UNIVERSITY OF MINNESOTA

Driven to Discover℠

Institute for Ag Professionals

Proceedings of the

2010 Crop Pest Management Shortcourse &

Minnesota Crop Production Retailers Association Trade Show

www.extension.umn.edu/AgProfessionals

Do not reproduce or redistribute without the written consent of author(s).

IDC Management in Soybeans: Research from Large Plot Trials

Daniel Kaiser

CPM Short Course

December 11, 2010

Iron is needed to make chlorophyll in plants

- Iron in soil is insoluble.
  - The most soluble form is iron hydroxide, $Fe(OH)_3$
    - Low solubility
- Less soluble at high pH
- Especially insoluble in high lime ($CaCO_3$), high pH, soils.

Plants need to release chemicals from roots to get iron from the soil

- Strategy 1
  - Soybeans, azaleas, etc. release acids and chemical reductants.
    - Acid makes $Fe(OH)_3$ more soluble
    - Reductants change insoluble Fe(III) to soluble Fe(II)
- Strategy 2
  - Grasses and corn release iron chelators
    - These chemicals solubilize Fe(III)

Plants vary greatly in their ability to get Fe out of soil

- Azaleas and blueberries only survive in acid soils were $Fe(OH)_3$ is more soluble
  - They are chlorotic in soils with pH>5.5
- Soybeans, grapes, pin oak etc. are chlorotic only in high pH (alkaline) soils
  - Generally pH> 7.8.

High Lime Iron Deficiency Chlorosis in Strategy 1 Plants

- Has been the subject of much study
  Soybean, sunflower, dry bean, peanut, grapes, citrus, apple and peaches.
- Difference among varieties.
- Often not greatly affected by the value of the soil test iron.
- Related to lime content but the crop response is complicated.
  - High season to season variation in soybean IDC.

IDC Typically occurs in shallow depressions

- Generally worse in the rims where calcium carbonate was deposited.
- Carbonate deposits are due to the particular conditions that existed when much Minnesota was a wet prairie.
- Affected areas are localized.
- Moisture and Temperature also impact chlorosis

Management Options

- Decrease soil lime content
  - Not practical on a large scale
- Drain the soil
  - May work, but at this point we do not know
- Plant a tollerant variety
  - Best strategy to date
- Fertilize with iron
  - Inconsitant past results

Soybean grain yields – Oat Cover

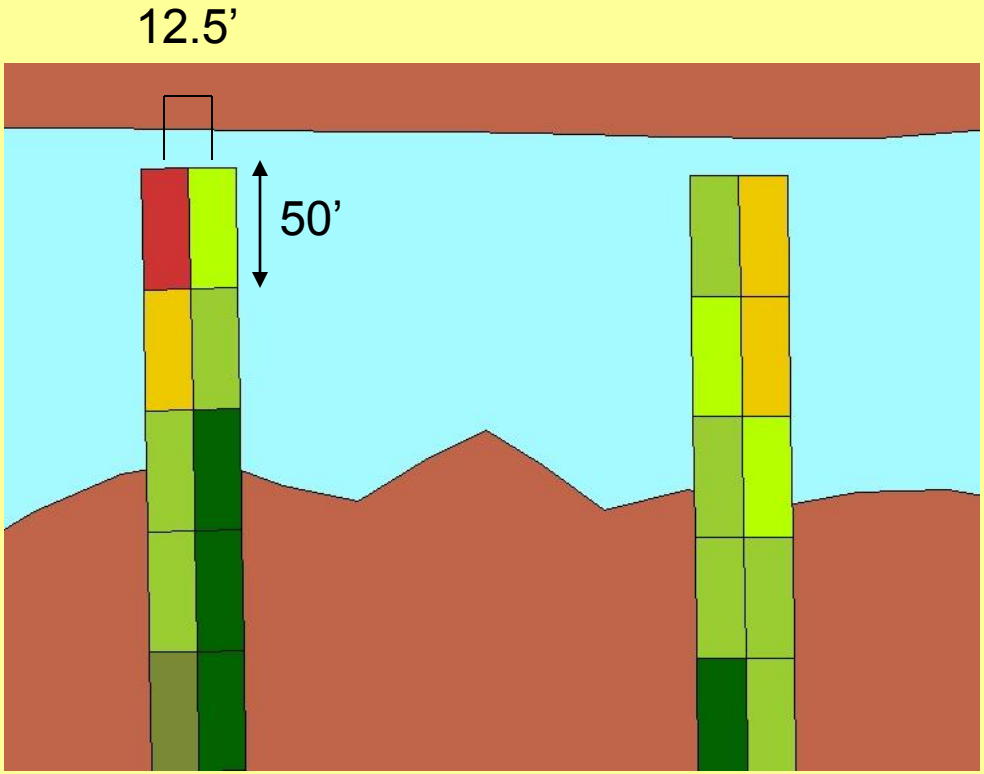
N Applied	Oats planted	C 06	YM 06	K 07	YM 07	C 08	R 08	C 09	R 09
lb/A		---------- bu/A ----------							
0	No	42.1	52.0	3.6	51.7	34.3	30.4	51.0	42.0
100	No	28.6	32.2	0.3	46.5	--	--	--	--
200	No	25.3	19.1	0.1	40.2	--	--	--	--
0	Yes	42.5	52.4	40.2	50.7	41.7	28.1	50.0	44.0
100	Yes	20.5	42.6	24.5	43.4	--	--	--	--
200	Yes	18.9	25.9	7.2	33.7	--	--	--	--

At all sites in 2006 and 2007, the addition of nitrogen fertilizer reduced soybean grain yields because of increased severity of IDC.
At four of the sites, YM06 and K07, the presence of a oat cover crop reduced the effects on soybean grain yield of elevated soil nitrogen. Yield was increased by the use of an oat cover at YM06, K07, C08, and R09.

Strip Trials

- Advantages – somewhat resembles a large scale small plot study over many field locations
  - Need to grid sample to determine soil test variability
- Disadvantages – soil variability can mask treatment differences
  - Statistics become “fuzzy” on analyzing data
  - One number per treatment strip is a more valid test, but does not answer the question on variability within a field

2009 Soygreen Strips



3 row harvest strips

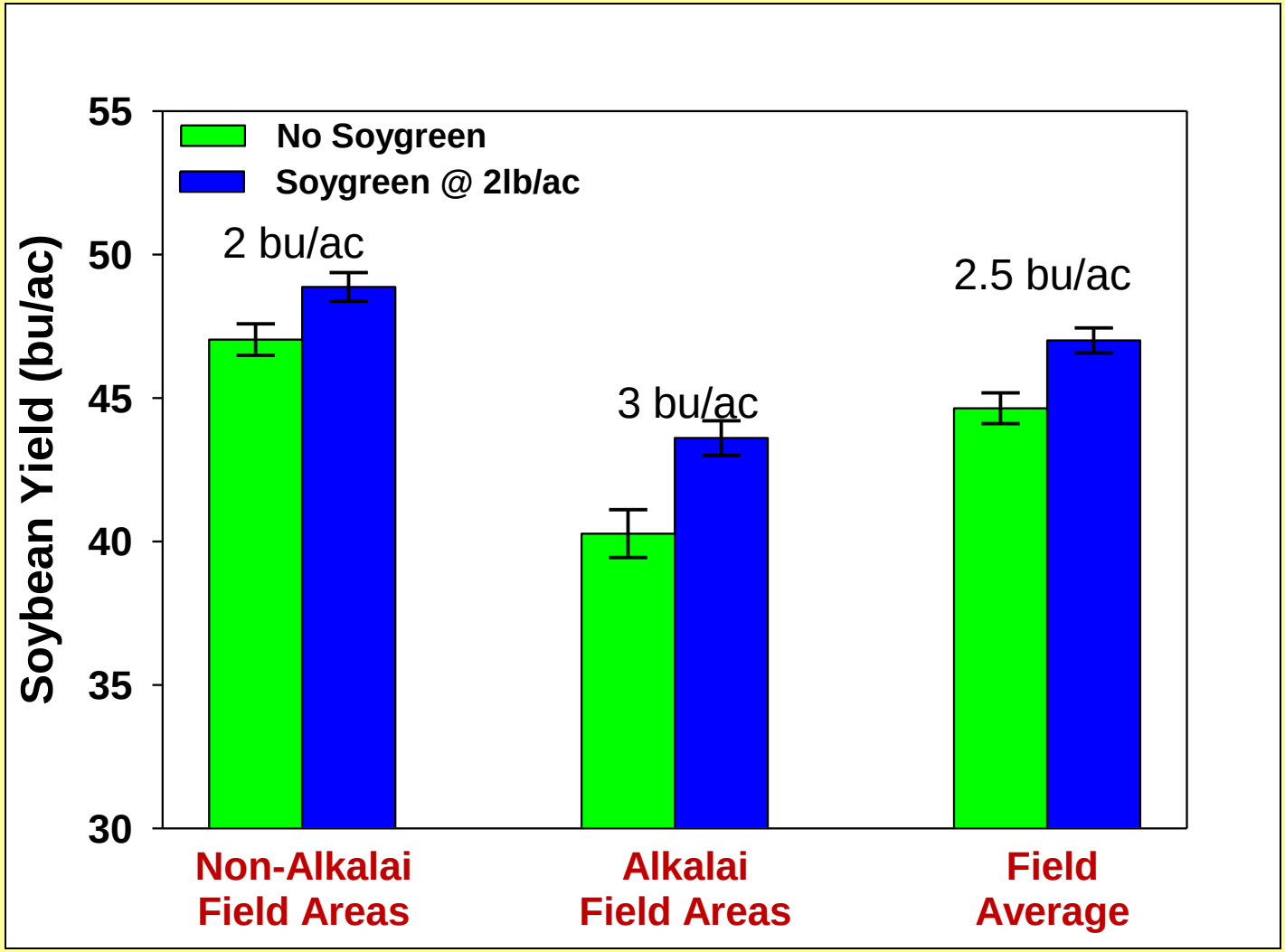
½ mile long

Study effects of soygreen within mapped field areas with High IDC

0 vs 2lbs of Soygreen In-furrow

3-30” row 50’ long harvest segments

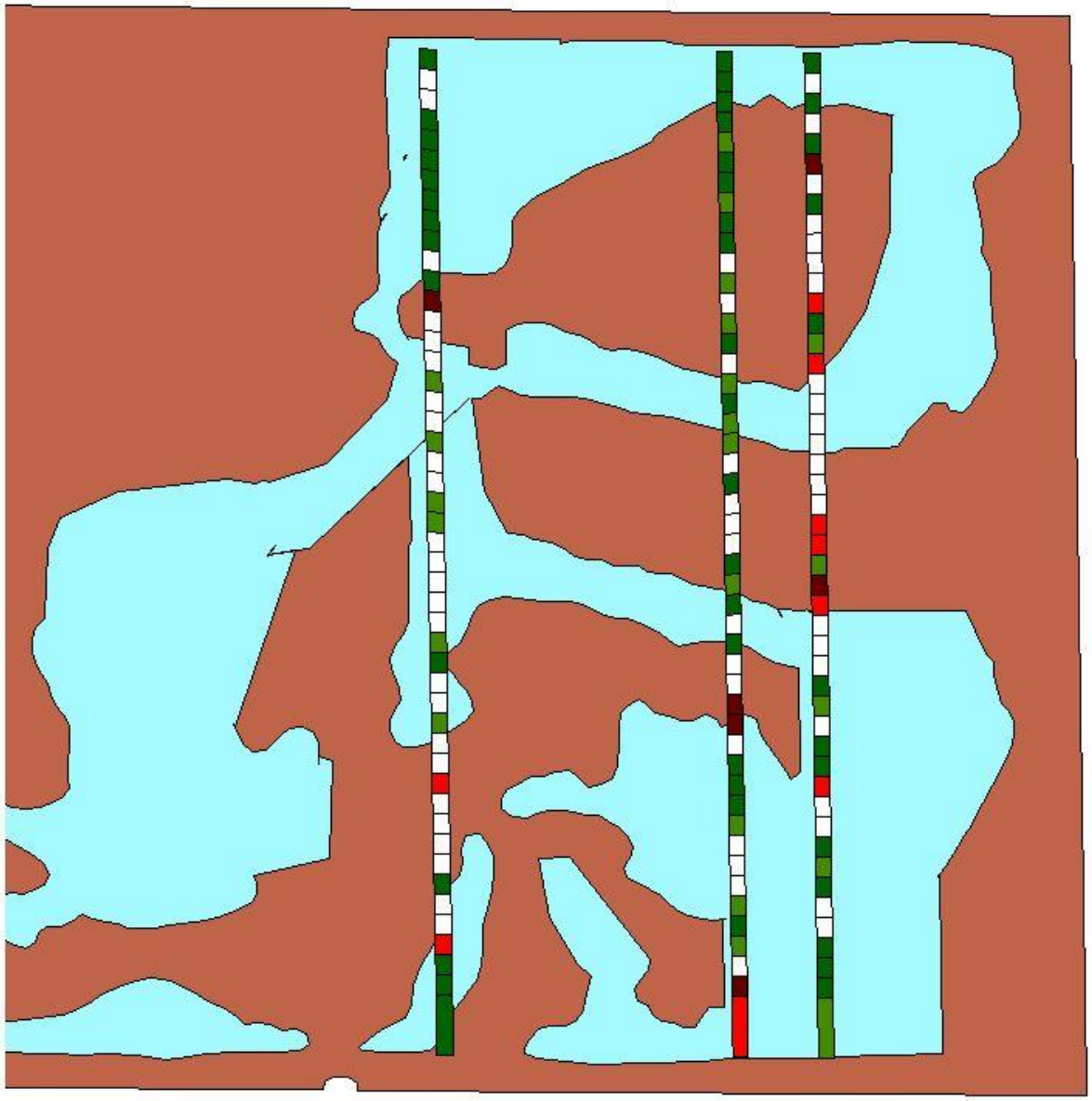
Field Area Averages



Statistics

	P>F
Field area	0.04
Soygreen	0.03
F.A. x Soygreen	0.11

Soygreen Yield Increase



- Simplistic View
- Blue areas are considered more responsive
- "Responses inside and outside of these areas

Yield Response
- Greatly Negative
- Slightly Negative
- No Response
- 2 to 4 bu/ac
- Greater than 4 bu/ac

Soygreen Rate (lb/ac)
- 0
- 2

Previous yield maps may not always work!

New Trials 2010 - Goals

- We did not have backing soil data for the 2009 study
  - Main focus was to take an initial look at variability
- Wanted to focus more on within site variability
- Focus more on management strategies that have worked in past small plots studies
- Put an additional focus on variety selection and the effect of different management strategies

Research Questions

- Did the oats perform as expected by extracting N out of the soil?
- Were there Oats a successful management tool?
- Did soygreen help with Fe uptake and Yields?
- Could EDDHA-Fe be used to maximize the yield potential of a less tolerant high yielding variety?

Locations

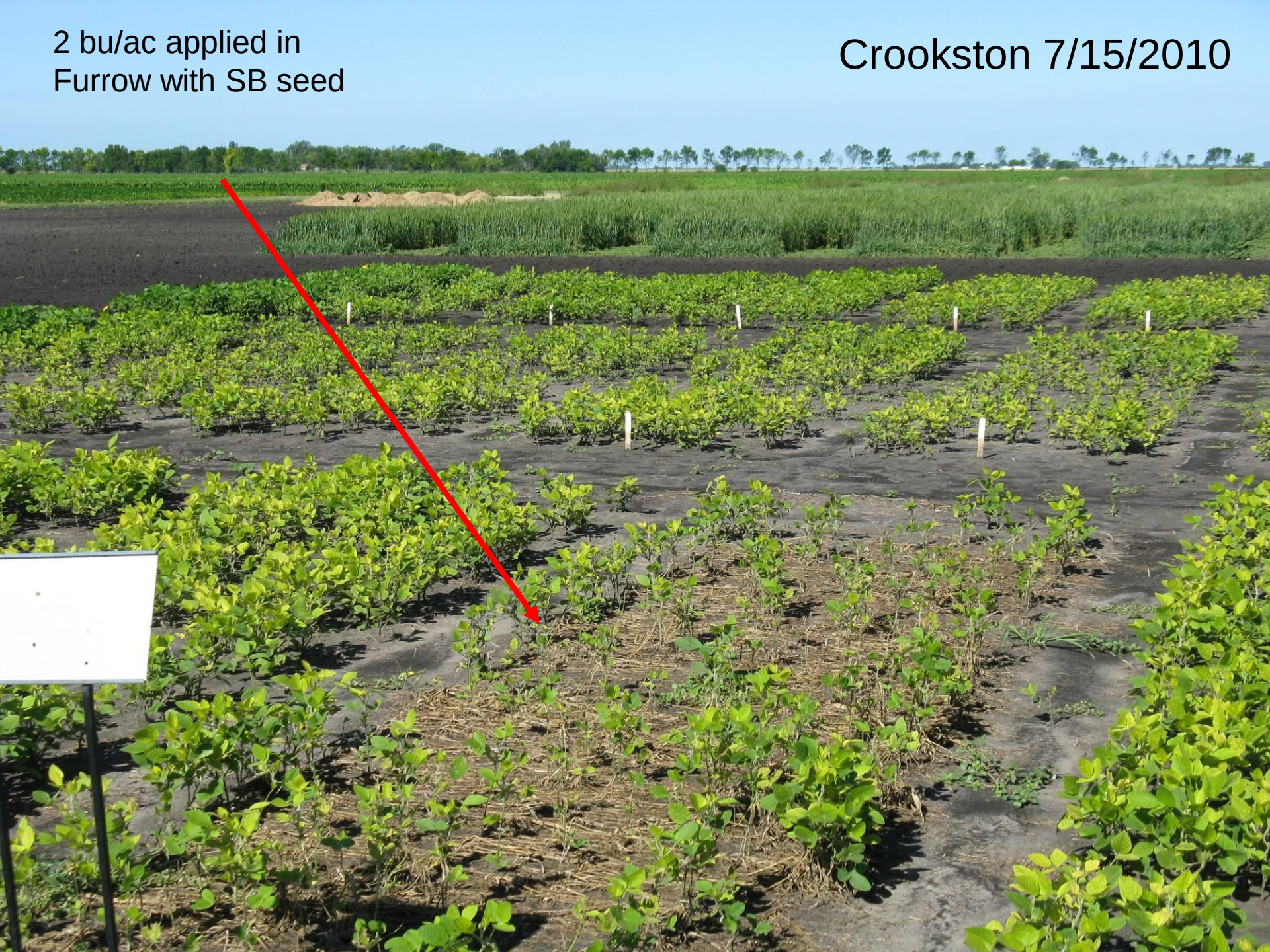
- **Olivia, MN**
  - Amiret Loam & Canisteo-Seaforth Complex
  - NO3-N: 24 lb/ac……range 11-48
  - CCE: 6.7% ……range 0.9-11.7
  - Salts: 0.49 mmhos/cm ……range 0.25-1.80
  - 15 ppm Olsen P, 262 ppm K, 8.2 pH
- **Renville, MN**
  - Leen-Okaboji Complex
  - NO3-N: 28 lb/ac……range 9-55
  - CCE: 10.7% ……range 3.0-20.7
  - Salts: 0.76 mmhos/cm ……range 0.46-2.00
  - 18 ppm Olsen P, 248 ppm K, 8.2 pH

Treatments - 2010

- Oats broadcast seeded and drug in 1 day before planting
- 3 lbs per acre Soygreen (6% EDDHA-Fe)
- Neither or both
- Two varieties, Gold Country 2717 and 3517 planted at 150K

Oats - Methods

- Air applicator provided good seed distribution
- Good emergence in the spring
- Proximity to the row is important
- Make sure that oats are not concentrated in the row


2 bu/ac applied in
Furrow with SB seed
Crookston 7/15/2010

Oats - Methods

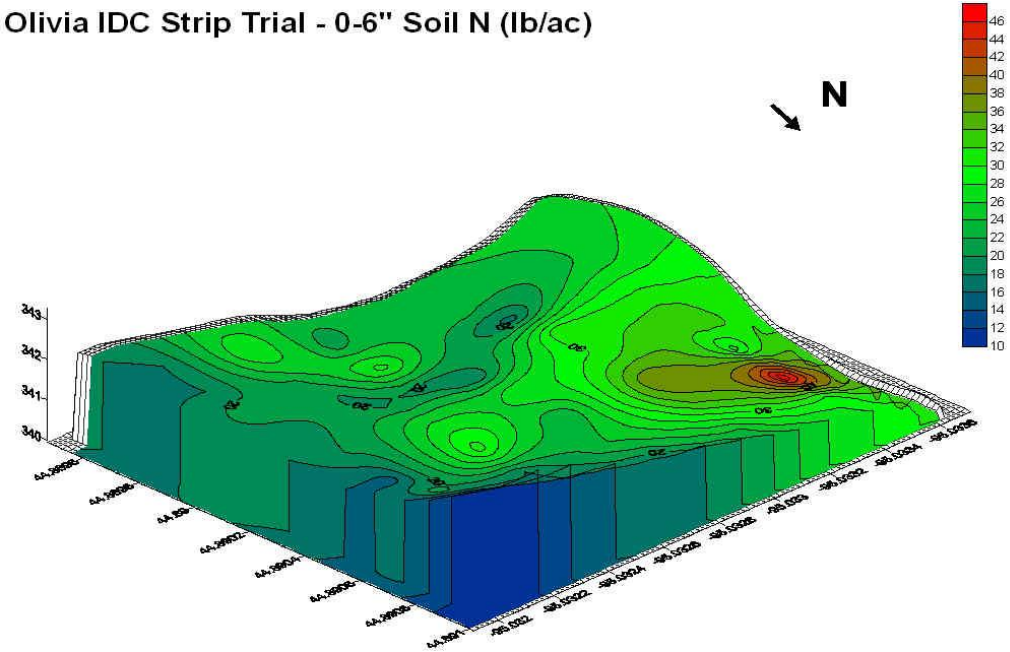
- Seeded 5/5/20
- Sprayed 6/16/20
  - Oats ~ 16” tall
- Sprayed with
  - 36 oz per ac Cornerstone
  - 0.125 oz per ac. Harmony SG
  - Class Act 2.5% v/v
- Good weed and oat kill first pass
- Spot Sprayed a second pass to take care of later weed flush

What I Learned – Growing and maintaining a grass with a broadleaf tends to limit your early season weed control options!!!!!!

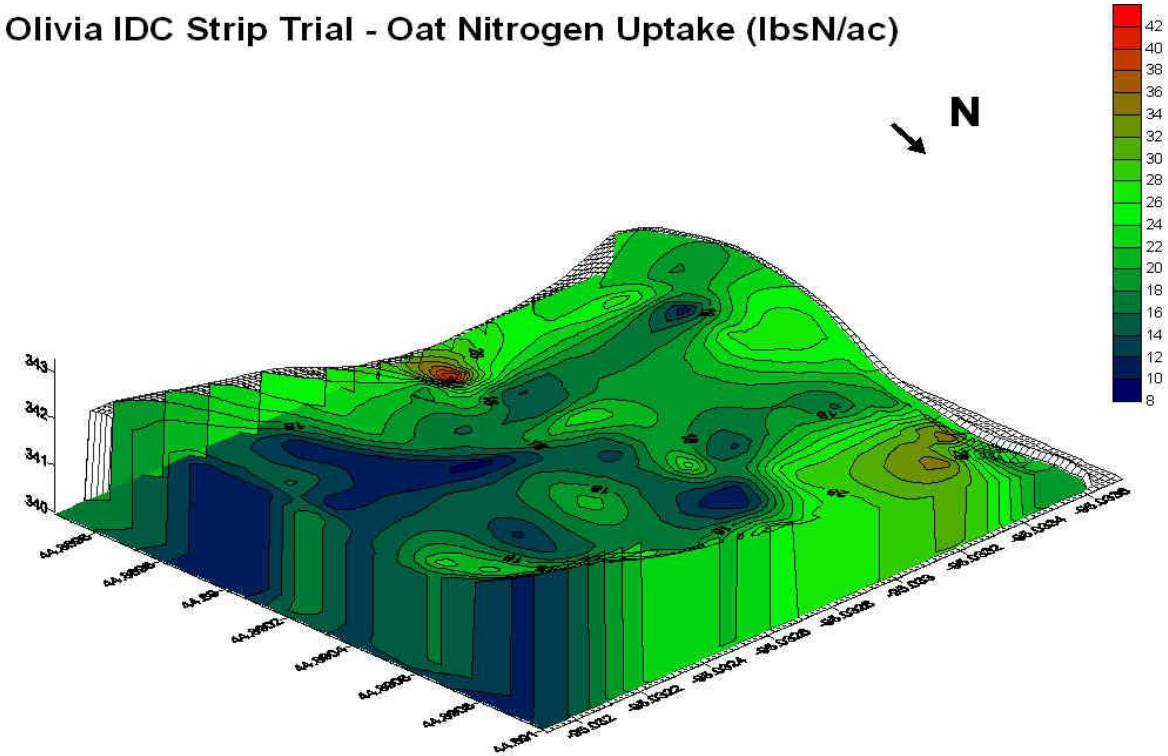
Oat N Uptake

	Oat Biomass	Oat N Uptake	NO3-N
	----------lb/ac----------		-% of TN-
Olivia	595	18.9	3.5
Renville	647	25.9	9.8

***% of TN: percent of total N*

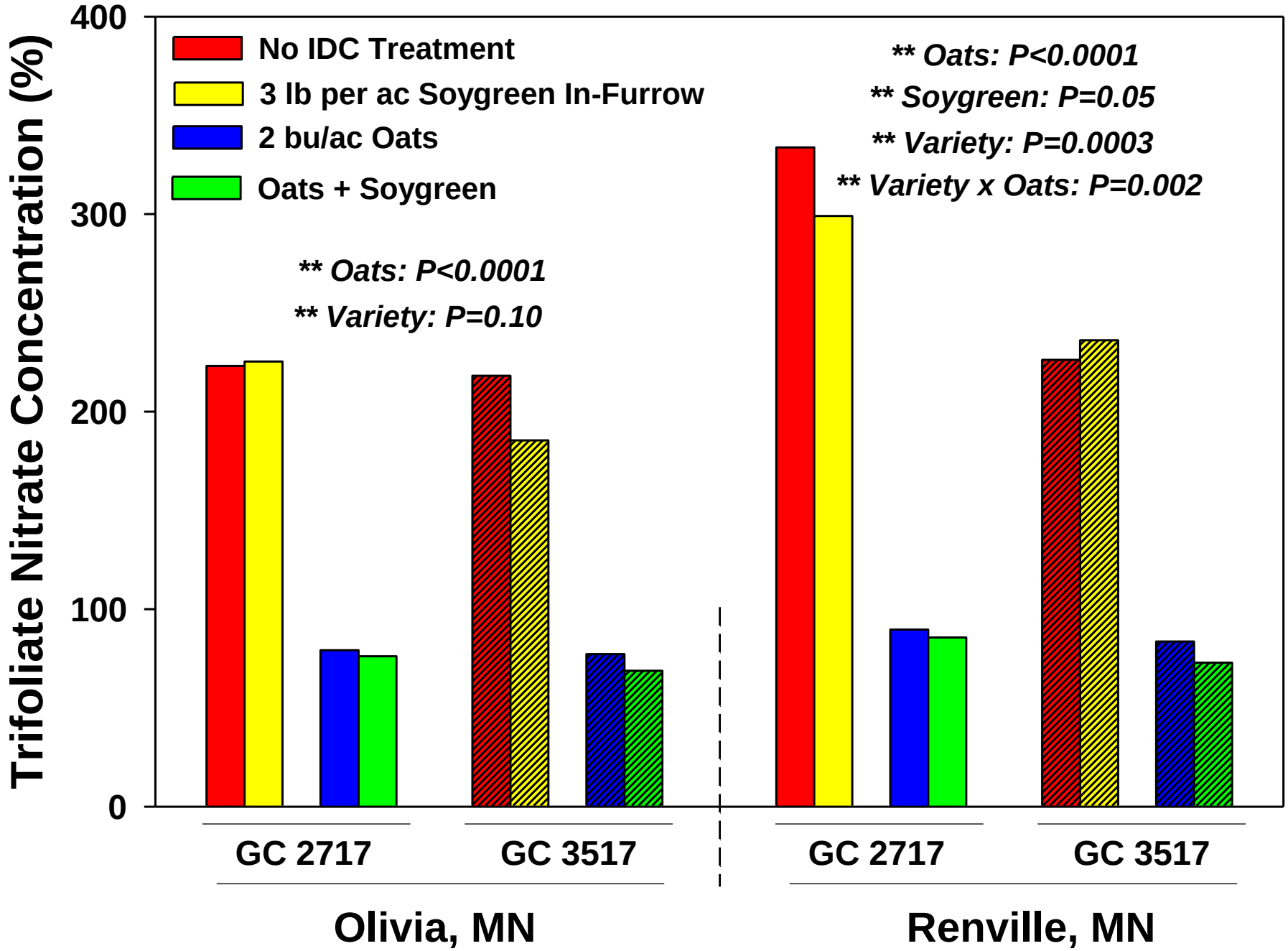


Olivia, MN
0-6” soil Nitrate
Oat N uptake at killing

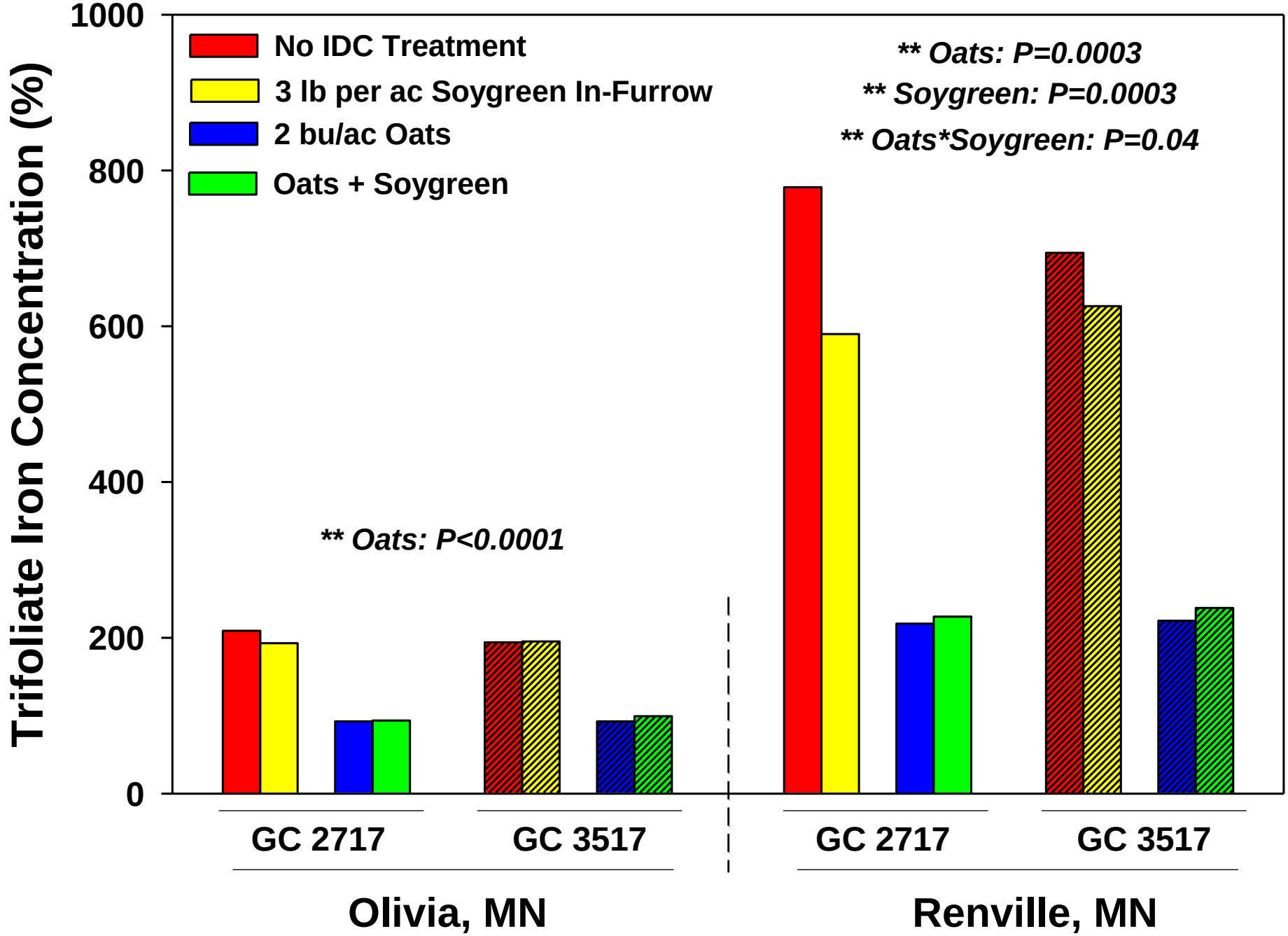


No Clear Relationship between soil N pre-plant and Oat N uptake

Trifoliate Samples Taken at V3



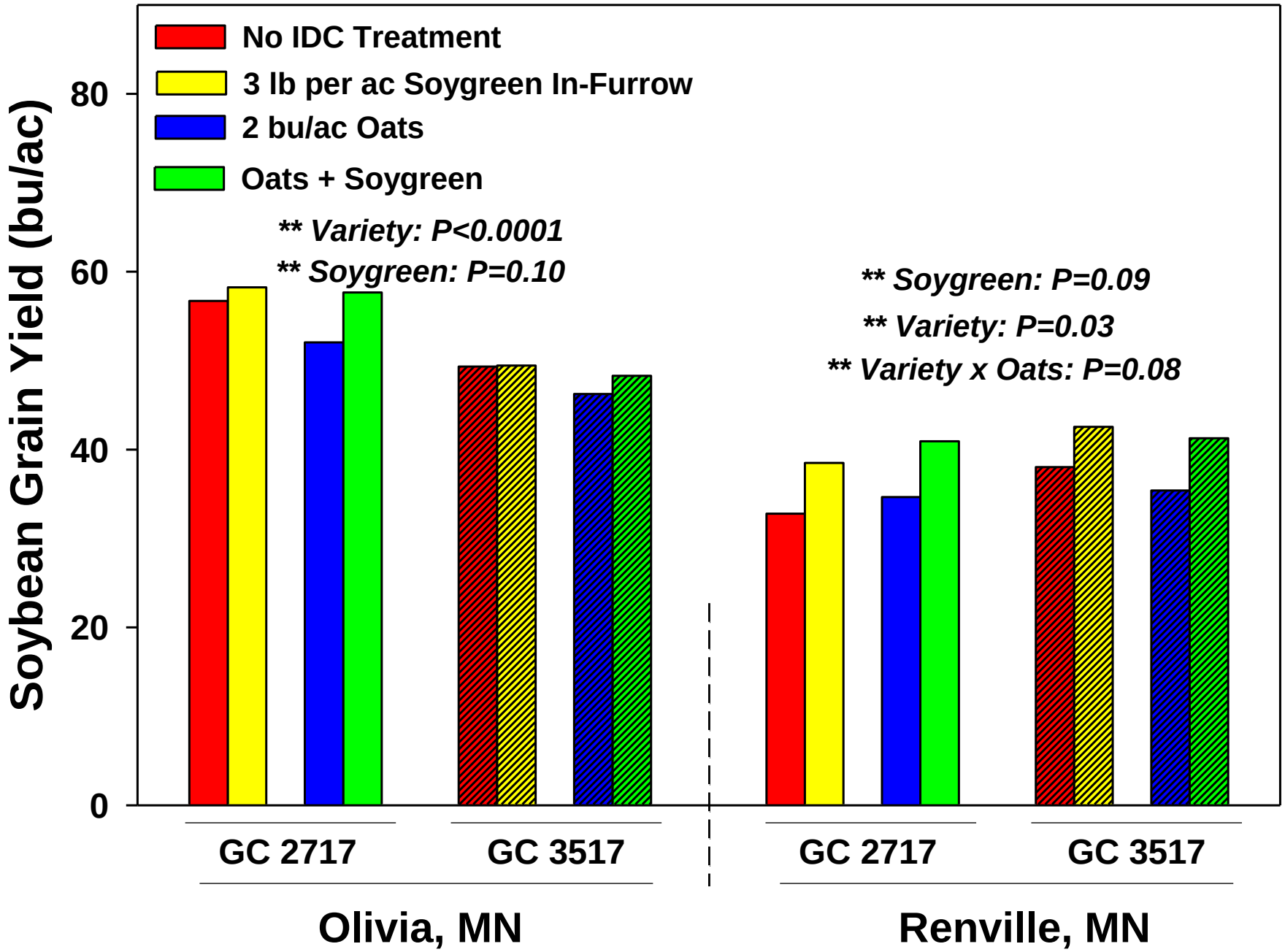
Trifoliate Samples Taken at V3

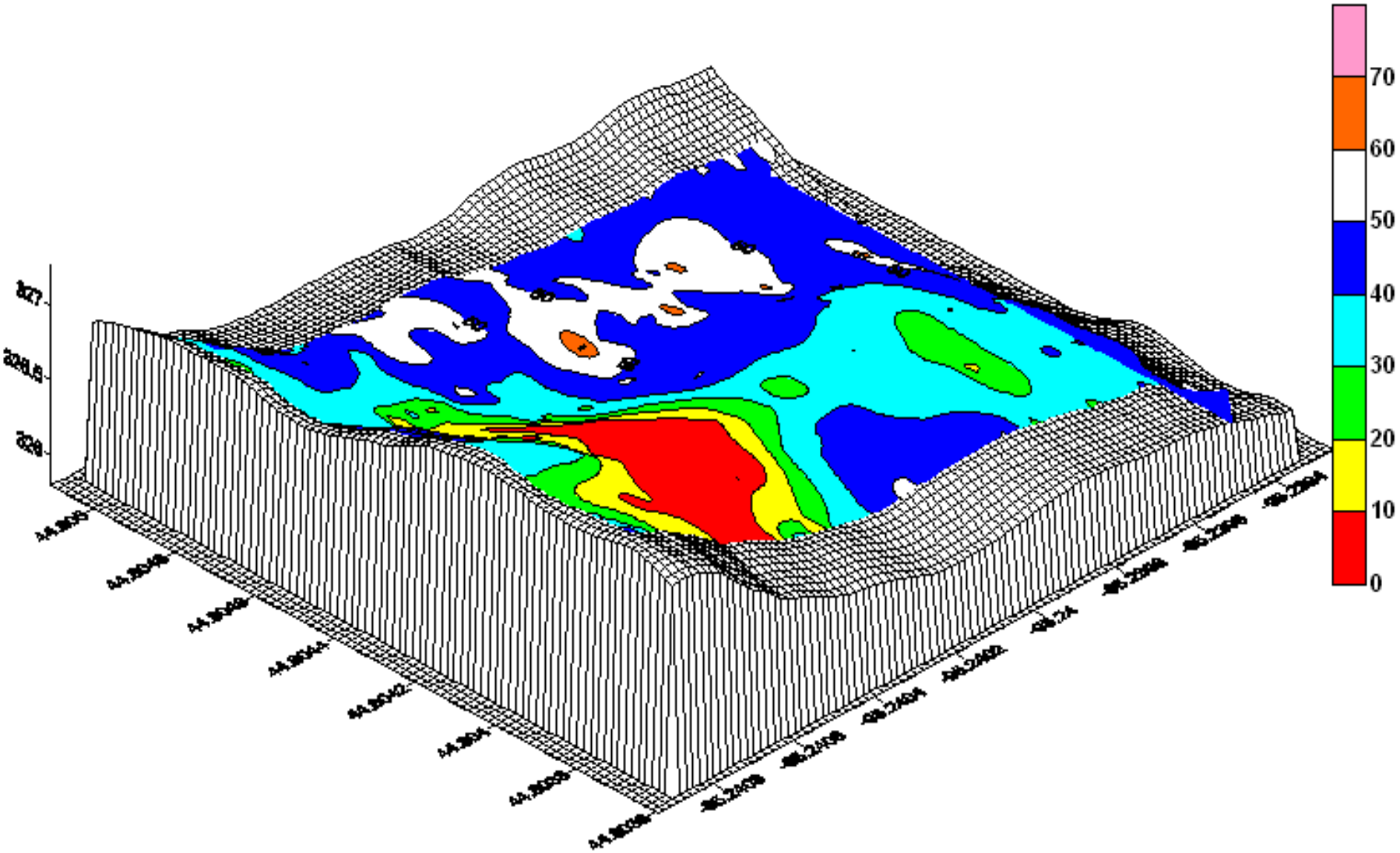


Soybean Tissue Analysis

- Oats clearly reduced trifoliate N concentration
- Plants grown with oats or soygreen had LOWER Fe concentration
  - Possible dilution effect from similar uptake but different plant growth
- Does this relate to yield
  - Maybe/Maybe not
- The oats are doing their job!!!!

Soybean Yield





Renville IDC soybean yield with elevation

5 Rating

High Yielding

IDC Tollerant

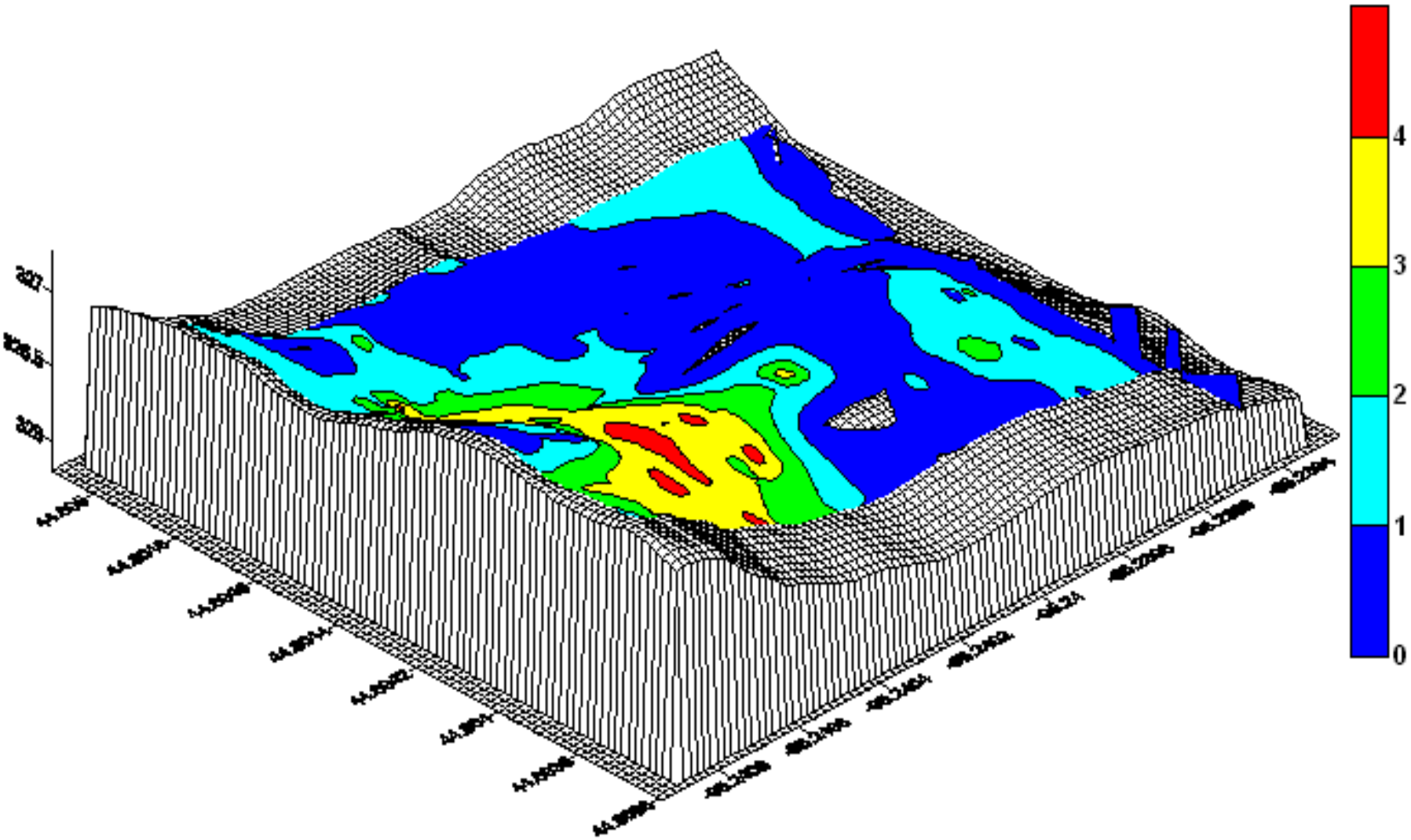
3 Rating

No TRT

+ EDDHA-FE

2 Rating

2 Rating



Renville IDC soybean chlorosisrating with elevation

Renville MN - Soybean Yields

Yield Based on Chlorosis Severity

		Chk	IF-Fe	Oats	Oats+Fe
Low	V1	47.2	50.9	42.8	48.8
	V2	46.0	49.5	42.7	46.7
Mod	V1	30.6	38.7	26.9	41.7
	V2	42.5	46.0	32.1	43.6
High	V1	6.6	15.3	26.6	28.5
	V2	16.6	26.5	23.2	31.8

*****IF-Fe – In furrow Soygreen at 3 lbs of product per acre (30”rows)***

Renville MN – Low to No IDC

Some yellowing, but normal plant growth

		Chk	IF-Fe	Oats	Oats+Fe
Low	V1	47.2	50.9	42.8	48.8
	V2	46.0	49.5	42.7	46.7

- **Soygreen: *P*=0.16**
- **Oats: *P*=0.06**
- **Soygreen x Oats: *P*=0.47**
- **Variety: *P*=0.24**
- **Variety x Oats: *P*=0.92**
- **Variety x Soygreen: *P*=0.60**
- **Variety x Soy x Oats: *P*=0.69**

- Lower yields when oats were over seeded, related to the time of Kill
- Soygreen did not increase yields
- Varieties did not differ in their yields
- Treatment effects did not vary by variety

Renville MN – Moderate IDC

Significant yellowing and limited plant growth

		Chk	IF-Fe	Oats	Oats+Fe
Mod	V1	30.6	38.7	26.9	41.7
	V2	42.5	46.0	32.1	43.6

- **Soygreen: *P*=0.04**
- **Oats: *P*=0.26**
- **Soygreen x Oats: *P*=0.32**
- **Variety: *P*=0.0002**
- **Variety x Oats: *P*=0.08**
- **Variety x Soygreen: *P*=0.25**
- **Variety x Soy x Oats: *P*=0.85**

- Soygreen significantly increased yields for both varieties
- Varieties differed in their yield potential, tolerant variety out yielded less tolerant
- Yield was reduced by oats alone, more so with the tolerant variety (V2)

Renville MN – Severe Chlorosis

Plants pretty much dead

		Chk	IF-Fe	Oats	Oats+Fe
High	V1	6.6	15.3	26.6	28.5
	V2	16.6	26.5	23.2	31.8

- **Soygreen: *P*=0.20**
- **Oats: *P*=0.09**
- **Soygreen x Oats: *P*=0.81**
- **Variety: *P*=0.02**
- **Variety x Oats: *P*=0.02**
- **Variety x Soygreen: *P*=0.38**
- **Variety x Soy x Oats: *P*=0.55**

- Oats increased yields
- Varieties differed in yield potential and response to oats
- V1 (high yielder) produced relatively no yield without IDC management and had higher response to oats
- Even with 10 bu upward trend, no response to Soygreen.

Did Grid Sampling Help?

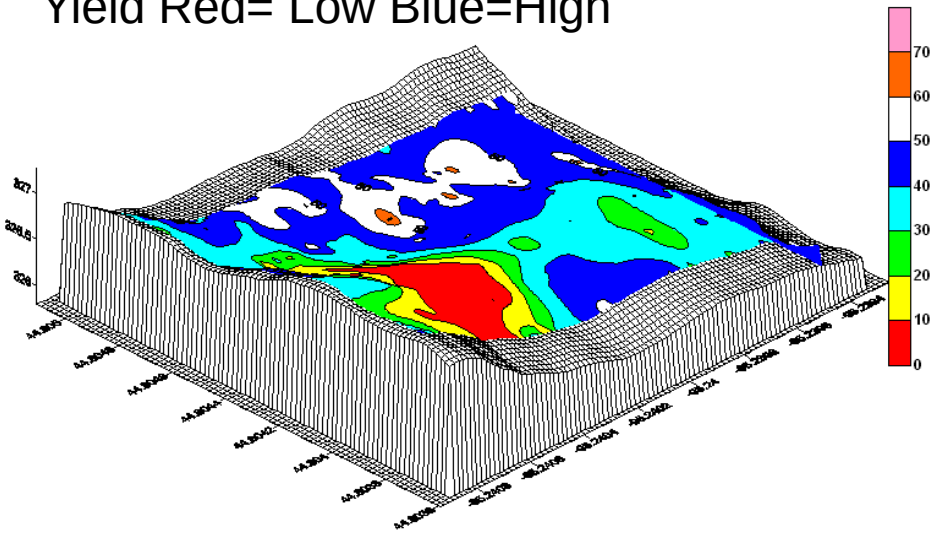
- Soil salts, nitrates, carbonates, pH, as well as other factors were compared from the grid data
- Nothing seemed to be well correlated to areas with more severe chlorosis
- Some data from Olivia (not shown) may point to salts
- System is too complex for a simple answer

Summary by IDC Zone
Renville, MN

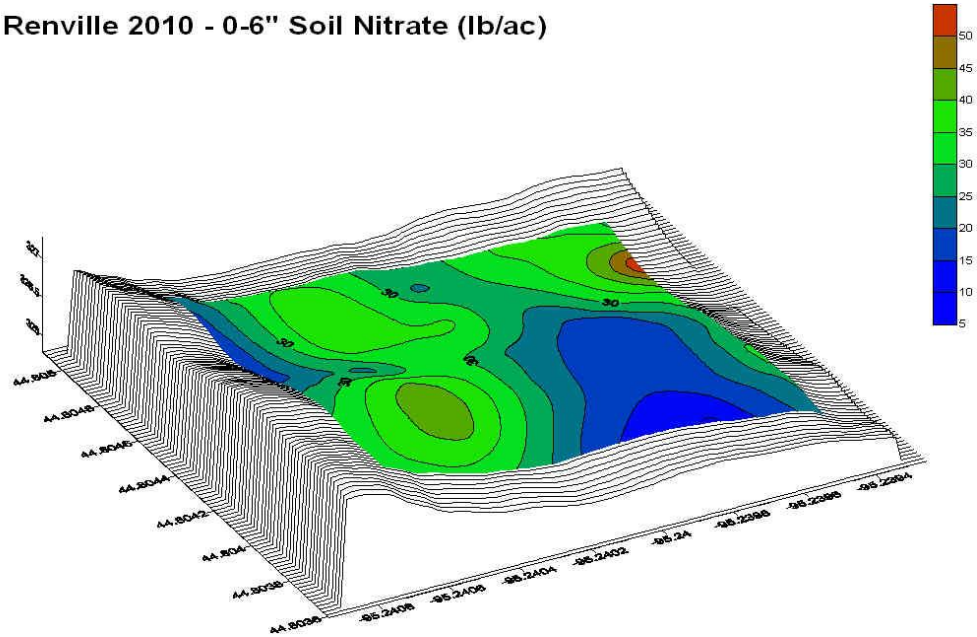
	NO3-N	CCE	Salts	pH	K
	lb/ac	%	mmohs/cm		ppm
Low	30	11.9	0.57	8.2	243
Mod.	26	9.8	1.03	8.1	233
High	28	9.2	0.77	8.1	278

*****No major trends between soil test factors and IDC severity***

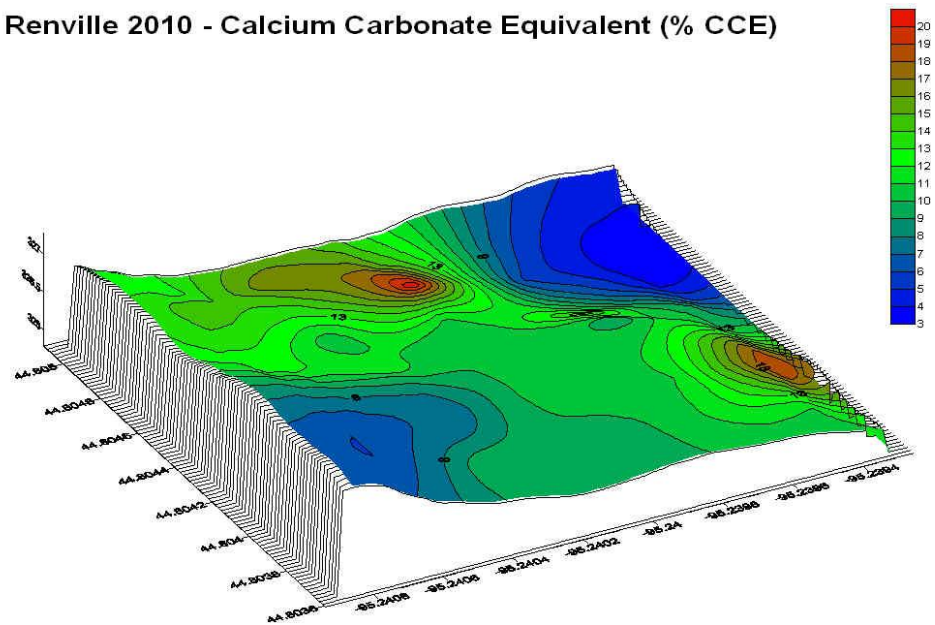
Yield Red= Low Blue=High

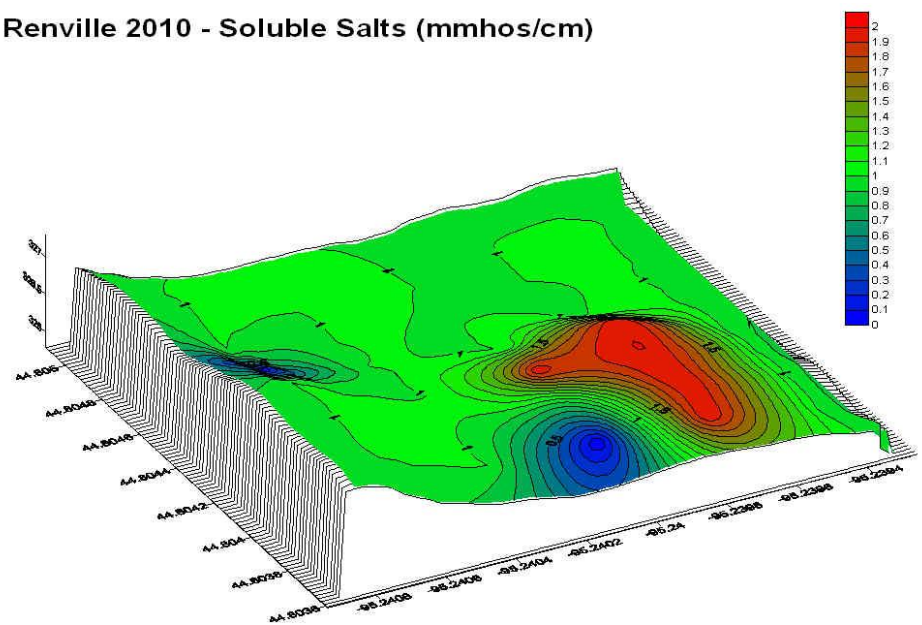


Renville IDC soybean yield with elevation

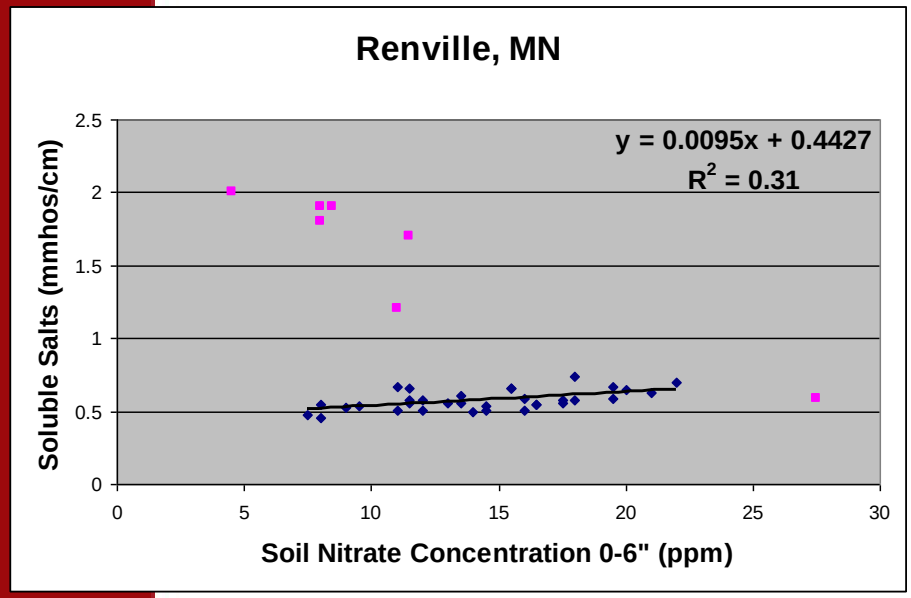


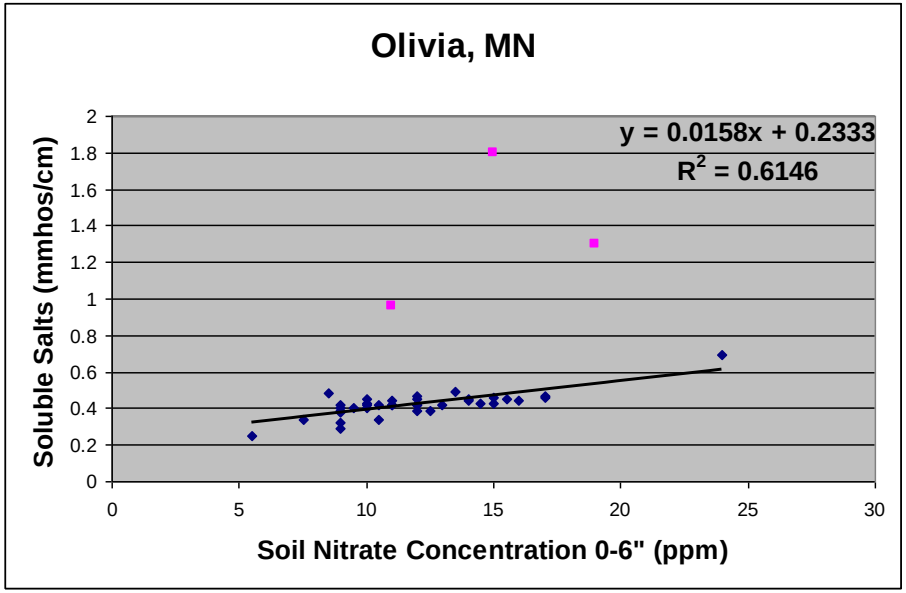
Soil Test Values Red = High Blue = Low





Soluble Salts and Nitrates





- Nitrate is an ion that may affect soil salts
- For low salt levels (<0.75 mmhos/cm)
  - 31% of the variablity in salts could be explained by NO3-N concentration at Renville and 61% at Olivia

- **Did the oats perform as expected by extracting N out of the soil?**
  - **Yes: plant NO3-N appeared to be lowered**
- **Were there Oats a successful management tool?**
  - **Kind of: Yields were less with outside of severely chlorotic areas.**
  - **Oats take a higher degree of management than in-furrow management with EDDHA-Fe**
- **Did EDDHA-Fe help with Fe uptake and Yields?**
  - **Possibly and Yes, yields were increased in some areas**
- **Could EDDHA-Fe be used to maximize the yield potential of a less tolerant high yielding variety?**
  - **No, defensive varieties are still the #1 management tool with chlorosis**

Management Options

- Plant oats
  - Kill at the optimum time
- EDDHA Fe
  - Ferraline – Helena
  - Soygreen – West Central Inc.
  - Iron EDDHA 6%– Winfield Solutions
  - Some generics
- RATES-?????

Questions???

Thank You
Dr. Paul Bloom
Chris Dunsmore
Steve Commerford
Phil Haen
Dan Lippert
Soils Field Crew
Gold Country Seed
West Central INC.

Daniel Kaiser

University of Minnesota

612-624-3482

dekaiser@umn.edu

http://www.tc.umn.edu/~dekaiser/

Funding provided by the Minnesota Soybean Research and Promotion Council