Corn Following a Rye Cover Crop – Can We Make it Work?

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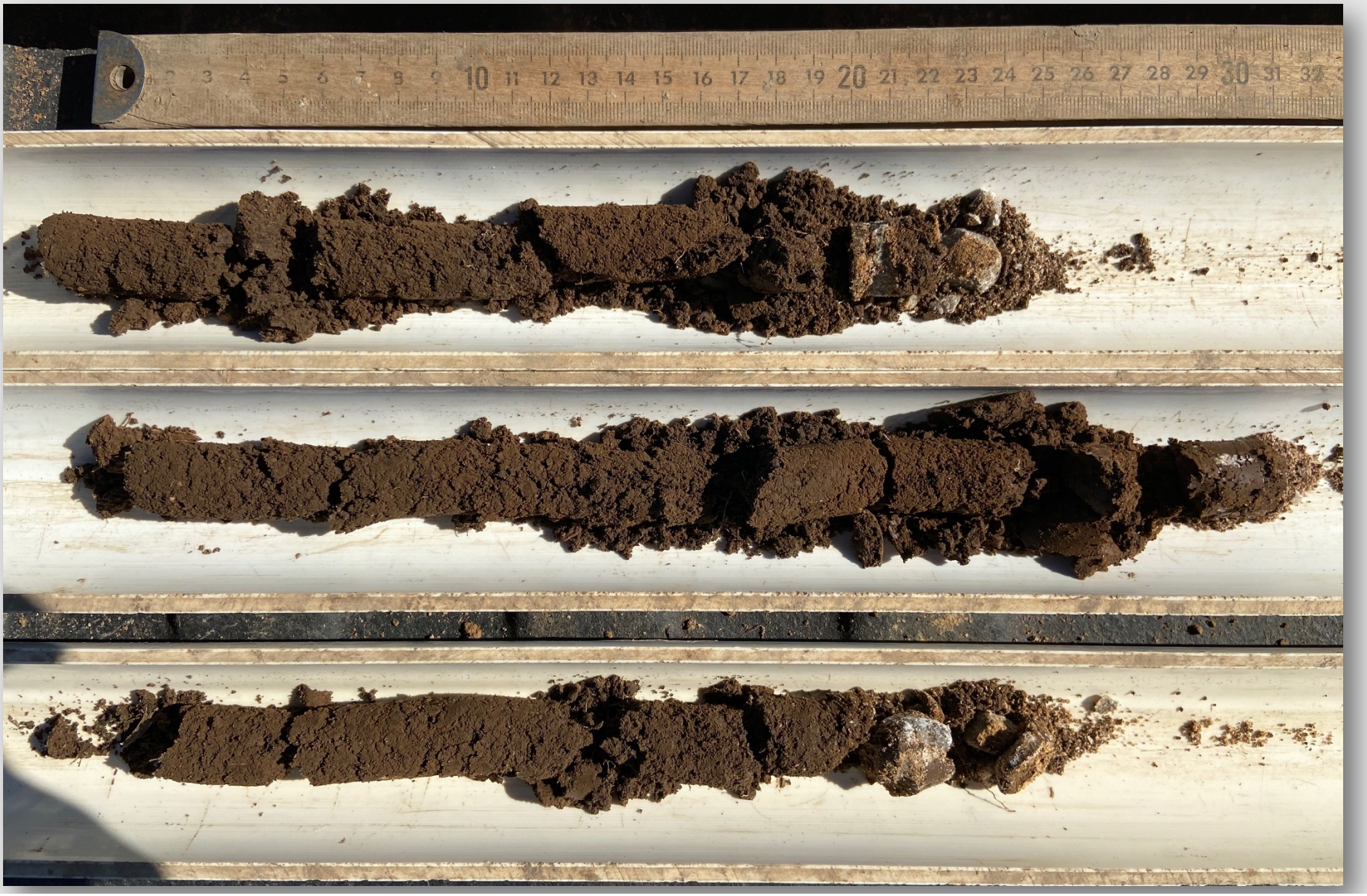
Farmers want to protect their soils.
Rye is one of the most common species for cover crop in grain fields in the Midwest.

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



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:**
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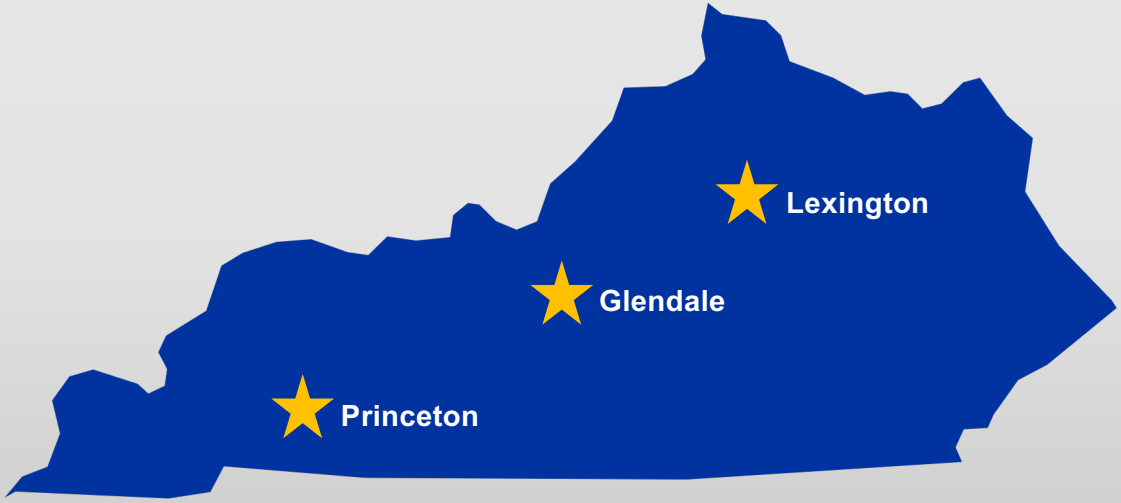
  - **Insects** (Dunbar et al., 2016)

Experimental Locations

Lexington, KY (2018, 2019, 2020)
– no-till, irrigated, following soybean
– Maury silt loam

Glendale, KY (2019, 2020)
– no-till, rainfed, following soybean
– Crider silt loam

Princeton, KY (2019, 2020)
– no-till, rainfed, following corn
– Crider silt loam



Research Questions

1. **Is a higher corn N rate required to limit corn N stress and yield loss following a rye cover crop?**

2. **Is a split N application required to limit corn N stress and yield loss following a rye cover crop?**

3. **What role does an in-furrow starter (fertilizer and fungicide) have in improving corn emergence and yield following different rye cover crop termination timings?**

Nitrogen Trial Factors

- **Rye Cover Crop**: 'Aroostook' cereal rye (drill-seeded 60 lbs A^{-1}) vs. no rye cover crop
  - Chemically terminated 14-21 days prior to corn planting.

- **Nitrogen Fertilizer Timing**:
  - 30 lbs N A^{-1} applied in a 2x2 starter + remaining N surface-banded pre-plant (**Pre-plant**).
  - 30 lbs N A^{-1} applied in a 2x2 starter + remaining N surface-banded at V6 (**Split**).

- **Nitrogen Fertilizer Rate**: 0, 30, 90, 150, 210, 270 lbs N A^{-1}

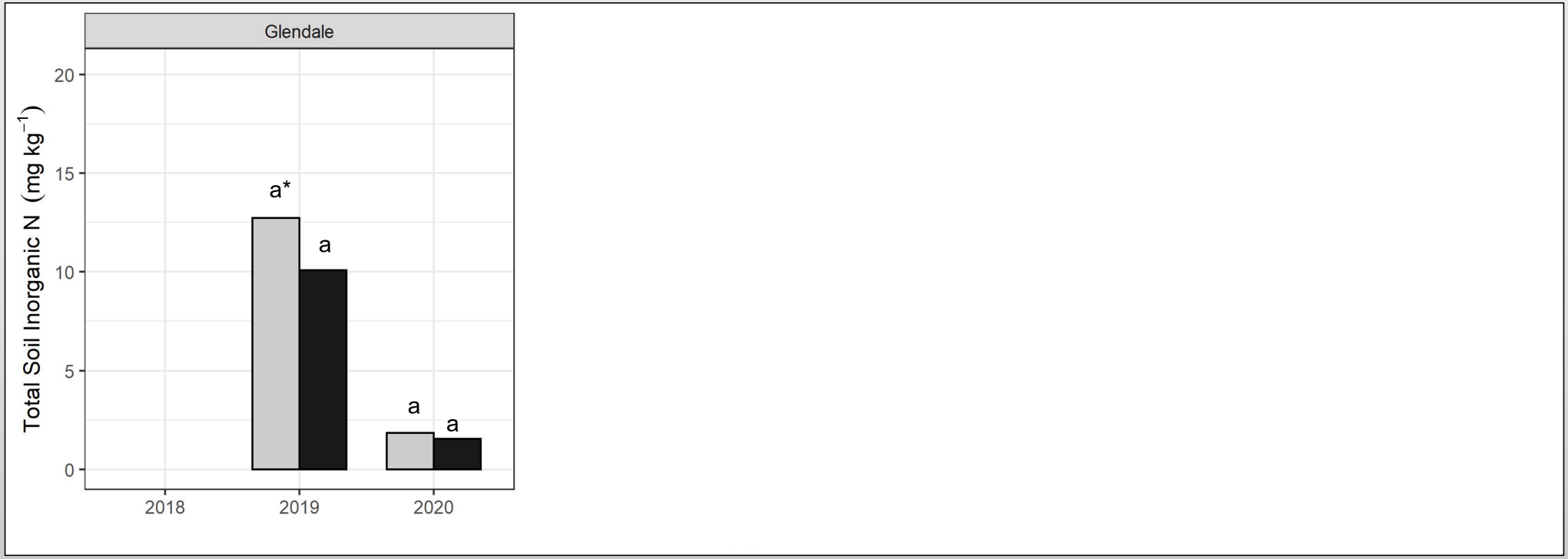
Cover Crop Shoot Biomass Data

Location	Year	Total Biomass	Total C	Total N	C:N Ratio
		--- lbs A^{-1} ---	--- lbs C A^{-1} ---	--- lbs N A^{-1} ---	---- C:N ----
Glendale	2019	2273			
	2020	1555			
Lexington	2018	432			
	2019	2143			
	2020	3157			
Princeton	2019	321			
	2020	1347			

Cover Crop Shoot Biomass Data

Location	Year	Total Biomass	Total C	Total N	C:N Ratio
		--- lbs A^{-1} ---	--- lbs C A^{-1} ---	--- lbs N A^{-1} ---	---- C:N ----
Glendale	2019	2273	965	49	20
	2020	1555	651	24	25
Lexington	2018	432	175	12	15
	2019	2143	885	46	20
	2020	3157	1365	40	35
Princeton	2019	321	134	9	15
	2020	1347	555	21	27

Rye Cover Crop Reduced Preplant Soil Inorganic N (0-12 in)



*Bars within each location and year followed by the same letter are not significantly different at α=0.1

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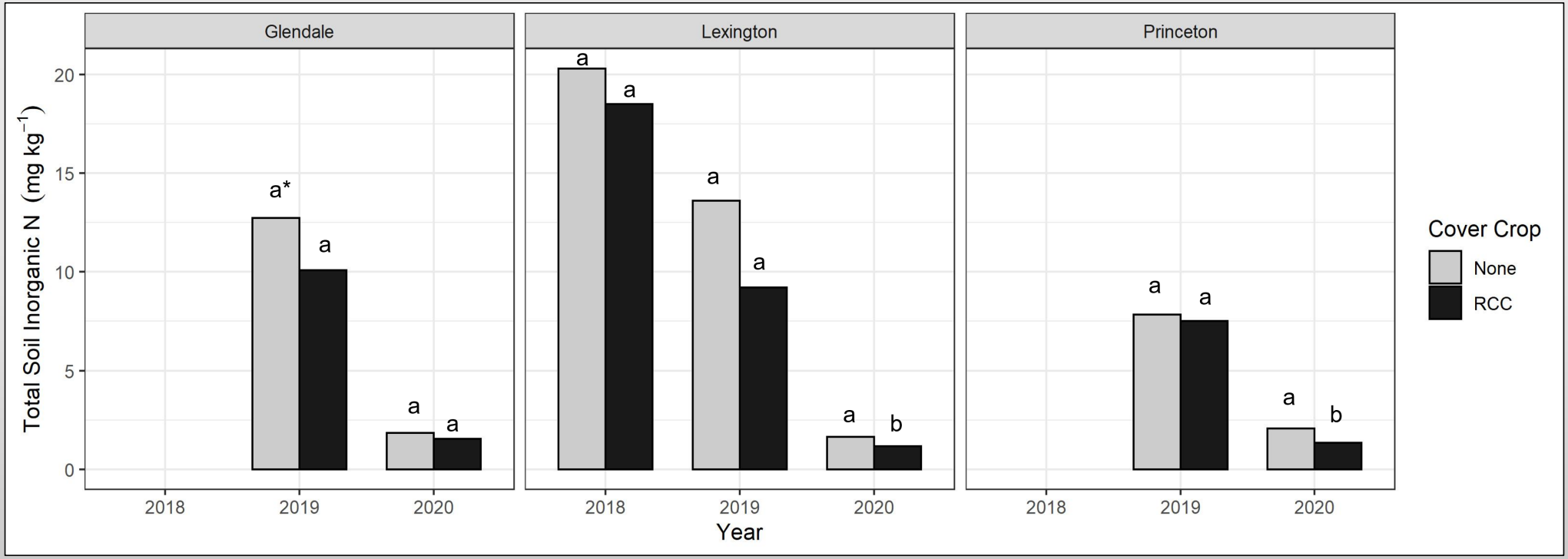

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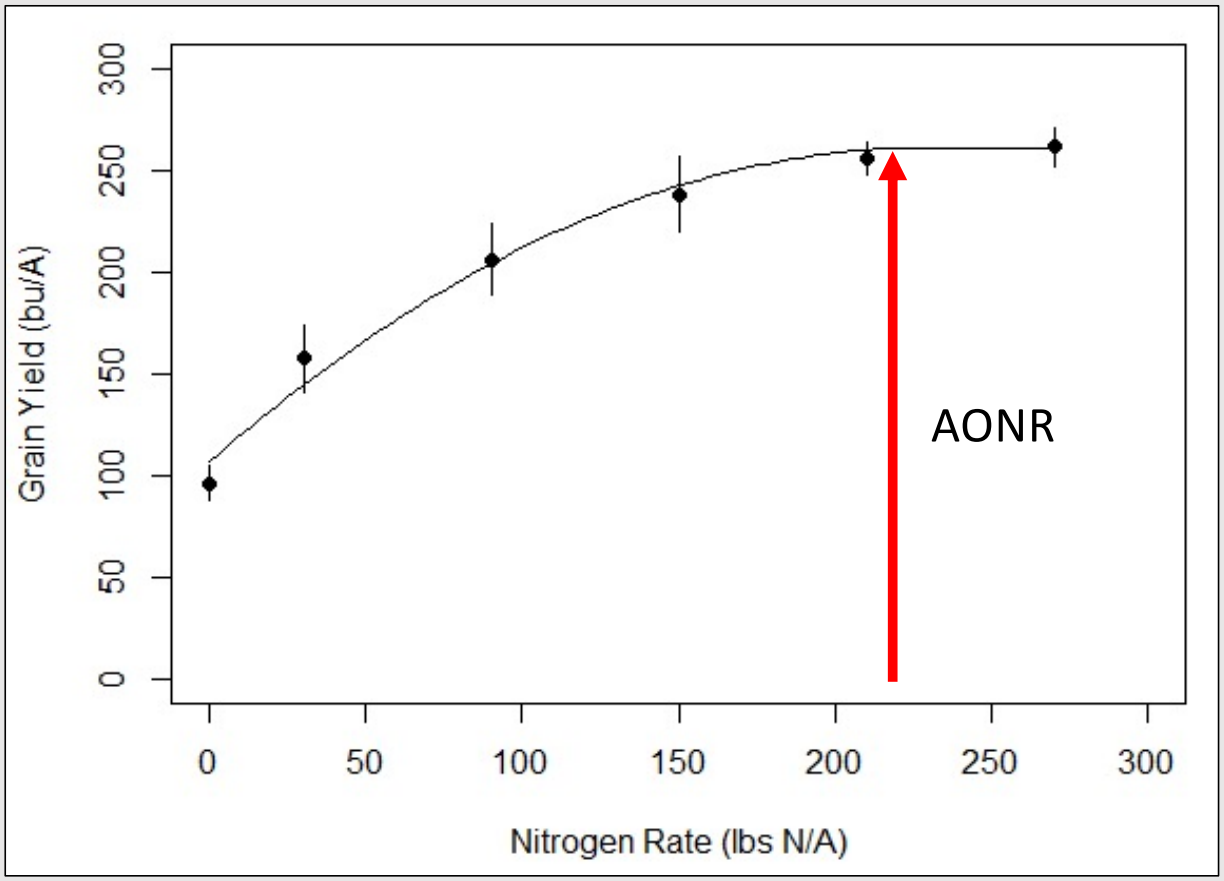
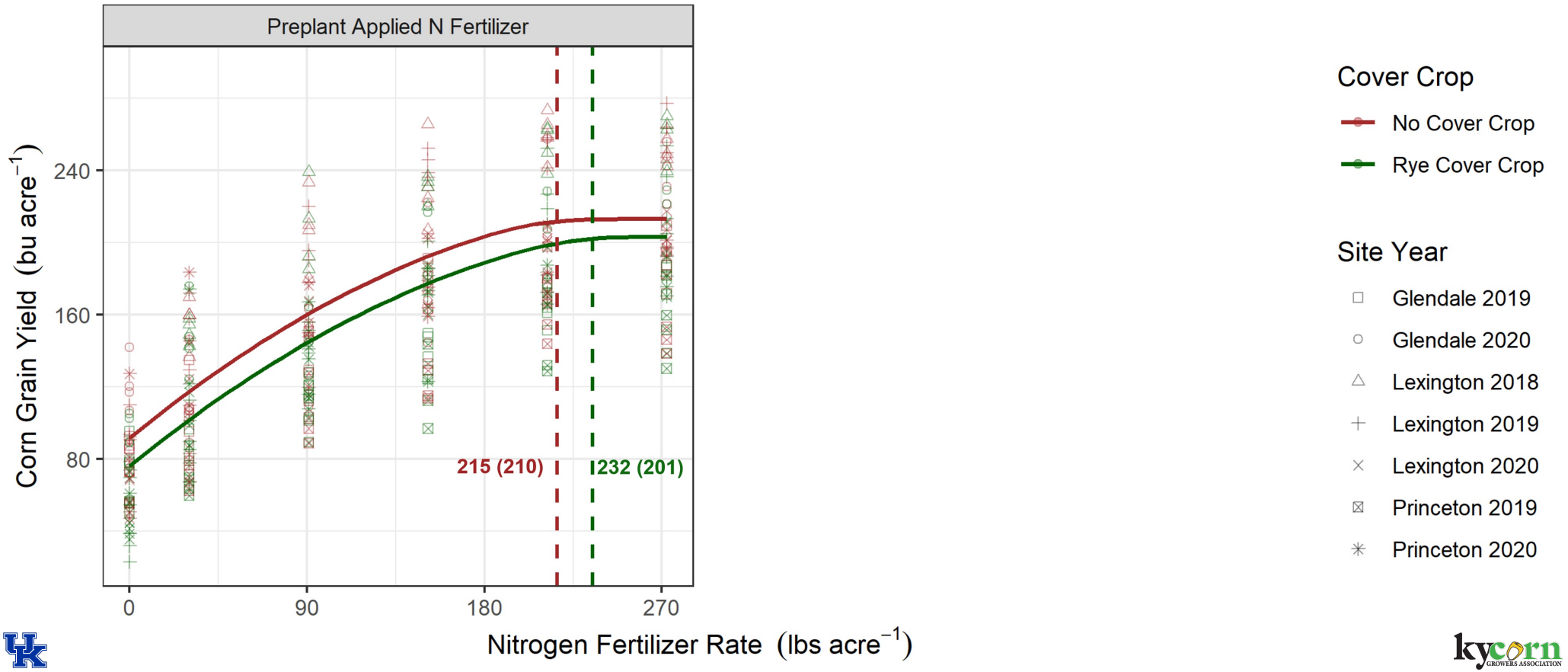
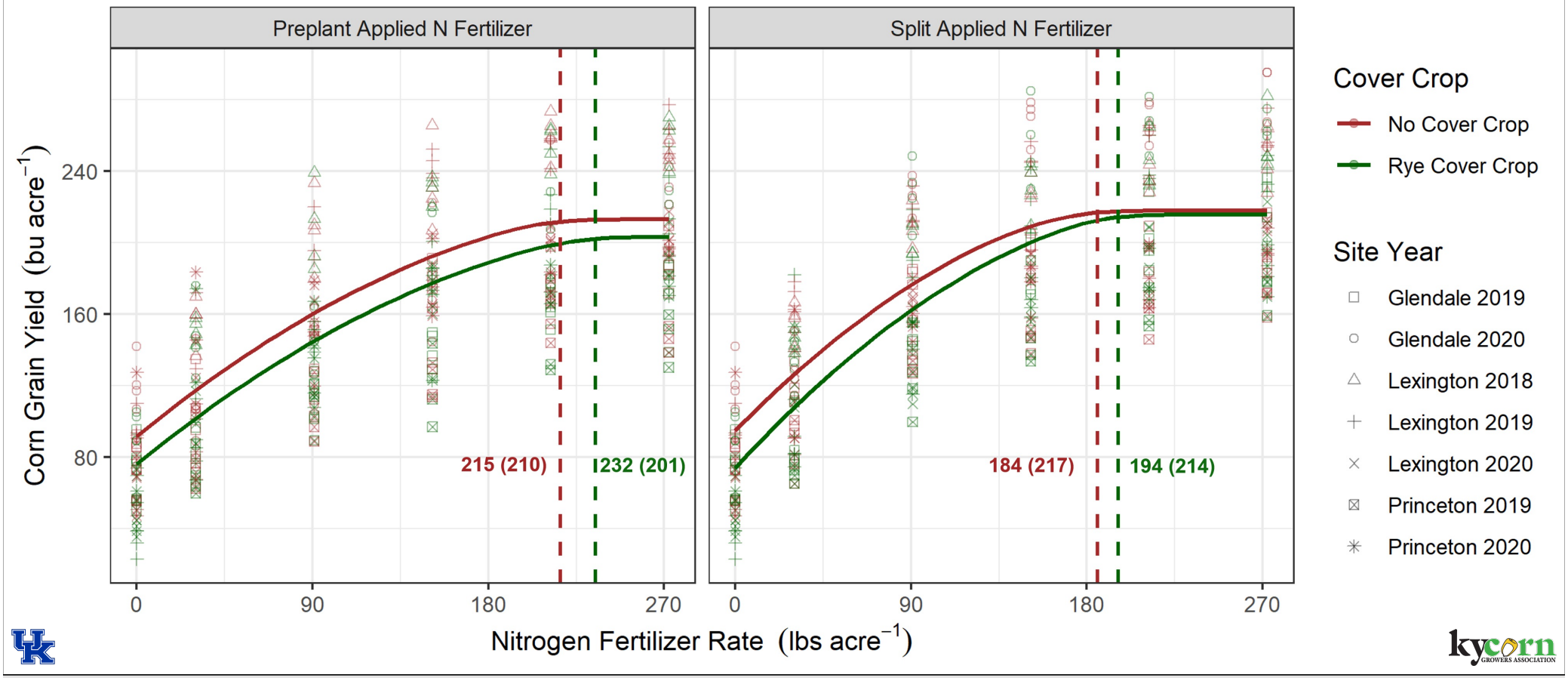
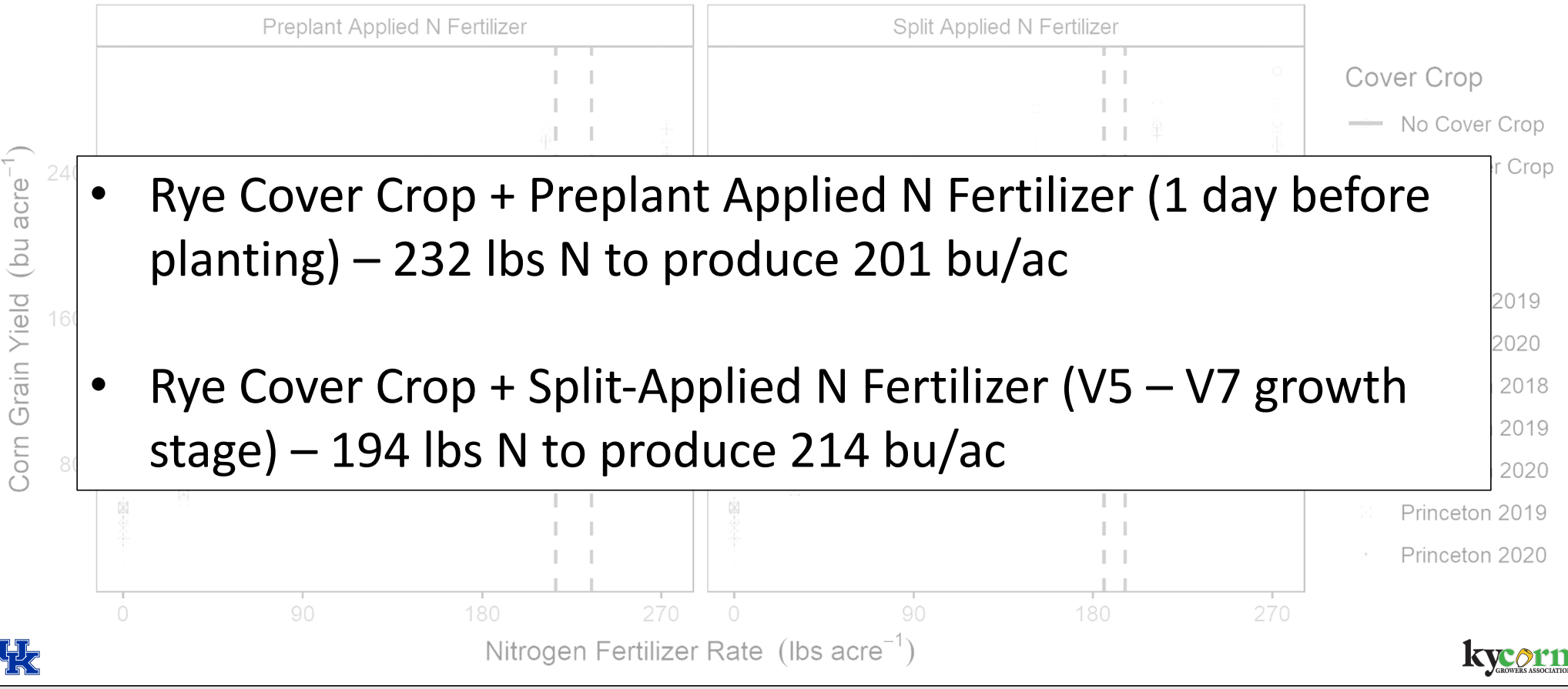


Nitrogen fertilizer rate required by corn to reach maximum grain yield

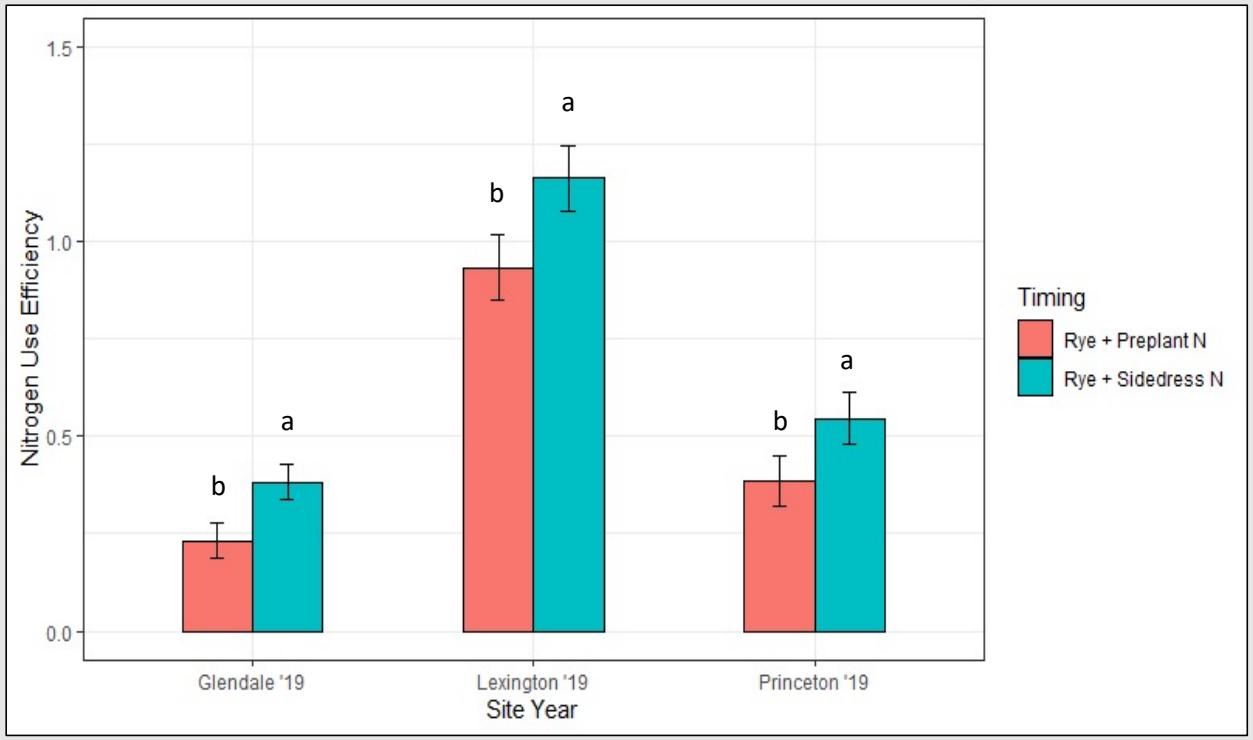






- Rye Cover Crop + Preplant Applied N Fertilizer (1 day before planting) – 232 lbs N to produce 201 bu/ac
- Rye Cover Crop + Split-Applied N Fertilizer (V5 – V7 growth stage) – 194 lbs N to produce 214 bu/ac

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



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

Pounds of N Required to produce 1 bushel of grain

Take Home Points

- A rye cover crop can reduce preplant soil inorganic N, R1 ear leaf chlorophyll content (greenness), and corn yield

- Split application of N fertilizer has potential to reduce N stress, improve corn N use efficiency, and lower the agronomic optimum N rate compared to N applied at planting.

Does an in-furrow starter (fertilizer and/or fungicide) provide a greater benefit to corn following a delayed termination rye cover crop?


Biomass: 4163 lbs/A
C:N Ratio: 31:1
Total N Uptake: 58 lbs/A
Biomass: 1639 lbs/A
C:N Ratio: 21:1
Total N Uptake: 31 lbs/A

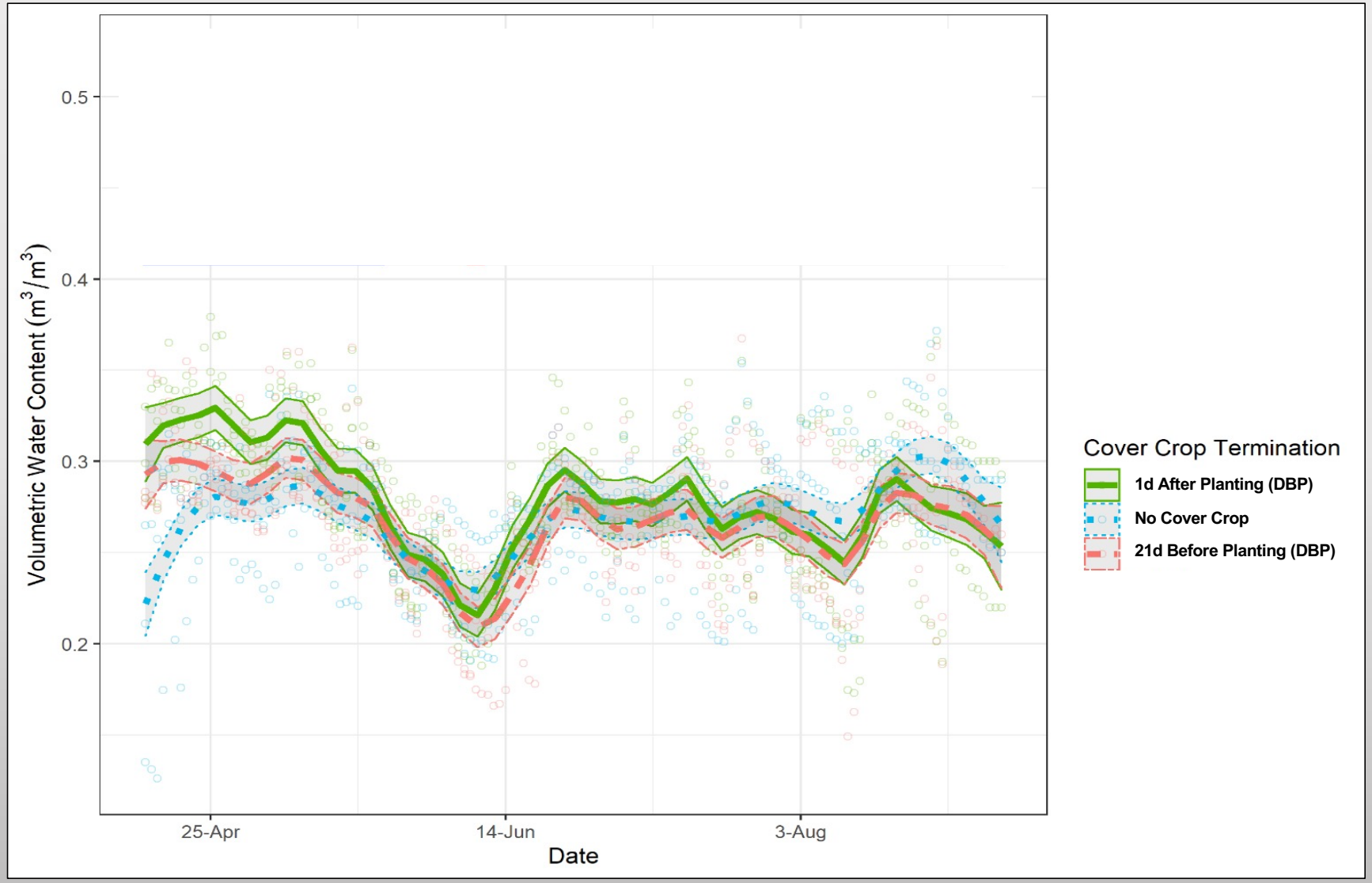
Termination Date Trial Factors

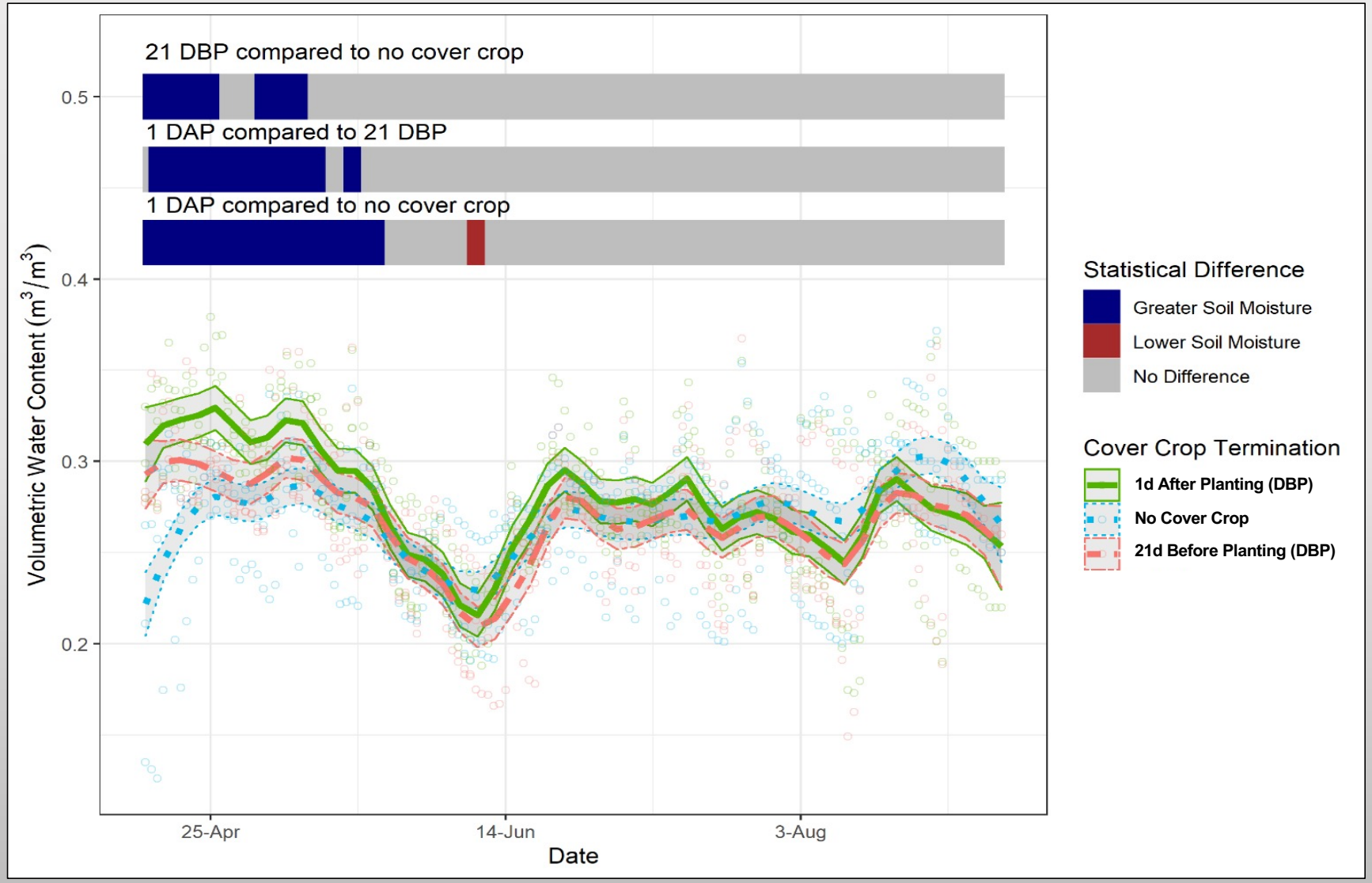
- **Rye Cover Crop Termination**: 'Aroostook' cereal rye (drill-seeded 60 lbs A^{-1}) vs. no rye cover crop
  - Chemically terminated 14-21 days prior to corn planting.
  - Chemically terminated 1 day after corn planting.

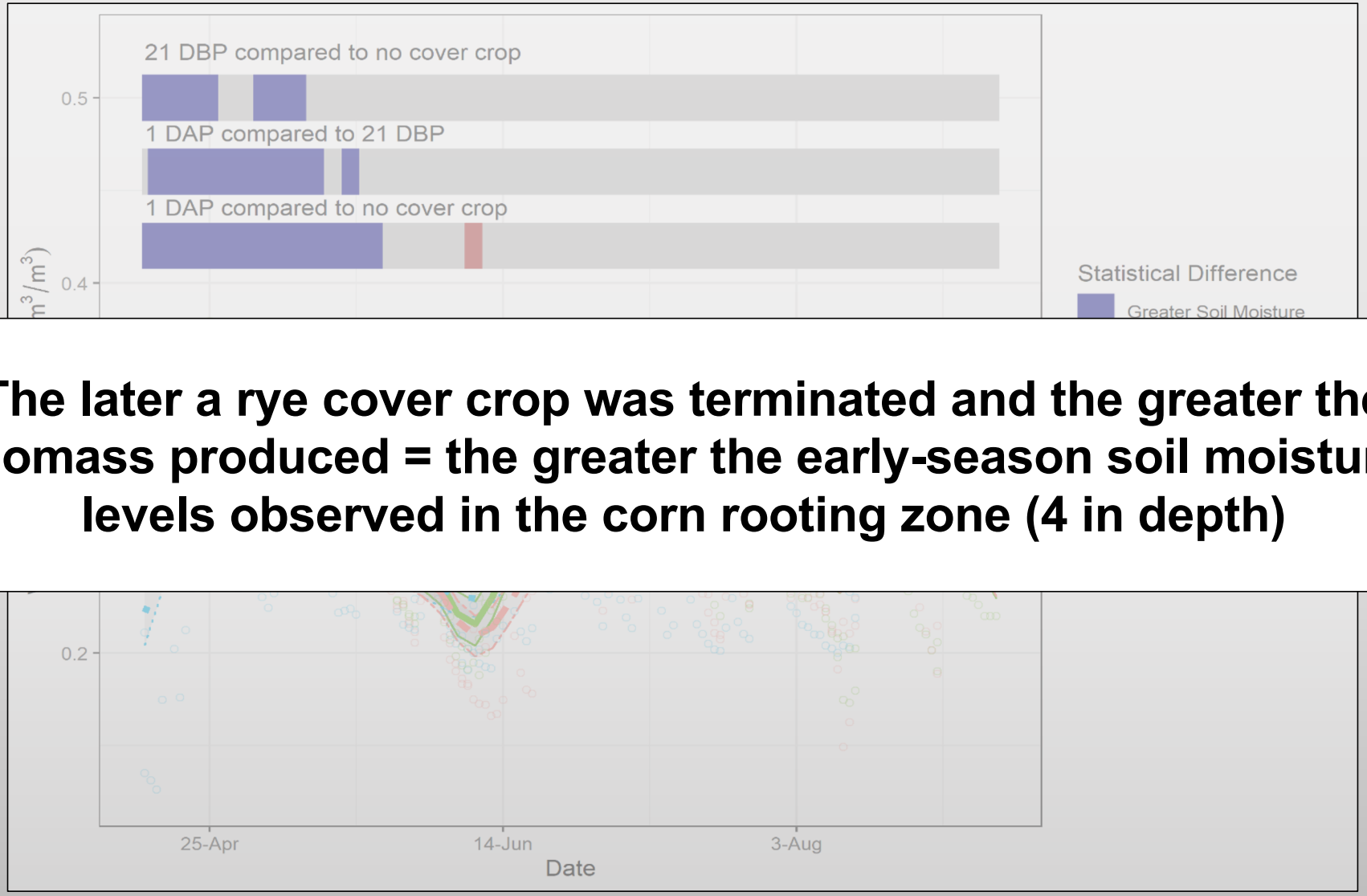
- **In-Furrow Starter**:
  - 10-34-0 Fertilizer Alone (5 gal A^{-1})
  - Headline Fungicide Alone (12 oz A^{-1})
  - 10-34-0 Fertilizer + Headline Fungicide


9 inches


20 inches


0.5
0.4
0.3
0.2
Volumetric Water Content (m3/m3)
25-Apr
14-Jun
3-Aug
Date
Cover Crop Termination
1d After Planting (DBP)
No Cover Crop
21d Before Planting (DBP)


21 DBP compared to no cover crop
1 DAP compared to 21 DBP
1 DAP compared to no cover crop
Volumetric Water Content (m3/m3)
0.5
0.4
0.3
0.2
25-Apr
14-Jun
3-Aug
Date
Statistical Difference
Greater Soil Moisture
Lower Soil Moisture
No Difference
Cover Crop Termination
1d After Planting (DBP)
No Cover Crop
21d Before Planting (DBP)



The later a rye cover crop was terminated and the greater the biomass produced = the greater the early-season soil moisture levels observed in the corn rooting zone (4 in depth)

Treatment	Lexington	Glendale	Princeton
	Corn Grain Yield (bu A^{-1})		
No Cover Crop	255.9 a	245.6 a	181.4 a
14-d Prior to Corn Plant Term.	253.8 a	233.6 a	166.2 b
1-d After Corn Plant Term.	218.9 a	186.1 b	162.2 b
No In-Furrow	248.3 a	226.5 a	170.3 a
In-Furrow Fert. (10-34-0)	243.3 a	222.7 a	171.5 a
In-Furrow Fung. (Pyraclostrobin)	240.7 a	223.8 a	169.3 a
IF Fert. + Fung.	239.3 a	214.1 a	168.6 a

*Column values followed by the same letter are not significantly different at α=0.1

Treatment	Lexington	Glendale	Princeton
	Corn Plant Stand (plants A^{-1})		
No Cover Crop	36643 a	35957 a	36482 a
14-d Prior to Corn Plant Term.	36804 a	35225 a	35635 a
1-d After Corn Plant Term.	27279 b	23359 b	35292 a
No In-Furrow	33988 a	32290 a	35224 a
In-Furrow Fert. (10-34-0)	32700 a	30976 a	36354 a
In-Furrow Fung. (Pyraclostrobin)	34038 a	31183 a	35789 a
IF Fert. + Fung.	33576 a	31606 a	35843 a

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Trial Conclusions

- A late-terminated rye cover crop (1 DAP) can increase biomass contributions and early-season soil moisture.
- However, a late terminated rye cover crop can also reduce corn plant stand and yield.
  - Shading after termination
- An in-furrow application of fertilizer and/or fungicide cannot ameliorate negative effects of a late-terminated rye cover crop.
  - In-furrow does not supply enough N
  - Need to target Pythium (seed treatments)
- Future research required – corn planter settings and equipment

Rye Cover Crop Research Summary

- Split-N application more beneficial when corn follows rye
  - How N is applied and when N is applied is important for reducing rye yield penalty
- In-furrow fertilizer + fungicide did not provide a benefit to corn following a rye cover crop
- Delayed rye cover crop termination reduced corn yield by an average of 28 bu/A relative to early rye termination

What's Next? (Purdue University)

- Additional and delayed nitrogen fertilizer timings (V10-12)
- What about sulfur?
- What about hybrid type?
- Planter technologies?
- Different cover crops?

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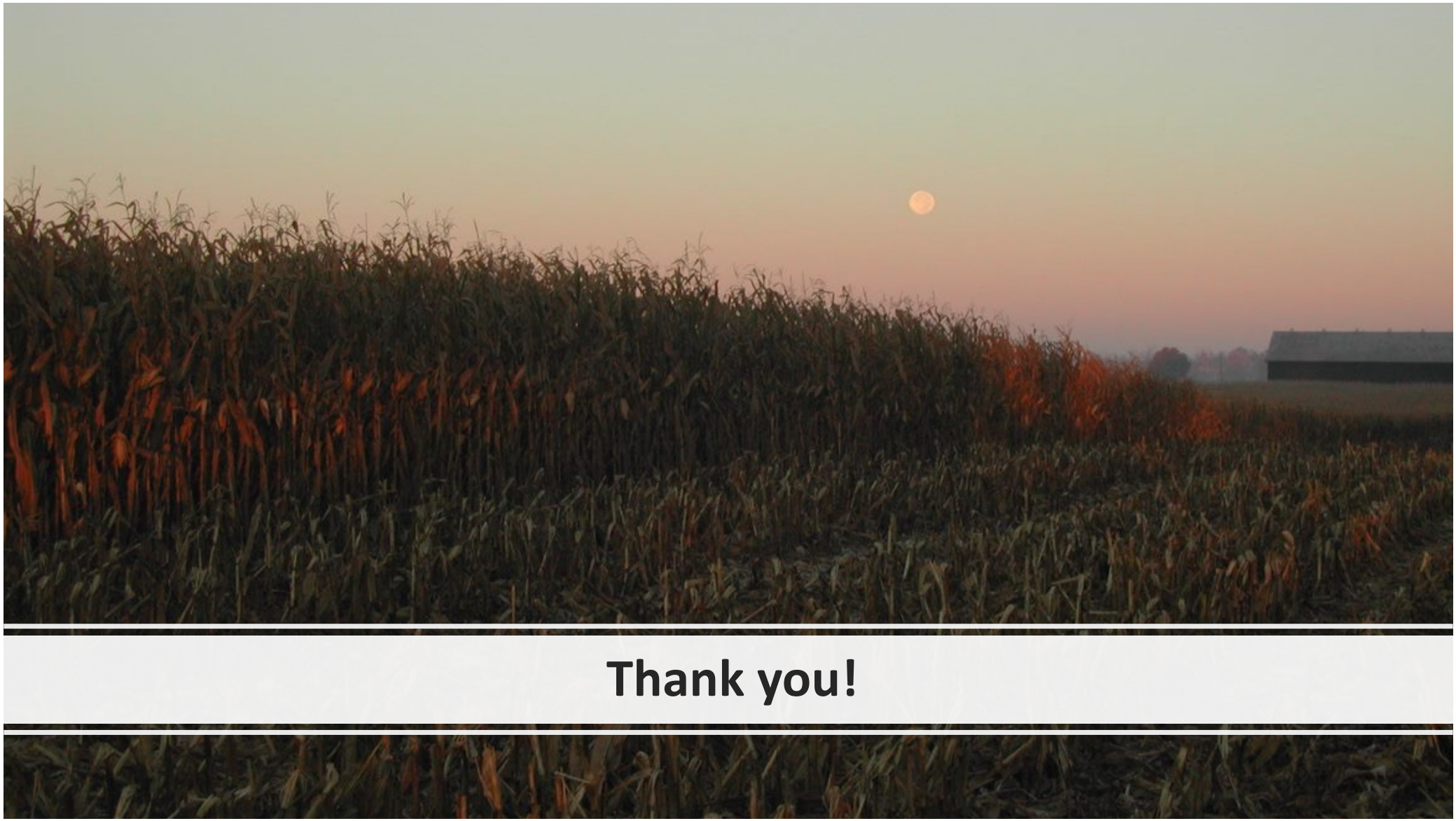

Thank you!

Questions?

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