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Role of Cover Crops in Nutrient Cycling and Soil Health

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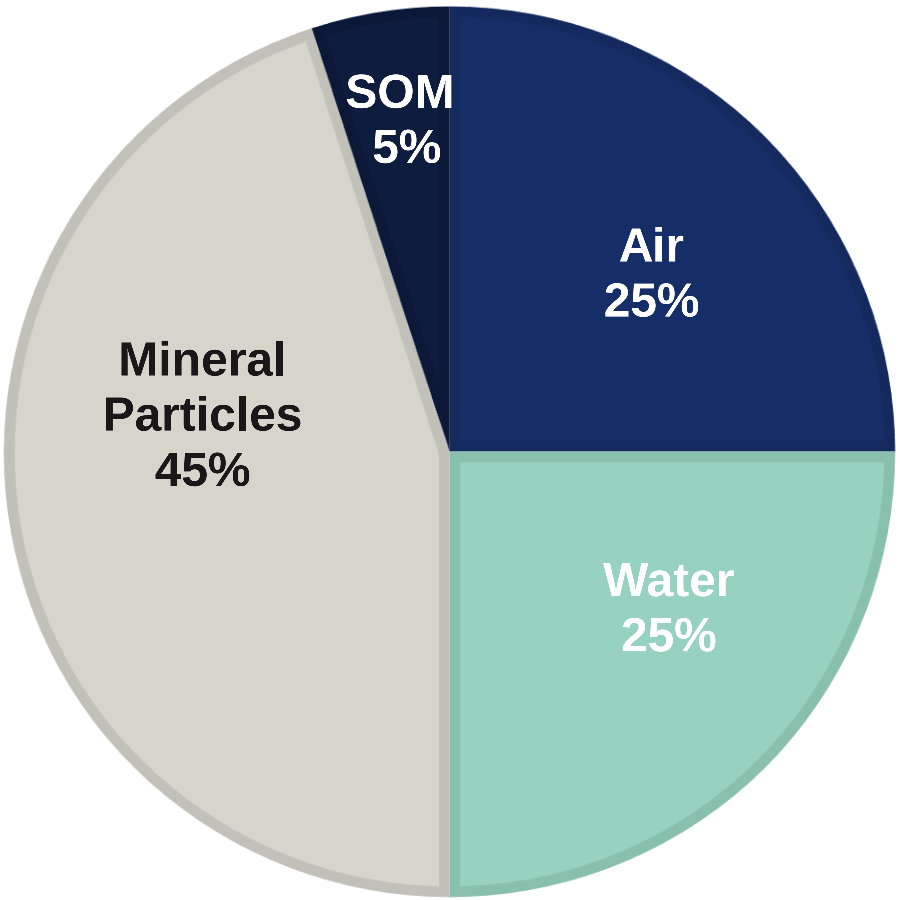
Overview

- Soil organic matter role in nutrient cycling
- Pools of soil organic matter
- Cover crop role in nutrient cycling
  - Nitrogen retention
  - Nitrogen supply
- Nitrogen contributions from soil organic matter

Soil Organic Matter (SOM) improves soil health by directly influencing other soil components



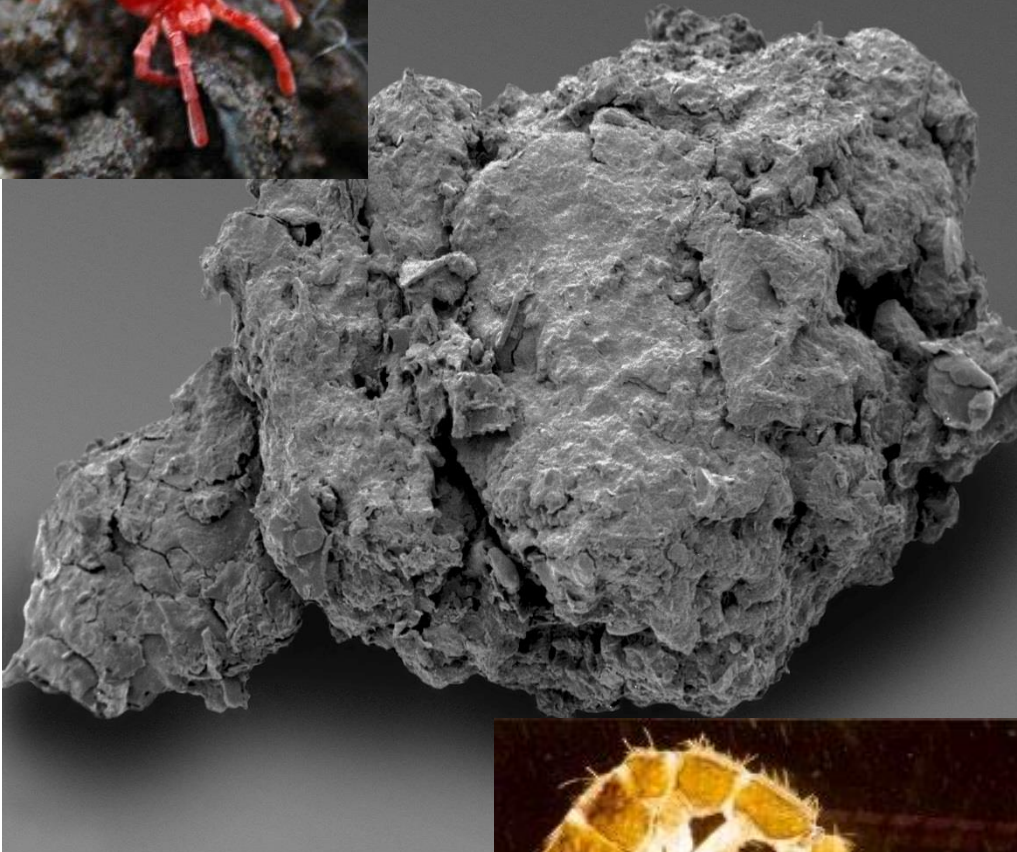
Healthy soil has structure and can support life

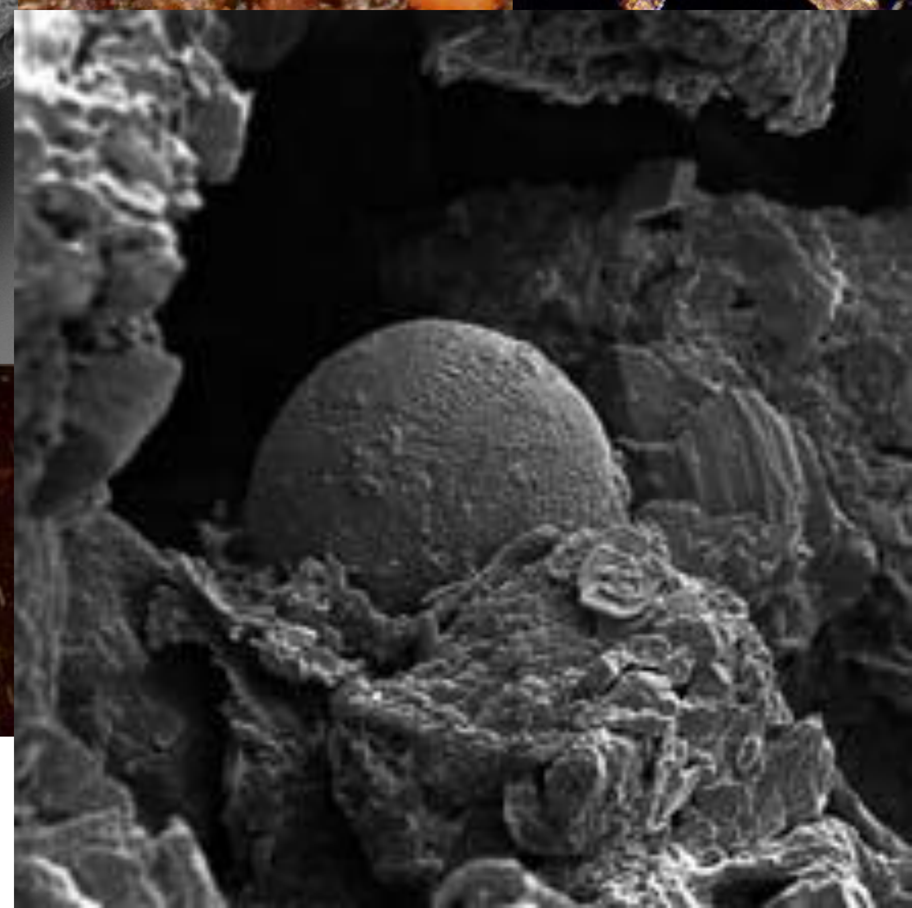
<u>SOM Role in Nutrient Cycling</u>

- Soil Particle Aggregation
    - Water Flow/Absorbance
    - Support Organisms
    - Root Growth
- Nutrients and Carbon Supply
- Chelates
- Cation Exchange Capacity
    - Clays = 50-150 meq/100 g
    - Humus $\geq$ 200 meq/100 g

Low SOM
Poor Structure

High SOM
Good Structure





Soil animal photos from bio@biois.com

Scanning electron micrographs from www.micropedology.uni-bremen.de

Soil Organic Matter Pools

- **Labile SOM** - 5-20% of SOM
  - Simple compounds
  - Principal energy source
  - Changes rapidly
- **Stable SOM** - 60-90% of SOM
  - Stable structure, adsorbed to clay, protected in aggregates
  - Changes slowly

Photo: Edwin Remsberg and USDA-SARE

Photo: Edwin Remsberg and USDA-SARE

Build Healthy Soil by diversifying SOM inputs

Photo: Edwin Remsberg and USDA-SARE

Soil Organic Matter and Cover Crops

Cover crops can add 1 to 5 tons organic matter/acre/yr
Leads to significant increases in %OM over time

- Roots
- Leaves
- Mulches
- Manures
- Composts

OM increase from CCs

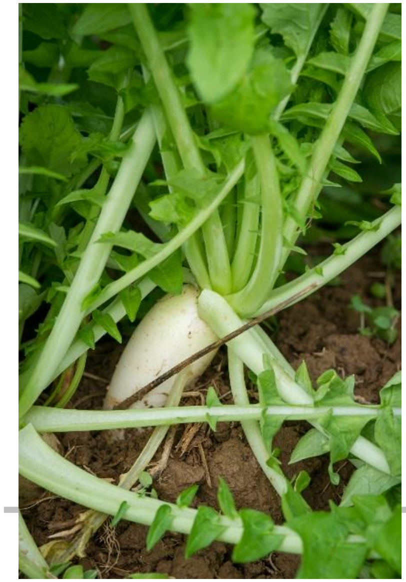
Equilibrium organic matter level is a balance between gains and losses to the soil

- Harvest
- Decomposition
- Erosion

Plant certain types of cover crops based on your goals

Grasses
Annual ryegrass: nitrogen scavenger, erosion prevention, weed suppression

Legumes
Crimson clover: nitrogen source, erosion prevention



Brassicas
Forage radish: erosion prevention, weed suppression, soil compaction reduction

Photos: Edwin Remsberg

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Legume Crops

- Fix and Supply Nitrogen
    - Root nodules
    - Plant available form
- Low C:N
    - ~3.5 to 4% N before flowering
    - ~3 to 3.5 % N after flowering
- Prior to N demanding crop
- Low biomass production
- Inoculate seeds

Brassica Crops (broadleaves)

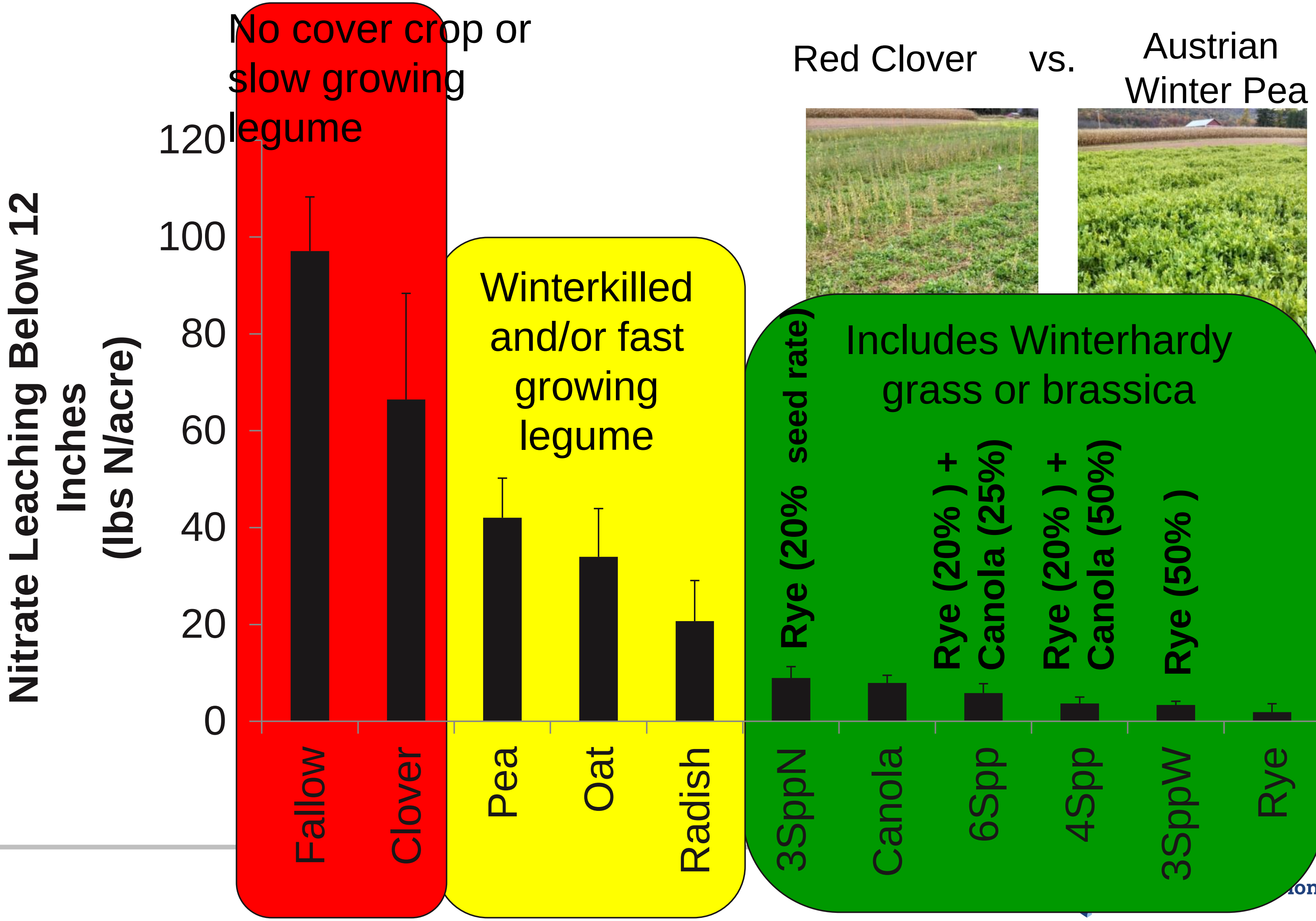
Photo: Edwin Remsberg and USDA-SARE

- Deep taproots
  - Biodrilling
- Radish and Canola respond to high N soils
- Scavenge N
  - Produce less biomass
- Winterkilled or planted in early spring
  - NO_3 leaching
  - Good in mixes

Cereal Crops/Grasses

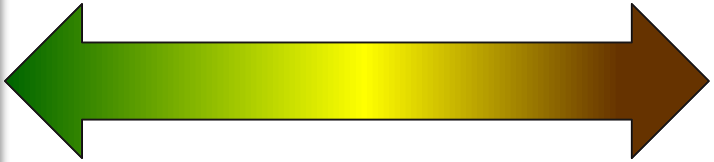
- Fibrous Roots
- High C:N
  - ~ 2 to 3 % N before flowering
  - ~1.5 to 2.5 % N after flowering
- Nitrogen Retention
  - Control NO_3 leaching
- A lot of above ground biomass
- Between Summer Annuals
  - Corn – Cover – Soybean

Species Characteristics Affect N Retention



Cover crop species usually have a tradeoff between N supply and N retention

<u>Legumes</u>
Poor N retention
Greater N Supply



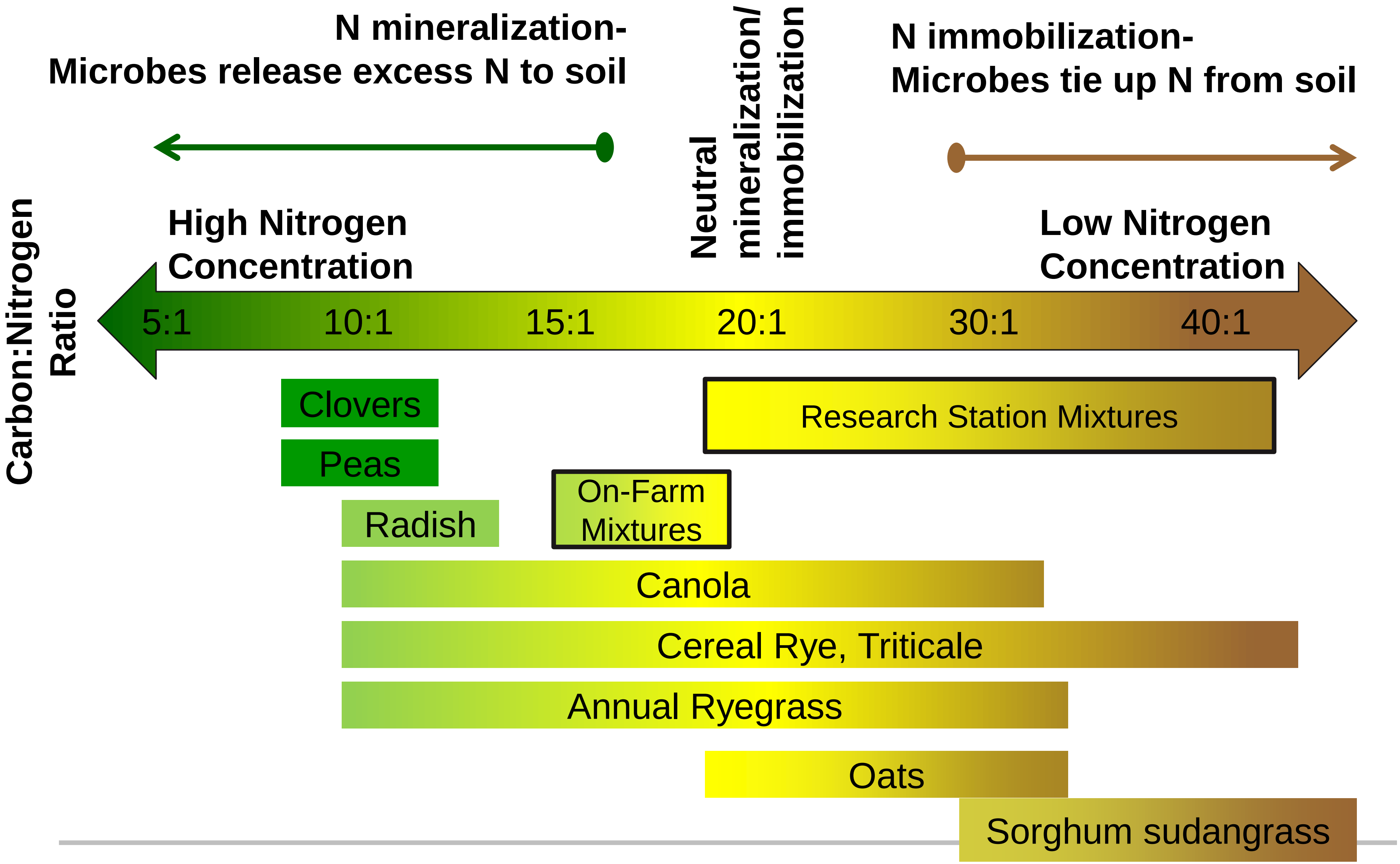
Low C:N

High C:N

<u>Non-Legumes</u>
Good N retention
Less N Supply

Cover crop biomass carbon:nitrogen ratio influences N supply

C:N ratio of cover crop residues regulates N supply vs. N tie up



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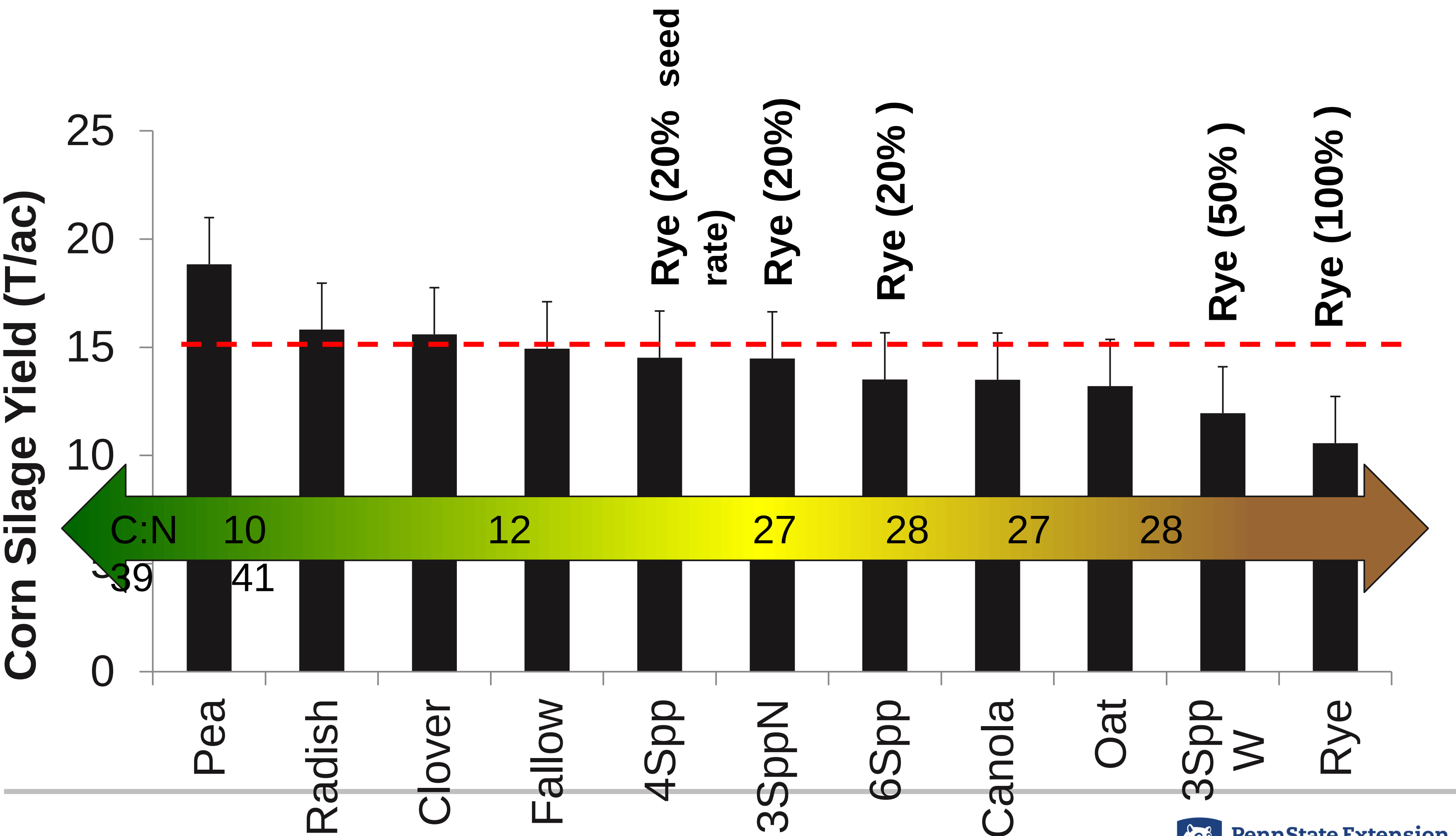
Corn Yield Declined with Increasing C:N Ratio of Cover Crop



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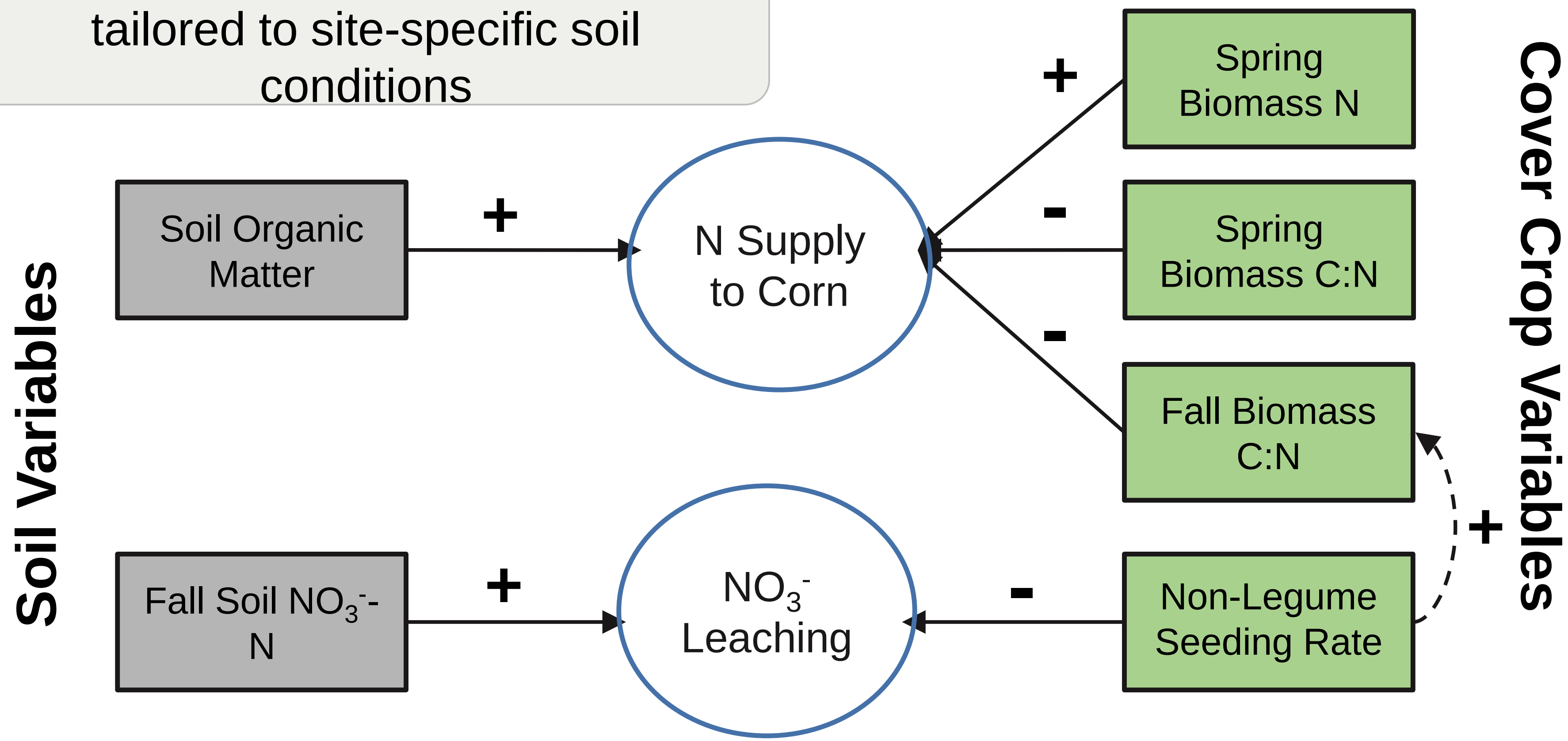
Across sites and cover crop treatments, N retention and supply were controlled by interrelated factors

Cover crop mixtures should be tailored to site-specific soil conditions



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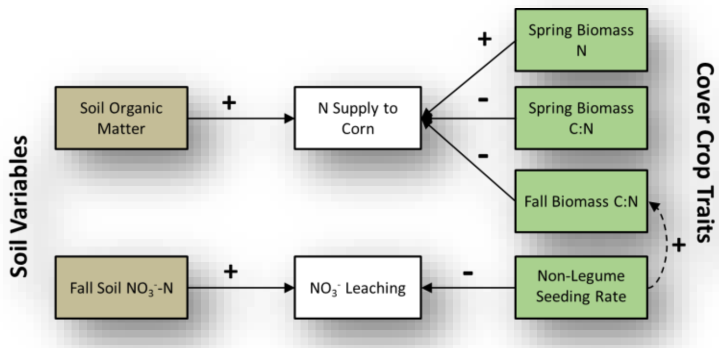
Key Takeaways for Nitrogen Management with Cover Crop Mixtures

To prevent nitrate leaching:

- For every 3 ppm soil nitrate-N at cover crop planting, add 10 %pts to the seeding rate of winter-hardy grasses
- Fill in remaining seeding rate to 100% with legumes or other species of interest



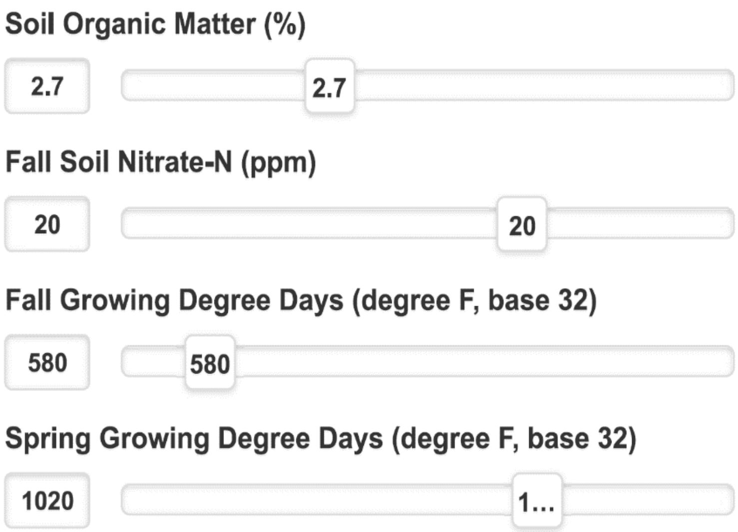
Example
12 ppm nitrate-N =
40% winter-hardy grass seeding rate

To maintaining N supply to next crop:

- Non-legumes decrease N supply, but this can be offset by high soil organic matter
- To achieve high levels of both N retention and N supply, maintain low fall soil nitrate levels and/or increase SOM levels

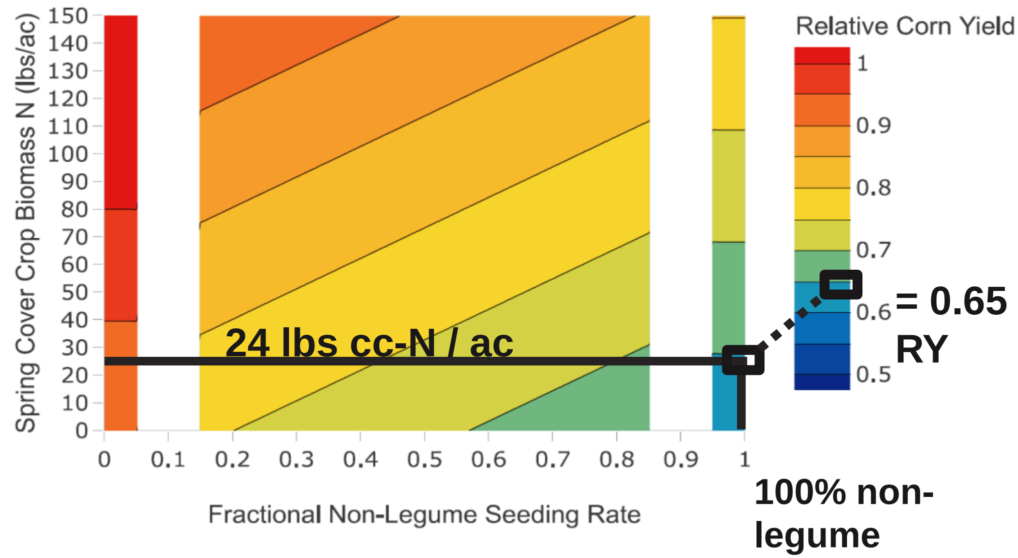
Graphical Decision Support Tool: CC & SOM Credited N-Recommendation

- Developed a tool based on trials through PA
- Calculates:
  - N contribution from CCs and SOM based on site-specific measurements
  - Adjusted fertilizer recommendation to achieve yield potential
- Fall GDD at cover crop planting
- Spring GDD at cover crop termination



Calculating CC-credited N-rates

- 35 lbs N applied as manure
  - Determined from testing and availability factors
- 69 lbs N/ac minus <u>35 lbs manure-N</u> =
  34 lbs N/ac



Yield Potential

22

Relative Yield

0.65

Supplemental Nitrogen Requirement

69 lbs N/ac

Nitrogen Rate Comparisons

In Corn Silage (following Rye CC)

- 22 T/ac Yield Potential
  - Agronomy Guide 100 lbs N / ac
  - CC Tool 34 lbs N / ac
  - PSNT 83, 54, & 0 lbs N / ac

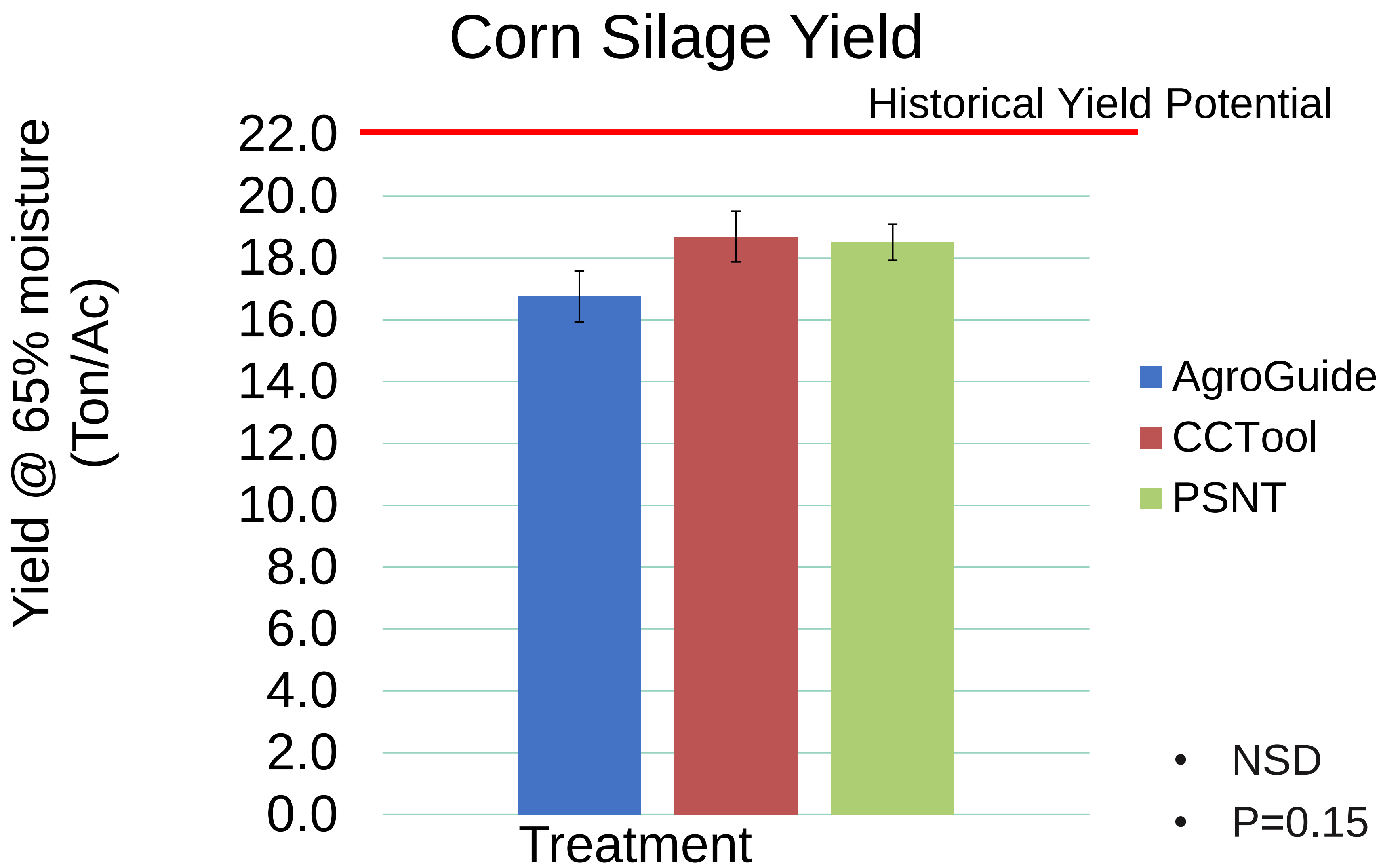
In Corn Grain

- 160 Bu/ac Yield Potential
  - CC Tool 0 lbs N / ac
  - PSNT 90 lbs N / ac
- All N applied as 30% UAN on July 6th

Evaluation

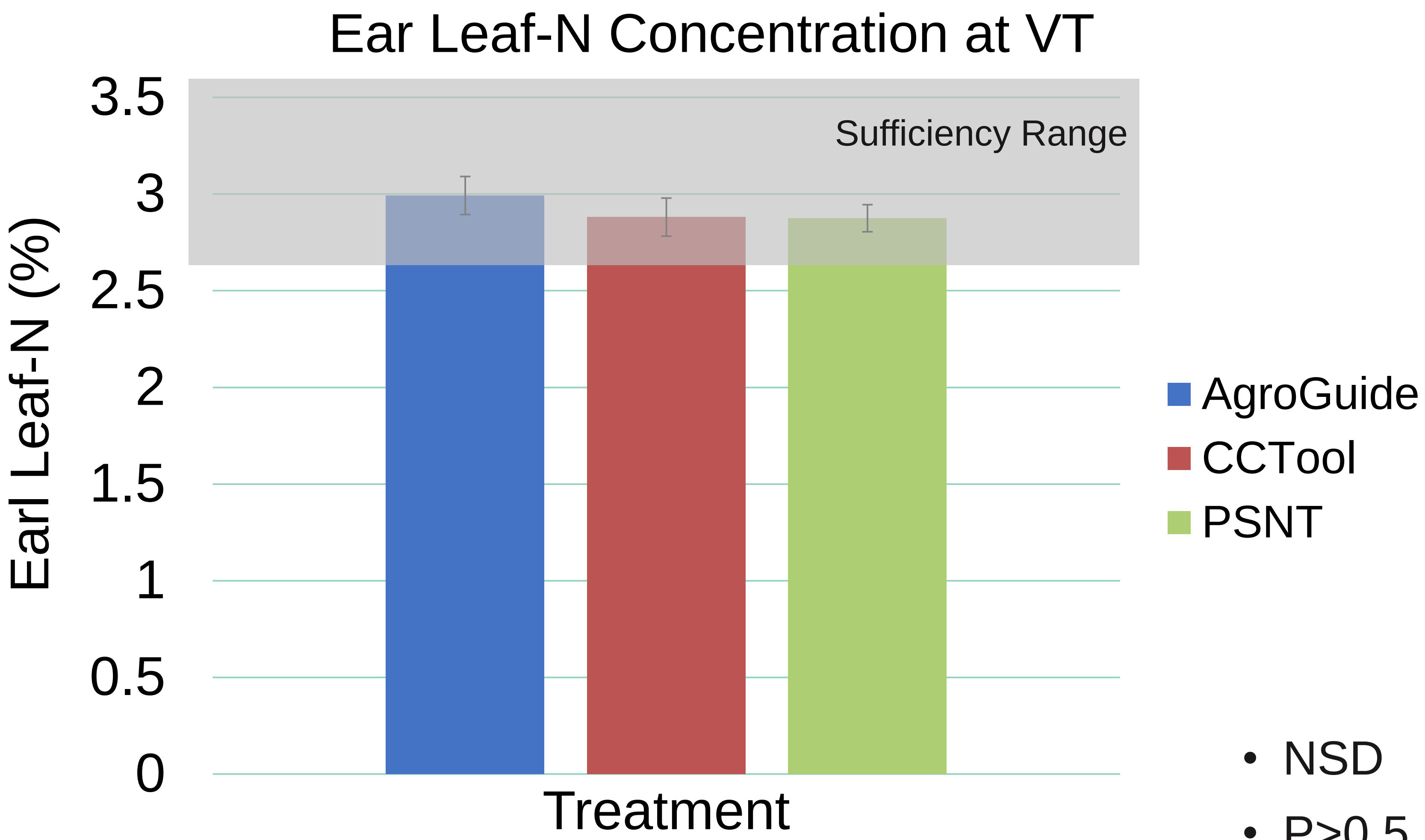
- To evaluate corn N sufficiency throughout the season:
  - Ear leaves were sampled at tasseling (VT) to determine N concentrations.
  - Late-season corn-stalk nitrate testing was conducted at ½ milk-line stage.
  - Corn silage and grain yields were measured.
- Means comparisons using PROC Mixed
  - Treatment as fixed effect, Block as Random Effect

Corn Silage Results



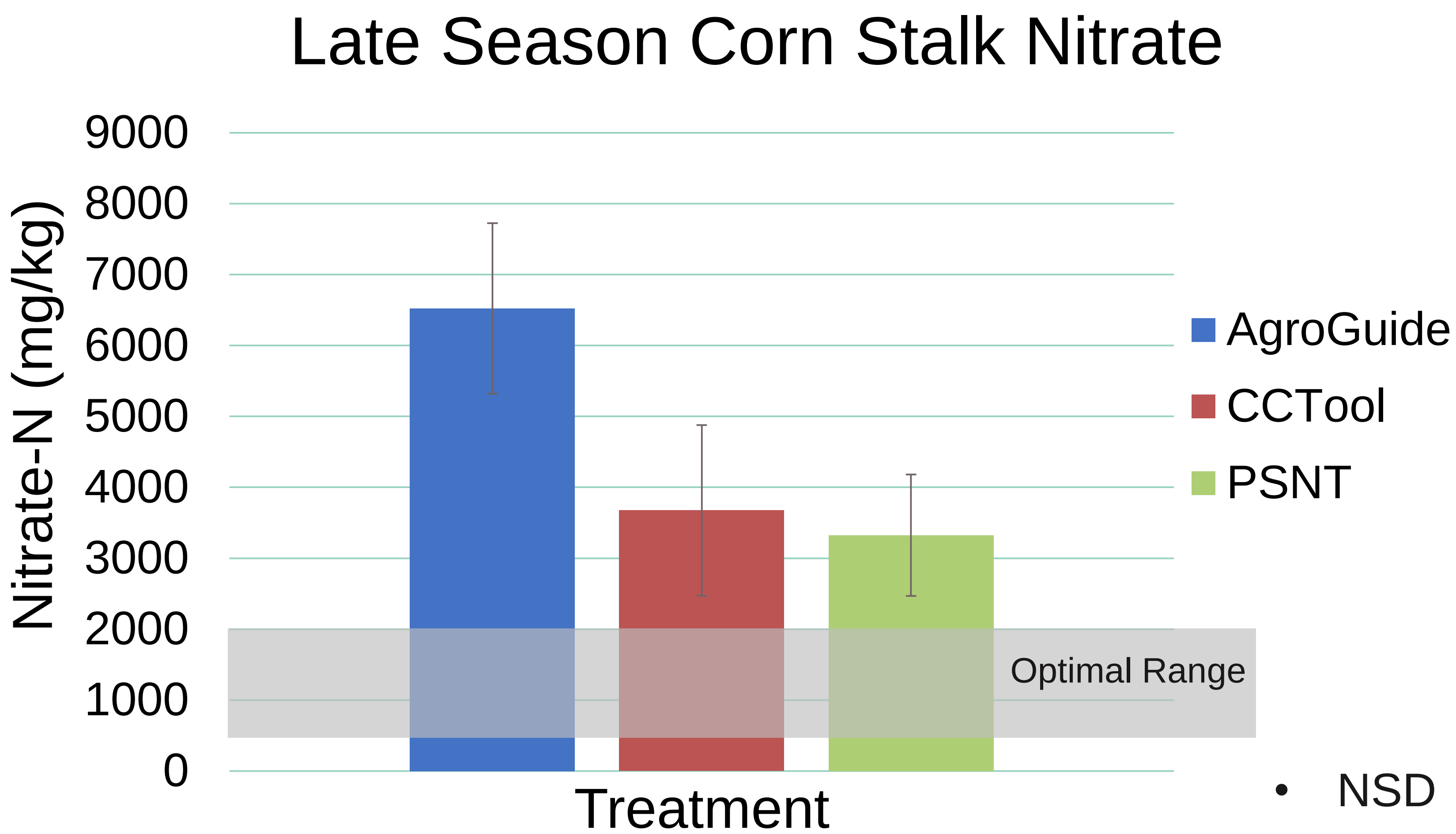
- NSD
- P=0.15

Corn Silage Results



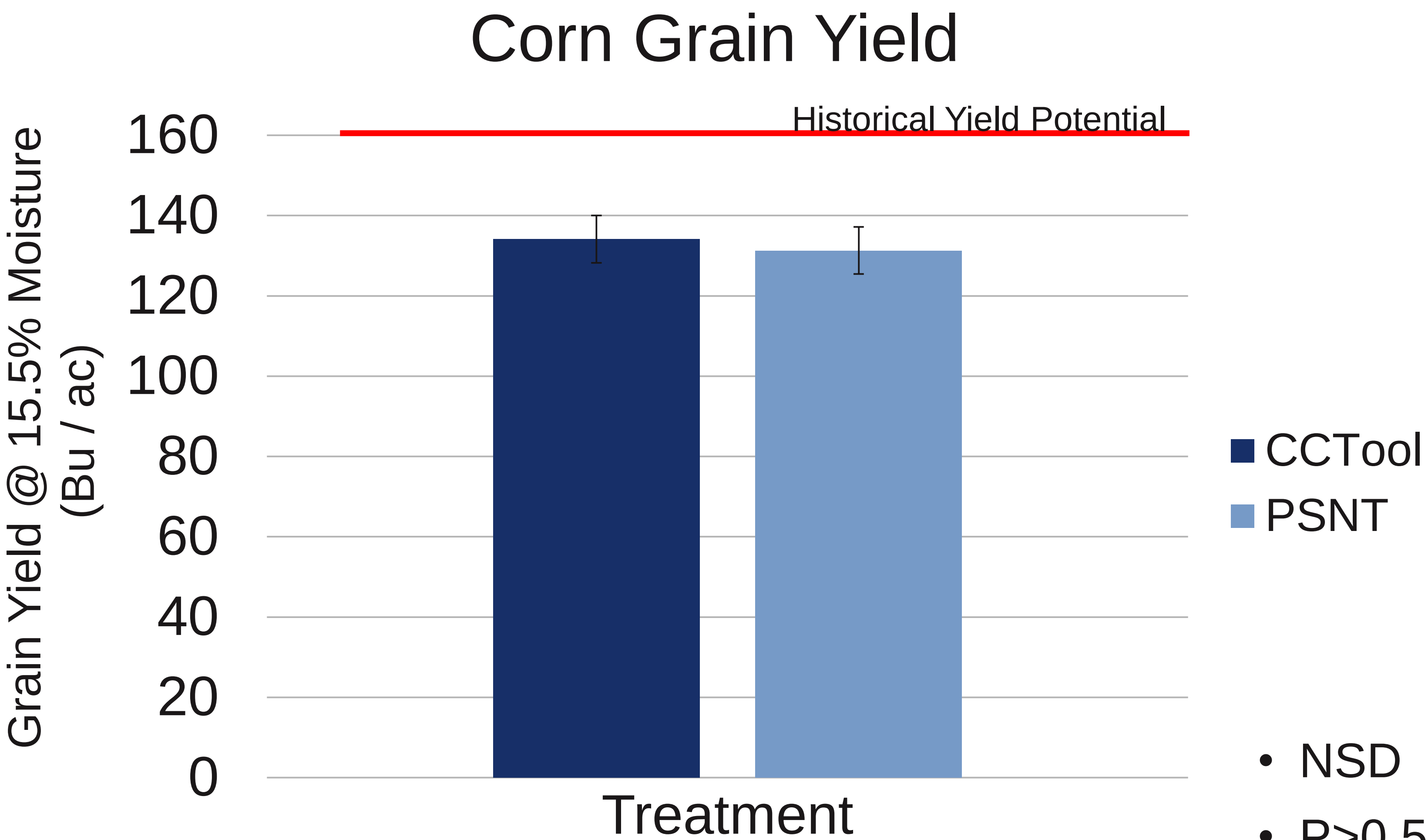
- NSD
- P>0.5

Corn Silage Results



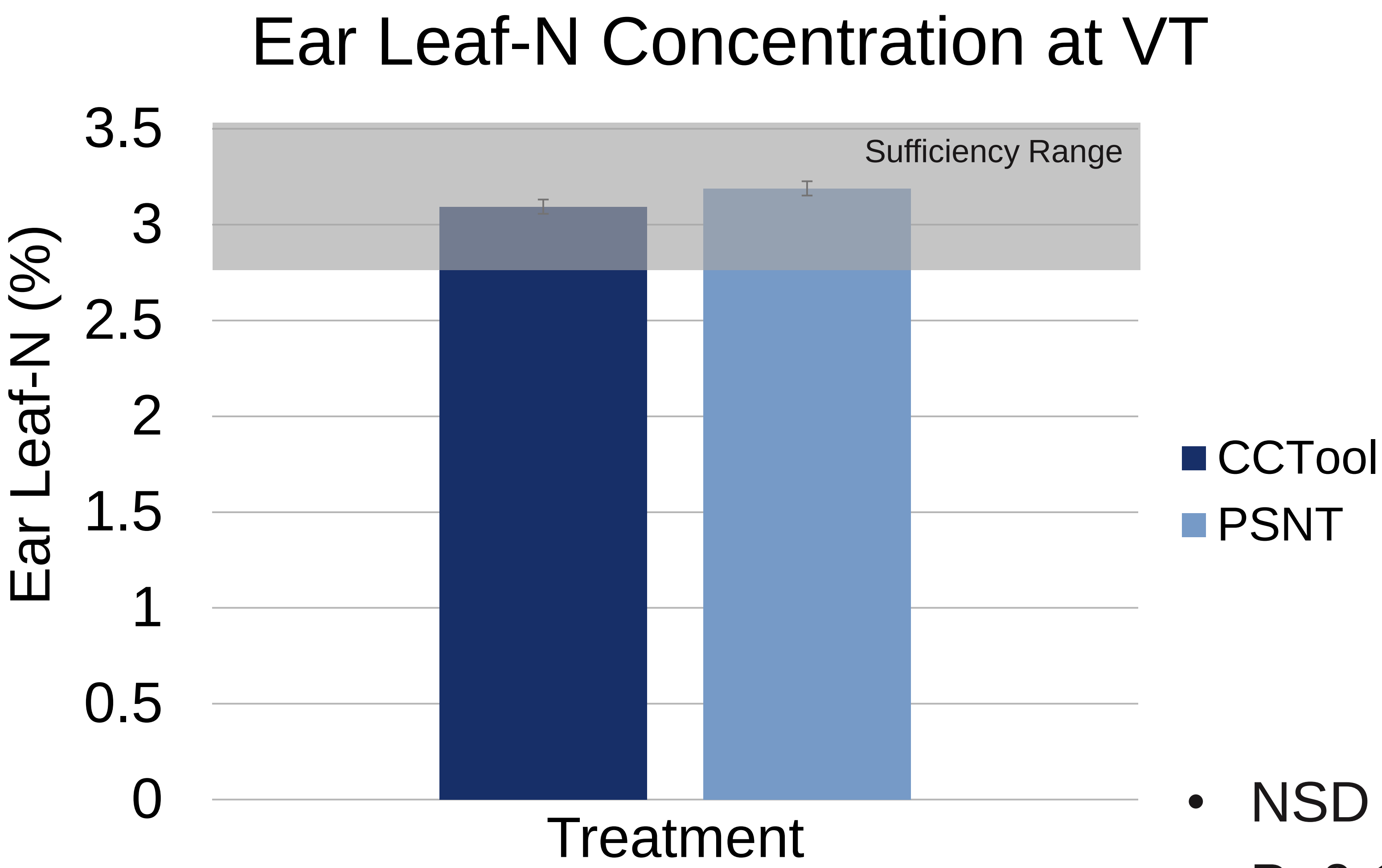
- NSD
- P=0.15

Corn Grain Results



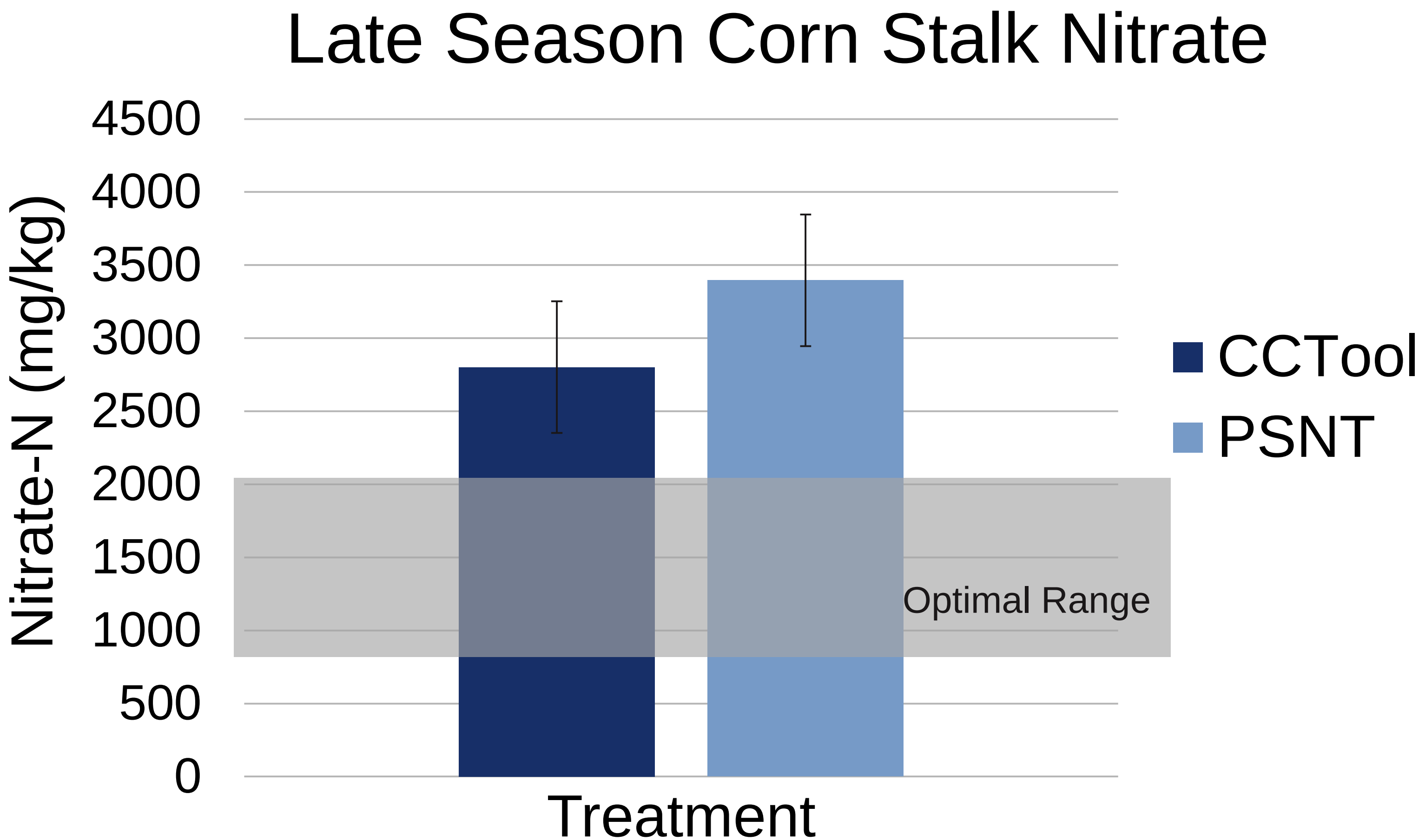
- NSD
- P>0.5

Corn Grain Results



- NSD
- P=0.11

Corn Grain Results



P<0.05

Conclusions

- CC Tool recommended N fertilizer rate was sufficient to meet the needs of a no-till corn silage and corn grain crops

- The CC Tool recommended N rate was lower than both the Agronomy Guide recommendation and the PSNT recommendation,
  - Highlights need/opportunity to credit the N contribution of cover crops and soil organic matter.

Summary

- SOM is important in improving both physical and biochemical aspects of nutrient cycling
- Cover crop management strategies depend on goals and should be tailored to site specific conditions
- N retention and supply determined largely by cover crop C:N, soil fall NO_3- supply, and SOM
- SOM and cover crop residue contributions need to be considered for effective nutrient management

Thank You

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