Function and benefit of green manures

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Grasses

Winter rye (or cereal rye)
Annual ryegrass
Oat
Barley
Triticale

- Establish and grow quickly
- Scavenge soil nitrogen
- High C:N ratio

Brassicas

Radish
Mustard
Turnip

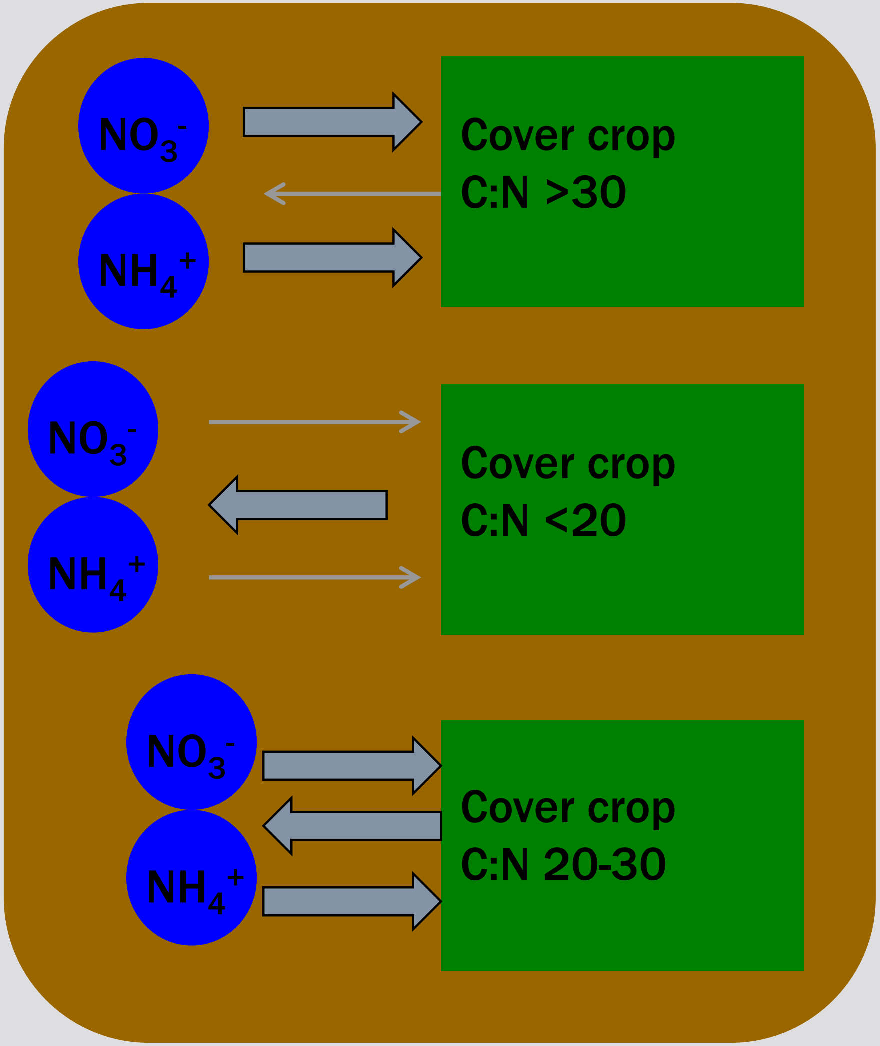
- Slower to establish
- Scavenge soil nitrogen (even more than the grasses if given enough time)
- Medium C:N ratio

Legumes

Red Clover
Berseem Clover
Crimson Clover
Hairy Vetch

- Slower to establish
- Fix N from atmosphere
- Low C:N ratio

Why the C:N ratio matters



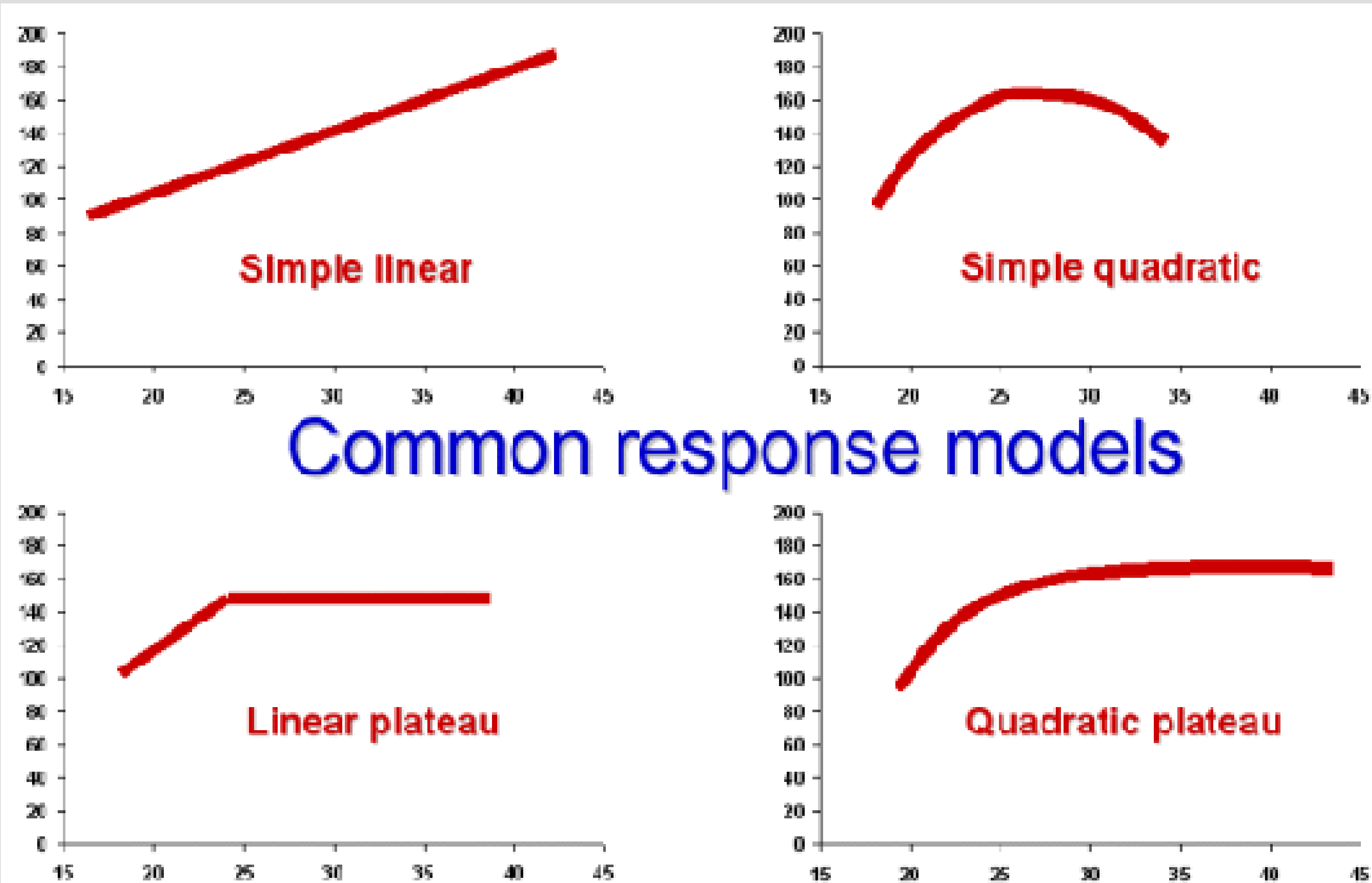
Soil microorganisms degrade plant material.

They need nitrogen to do this.

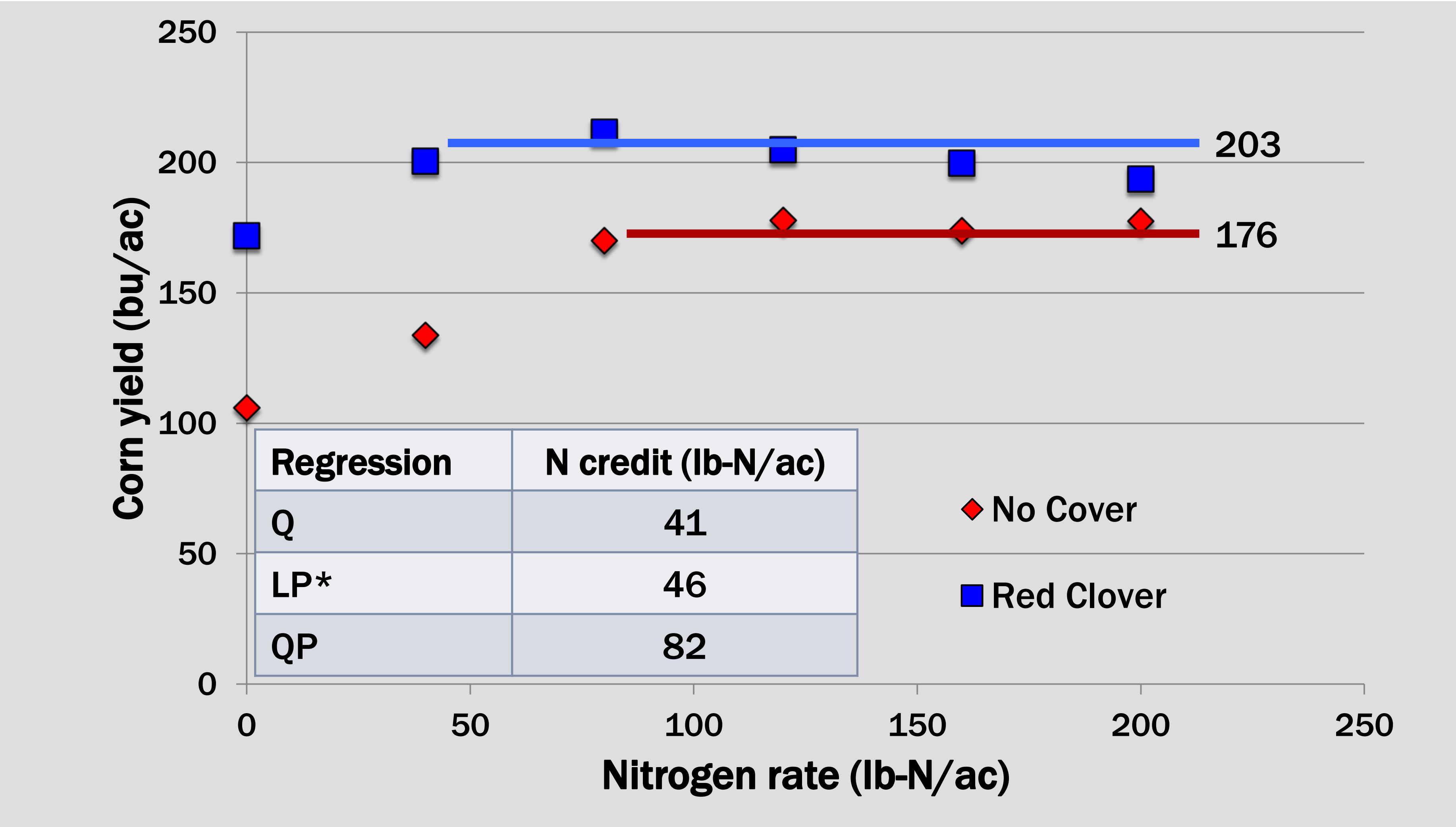
If plant material has a high C:N ratio (>30), then the soil microbes use the N in the soil.

If the plant material has a low C:N ratio (<20), then there plant material can supply more than enough N for the microbes and a lot of N is left over after the plant decomposes

Nitrogen credits are determined as the difference between argonomically optimum N rates

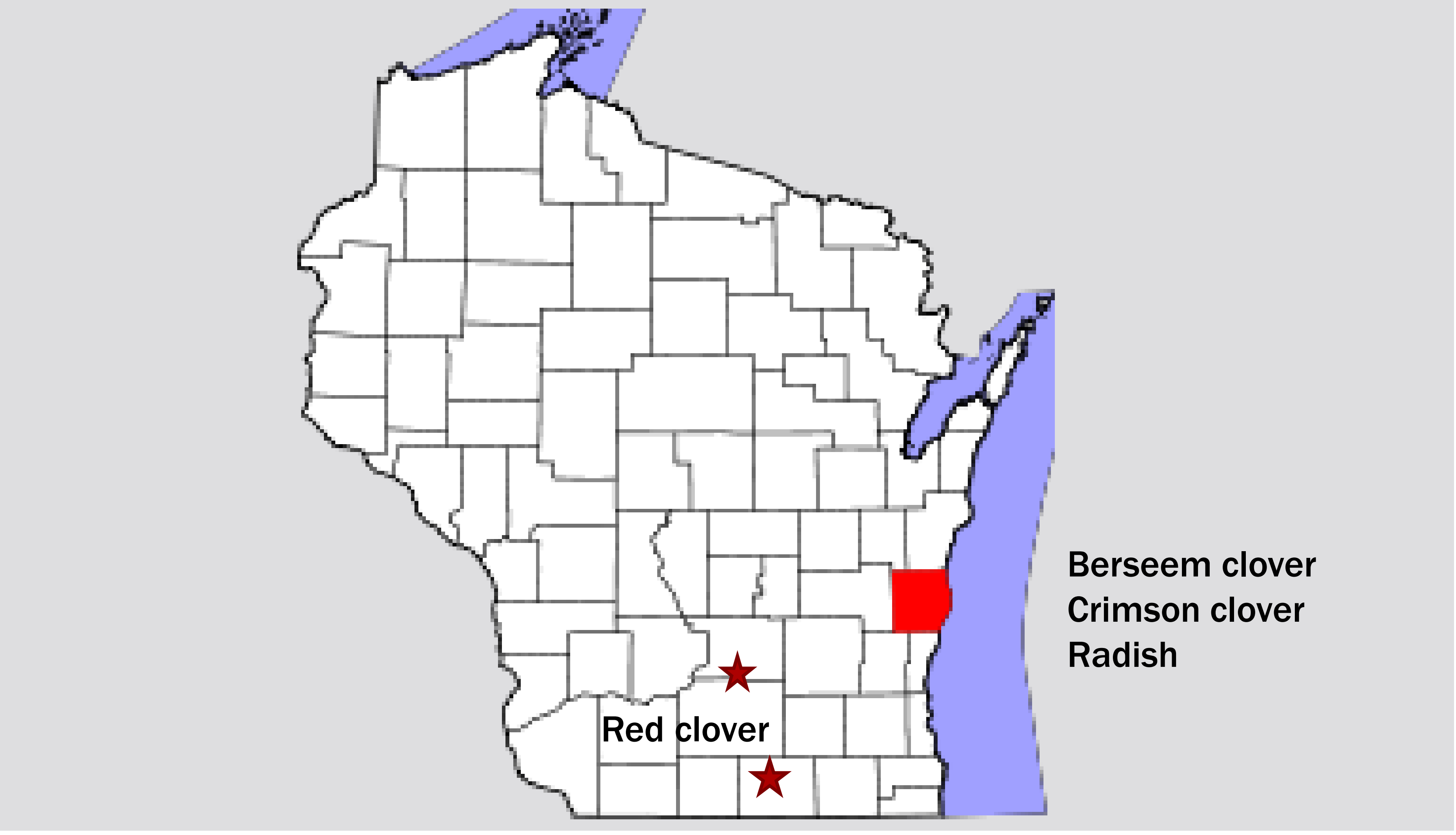


Yield response from Janesville in 2010 shows a 41 to 82 lb-N/ac N credit from red clover (plus yield gains)



Regression	N credit (lb-N/ac)
Q	41
LP*	46
QP	82

Study locations in Wisconsin



Frost-seeded red clover study at Arlington ARS

Funded by Wisconsin Fertilizer Research Council

2015

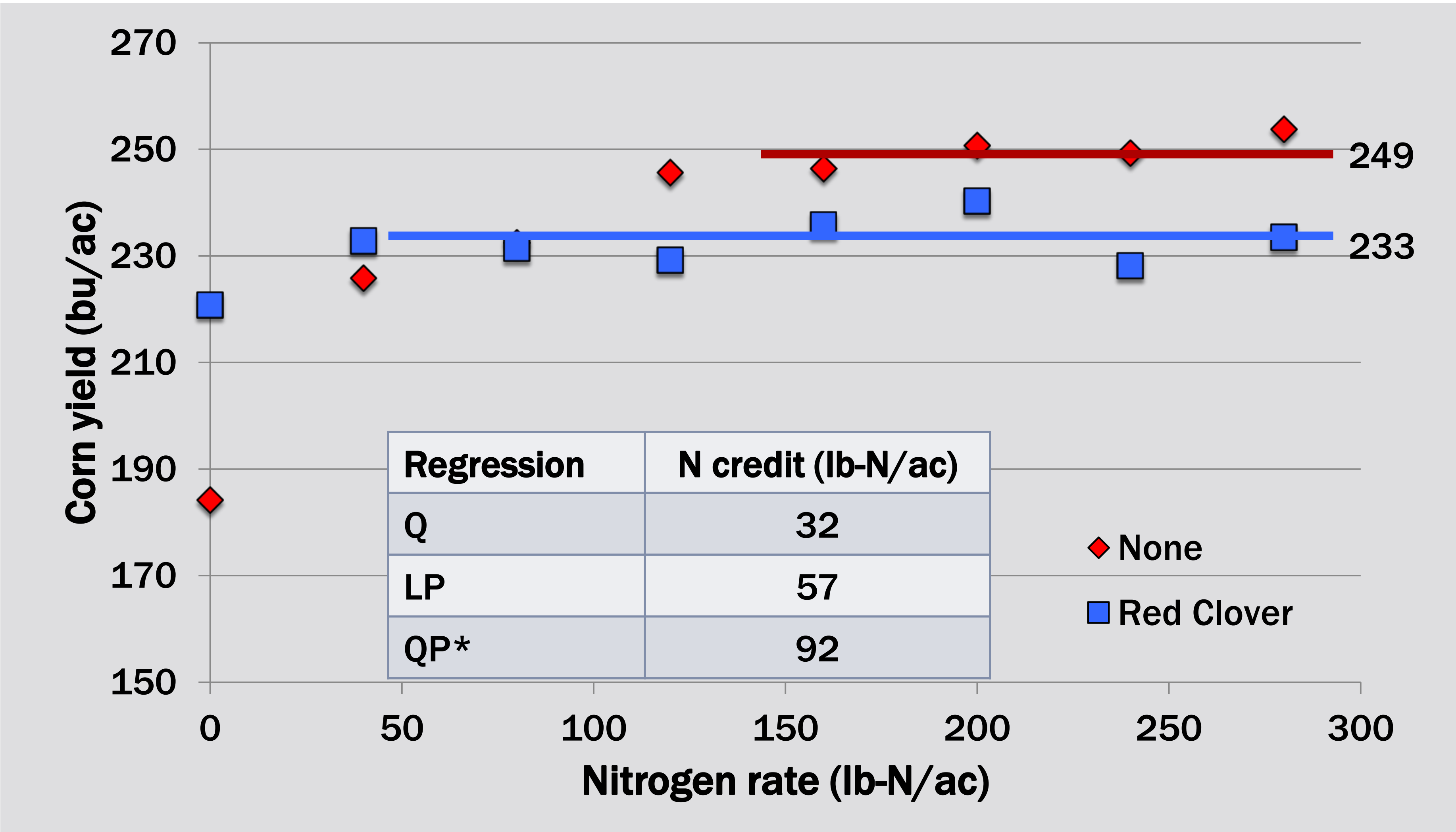
- April 1 – apply urea to wheat
- April 16 – interseed red clover and potash
- July 27 – harvest winter wheat grain
- Sept 8 – clipped clover to 4-6”
- October 26 – terminate red clover
  - 1 qt glyphosate and 1 qt 2,4 D

2016

- May 5 – plant corn
- June 13 (V4-6) – apply N, broadcast urea with Agrotain®
- Oct 25 – harvest corn


100 lb-N/ac in AGB
C:N = 14

Nitrogen credits were also measured at Arlington in 2016, although 16 bu/ac yield reductions



Regression	N credit (lb-N/ac)
Q	32
LP	57
QP*	92

Use of red clover reduced soil nitrate in the fall and increase soil nitrate at sidedress

	Fall (0-1’)	Fall (1-2’)	PSNT (0-1’)
	Nitrate-N (ppm)		
No cover	2.4	1.0	10.4
Red clover	0<.1	<0.1	20.5

0 lb-N/ac N credit

100 lb-N/ac N credit


Pictures taken October 1, 2013
Red Clover
Trifolium Pratense
Planting Date: July 30, 2013
Seeding Rate: 11 lb/acre
Seed Cost: $22.66/acre
Extension
NRCS
Red Clover
(Frost seeded)
Trifolium Pratense
Planting Date: April 4, 2013
Seeding Rate: 10 lb/acre
Seed Cost: $20.60/acre
Extension
NRCS

Sheboygan County berseem and crimson clover study in 2015

- August 15, 2014 – covers planted
  - Berseem clover, 15 lb/ac
  - Crimson clover, 15 lb/ac
  - None

2015

- April 30 – Corn planting
- May 7 – Nitrogen fertilizer, broadcast urea with Agrotain®
  - 8 N rates (0, 40, 80, 120, 160, 200, 240, 280 lb/ac)
- Nov. 9 – Corn harvest

Crimson clover had 47 lb-N/ac in above ground biomass (C:N = 16)

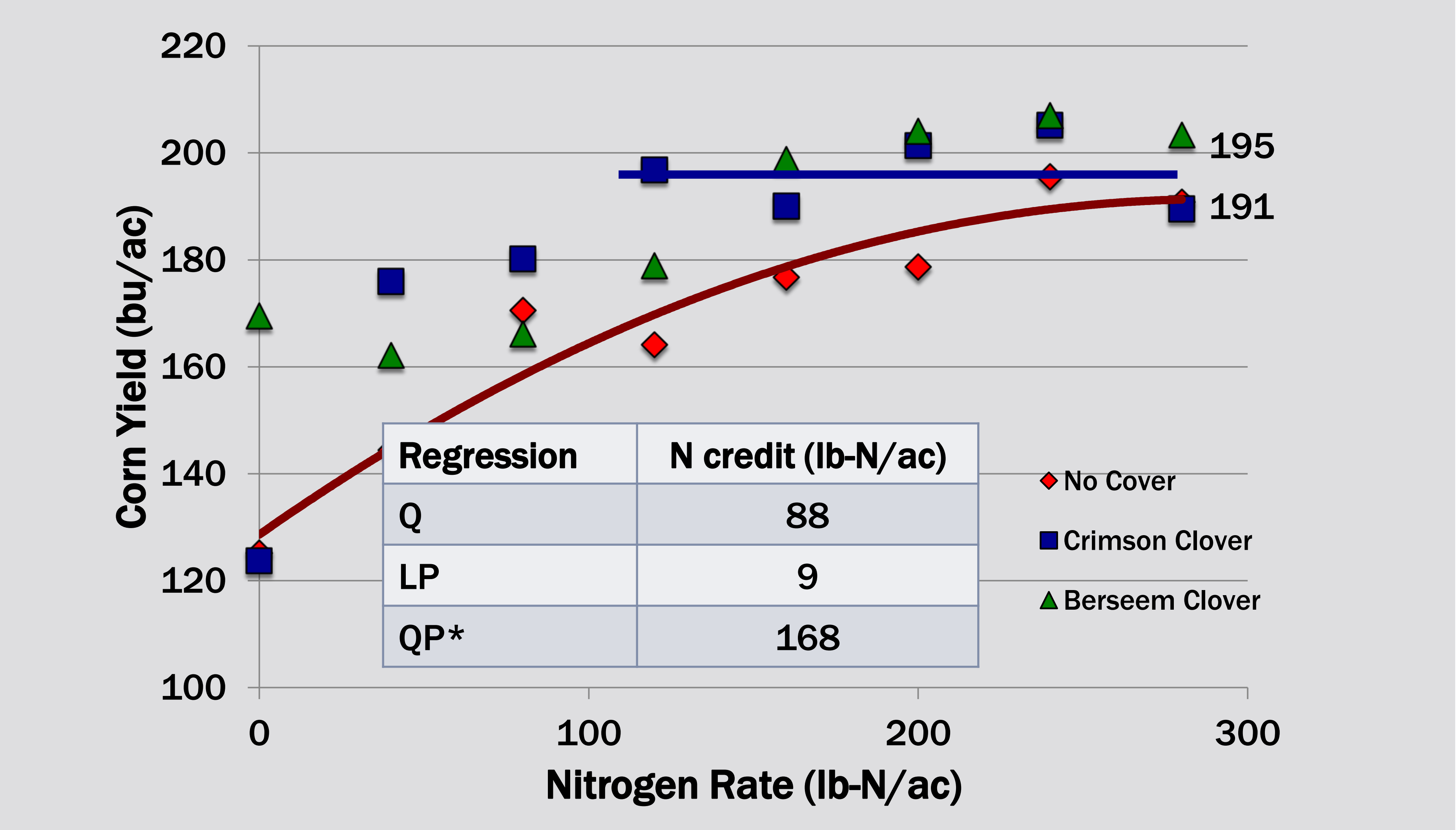
Berseem clover had 75 lb-N/ac in above ground biomass (C:N=14)

Berseem Clover—Spring Residue

Crimson Clover—Spring Residue

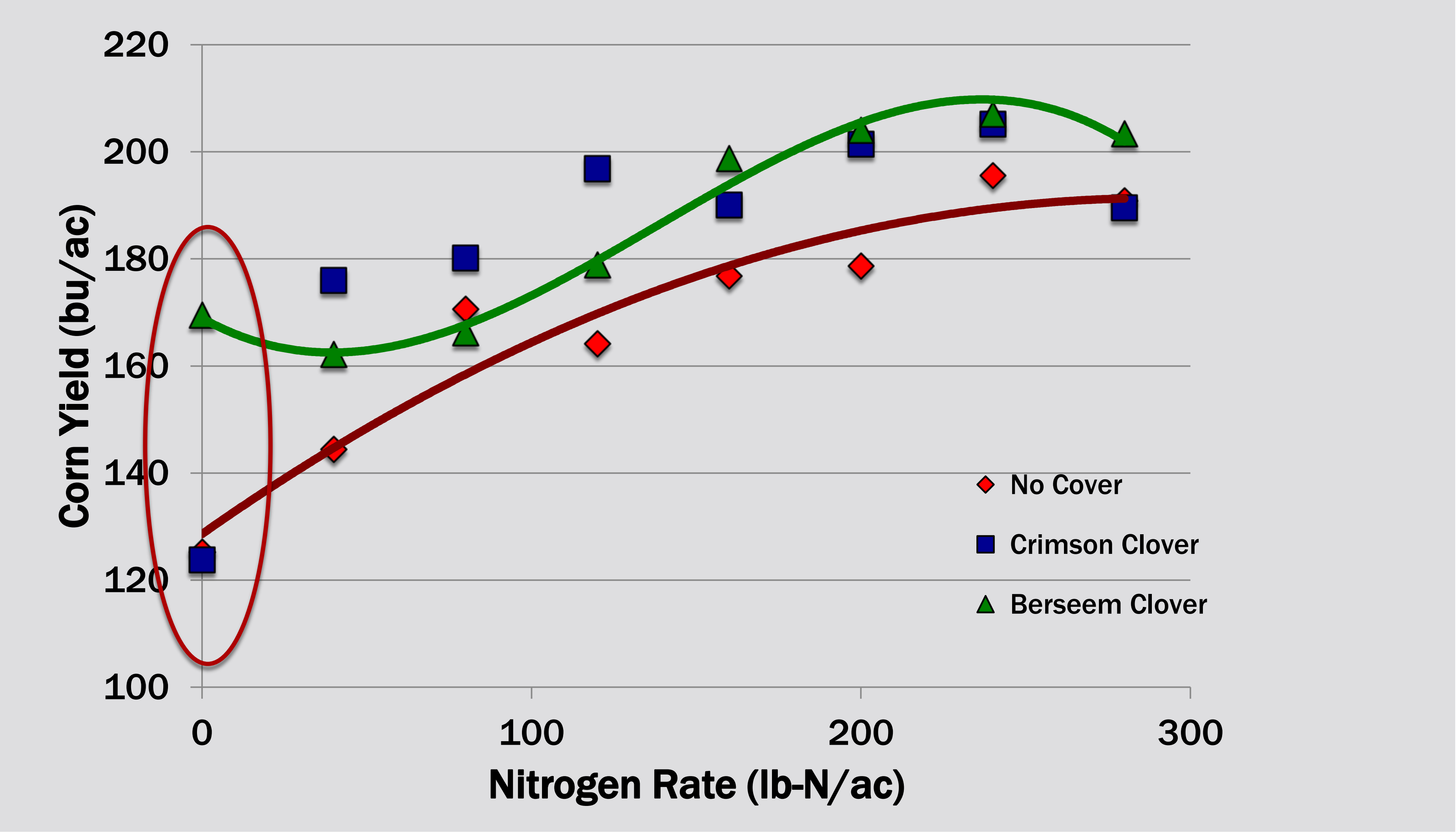
April 23, 2014

Crimson clover provides an N credit, both crimson and berseem clover provide yield benefits



Regression	N credit (lb-N/ac)
Q	88
LP	9
QP*	168

Crimson clover provides an N credit, both crimson and berseem clover provide yield benefits



But no N credit based on PSNT

	PPNT (0-1')	PPNT (1-2')	PSNT (0-1')
	Nitrate-N (ppm)		
No cover	3.5	3.3	8.6
Crimson	3.7	2.6	5.3
Berseem	3.7	3.2	8.7

Sheboygan County berseem and crimson clover study in 2016

Soil – Kewaunee Silt Loam

2015

- August 12 – Clovers planted (15 lb/ac)
- Sept. 4 – TSP and KCl
- Nov. 5 – Clover biomass sampling (end of growth)

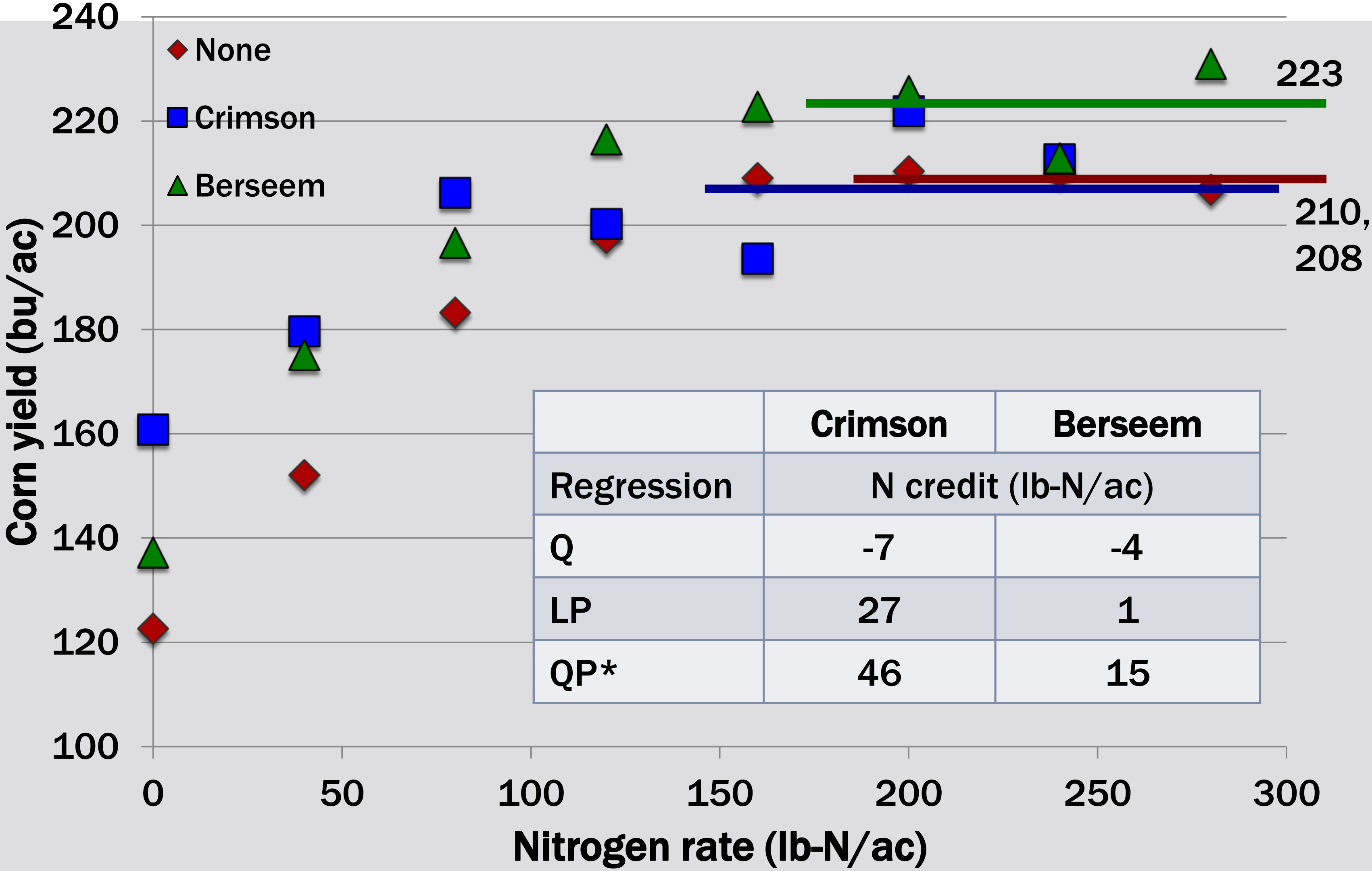
2016

- May 8 – Corn planting
- June 20 – N fertilizer application, broadcast urea w/ Agrotain®
- Nov. 15 – Grain harvest


81 lb-N/ac in AGB
C:N 11


70 lb-N/ac in AGB
C:N 13

Crimson had the clearer N credit, Berseem had the clearer yield benefit



	Crimson	Berseem
Regression	N credit (lb-N/ac)	
Q	-7	-4
LP	27	1
QP*	46	15

There was plenty of nitrogen in the soil, no N credit of legumes relative to the no cover crop plots

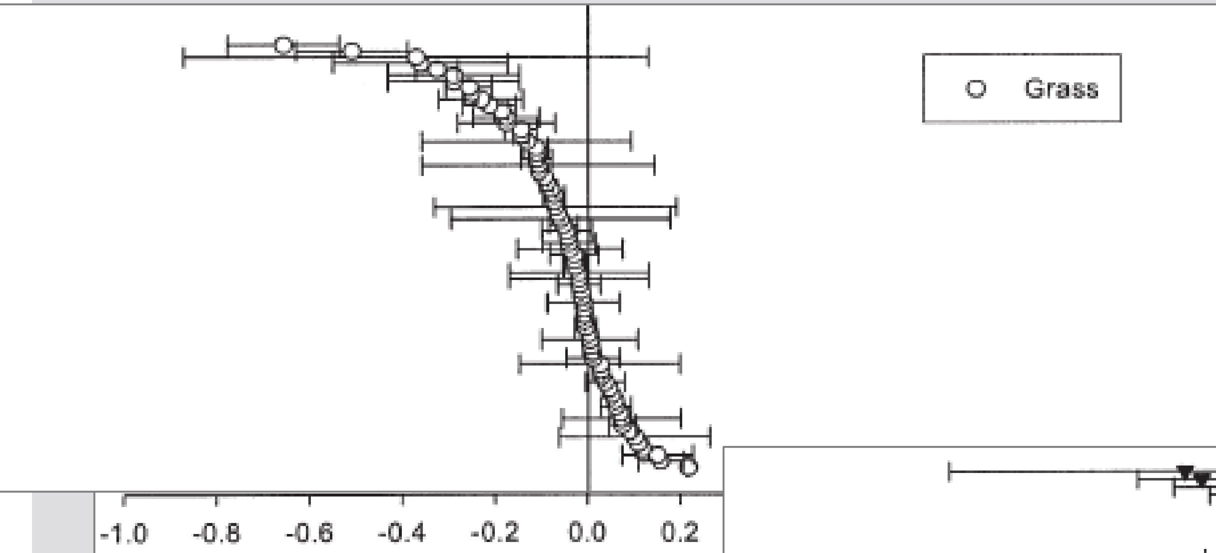
	PPNT (0-1’)	PPNT (1-2’)	PSNT (0-1’)
	Nitrate-N (ppm)		
No cover	5.7	3.1	19.6
Crimson	8.2	3.4	22.4
Berseem	7.8	2.5	18.6

Cover crop	Nitrogen credit	Yield difference
	lb-N/ac	bu/ac
Red clover	46	27
Red clover	92	-16
Crimson	168	4
Crimson	46	2
Berseem	40	15
Berseem	15	13
Average	68	8

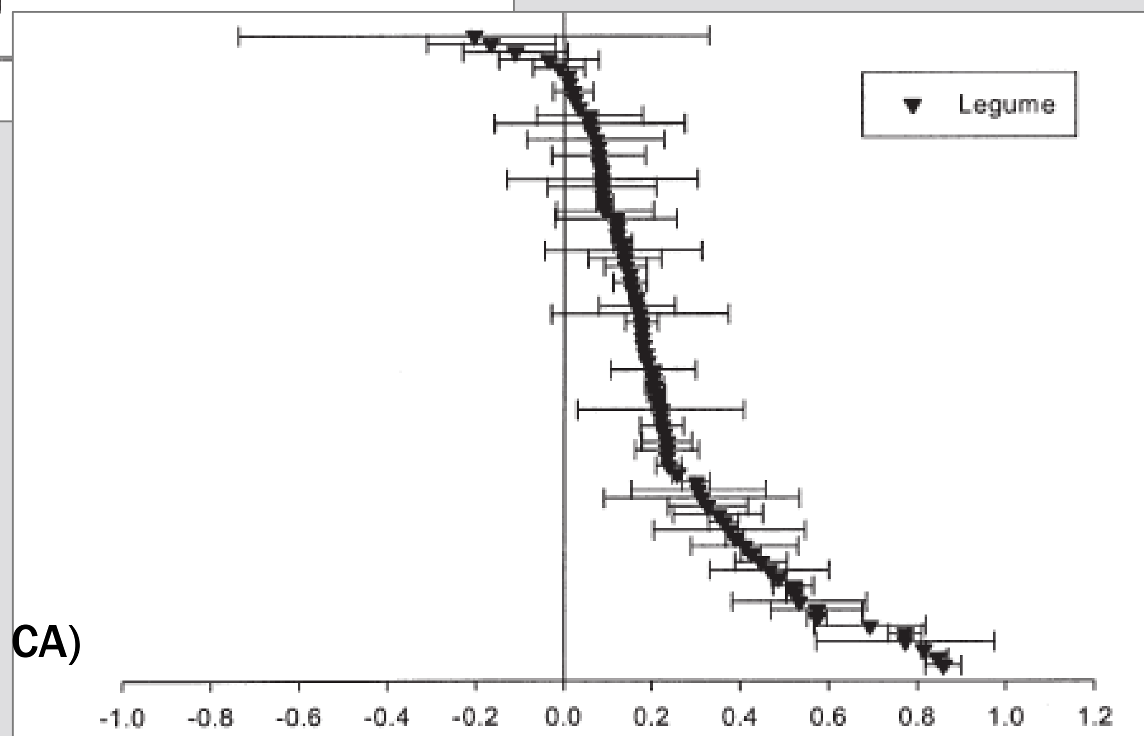
Review of Corn Yield Response under Winter Cover Cropping Systems Using Meta-Analytic Methods

Fernando E. Miguez and Germán A. Bollero*

2005 publication



68 observations (US & CA)



82 observations (US & CA)

White et al., 2016 Agronomy Journal

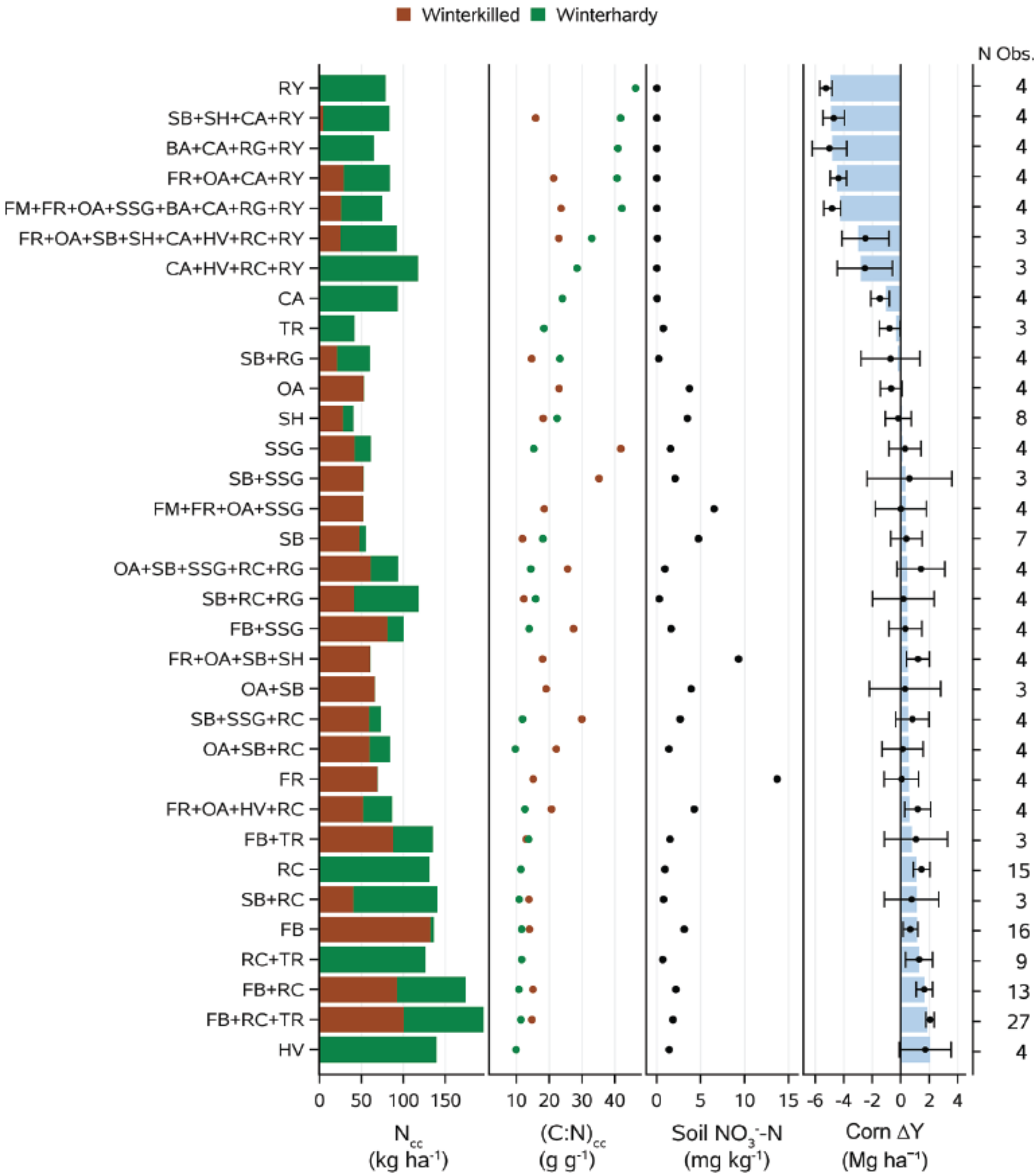
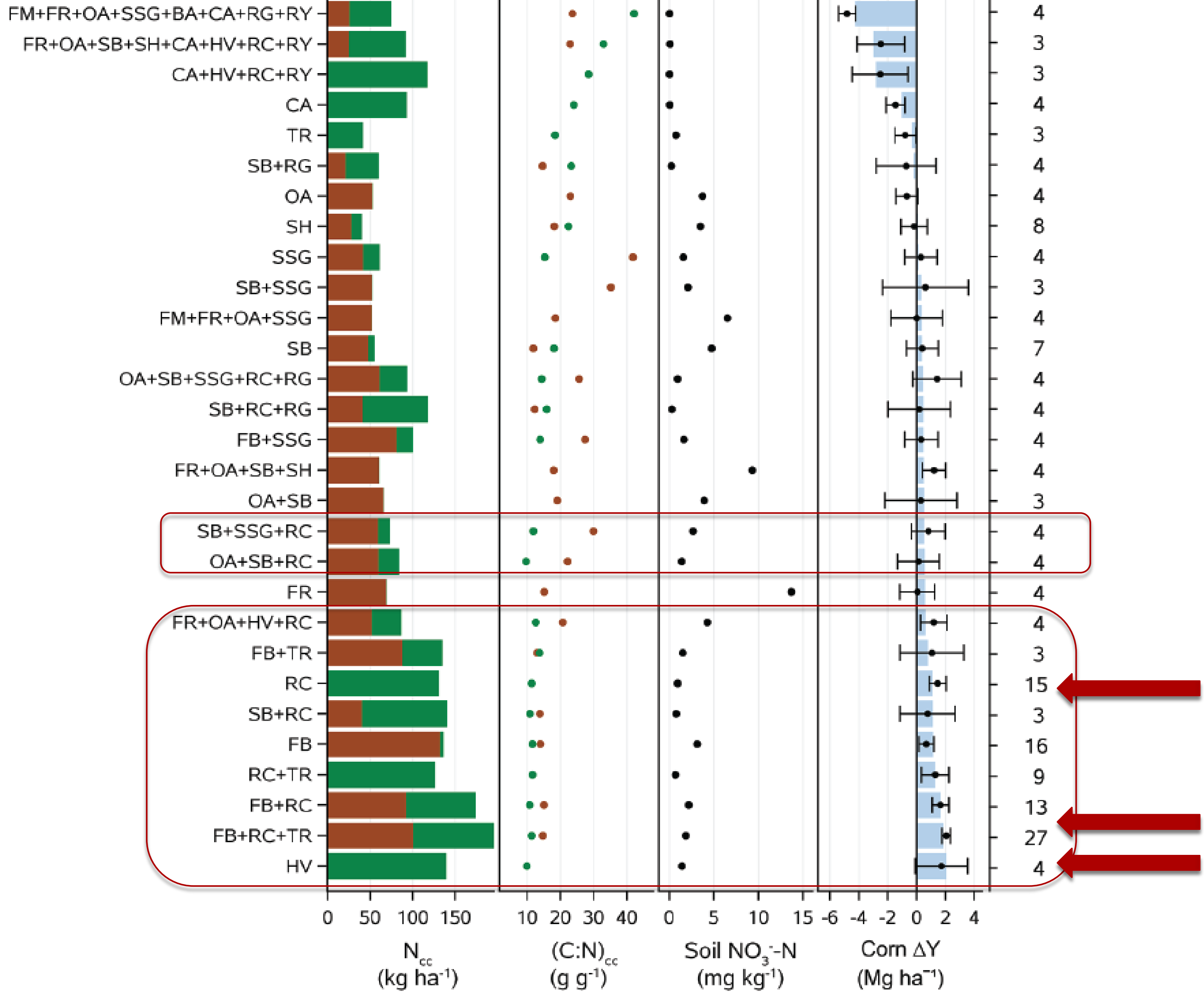


Fig. 3. The cover crop biomass characteristics and soil NO_3^-–N concentrations used to calibrate Eq. [3] to predict corn yield response, averaged by cover crop treatment across all experiments. Cover crop treatments included in the data set are listed on the *y* axis, with species codes used from Table 1. In the first and second columns are the cover crop biomass N content (N_{cc}) and C/N ratio [$(C/N)_{cc}$] for winterkilled and winter-hardy components of each treatment. In the third column are soil NO_3^-–N concentrations measured in the 0- to 20-cm depth segment at the time of cover crop termination in spring. In the fourth column, blue bars are the model prediction for the corn yield response (ΔY) and black dots are the measured ΔY bounded by a 95% confidence interval of the mean. The ΔY was calculated as the difference between the corn yield after a cover crop and the corn yield after no cover crop. Cover crop treatments are sorted in ascending order of ΔY as predicted by the model.



FM+FR+OA+SSG+BA+CA+RG+RY
FR+OA+SB+SH+CA+HV+RC+RY
CA+HV+RC+RY
CA
TR
SB+RG
OA
SH
SSG
SB+SSG
FM+FR+OA+SSG
SB
OA+SB+SSG+RC+RG
SB+RC+RG
FB+SSG
FR+OA+SB+SH
OA+SB
SB+SSG+RC
OA+SB+RC
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15
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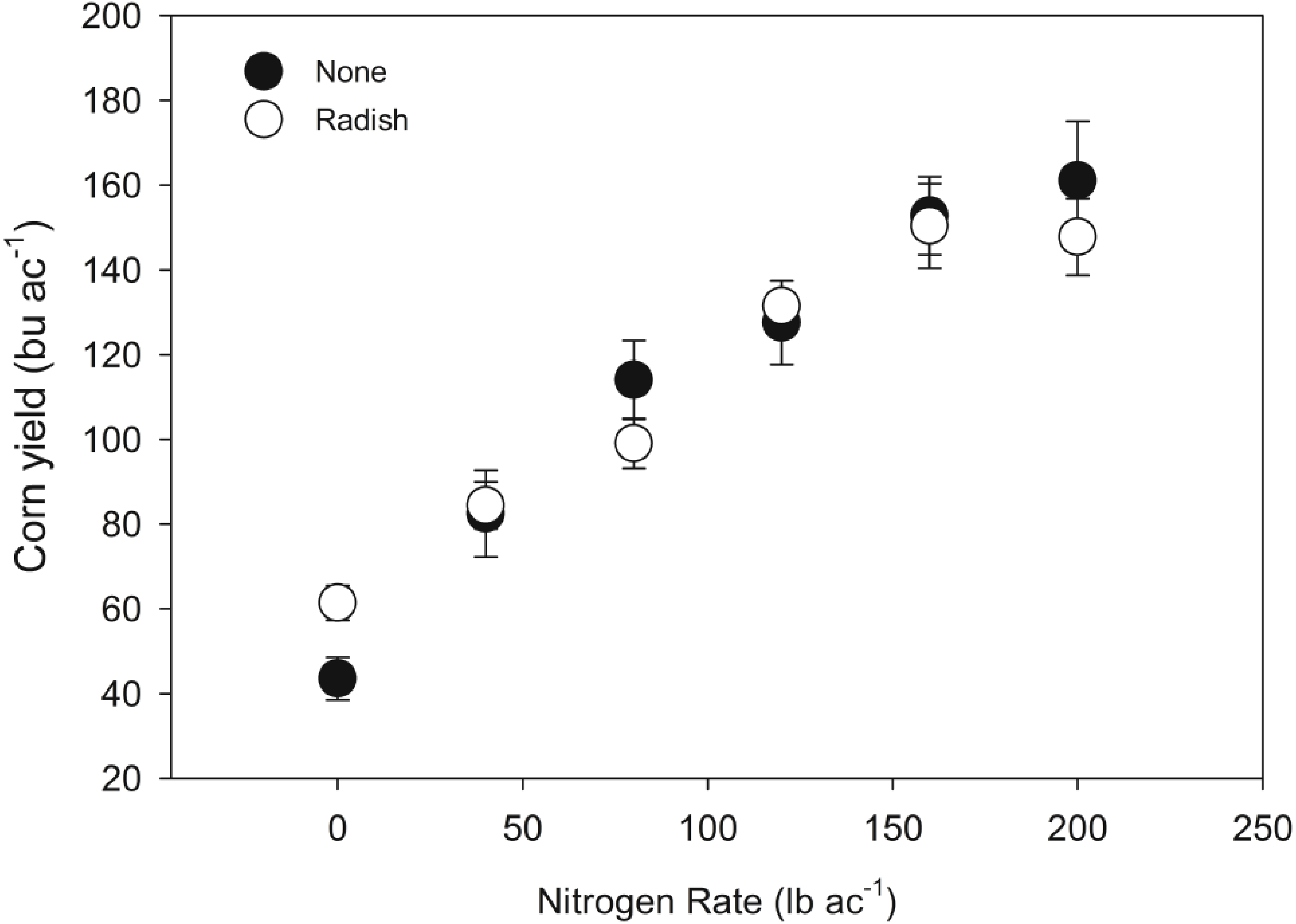
16
9
13
27
4
0 50 100 150
10 20 30 40
0 5 10 15
-6 -4 -2 0 2 4
N_{cc} (kg ha^{-1})
(C:N)$_{cc}$ (g g^{-1})
Soil NO_3^--N (mg kg^{-1})
Corn ΔY (Mg ha^{-1})

The magnitude of the N credit of a legume will vary from year to year and site to site.

- Environmental factors like moisture and temperature are the drivers of decomposition and mineralization.
- Some sort of predictive model based on these factors would be necessary to fine-tune N recommendations when N is applied at sidedress.
- There are current efforts, both university and industry, to develop these models.
- In my opinion, this is the biggest gap in predictive model development – accurately predicting the release of N from organic sources (cover crops and manure).

None
Radish
Corn yield (bu ac-1)
Nitrogen Rate (lb ac-1)
200
180
160
140
120
100
80
60
40
20
0
50
100
150
200
250

Summary

- Clear N credit of red and crimson clover
- Yield benefits with most clovers
- No green manure N credit for radish

- Use of clovers in rotations with small grains enhance the benefit of the diversified rotation

Questions?
Comments?
Concerns?