Corn Nitrogen Management in Conventional and Conservation Cropping Systems

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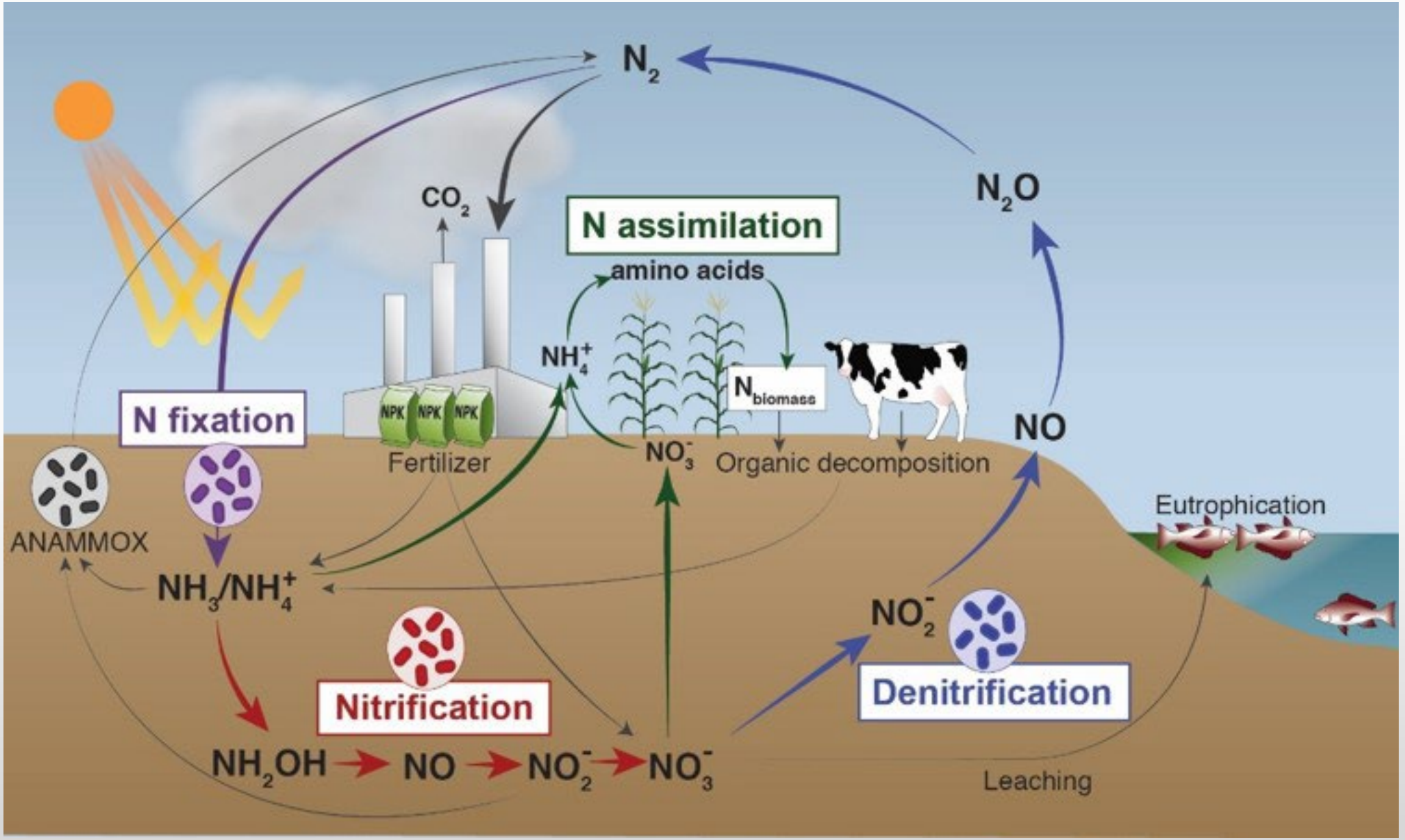

Source: http://websites.umich.edu/~lehnert/picts/N-cycle.jpg

- Weather is difficult to predict = N transformations and movement difficult to predict
  - Use N fertilizer timing to minimize and spread risk of N loss
  - N loss = lost $ and environmental harm
- Too much rainfall, ponding = leaching and denitrification
- Too hot and dry = volatilization, insufficient mineralization, poor plant uptake
- High residue carbon = immobilization

Source: https://www.agric.wa.gov.au/soil-carbon/immobilisation-soil-nitrogen-heavy-stubble-loads.

Nitrogen Fertilizer Rate Recommendations for Corn in Indiana

- Based on 263 field scale N rate trials around the state since 2006
- **Agronomic Optimum N Rate**
- **Economic Optimum N Rate**


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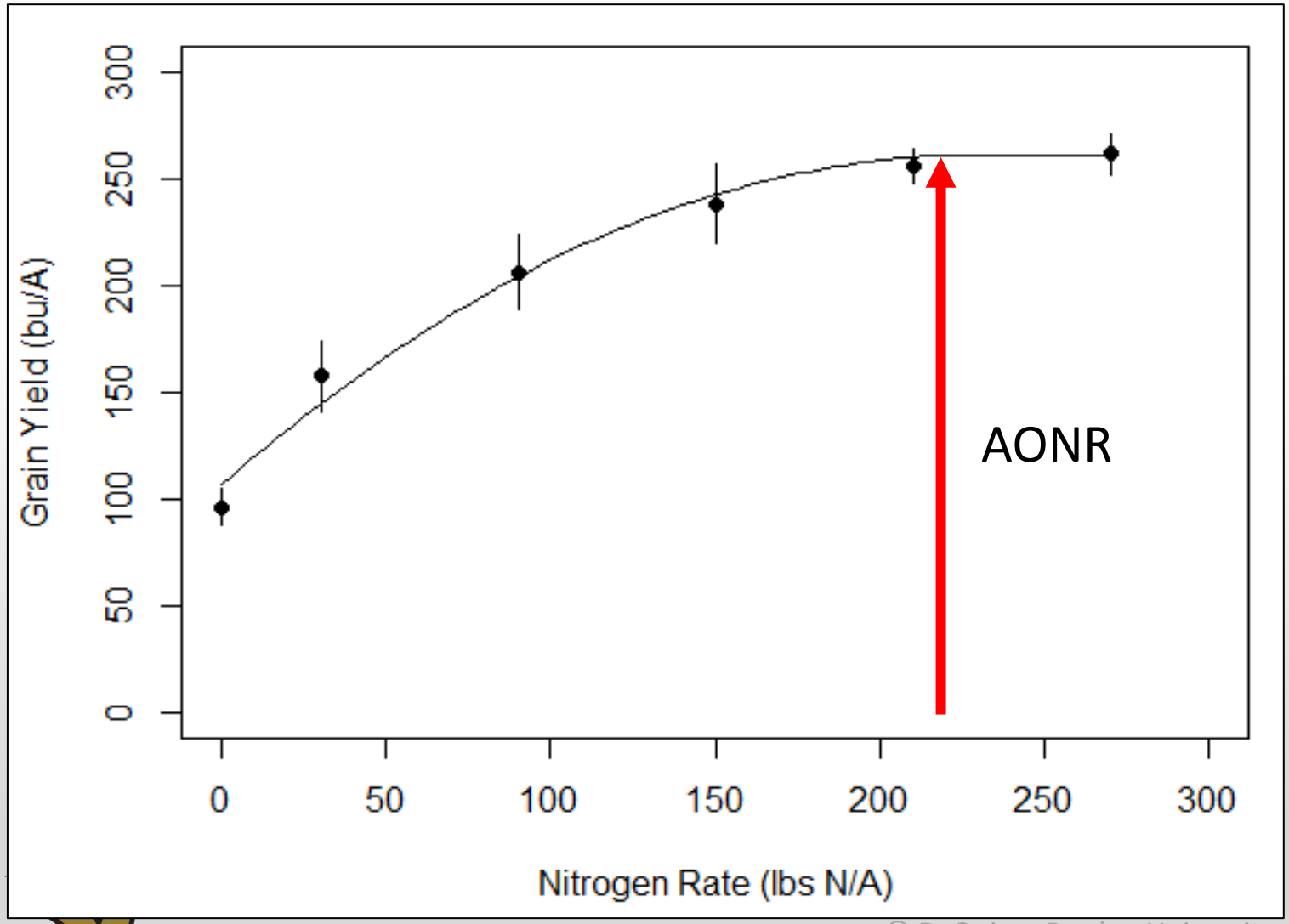
Bulletin 974

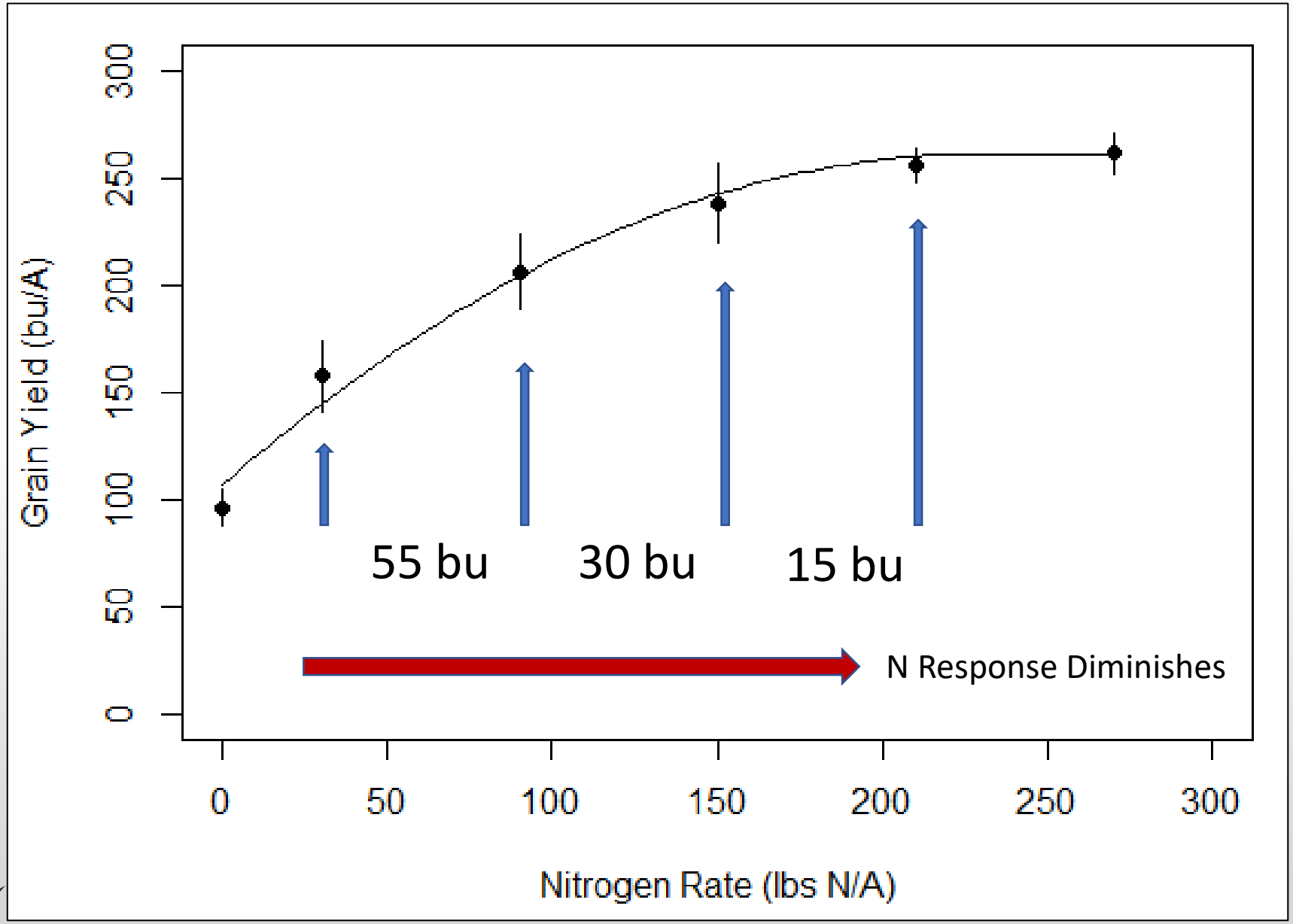
TRI-STATE FERTILIZER RECOMMENDATIONS

for Corn, Soybean, Wheat, and Alfalfa

What is the Agronomic Optimum N Rate?



Nitrogen fertilizer rate required by corn to reach maximum grain yield



- **As N fertilizer rate increases, yield response diminishes**
- **Non-linear response**
  - **Cannot base N fertilizer rate off of yield goal**

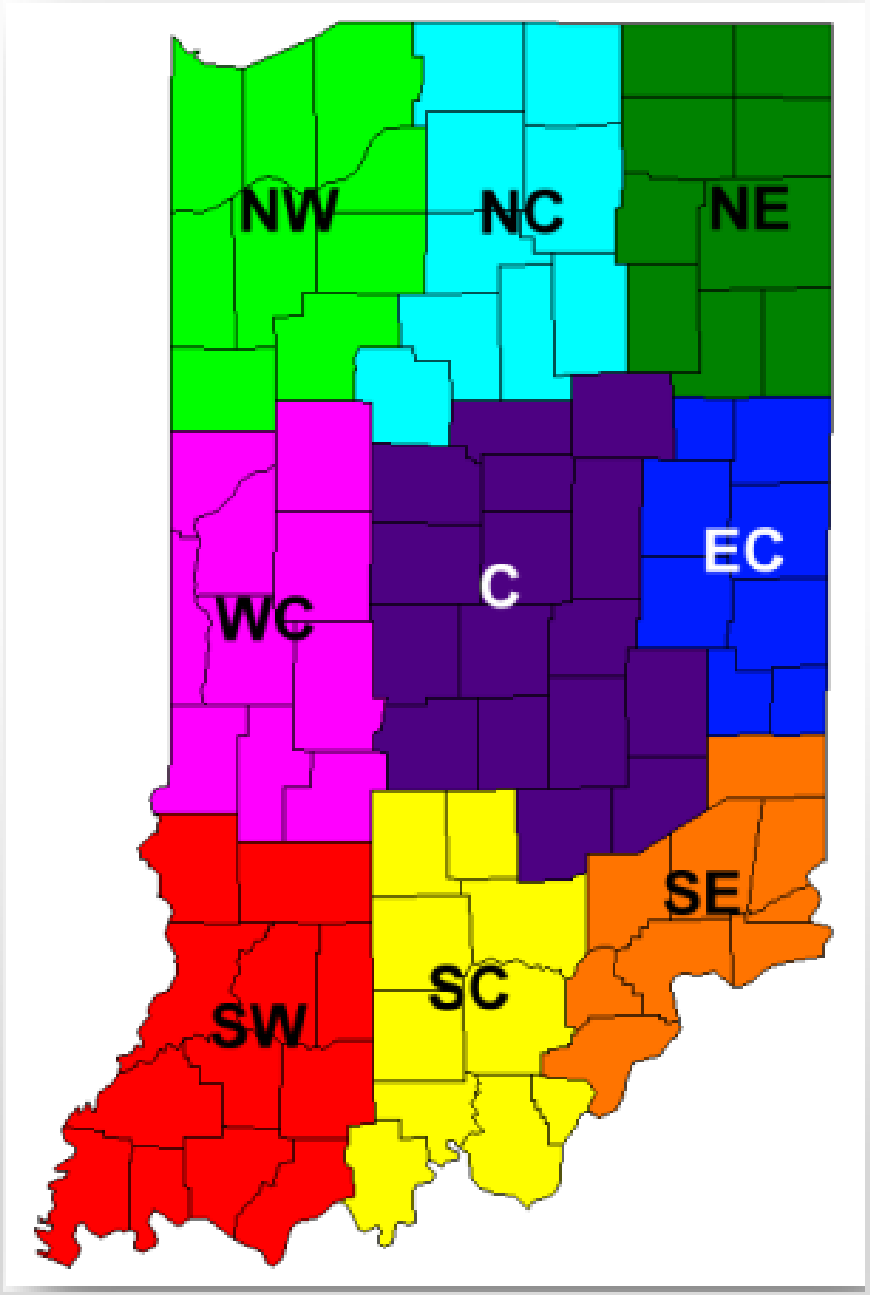
AONR Variability

- May range from 130 – 262 lbs N/ac in one location
  - Importance of data driven N rate recommendations
  - Importance of efficient N applications, spreading risk
- Why? – variability in soil N supply, soil N loss, and weather
  - Complex biological system
  - Difficult to model
  - Cannot predict soil N supply
- Applying “More than enough N as insurance” is not a good economic or environmental practice
- Why N fertilizer application placement and timing is important

What is the Economic Optimum N Rate?

- N Fertilizer rate that returns the most profitable economic yield
  - Yield gain from N application more than pays for invested N fertilizer

- Influenced by corn grain price and N fertilizer price
  - Did those couple extra bushels pay for the N fertilizer applied?



N fertilizer recommendations designated based on specific region within the state

- **Soil type**
- **Soil organic matter**
- **Soil drainage**

Take Home Points on N Fertilizer Rate

- Optimum N fertilizer rates vary from field to field and from year to year
  - Non-linear response, more N does not always mean more grain
  - Is it worth chasing those few extra bushels?
- Fertilize for maximum economic net return, not maximum yield
- Utilize efficient N fertilizer application methods to improve NUE and lower N fertilizer losses.

So What About Cover Crop Systems?

Farmers want to protect their soils.
Rye is one of the most common species for cover crop in grain fields in the Midwest.

- Soil Erosion
- Nitrate Leaching
- Resistant Weed Populations
- Water Retention
- Soil Organic Matter

Corn Plant Health – June 23rd (Growth Stage V6)


Rye Cover Crop
No Rye Cover Crop

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)

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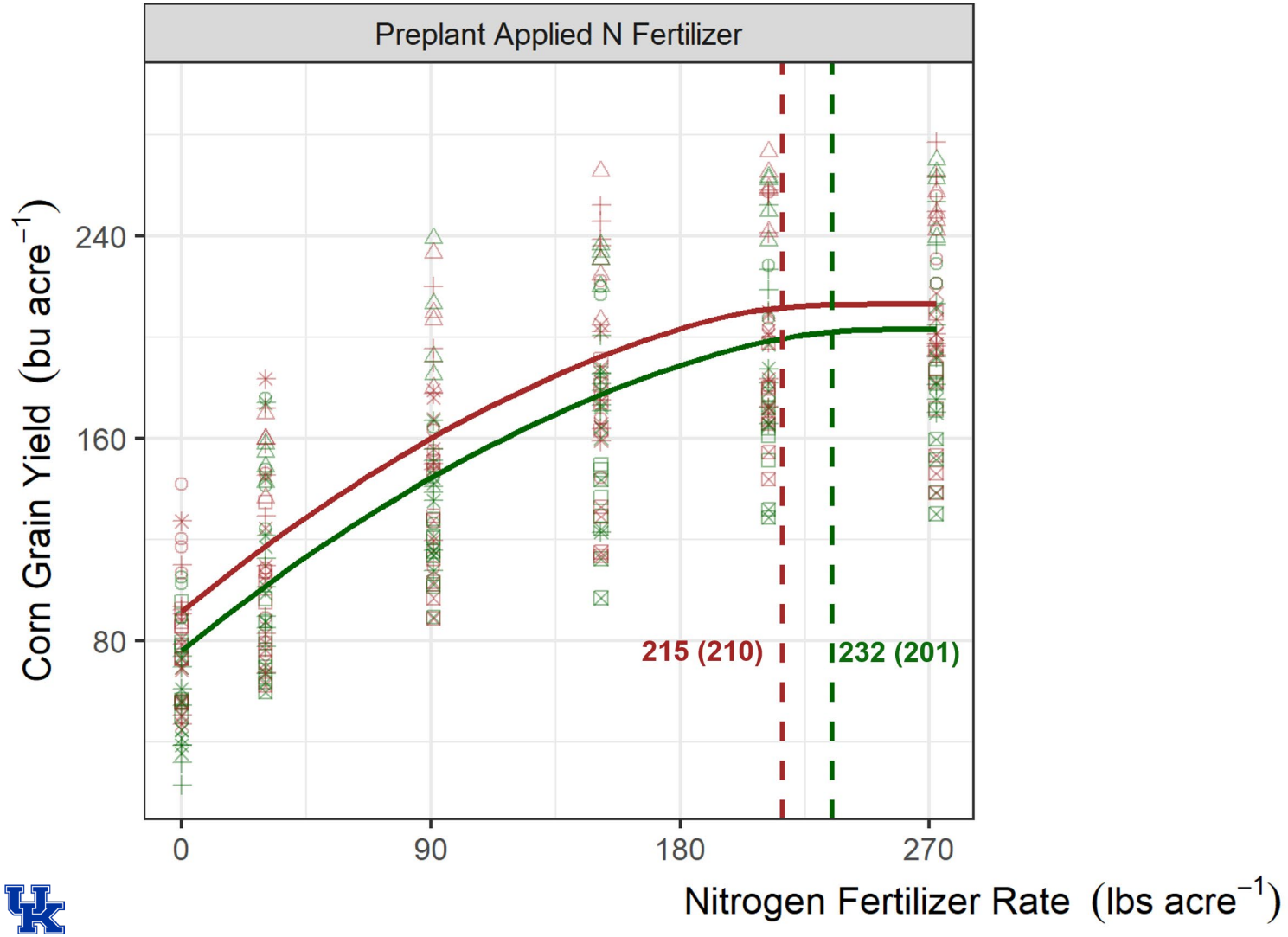
Next Generation Cover Crop and N Fertilizer Management that could reduce Yield Lag

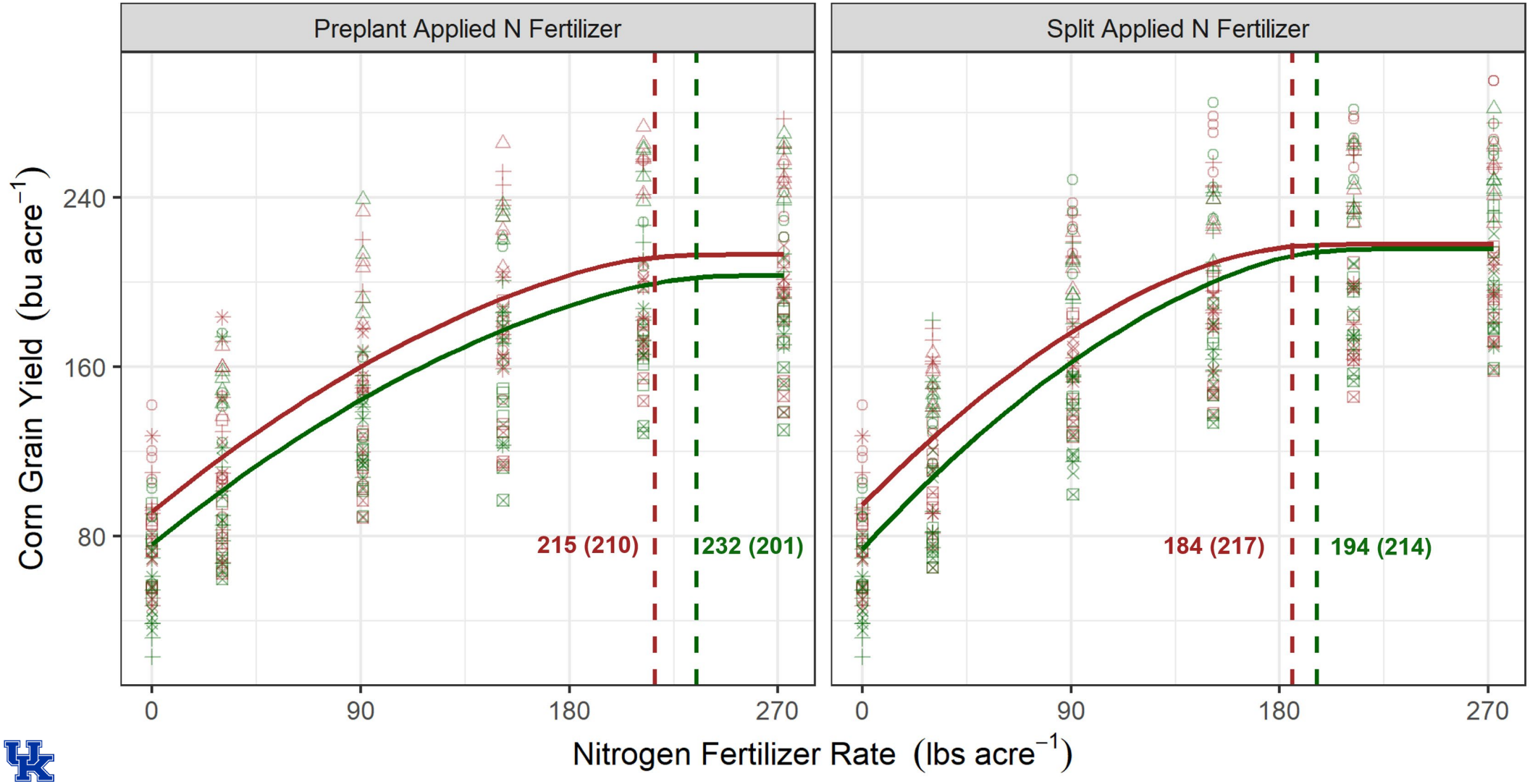
N Application Rate and Timing

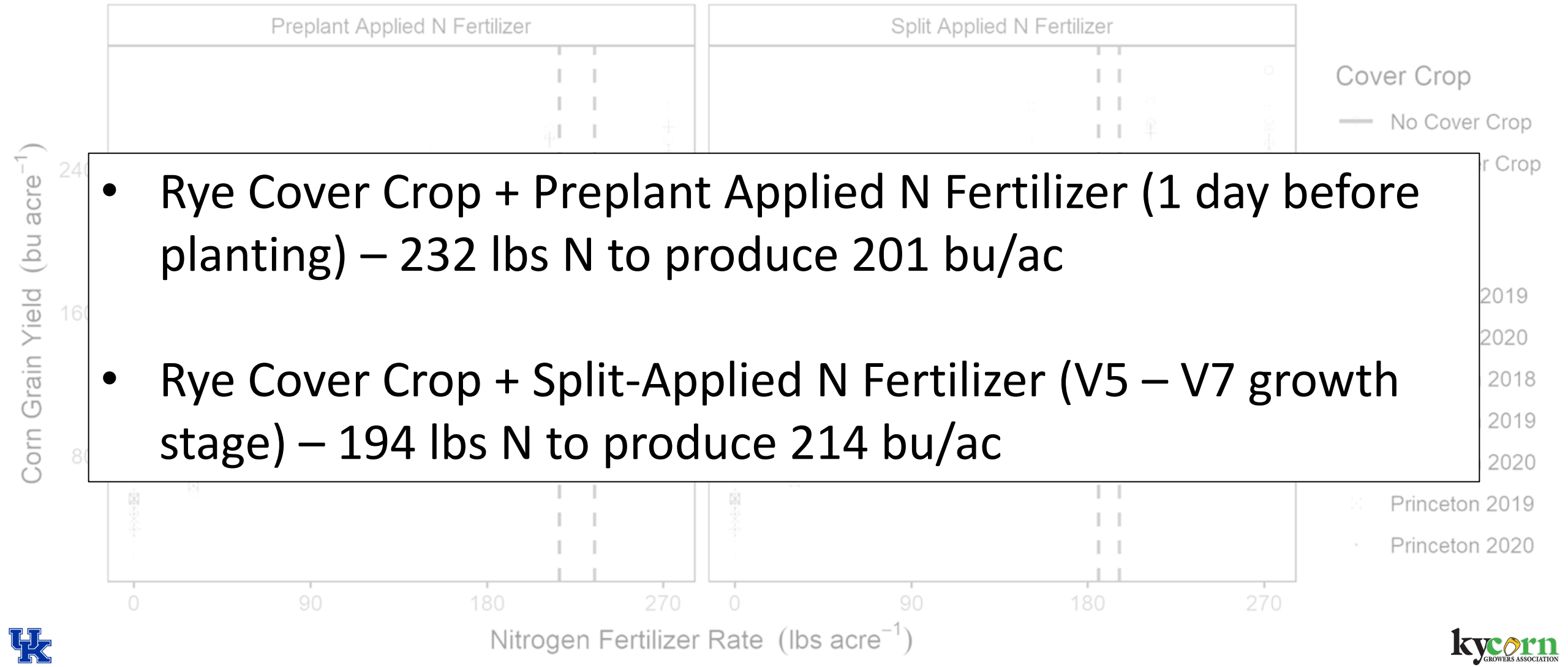
Planting Settings to protect population

Precision Planted Cover Crops

Overwintering Legumes

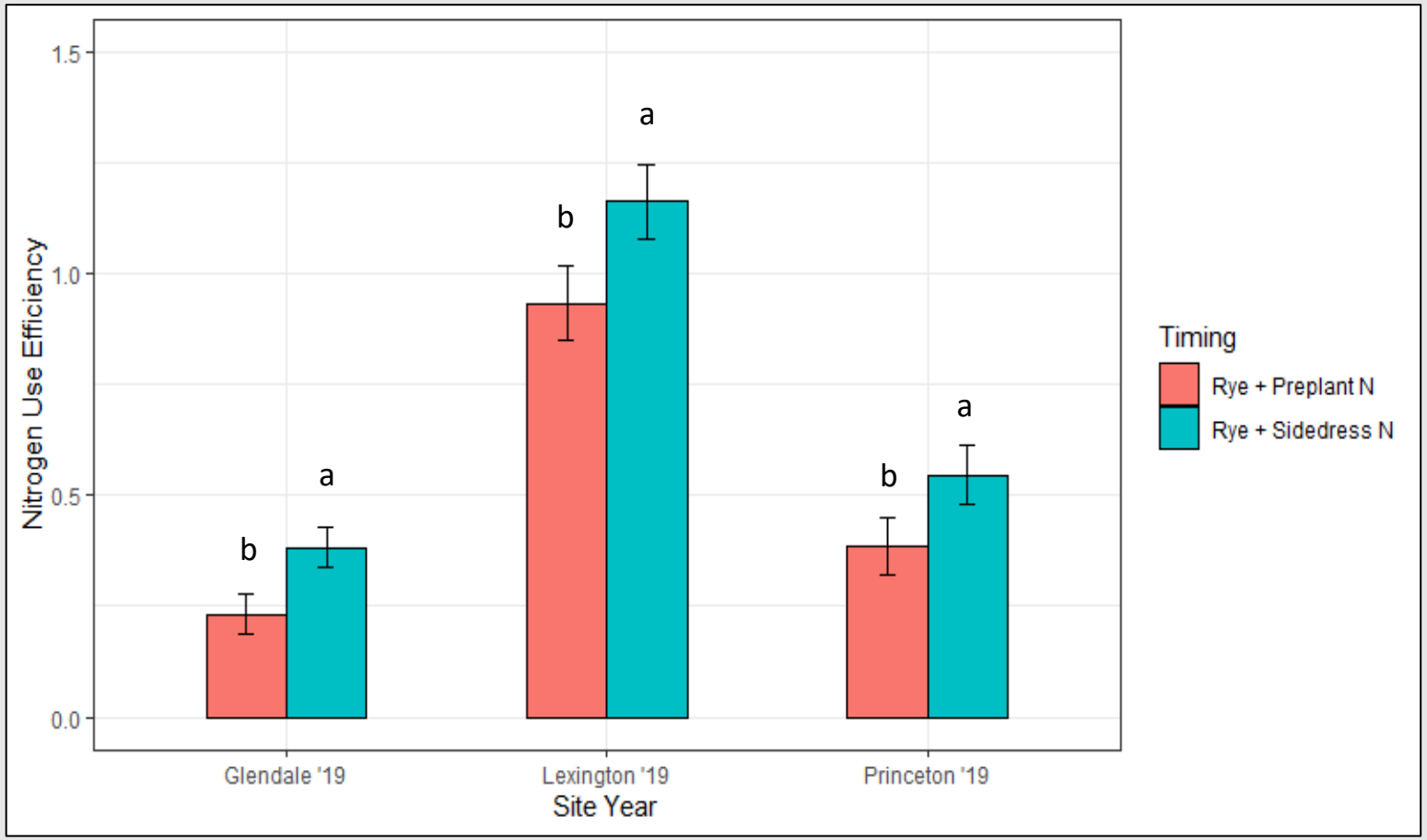






- Rye Cover Crop + Preplant Applied N Fertilizer (1 day before planting) – 232 lbs N to produce 201 bu/ac
- Rye Cover Crop + Split-Applied N Fertilizer (V5 – V7 growth stage) – 194 lbs N to produce 214 bu/ac

Split N applications improve corn nitrogen use efficiency following a rye cover crop



*Bars followed by the same letter within each site-year are not significantly different from each other at α=0.1

NUE = (Yield of treatment – Yield of 0N check) / Nitrogen rate applied

Amount of grain produced per pound of nitrogen fertilizer applied

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

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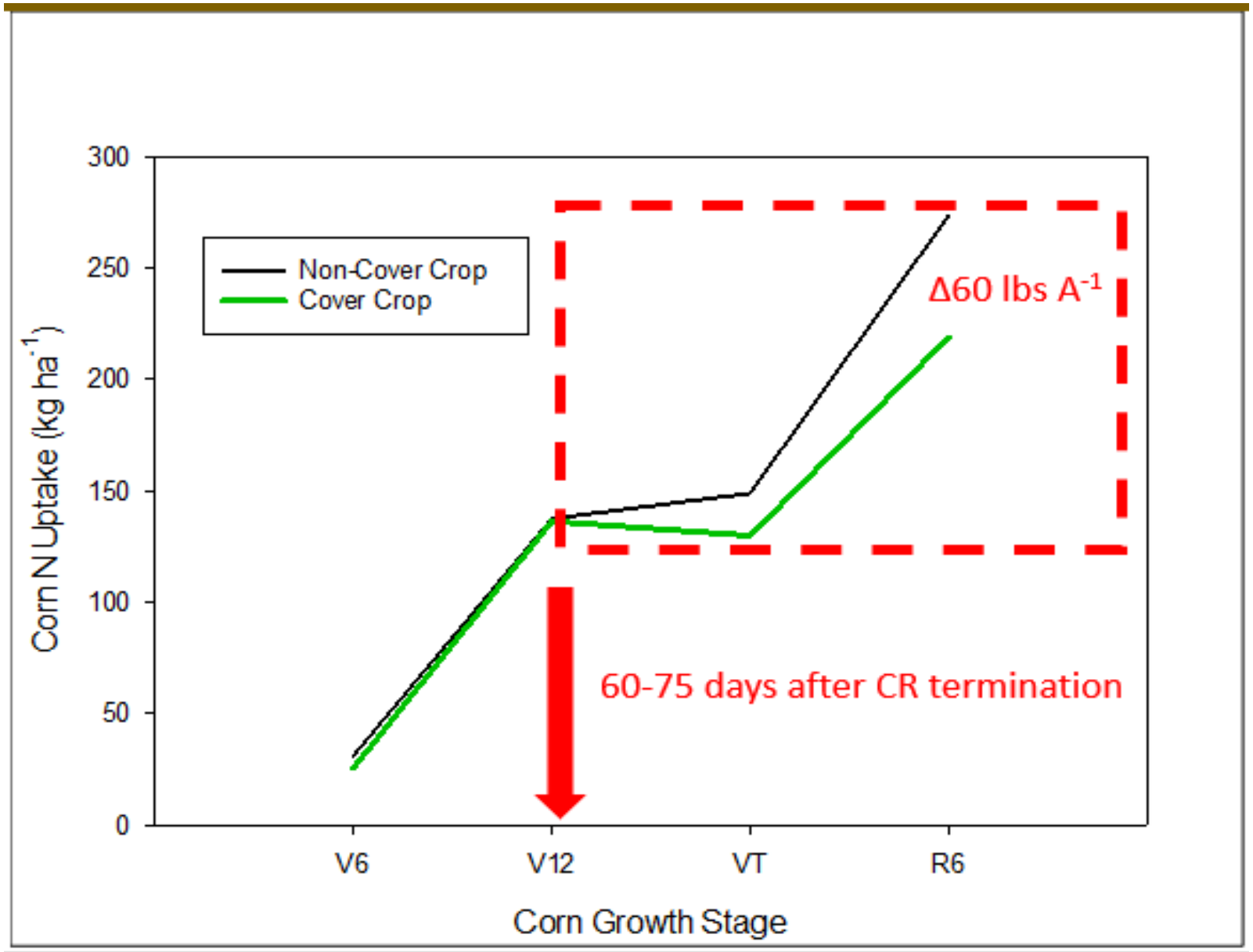
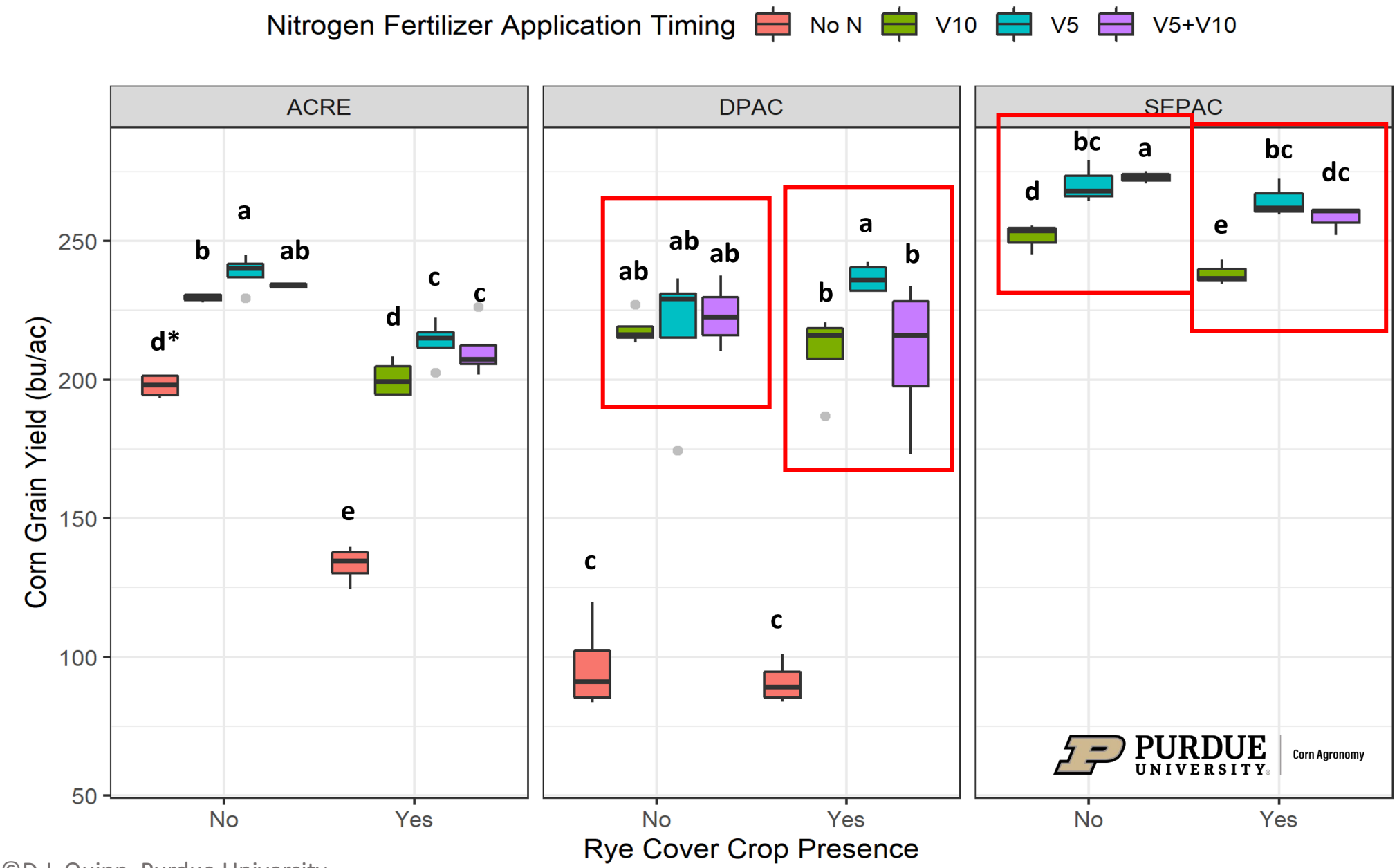


Reduced N Uptake at V12 Growth Stage

Slide by – S. Armstrong, 2022

Impact of In-Season N Fertilizer Timing in Cover Crop Systems – SEPAC, DPAC, ACRE 2022



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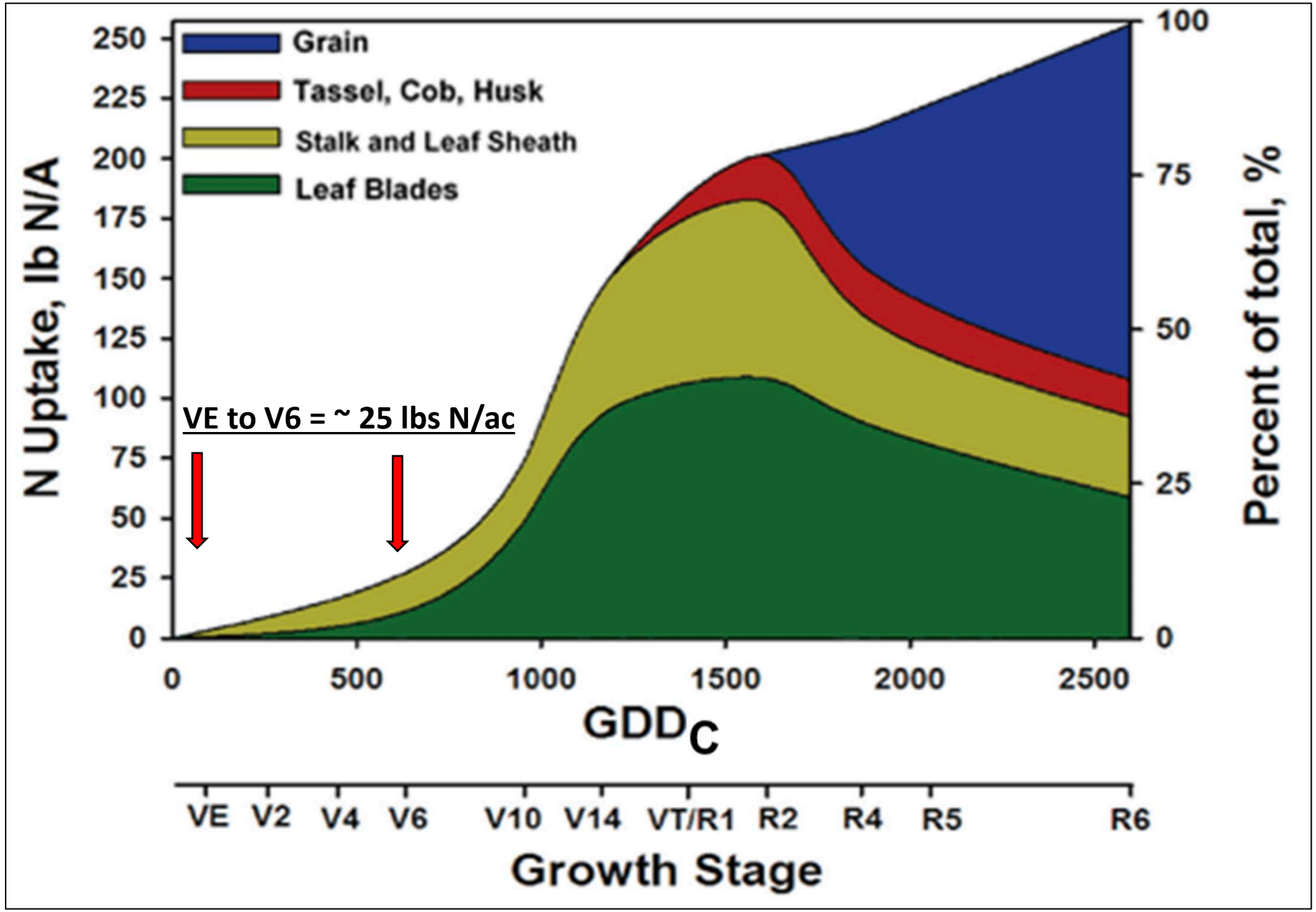
* Boxplots which contain the same letters above and are within the same location are not statistically different from each other (P>0.1)

Efficient N Application Methods

- Avoid Fall N application if possible
  - Soil temps below 50 degrees F
  - Use a Nitrification Inhibitor

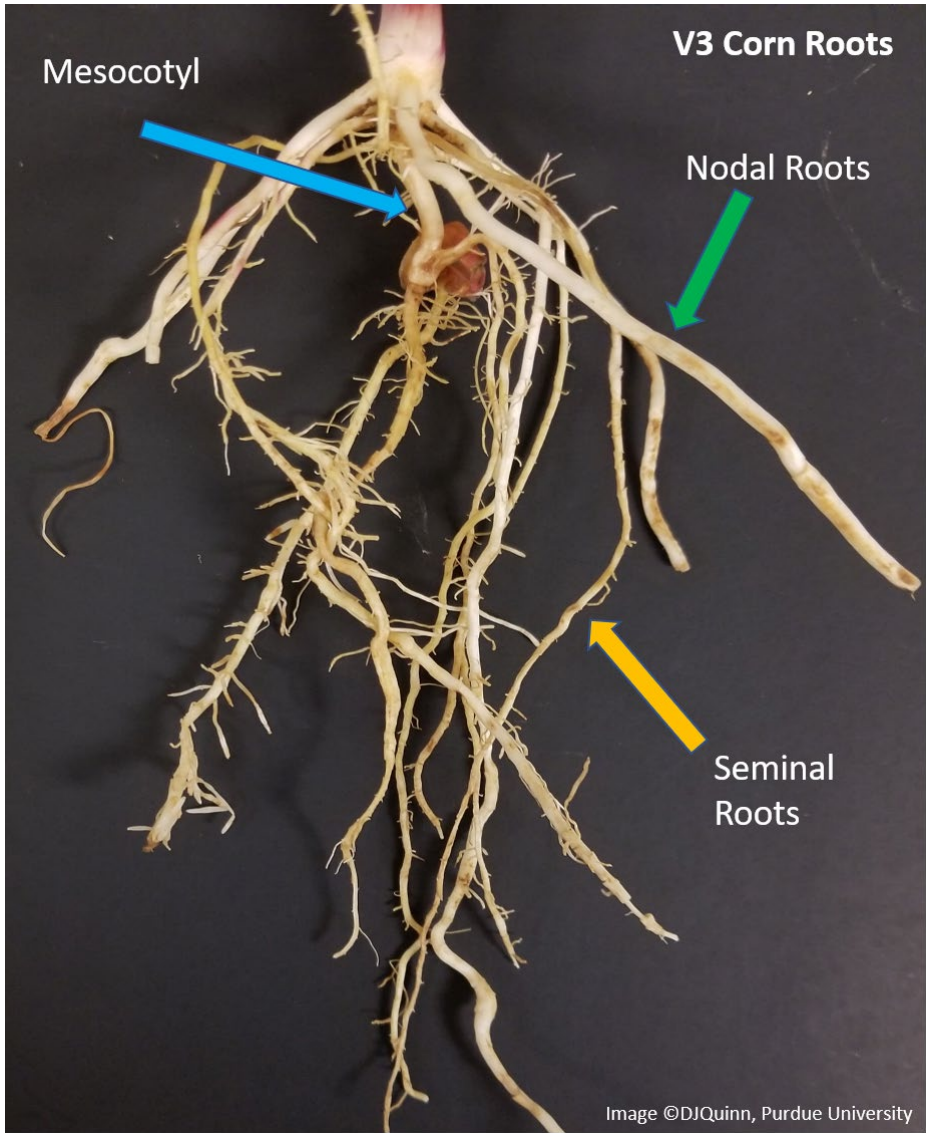
- Utilize Split Application of N fertilizer
  - Starter + V5–V7 sidedress
  - Utilize urease inhibitor if N is surface applied
    - UAN and Urea



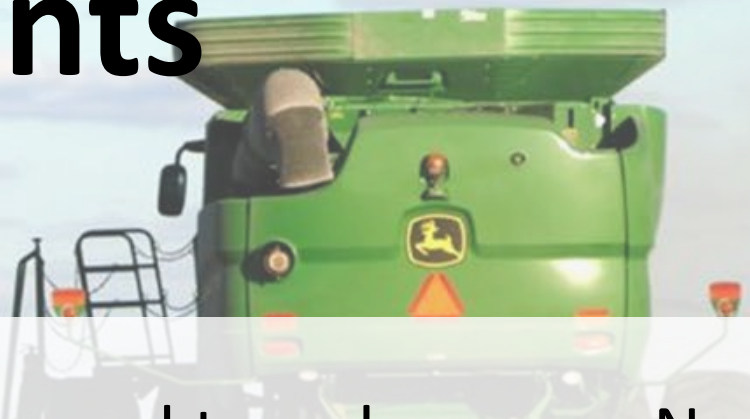
Bender et al., 2013

Importance of Adequate N applied at Planting

- Sufficient N applied at planting required for early-season corn needs
- Banded starter fertilizer can help with transition period of corn roots
  - Seminal to nodal @ ~V3
- Waiting too long to apply any N, can result in yield loss



Take Home Points



- 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)

- Utilize split-application of N to reduce N loss risk and improve timing with corn N uptake requirements

- Late-season N application responses are often environmentally dependent and can be risky with waiting too long

Questions?

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