REFLECTANCE SENSORS TO PREDICT MID-SEASON NITROGEN NEED OF COTTON

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Cotton and nitrogen

- Under-application of N limits yield
- Over-application of N can result in excess vegetative growth
  - Delayed maturity (reduced quality, price)
  - Increased need for growth regulator, defoliant, and insecticide
  - Also the money spent on N is wasted

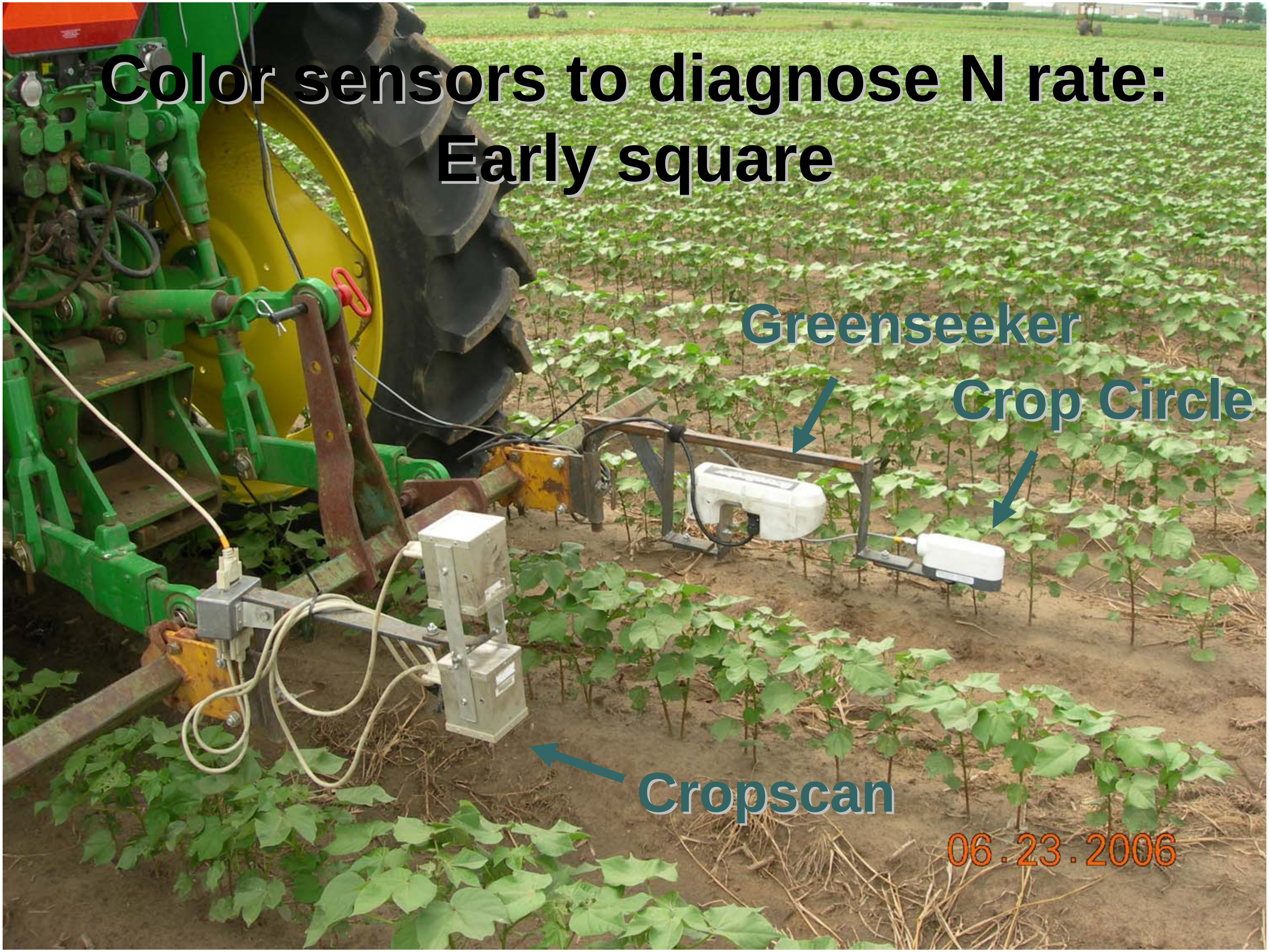
Objective

- Calibrate canopy reflectance sensors to predict the amount of N fertilizer needed by a cotton crop

Methods

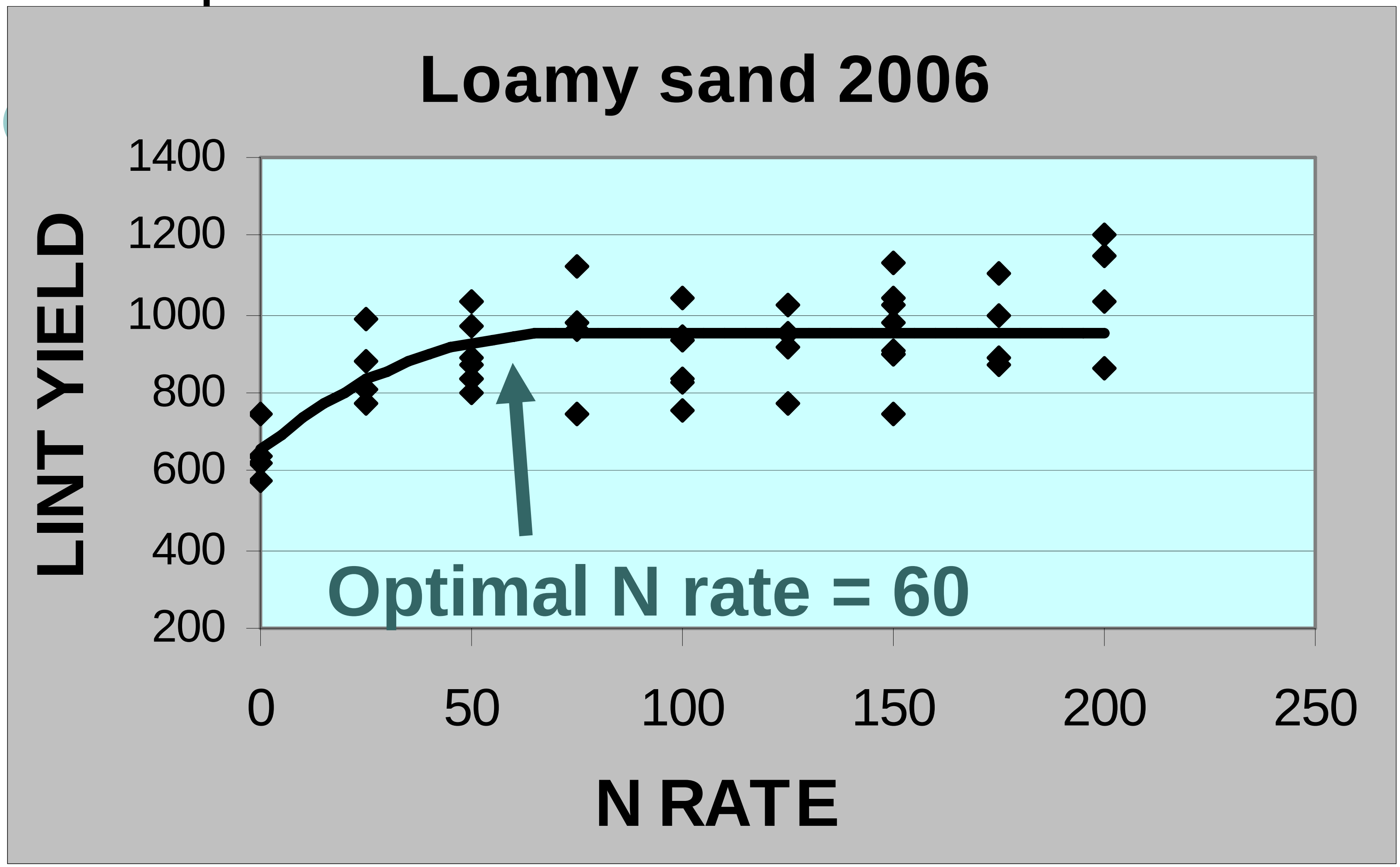
- Six N rate experiments
  - 3 in 2006, 3 in 2007
  - Loamy sand, silt loam, clay each year
- Three sensor types (Greenseeker, Crop Circle, and Cropscan)
- Three stages (early square, mid square, and first bloom)
- Three heights above the canopy (10, 20, and 40 inches).

Color sensors to diagnose N rate: Early square



RESULTS

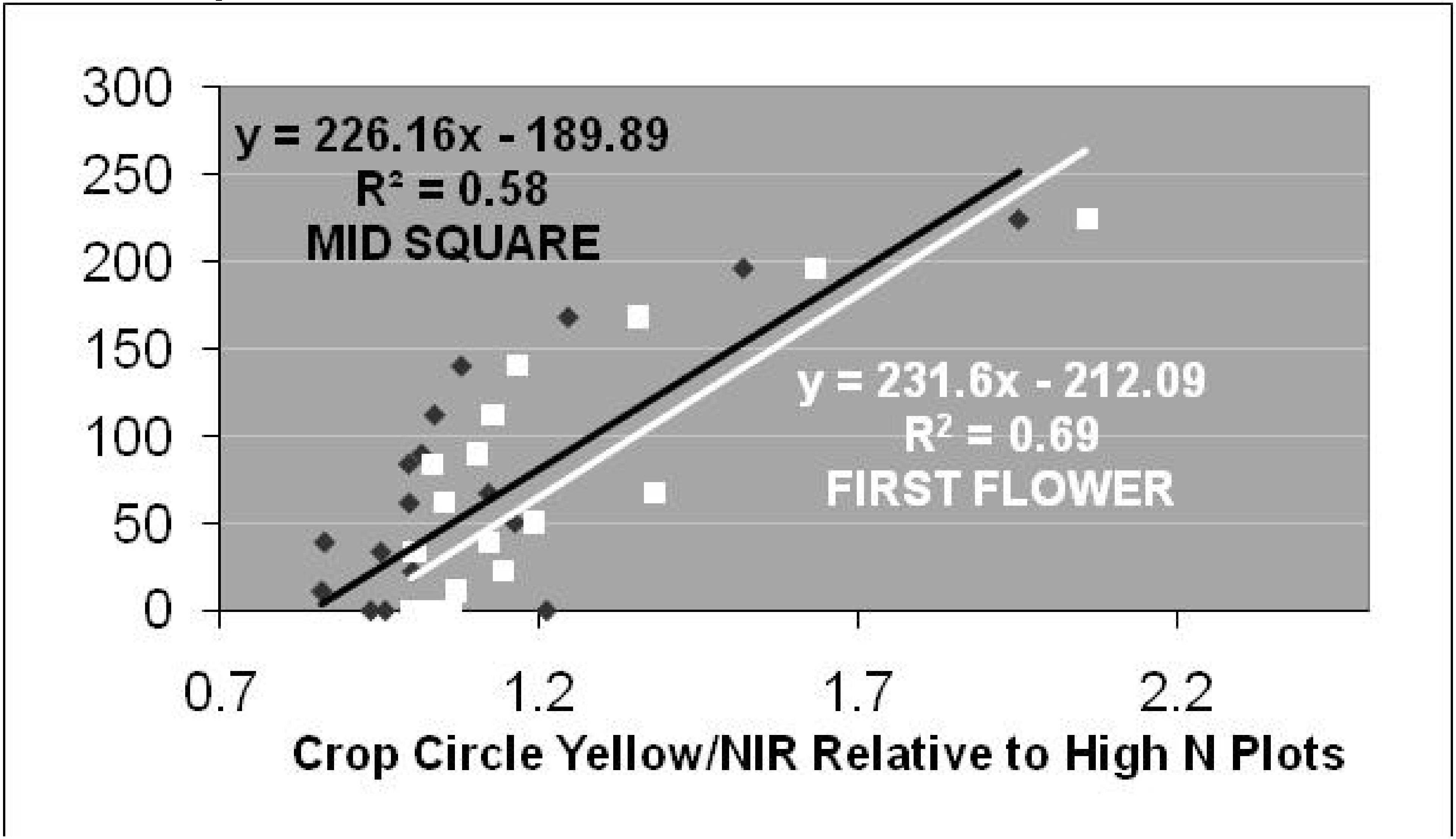
Results: optimal N rates



Optimal N rates

Year	Soil texture	Optimal N rate
2006	Clay	200
2006	Loamy sand	60
2006	Silt loam	0
2007	Clay	175
2007	Loamy sand	45
2007	Silt loam	80

Predicting optimal N rates from sensor measurements



GROWTH STAGE

- Early square readings:
  - Correlations generally low ($R^2<0.50$).
  - The effect of N status on reflectance is more obvious later in the season.

- Mid square + early flower readings:
  - Strong relationships to Optimal N rate.
  - Mid square: 18 variables predicted N rate with an $R^2>0.50$.
  - Early flower: 28 variables had $R^2>0.50$.

Regression analysis, sensor vs. optimal N rate

- 20 inch height worked best
- Equations for mid-square and first flower were not different
- NDVI and Vis/NIR worked equally well

DIURNAL VARIATION OF REFLECTANCE MEASUREMENTS

Objectives

(I). Quantify variability during the day for passive and active sensors

(II). Assess variability impact on diagnosing N need

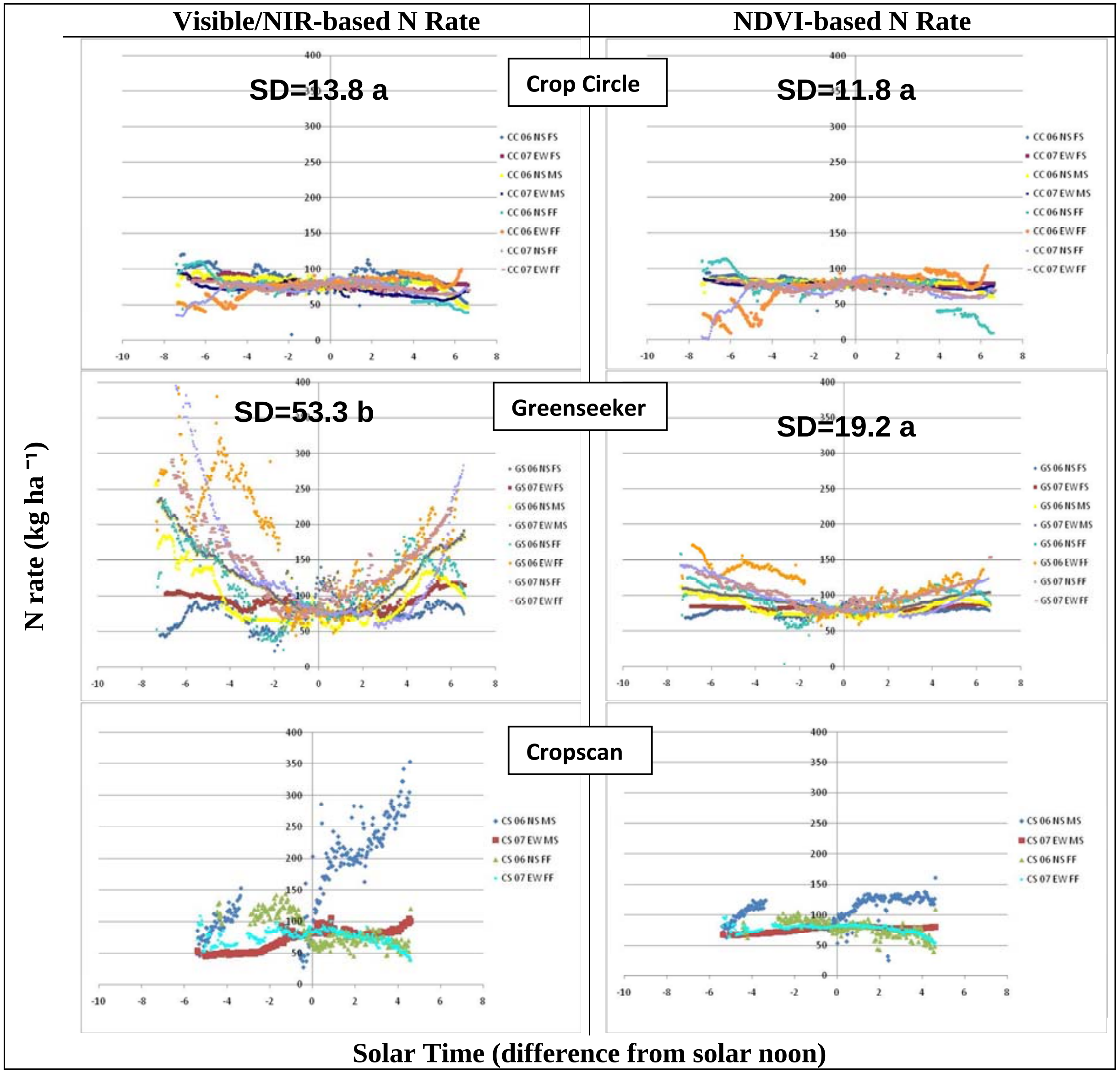
(III). Correction equation

METHODS;LIKE THIS BUT WITH COTTON

RESULTS

Sensor-base N rate;

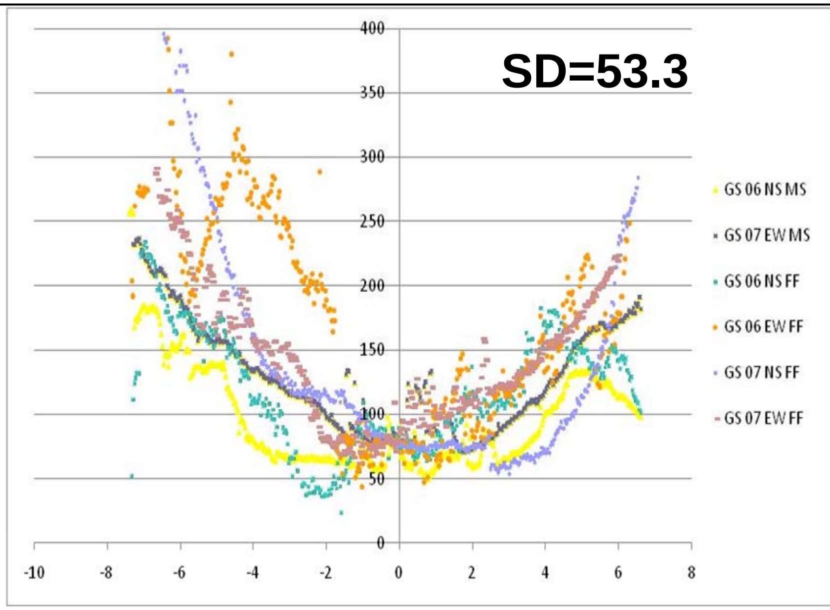
lots of variability



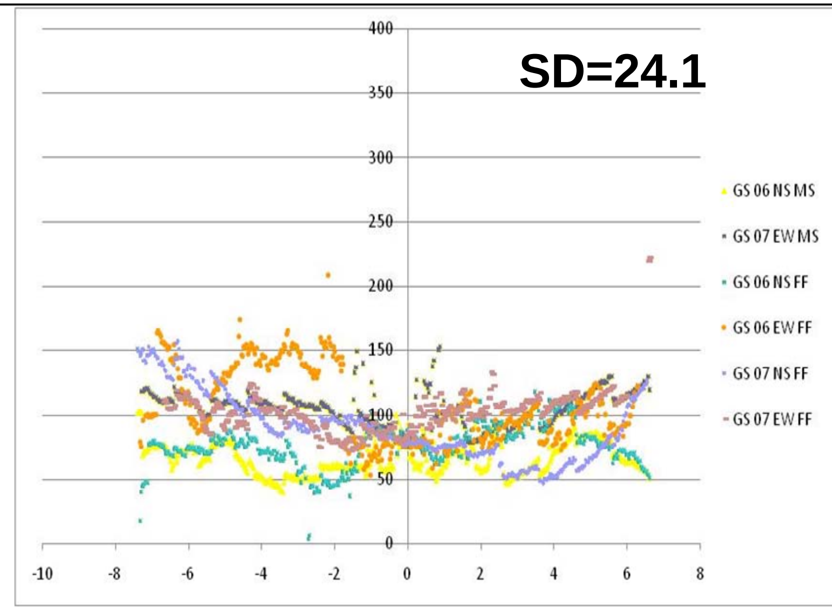
Equation using solar time, temperature, and solar radiation improved Greenseeker

N rate (kg ha⁻¹)

Visible/NIR-based N Rate Before Correction



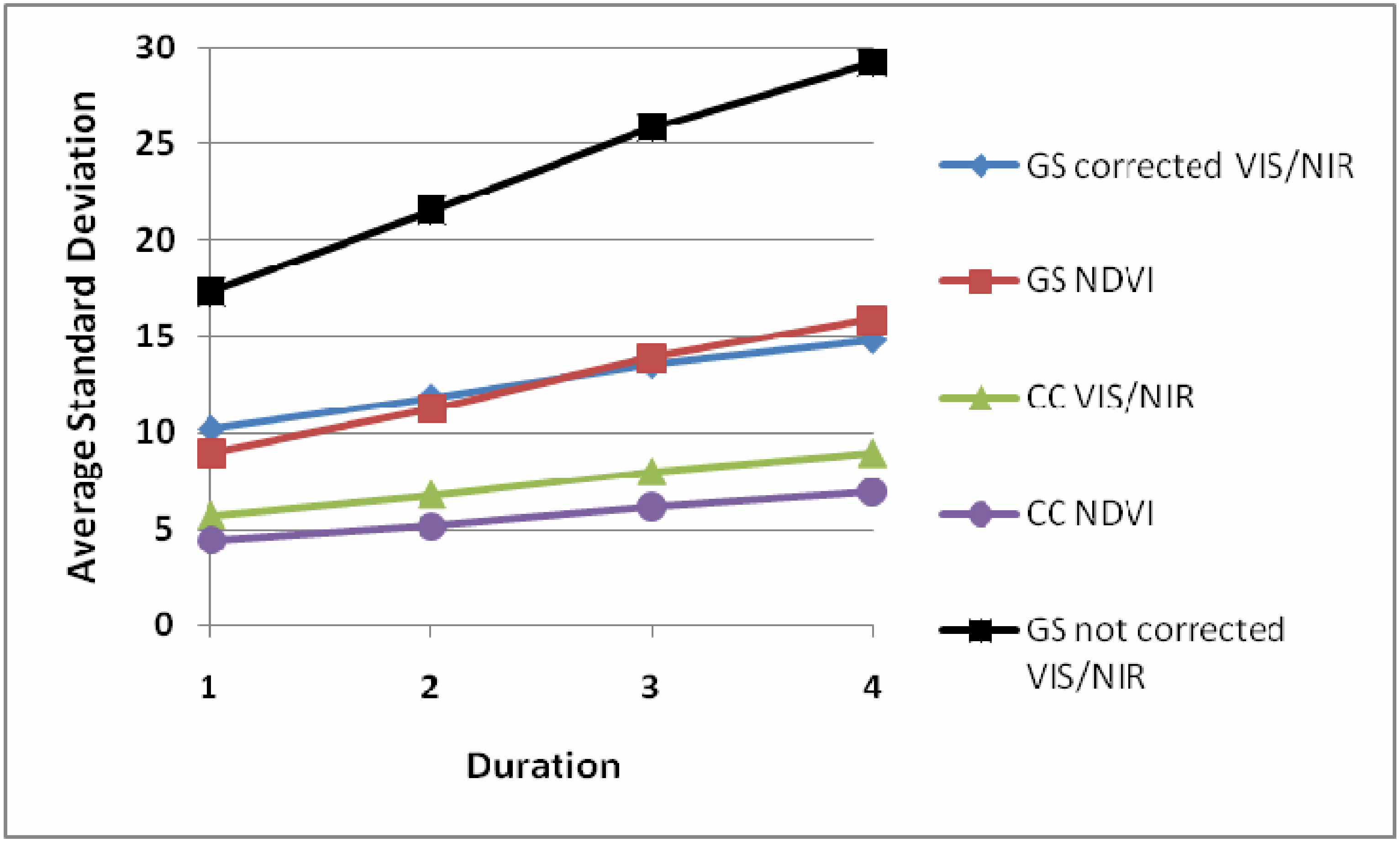
Visible/NIR-based N Rate After Correction



Solar Time (difference from solar noon)

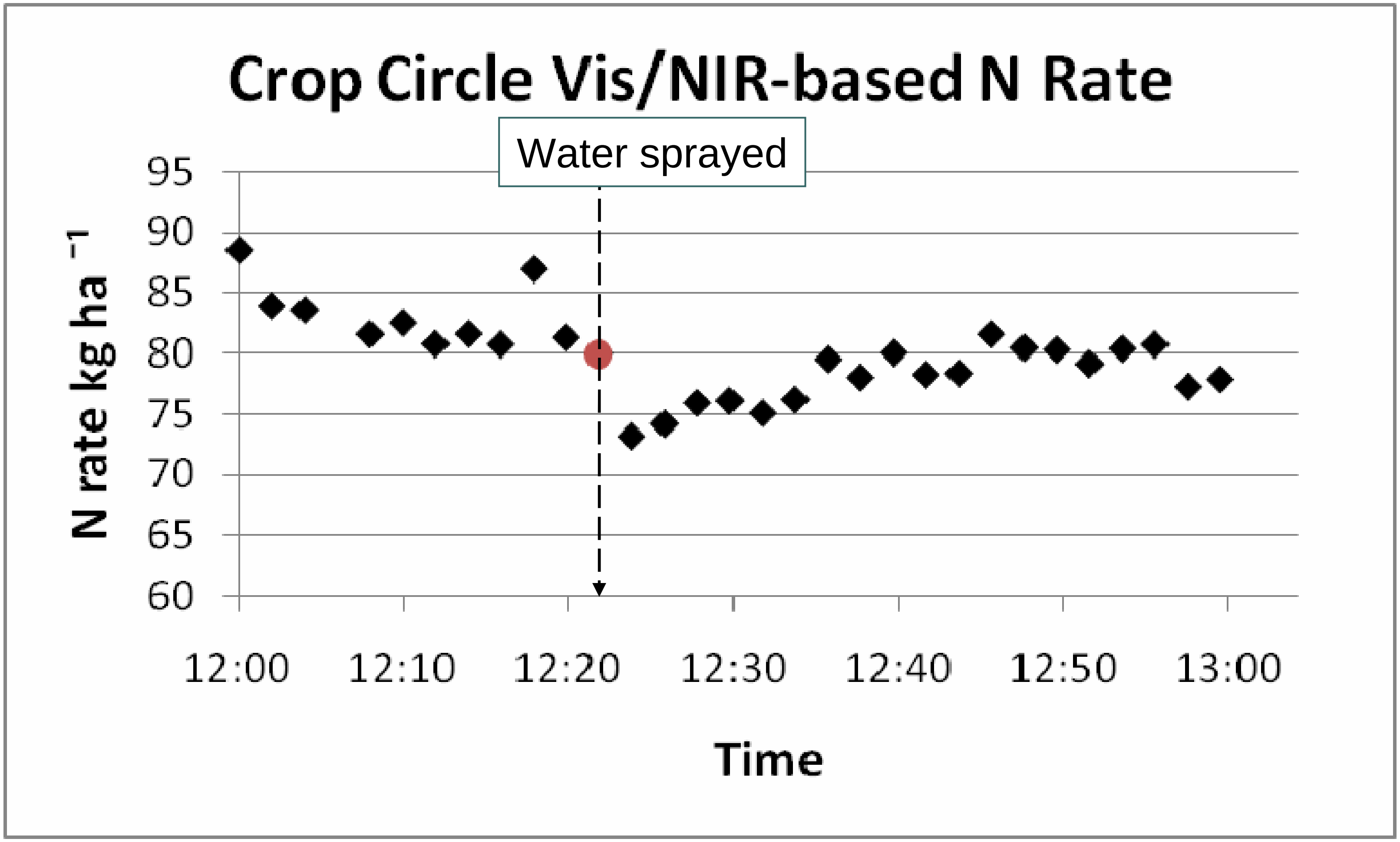
Longer duration = more error

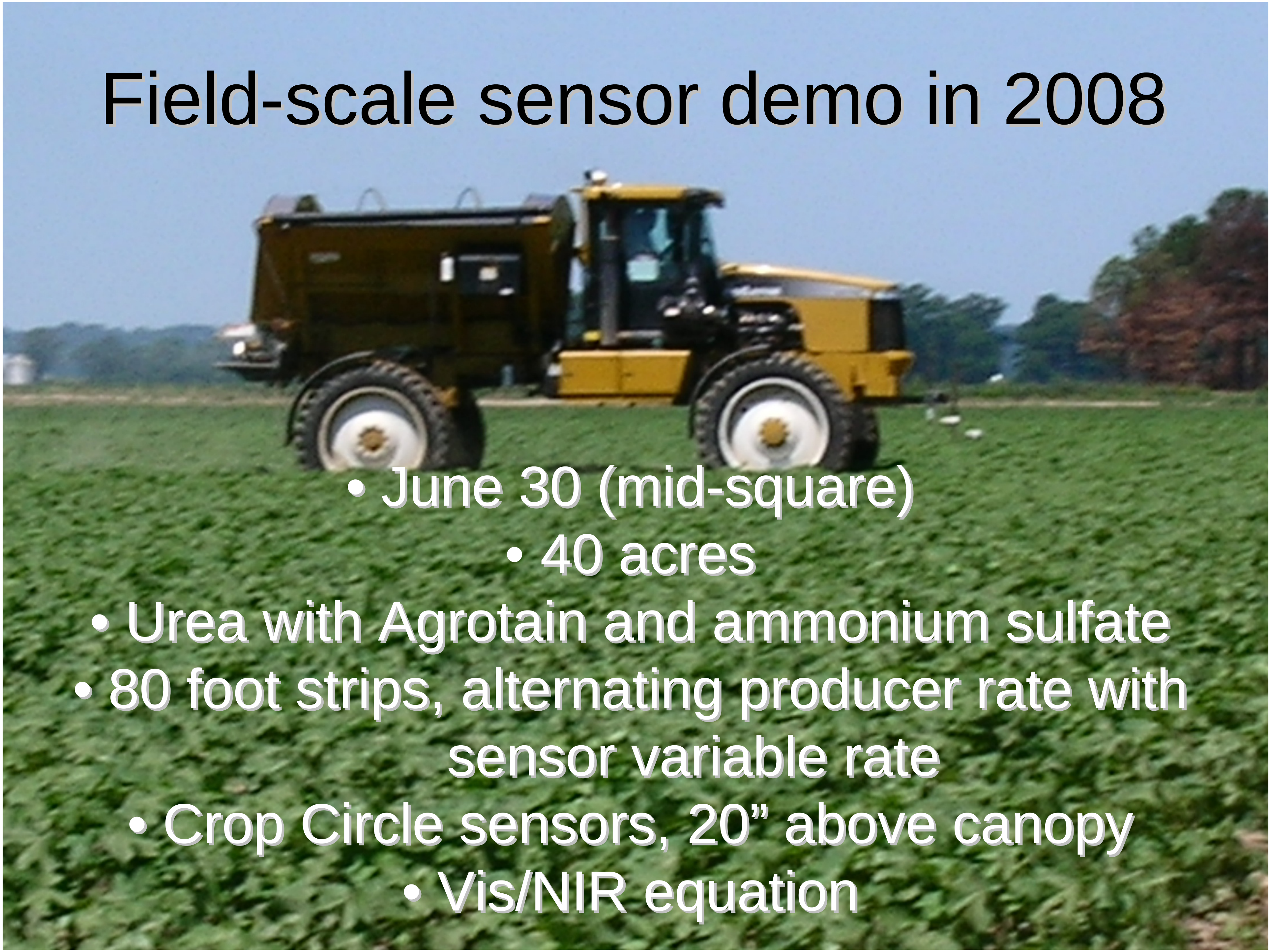
(How long can you go before re-checking the high-N area?)



Water Effect on N rate

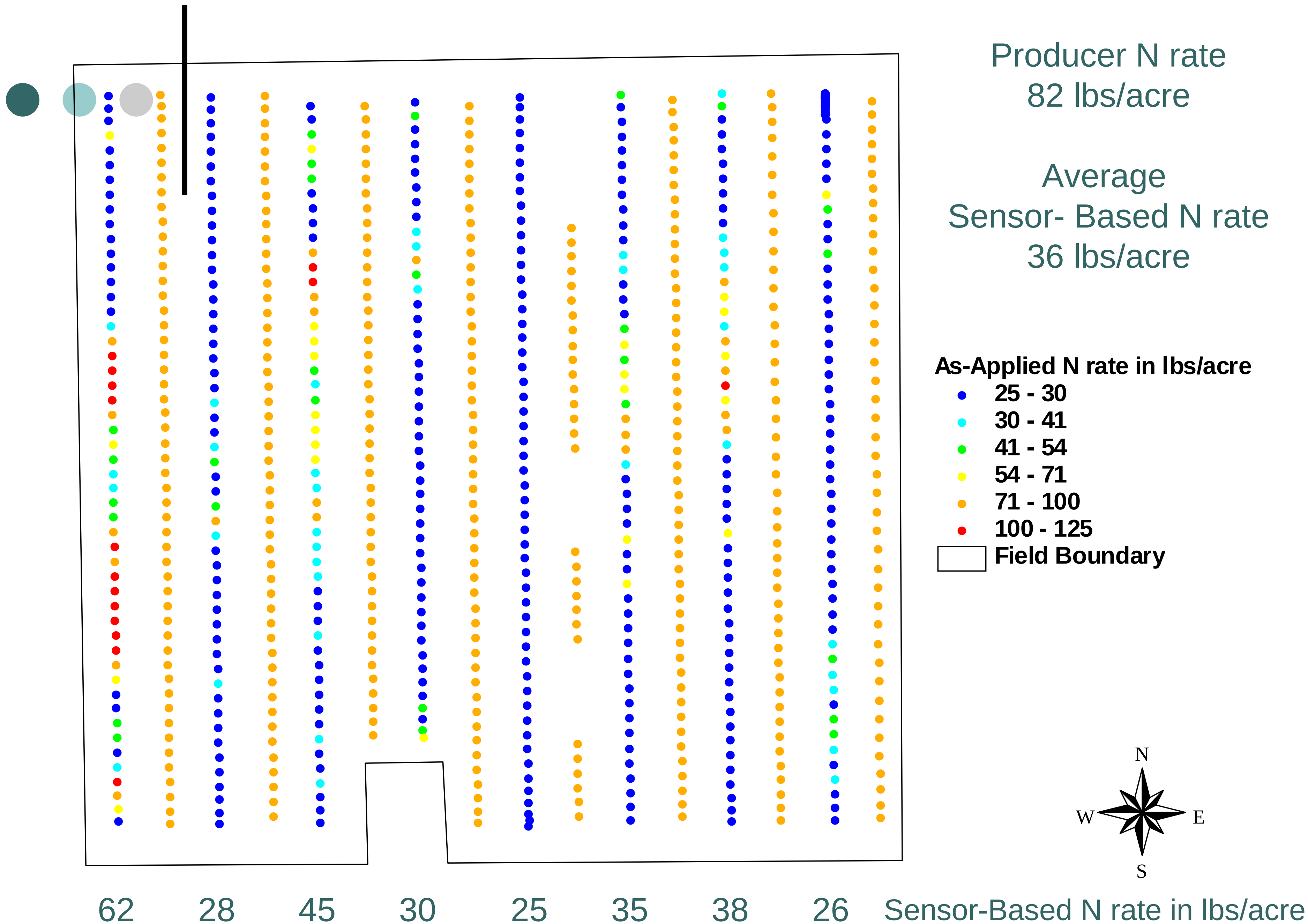
(active sensors)





Field-scale sensor demo in 2008

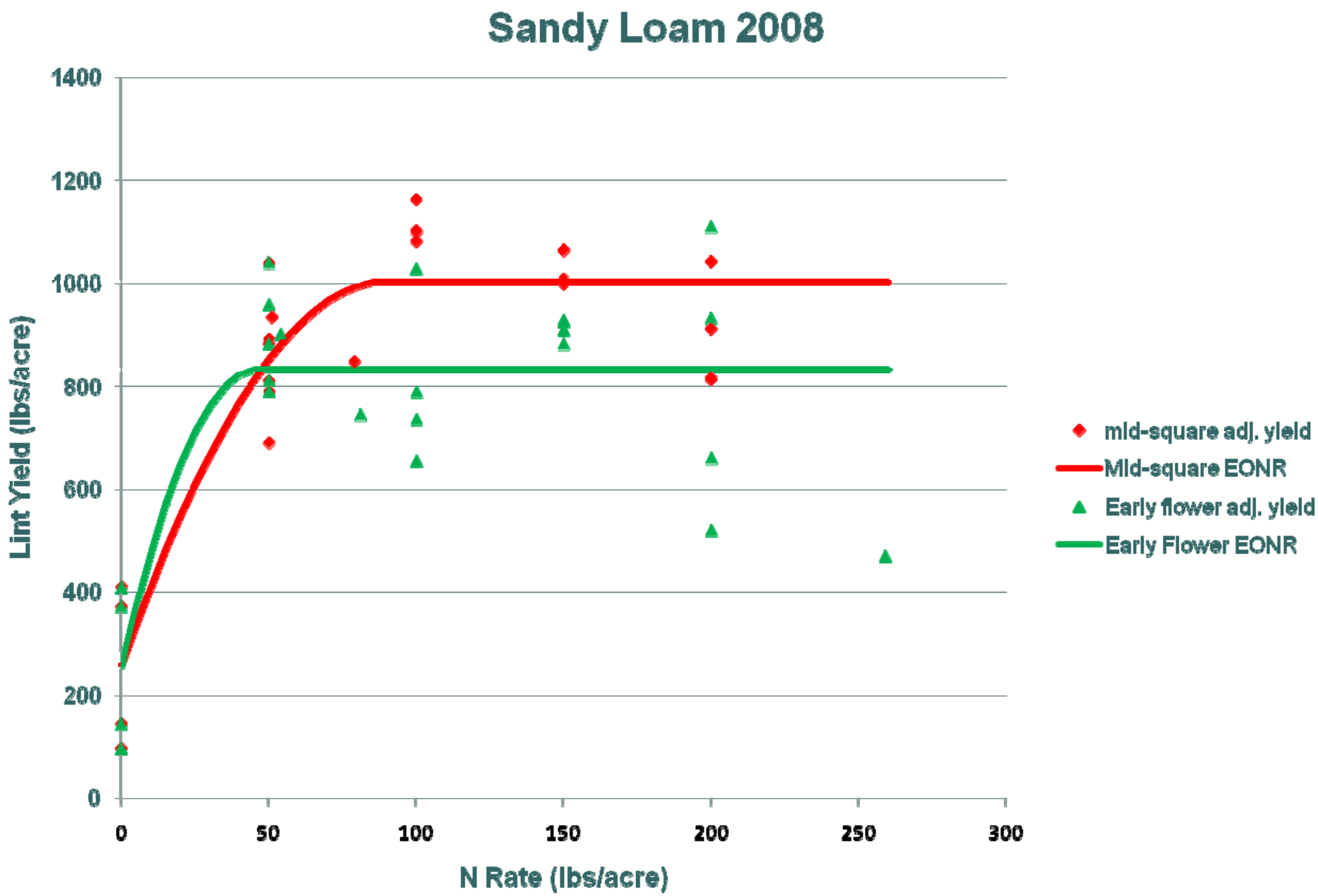
- June 30 (mid-square)
- 40 acres
- Urea with Agrotain and ammonium sulfate
- 80 foot strips, alternating producer rate with sensor variable rate
- Crop Circle sensors, 20” above canopy
- Vis/NIR equation


Producer N rate
82 lbs/acre
Average
Sensor- Based N rate
36 lbs/acre
As-Applied N rate in lbs/acre
25 - 30
30 - 41
41 - 54
54 - 71
71 - 100
100 - 125
Field Boundary
N
W
E
S
62
28
45
30
25
35
38
26
Sensor-Based N rate in lbs/acre


July 18 aerial photo
•Looking good!
•Sensors saved 45 lb N/acre
•Can't distinguish from producer rate strips

Sensor-based strips defoliated better

NEW RESEARCH QUESTION 2008:
N at mid-square or early flower OK?



CONCLUSION

- Reflectance sensor readings related well to optimum N rate.
  - Potential for accurate on-the-go prediction.
  - All three sensor types appear to be potentially useful.
  - Mid square or early flower seem to be the best stages for accurate sensor-based sidedressing.
  - 50 cm is the most reliable height.

CONCLUSION

- passive and active sensors had variability during the day
    1. greater error in sensor-based N recommendation
- Linear equation based on temperature, solar radiation, and solar time improved Greenseeker Vis/NIR and NDVI
- increasing the duration over which readings are taken =greater error for predicted N rate
- Spraying water resulted in lower N rates for active sensors and higher N rates for the passive sensor


Questions?