CORN YIELD GAP REDUCTION STRATEGIES FOR COVER CROP SYSTEMS

Dr. Shalamar Armstrong
Associate Professor of Agronomy
Department of Agronomy, Purdue University

Dr. Dan Quinn
Assistant Professor of Agronomy
Department of Agronomy, Purdue University

PURDUE UNIVERSITY | Corn Agronomy | PURDUE UNIVERSITY | Agronomy COLLEGE OF AGRICULTURE | S.E.N.D. Soil Ecosystem and Nutrient Dynamics

1

Sustainably Intensified Agriculture (SIA)

SIA Principles:

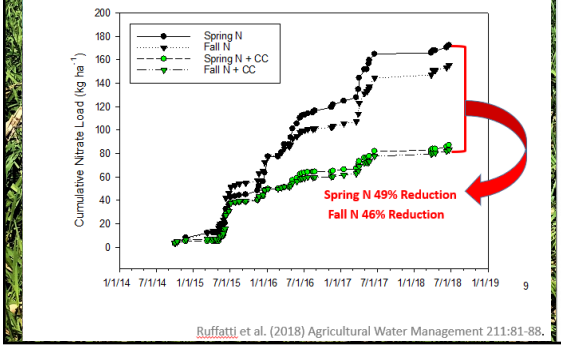
- Maximize Production and Profit
- Maximize Nutrient Use Efficiency
- Minimize Environmental Degradation

2

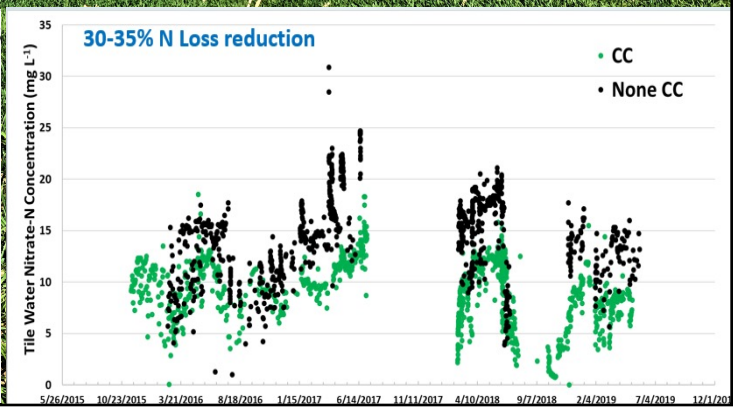
Cereal Rye, the workhorse Cover Crop of the Midwest

- Nitrogen loss reduction
- Carbon capture
- Erosion control

Water Quality Impacts: 4R + Cover Crops

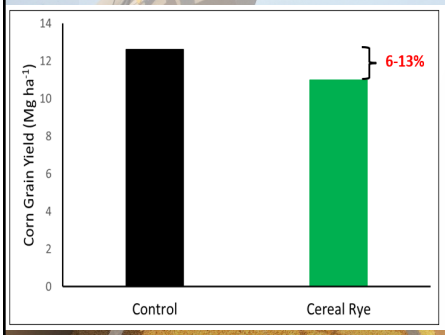


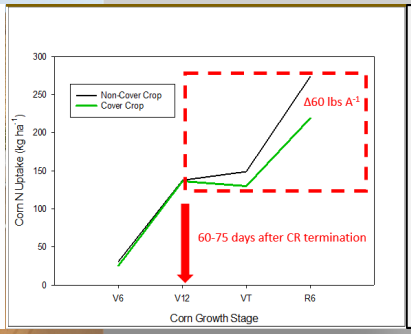
Ruffatti et al. (2018) Agricultural Water Management 211:81-88.

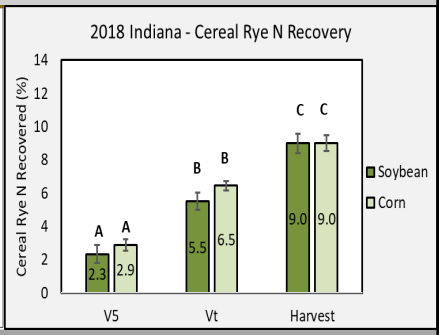


3

Cereal Rye Impact on Corn N Uptake and Grain Yield







Reduced N Uptake

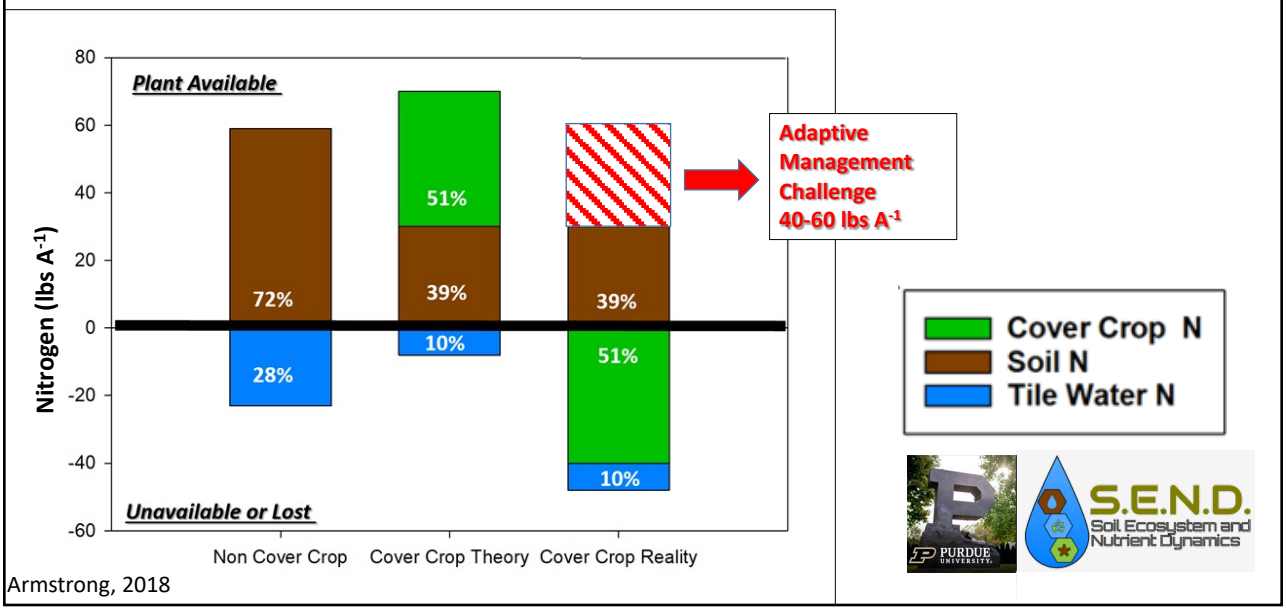
Slow N Release

Cereal Rye

- Significantly reduces erosion and NO_3-N losses via Tile
- To overcome corn yield lag could requires greater N rates.

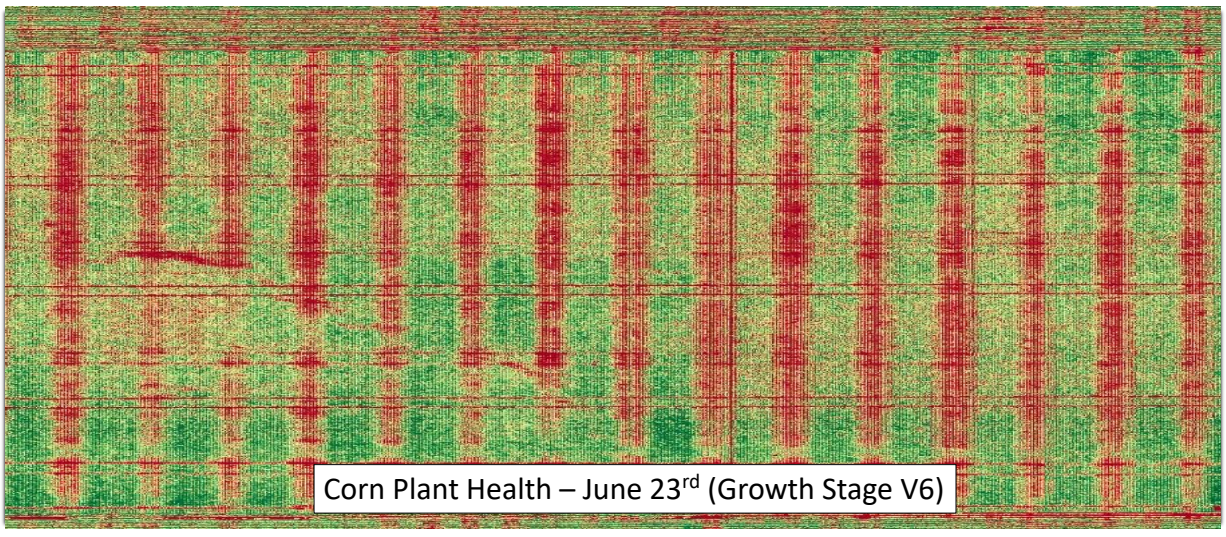
4

Changes in Soil Nitrogen Availability During the Life Cycle of Cereal Rye



Armstrong, 2018

5



6

6

7

Rye Cover Corn Yield Reduction Causes

- **Corn Yield Reduction Observed:** (Raimbult et al., 1990; Duiker and Curran, 2005; Miguez and Bollero, 2006; Kaspar and Bakker, 2015; Pantoja et al., 2015; Martinez-Feria et al., 2016)

- **Limited N Availability:**
  - **Rye N uptake** (Raimbult et al., 1991; Unger and Vigil, 1998; McSwiney et al., 2010; Krueger et al., 2011; Mirsky et al., 2015; Pantoja et al., 2015; Hill et al., 2016)
  - **N immobilization** (Reeves, 1994; Kuo et al., 1997; Kuo and Jellum, 2002; McSwiney et al., 2010; Pantoja et al., 2015; Nevins et al., 2020)

- **Reduced Plant Stand:**
  - **Disease** (Smiley et al., 1992; Bakker et al., 2016; Acharya et al., 2017)
  - **Equipment Interference** (Kaspar and Bakker, 2015; Marcillo and Miguez, 2017)
  - **Moisture Reduction** (Eckert, 1988; Kaspar and Bakker, 2015; Marcillo and Miguez, 2017)
  - **Insects** (Dunbar et al., 2016)

8

Rye Cover Corn Yield Reduction Causes

- **Corn Yield Reduction Observed:** (Raimbult et al., 1990; Duiker and Curran, 2005; Miguez and Bollero, 2006; Kaspar and Bakker, 2015; Pantoja et al., 2015; Martinez-Feria et al., 2016)

How do we manage this?

- **N immobilization** (Reeves, 1994; Kuo et al., 1997; Kuo and Jellum, 2002; McSwiney et al., 2010; Pantoja et al., 2015)

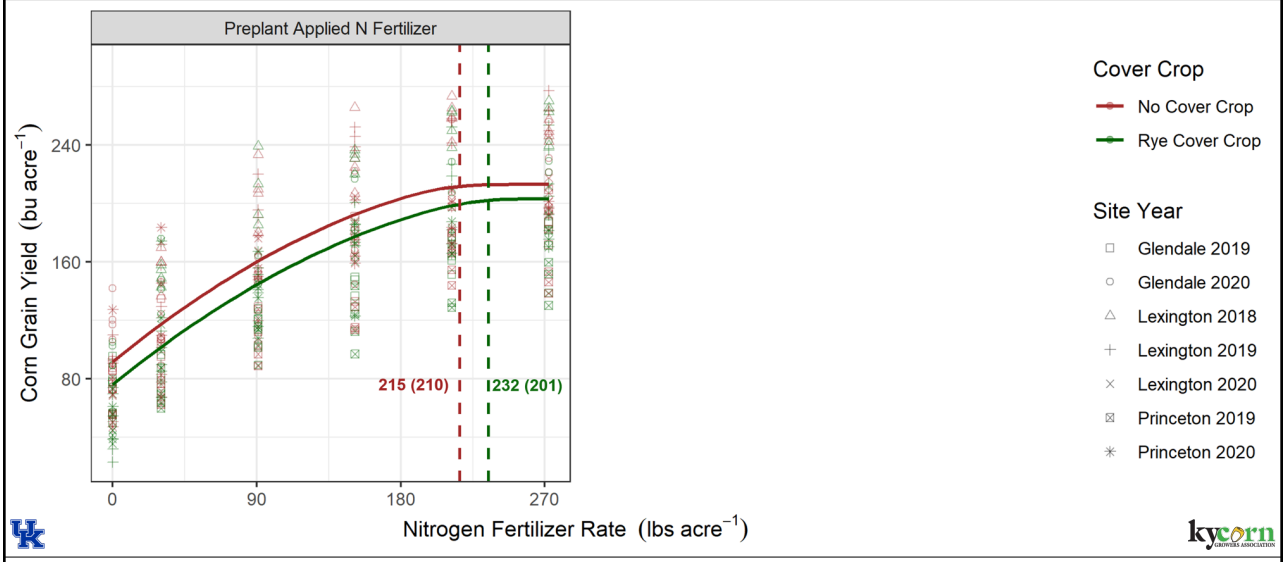
- **Reduced Plant Stand:**
  - **Disease** (Smiley et al., 1992; Bakker et al., 2016; Acharya et al., 2017)
  - **Equipment Interference** (Eckert, 1988; Kaspar and Bakker, 2015; Marcillo and Miguez, 2017)
  - **Moisture Reduction** (Eckert, 1988; Kaspar and Bakker, 2015; Marcillo and Miguez, 2017)
  - **Insects** (Dunbar et al., 2016)

9

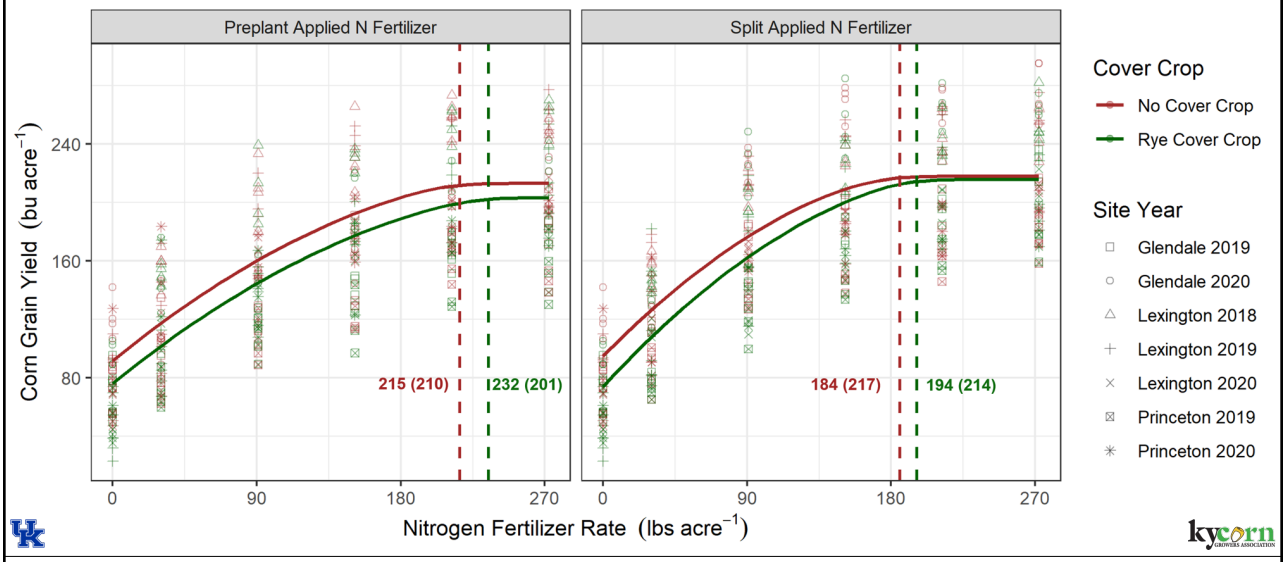
Next Generation Cover Crop and N Fertilizer Management that could reduce Yield Lag

N Application Rate and Timing | *Planting Settings to protect population* | *Precision Planted Cover Crops* | *Overwintering Legumes*

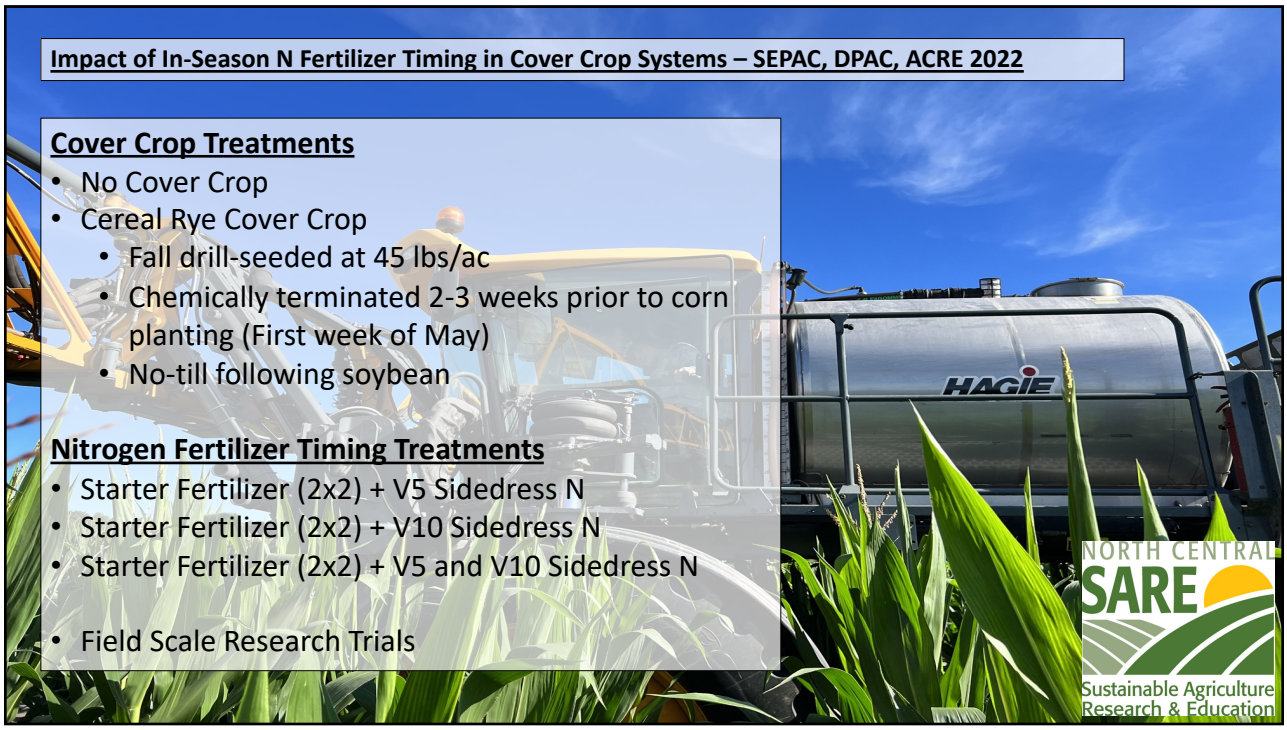
10



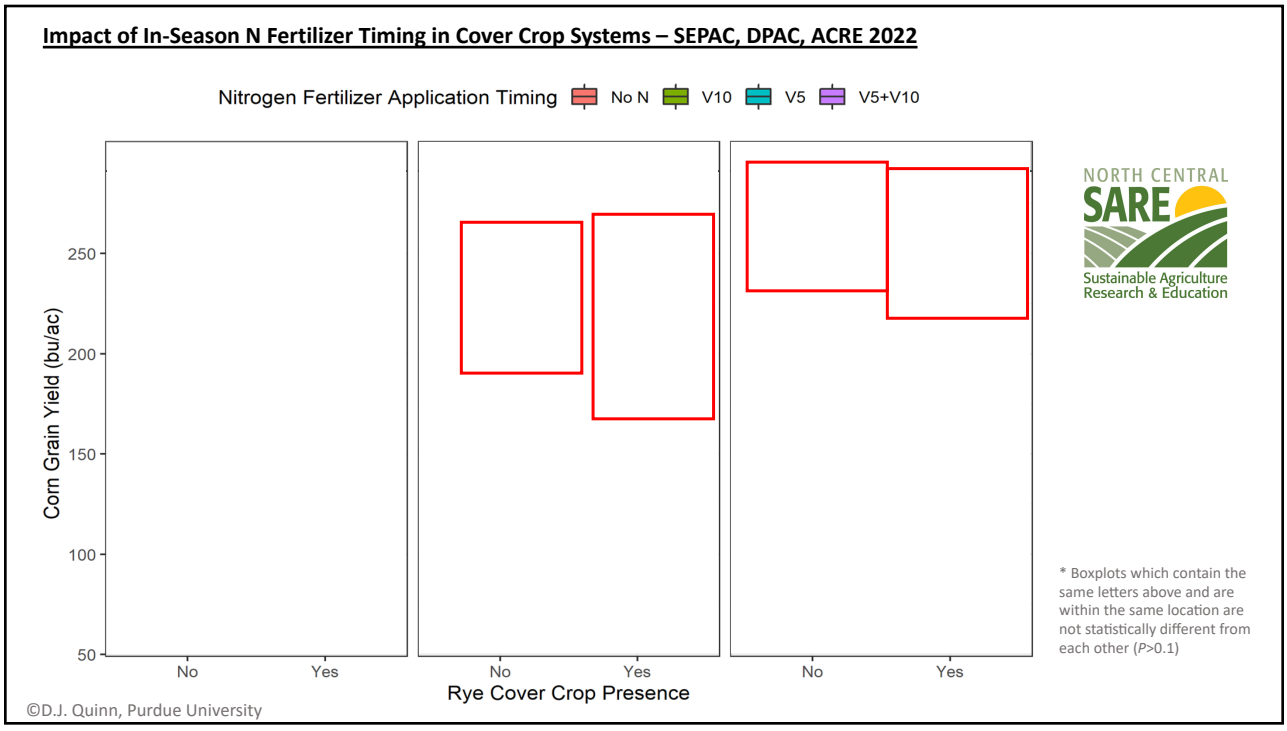
11



12


Impact of In-Season N Fertilizer Timing in Cover Crop Systems – SEPAC, DPAC, ACRE 2022
Cover Crop Treatments
• No Cover Crop
• Cereal Rye Cover Crop
• Fall drill-seeded at 45 lbs/ac
• Chemically terminated 2-3 weeks prior to corn planting (First week of May)
• No-till following soybean
Nitrogen Fertilizer Timing Treatments
• Starter Fertilizer (2x2) + V5 Sidedress N
• Starter Fertilizer (2x2) + V10 Sidedress N
• Starter Fertilizer (2x2) + V5 and V10 Sidedress N
• Field Scale Research Trials
HAGIE
NORTH CENTRAL SARE
Sustainable Agriculture Research & Education

13


Impact of In-Season N Fertilizer Timing in Cover Crop Systems – SEPAC, DPAC, ACRE 2022
Nitrogen Fertilizer Application Timing
No N
V10
V5
V5+V10
Corn Grain Yield (bu/ac)
250
200
150
100
50
No
Yes
No
Yes
No
Yes
Rye Cover Crop Presence
NORTH CENTRAL SARE
Sustainable Agriculture Research & Education
* Boxplots which contain the same letters above and are within the same location are not statistically different from each other (P>0.1)
©D.J. Quinn, Purdue University

14

Next Generation Cover Crop and N Fertilizer Management that could reduce Yield Lag

15

Impact of Planter Closing Wheels in Cover Crop Systems – TPAC 2022

Cover Crop Treatments
- No Cover Crop
- Cereal Rye Cover Crop (same as N fertilizer timing studies)

Closing Wheel Treatments
- John Deere Standard Rubber
- Copperhead Cruiser Extreme
- Martin Cupped Razor

16

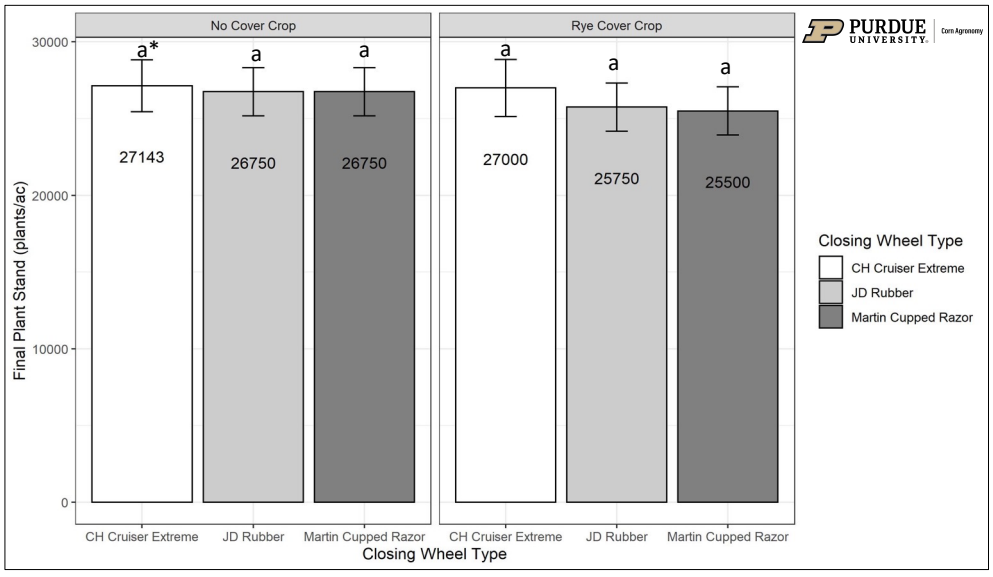
Copper Head Furrow Cruiser Extreme

JD Standard Rubber

17

Final Plant Stand (plants/ac) – Field Corn

TPAC - 2022

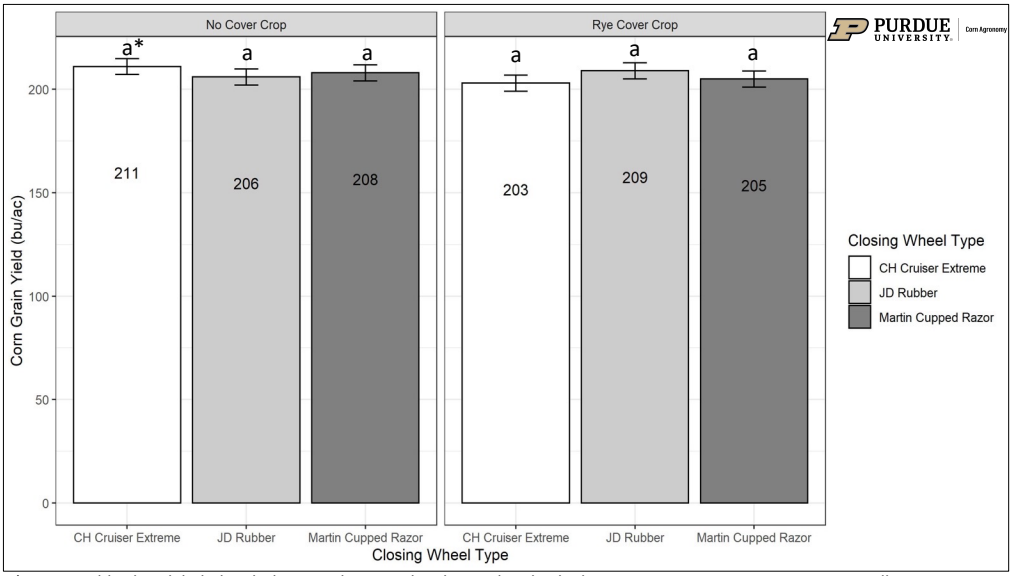


* Mean yield values labeled with the same letter and within each individual cover crop treatment are not statistically different (P>0.1).

18

Closing Wheel Yield Results – Corn Grain

TPAC - 2022



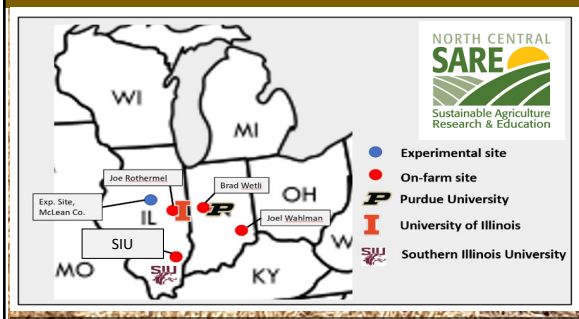
* Mean yield values labeled with the same letter and within each individual cover crop treatment are not statistically different (P>0.1),

19

Next Generation Cover Crop and N Fertilizer Management that could reduce Yield Lag

20

Precision Winter Cereal Rye Cover Cropping for Improving Farm Profitability and Environmental Stewardship



Dr. Shalamar Armstrong (Associate Professor of Agronomy, Department of Agronomy, Purdue University)
Dr. Amir Sadeghpour (Associate Professor of Soil Management, Department of Plant, Soil, and Agricultural Systems, Southern Illinois University)
Dr. Andrew Margenot (Assistant Professor of Soil Science, Crop Science Department, University of Illinois)

21

Exploring A Cereal Rye Alternative (Balansa Clover)

Cover Crop Species

1. Balansa Clover
2. Cereal Rye

Planting Method

1. Conventional
2. Precision

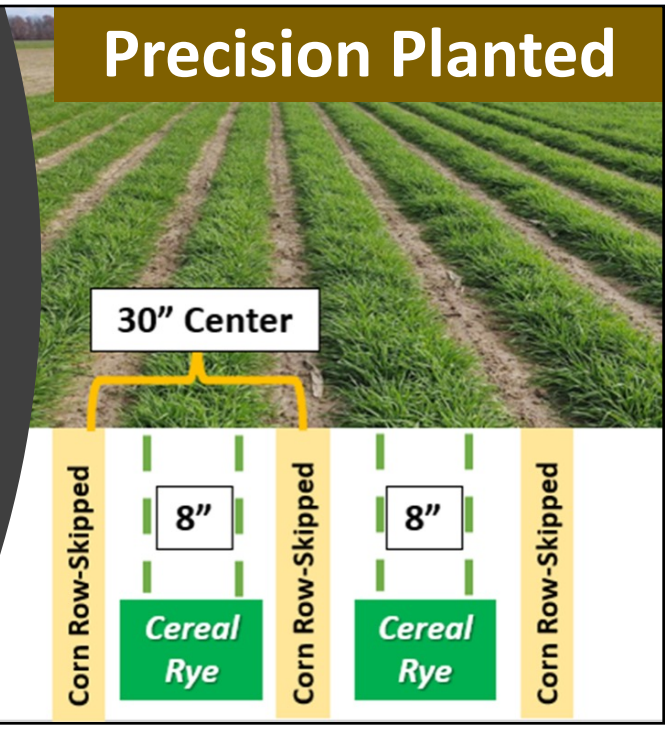
Nitrogen Rate

0, 40, 100, 150, 200. 250 lb A^{-1}

Cover crops

- **Planted Sept. 11th**
- **Terminated: CR (4/6) BC (5/20)**

Precision Planted



22


Patience!
Southern-IN
12-10-20
4-7-21
4-15-21
4-29-21

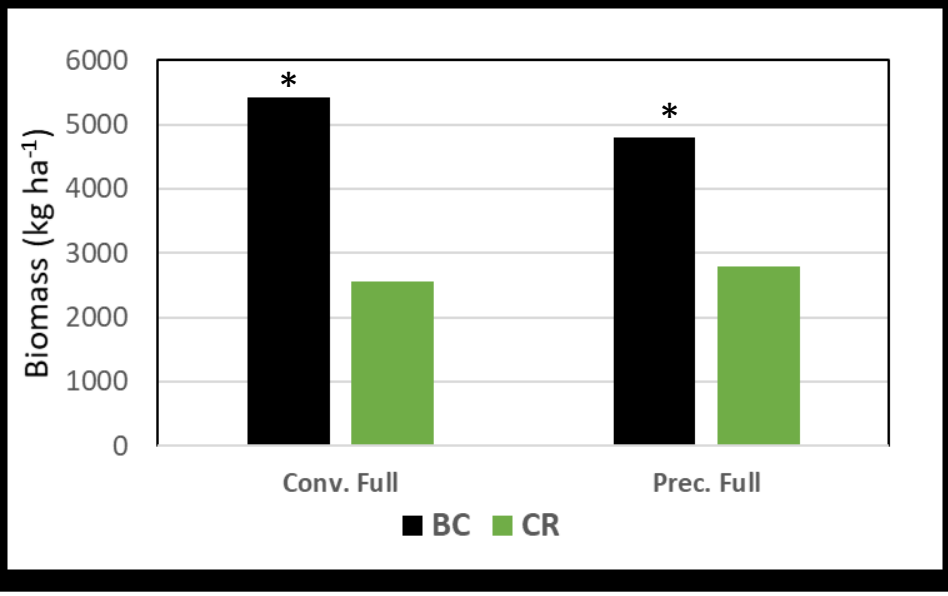
23


Balansa Clover May 15, 2021

24

25

Cover Crop Performance 2021

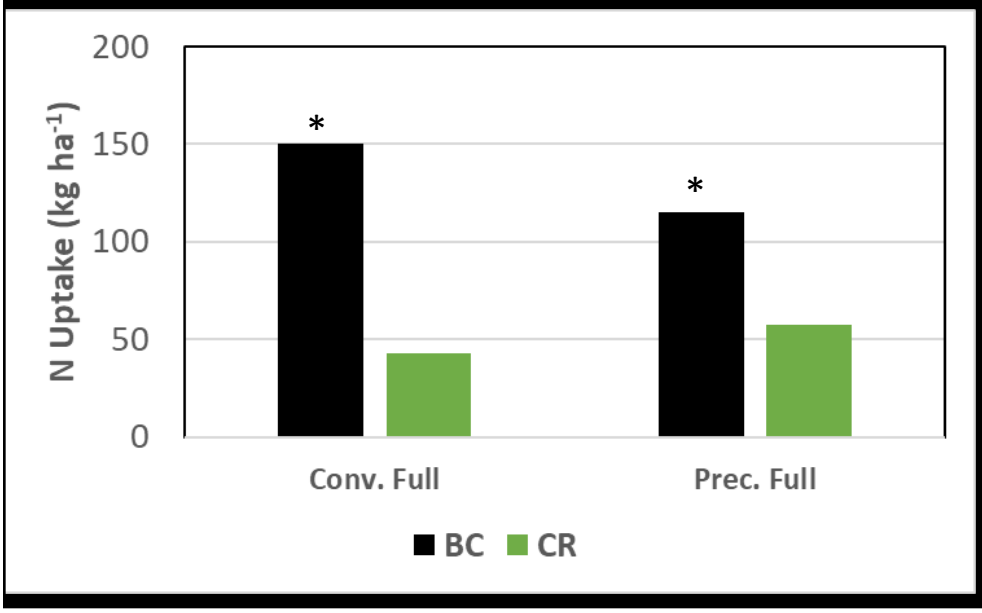


Average Biomass

- Balansa Clover **(4560 lb A^{-1})** **(C: 1778 lb A^{-1})**
- Cereal Rye **(2386 lb A^{-1})** **(C: 954 lb A^{-1})**

26

Cover Crop Performance 2021

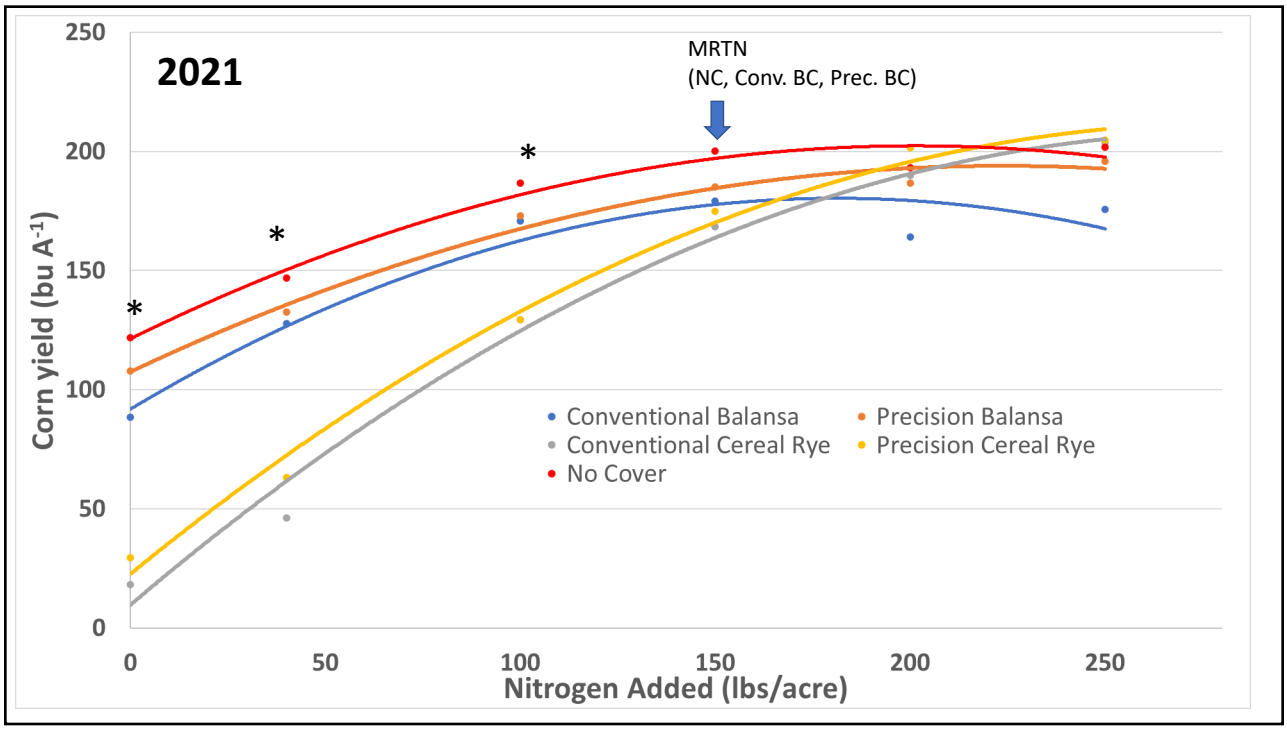


Average N Uptake

- Balansa Clover **(118 lb A^{-1})** **C/N: 10**
- Cereal Rye **(45 lb A^{-1})** **C/N: 23**

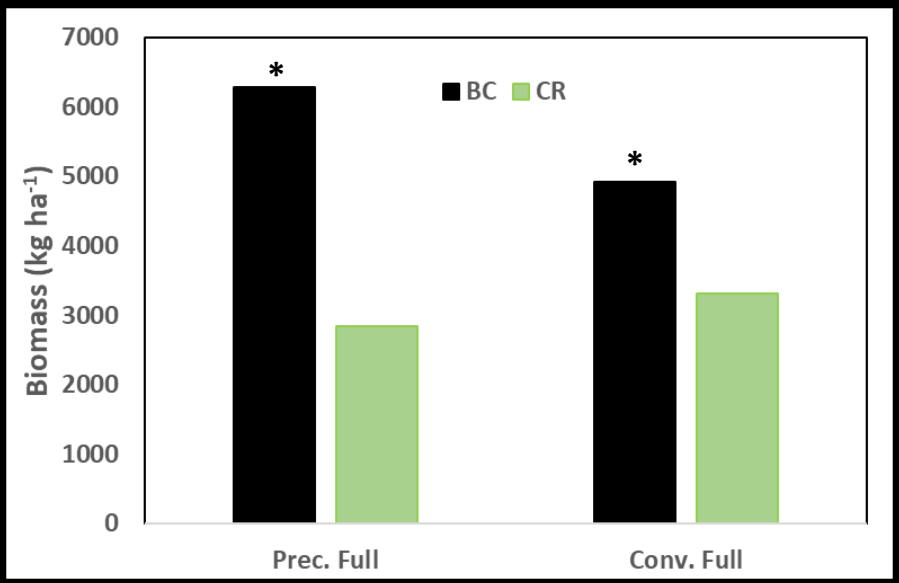
27

28



29

Cover Crop Performance 2022

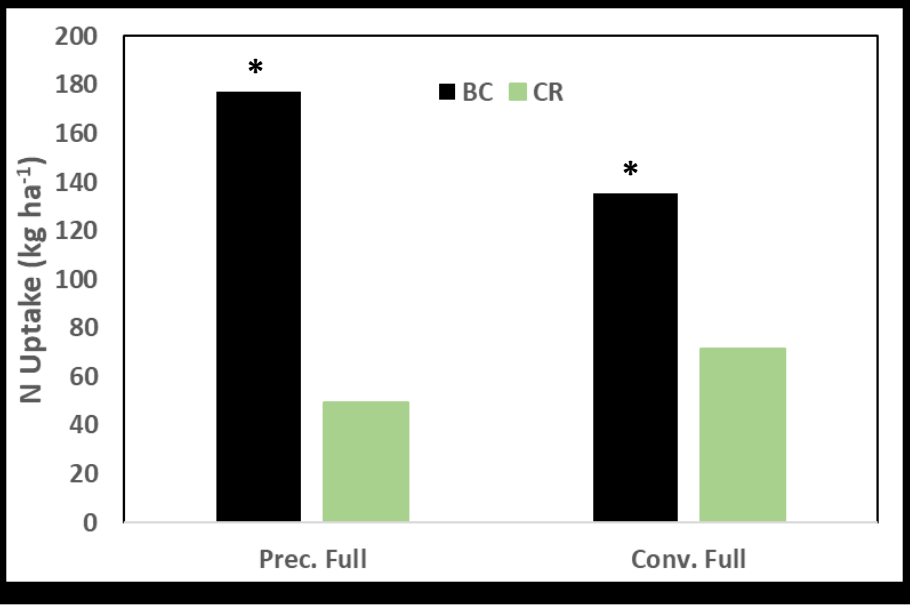


Average Biomass

- Balansa Clover
  (5,000 lb A^{-1})
  (C: 2028 lb A^{-1})
- Cereal Rye
  (2748 lb A^{-1})
  (C: 1098 lb A^{-1})

30

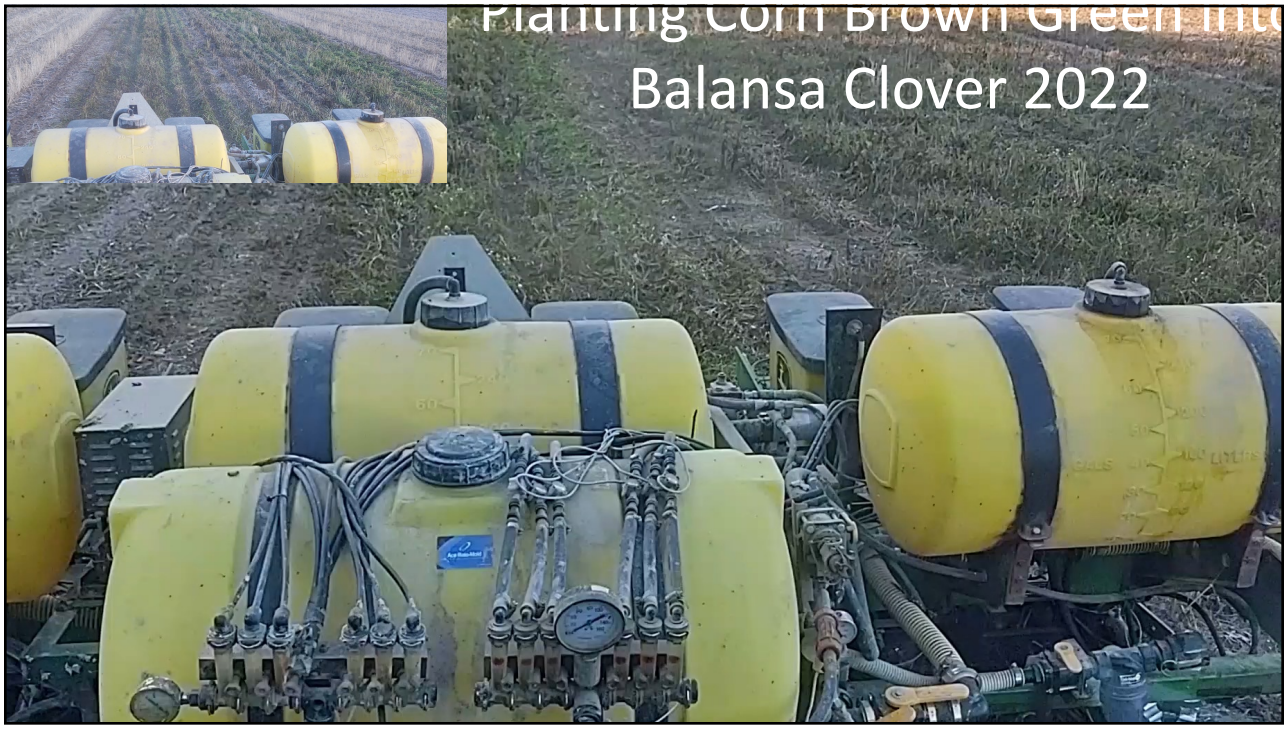
Cover Crop Performance 2022



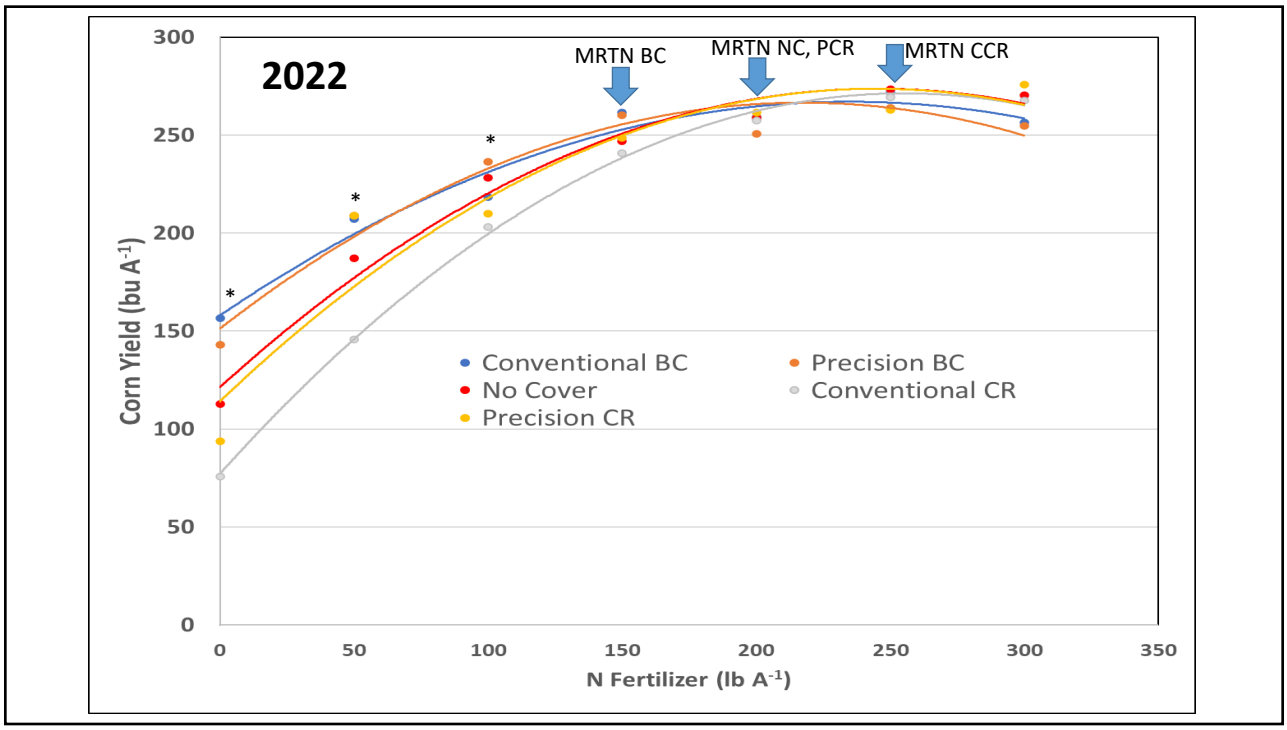
Average N Uptake

- Balansa Clover **(156 lb A^{-1})** **C/N:13**
- Cereal Rye **(61 lbsA^{-1})** **C/N:18**

31



32



33

Summary

- Precision planting cover crops at 50% lower seeding rate generated equal biomass, biomass C and N with equal or greater cash crop yield relative to the control.
- The inclusion of Balansa Clover generated 137 lb/A of N within the biomass, which could function as an N credit, depending on your residue management.
- Balansa Clover MRTN was 150 lb N/A, which was 100lbs N/A less than cereal rye plots and was 50lbs N/A less one of two years relative to no cover crop Control.
- The inclusion of Balansa Clover could be vital in the production of low carbon intensity corn due to its ability to generate an N credit and capture carbon within a No-till residue management system.

34

Summary cont.

- In-season N fertilizer application management can be used to reduce corn N stress, yield loss, and N fertilizer requirement following a rye cover crop.
  - Can get away with delayed sidedress N without a rye cover crop, can't get away with it with a rye cover crop (V5 sidedress essential)
- Closing wheel type improved visual furrow closure and seed-to-soil contact in high residue systems, yet did not translate to yield
  - Trend of better final plant stand, will continue study in 2023

35

Questions

SEND LAB Website:
https://ag.purdue.edu/agry/armstrong-sendlab/

Corn Agronomy Website: https://thekernel.info

@covercropDr

@PurdueCorn

PURDUE UNIVERSITY

Agronomy
COLLEGE OF AGRICULTURE

S.E.N.D.
Soil Ecosystem and Nutrient Dynamics

36