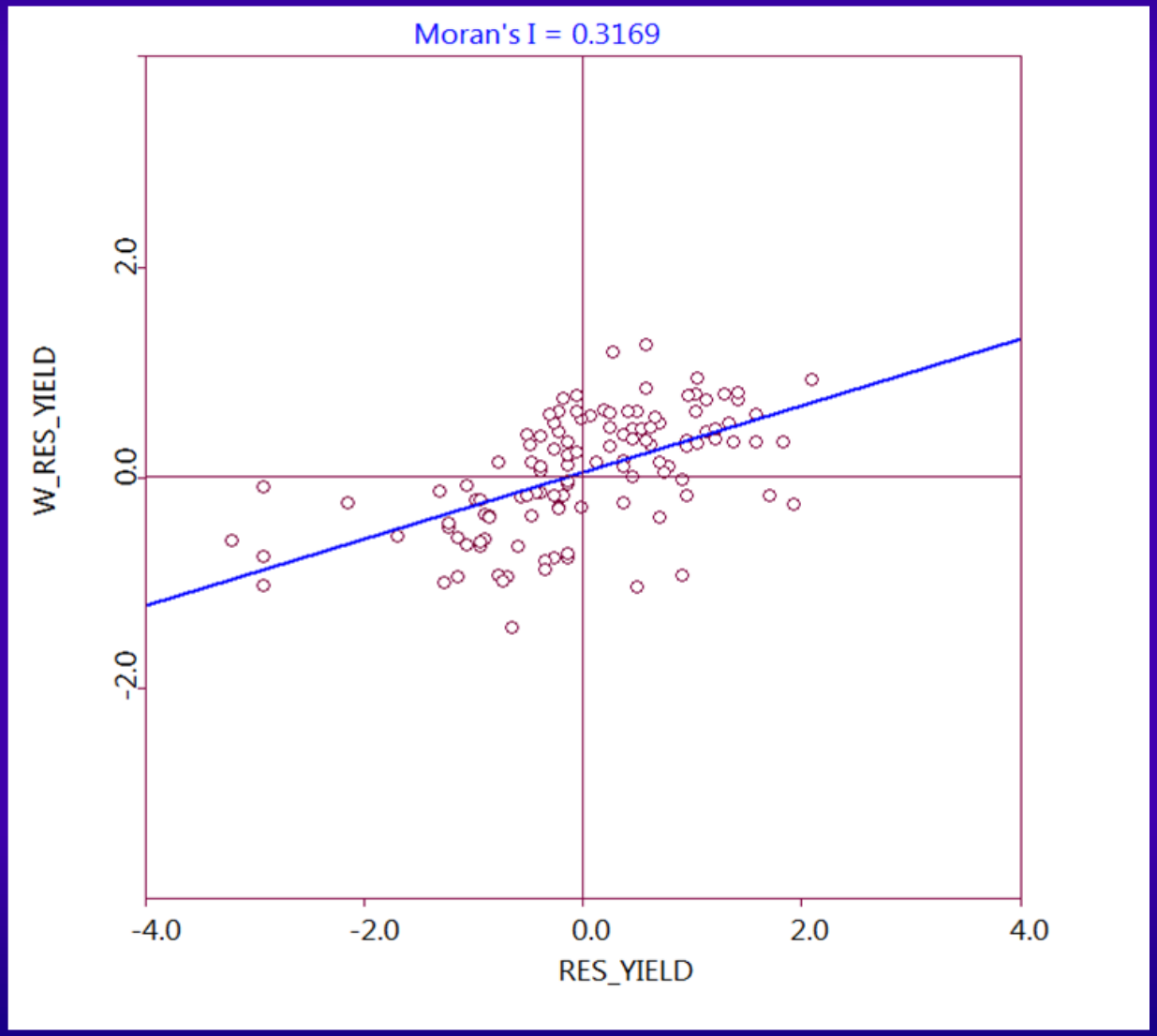
- Soil nitrate before cotton planting
- NDVI readings (early square, early, mid, & late bloom)
- Leaf N concentrations (early square, early, mid, & late bloom)
- Lint yield at harvest using a picker equipped with an automatic yield monitor
- Soil nitrate after cotton harvest
- Relationships among lint yield, NDVI, leaf N, & soil N

GreenSeeker RT 200 NDVI Mapping System

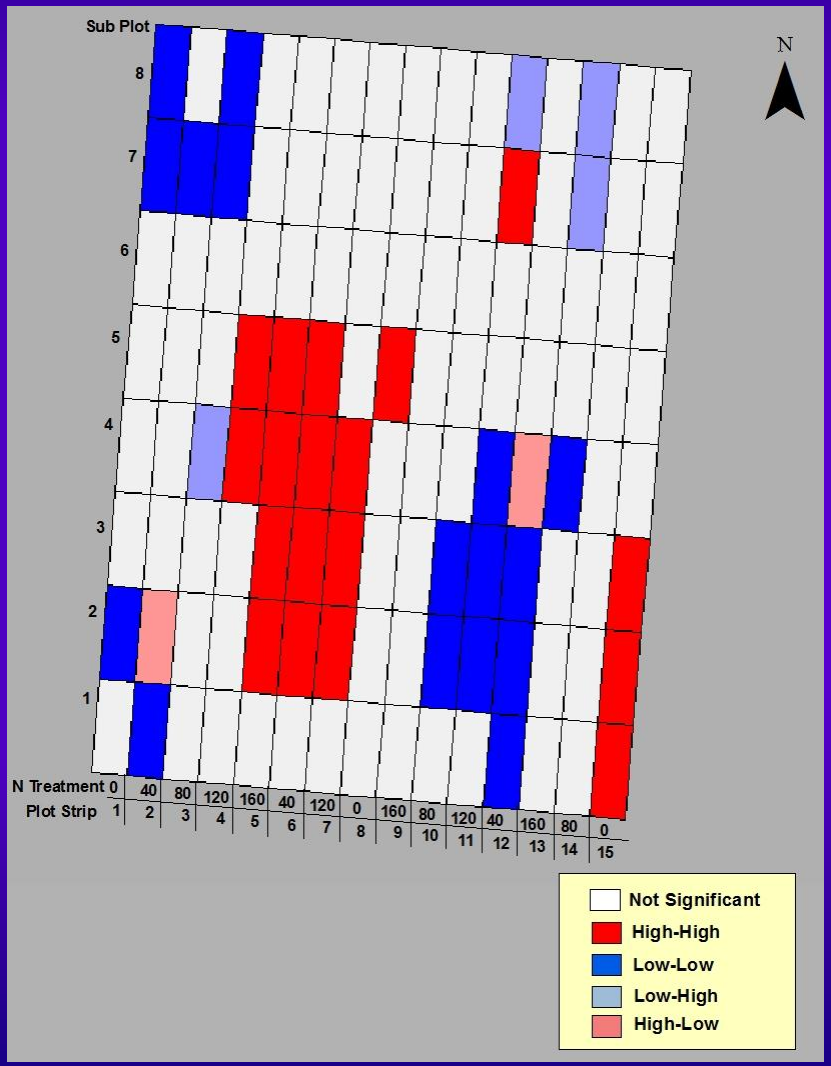
Coefficient of Variation (%) in NDVI, Leaf N, Yield, and Soil N within Each Strip Plot

Strip plot	N rate	NDVI 7-5-11	NDVI 7-27-11	NDVI 8-4-11	NDVI 8-17-11	Leaf N 7-5-11	Leaf N 7-27-11	Leaf N 8-4-11	Leaf N 8-17-11	Yield	Post-harvest soil N
1	0	19.2	10.1	11.3	9.3	8.3	13.1	14.8	18.1	5.6	79.7
2	40	10.3	7.5	5.6	3.6	5.4	8.2	16.3	11.3	23.2	37.5
3	80	4.3	4.2	3.2	2.7	5.3	7.0	7.5	5.1	17.5	34.9
4	120	6.1	7.0	1.5	1.0	7.5	4.7	6.7	6.4	13.7	58.7
5	160	2.8	2.2	1.7	1.4	2.4	5.8	4.3	3.3	9.6	60.3
6	40	5.8	8.6	2.9	2.1	4.3	3.8	3.7	6.6	29.3	51.1
7	120	18.0	13.8	6.8	5.3	6.3	3.1	3.1	5.7	27.0	49.9
8	0	6.1	5.1	2.4	1.2	5.6	6.1	7.7	8.7	19.5	59.8
9	160	5.1	4.0	3.0	1.9	3.9	5.5	3.0	4.5	20.1	103.2
10	80	4.4	19.7	2.2	1.9	3.2	9.2	2.2	4.7	20.3	53.9
11	120	1.6	3.4	3.0	1.9	3.2	8.6	3.9	3.9	13.4	79.3
12	40	3.8	3.9	2.8	2.3	4.4	10.5	2.6	8.3	36.3	59.2
13	160	2.1	1.8	1.5	1.3	4.5	4.8	3.6	4.9	24.0	40.8
14	80	3.4	4.9	1.0	1.0	2.9	3.5	4.2	5.0	19.0	72.8
15	0	7.6	5.4	2.9	3.0	4.0	7.0	3.9	9.4	9.1	22.0

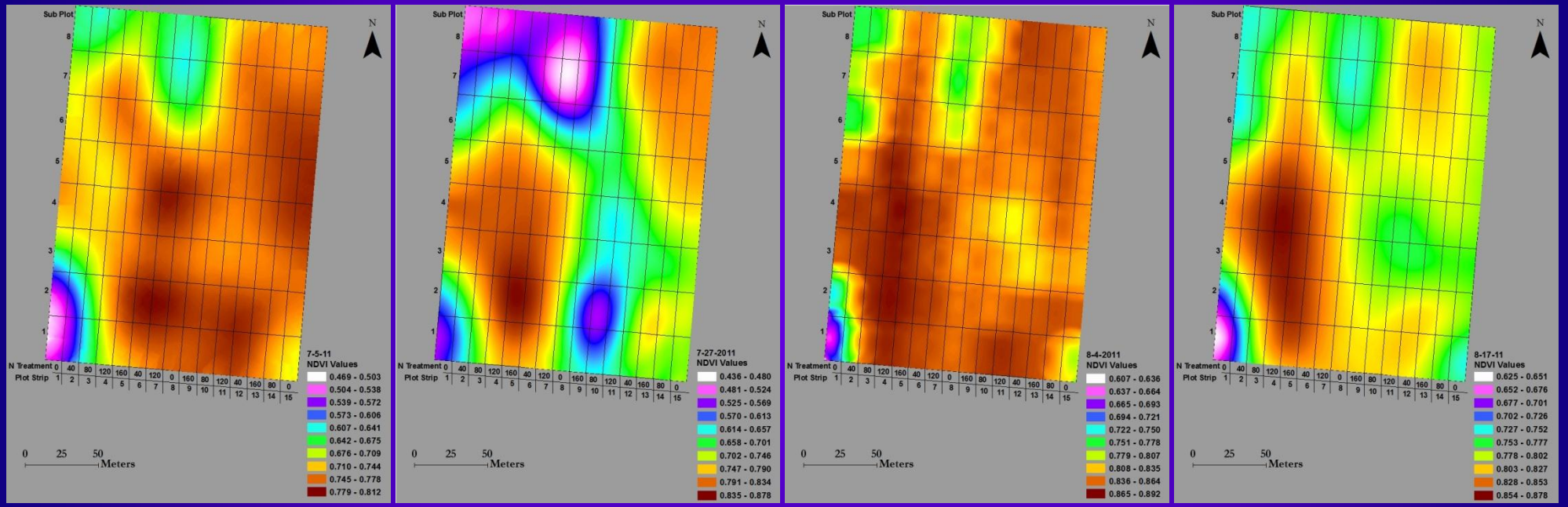
Moran’s I and Scatter Plot of Residual Yields



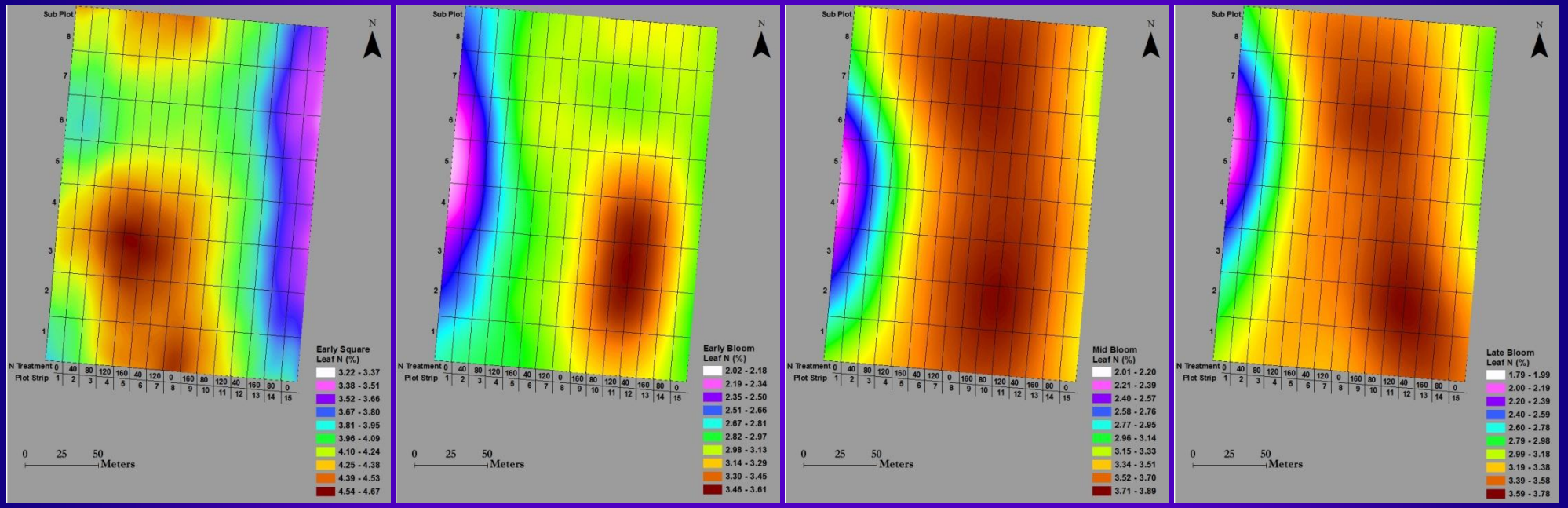
LISA Cluster Map of Residual Yields



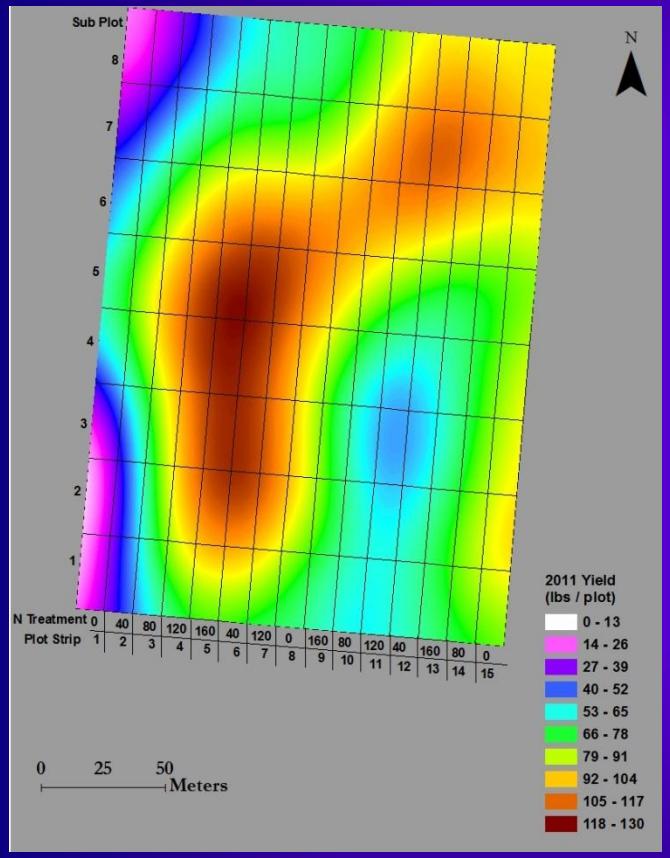
Canopy NDVI Maps

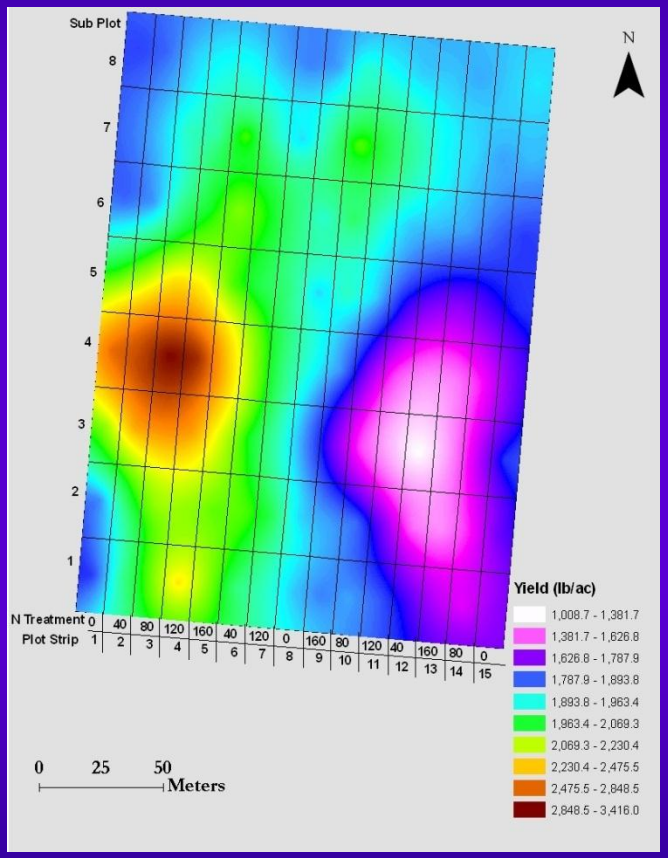


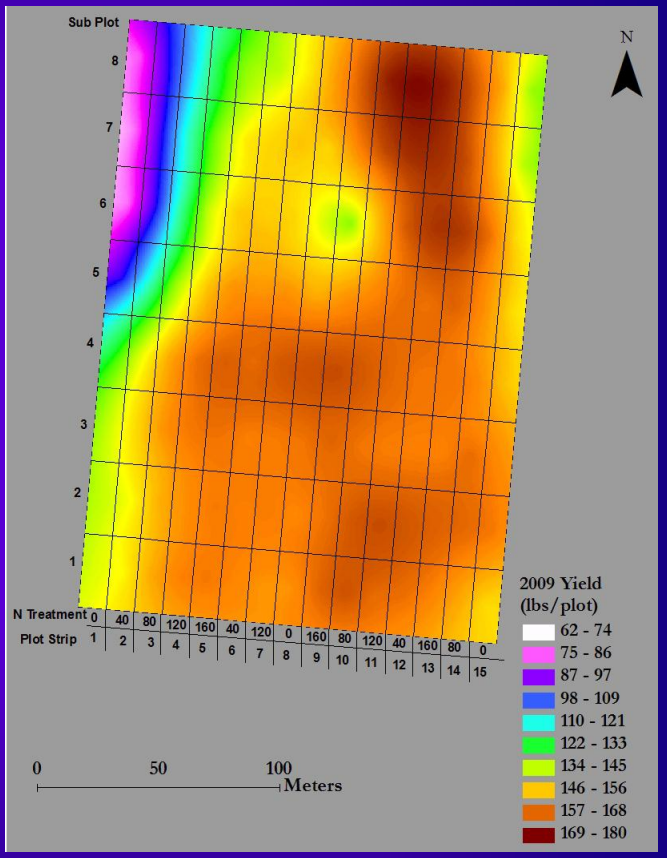
Leaf N Maps


Sub Plot
N
N Treatment 0 40 80 120 160 40 120 0 160 80 120 40 160 80 0
Plot Strip 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
0 25 50
Meters
Early Square Leaf N (%)
3.22 - 3.37
3.38 - 3.51
3.52 - 3.66
3.67 - 3.80
3.81 - 3.95
3.96 - 4.09
4.10 - 4.24
4.25 - 4.38
4.39 - 4.53
4.54 - 4.67
Early Bloom Leaf N (%)
2.02 - 2.18
2.19 - 2.34
2.35 - 2.50
2.51 - 2.66
2.67 - 2.81
2.82 - 2.97
2.98 - 3.13
3.14 - 3.29
3.30 - 3.45
3.46 - 3.61
Mid Bloom Leaf N (%)
2.01 - 2.20
2.21 - 2.39
2.40 - 2.57
2.58 - 2.76
2.77 - 2.95
2.96 - 3.14
3.15 - 3.33
3.34 - 3.51
3.52 - 3.70
3.71 - 3.89
Late Bloom Leaf N (%)
1.79 - 1.99
2.00 - 2.19
2.20 - 2.39
2.40 - 2.59
2.60 - 2.78
2.79 - 2.98
2.99 - 3.18
3.19 - 3.38
3.39 - 3.58
3.59 - 3.78

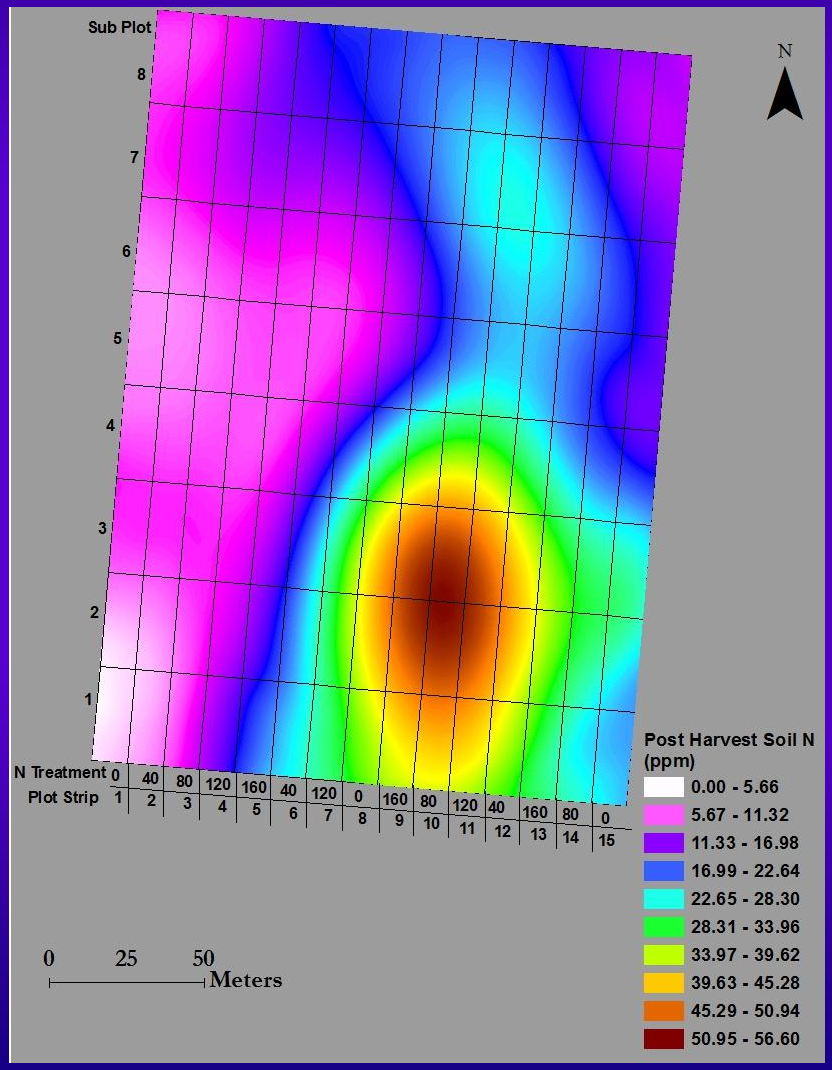
Lint Yield Maps







Post-Harvest Soil N (Nitrate + Ammonium) Map



Correlations of Yields with NDVI

Dependent variable	Independent variable	R^2	Significance
Lint yield	NDVI_7-20-09	0.28	**
Lint yield	NDVI_8-04-09	0.43	*
Lint yield	NDVI_8-24-09	0.51	**
Lint yield	NDVI_6-23-10	0.02	ns
Lint yield	NDVI_7-20-10	0.25	**
Lint yield	NDVI_8-03-10	0.14	**
Lint yield	NDVI_8-16-10	0.16	**
Lint yield	NDVI_7-05-11	0.13	**
Lint yield	NDVI_7-27-11	0.18	**
Lint yield	NDVI_8-04-11	0.29	**
Lint yield	NDVI_8-17-11	0.26	**

Correlations of Leaf N Conc. with NDVI

Dependent variable	Independent variable	R^2	P
Leaf N_7-20-09	NDVI_7-20-09	0.19	**
Leaf N_8-04-09	NDVI_8-04-09	0.36	**
Leaf N_8-24-09	NDVI_8-24-09	0.11	**
Leaf N_6-23-10	NDVI_6-23-10	0.02	ns
Leaf N_7-15-10	NDVI_7-20-10	0.01	ns
Leaf N_8-02-10	NDVI_8-03-10	0.01	ns
Leaf N_8-16-10	NDVI_8-16-10	0.02	ns
Leaf N_7-05-11	NDVI_7-05-11	0.01	ns
Leaf N_7-27-11	NDVI_7-27-11	0.00	ns
Leaf N_8-04-11	NDVI_8-04-11	0.05	*
Leaf N_8-17-11	NDVI_8-17-11	0.08	**

Summary

- ✓ Significant global spatial autocorrelation of *residual yields within the test field based on Moran's* I statistic.
- ✓ The LISA cluster map shows that there are some significant local clusters of residual yields within the test field.
- ✓ Significant but weak correlations of lint yield with canopy NDVI at early square and early, mid, and late bloom stages.
- ✓ Canopy NDVI is not a strong indicator of plant N nutrition during early square to late bloom.

Acknowledgments

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Thanks!!!

Questions???