Getting Nitrogen Right

IFCA Webinar
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ILLINOIS
Crop Sciences
COLLEGE OF AGRICULTURAL, CONSUMER
& ENVIRONMENTAL SCIENCES

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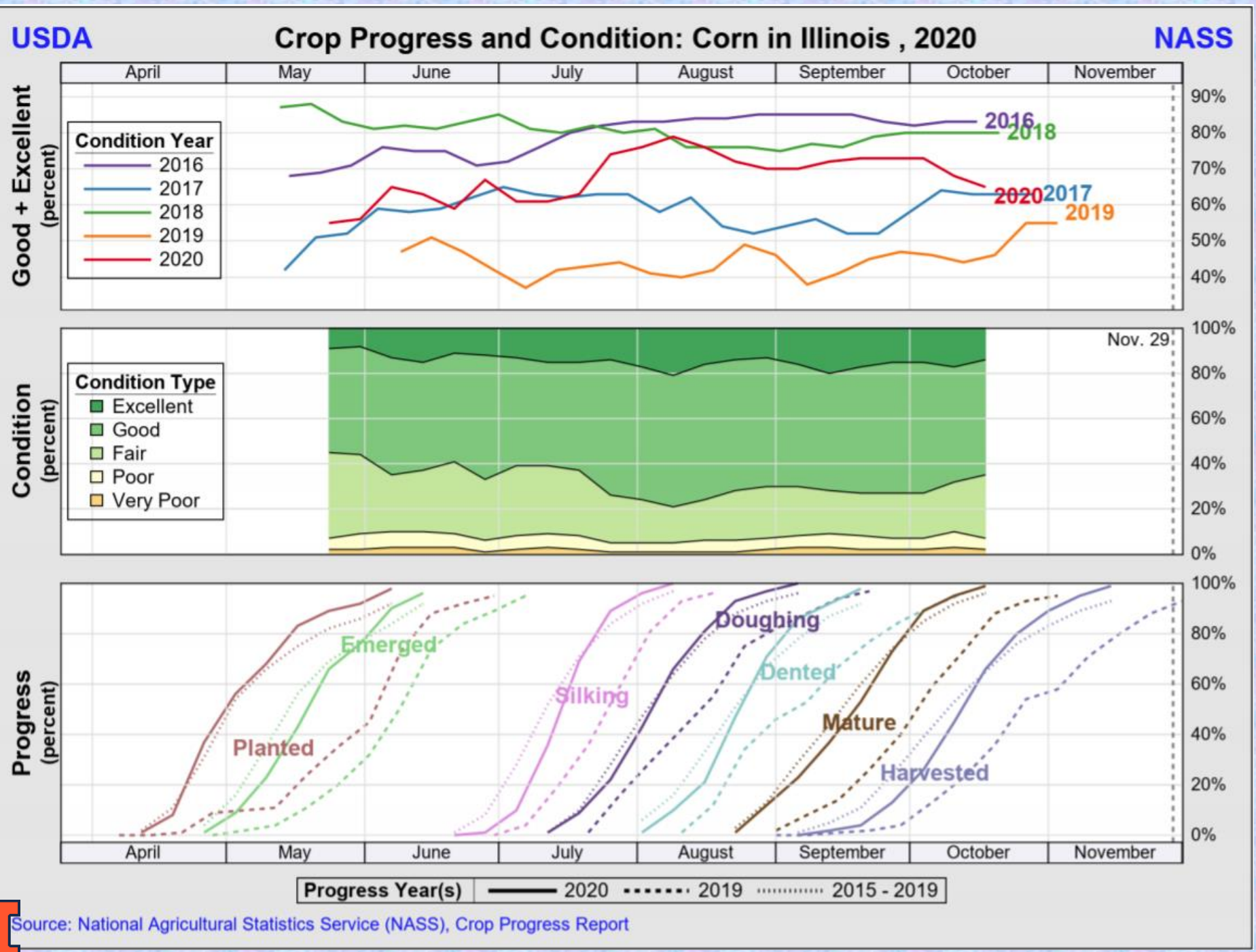
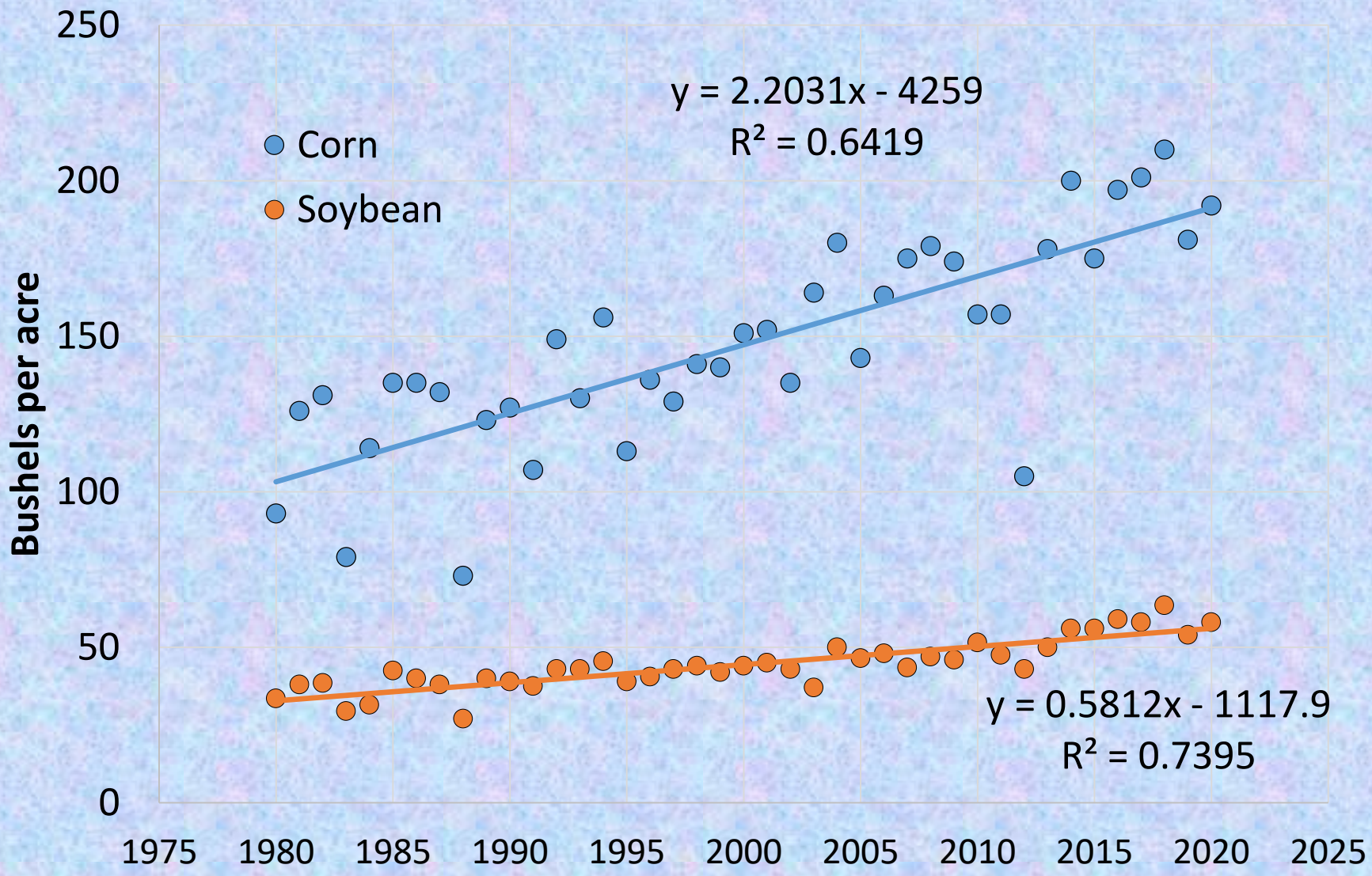
The 2020 Illinois corn crop

- "Better than 2019" but some issues with too wet, too dry, late planting, frost damage, etc., with a lot of variability around Illinois
- Crop condition rating was mediocre at 60 to 70% good+excellent most of the season
- Relatively dry in late summer and fall, with a good fall season for NH_3 and tillage, including soil cool-down in late October
- Final yield estimate of 192 bushels per acre, right on the trendline yield



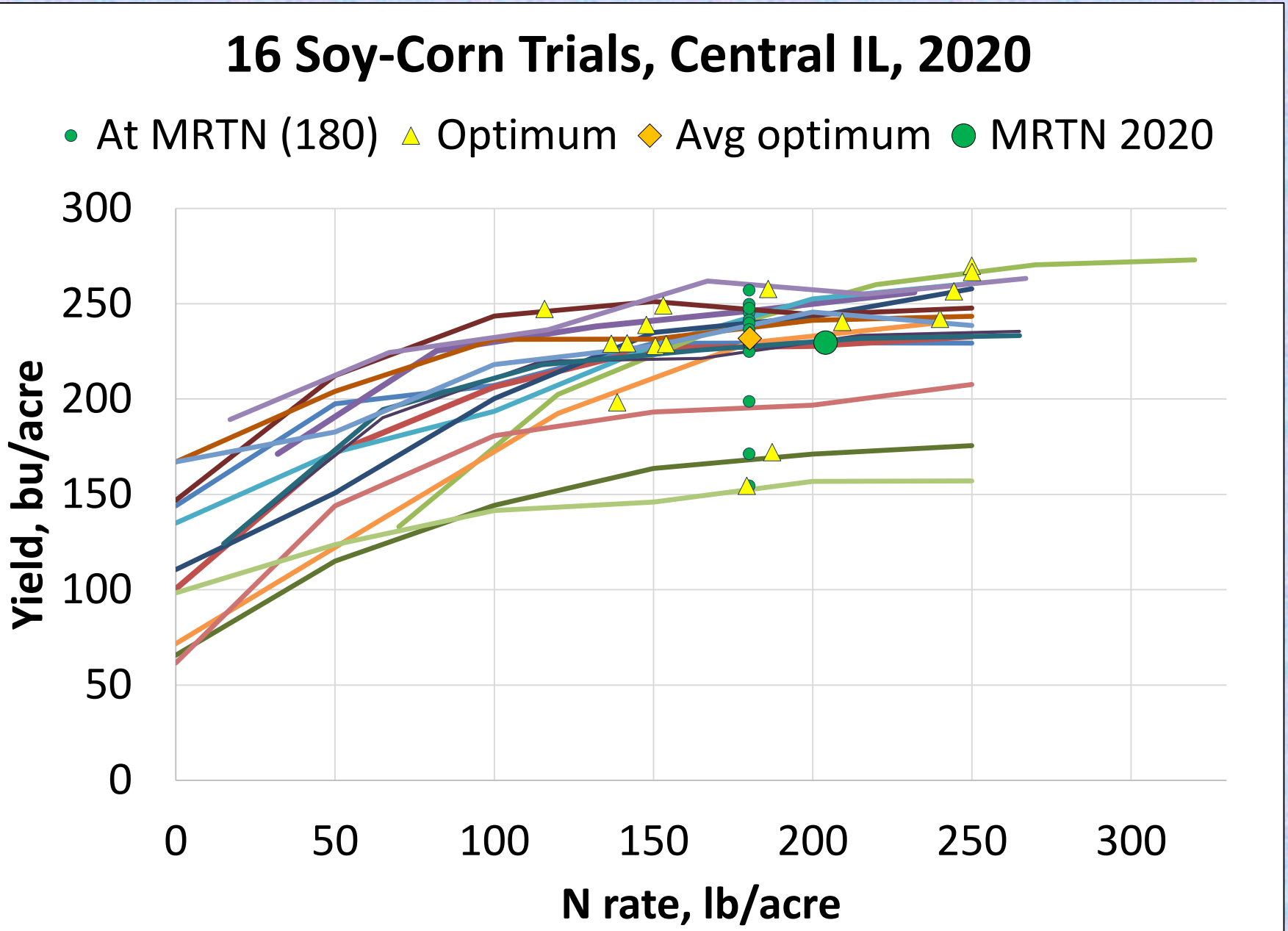
Source: National Agricultural Statistics Service (NASS), Crop Progress Report

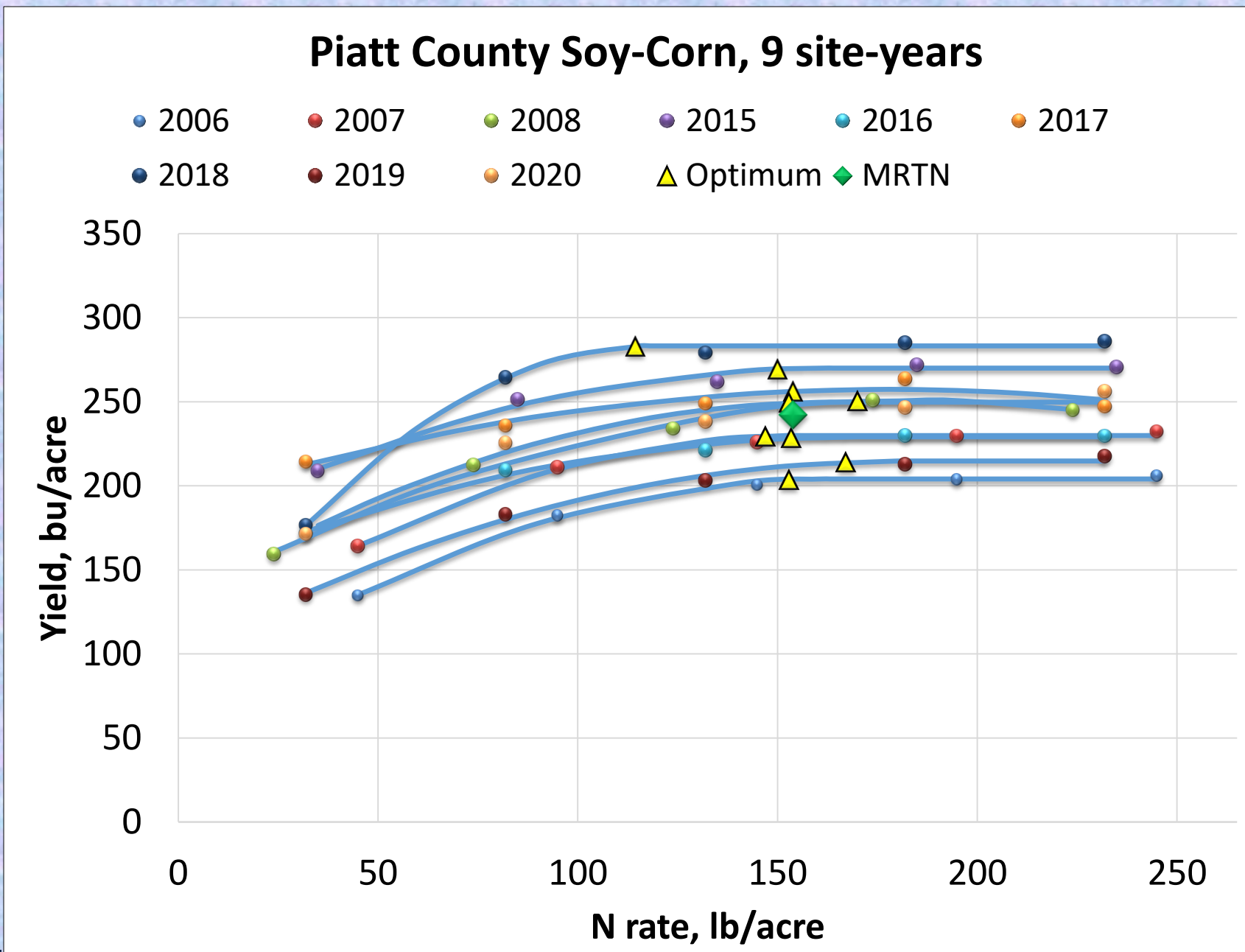
Illinois yields, 1980-2020

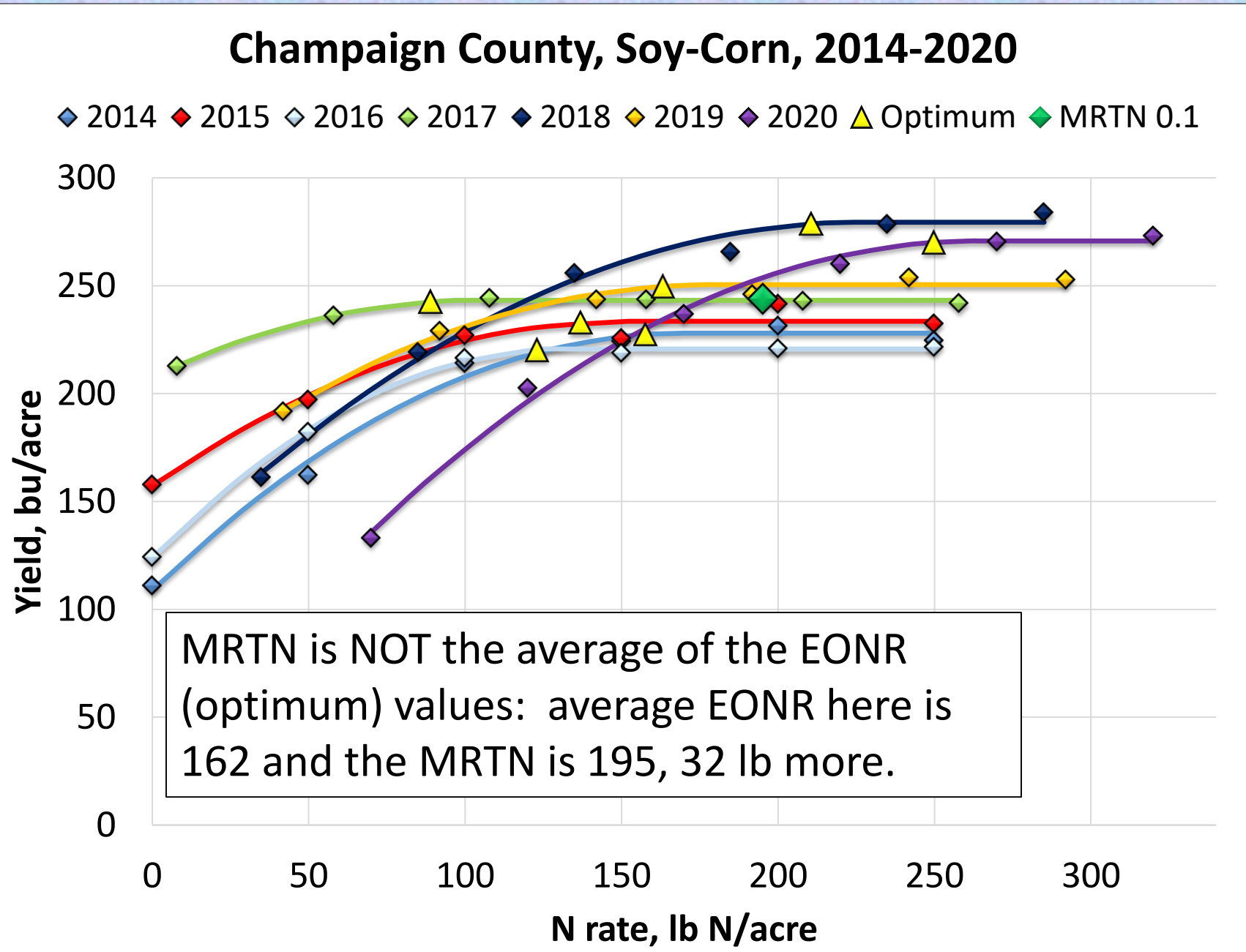


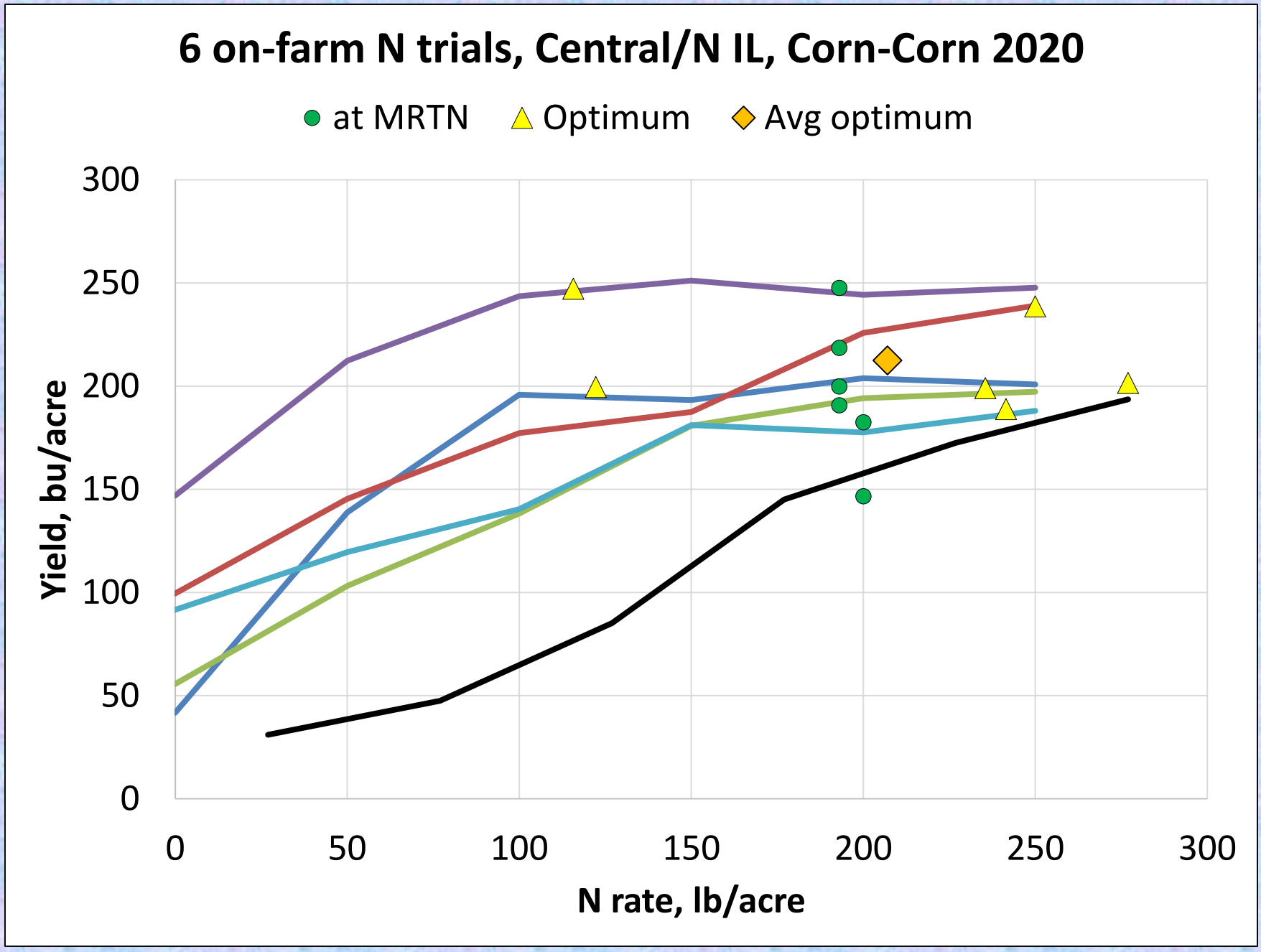
Guiding principles for N management:

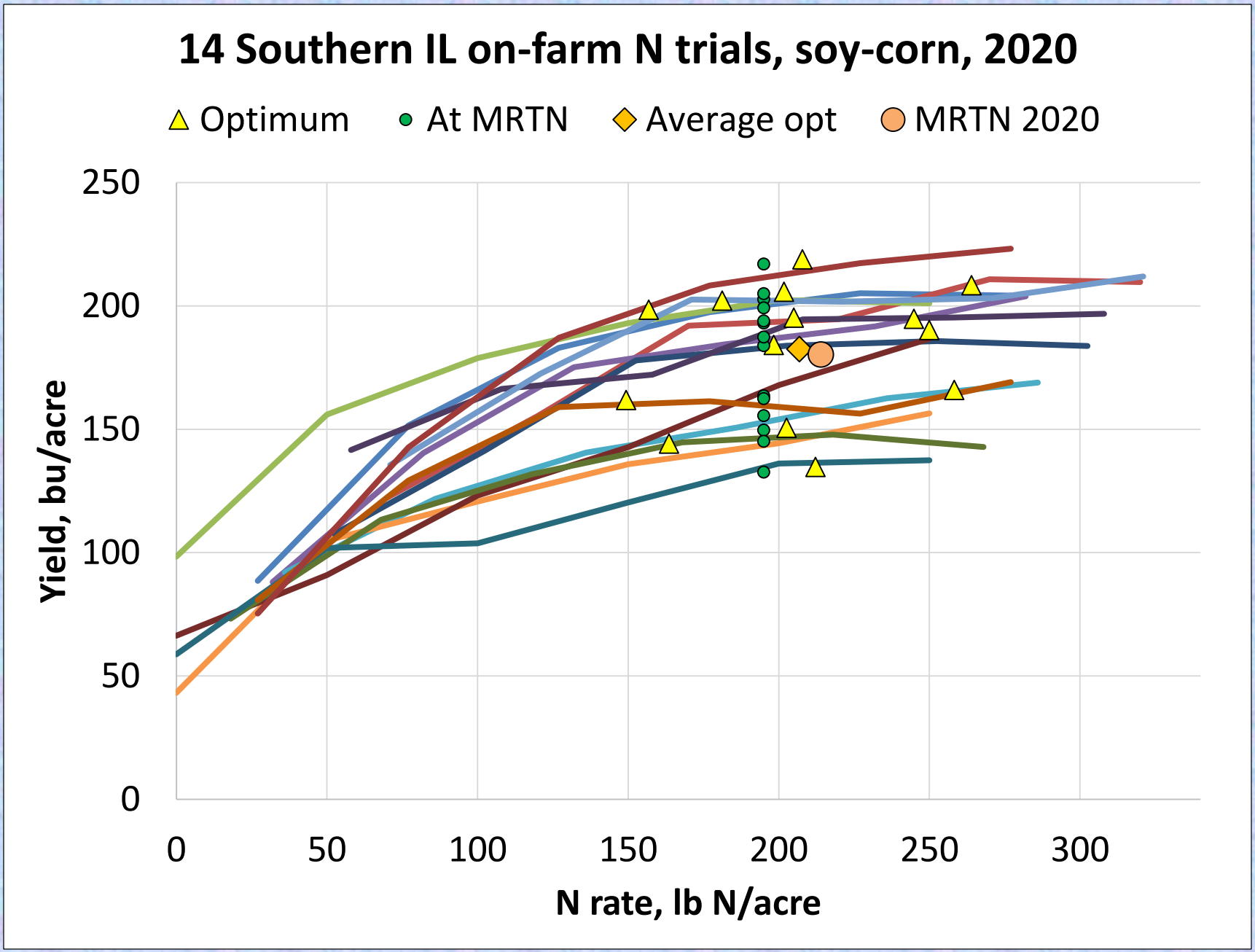
- N rate is the first consideration
- The crop needs a good supply of N for early growth, and in lower-OM soils or cool soils, this needs to come mostly from fertilizer
  - If no N can be been applied before planting, some N (20-50 lb, depending on placement) should be applied into the rooting zone at or soon after planting, and the remaining can go on in-season
- Applying some N up front and the rest in-season is often logistically sound, but:
  - It does not always increase yields compared to all-early N
  - It tends not to lower the total amount of N required
  - Planning for multiple in-season applications (spoon-feeding) is not likely to be cost-effective


16 Soy-Corn Trials, Central IL, 2020
At MRTN (180)
Optimum
Avg optimum
MRTN 2020
Yield, bu/acre
300
250
200
150
100
50
0
0
50
100
150
200
250
300
N rate, lb/acre


Piatt County Soy-Corn, 9 site-years
2006
2007
2008
2015
2016
2017
2018
2019
2020
Optimum
MRTN
350
300
250
200
150
100
50
0
Yield, bu/acre
0
50
100
150
200
250
N rate, lb/acre


Champaign County, Soy-Corn, 2014-2020
2014
2015
2016
2017
2018
2019
2020
Optimum
MRTN 0.1
300
250
200
150
100
50
0
Yield, bu/acre
0
50
100
150
200
250
300
N rate, lb N/acre
MRTN is NOT the average of the EONR (optimum) values: average EONR here is 162 and the MRTN is 195, 32 lb more.


6 on-farm N trials, Central/N IL, Corn-Corn 2020
at MRTN
Optimum
Avg optimum
Yield, bu/acre
300
250
200
150
100
50
0
0
50
100
150
200
250
300
N rate, lb/acre


14 Southern IL on-farm N trials, soy-corn, 2020
Optimum
At MRTN
Average opt
MRTN 2020
Yield, bu/acre
250
200
150
100
50
0
0
50
100
150
200
250
300
N rate, lb N/acre

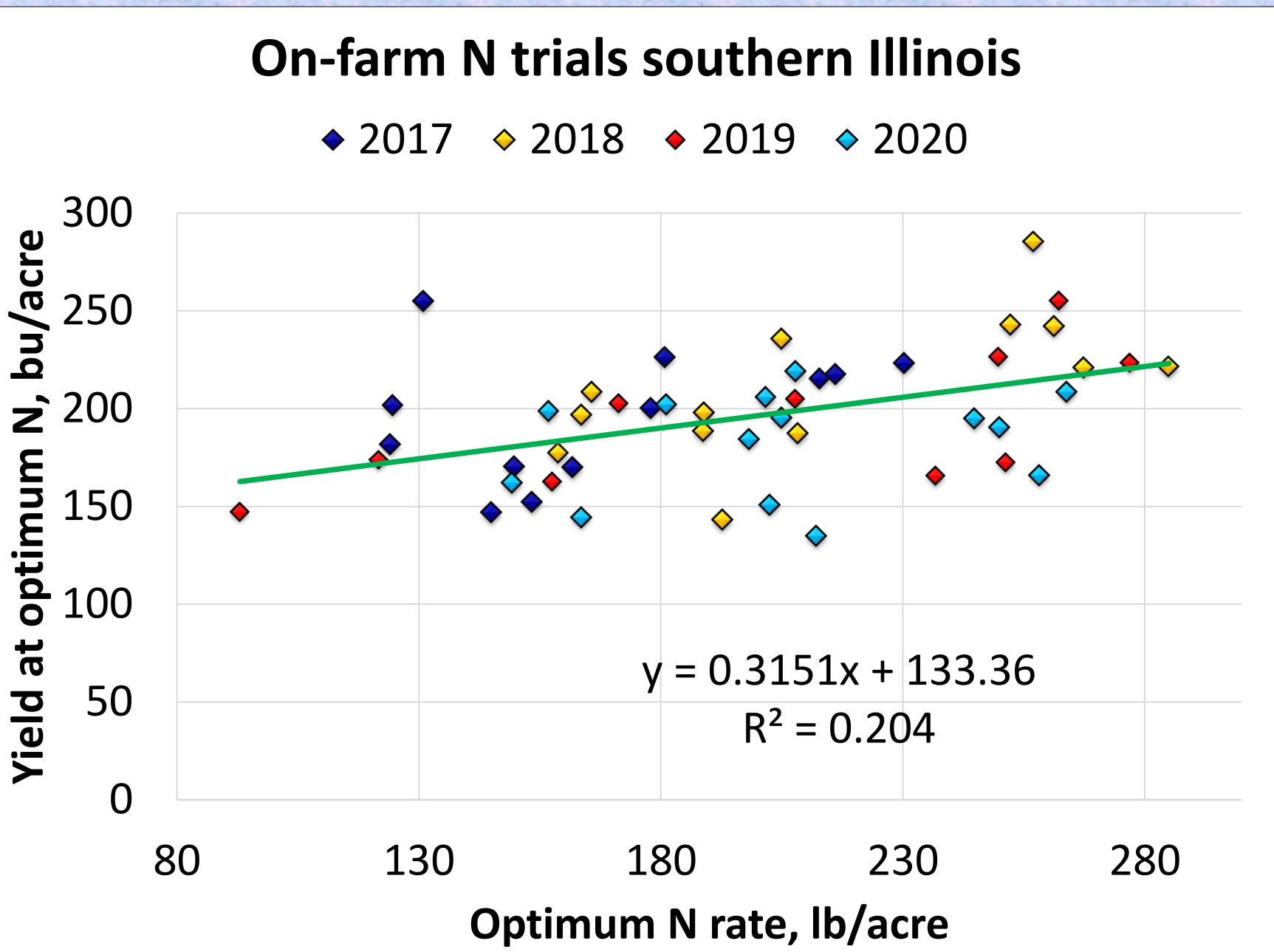
Illinois corn N rate calculator output for 2021

- Numbers below at N:corn price ratio of 1:10

Updated calculator: http://cnrc.agron.iastate.edu/nRate.aspx

IL Region	Rotation	Trials	2020 calculator, range		
		#	Low	**MRTN**	High
North	Soy-C	61	155	**171**	187
	Corn-C	67	190	**205**	222
Central	Soy-C	284	168	**181**	195
	Corn-C	148	187	**200**	214
South	Soy-C	126	187	**200**	215
	Corn-C	22	182	**197**	215

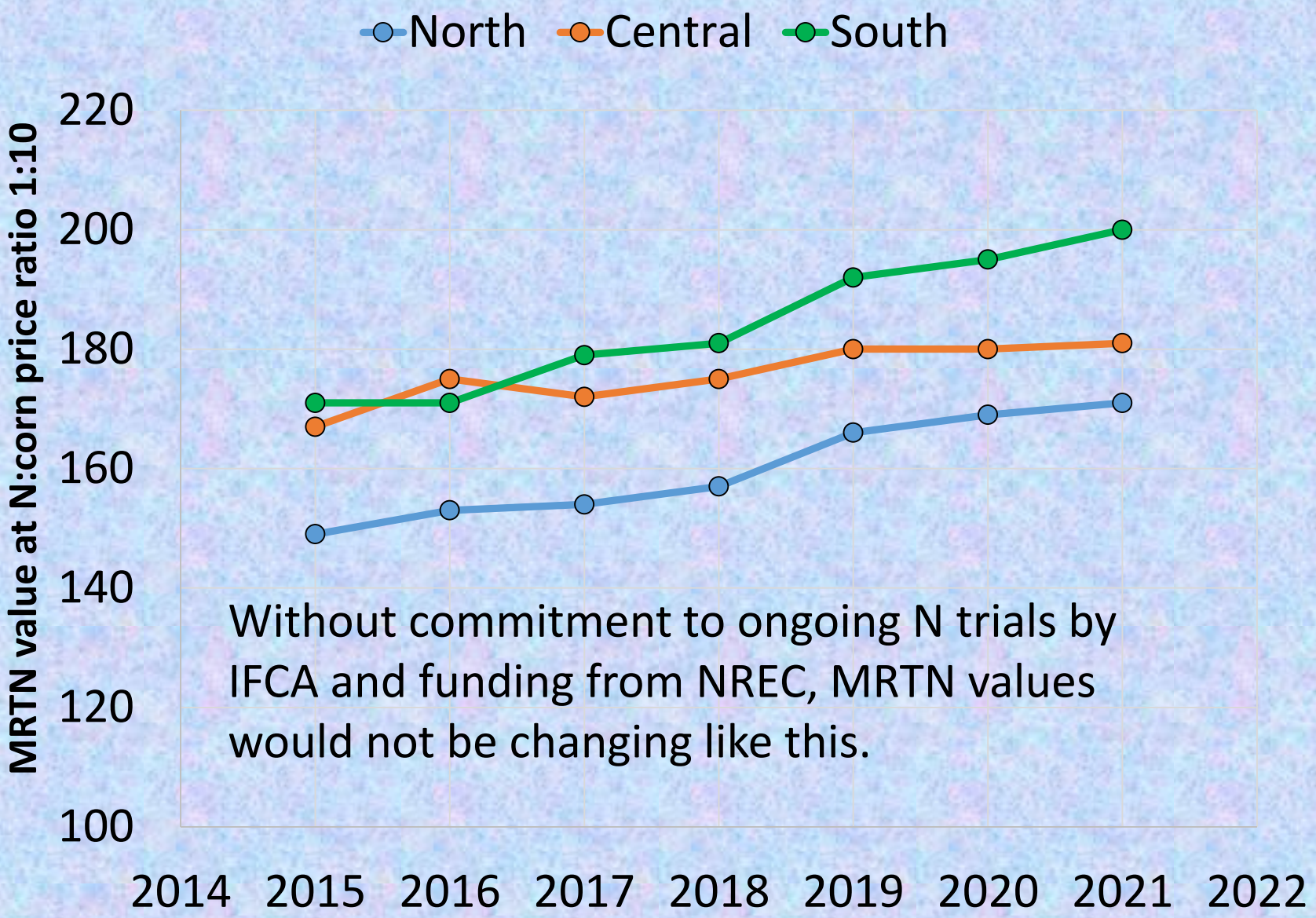
Lake Springfield MRTN values similar to those in Central IL


On-farm N trials southern Illinois
2017
2018
2019
2020
Yield at optimum N, bu/acre
300
250
200
150
100
50
0
80
130
180
230
280
Optimum N rate, lb/acre
y = 0.3151x + 133.36
R² = 0.204

N responses in southern Illinois

- Adding data from 53 trials between 2017 and 2020 in S. IL increased the MRTN N rate from 179 lb/acre in 2017 to 200 lb/acre in 2021
  - Adding the 2020 data increased the MRTN by about 5 lb/acre
- Lower-OM soils in southern Illinois supply less mineralized N to the crop, so higher yields tend to require more fertilizer N, unlike C and N IL
  - The MRTN rate (200 lb/acre) is adequate for yields up to 200 bu/acre
  - Adding 1 more lb N for each expected bushel above 200 may be justified
  - An alternative is to use a rate toward the higher end of the MRTN range for fields with a record of high yields

Change in Illinois MRTN, 2015 to 2021



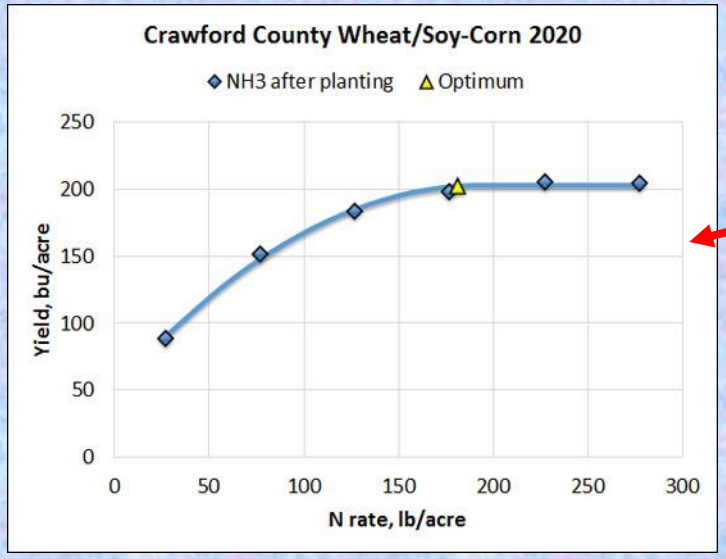
Changing MRTN with changing prices, 2021

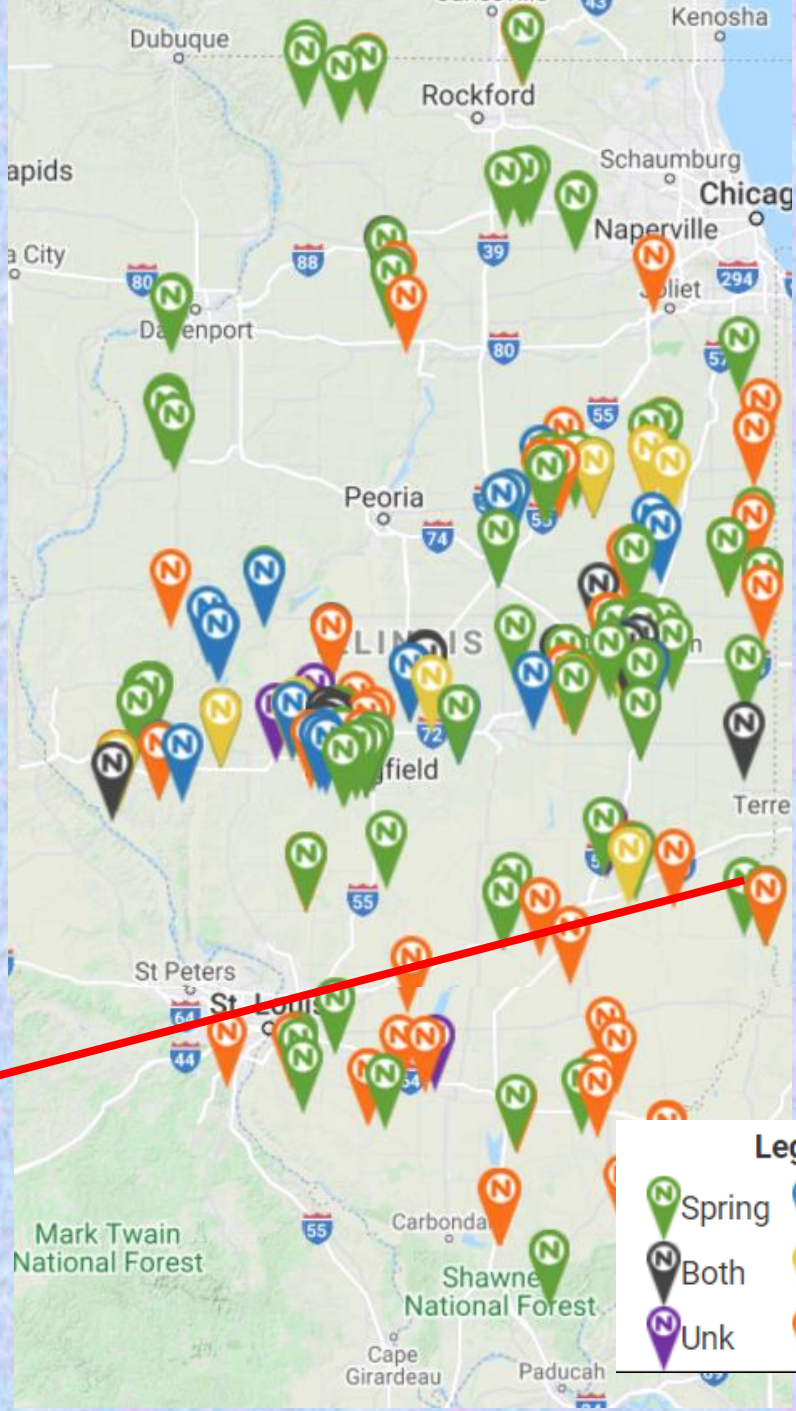
- Corn at $5.00; N price as indicated

IL Region	Rotation	MRTN at N price, $/lb		
		$0.30	$0.40	$0.50
North	Soy-C	194	182	171
	Corn-C	235	218	205
Central	Soy-C	200	190	181
	Corn-C	227	211	200
South	Soy-C	225	210	200
	Corn-C	225	211	197

If using more than one source, use the price of the source used for the last (rate-finishing) application to set total rate

Between 2014 and 2020, we added 374 N trials to the MRTN database, 266 on-farm (from IFCA) and 108 from research center trials. Most were funded by NREC.

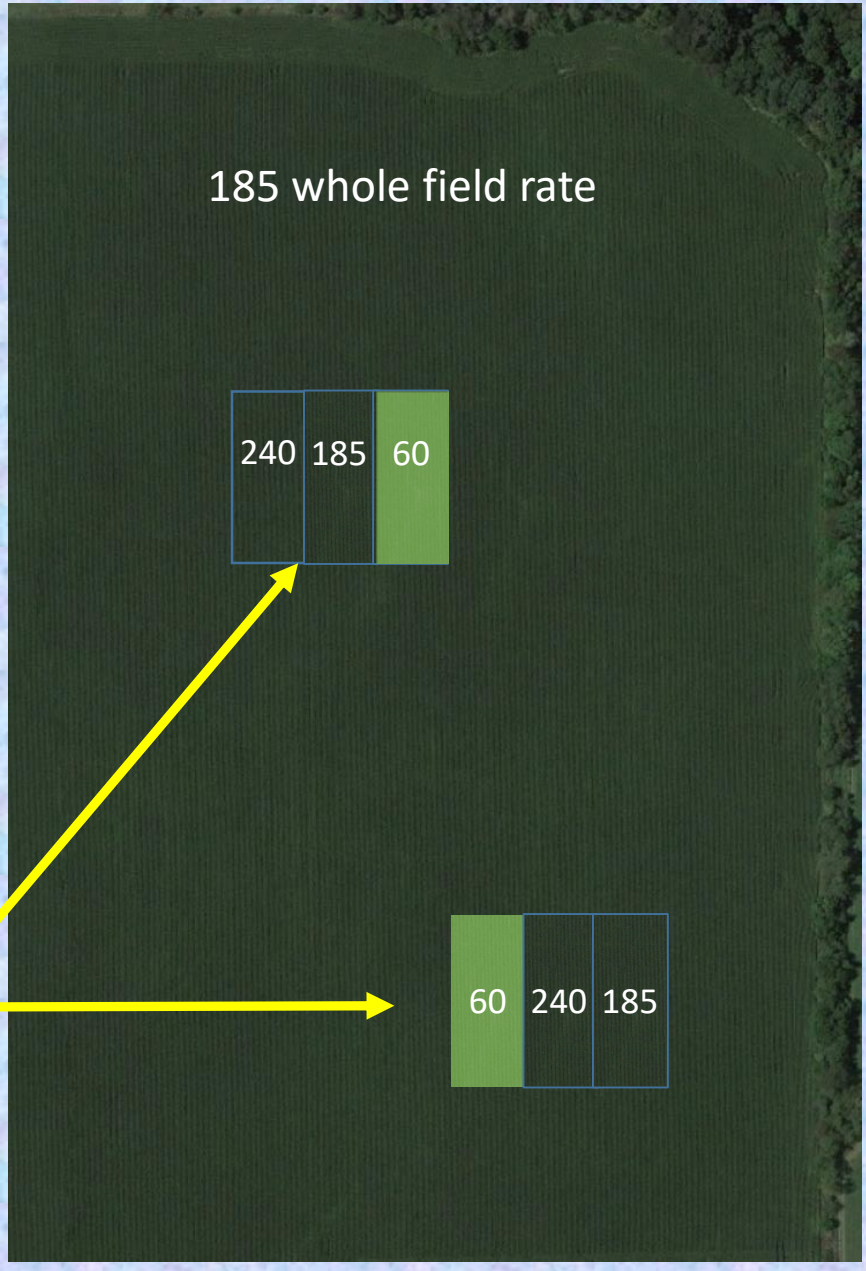




What's next for predicting best N rate?

- Running on-farm trials is necessary to improve the predictive capability of the N rate calculator, but is relatively expensive and does not "sample" years and soils enough to enable fine-tuning of rates across 11 million acres of Illinois corn
- One idea would be to design smaller trials more easily done by producers and retailers:
  - Only three rates, including the one used in a field plus one lower and one higher
  - Large plots to allow sensing (aircraft, drone, satellite) during the season and yield monitor yields
  - Done on different soils within and across fields
- Sensing and yield monitor data along with weather and soil information then used to "train" an N prediction model that would, over time, get more specific to soils and (maybe) to in-season weather

Instead of this (in 30-40 IL fields)

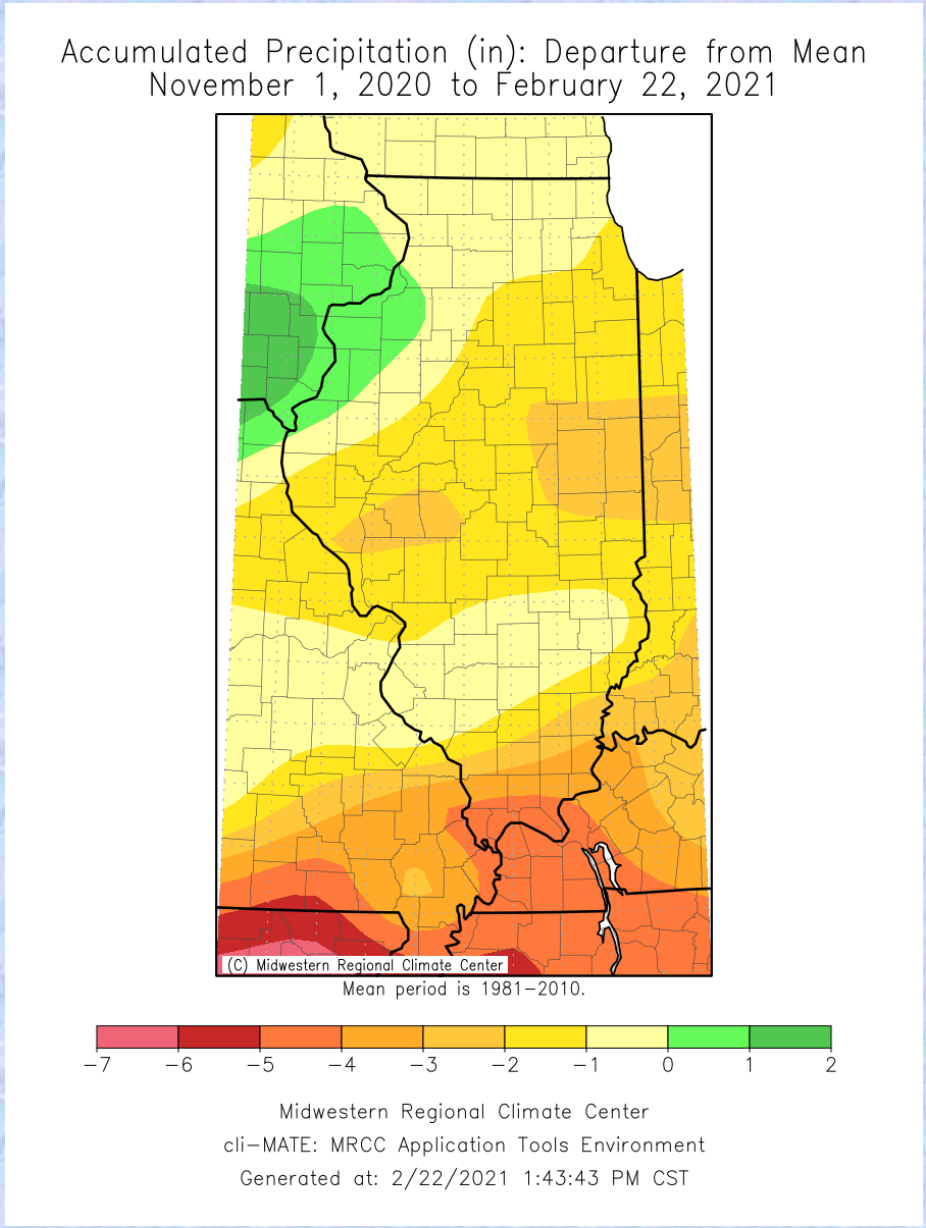


Something like this:

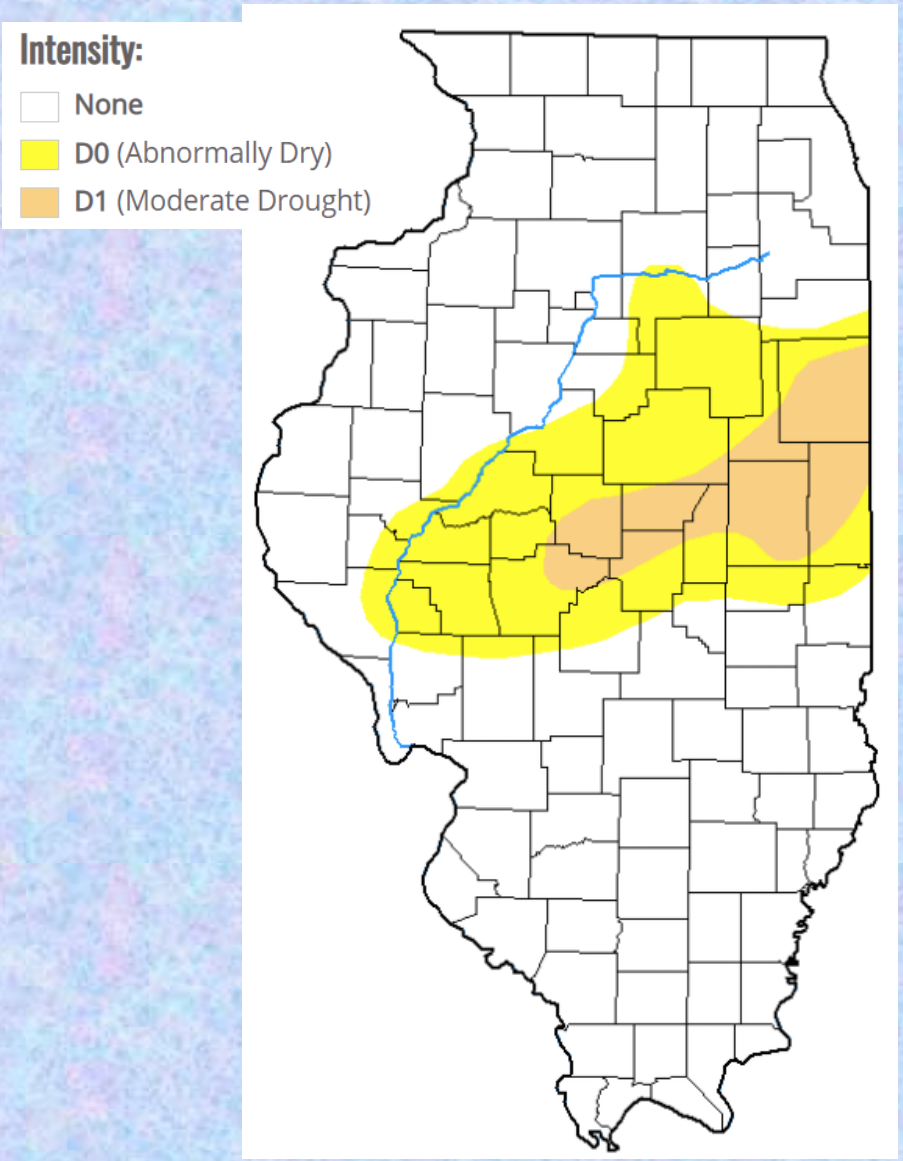
In lots of fields

Looking ahead to 2021

- Fall ammonia application began in late October after early cooldown, and dry weather kept it going
  - Fall NH_3 application in 2020 exceeded that in 2018 and 2019
- With below-normal precipitation since November 1, soils in most of Illinois remain dry
  - Soils may still have more residual N than normal due to low tile flow since harvest
  - Nitrification of fall-applied NH_3 should be low due to average soil temps Nov-Feb
  - Dry soils mean that any NO_3 probably remains in the soil
- Current prices: NH_3 $520 per ton ($0.28 per lb of N); UAN28 $235/ton ($0.42/lb N); urea $400/ton ($0.43/lb N)
- New corn cash price for fall about $4.50

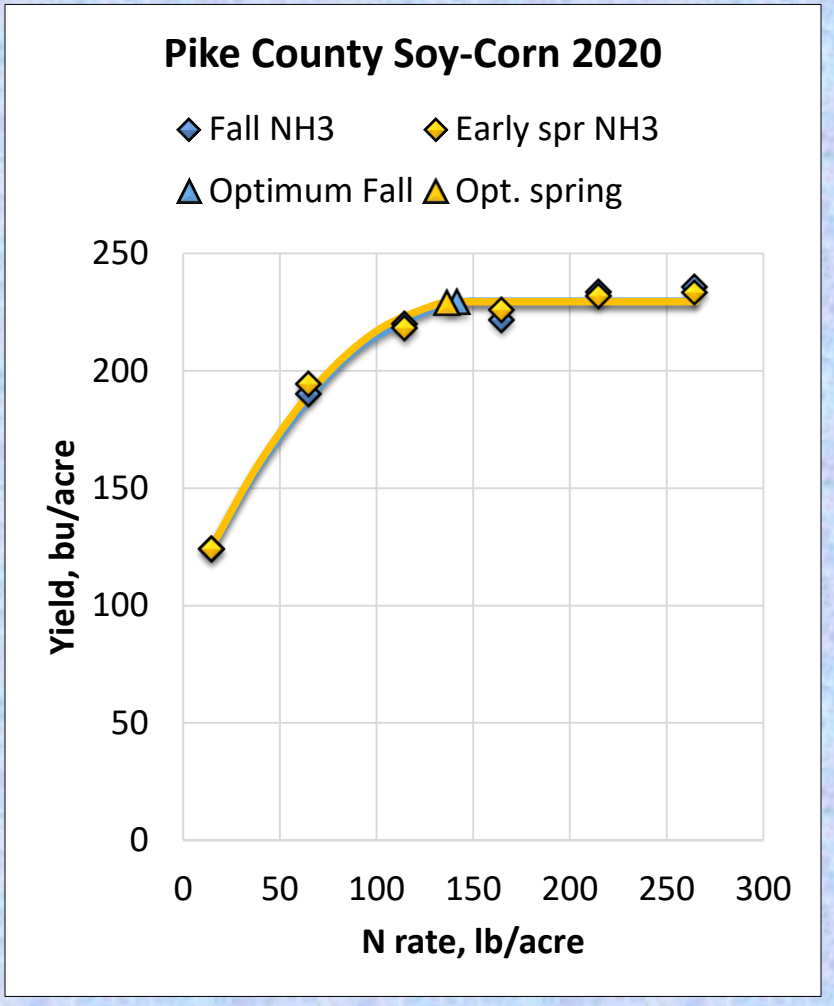


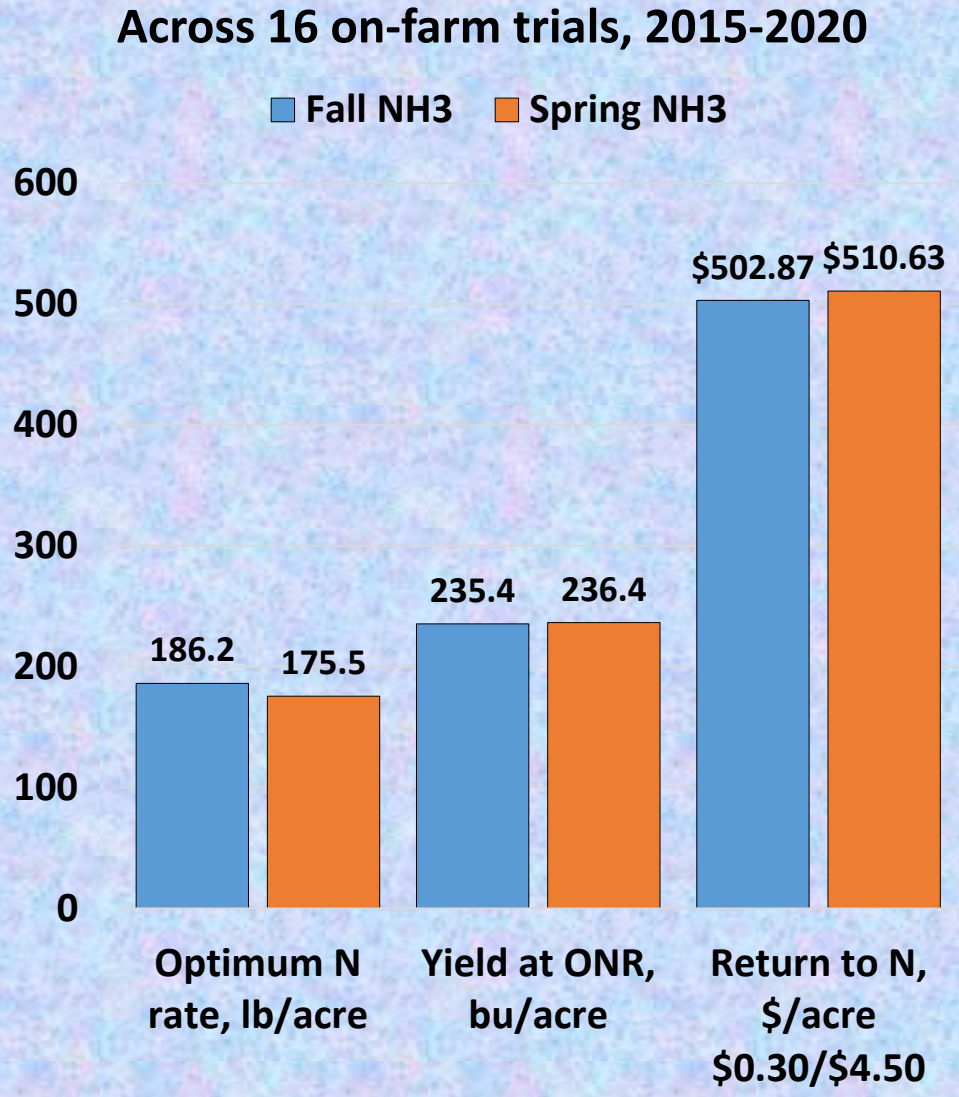
Illinois drought map, 2/26/21

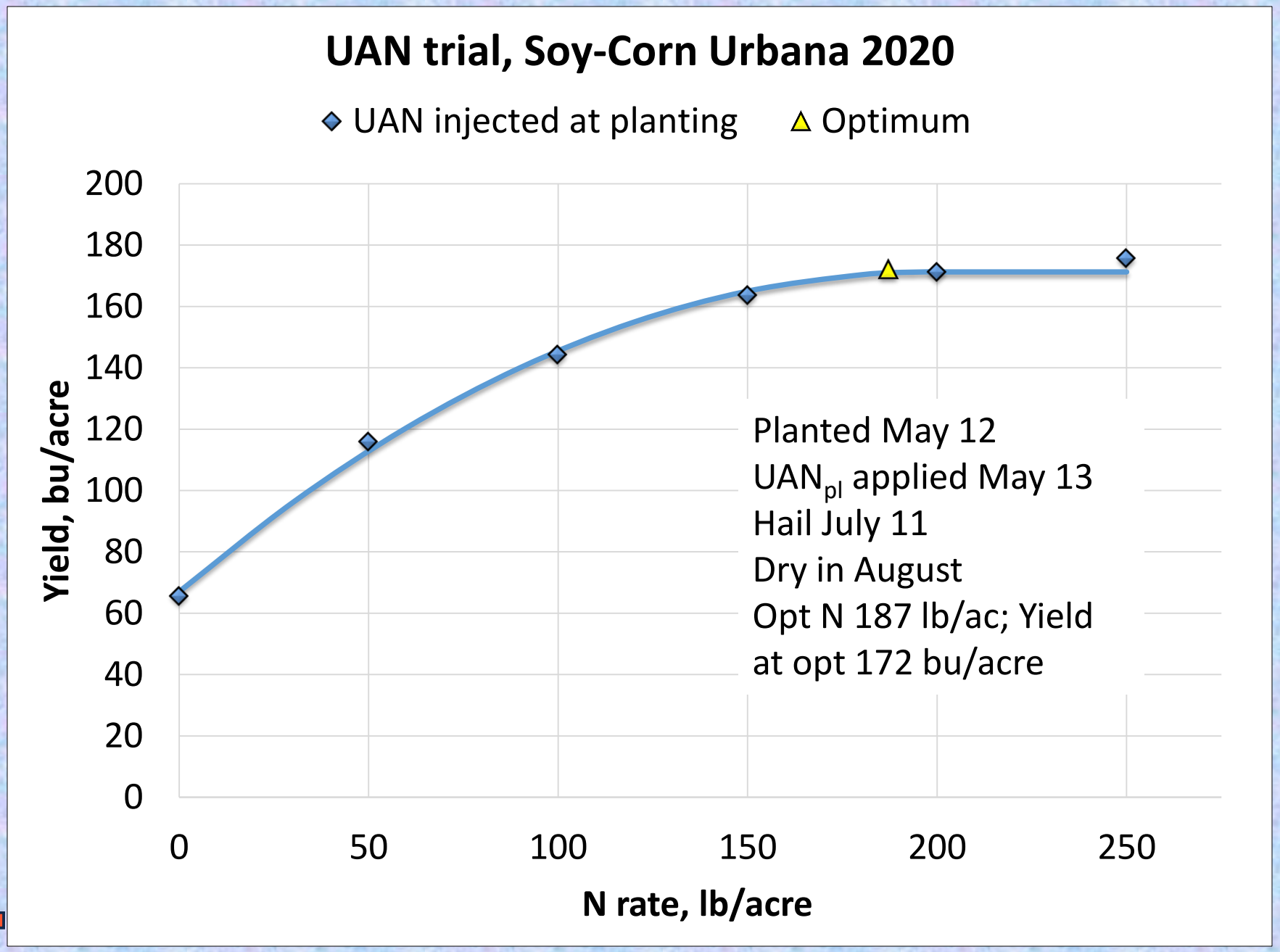


Fall/winter temperatures have been average; February cold

N timing: fall v. spring NH_3






UAN trial, Soy-Corn Urbana 2020
UAN injected at planting
Optimum
Yield, bu/acre
200
180
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
N rate, lb/acre
Planted May 12
UAN$_{pl}$ applied May 13
Hail July 11
Dry in August
Opt N 187 lb/ac; Yield
at opt 172 bu/acre

All 150-lb N treatments

Timing/placement	Yield, bu/ac 2020	2019
150 injected at planting	164	172
50P+100 injected V6	**167**	**184**
50P+100 dribbled in-row V6	165	176
50P+50inj/50dr V6	**166**	**178**
50P+50inj V6+50dr V10	170	173
50P+50dr V6+50dr V10	**173**	**162**
50P+100dr V10	179	172
75inj/75dr at planting	165	169
150 dr at planting	**155**	**195**

In 2019, N_{opt} = 149 lb/ac; Y_{optN} = 172 bu/acre

N timing lessons revisited

- Data and anecdotes confirmed the need to have enough N in the soil near the row early
- Planting in April and having 6 weeks of (wet) weather before N application will often cost serious yield
  - But if it doesn't get wet and soil warms normally by planting, N timing is less critical
- We don't have a good idea of how much N (and how close to the seed) is "enough" but mineralized N contributes, so the amount of fertilizer N needed depends on soil temperatures at planting, soil organic matter, and rainfall between planting and V2-V3

Arithmetic for early N

- An acre of soil about 7 inches deep weighs about 2 million lb: 1 ppm = 2 lb
- 20 lb. of N mixed uniformly into this layer is 10 ppm N
- If we consider 40 ppm near the seed at emergence to be a safe amount, we need:
  - 40 lb. N broadcast and (if uniform) to 3.5” deep
  - For a zone 7.5” wide and 3.5” deep (= 1/8th of the soil volume), 40 ppm requires only 10 lb N if it’s uniformly distributed and if the N stays in that zone for at least 3 weeks (300 GDD) after planting
  - 30 to 50 lb N placed 2 x 2” or dropped atop the row is often safer than 10-15 lb N in-furrow or “Y-tubed” using seed firmers, but in-furrow N (<15 lb) is better than no N

Split N or not?

- Less early-season N from mineralization in lower-OM soils increases the risk of delaying N application in such soils
- Corn grown in very well-drained, very poorly drained, or root-restricting soils is more likely to benefit from splitting N
- If N is split, apply enough at or before planting
- Near-row dribbling works well, if done well
- Risks of splitting N:
  - Inability to apply due to wet periods
  - Delay in N availability to plants due to dry soils
  - Cost, and the yield increase needed to cover it

Late-split N

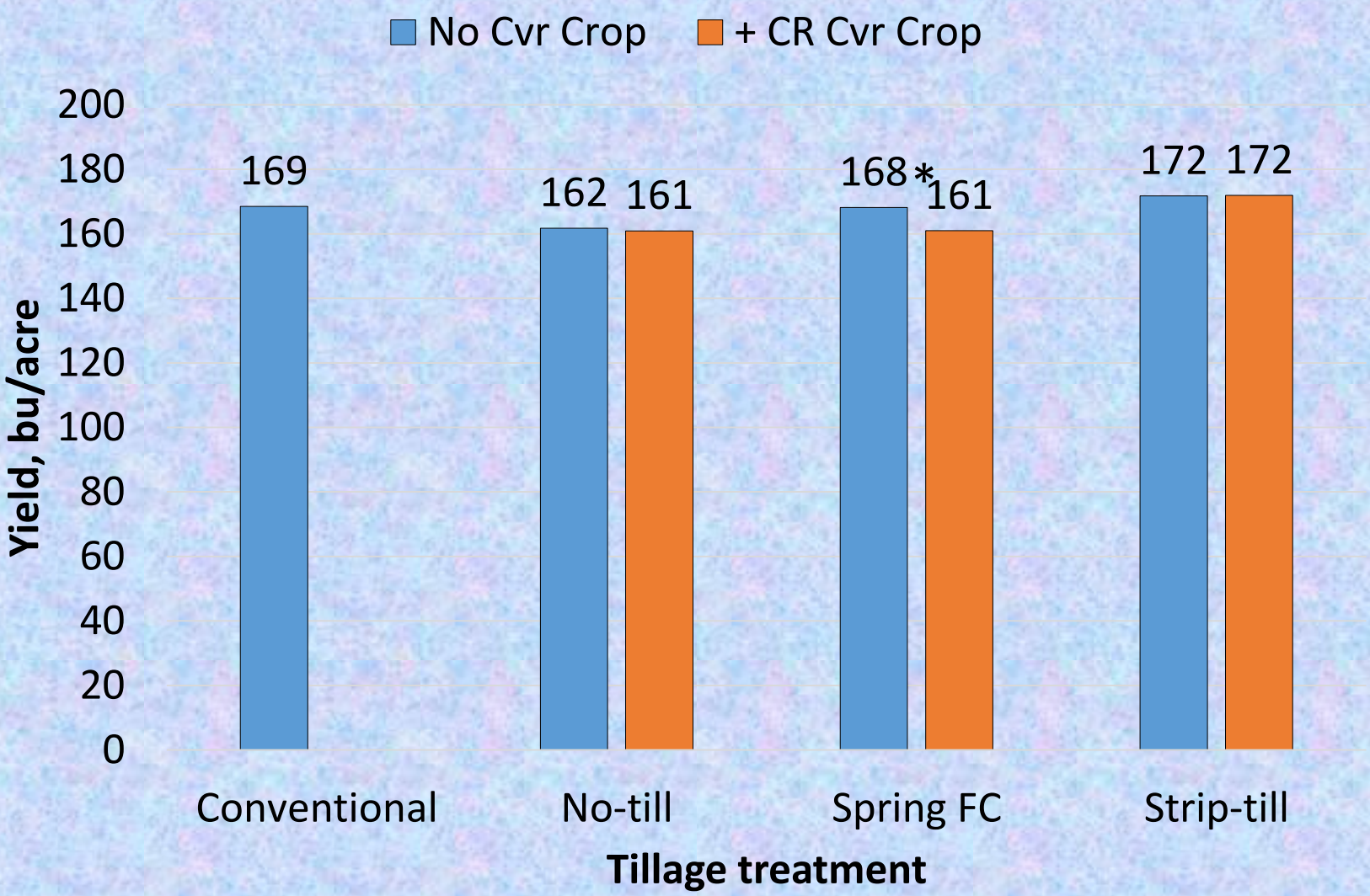
- Across 15 trials in 2016-17, we found no advantage—higher yield or lower N rate—from keeping 50 lb N back to apply as in-row "Y-drop" at tassel
  - At current MRTN N rates, applying all N early or most early + 50 lb late would have produced identical yields at every site
- Subtracting the cost of late application would have made late-split N unprofitable
- A very wet June (like 2015) might mean a yield boost from late-split N, as an additional amount above the MRTN:
  - We think the new approach to MRTN might eventually tell us when this is needed
  - Cost and timing of aerial or ground application an issue

Cover crops and N on corn

A new study in 2020

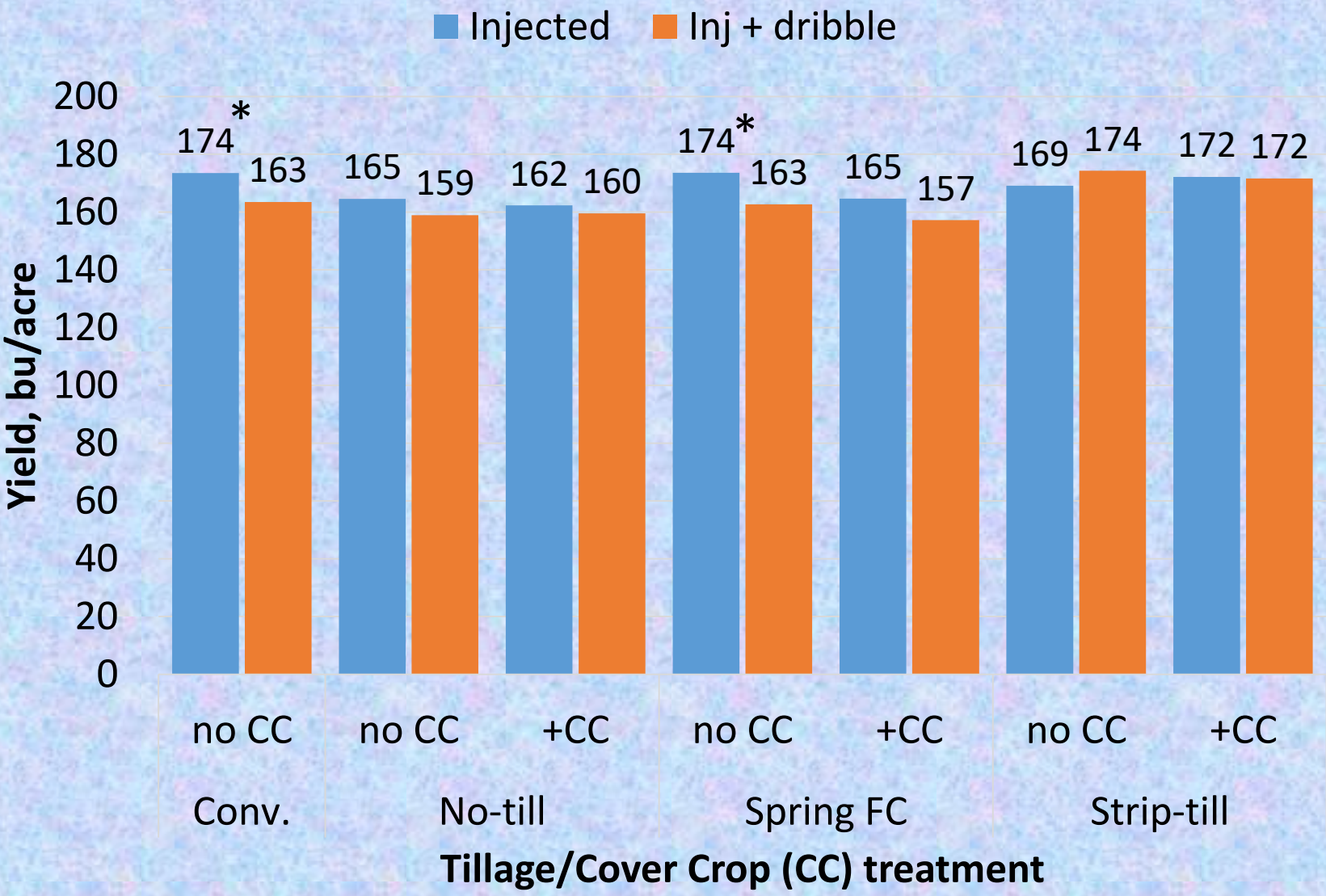
- UI South Farms, Flanagan silt loam soil
- Following soybean
- Main-plot treatments (7):
  - Fall chisel/spring FC tillage (conventional
  - Fall strip-till with/without cover crop cereal rye
  - Spring field cultivator with/without CCCR
  - No-till with/without CCCR
- Two subplot N placement treatments (180 lb N)
  - All injected between rows at planting
  - 50% injected between rows and 50% dribbled near rows at planting (Unverferth applicator)

Tillage x cover crop, Urbana, 2020

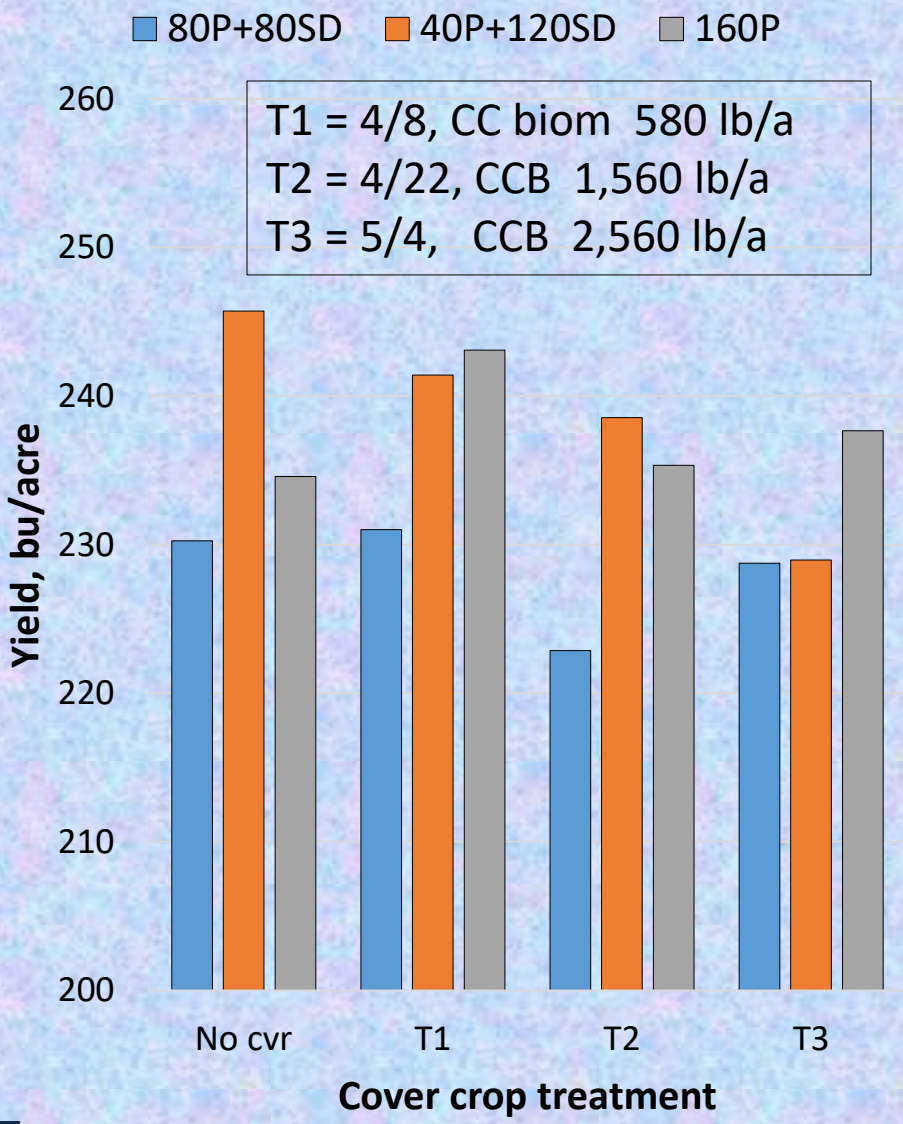


Cereal rye planted late (Nov. 2019): April 24 samples ~550 lb DM/acre, 12-16 lb N

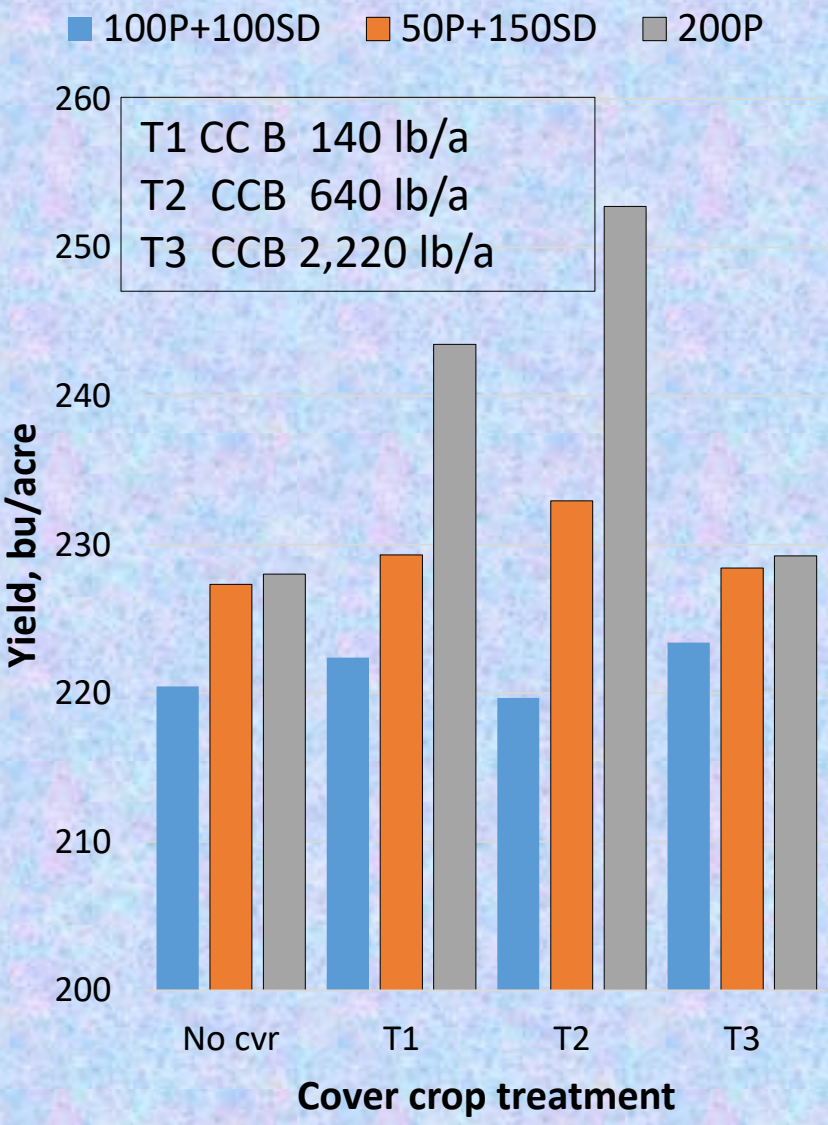
Tillage x cover crop x N placement, Urbana, 2020



Monmouth cover crop x N
soy-corn 2020



Monmouth cover crop x N
corn-corn 2020



Cover crop rye and N supply

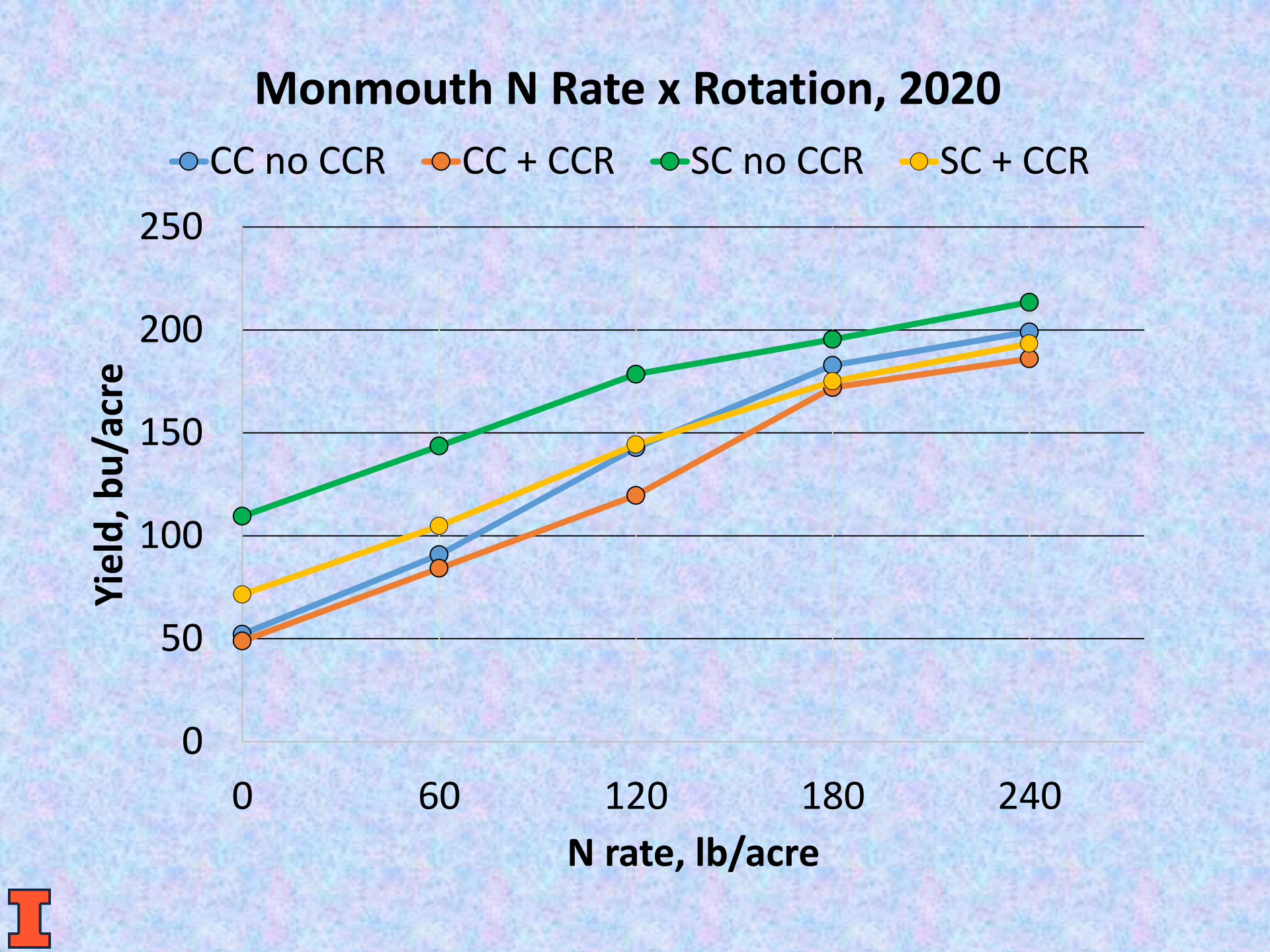
- Allowing grass (crop or weed) roots to grow into the corn rooting zone and stay active up to corn planting is a near-certain way to reduce corn yield potential
- Killing CCR early enough (dead by 2-3 weeks before planting) can help, but soil N supply needs to recover (from mineralization or fertilizer) before corn emergence
- Might help to keep rye roots out of the corn rooting zone (planting rye 6+ inches away; strip-tilling), but may not prevent yield loss
- Applying 75-100 lb N (less if N is directed into the corn rooting zone) to make N available to corn roots by V1-V2 will usually prevent this problem
- Late planting (warm soils) and drier conditions after planting help by increasing mineralized N supply near the corn roots

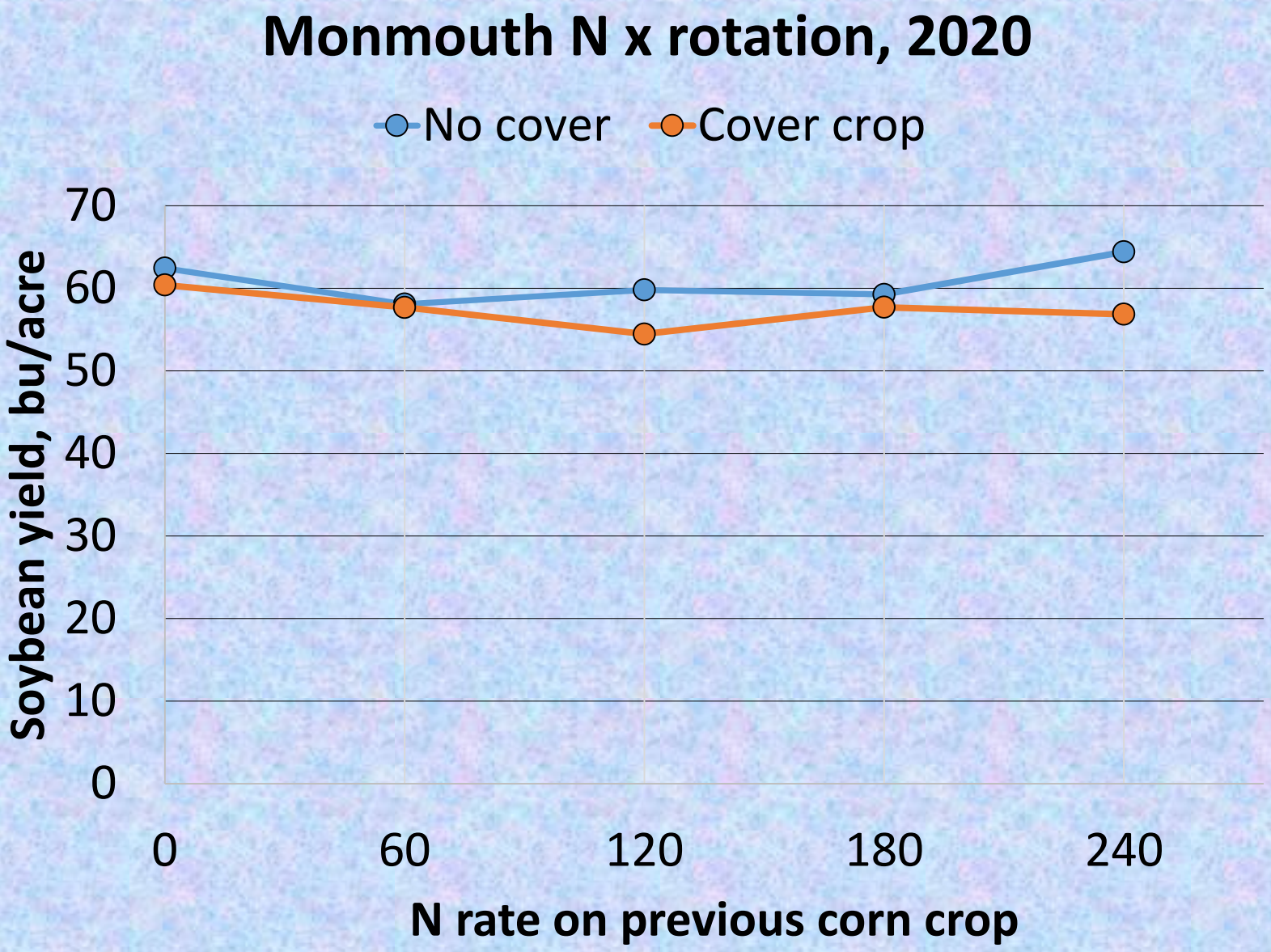
Corn can follow cover crop rye if managed properly

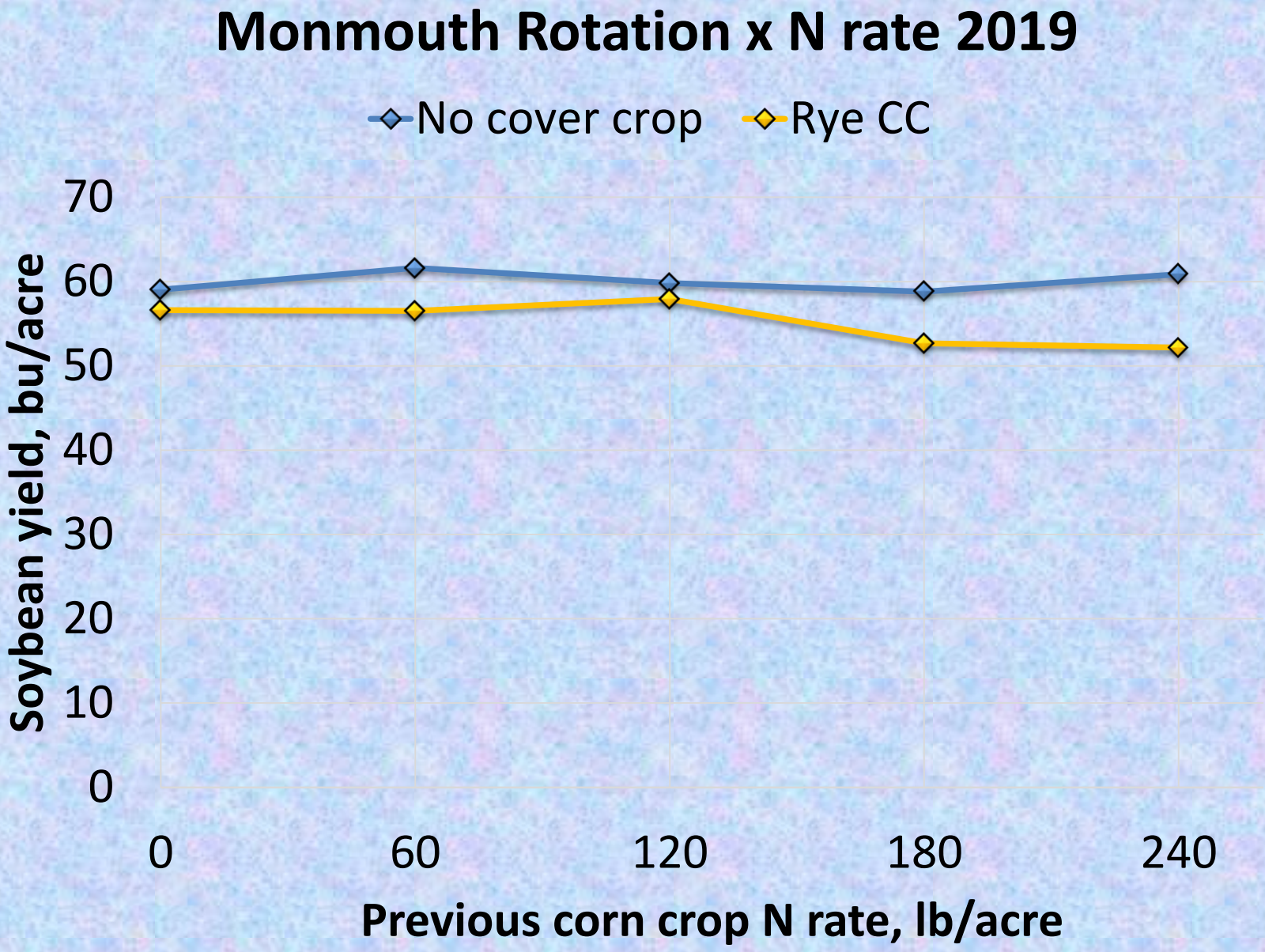
Photo by Dan Schaefer

Refreshing strips before planting corn (following corn) on June 4, 2019, near Champaign. Yields in this study were in the 185-bushel range:

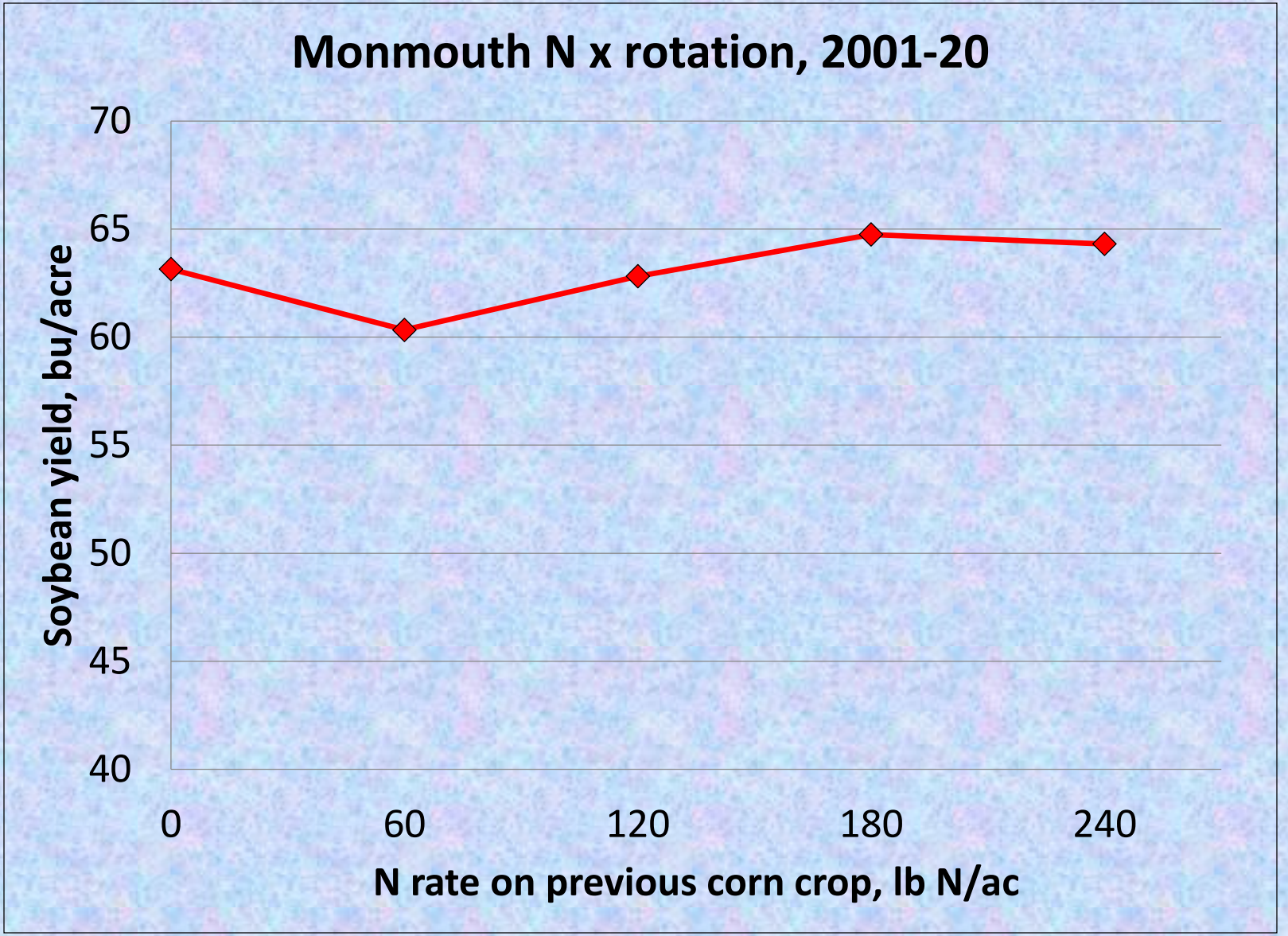
- There was not a lot of cover crop cereal rye growth; and no effect of cover crop treatments (no cover; rye CC with three kill dates)
- Yields were affected by N management: 50 lb UAN injected at planting + 150 sidedressed yielded ~ 5 bushels less than 200 at planting or split 100 planting+100 SD


Monmouth N Rate x Rotation, 2020
CC no CCR
CC + CCR
SC no CCR
SC + CCR
250
200
150
100
50
0
Yield, bu/acre
0
60
120
180
240
N rate, lb/acre


Monmouth N x rotation, 2020
No cover
Cover crop
Soybean yield, bu/acre
70
60
50
40
30
20
10
0
0
60
120
180
240
N rate on previous corn crop


Monmouth Rotation x N rate 2019
No cover crop
Rye CC
Soybean yield, bu/acre
70
60
50
40
30
20
10
0
0
60
120
180
240
Previous corn crop N rate, lb/acre

Could N rate on corn affect soybean yield the next season?



N management if the spring is “normal”

- Weather and soil conditions allow NH_3 application in late March or early April:
  - Apply deep enough to get good cover
  - Nitrification inhibitor may be helpful if warm and wet conditions are forecast between early application and planting
  - Applying at an angle more than 2-3 weeks before planting is usually safe, but using RTK to apply off the row might be better
    - To keep the N near the corn roots (to come), might move application band 6-8” from the (new) row rather than 15” (midway between rows)
- Adjust (lower) the preplant N rate to account for planting-time and/or sidedress N, and MAP/DAP

Inhibitors with spring N?

- When NH_3 is applied more than a month before planting or before mid-April, when soil temperatures increase early, or when rain is in the forecast, nitrification inhibitor is usually not needed
- UAN injected or worked in, urea worked in, or broadcast fertilizer applications made at or after planting when rain is likely to fall soon usually do not need urease inhibitor
- Surface-applied UAN or urea, especially if the forecast is for warm weather and little rainfall for more than a week after application, may benefit from a urease inhibitor
  - Subsurface placement of UAN often protects against volatilization loss better than using a urease inhibitor
- Under loss conditions, using both NI and UI with surface-applied urea has sometimes increased yield above using a UI only
- Sidedress? Not with NH_3; not with injected UAN; maybe with surface-placed urea or UAN with high temps and limited rainfall

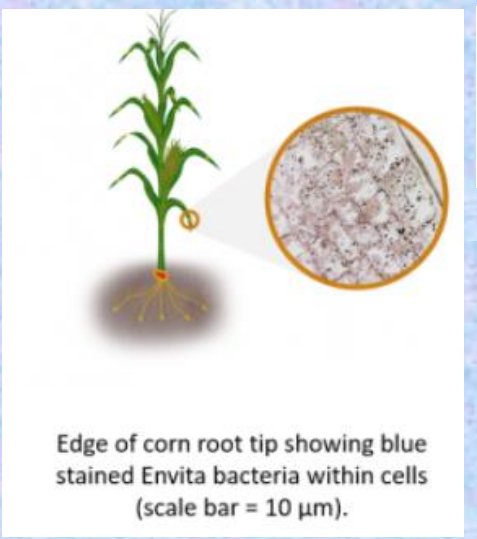
Monitoring soil N

- IFCA has initiated a new project this spring to monitor soil N to estimate how much N from fertilizer remains
- There will be 10 or more “sentinel” sites this spring, some with fall NH_3 applied, some with spring N
- Samples will be taken around planting time (after N application), one at sidedress time, and one in late June. Samples will be analyzed for nitrate and ammonium
- Data from these samples will be made available as soon as possible to provide assurance that soil N is still present, or to indicate that there may be a need to apply more N

Can bacteria provide “free” N for corn?

Researchers found corn in Mexico with “slime” on brace roots; bacteria in the slime were fixing some N

Envita bacteria from Azotic North America

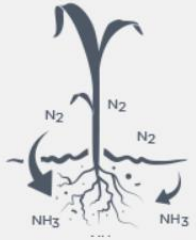


Edge of corn root tip showing blue stained Envita bacteria within cells (scale bar = 10 µm).

Envita benefits:

- Increases yield on average between 5-13%, and in some cases up to 20%
- Can replace an average of 27% of the plant’s nitrogen needs

PIVOT BIO PROVEN



STEP 3: FINE-TUNE

Precisely fine-tune these microbes so they release nitrogen through the roots to meet the growing crop’s nutritional needs.

THANK YOU

HAVE A SAFE SPRING SEASON IN 2021

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