Nitrogen Dynamics with a Rye Cover Crop

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USDA United States Department of Agriculture
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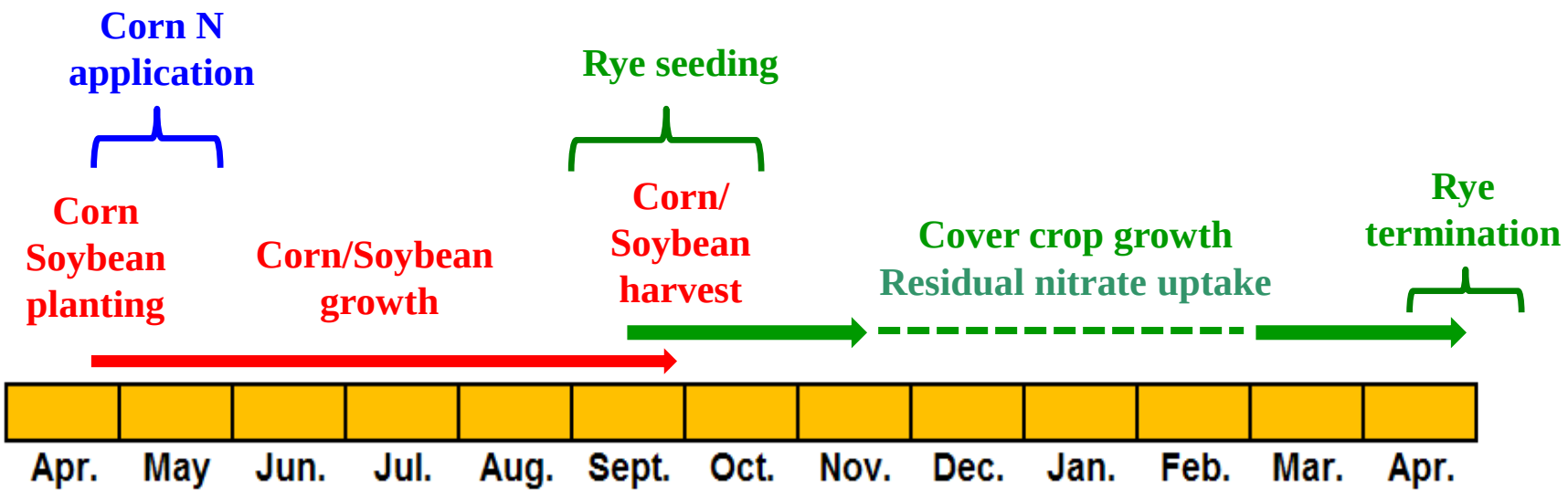
Winter Cereal Rye Cover Crop

- Rye cover crop benefits
  - Conserve/recycle soil nitrate
  - Reduce tile flow nitrate-N
    - (31% -- Iowa Nutrient Reduction Strategy)
  - *Soil surface protection (erosion)*
  - *Improve soil carbon content (OM)*
  - *Improve soil physical properties*

Winter Cereal Rye Cover Crop System



Winter Cereal Rye Cover Crop

- Assume nitrate-N loss via tile drainage averages 30 lb N/acre per year
- 31% nitrate-N concentration reduction in tile flow with a rye cover crop
- Assume concentration reduction approximates load reduction
- Approximately 9 lb less nitrate-N/acre lost in tile drainage with a rye cover crop

Winter Cereal Rye Cover Crop Studies

- Corn N rate fertilization
  - Rye N uptake and degradation
  - Soil nitrate
  - Corn optimal N rate
  - Corn and soybean yield
- Rye plant root and shoot components
  - Biomass, carbon, N content
- Tillage and starter N influence on corn yield

Nitrogen Rate Fertilization

- Five locations, 2009-2013
- No-till corn-soybean rotation
- With and without ‘Wheeler’ winter cereal rye (1 bu/acre) drilled after crop harvest
- Rye termination at least 7 days before corn planting and at or within 7 days before soybean planting
- Aboveground rye biomass sampled at time of termination

Nitrogen Rate Fertilization

- Six N rates injected early sidedress as UAN
  - 0 to 200 lb N/acre in 40 lb increments
- Soil nitrate sampling spring preplant, late spring, and post-harvest
- Corn and soybean grain yield
- Economic optimum N rate (EONR) from corn N rate response

Nitrogen Rate Fertilization

Rye cover crop growth on October 20, 2008 (17 days of growth after planted into soybean stubble), Ames.

Nitrogen Rate Fertilization

Rye cover crop May 18, 2009 (rye termination May 4), Ames.

Nitrogen Rate Fertilization

March 29, 2012

April 17, 2012

Rye seeded Oct. 5, 2011, Ames.

Nitrogen Rate Fertilization

Rye cover crop following corn, before herbicide application on May 9, 2010, Crawfordsville.

Nitrogen Rate Fertilization

Soybean growth with the rye cover crop on June 1, 2010 (21 days after herbicide application and planting), Crawfordsville.

Nitrogen Rate Fertilization

Soybean growth with the rye cover crop (foreground) and without the rye cover crop (background) on June 24, 2010, Crawfordsville.

Nitrogen Rate Fertilization

No rye cover crop left – with rye cover crop right Ames on June 8, 2012 (rye terminated May 2, corn planted May 10).

Rye Cover Crop Biomass and N Uptake (2009-2013)

Following Corn.

N Rate	Rye Biomass	Rye N Uptake
lb N/acre	lb DM/acre	lb N/acre
2009†		
	440	10
2010-2013‡		
0	845c	16c
120	985b	21b
200	1220a	28a

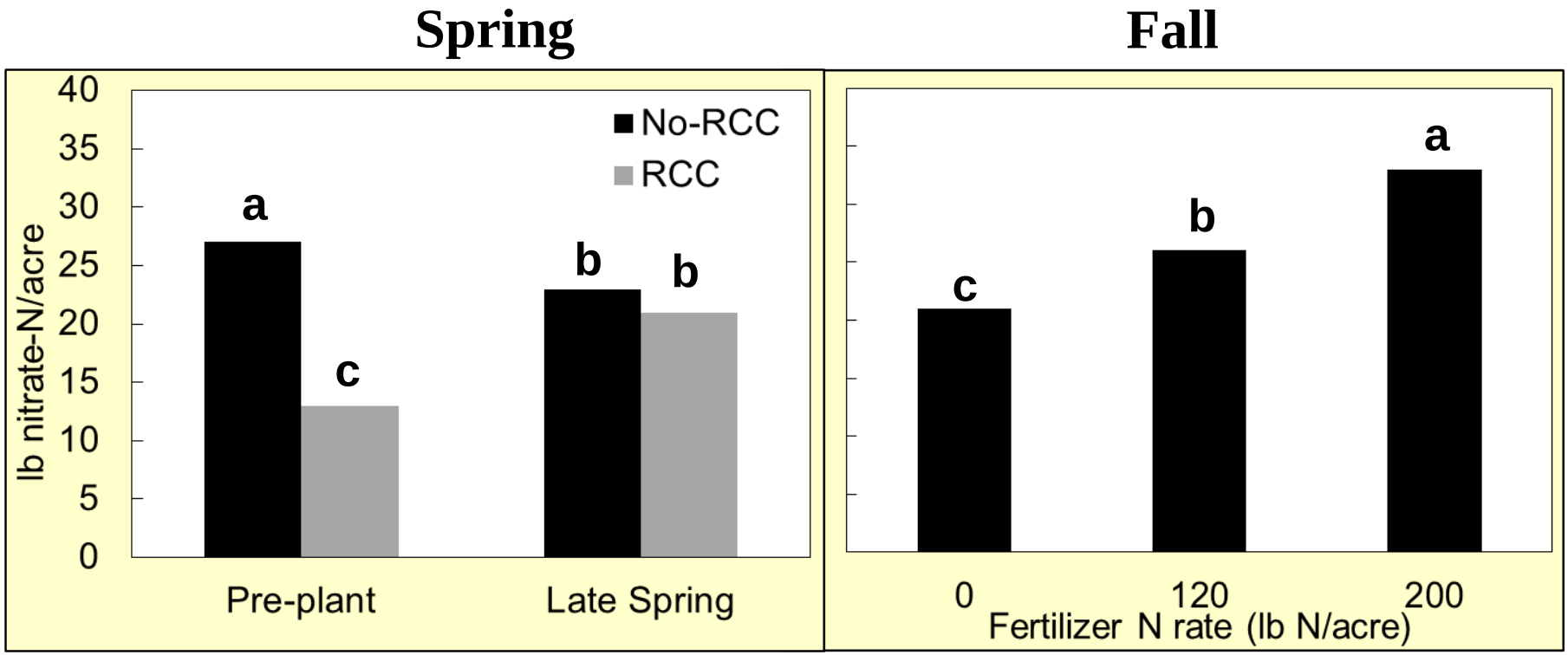
† No N rate treatments had been applied.

‡ Prior year N rate application to corn.

Following soybean.

580 lb DM/acre and 18 lb N/acre uptake.

Soil Nitrate in Corn Year



Spring sampling was to 2 foot depth only in the zero lb N/acre plots, and Fall sampling was to 3 foot depth before rye growth.

Means with the same letter within each sampling time are not different, $P \leq 0.05$.

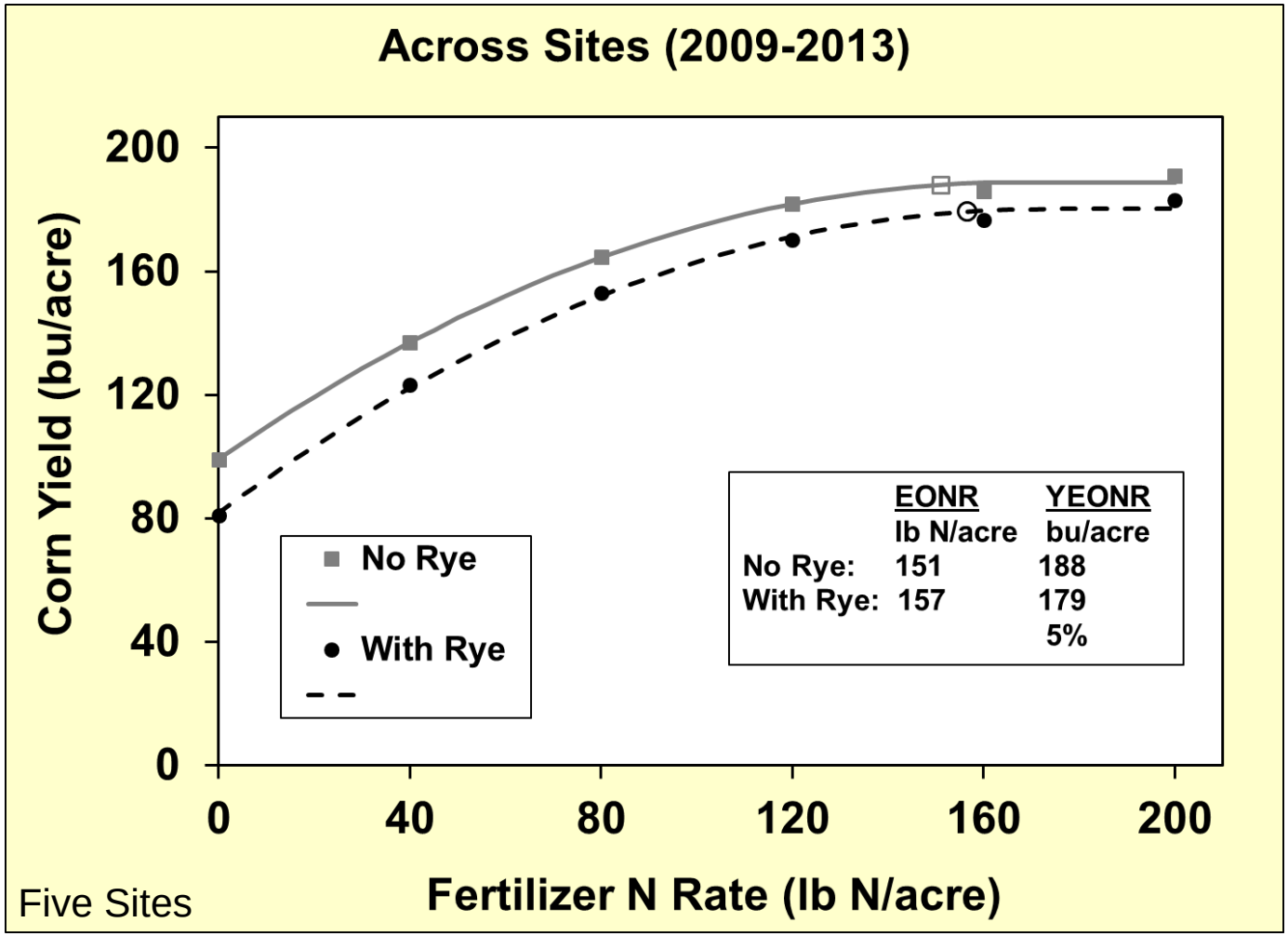
Soybean Grain Yield

Soybean grain yield with and without rye cover crop, 2009-2013.

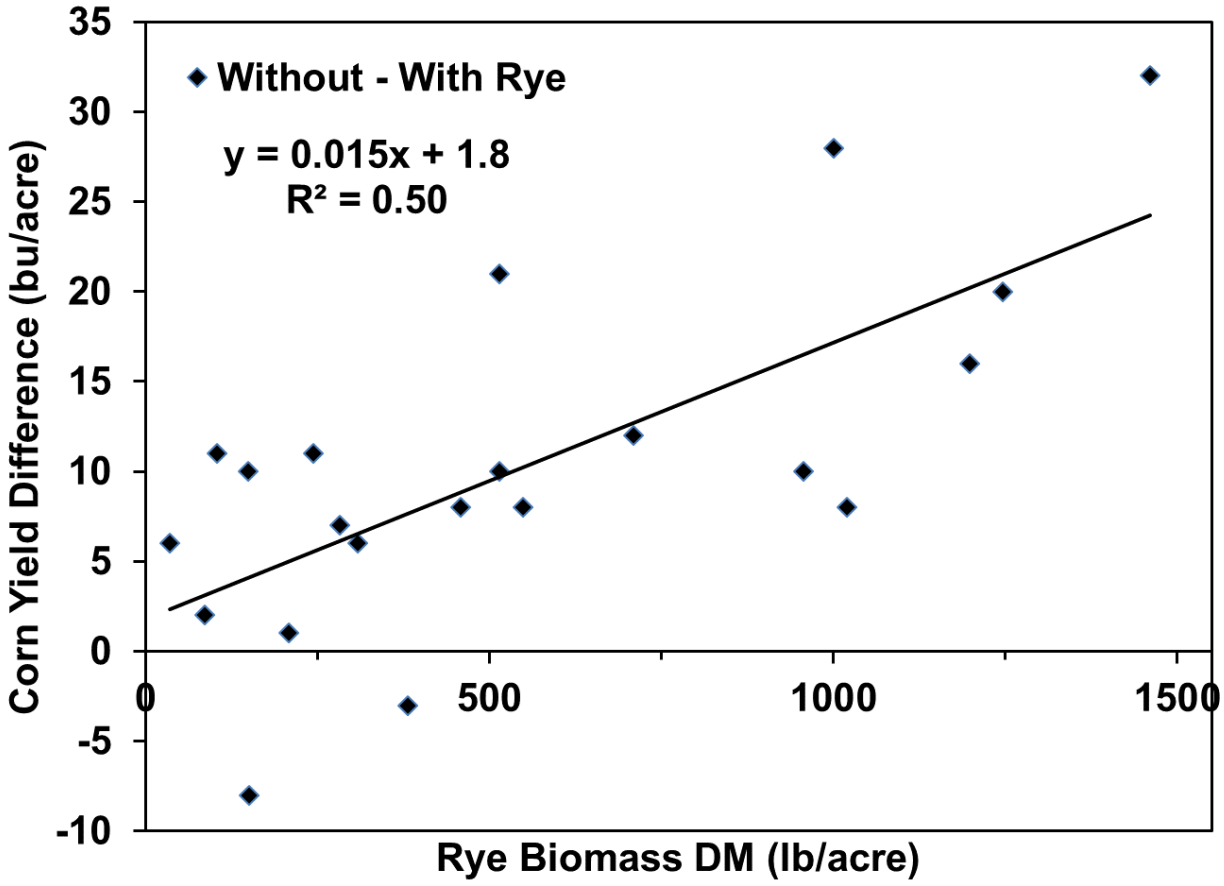
Cover Crop	Ames	Crawfordsville	Lewis	Nashua	Sutherland
	- - - - - - - - - - - - - - - - - - bu/acre - - - - - - - - - - - - - - - - - -				
With rye	54.4a†	58.5a	58.5a	61.2a	63.3a
Without rye	53.5a	59.0a	58.1a	62.4a	62.8a

† Yields at a site followed by the same letter are not different, $p \leq 0.10$.

Corn Nitrogen Response



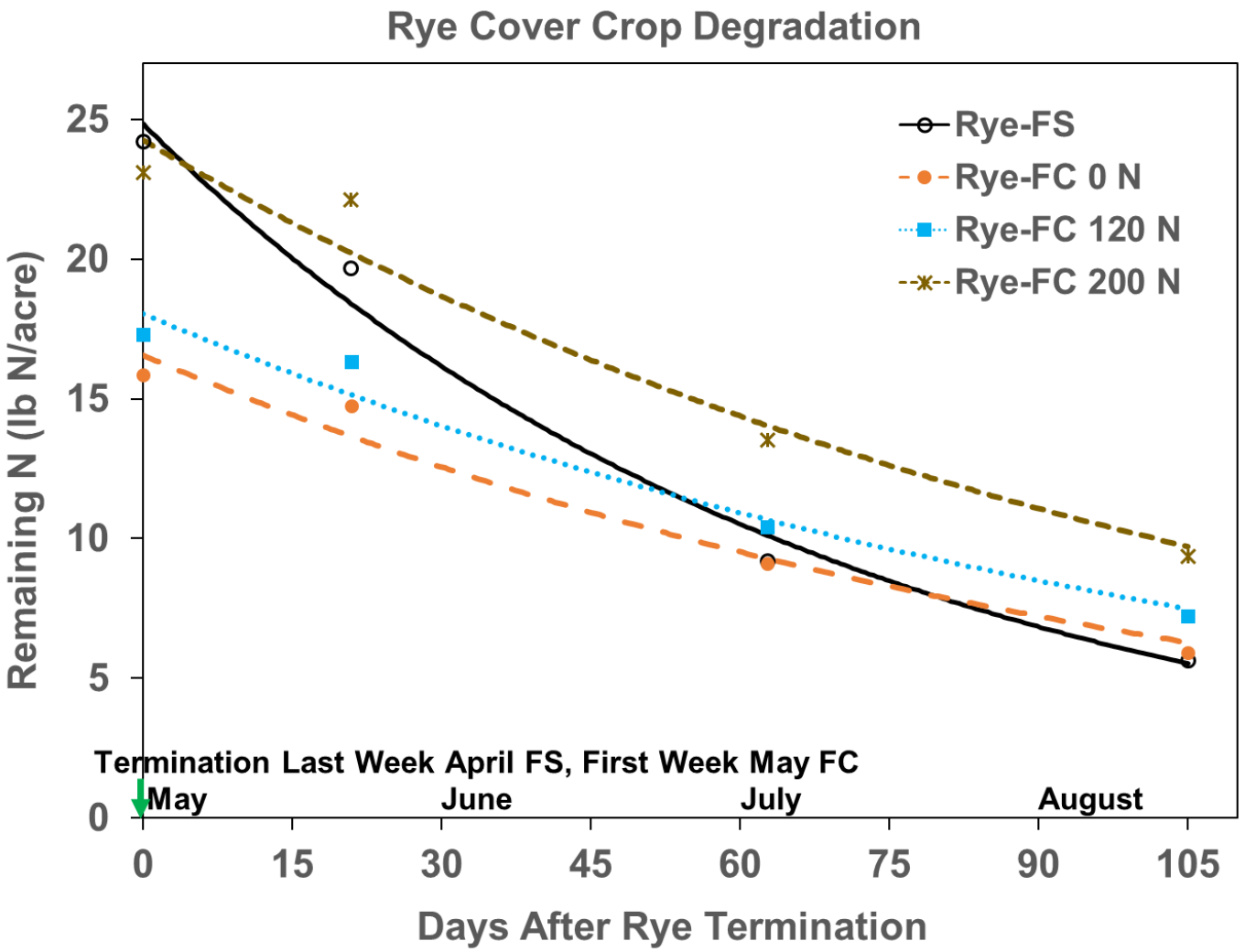
Corn Yield Response vs Rye Cover Crop Biomass Amount, 2009-2013



Rye Biomass Degradation and N Cycling

- Four sites in 2010 and 2011
- Following corn
  - 0, 120, and 200 lb N/acre
- Following soybean
- At time of rye control
  - Rye biomass placed in mesh bags
  - Collected at 21, 63, 105 days (3, 9, 15 week)
  - Dry matter, carbon, and N remaining

Rye Biomass Degradation and N Cycling



Gone from rye:

After corn: 60%
10-14 lb N/acre

After soybean: 77%
20 lb N/acre

Rye Shoot and Root Composition

- Rye drilled after corn and soybean harvest (fall 2014) at Ames in three corn N rates
- Root ingrowth tubes installed between rye rows (1-2 foot)
- Tubes collected at time of rye termination (April 29 after soybean and May 8 after corn)
- Shoot and root biomass, carbon, and N determined

Rye Shoot and Root Composition

Rye cover crop shoot and root composition, 2015.			
	Biomass	Nitrogen	C:N Ratio
	lb DM/acre	lb N/acre	
Following Corn			
Shoot	983a (2x)	18a (5x)	23b
Root	463b	4b	52a
Following Soybean			
Shoot	1096a (2x)	26a (5x)	16b
Root	573b	5b	47a

Letters in a column and crop indicate significant difference ($P \leq 0.10$).

Practices to Enhance Corn Yield

- Four sites in 2014 and 2015
  - Same sites as prior study
- Corn – soybean rotation
  - No-till and rye cover crop history since 2008
- Plus/minus rye cover crop
- Spring disk tillage and no-till
- Plus/minus 30 lb N/acre 2x2 starter
- Main N sidedress injected UAN (total 150 lb N/acre)

Practices to Enhance Corn Yield

- Rye broadcast in standing soybean (before leaf drop) at 1.5 to 2 bu seed/acre
- Planned rye termination at approximately 6-8 inch height
- Tillage after rye termination in spring
- Corn planting approximately 2 weeks after rye termination

Practices to Enhance Corn Yield

Rye cover crop following soybean, April 22, 2014 before rye termination, Lewis.

Practices to Enhance Corn Yield

Rye cover crop height, aboveground biomass dry matter, and N uptake at the time of termination (2014-2015).

	2014			2015		
Tillage System	Height	Biomass	N	Height	Biomass	N
	inch	--- lb/acre ---		inch	--- lb/acre ---	
Till	6.2	137	5.3	7.7a	325a	13a
No-Till				7.3b	273b	10b

Letters in a column indicate significant difference (P ≤ 0.10).

Practices to Enhance Corn Yield

Corn population, plant height, and grain yield, 2014-2015.

Practice		V6 Population	V6 Height	Yield
		pl/acre	inch	bu/acre
Tillage	Till	31,900b	21a	203a
	No-till	33,000a	20b	197b
Starter	Starter	32,500a	21a	201a
	No starter	32,400a	20b	198b
Cover Crop	No rye	32,500a	21a	202a
	With rye	33,500a	21a	198b

Letters indicate significant difference (P ≤ 0.10).
No interaction between practices.

Cover Crop Studies Summary

- Rye cover crop biomass production related to fall seeding date (& prior crop), spring climatic conditions, and date of termination
- Rye nitrogen uptake low
  - By individual treatment and across all sites:
    Mean 20, min. 2, max. 62 lb N/acre
- A small rye effect on soil nitrate-N in spring preplant (14 lb N/acre lower)
  - Soil nitrate amount low each year

Cover Crop Studies Summary

- No effect of rye cover crop on soybean grain yield
- Corn grain yield reduced with the rye cover crop
  - Across sites and years 5% less
- Across sites and years 6 lb N/acre higher EONR with rye cover crop

Cover Crop Studies Summary

- Faster rye N recycling following soybean than following corn
- Degradation rate of rye biomass similar for prior-year corn N rates
- Nitrogen recycled after 105 days
  - 20 lb N/acre (77% of uptake) after soybean
  - 10-14 lb N/acre (60% of uptake) after corn

Cover Crop Studies Summary

- Rye cover crop shoot biomass 2 times the root biomass
- Rye cover crop shoot N content 5 times the root N content
- Root N content low (< 4-5 lb N/acre)
- Following corn:
  - Rye shoot C:N ratio 23:1 and root 52:1
- Following soybean:
  - Rye shoot C:N ratio 16:1 and root 47:1

Cover Crop Studies Summary

- Tillage following termination of rye cover crop increased corn yield (6 bu/acre) compared to no-till
- High N starter (30 lb N/acre, 2x2) increased corn yield (3 bu/acre), with main N sidedressed
- With these practices corn yield only 2% different (4 bu/acre) between with and without rye cover crop

Acknowledgements

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