The effect of N management and cover crops on tile nitrate loads

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Midwest Cover Crop Council
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By using cover crops, …

- can we use immobilization of N as a tactic against tile N loss?

- can we tighten the N cycle and decrease loss of mineralized N during the non-growing season?

- can we turn inorganic N fertilizer into a slow release organic form?

Soil Mineralization vs. Immobilization

We are really talking about "net mineralization",

which is mineralization minus immobilization.

C:N ratio of residue impacts met mineralization

C:N < 15:1 = net mineralization
C:N > 30:1 = net immobilization

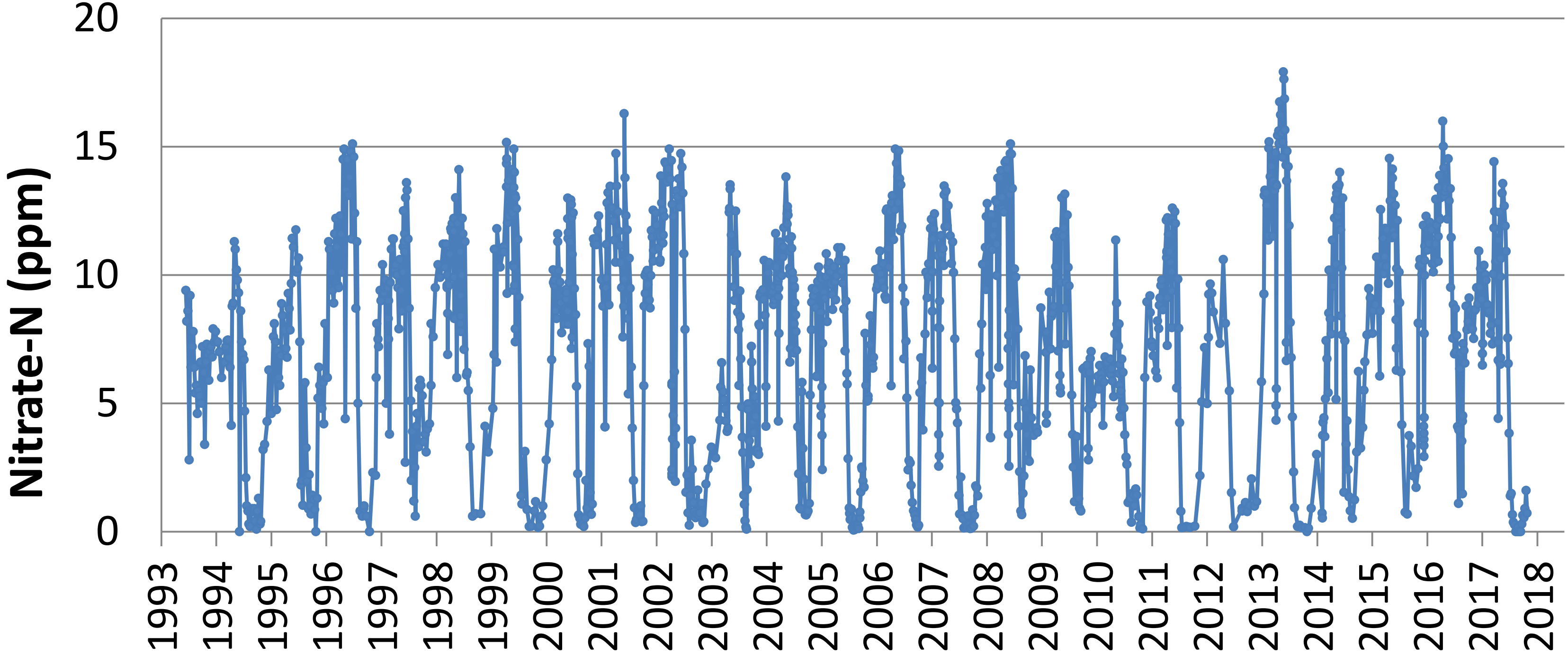
(Embarras River Watershed)

USGS gauge
at Camargo, IL

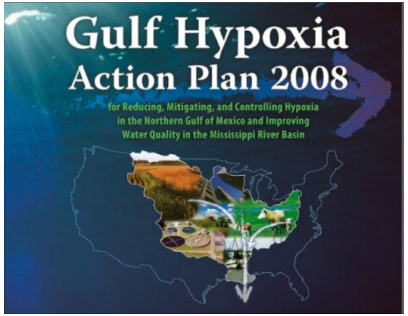
- 119,000 acres
- 90% row crop
- Few animals
- Little sewage effluent

Upper Embarras River Nitrate Concentration

25 Year Baseline of River Nitrate Load = 27 lbs/A/yr



U.S Science Advisory Board



Calls for 45% reduction of N and P export

IL Science Assessment

Suite of BMP for agricultural production

IL NLRS

IL Nutrient Science Advisory Committee

Recommendations for numeric nutrient criteria and eutrophication standards for Illinois wadeable streams and rivers

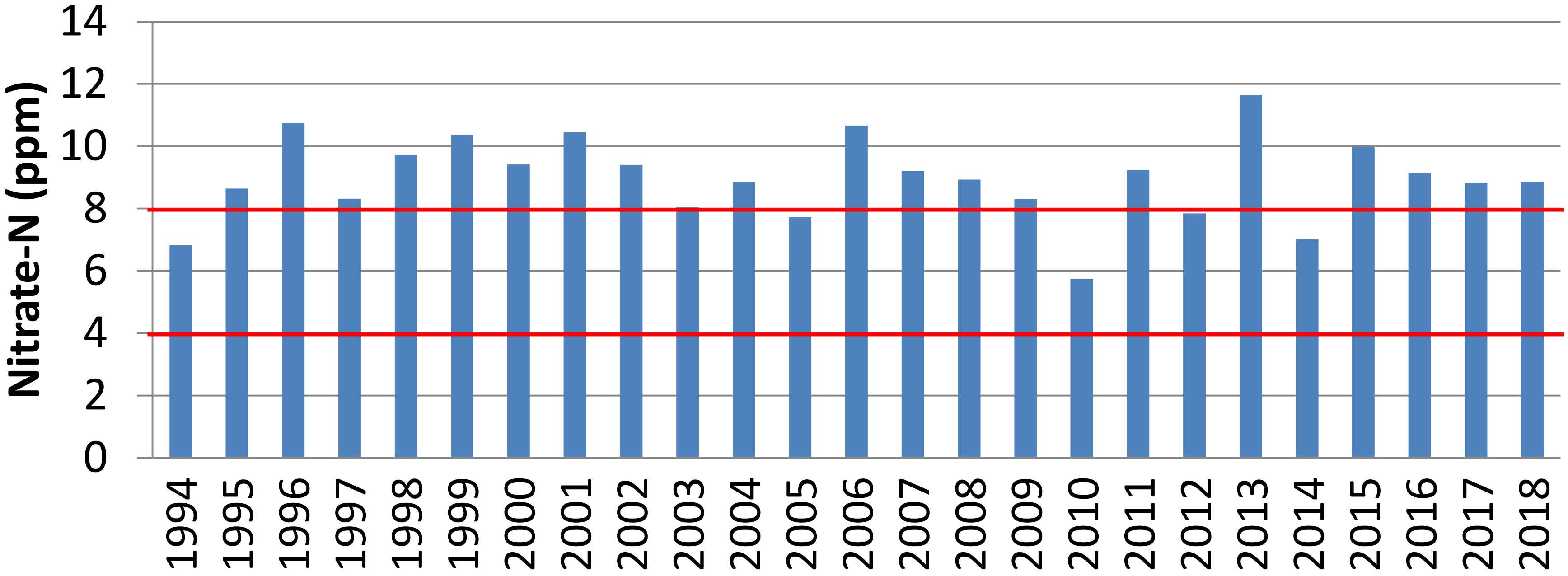
	Total Phosphorus (µg/L)			**Total Nitrogen** (µg/L)	
	North Ecoregion	South Ecoregion		North Ecoregion	South Ecoregion
Numeric Criteria	113	110		3979	901
Lower 95 % CL	33	18		-78†	256
Upper 95 % CL	193	202		8036	1546

† the negative concentration is a statistical artefact and can be interpreted as zero.

Flow-Weighted Mean of Nitrate Conc.

(Upper Embarras R. for past 25 years)

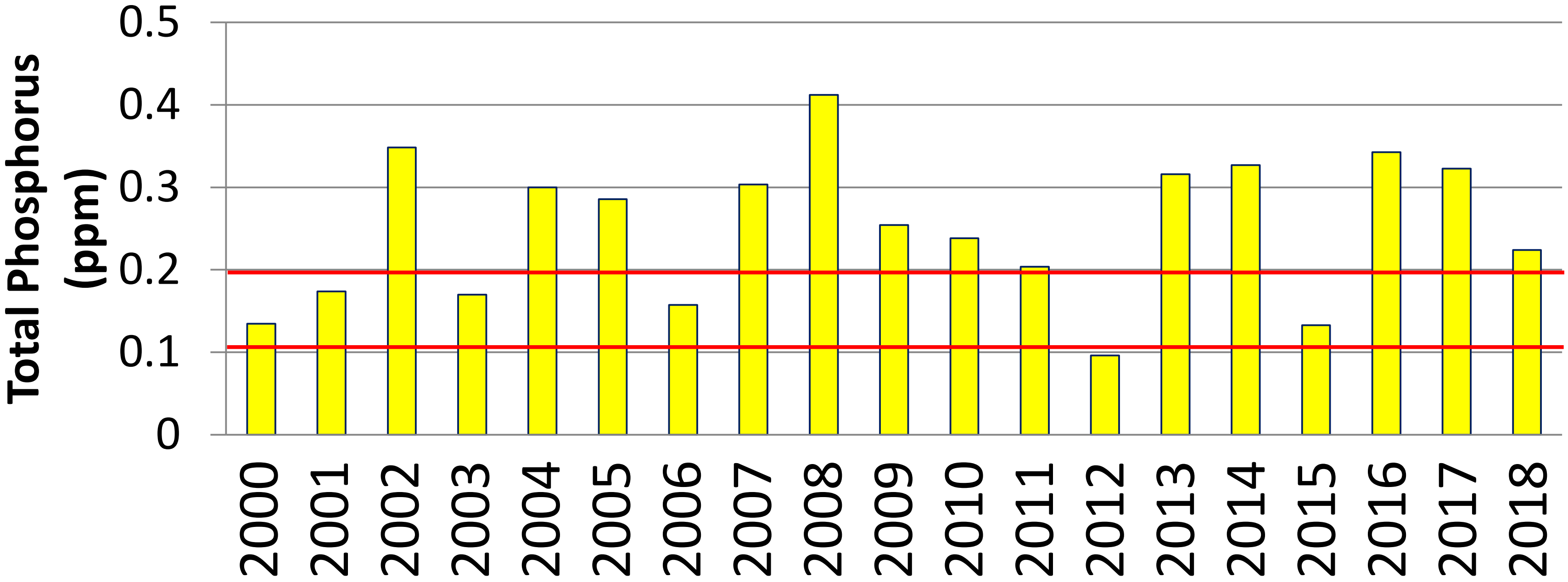
(Average FWM of nitrate = 8.96 ppm)



Flow-Weighted Mean of TP Conc.

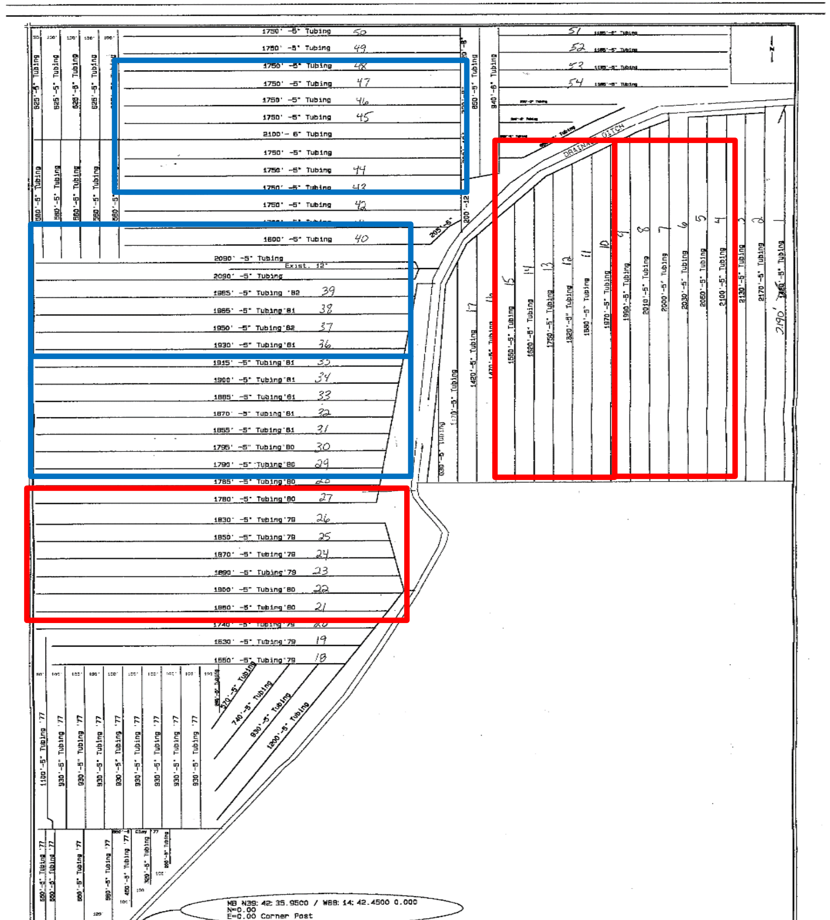
(Upper Embarras R. for past 19 years)

(Average FWM of total phosphorus = 0.25 ppm)

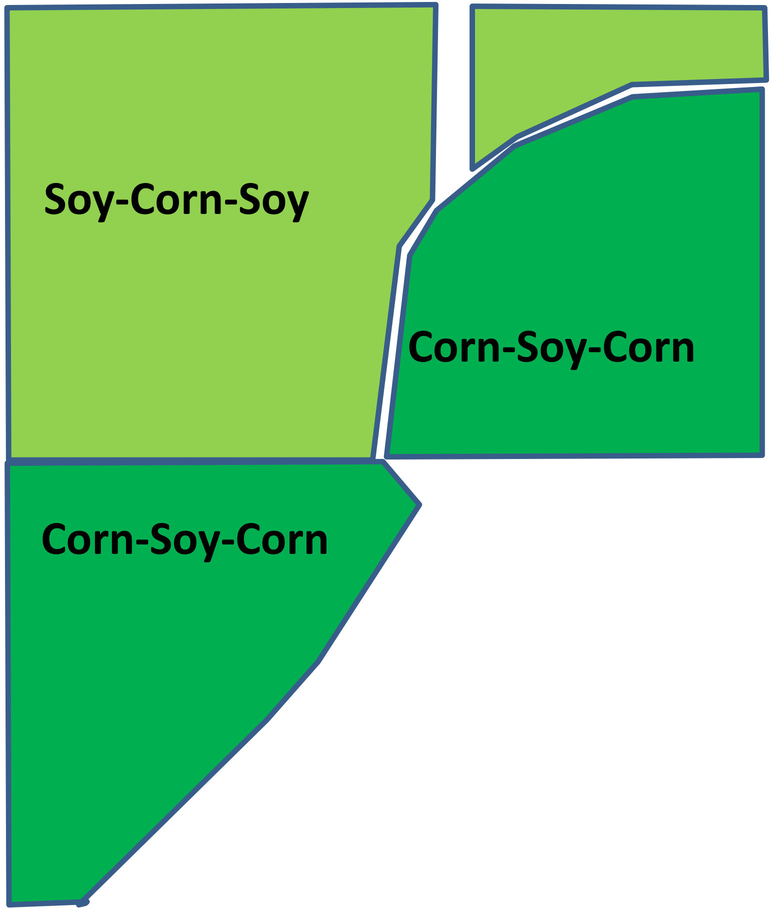


Replicated tile drainage study

Tile Map



Cropping Pattern



Large replicated plots

Photo: Jason Solberg

Pattern drainage in Lacustrine soil

Cereal rye after corn (before soybean)

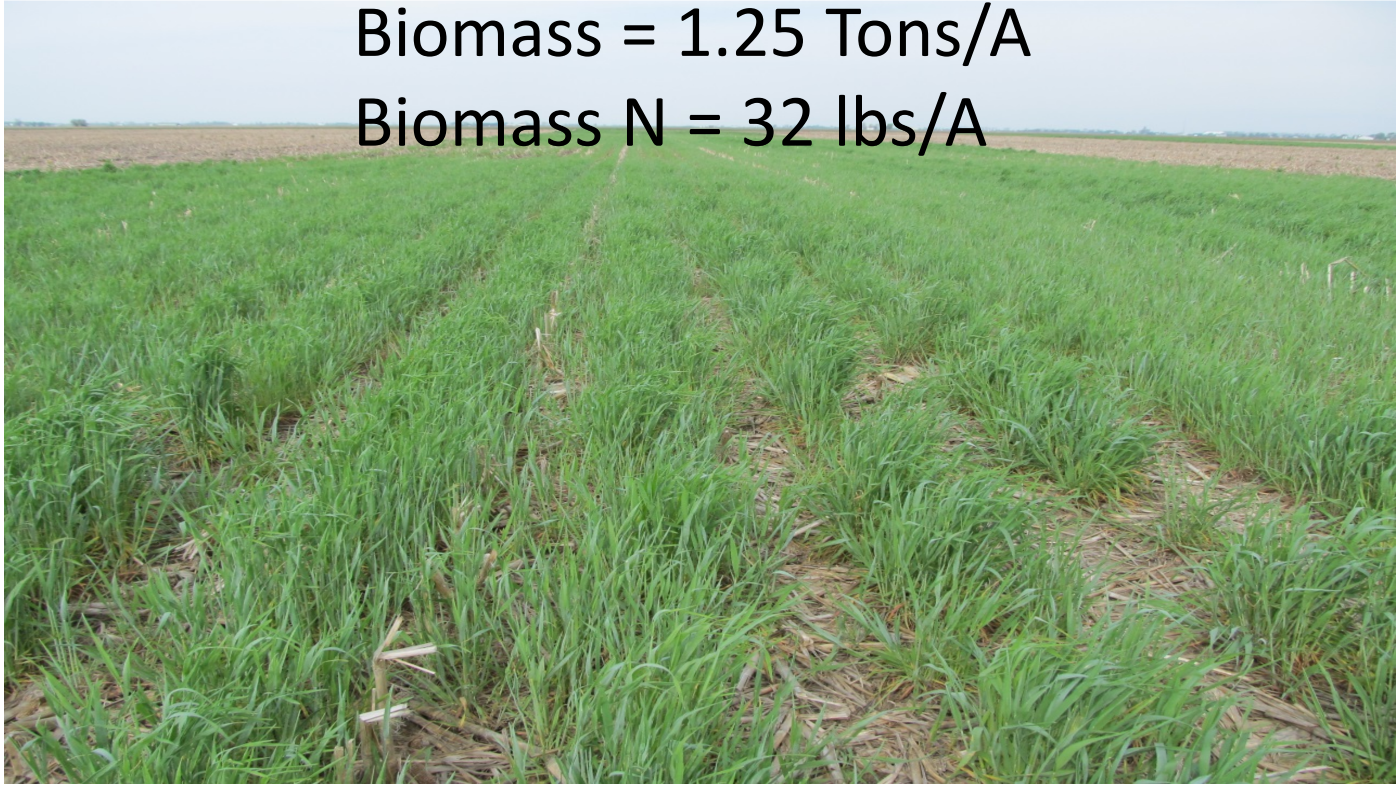


Photo by John M. Green

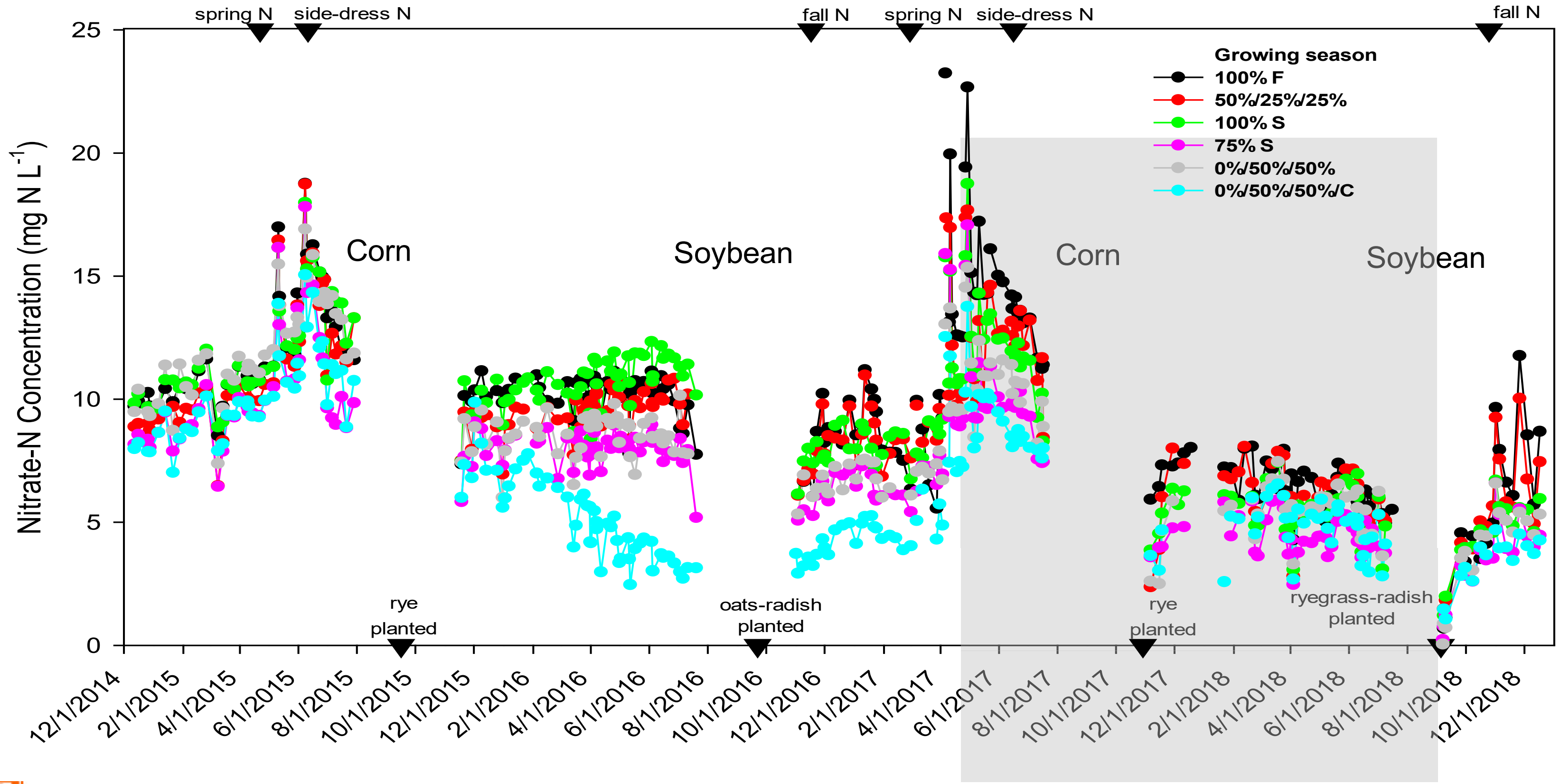
Oat and radish after soybean (before corn)

Not enough biomass to decrease tile nitrate load

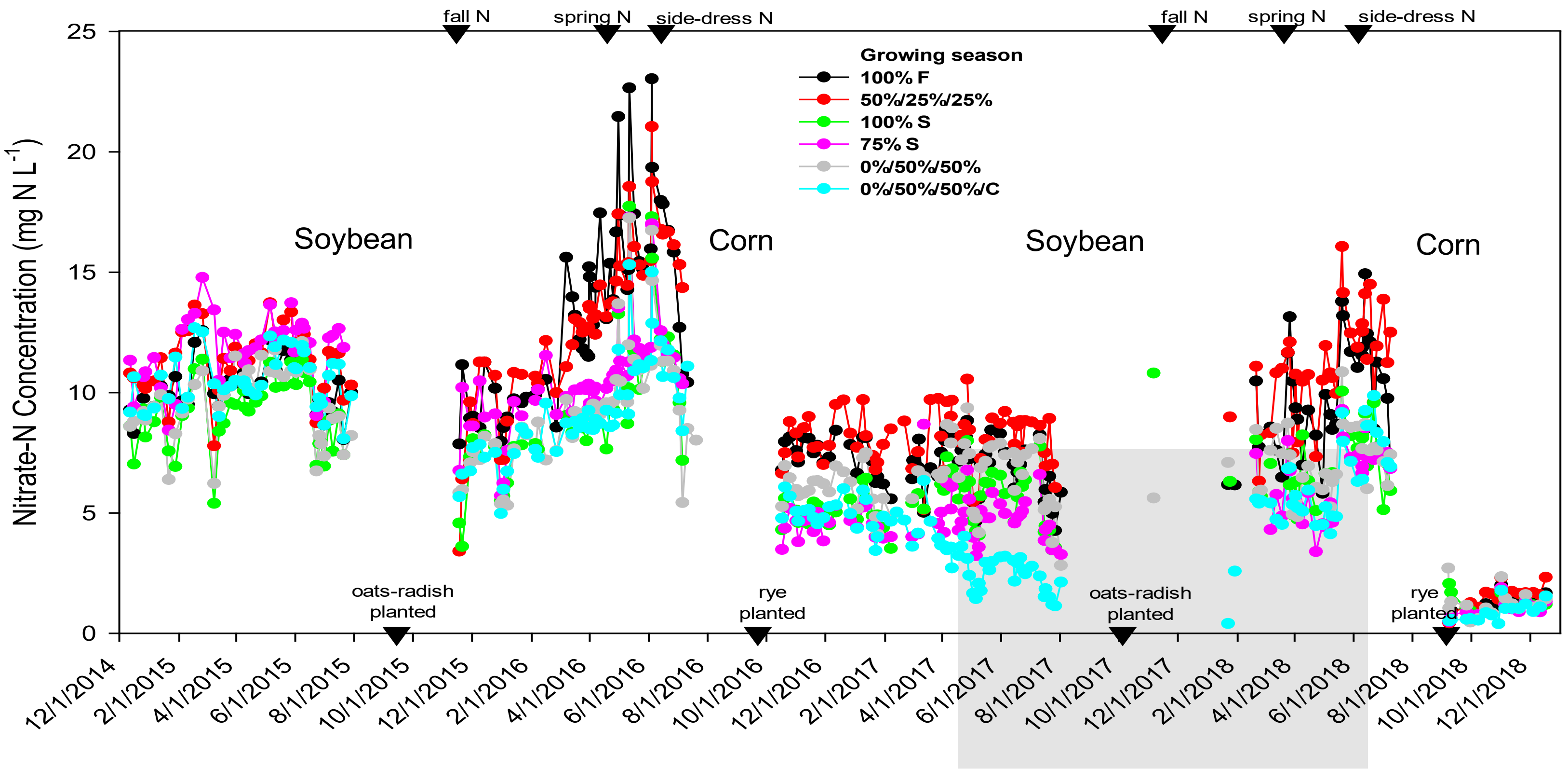
We switched to annual ryegrass and radish in 2018

Photo by John M. Green

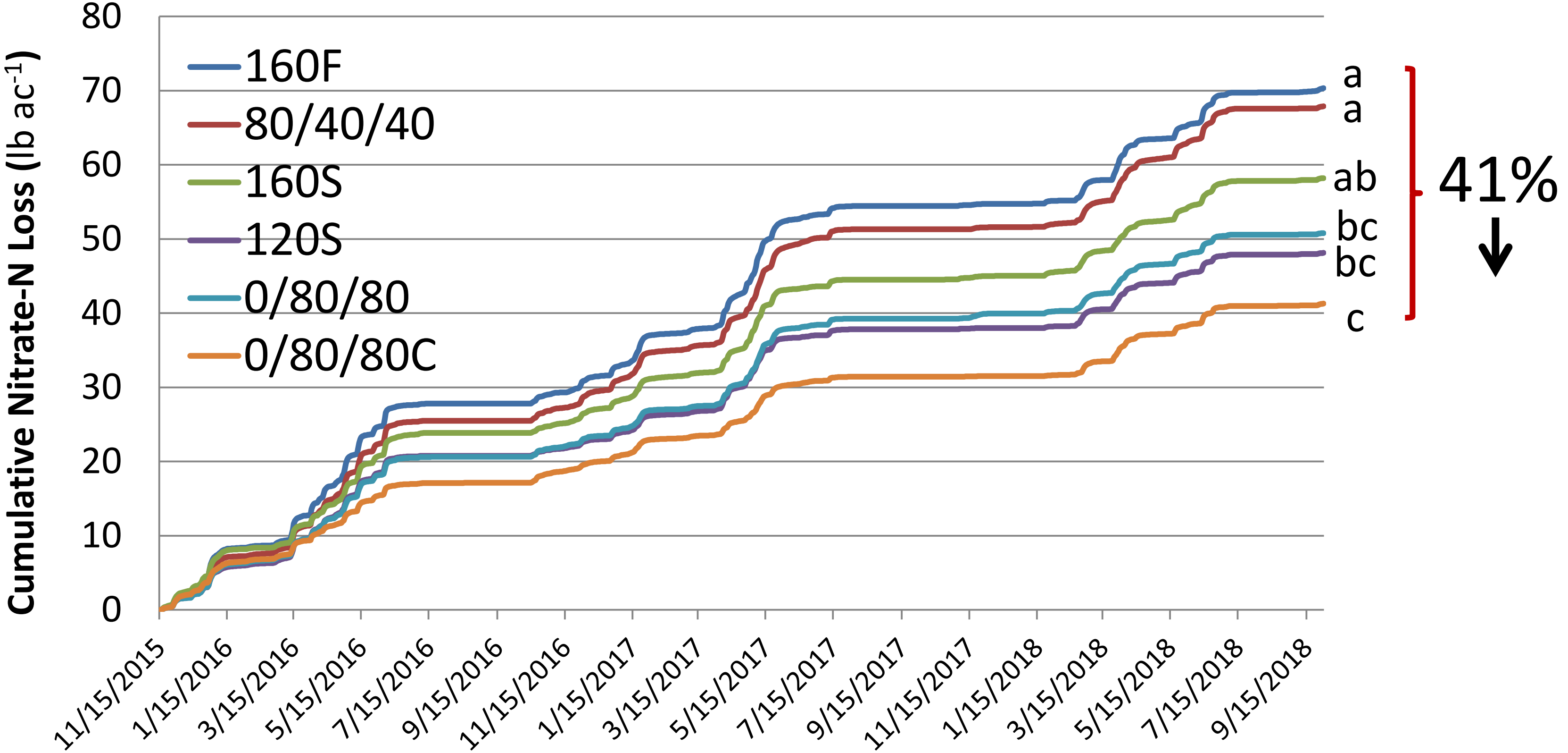
Tile Nitrate Concentration



Tile Nitrate Concentration



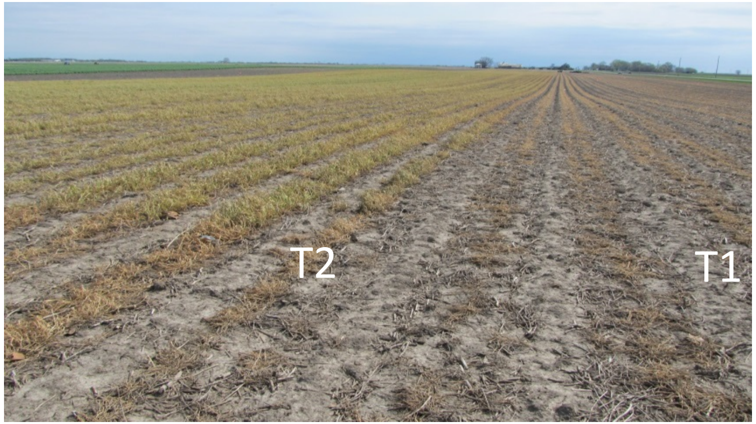
3 year Cumulative Tile Nitrate Load



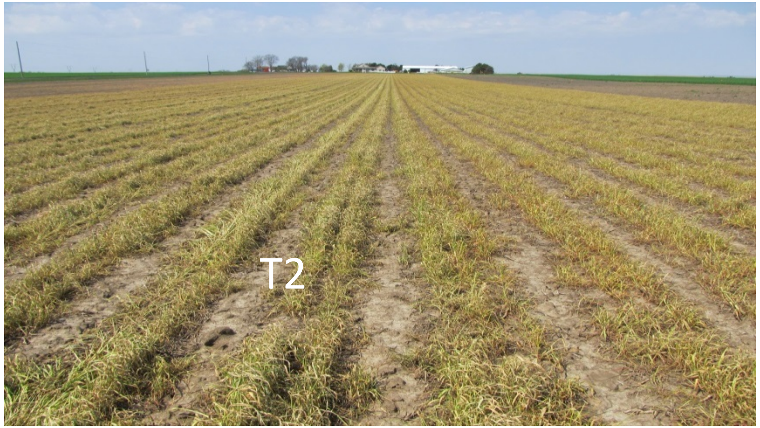
Cereal Rye Termination Study

3 termination dates in the spring
(approximately 2 weeks apart)

3 fertilizer N treatments
50 plant + 150 SD
100 F + 50 plant +50 SD
200 spring preplant



2017



Cereal rye
planted Oct. 18, 2016
following soybean

3 termination dates:

T1 = March 19
T2 = April 2
T3 = April 13

3 N systems:
50 plant + 150 SD
100 F + 50 plant +50 SD
200 spring preplant

Corn planted on
April 14, 2017

2017

N application

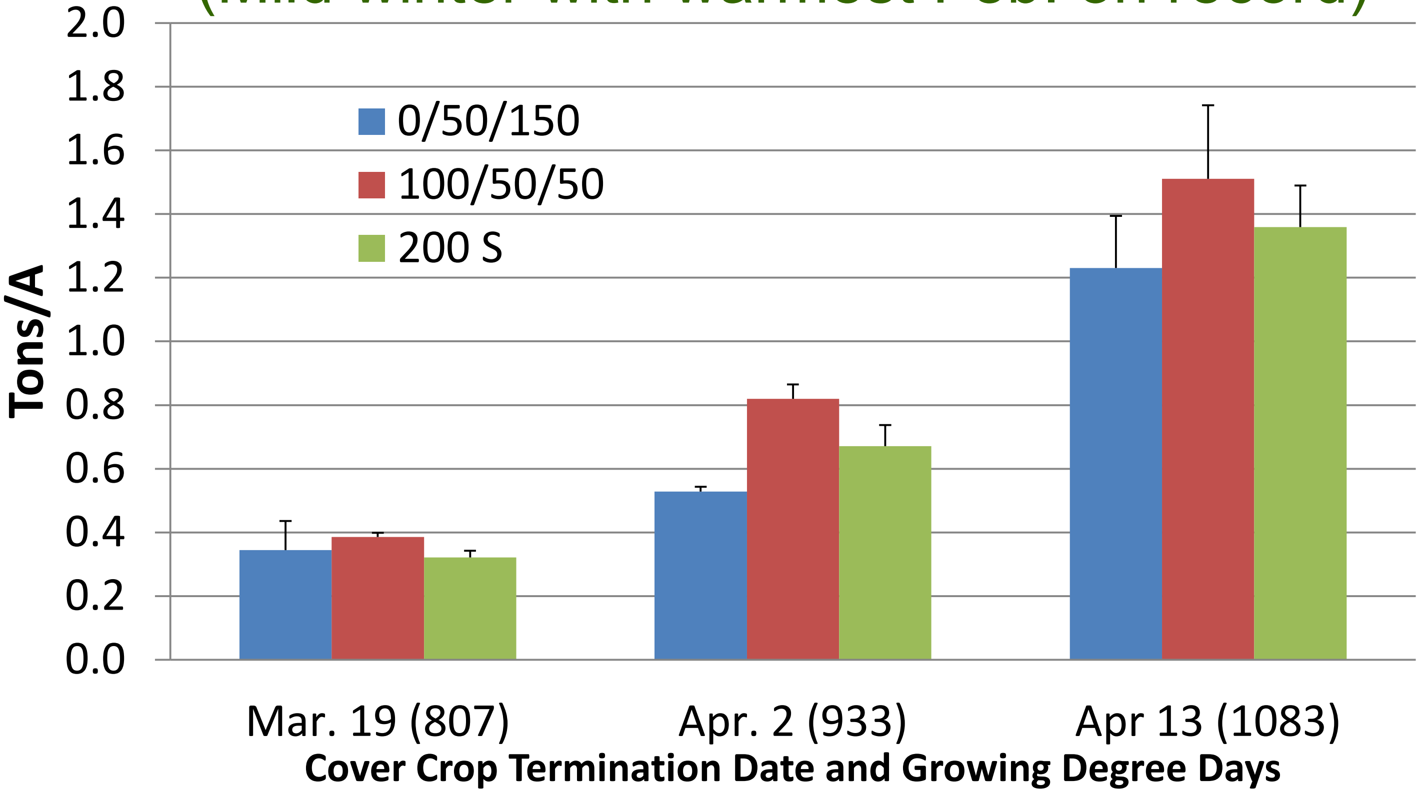
Fall N/strip = Nov. 1, 2016 as AA

Spring N = Mar. 9, 2017 as AA

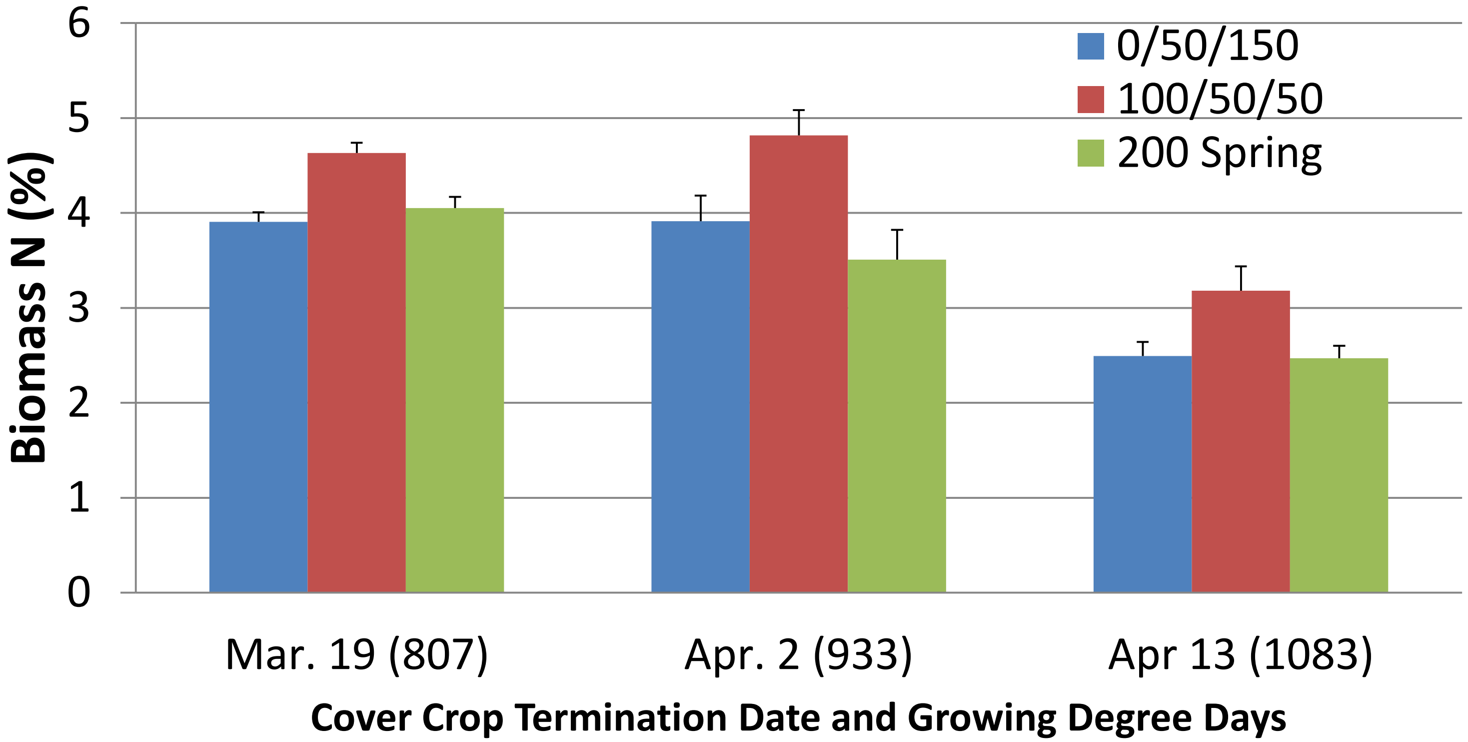
Side-dress = May 16 as AA

Cereal rye biomass

(Mild winter with warmest Feb. on record)

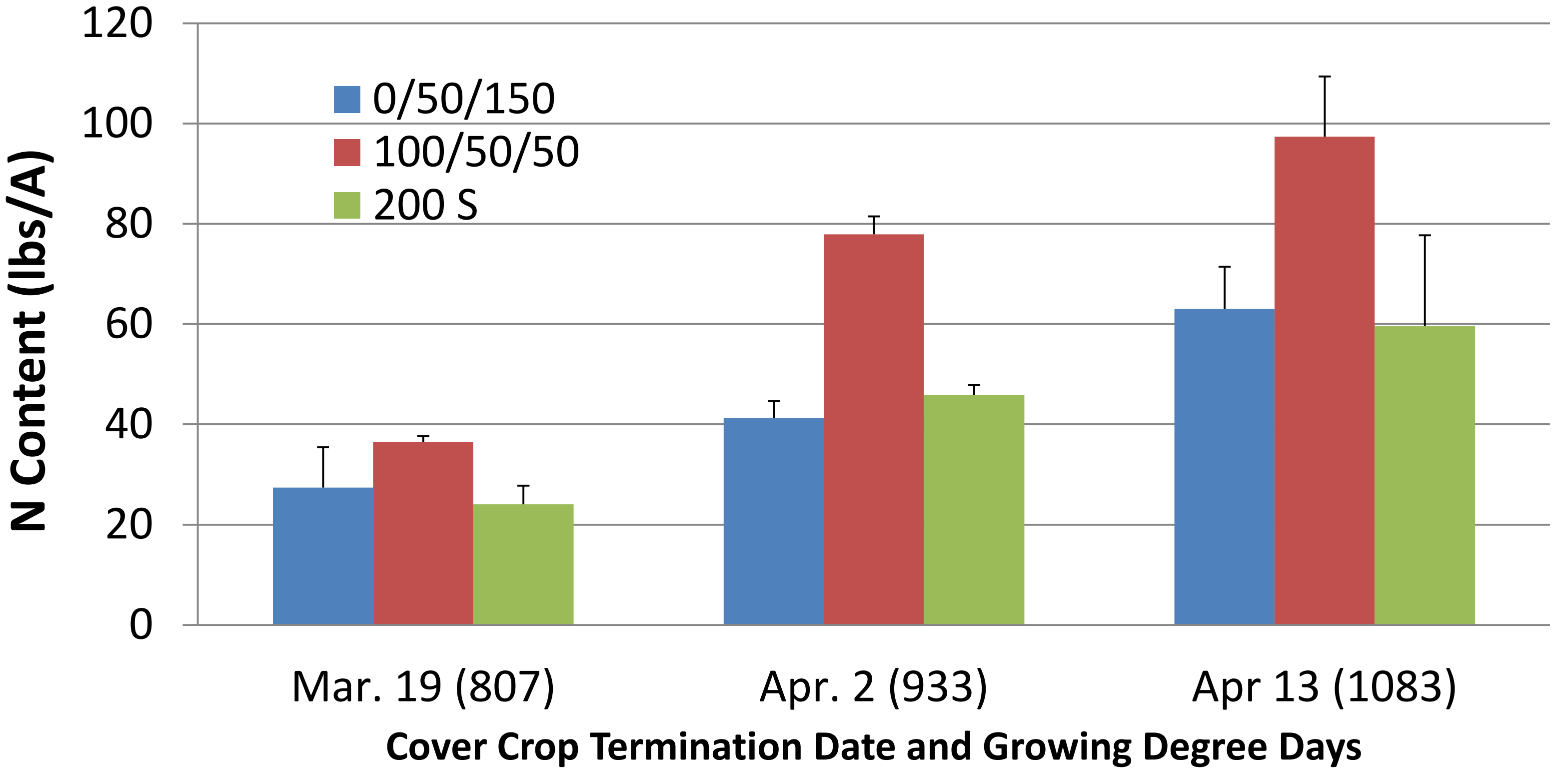


Cereal rye N concentration



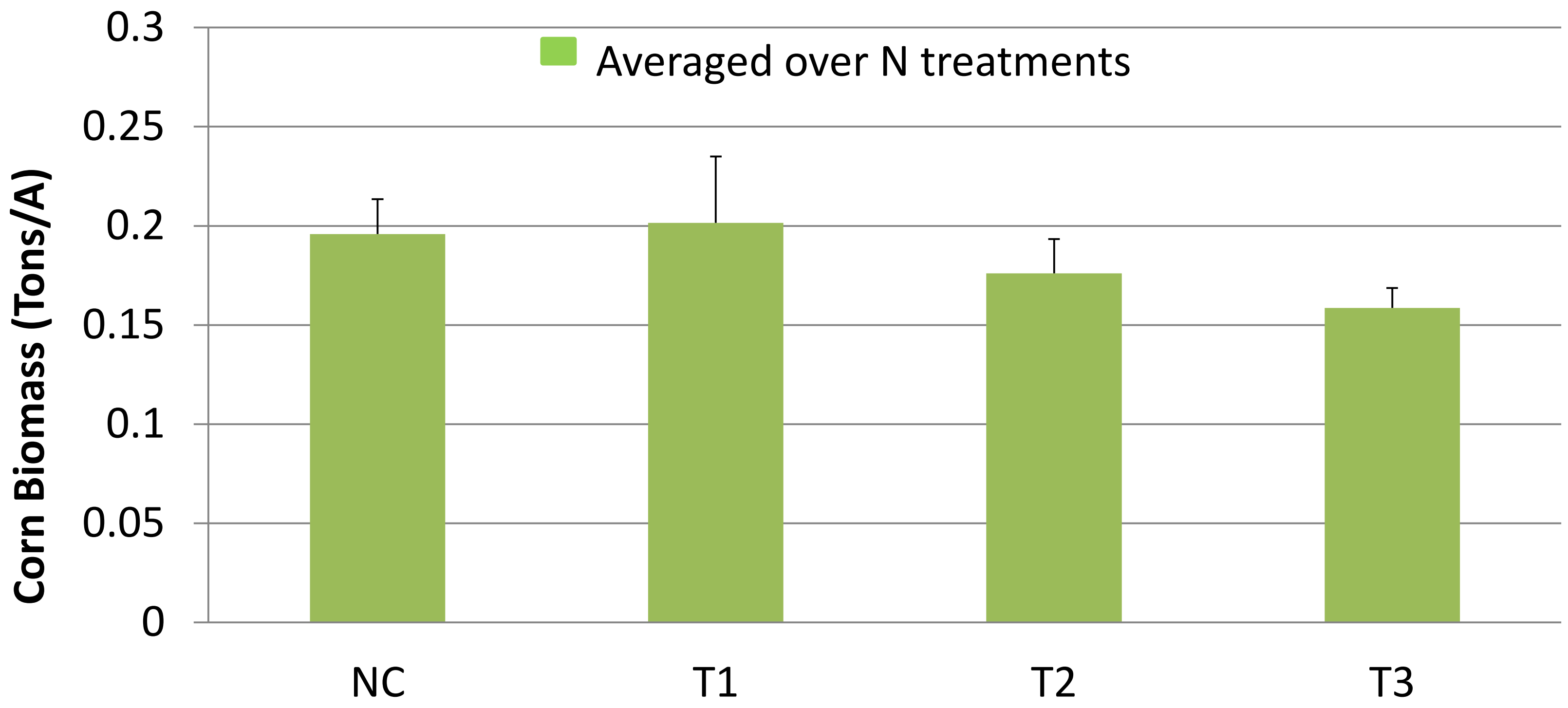
ILLINOIS

Cereal rye N content

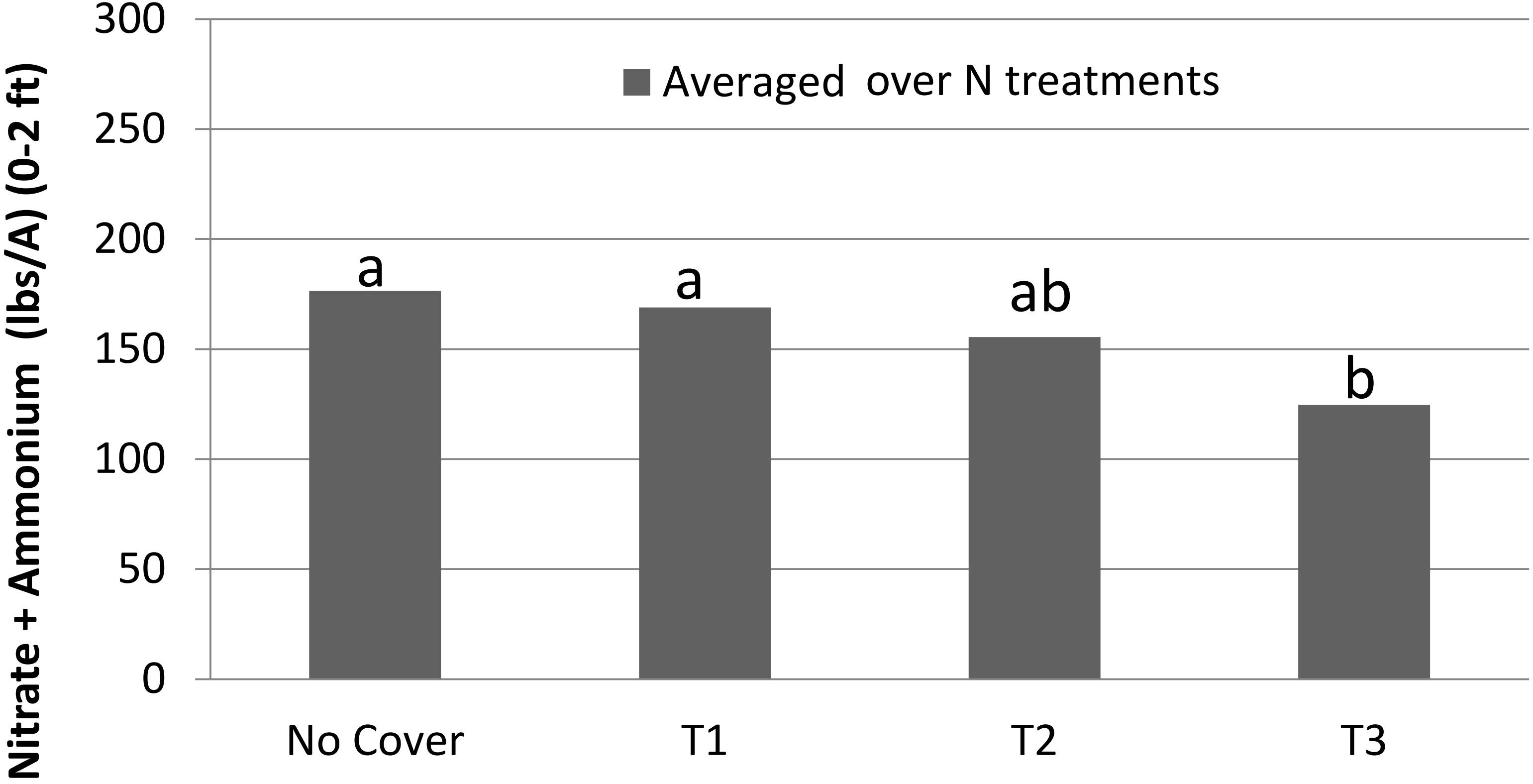


ILLINOIS

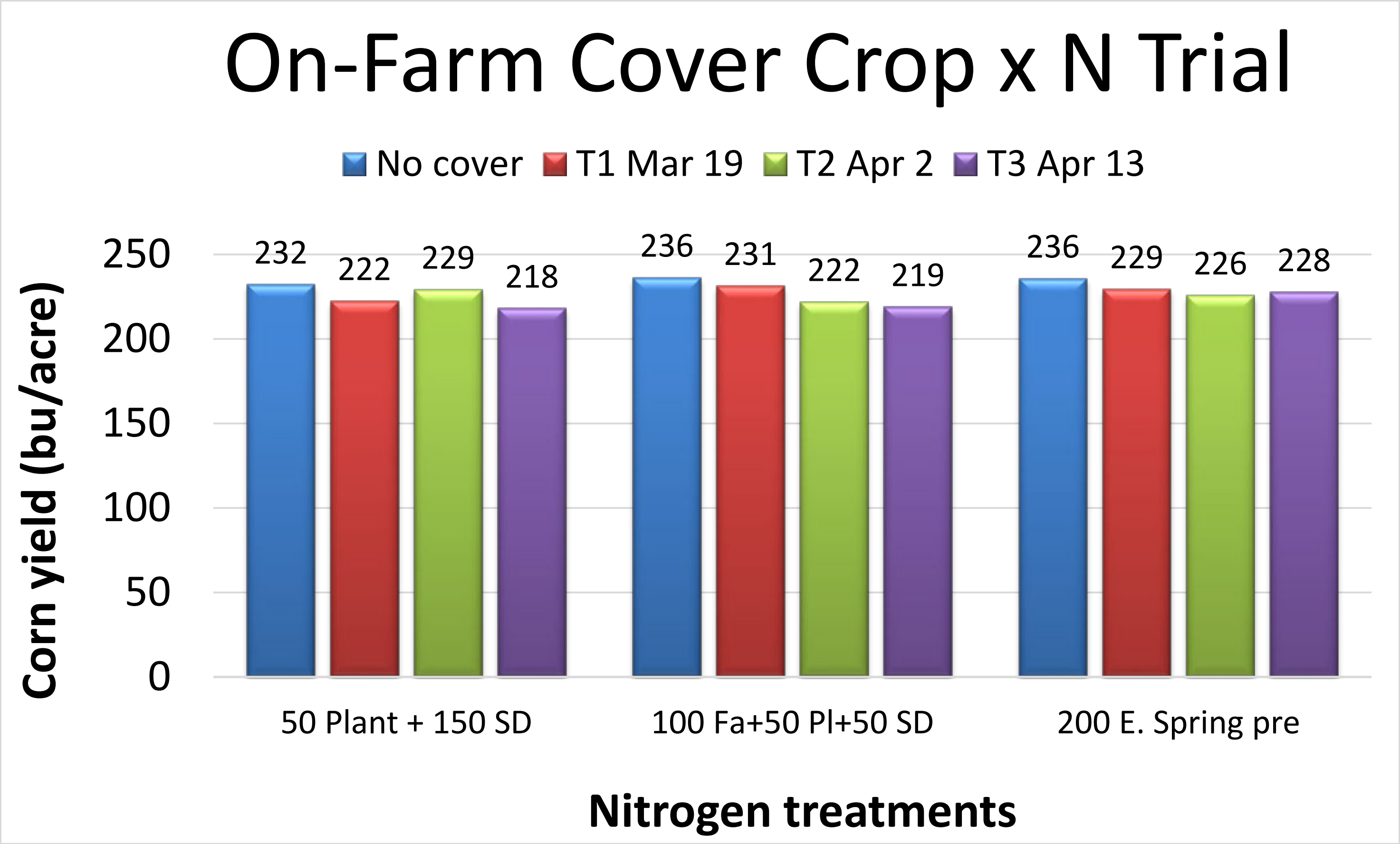
2017 Corn biomass at V7 (52 DAP)



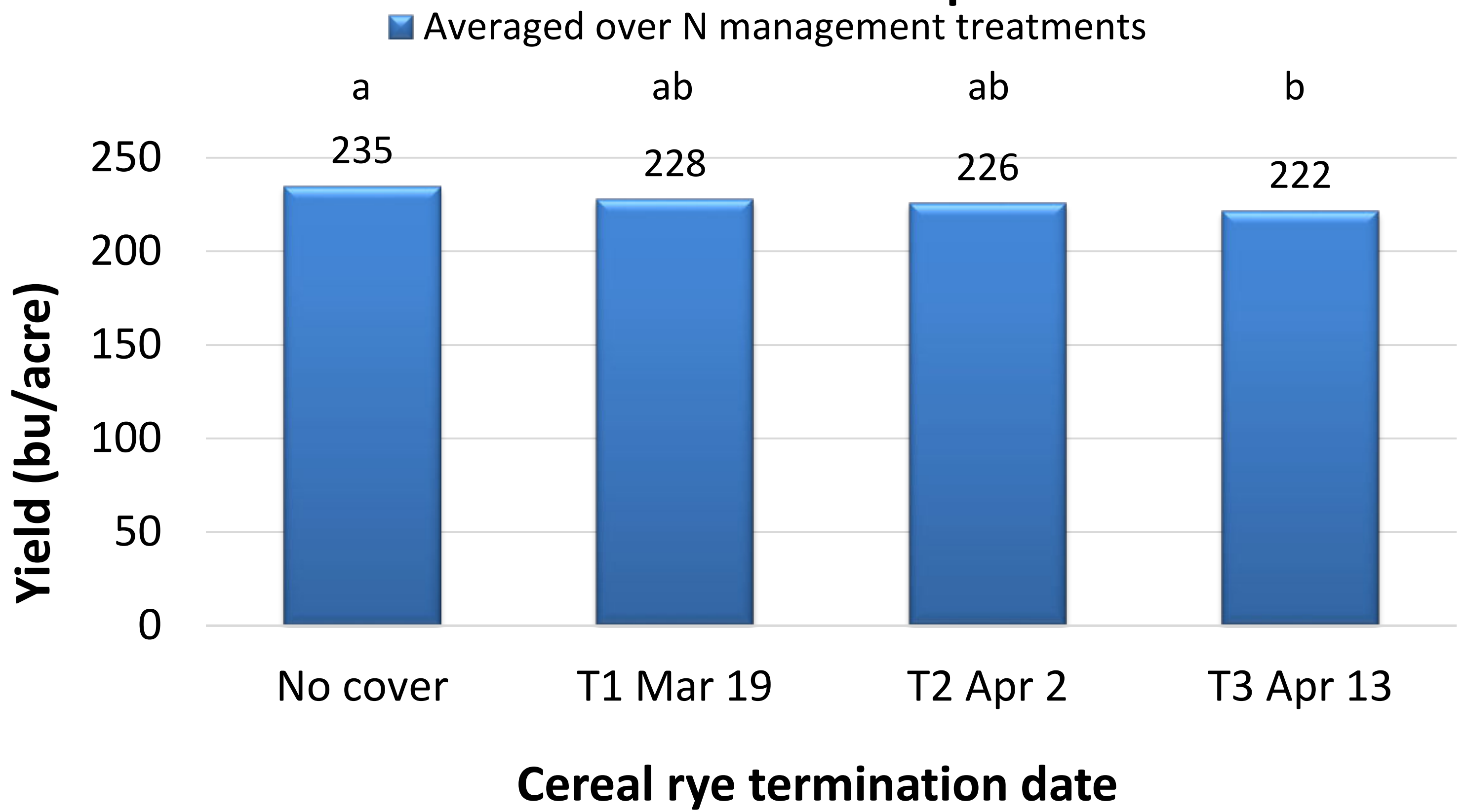
Soil inorganic N at V7



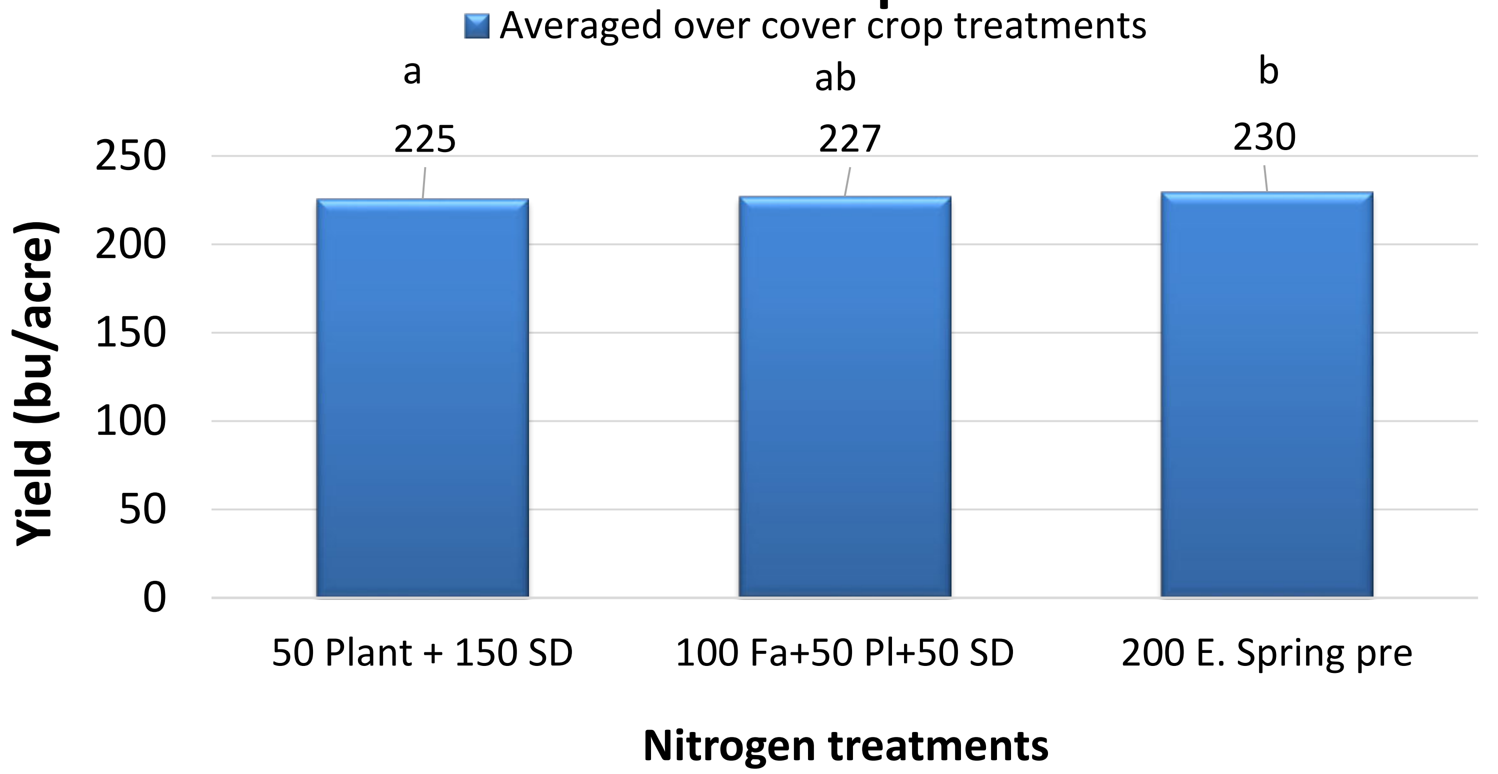
ILLINOIS


On-Farm Cover Crop x N Trial
No cover
T1 Mar 19
T2 Apr 2
T3 Apr 13
Corn yield (bu/acre)
250
200
150
100
50
0
232
222
229
218
236
231
222
219
236
229
226
228
50 Plant + 150 SD
100 Fa+50 Pl+50 SD
200 E. Spring pre
Nitrogen treatments

On-Farm Cover Crop x N Trial

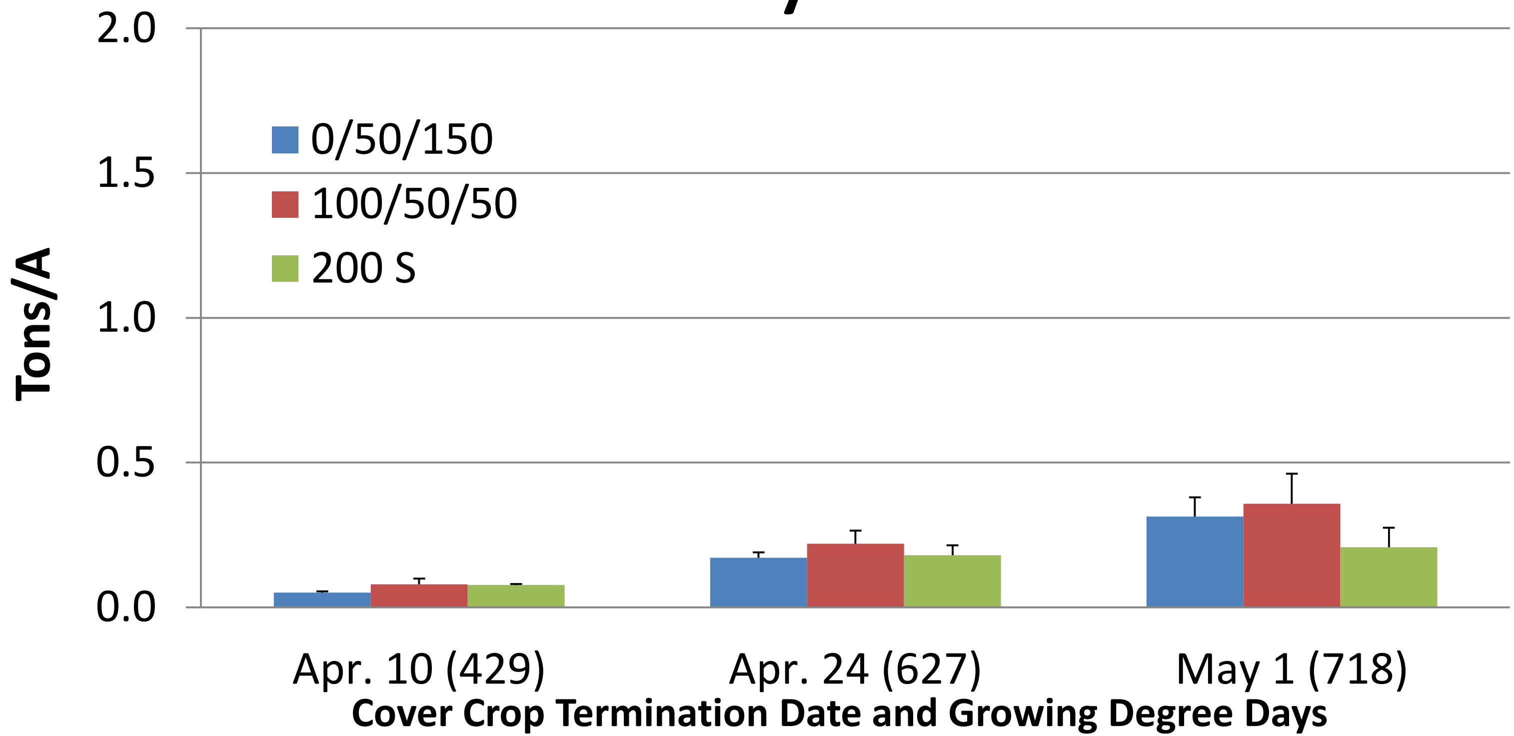


On-Farm Cover Crop x N Trial

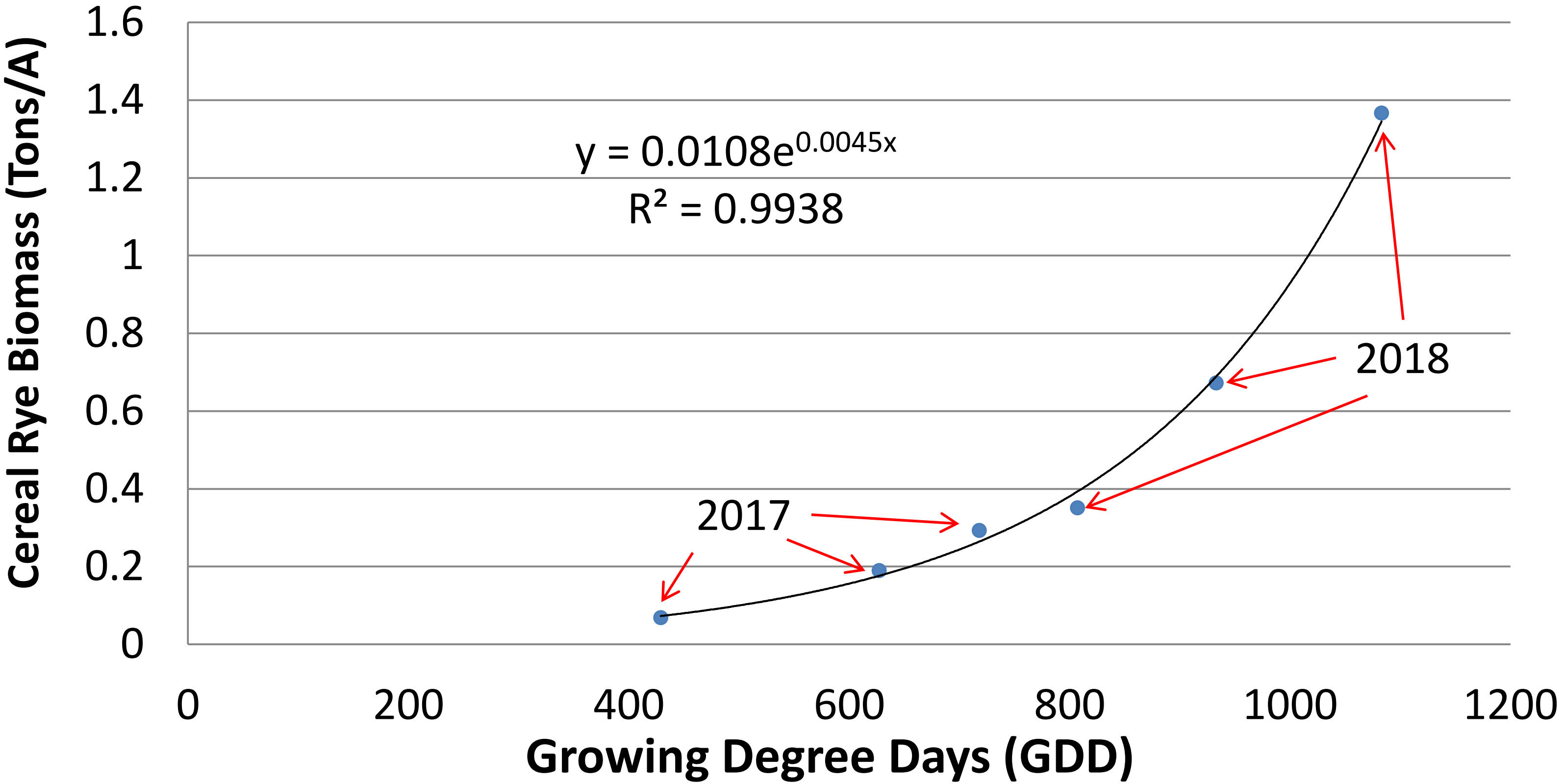


Biomass was much less in 2018

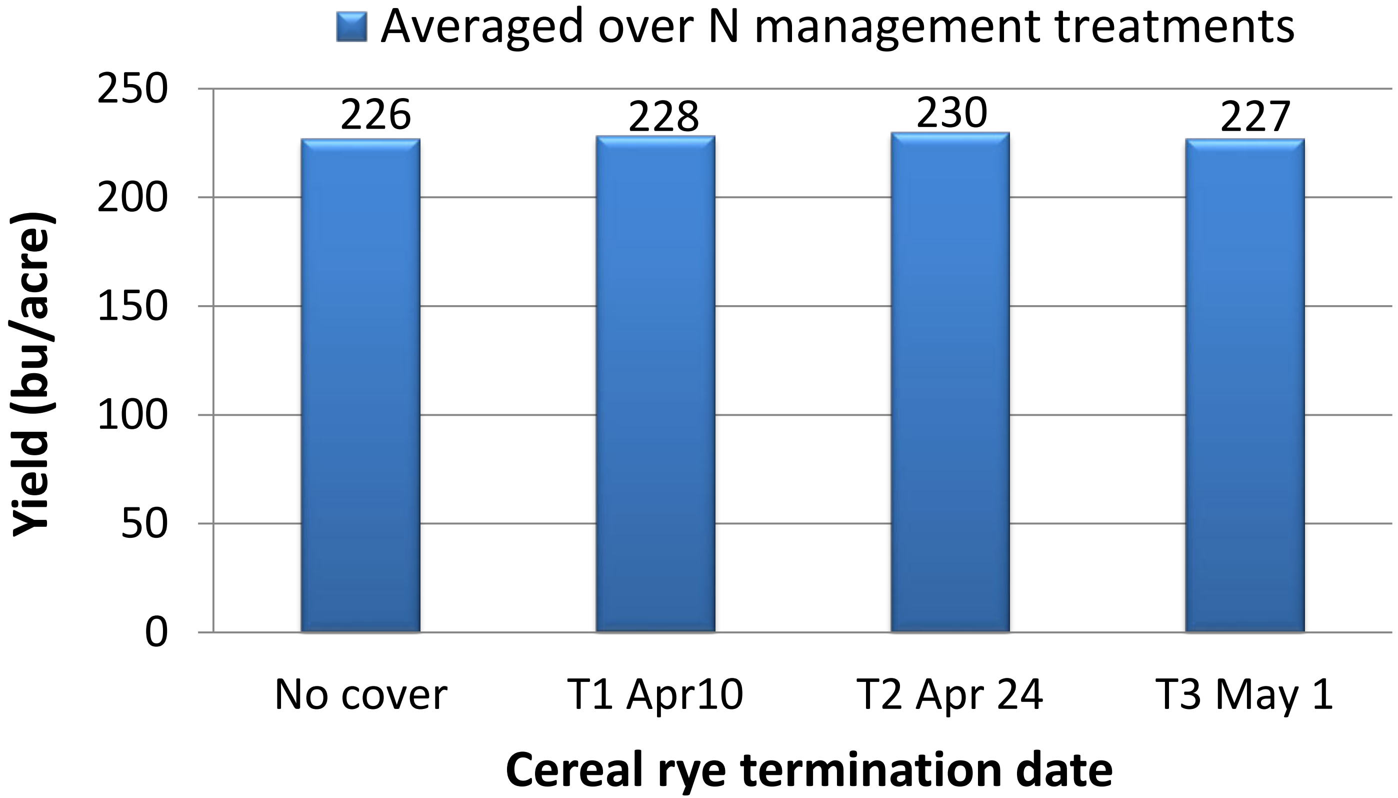
Cereal Rye Biomass



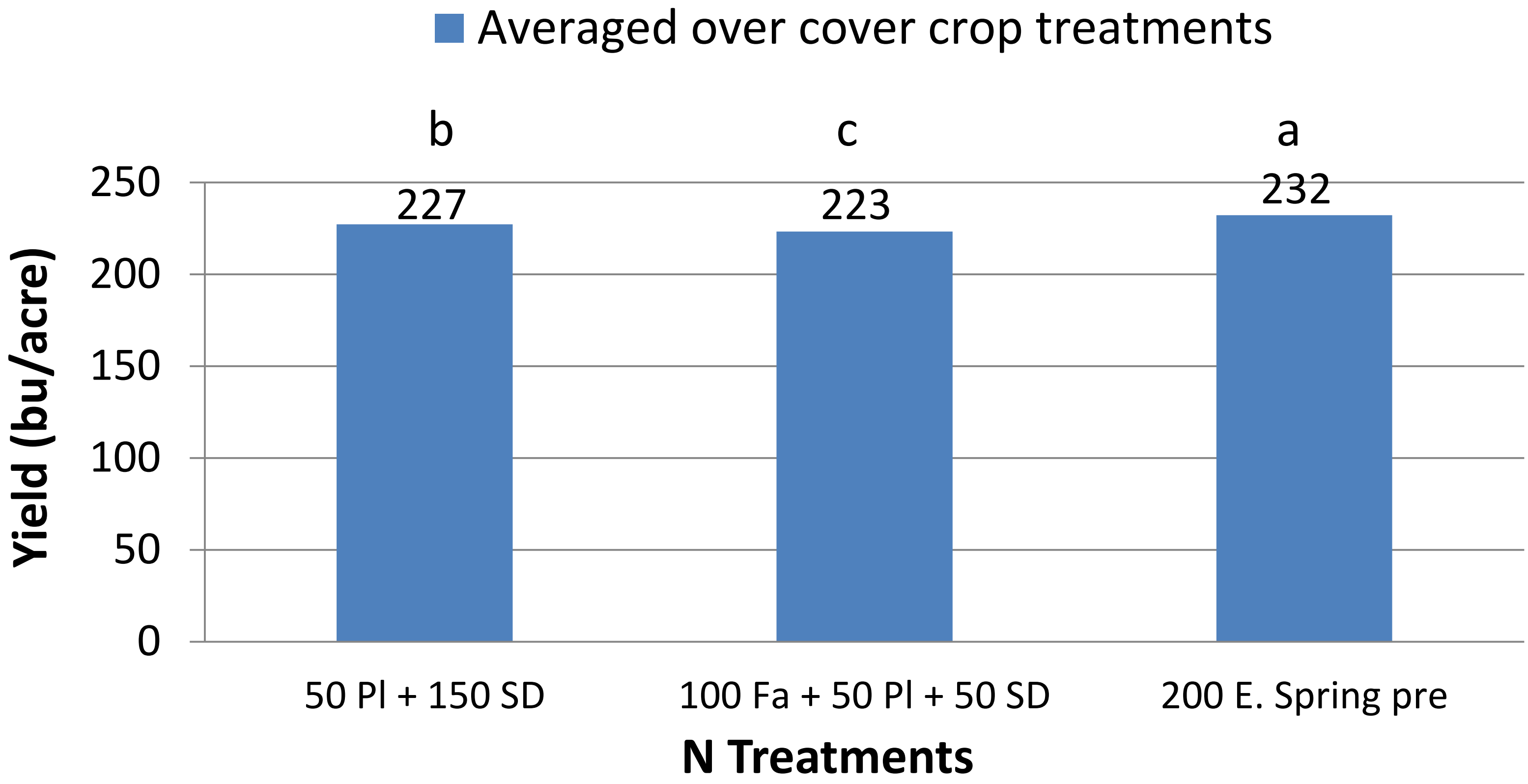
GDD vs. Cereal Rye Biomass 2017 and 2018



On-Farm Cover Crop x N Trial



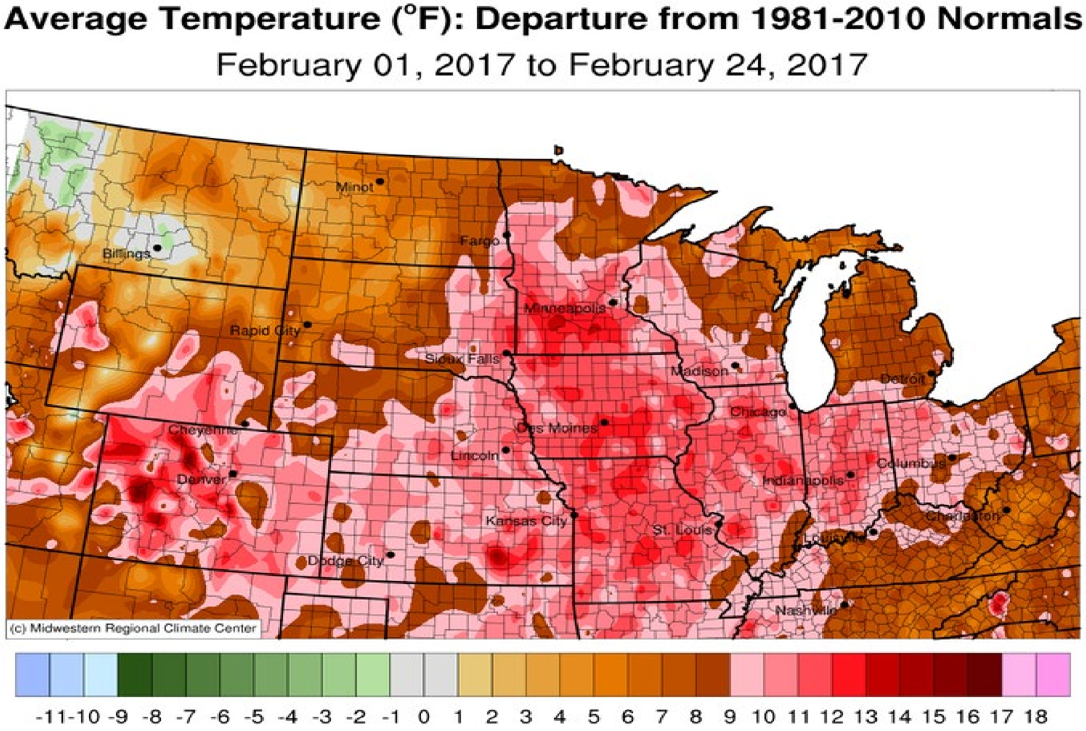
On-Farm Cover Crop x N Trial



Conclusions

- Both years spring N produced the greatest corn yield.
- There is a balance between cover crop biomass production and the potential for the cover crop residue to immobilize soil N, which can lead to delays in early crop growth and lower yield.
- Cereal rye ahead of soybean, let it grow/cereal rye ahead of corn, kill it early (unless it was a cold spring with little growth of the cover crop).

Warm winters are draining our ecological capital from the prairie.

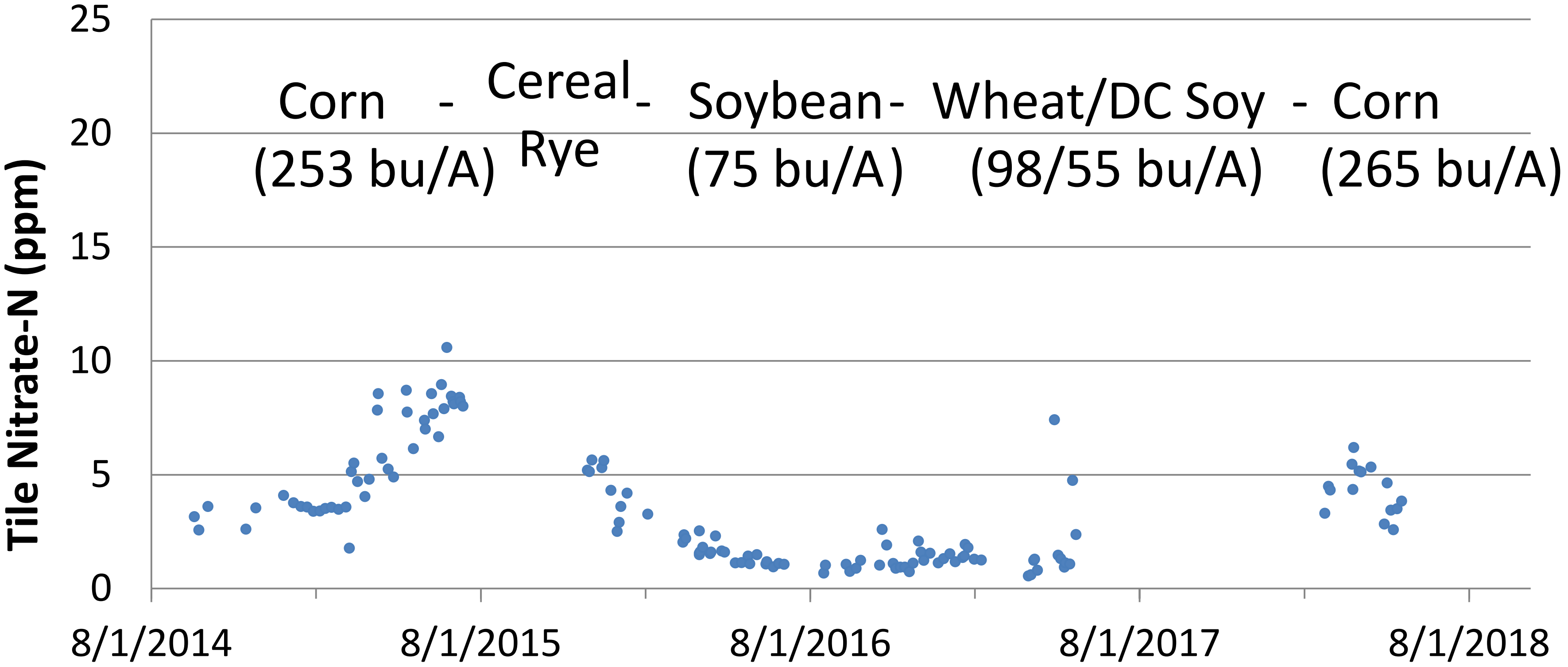


Warm winters enhanced mineralization outside of the row crop growing season.

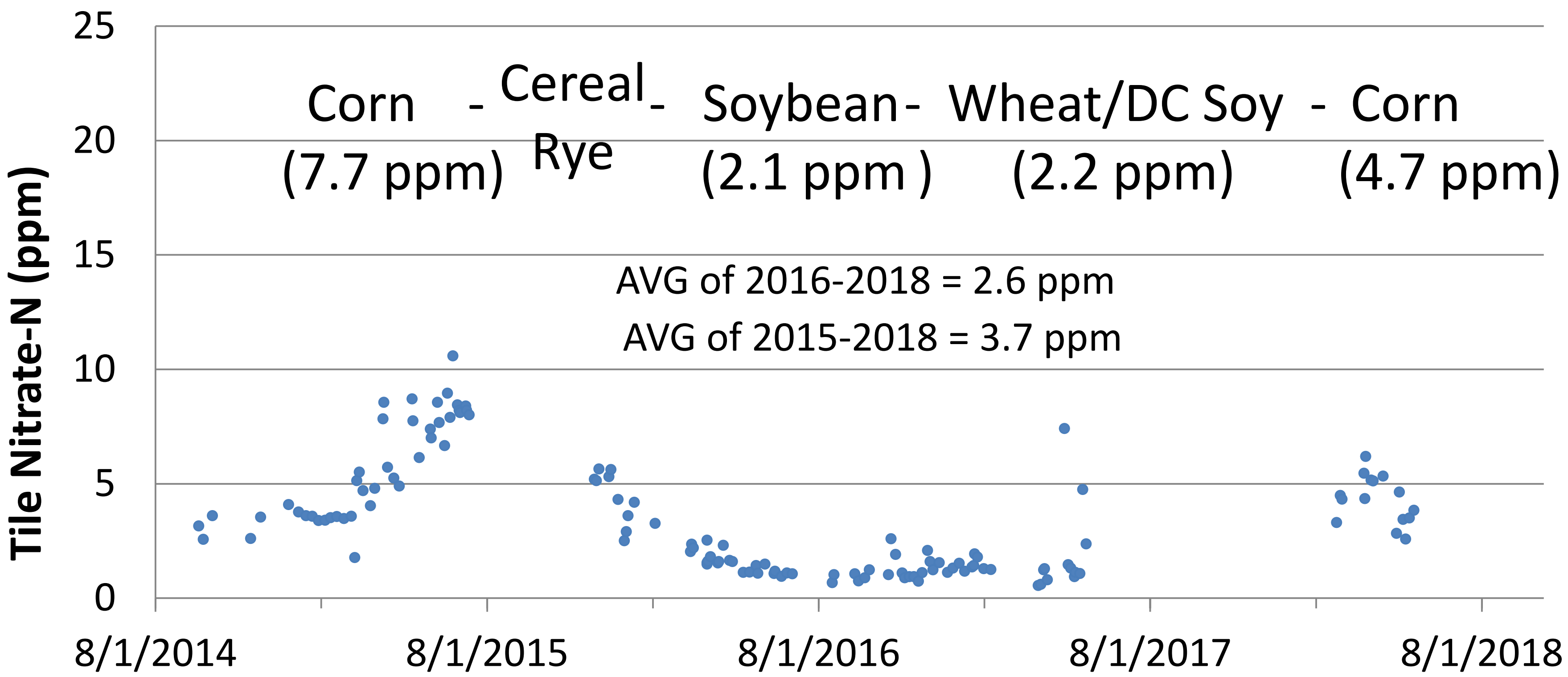
Over-wintering cover crops will capture mineralized N and release it during the growing season.

End of pipe techniques are not the best strategy for preventing this type of loss.

Tile Nitrate Concentration from C-S-W



FWM of Tile Nitrate Conc. from C-S-W



Summary

- In warm winters, cover crops can take up mineralized N and keep it from reaching the tiles.

- If cover crop growth is restricted by a cold winter, cold winters lose less nitrate anyway.

- Cover crops protect the soil, especially following soybean.