Proceedings of the 3rd Annual Nitrogen: Minnesota's' Grand Challenge & Compelling Opportunity Conference

Nitrogen Application Timing, Cover Crops, and Water Quality

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Illinois Nutrient Research & Education Council

Department of Agriculture
Illinois State University

Illinois Nutrient Loss Reduction Strategy

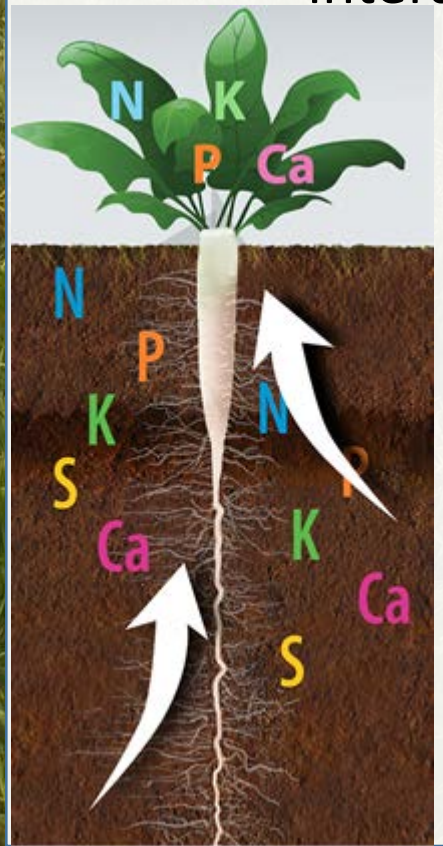
The target is a **45 percent reduction** in total phosphorus and nitrate-nitrogen that reaches Illinois waters **by 2025**.

To achieve those goals, we must enhance the efficiency of all common N management practices

How do cover crops affect N availability and fate within common N management systems of IL?

N Conservation

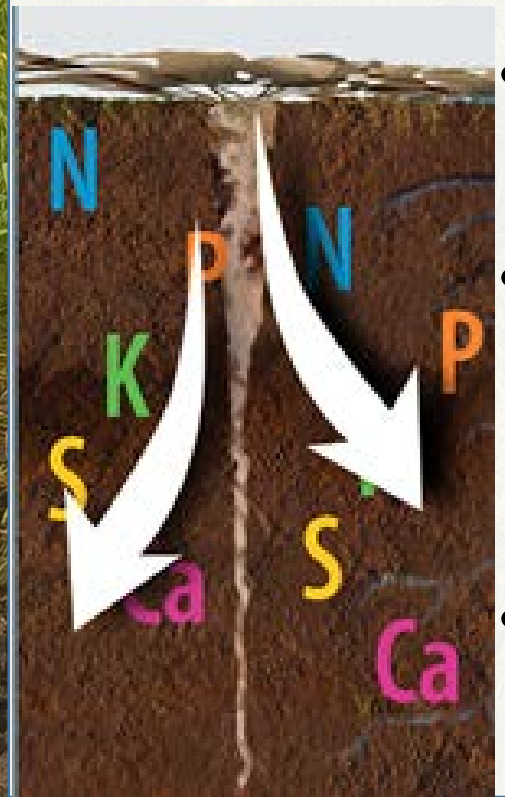
Inorganic N sources do cover crops interact with:



- Soil inorganic N from OM
- Residual N
- Applied N, if a portion of N is applied in the Fall (DAP or Manure)

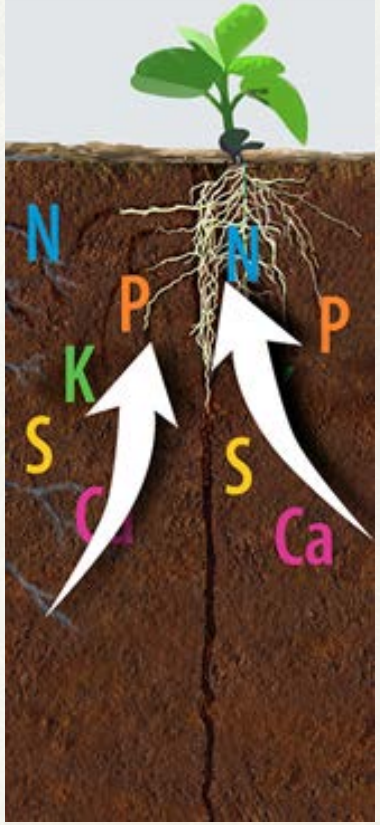
N Release

Cover crop residue N release depends on:



- Physiology
- Species: Legume, grass, cereal
- C:N ratio

N Uptake



Corn and Soybean N and Yield

Effect of Cover Crops and Nitrogen Application Timing on Nutrient Loading Through Subsurface Drainage

Shalamar Armstrong[1], Catherine O'Reilly[2], Richard Roth[3], Mike Ruffatti[3],Travis Deppe[3]and Corey Lacey[4]

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[3]M.S. Candidate In Agriculture Sciences , Illinois State University Department of Agriculture, [4]Graduate Research Assistant, Purdue University Department of Agronomy

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Nutrient Loss Reduction Strategies Evaluated

1. Change N application timing from fall to spring

2. Change N application timing from fall to spring + cover crop

3. Addition of cover crops to fall applied N

    ----Strip-till application of N into a living cover crop

Treatments

1. Control-No Fertilizer and No Cover crop

2. Spring Split Application of Nitrogen (20% Fall -DAP and 80% Anhydrous Ammonium)

3. Spring Split Application of Nitrogen (20% Fall-DAP and 80% Anhydrous Ammonium) + **Cover Crops**

4. Fall Split Application of Nitrogen (70% Fall-DAP and Anhydrous Ammonium and 30% sidedress- Anhydrous Ammonium)

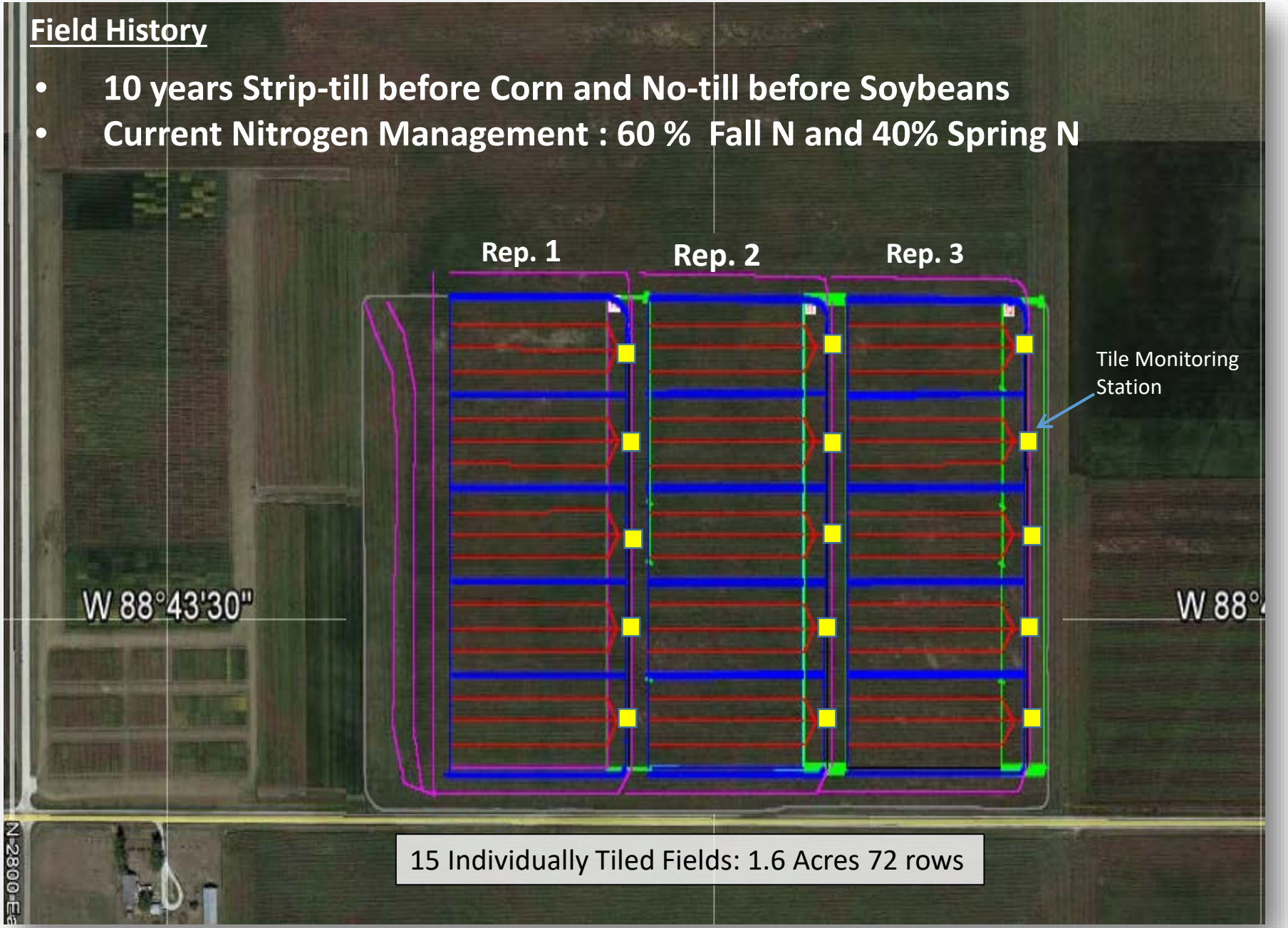
5. Fall Split Application of Nitrogen (70% Fall-DAP and Anhydrous Ammonium and 30% sidedress- Anhydrous Ammonium) + **Cover Crops**

*Fall Anhydrous Ammonia was strip tilled into a living stand of **Cereal and Radish Mix**

Total N rate for all plots: 200 lb/A

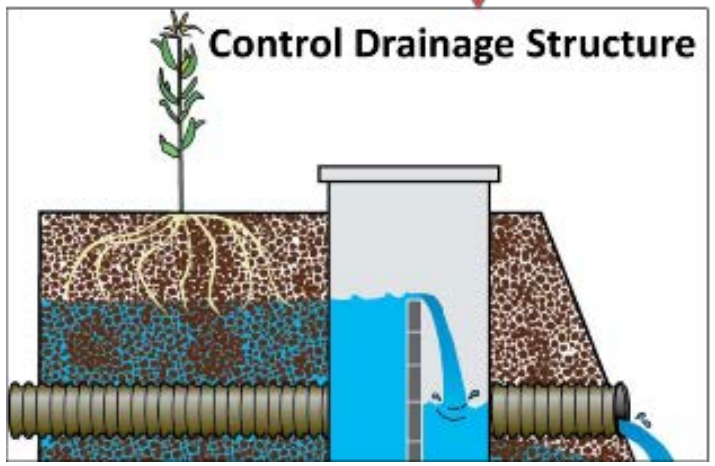
Field History

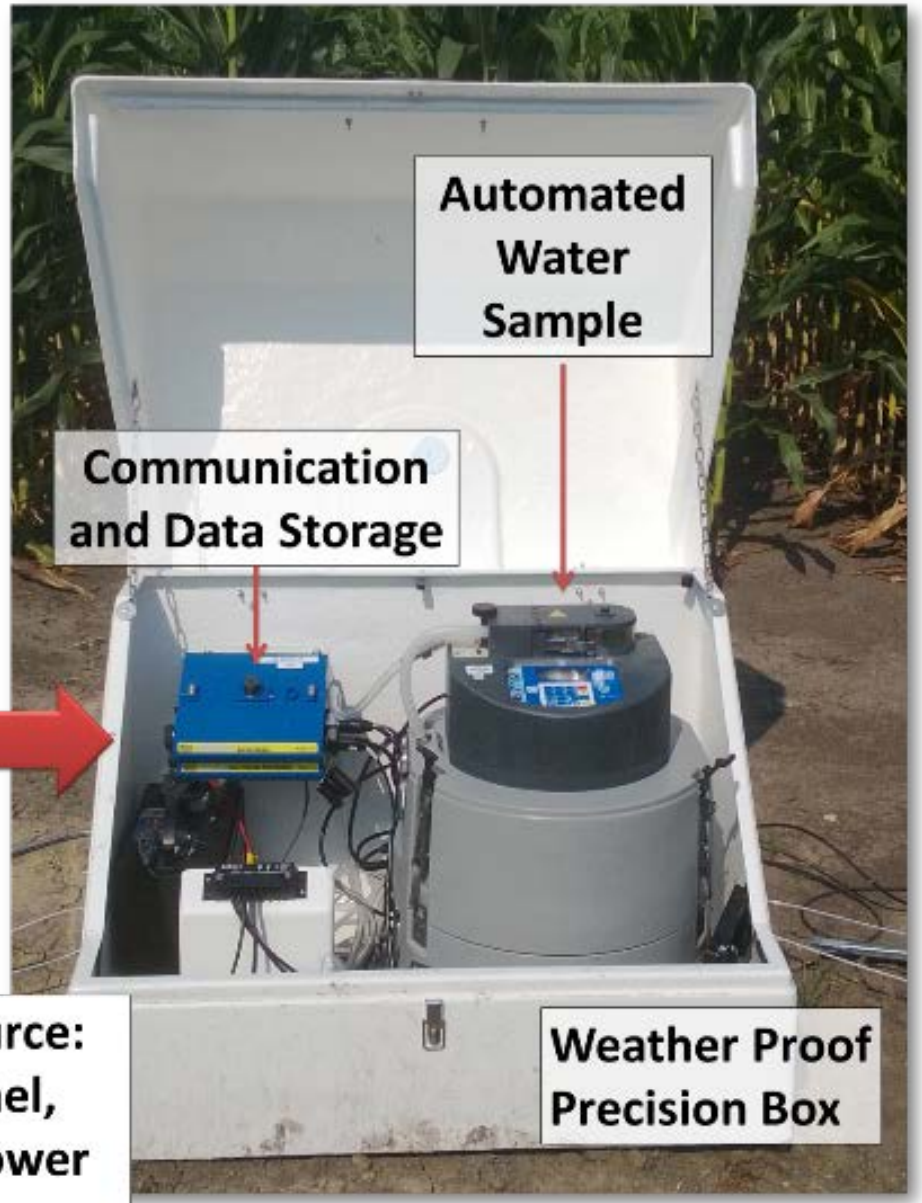
- 10 years Strip-till before Corn and No-till before Soybeans
- Current Nitrogen Management : 60 % Fall N and 40% Spring N



15 Individually Tiled Fields: 1.6 Acres 72 rows

Tile Monitoring Station





Methodology – Cover Crop Planting

<u>Cover Crop Mixture</u>
Daikon Radish (8%) Cereal Rye (92%)

<u>Seeding Rate:</u> 84 kg ha^{-1}

<u>Planting Date:</u> Early to mid- Sept.


Planted September 12, 2014
17 days after Planting

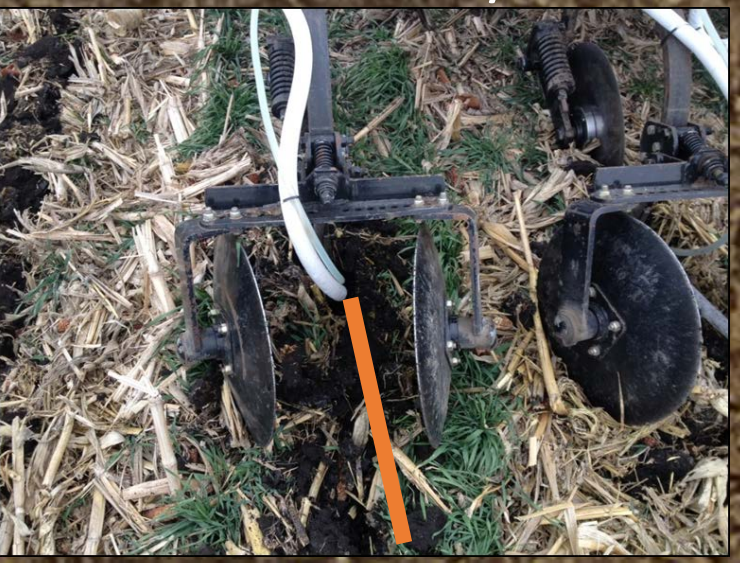

December 4, 2014


December 4, 2015

Precision Cover Crop and N Management

Precision Planting
Into fall N and Cover Crops residue

Fall Strip-till AA injection
corn-corn 2014/2015



Precision Field Management

Fall Strip-Till and N application into living cover crop stand and soybean residue going into corn 2017.

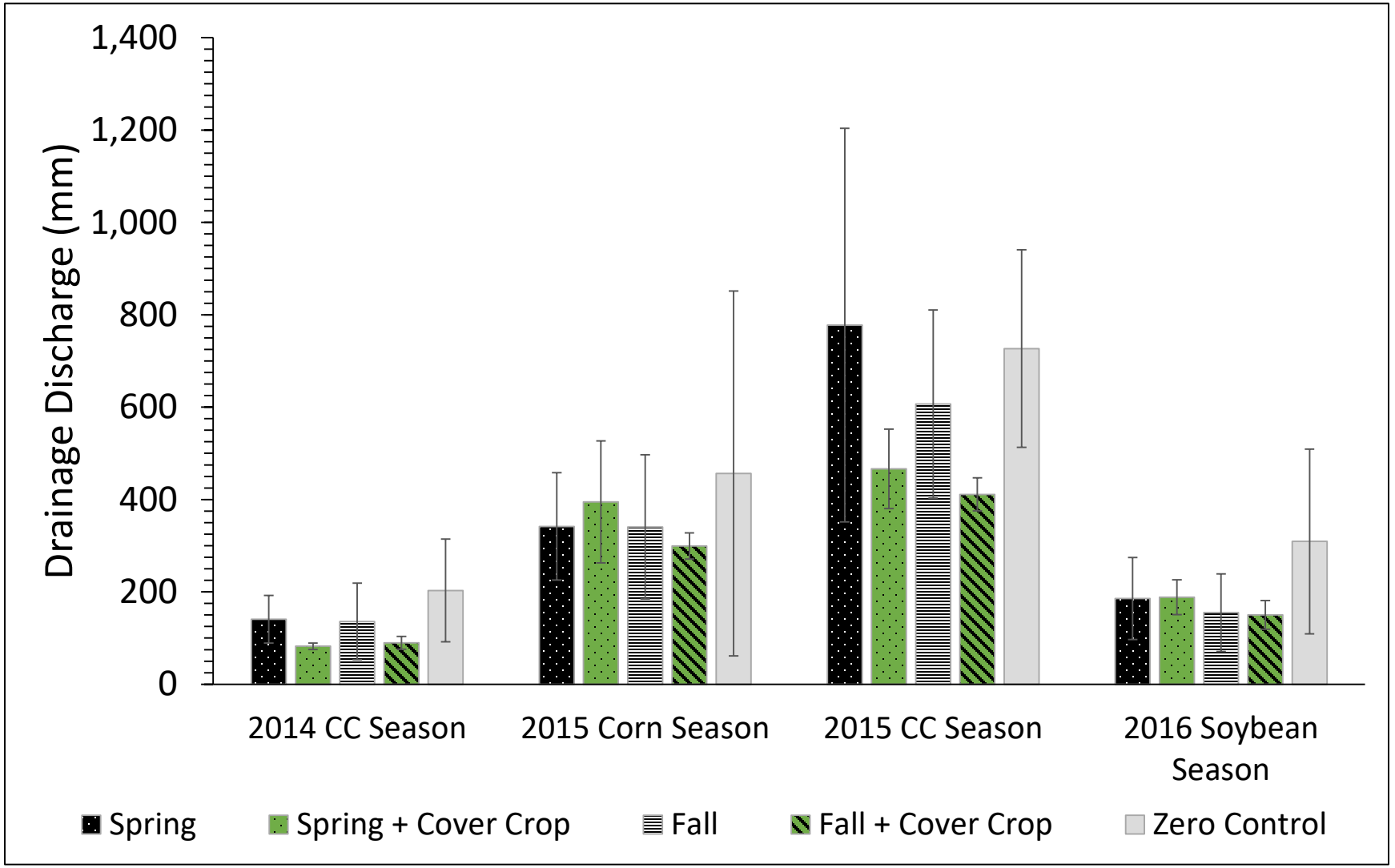
Cover Crop Biomass and N Uptake

Sampling Time	Treatment	Average Above Ground Biomass (lb A^{-1})	Average N Uptake (lb A^{-1})
Fall 2014	Fall N + CC	263	10
Fall 2014	Spring N + CC	211	9
Spring 2015	Fall N + CC	936	49
Spring 2015	Spring N + CC	821	36
Fall 2015	Fall N + CC	1224	49
Fall 2015	Spring N + CC	1299	56
Spring 2016	Fall N + CC	1628	54
Spring 2016	Spring N + CC	1941	63

On average, cover crops absorbed 25% (51 lb A^{-1}) of the total N rate applied.

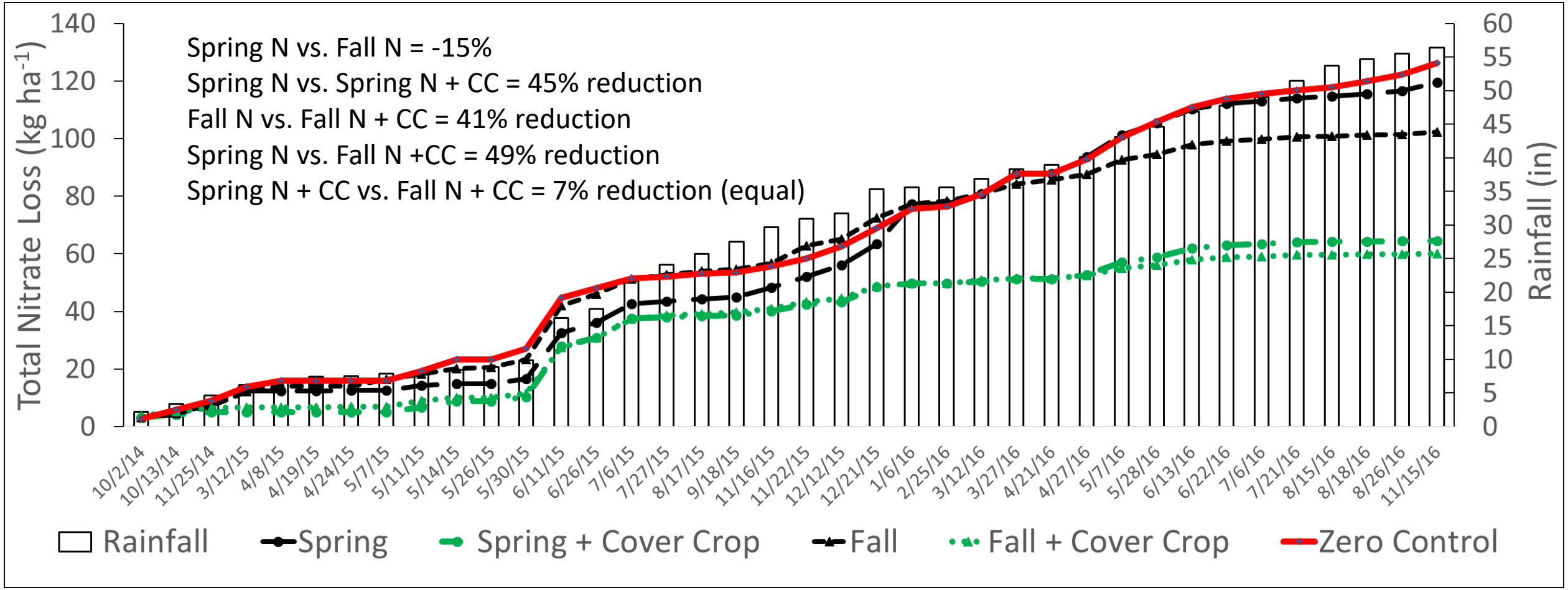
Within the cereal rye/radish mixture, radish is responsible for 55% of biomass produced and 51% of N uptake

Cover Crops impact on Total Discharge by Season

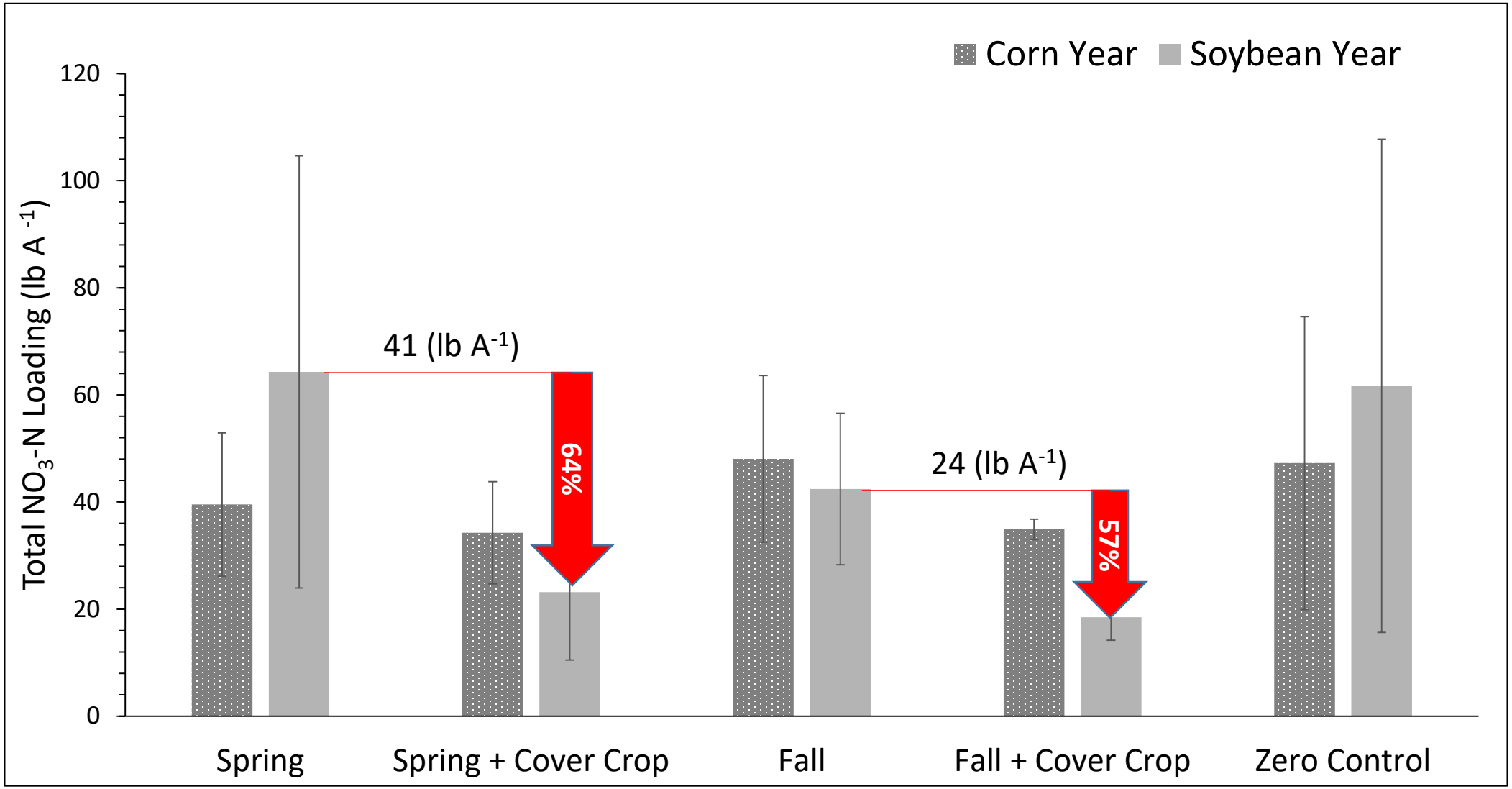


- 32-42% reduction in drainage during cover crop growing seasons
- Little to no impact of cover crops on discharge during cash crop seasons

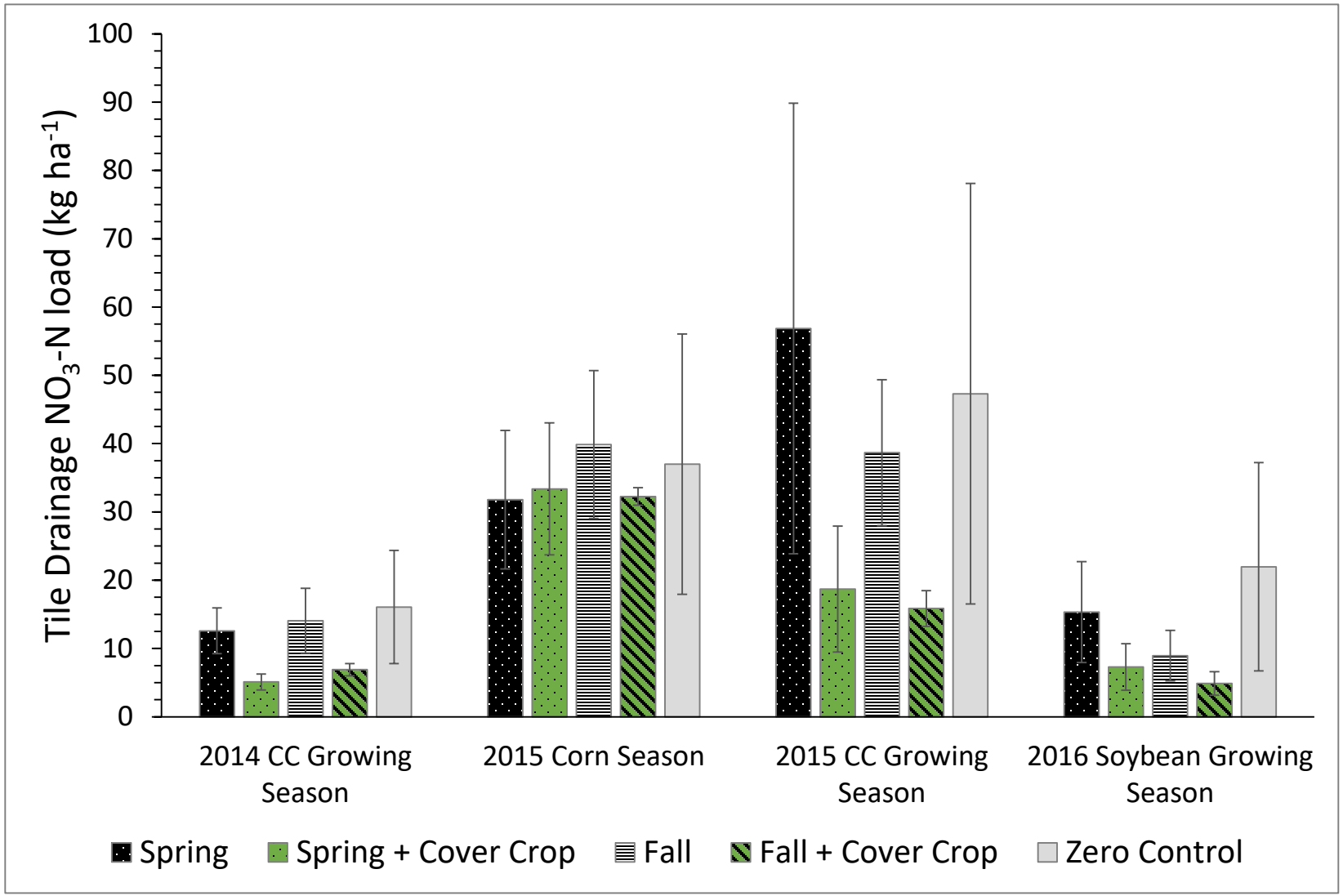
Cumulative Rainfall and Nitrate Loading



Cover crop impact on residual N loading in the soybean year following corn

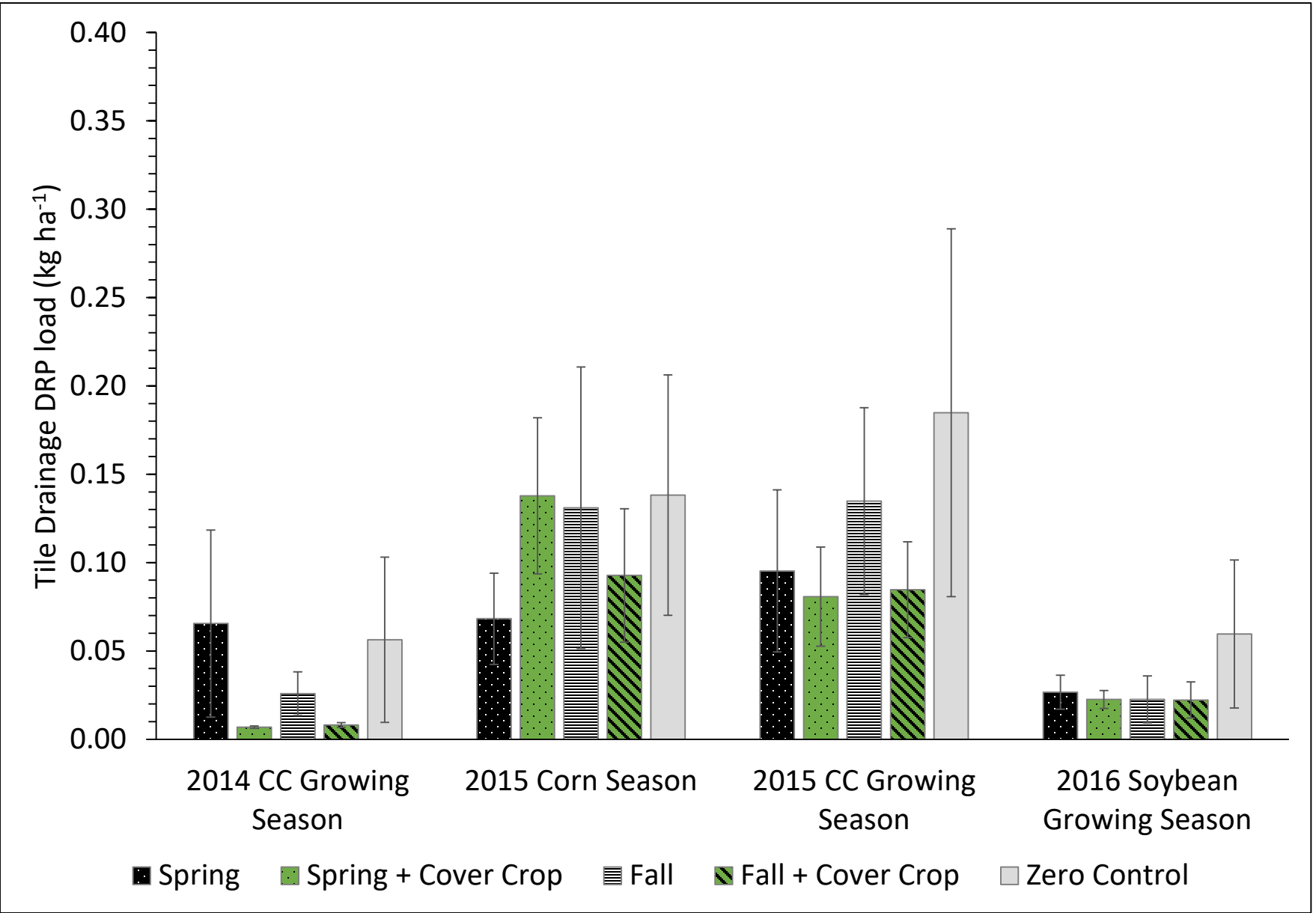


Cover Crop Impact on Nitrate Load by Season



- 51-67% reduction with cover crops during cover crop growing seasons
- 2015 CC growing season was warm and wet
  - SN vs FN: 47% increase

Cover Crops Impact DRP Load by Season

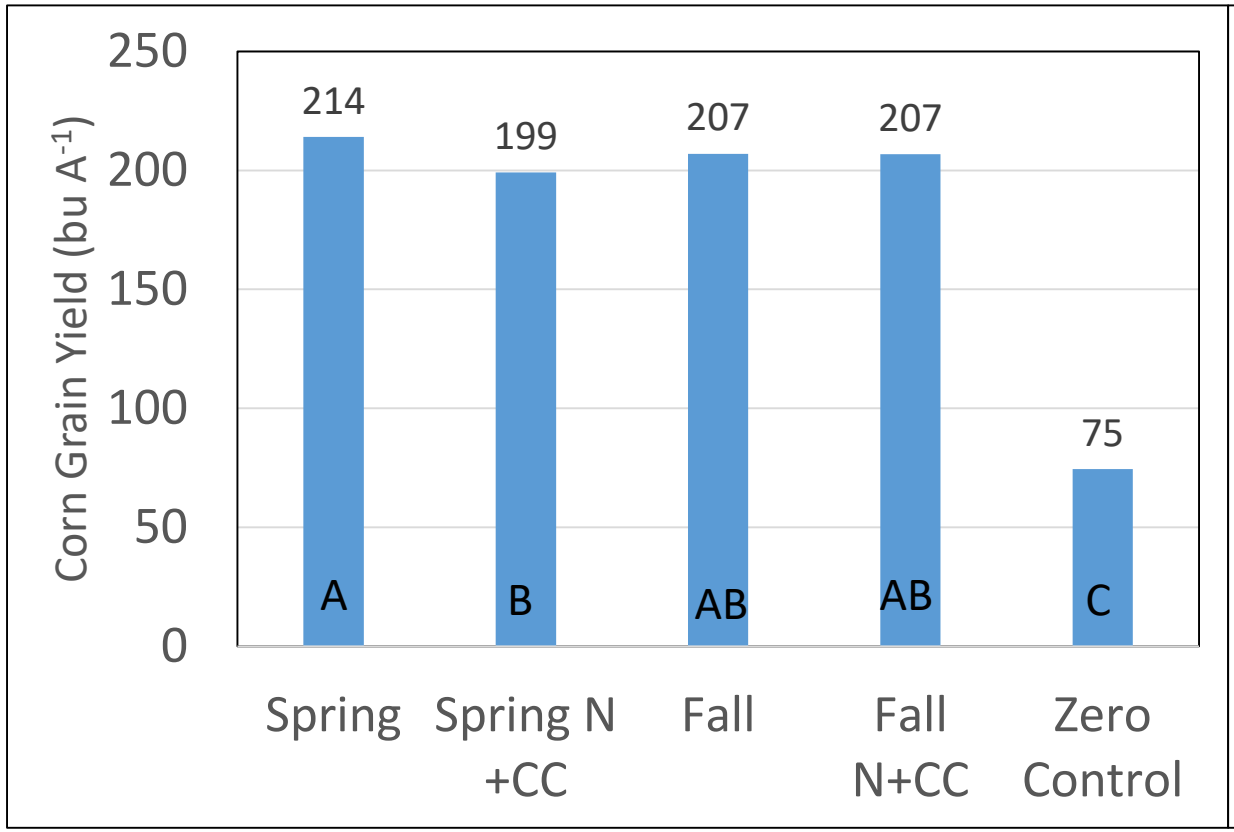


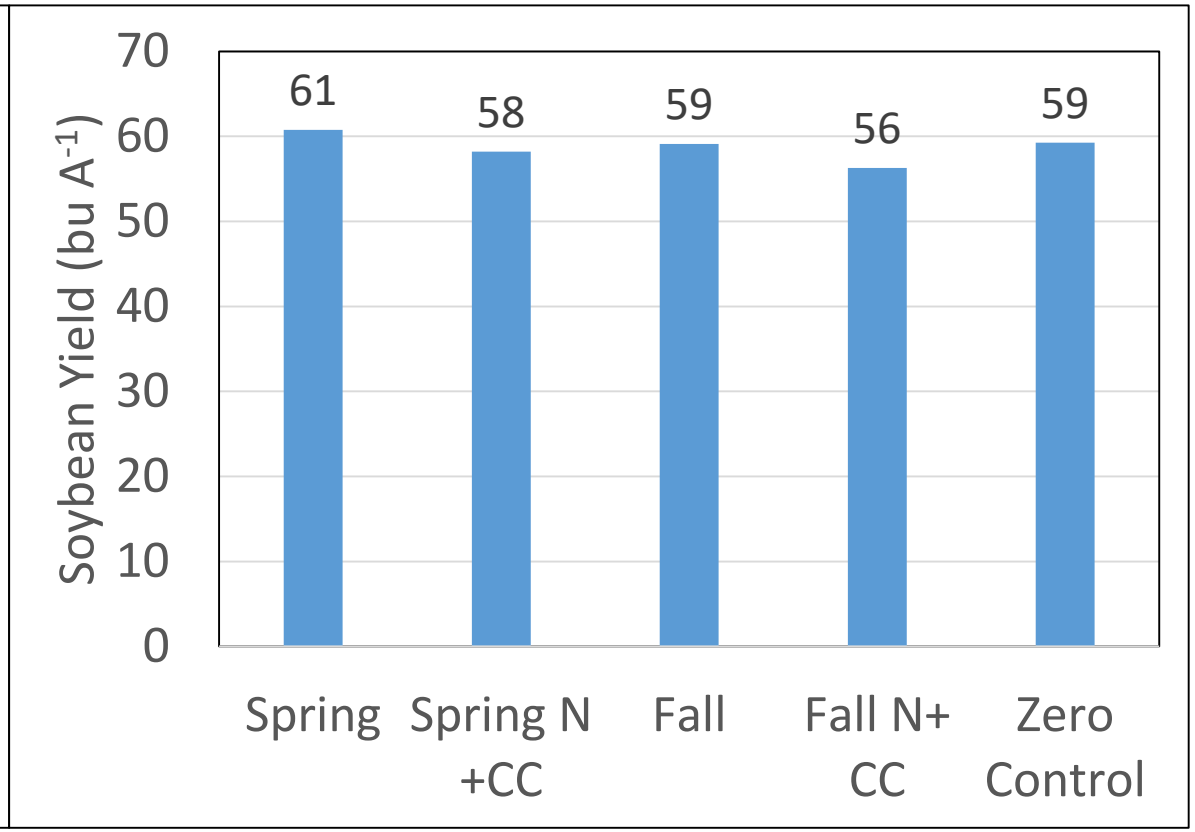
Cover Crop Seasons

- Spring system: 15-90% reduction with cover crops
- Fall system: 37-69% reduction with cover crops

Little to no impact of cover crops on DRP load load during cash crops season

Cover Crop Impact on Cash Crop Yield





Summary

- On average cover crops stabilized 50 lb N A^{-1}
- Despite N management system (Fall or Spring) cover crops reduced N loss via tile drainage by 41-49%. Spring N + CC = Fall N + CC
- Cover crops are most effective when they are growing.
- Cover crops reduced corn N uptake and yield in the spring system, but not in the fall N system.
- Cover crops did not impact soybean yield.

The Effect of Cover Crops on Surface Water Quality: A Paired Watershed Experiment in the Lake Bloomington Watershed.

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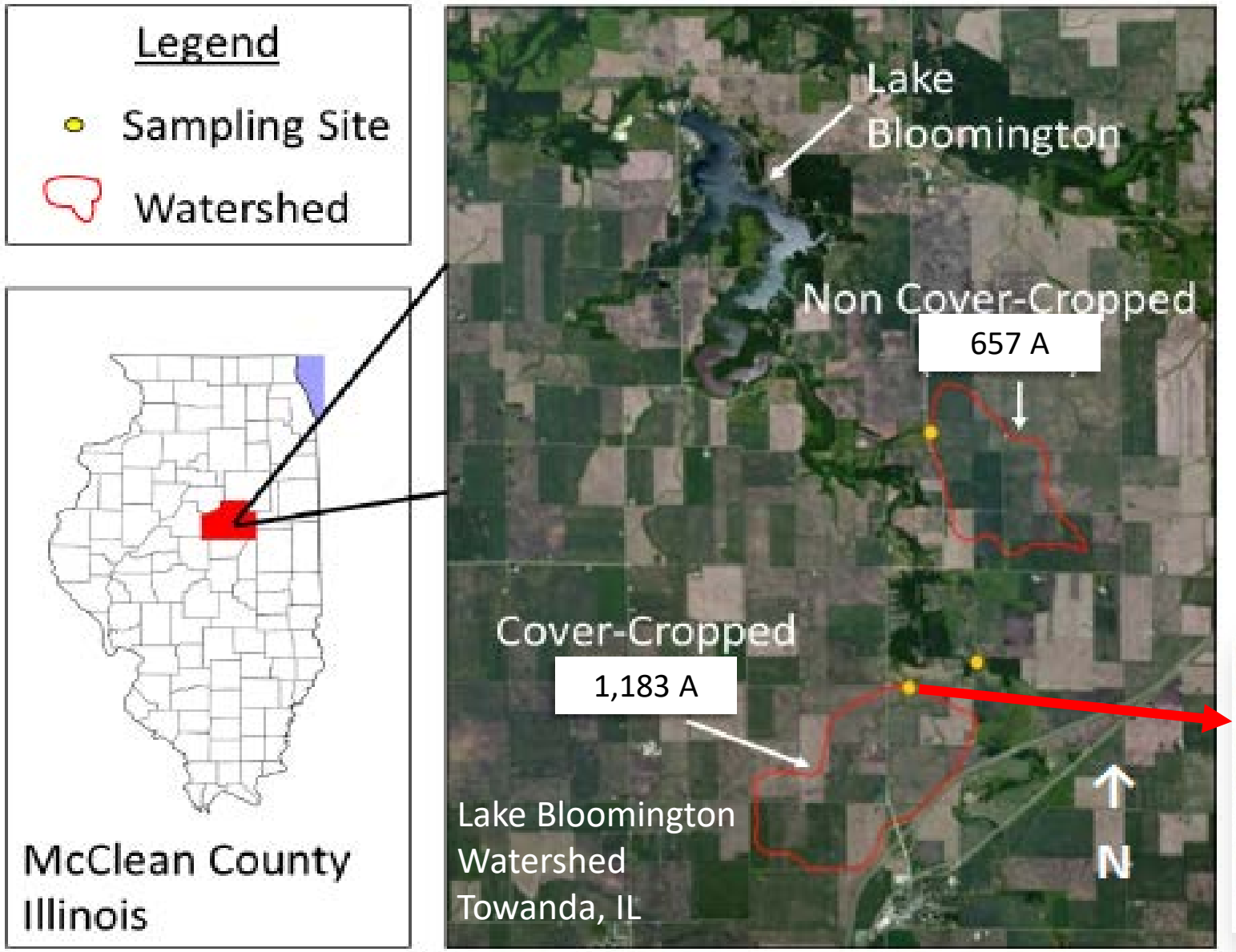
[2]Assistant Professor Agronomy, Agronomy Department, Purdue University,
[3]Graduate Student, Department of Geography-Geology, Illinois State University,
[4]Graduate Student, Agronomy Department, Purdue University, and [5]Department of Agriculture, Illinois State University

Lake Bloomington Watershed Scale



2016 Control

44% Corn/56% Soybean

2016 Treatment

32% Corn/68%Soybean

Fall 2015 Aerial Cover Crops Application 8/28/15-9/9/15

Approximately 48% (~ 567 A) of the treatment watershed was treated with cover crops.

11/28/2015, Schertz Aerial


Cereal Rye/Radish in Corn
10/5/15


Radish/Oats in Soybean
11/18/15


Radish/Oats in Soybean
11/18/15


Cereal Rye/Radish in Corn
12/15/15


Schertz Aerial, Fall 2016


Schertz Aerial, Fall 2016


2016 Soybean Harvest

Fall and Spring Cover Crop Biomass Samples

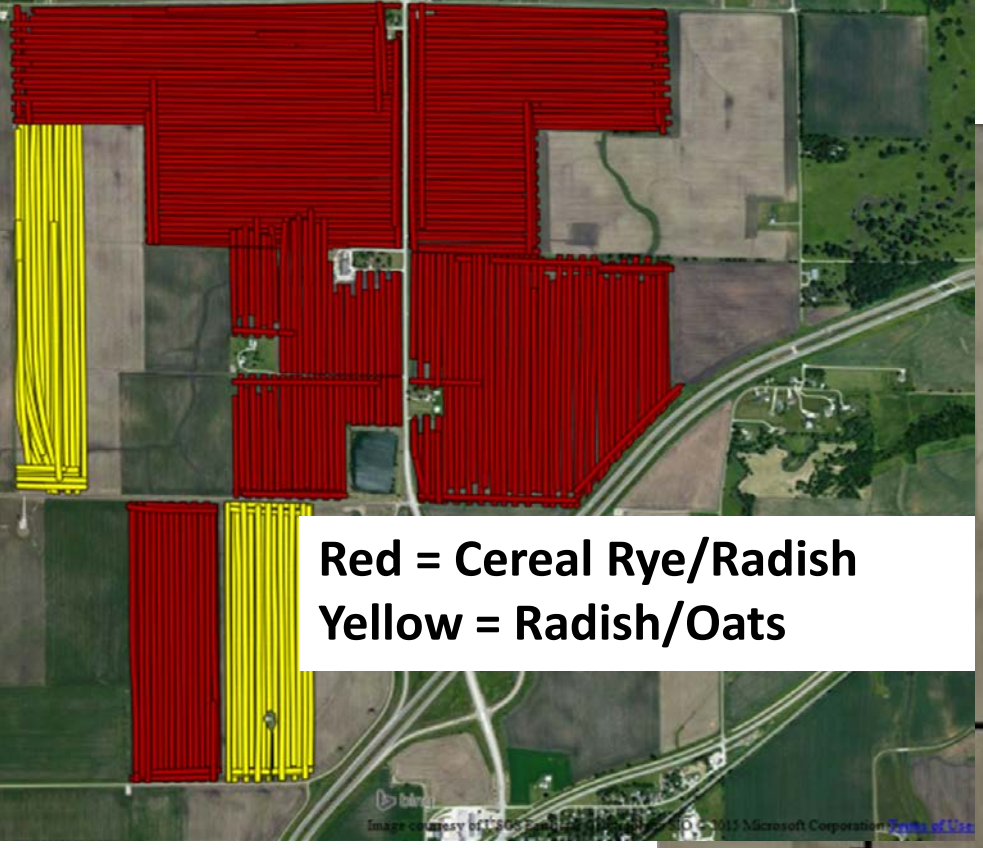
Above ground biomass was collected from a 1 m quadrant from 8 ha grids across the watershed.

Fall sampling: 11/28/15

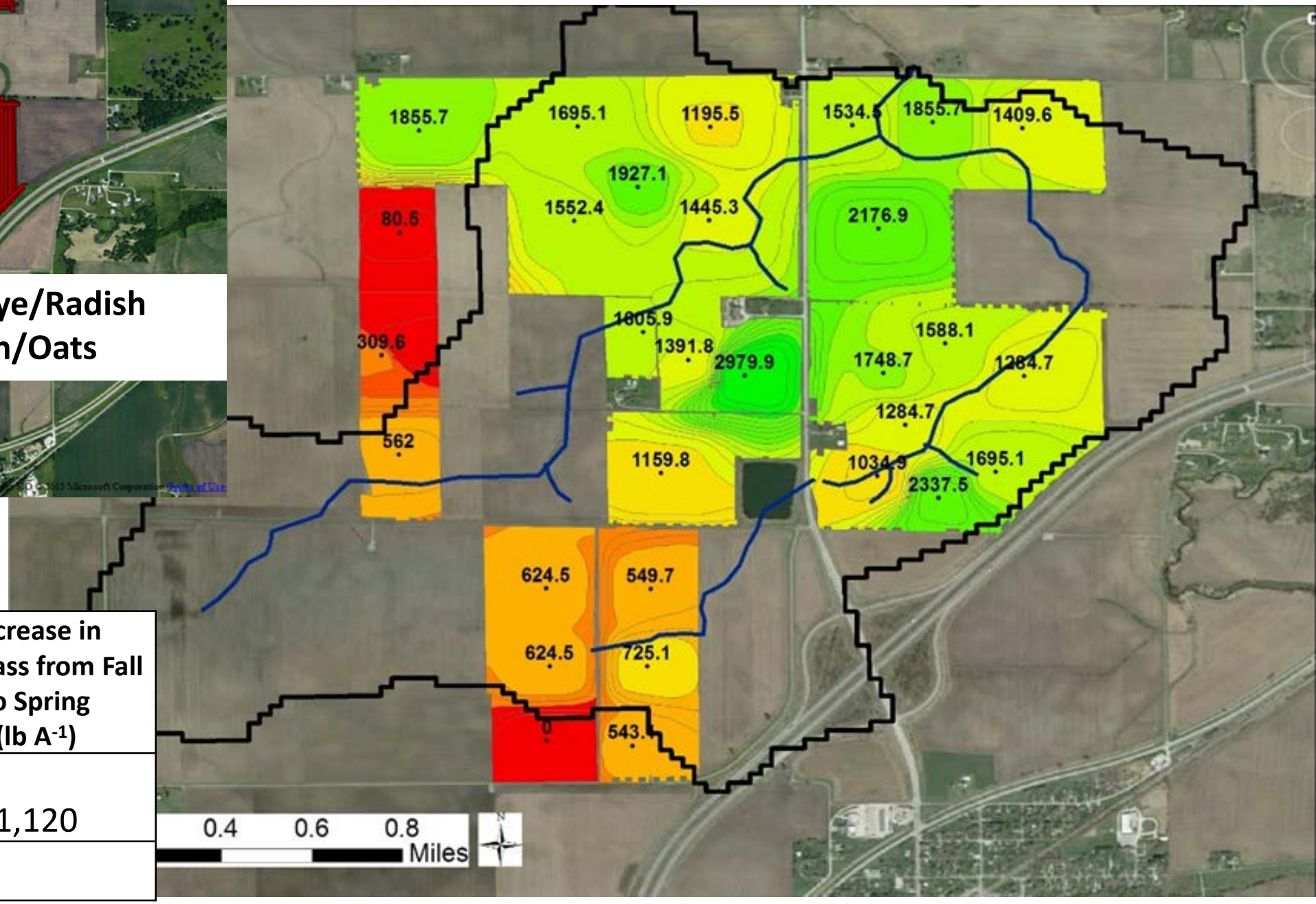
Spring sampling:4/2/15

Biomass samples were dried and analyzed for %N to determine cover crop N uptake

2015/2016 Cover Crop Biomass

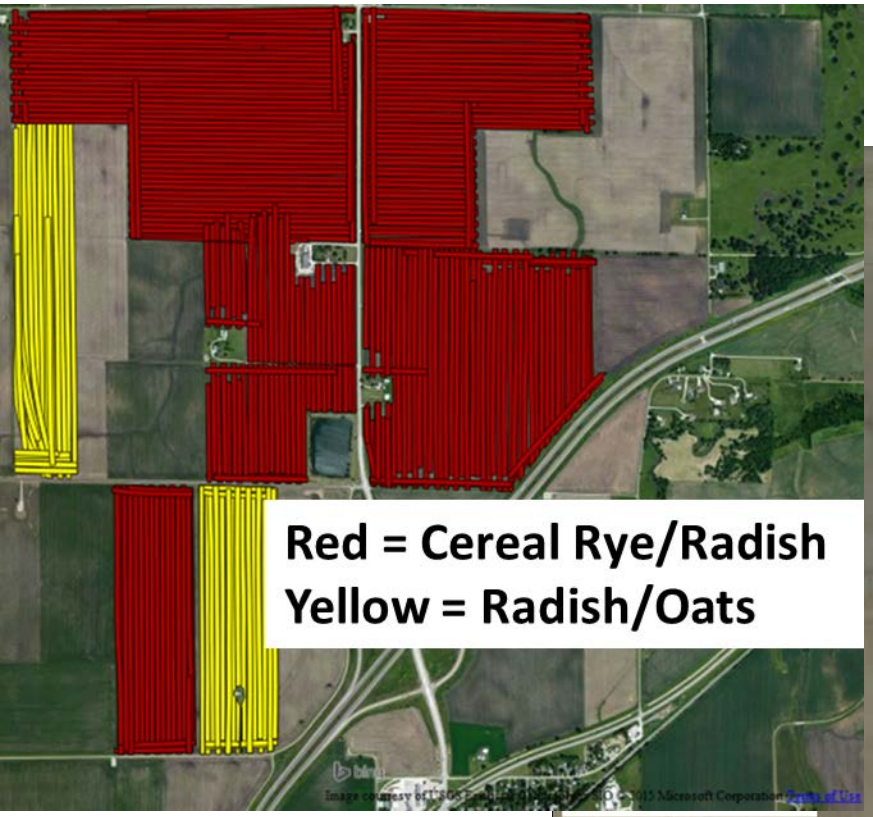


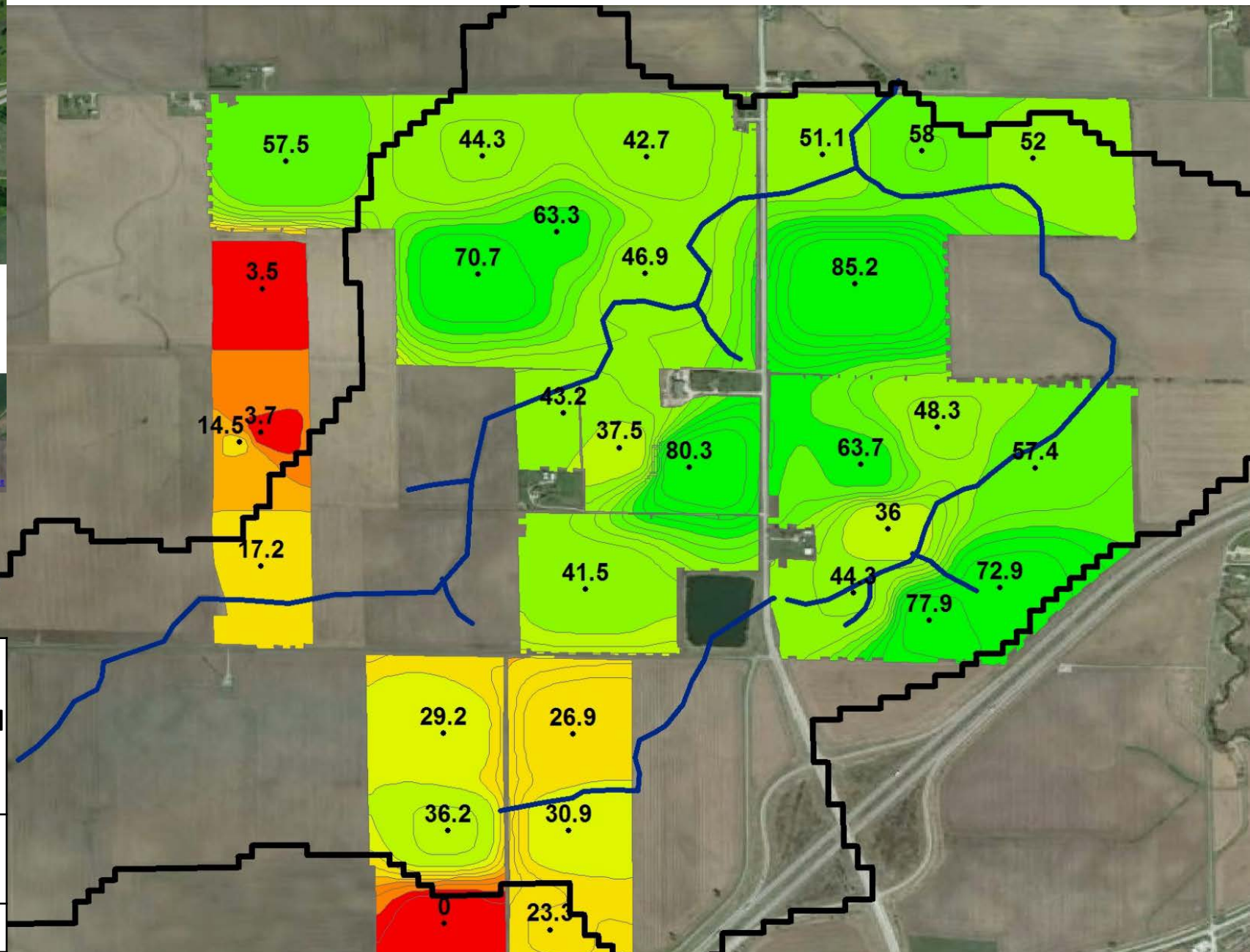
Red = Cereal Rye/Radish
Yellow = Radish/Oats



	Cover Crop Biomass (lb A^{-1})	Increase in Biomass from Fall to Spring (lb A^{-1})
CR/ Radish	1,497 A	1,120
Radish/Oats	409 B	

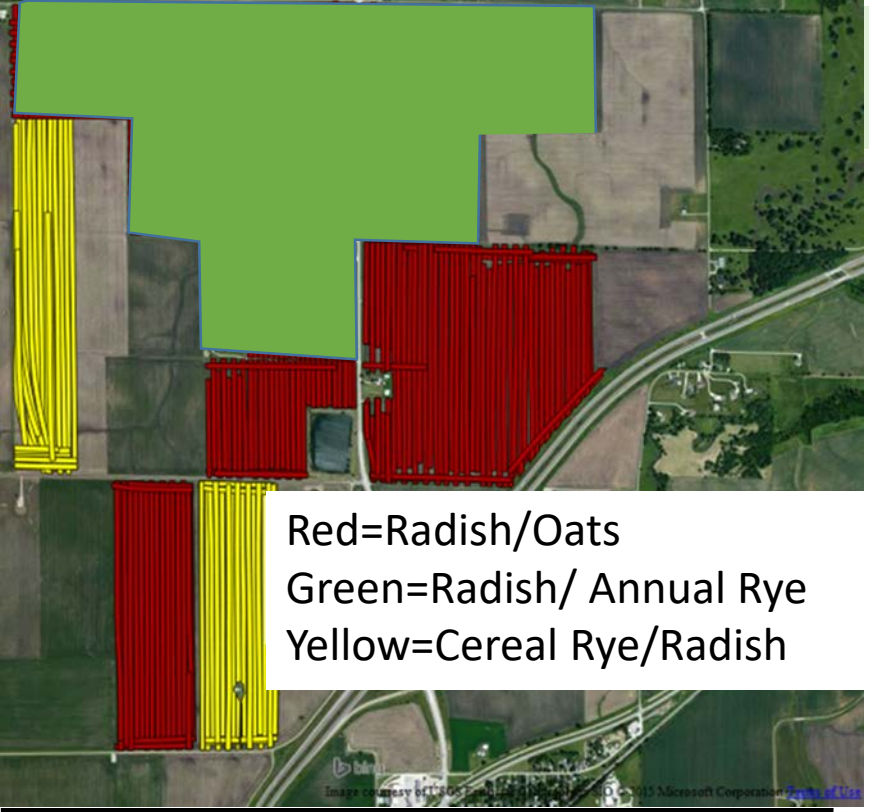
2015/2016 Total Cover Crop N Uptake



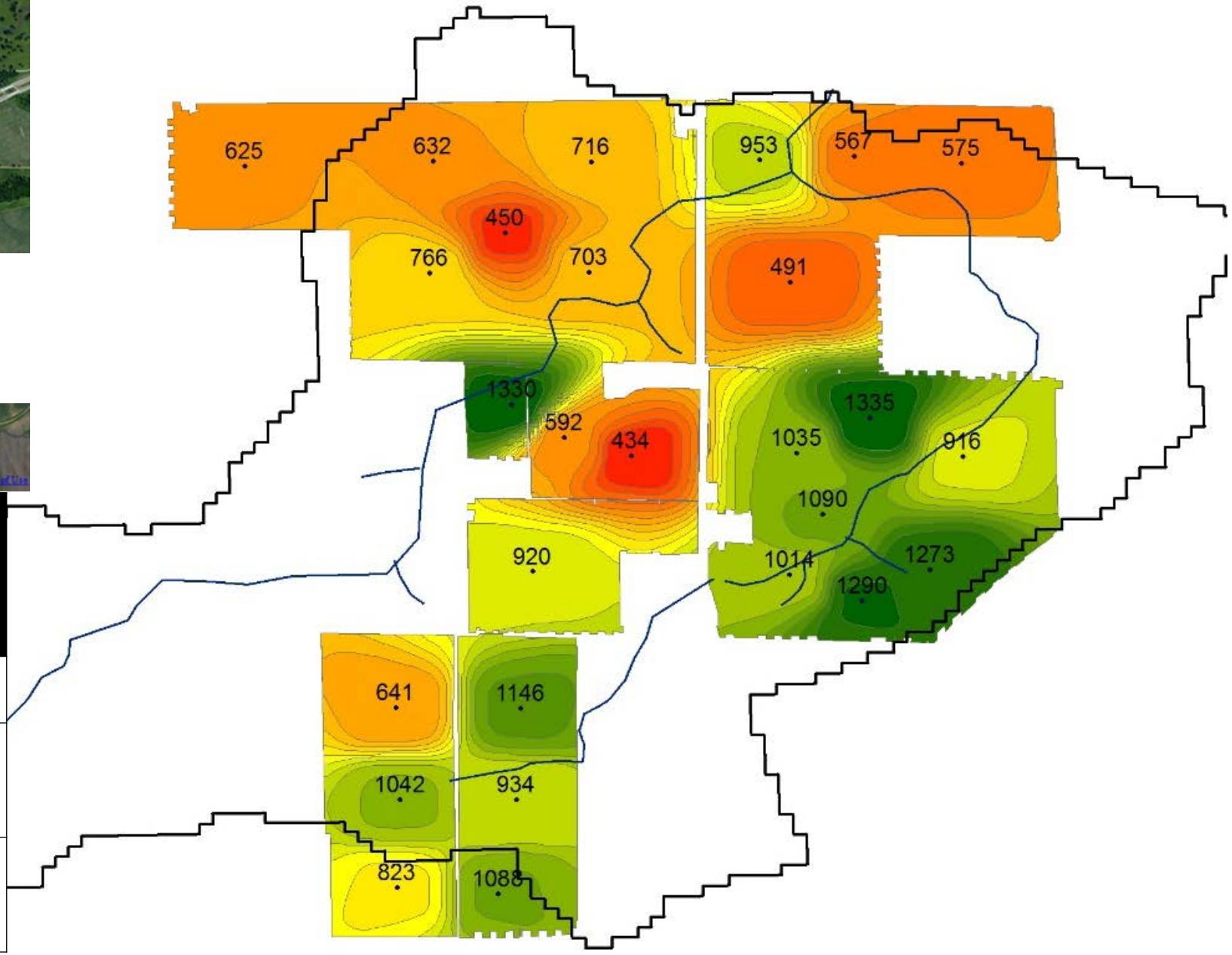


	Cover Crop N uptake (lb A^{-1})	Increase in N uptake from Fall to Spring (lb A^{-1})
CR/Radish	52 A	38
Radish/Oats	19 B	

2016 Fall, Cover Crop Biomass

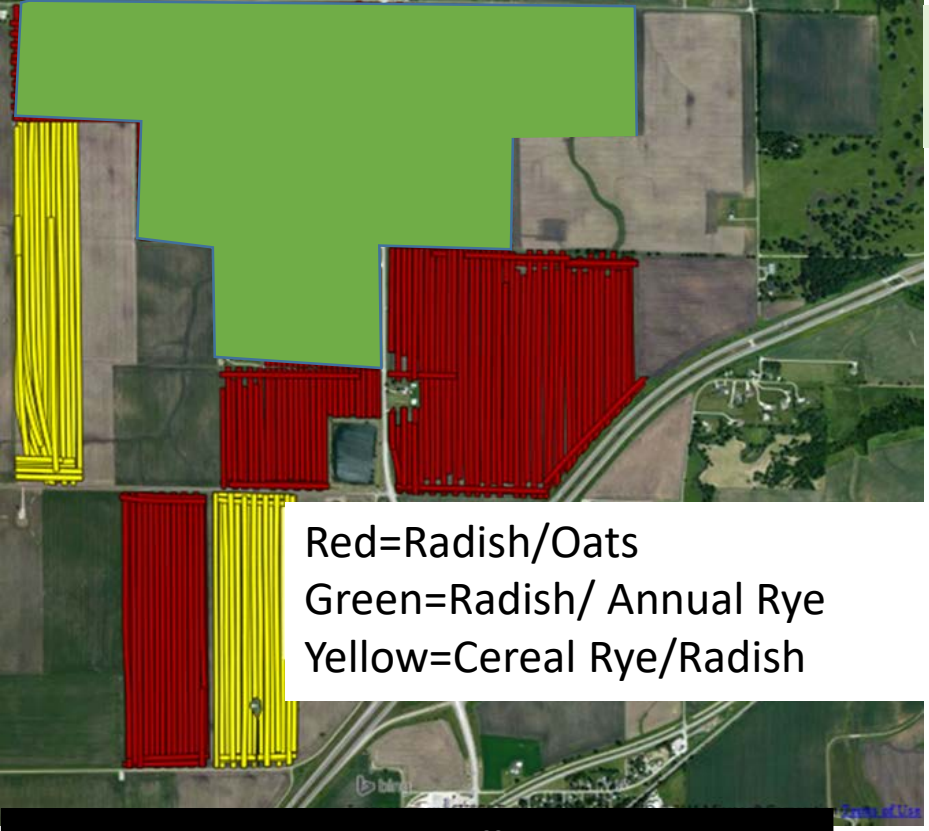


Red=Radish/Oats
Green=Radish/ Annual Rye
Yellow=Cereal Rye/Radish



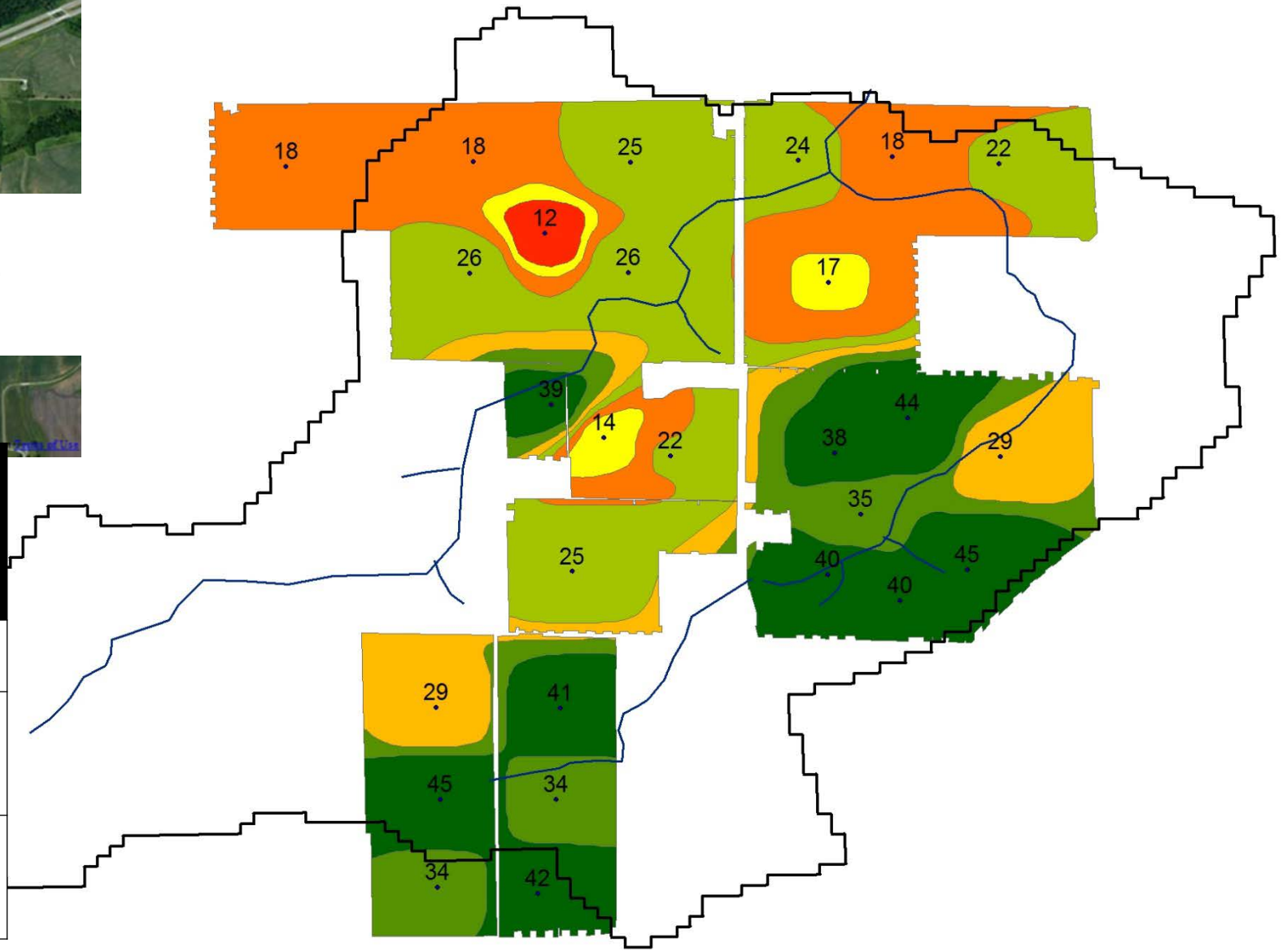
	Fall 2016, Cover Crop Biomass (lb A^{-1})
Radish/Oats	1,034
Cereal Rye/Radish	835
Annual Rye/Radish	703

2016 Fall, Cover Crop N Uptake

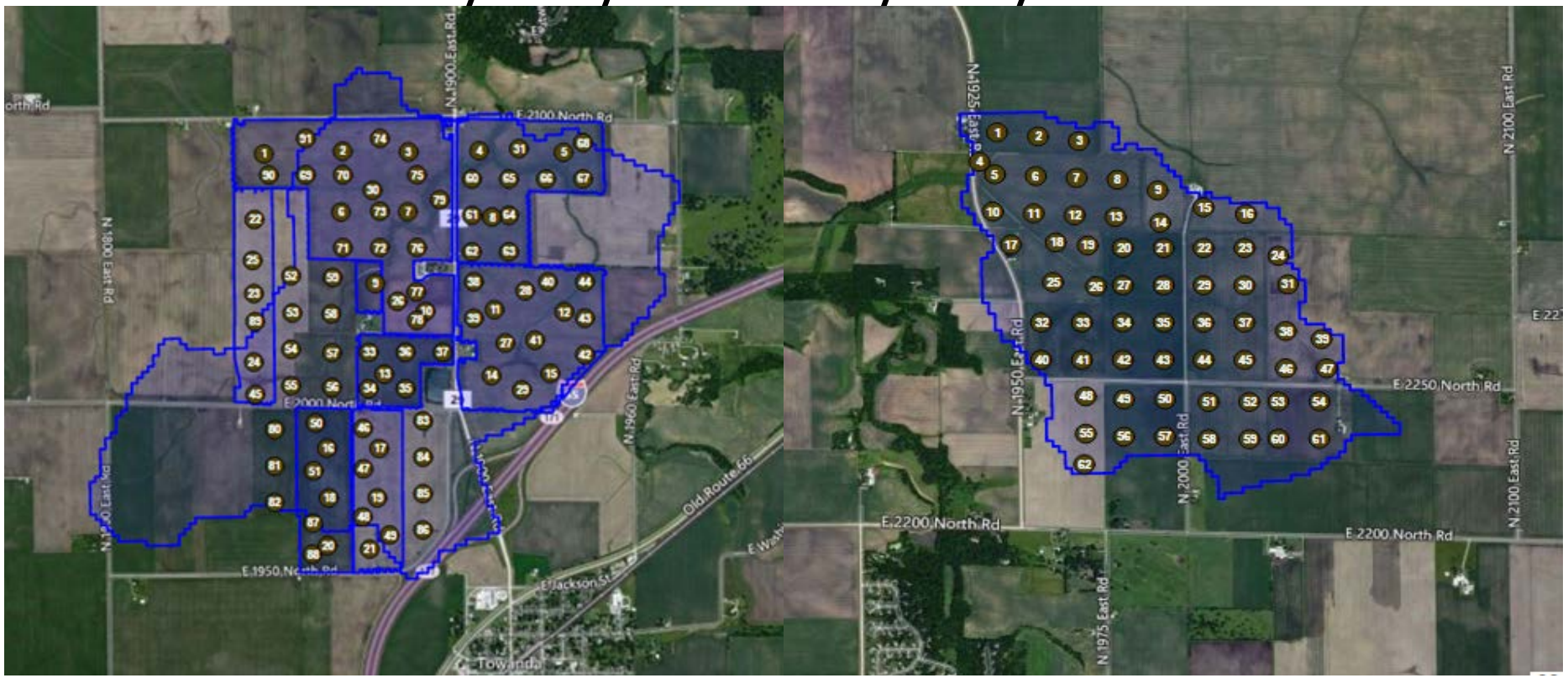


Red=Radish/Oats
Green=Radish/ Annual Rye
Yellow=Cereal Rye/Radish

	Fall 2016, Cover Crop N Uptake (lb A^{-1})
Radish/Oats	37
Cereal Rye/Radish	39
Annual Rye/Radish	22

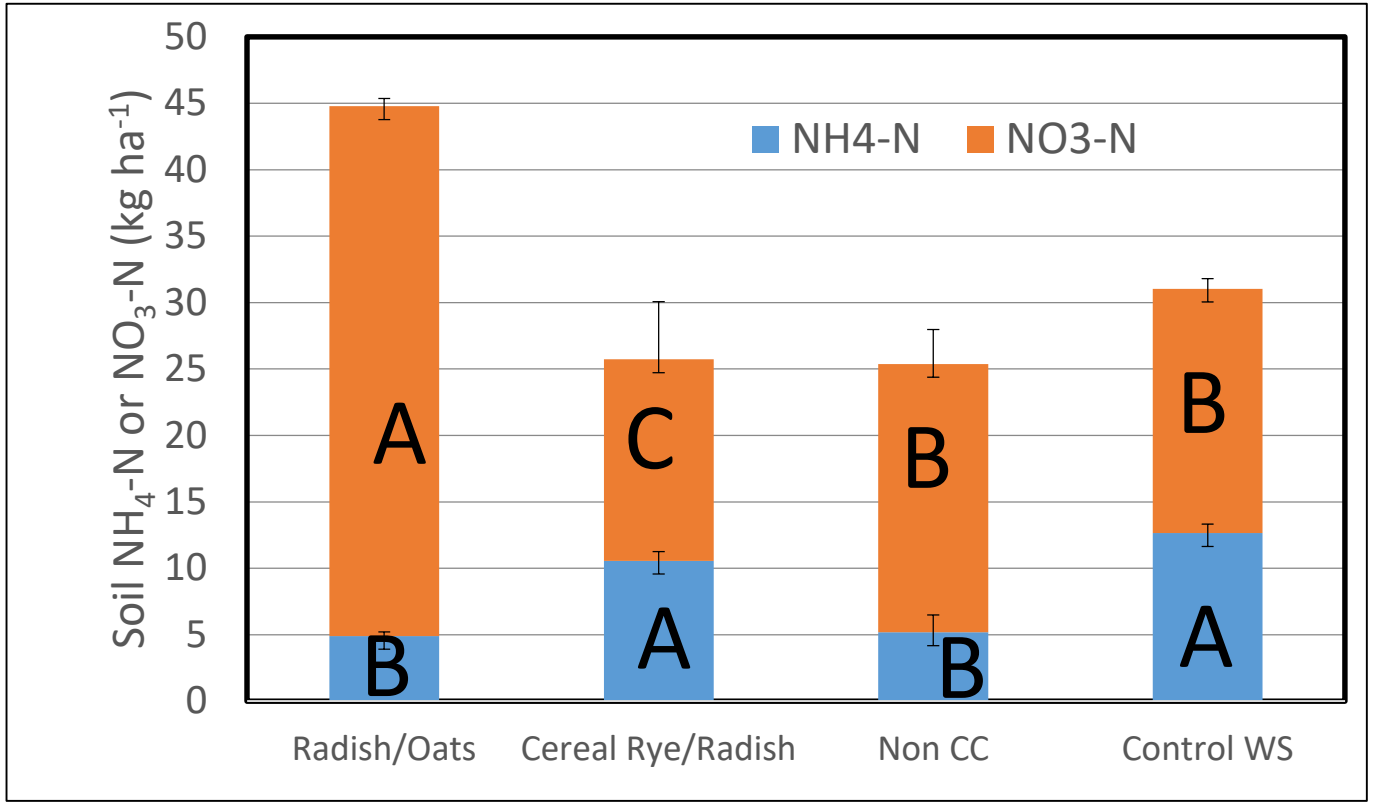


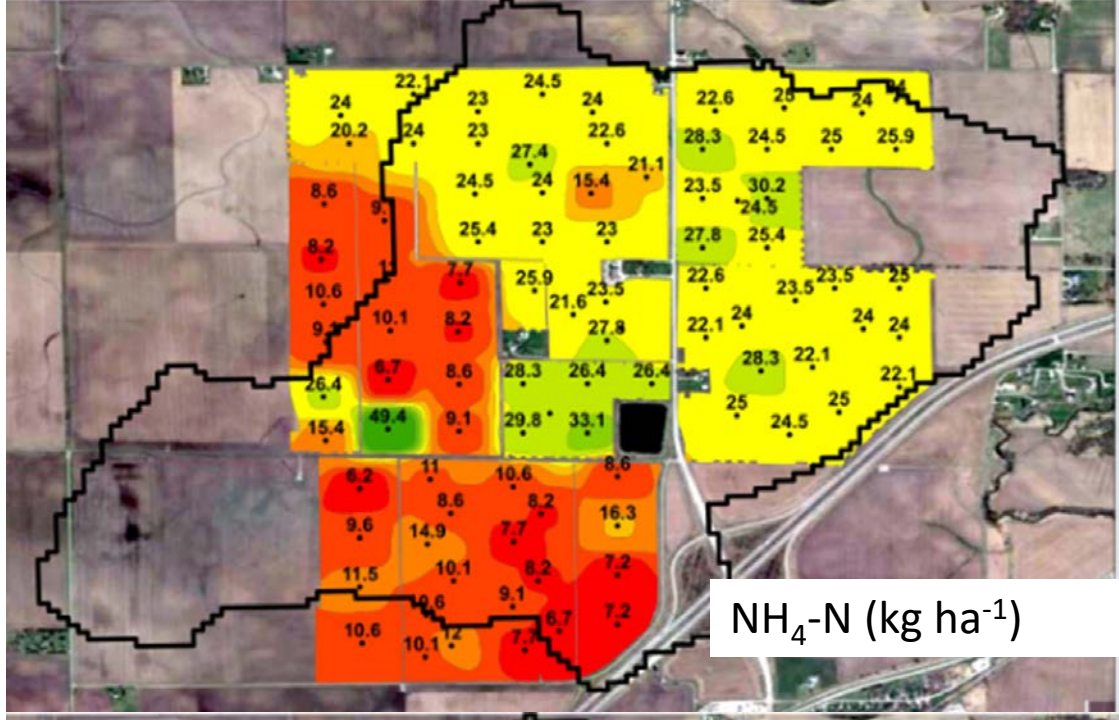
Spring Soil Samples
4/18/16 – 4/21/16

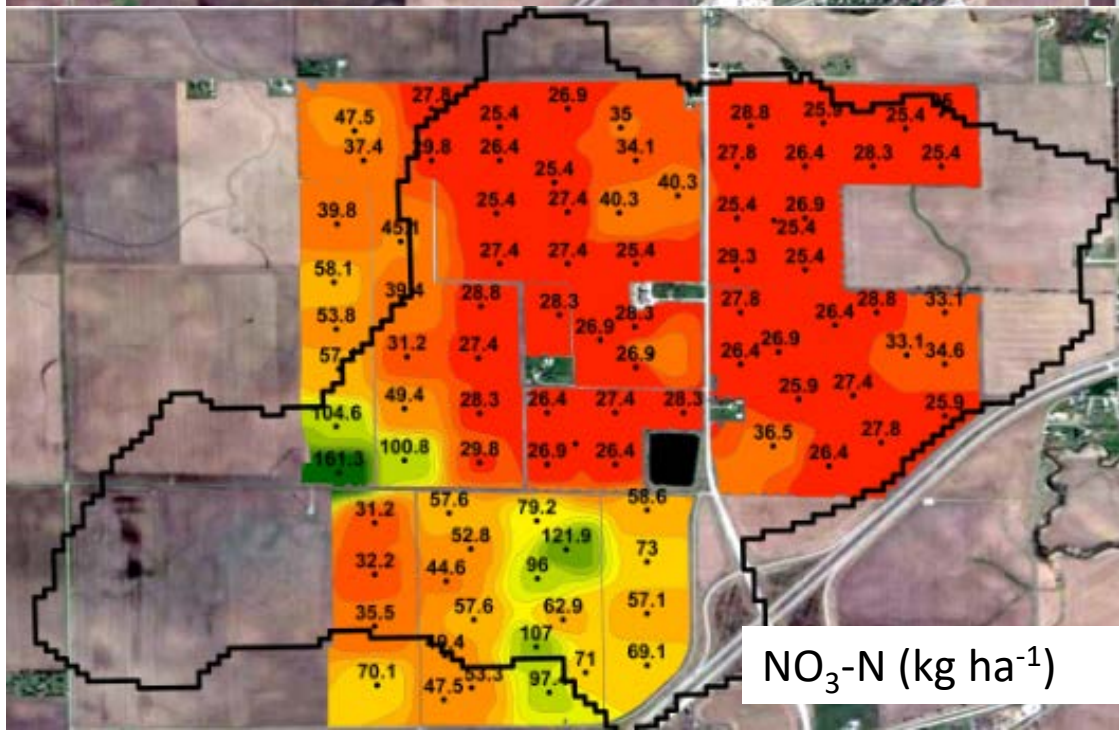


- Soil samples were collected from 0-30 cm and 30-60 cm on 10 A grids across the watershed.
- Soil were analyzed for NO_3-N and NH_4-N.

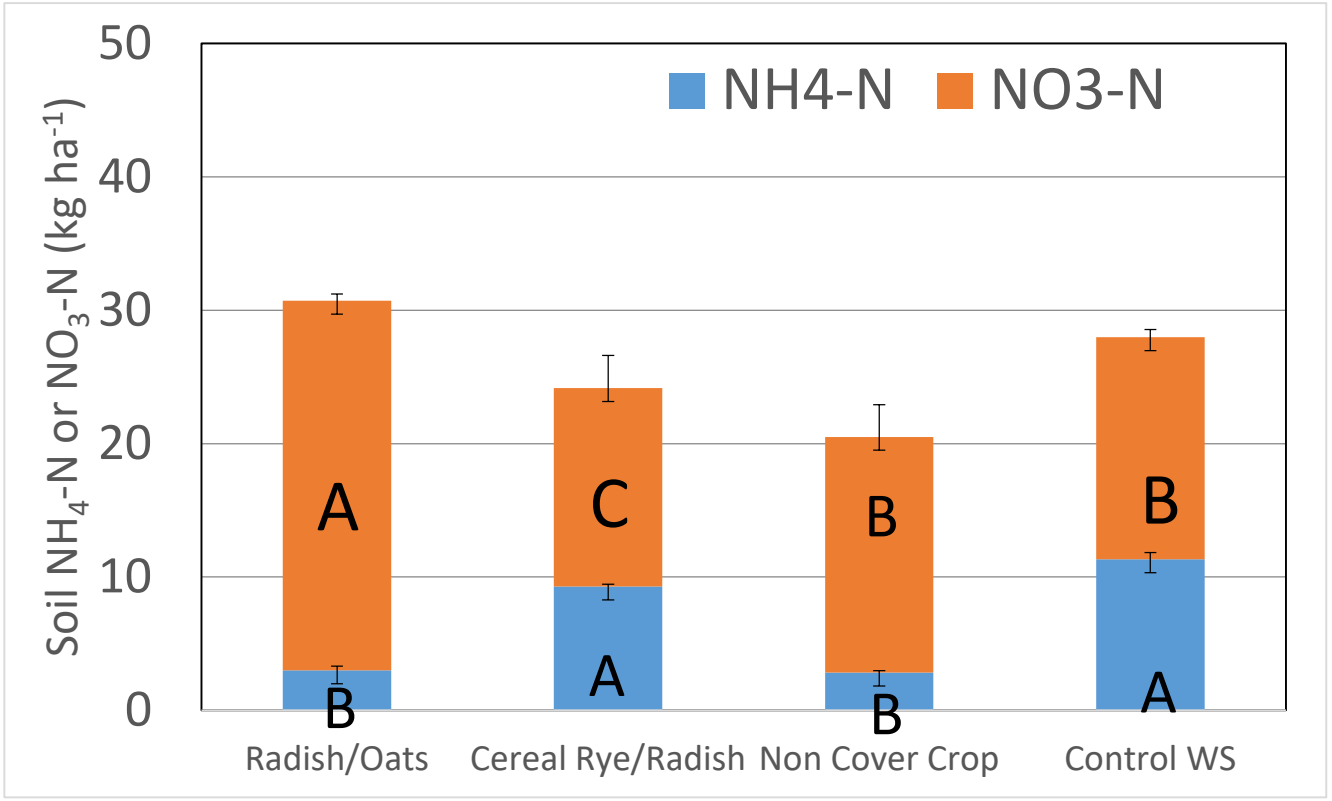
Spring 2016, Soil NH_4-N and NO_3-N concentrations at the 0-30cm depth

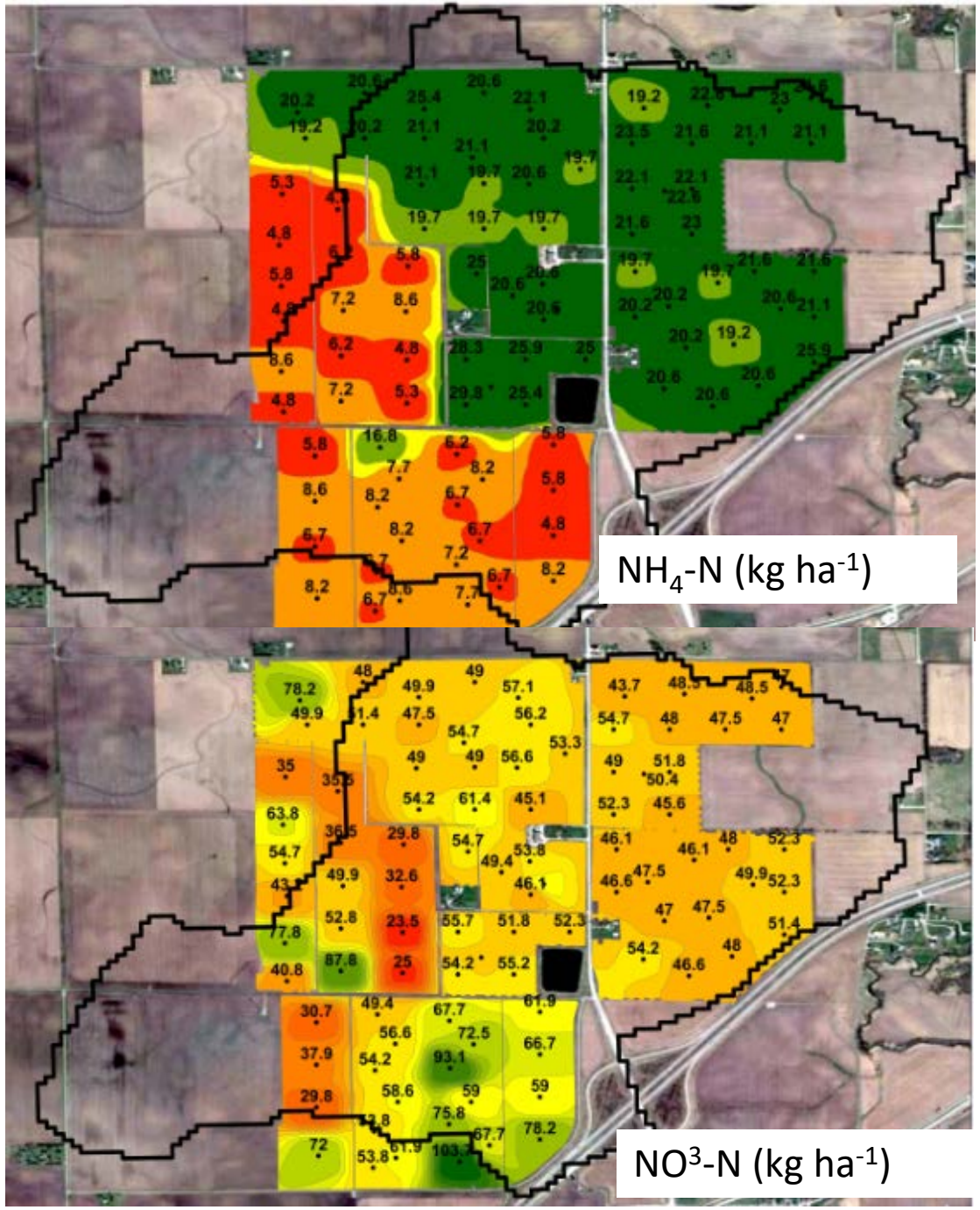




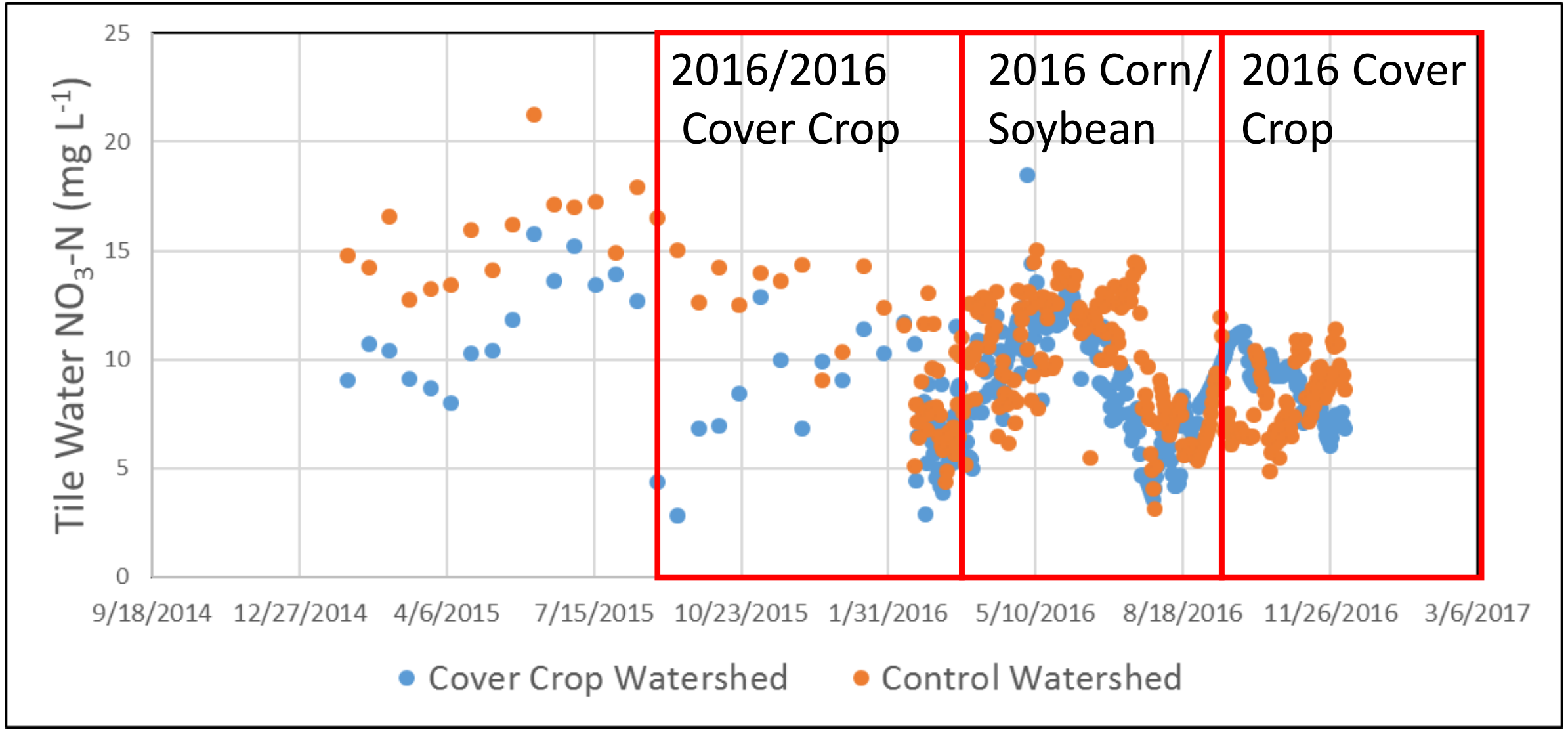


Spring 2016, Soil NH_4-N and NO_3-N concentrations at the 30-60cm depth

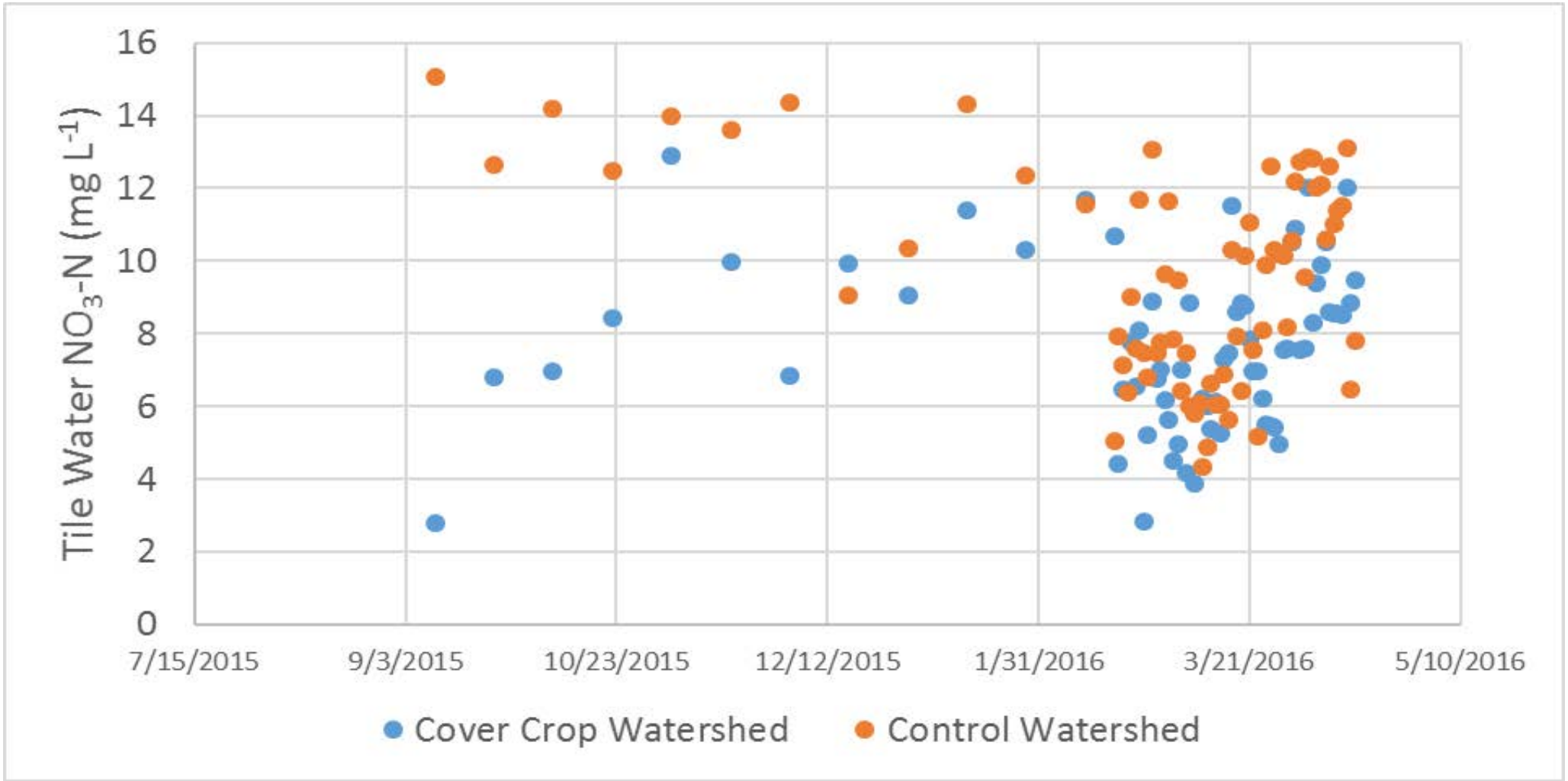




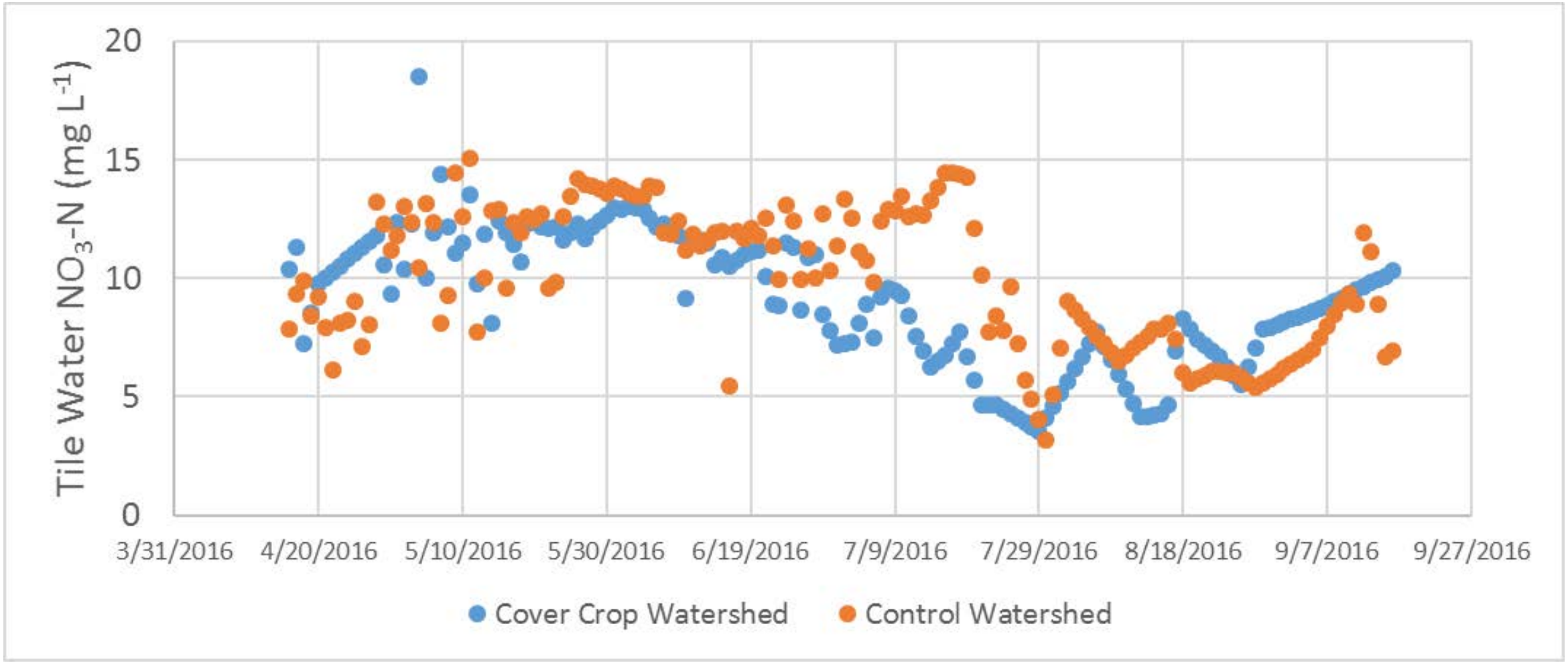
Cover Crops Impact on Nitrate Loading on a Watershed Scale



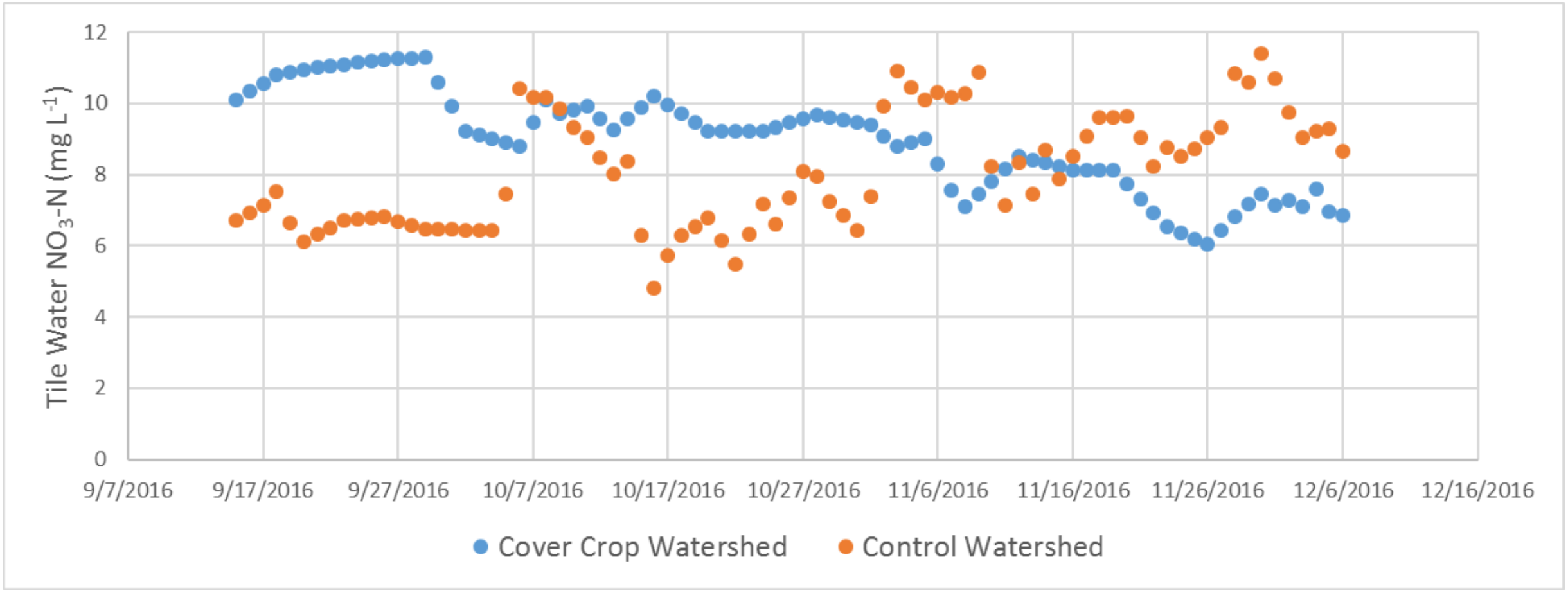
Nitrate Concentrations During Fall 2015 and Spring of 2016, Cover Crop Season



Nitrate Concentrations During 2016 Cash Crop Season



Nitrate Concentrations During Fall 2016 Cover Crop Season



Summary

- It is possible to cover crop on a watershed level, when you have the cooperation of farmers and industry leaders within the watershed.
- Cover Crops scavenged 21 – 58 kg N ha-1 (19 – 52 lb N A^{-1}).
- The type of cover crop planted can dictate the form(NO_3^- or NH_4^+) and location of available N in the soil during the spring after termination.
- During the cover crop growing season, we observed a water quality signal. However, during the cash crop growing season additional effective N management practices are need to effect water quality.

Cover Crops Residue N Release

Corey Lacey, Clayton Nevins, Trinity Johnson, Houston Miller, and Shalamar Armstrong

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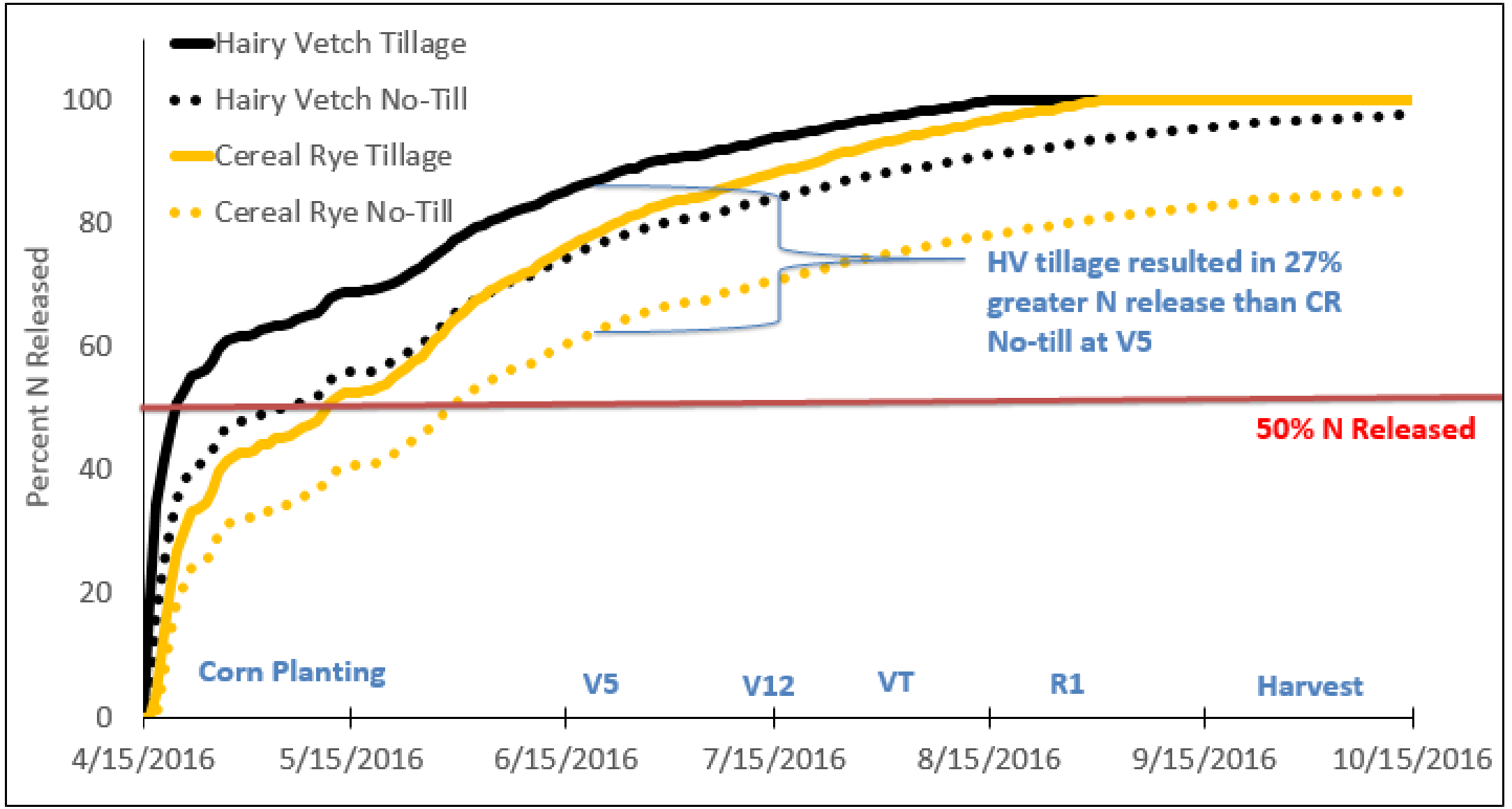
Cereal Rye terminated 3 weeks before planting.
What percentage of cover crop residue N will return to the soil by corn harvest?

Nitrogen Release – Field Scale



Thank You!

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