Meeting the Challenges of Spring Fertilizer Management

IFCA Webinar
March 1, 2019

ILLINOIS
Crop Sciences
COLLEGE OF AGRICULTURAL, CONSUMER & ENVIRONMENTAL SCIENCES

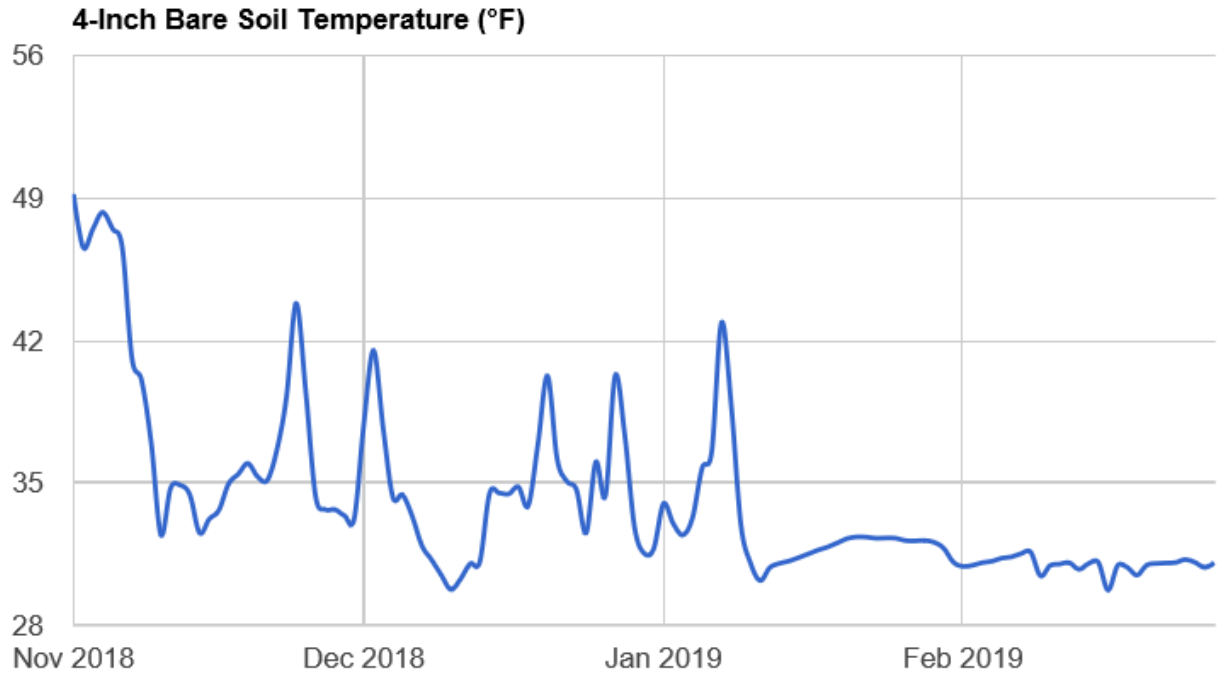
Emerson Nafziger
Crop Sciences
University of Illinois
ednaf@illinois.edu

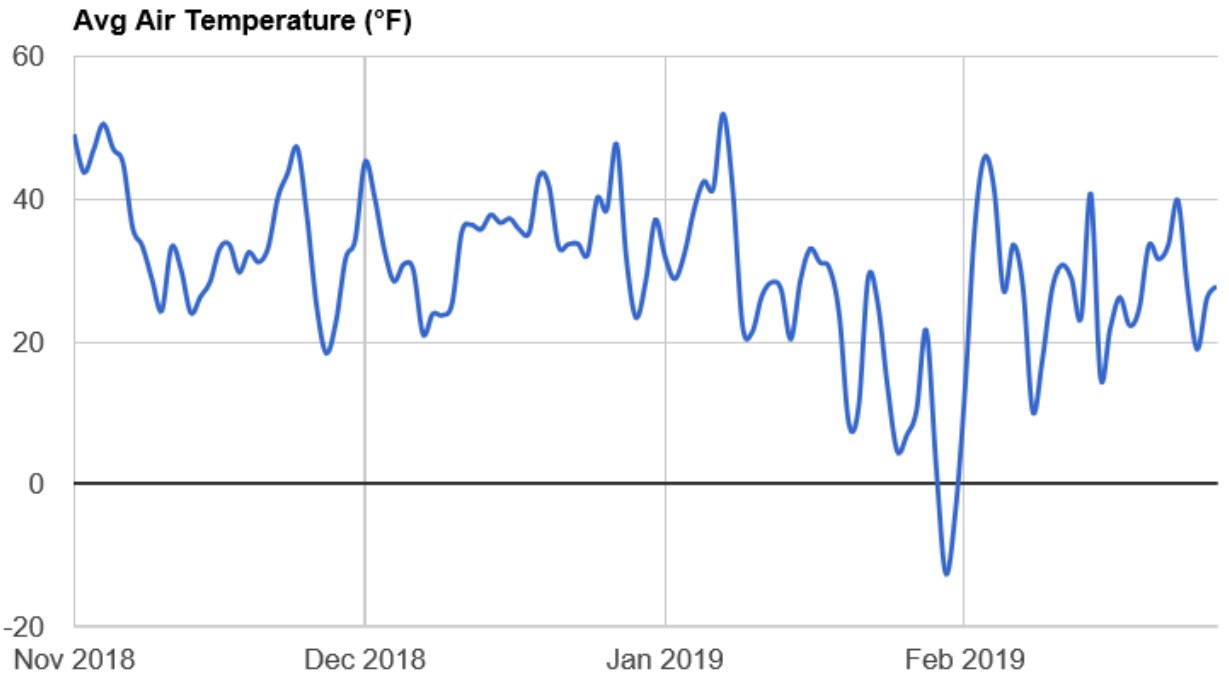
The N management challenge for 2019

- Harvest began early in 2018 but was delayed several times by wet weather
- Fall ammonia application began in late October after early cooldown, but was interrupted by wet weather, then by cold weather; harvest was delayed in places as well, along with tillage
- Fall NH_3 application ranged from somewhat less than normal to a lot less than normal
- There has been little chance to apply ammonia since November: wet, cold, wet, cold, etc.
- The price of NH_3 is higher now than it was in fall 2018

Peoria

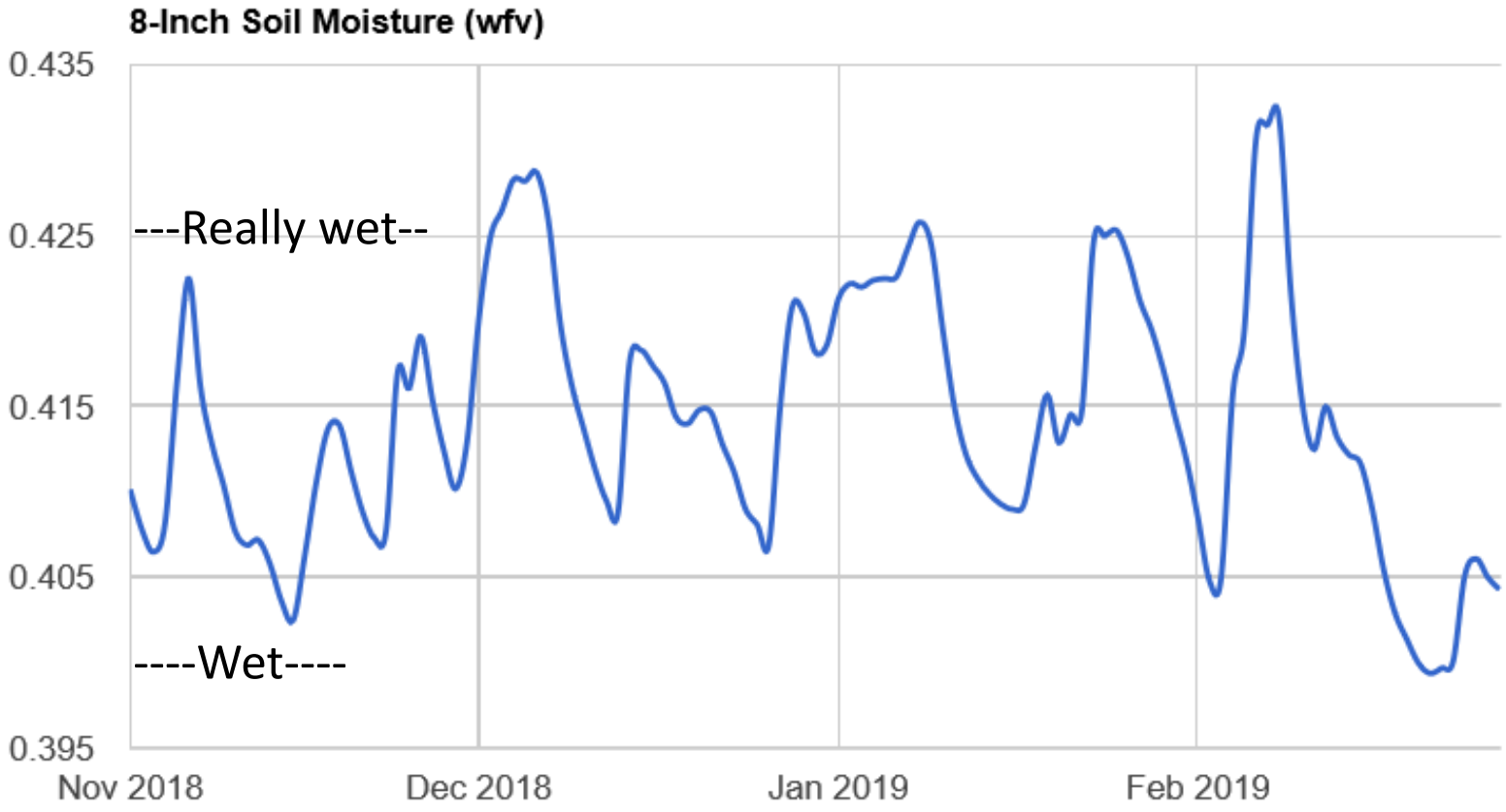
IL State water Survey



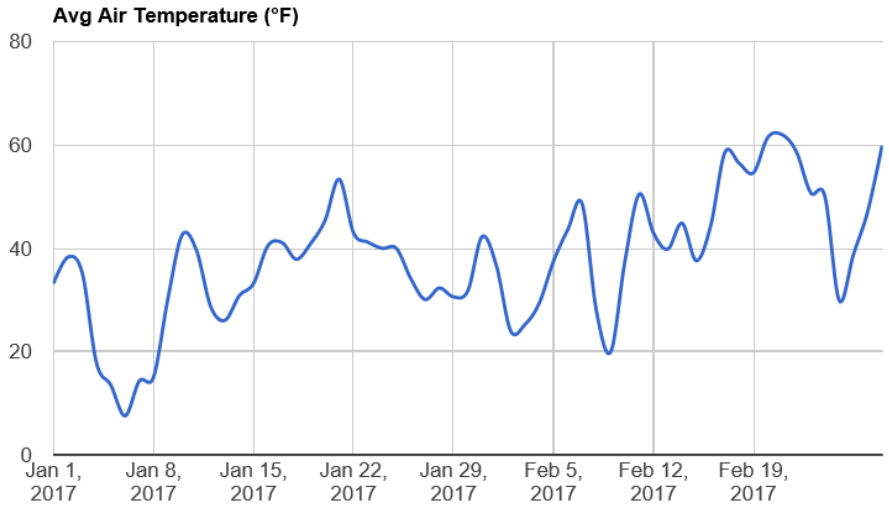


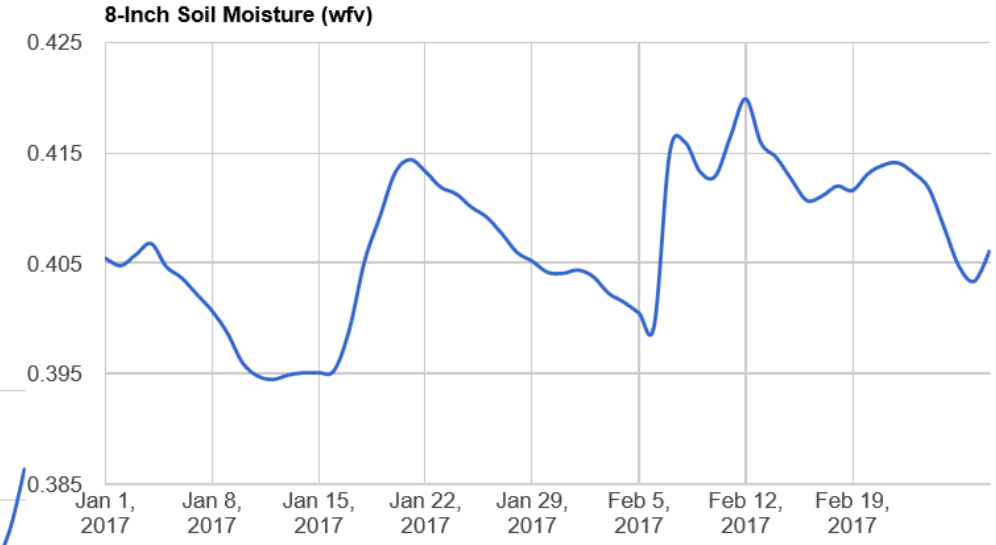
Peoria

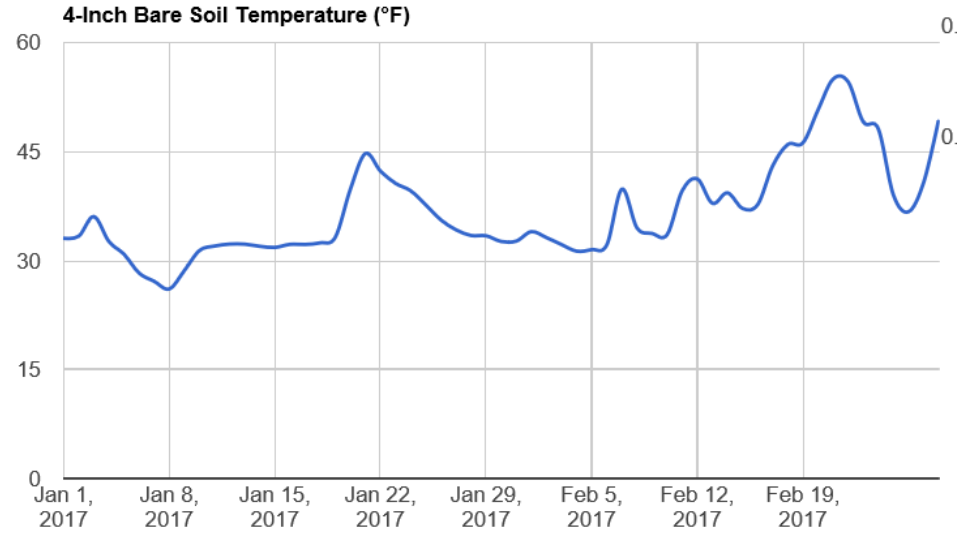
IL State water Survey



In February 2017 we applied a lot of NH_3
-Air and soil warmed; soils didn't dry much







"Off-Season" (Feb-March) NH_3

- A lot of NH_3 was applied during a warm spell in February 2017, but soils were not in the greatest condition during that time; [soils at 40° or less can't dry quickly]
- What about March 2019? – we need higher soils temps to allow drying, and with the cold start that won't happen early in the month
- Should we apply if it's frozen on top only, just enough to hold up equipment? - Not doing as much compaction is a plus, but NH_3 will still be into wet soils

Is NH_3 into wet soils a problem?

- More NH_3 dissolves more quickly in cold than in warm soils, so retention in soil isn't a problem, as long as soil isn't frozen and "chunky"
- If the soil at knife depth is too wet to shatter, the NH_3 will move very little from its release point:
  - 220 lb NH_3 (180 lb N) dissolves in 4.12 cubic ft (257 lb) of water at 50°; in wet soil (40% water) that would make a (uniform) band about 1/2 inch in diameter
- Is this lack of spread a problem?
  - Its high concentration makes it easier to have NH_3 leave solution and move up, but only if soil dries out
  - N in a small band is often less accessible to all roots
  - Tillage later will probably help, but avoid inverting the soil

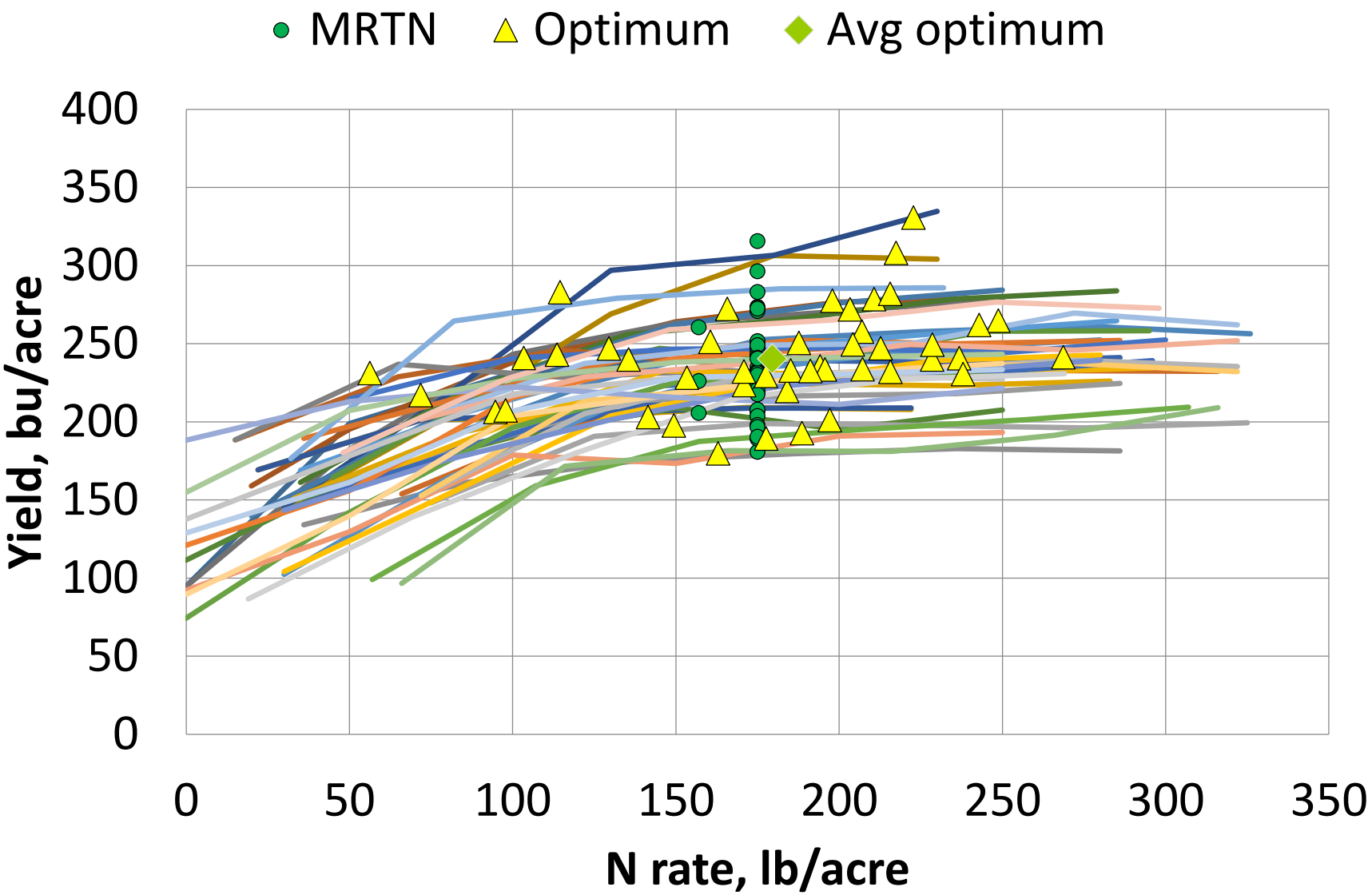
Lessons from N management research:

- 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 it's April without the chance to apply preseason N, some should be applied into the rooting zone, at least half soon after, and any remaining as in-season
- Applying some N up front and the rest in-season may be logistically sound
  - But planning for multiple in-season applications (spoon-feeding) is not likely to be cost-effective

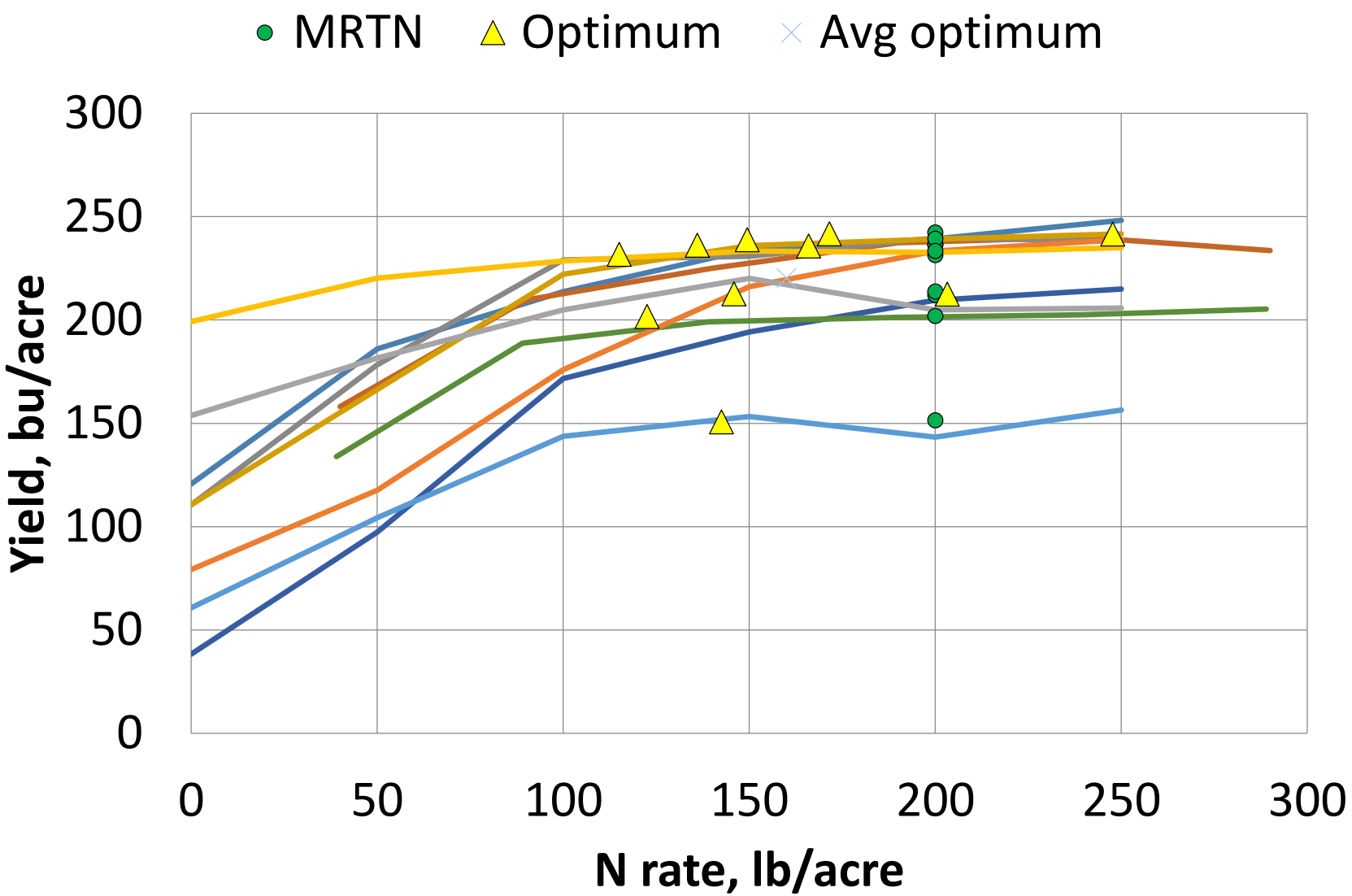
Simplified N management?

- The basics—applying the right rate and having enough N available in the soil early—do not in principle require more than one application of N
- But if conditions are less than ideal for supplying N to the crop—too cold, too wet, too warm and wet, delays—we need the flexibility to be able to address this
- N management programs/models?
  - Many focus on when and how much more N might be needed, rather than on having just enough
  - Their accuracy and cost-effectiveness remain questions
- Any N management approach needs to pay its cost

45 on-farm N trials, soy-corn, 2018



10 Central IL N trials Corn-Corn 2018



N responses, central/northern Illinois

- Corn following soybean: some trials showed the need for high N rates to produce (high) corn yields in 2018, others did not
  - Effect on MRTN will be to move it up some, moderated by data from previous years
- N responses in corn following corn continued the recent trend of showing optimum N rates less than the MRTN
  - Will probably lower the MRTN slightly for 2019, in central Illinois

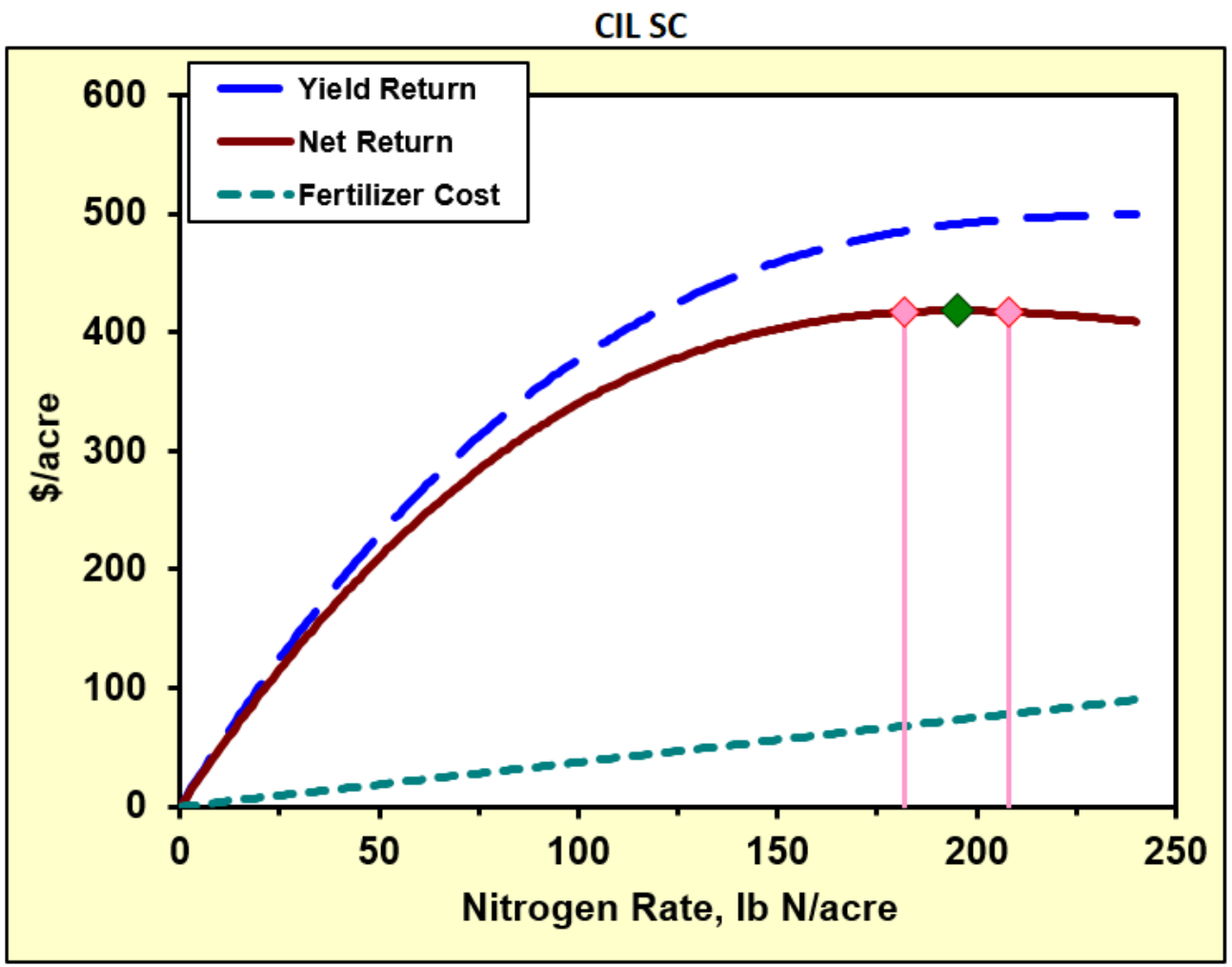
N rate calculator for corn following soybean for Central Illinois, 2018 data only (41 sites)

195 lb/acre is about 20 lb <u>more</u> than the 2018 version:

We use data over years because we one year doesn't predict well

Calculator run with CIL 2018 data only

	SC
Maximum Return to N (MRTN) Rate:	195
Profitable N Rate Range:	182 - 208
Net Return to N at MRTN Rate:	$417.97
Nitrogen Cost at MRTN Rate:	$73.13
Percent of Maximum Yield at MRTN Rate:	99%



N rate calculator for corn following corn in Central Illinois, using 2018 data only (10 sites)

170 lb/acre is about 30 lb less than the 2018 version

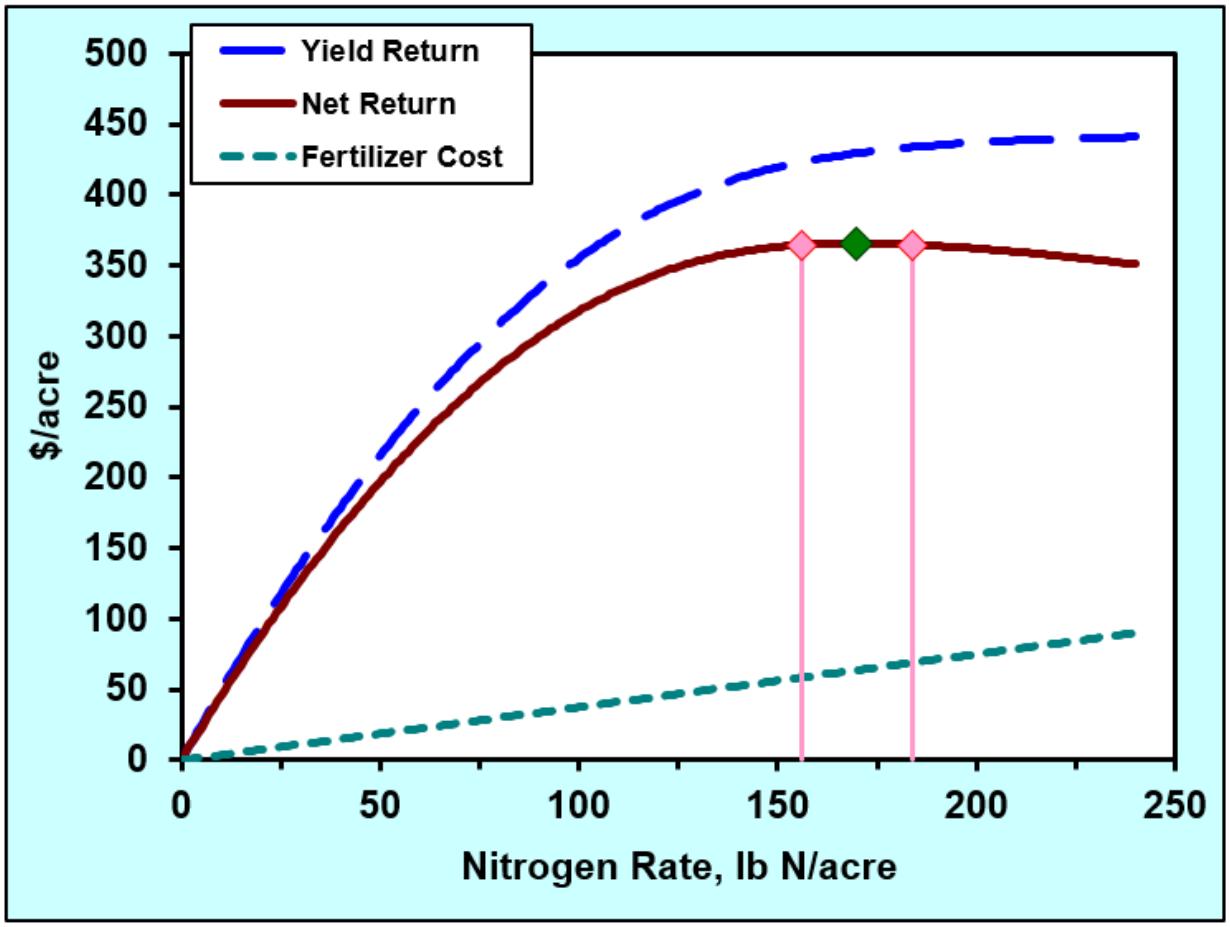
CC

170	lb N/acre
156 - 184	lb N/acre
$365.74	$/acre
$63.75	$/acre
99%	

Nitrogen Price:	0.38	$/lb N
Corn Price:	3.75	$/bu
Price ratio:	0.10	

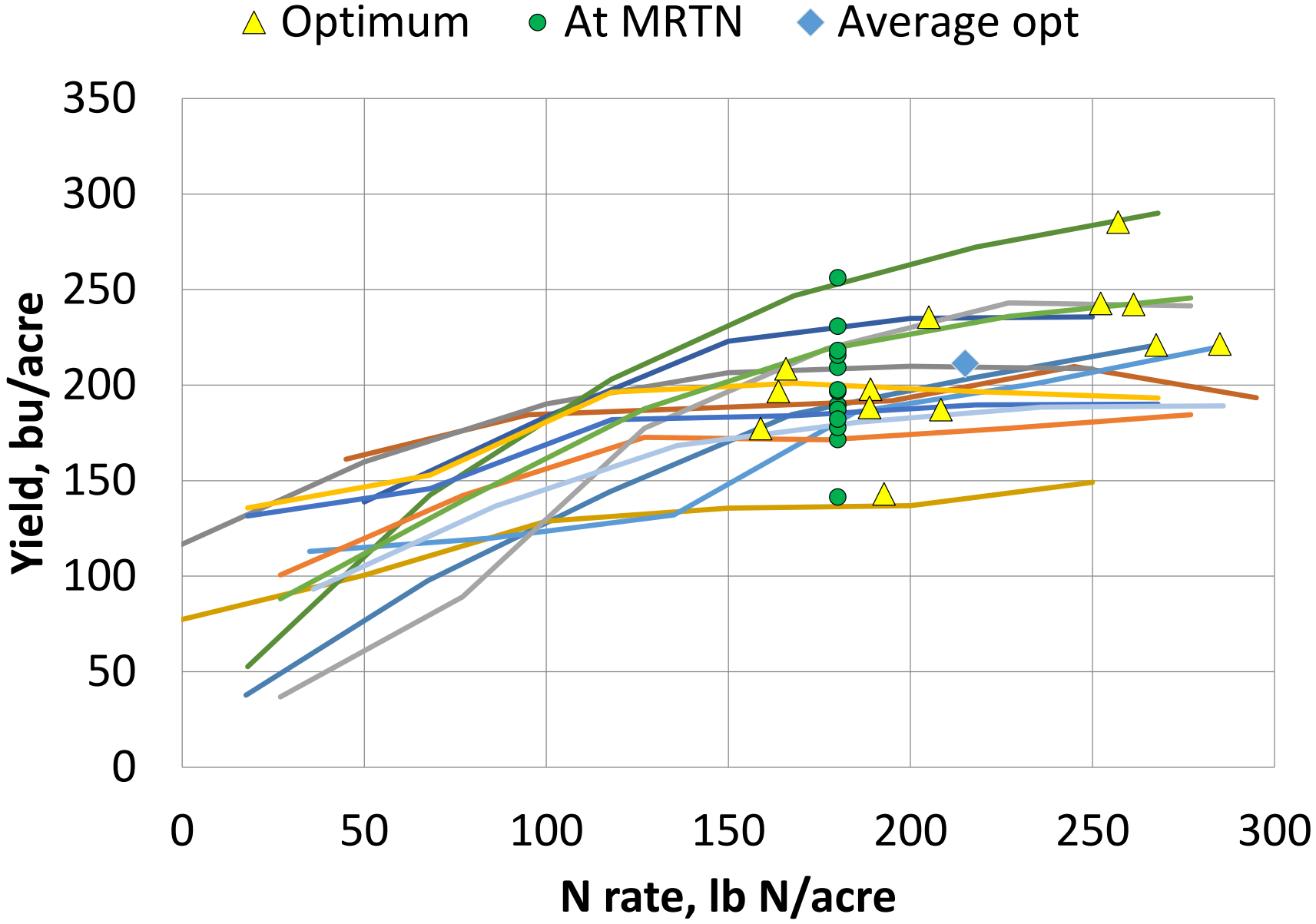
Ver 2013a

CIL CC



Iowa State University - Agronomy Extension

13 Southern IL on-farm N trials, 2018



N rate, southern Illinois

- 75% of the 2018 corn following soybean trials showed optimum N rates higher than the MRTN; the average difference was 35 lb N
- This likely came from high yields in soils with lower OM; this increases the need for fertilizer N
- Results across 2017 and 2018 suggest that we might consider adding a "high-yield supplement" in lower-OM soils (<2% OM) when yield potential is predicted (in time?) to be >200 bu/acre
  - Maybe MRTN (~180 lb/acre) up to 180 bu/acre, and 1 lb/bu (total, not +MRTN) for expected yields above 180?
  - More likely to be needed if it's wet in June
  - Mid- or later-season drought may mean wasting this extra N

Y-Drop Tubes

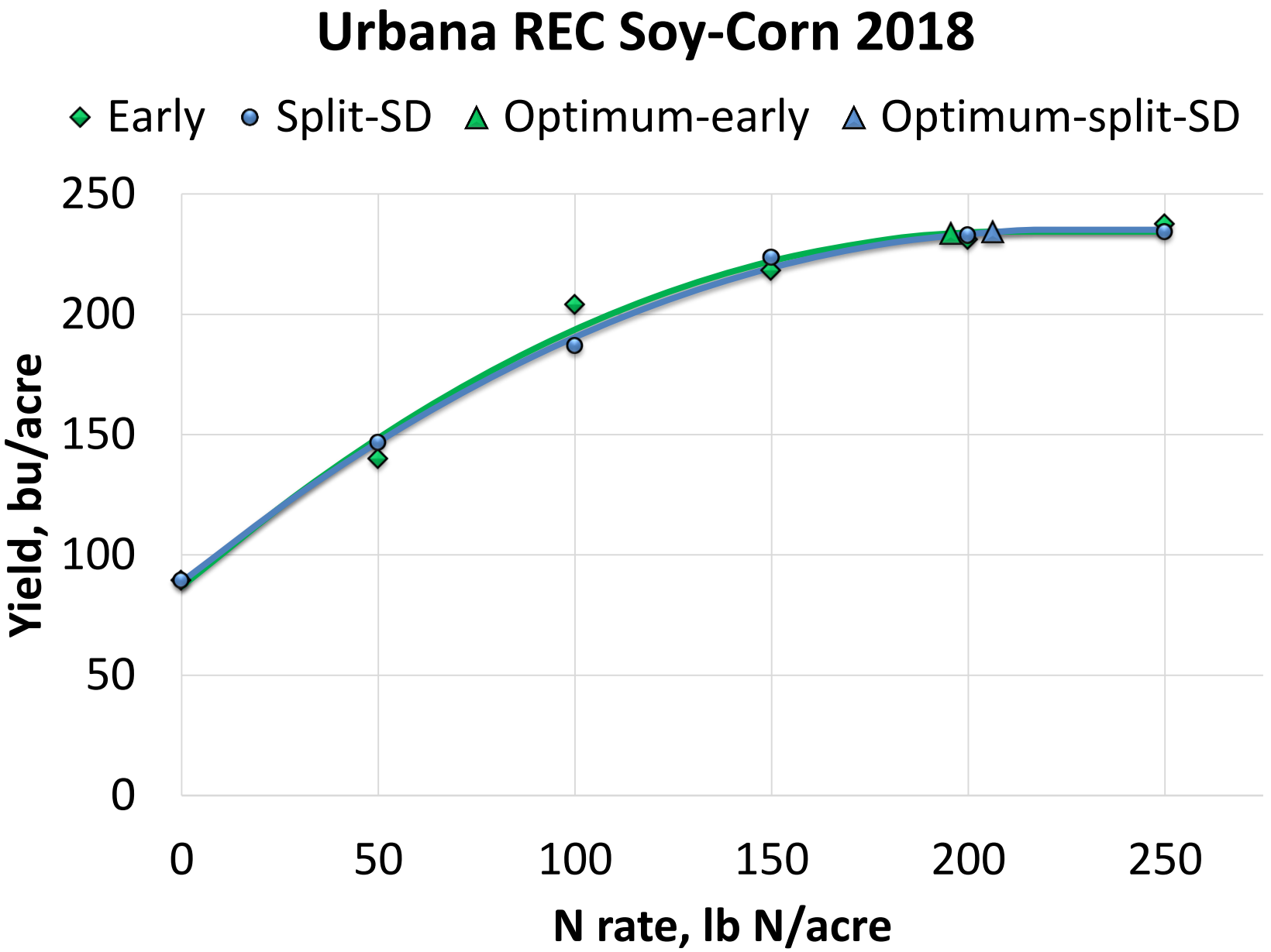
-the means to apply N anytime during vegetative growth

Late-split N

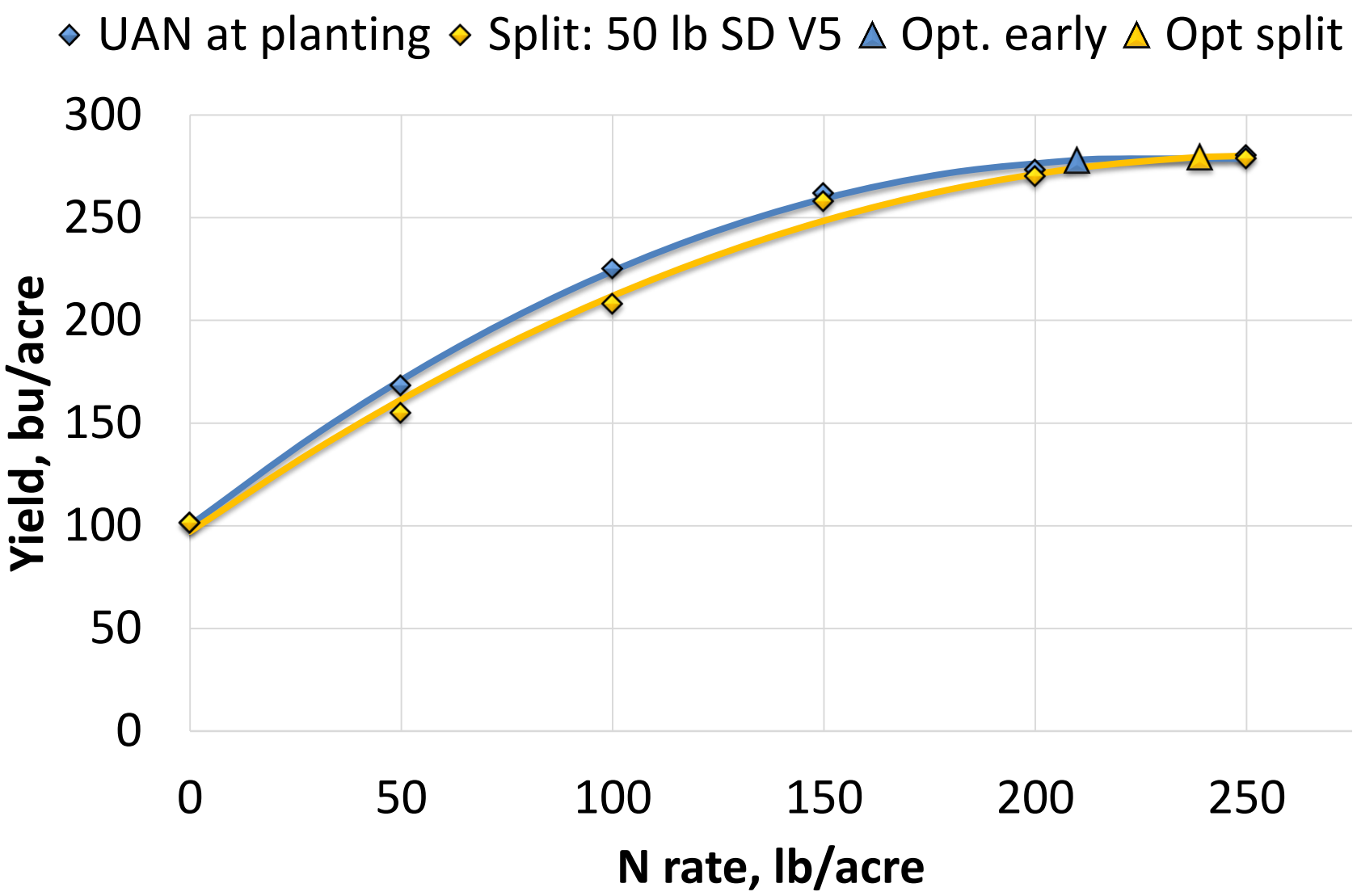
- Across 15 trials in 2016-17, we found no advantage in yield or optimum N rate from keeping 50 lb N back to apply by in-row surface banding at tassel
- Using MRTN N rates (175 for SC/210 for CC) applied all early or early + 50 lb late would have produced identical yields at every site
- Subtracting the cost of late application would have made late-split N unprofitable

Split-sidedress N in 2018

- Given the lack of response to late-split N, we converted these trial in 2018 to a compare N rates using all-early (planting time) applications to early + 50 lb applied as sidedress UAN at V5-V6

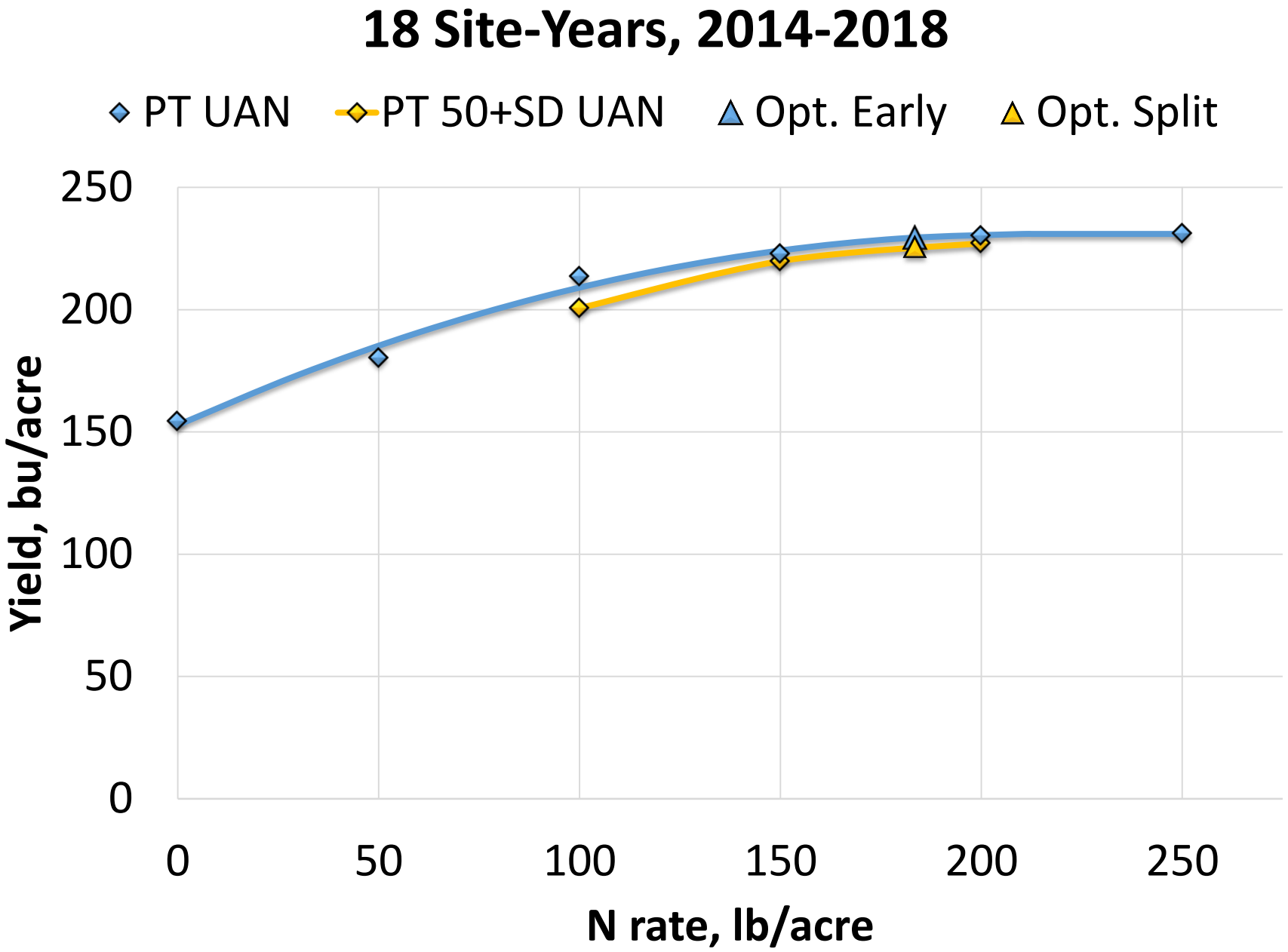

Urbana REC Soy-Corn 2018
Early
Split-SD
Optimum-early
Optimum-split-SD
250
200
150
100
50
0
Yield, bu/acre
0
50
100
150
200
250
N rate, lb N/acre

Neoga Soy-Corn 2018



Split-sidedress N in 2018: summary

- Across 8 trials in 2018—5 corn following soybean and 3 corn following corn:
  - Applying all of the N at planting resulted in an average optimum N rate of 164 lb N/acre and a yield at that N rate of 236 bu/acre
  - Applying all but 50 lb N at planting and applying 50 lb N at V6 resulted in an optimum N rate of 167 lb N and a yield at that rate of 233 bu/acre
  - The net return to N averaged $8.55 per acre less for split-sidedress N than for all N applied at planting

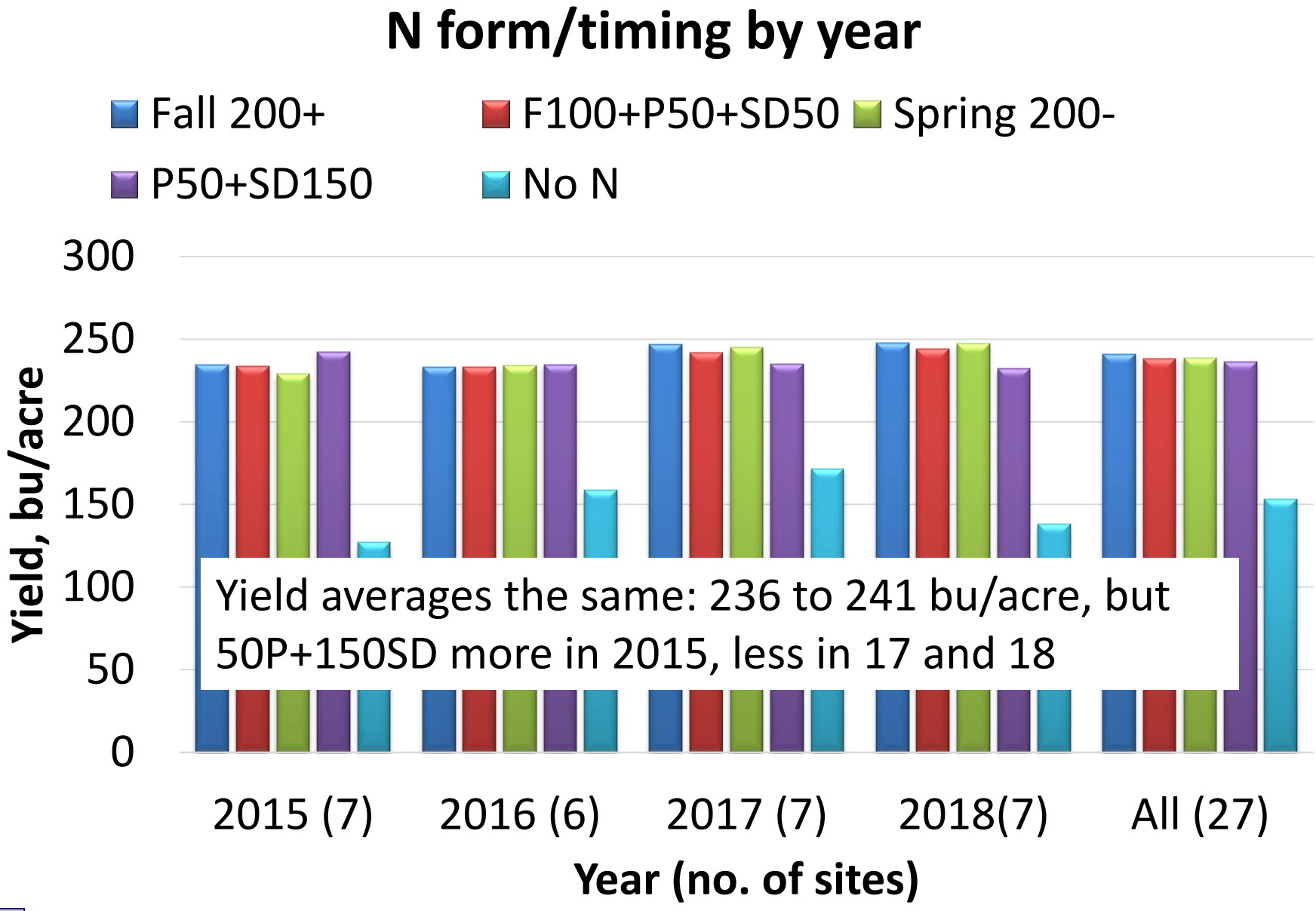

18 Site-Years, 2014-2018
PT UAN
PT 50+SD UAN
Opt. Early
Opt. Split
250
200
150
100
50
0
Yield, bu/acre
0
50
100
150
200
250
N rate, lb/acre

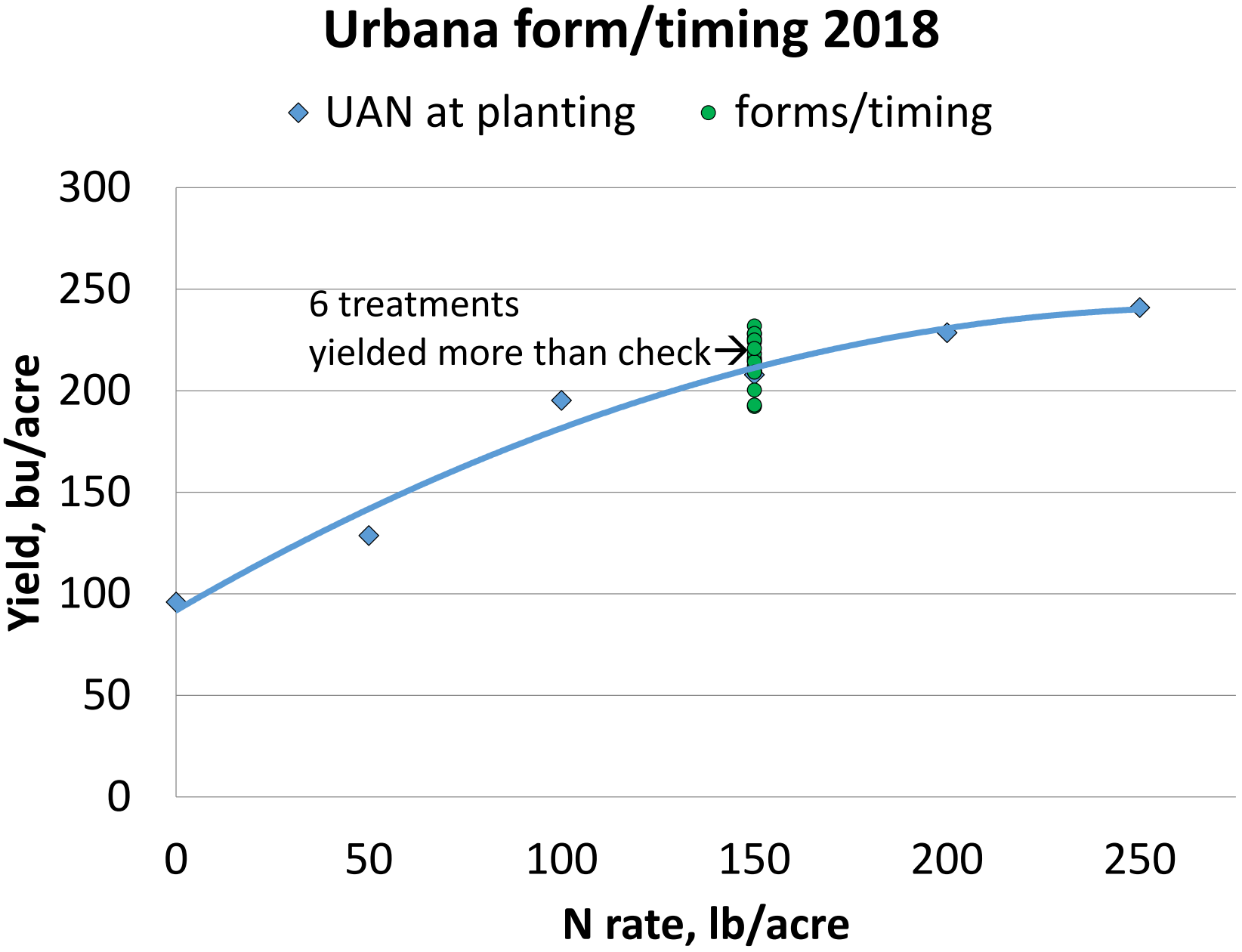
Split-sidedress experiment

- We compared 3 N rates—100, 150, and 200 lb N—applied as injected UAN at planting with 50 lb applied as broadcast UAN at planting and the rest as UAN injected at V5-V6
  - At the 100-lb rate, splitting the N lowered yields by 12 bu/acre compared to all N injected early
  - At the two higher rates, sidedressing 100 or 150 lb produced yields similar to all-early application, but never higher
  - Over the 18 sites, 200 lb at planting yielded significantly more than 50 P + 150 SD twice; significantly less once; no difference at 15 sites

N form and timing in the N-tracking study

- Over 27 site-years, 2015-18, we compared, in corn following soybeans:
  - 200 lb N/acre applied as fall NH_3 + N-Serve
  - 200 lb N as spring preplant NH_3
  - 100 fall NH_3 +NS + 50 lb N as UAN injected at planting + 50 lb N UAN injected at V5-V6
  - 50 lb N as injected UAN at planting + 150 lb N as injected UAN at V5-V6
- All of these ways to apply 200 lb N yielded between 236 and 241 bu/acre across all sites
  - The 50P+150 SD yielded more in 2015, less in 2017 and 2018


N form/timing by year
Fall 200+
F100+P50+SD50
Spring 200-
P50+SD150
No N
300
250
200
150
100
50
0
Yield, bu/acre
Yield averages the same: 236 to 241 bu/acre, but 50P+150SD more in 2015, less in 17 and 18
2015 (7)
2016 (6)
2017 (7)
2018(7)
All (27)
Year (no. of sites)


Urbana form/timing 2018
UAN at planting
forms/timing
6 treatments
yielded more than check
Yield, bu/acre
300
250
200
150
100
50
0
0
50
100
150
200
250
N rate, lb/acre

N source/timing experiment

- In a set of trials over 15 site-years (2015-2018) we compared yields from 150 lb N applied as:
  - All N at planting, including 9 forms/placement treatments
  - 50 lb N broadcast UAN at planting + 100 lb injected UAN at V5-V6
  - 100 lb N injected at planting + 50 lb N applied 7 different ways (times, forms, placement)
  - No N at planting, with 150 lb applied as either UAN injected at V5 or dribbled at V9

Treatment (all 150 lb N)	Rank (1 to 19)					Yield, p=0.1	
	2015	2016	2017	2018	2015-18	bu/acre	
All N applied at planting:	(3)	(4)	(4)	(4)	(15)		
UAN injected mid-row ("check")	7	7	11	15	10	224	bcde
UAN dribbled mid-row	19	13	4	12	15	222	cde
Urea/Agrotain broadcast	9	1	18	13	12	224	bcde
SuperU broadcast	1	2	7	1	1	229	a
ESN broadcast	12	3	19	6	7	225	abcd
UAN/Agrotain broadcast	17	18	1	16	16	221	def
NH_3 injected mid-row	18	11	6	8	13	223	bcde
NH_3/N-Serve injected mid-row	16	15	15	4	14	223	bcde
UAN/Instinct II broadcast	13	16	17	14	17	221	def
Split N application (1st at planting):							
UAN 50 broadcast+UAN 100 injected V5	15	9	13	18	18	220	ef
UAN 100 inj+UAN 50 injected V5	4	14	10	11	9	224	bcde
UAN 100 inj+Urea/AT 50 broadcast V5	5	10	3	5	2	227	ab
UAN 100 inj+UAN 50 dribbled in-row V9	8	5	2	9	3	227	ab
UAN 100 inj+Urea/AT 50 broadcast V9	11	8	5	2	4	227	ab
UAN 100 inj+UAN 50 dribble in-row V5	2	6	14	3	5	226	ab
UAN 100 inj+UAN 50 dribble mid-row VT	14	4	9	10	8	225	bcd
UAN 100 inj+UAN 50 dribble in-row VT	3	12	12	7	6	226	abc
All N sidedressed:							
UAN injected mid-row V5	6	17	8	19	11	224	bcde
UAN dribbled mid-row V9	10	19	16	17	19	217	f

N timing and form summary

- The “check” of 150 lb N as injected UAN at planting was average – ranked 10 out of 19
- 0 or 50 lb (broadcast UAN) at planting with the rest applied later did not perform very well
- With the exception of SuperU and (sometimes) ESN, applying all of the N at planting produced lower-half yields
- Applying UAN on the surface is generally not great, but works OK for sidedressing if dribbled in-row, which is closer to roots

N timing and form summary

- Split N/sidedressing generally yielded a little more than most all-early applications at this rate, but not enough more to make the economics work for most of these treatments
- In two nitrification inhibitor (N-Serve, Instinct II) comparisons included, inhibitor did not add yield; but SuperU (NI + UI) performed better than urea with Agrotain (UI) when surface-applied

So does it pay to split N or not?

- Not consistently, if conditions (warming soils, lack of heavy rainfall) are favorable for N retention after applying all of the N early
  - That includes applying all of the N as NH_3 in the fall (though tile loss might increase)
- Adequate (half or more of) the N needs to be present at or soon after planting so the roots can have access it by two weeks after emergence
- When it's very wet during vegetative stages, supplemental N may pay, but we lack clear guidelines
- Lower-OM soils may benefit more; waiting to allow assessment of yield/demand (if that's possible) may make split N pay in such soils

Split N?

- High soil productivity means less benefit, but less early-season N from mineralization in lower-OM soils may make it more risky to delay significant amounts of N in such soils
- Corn grown in very well-drained, very poorly drained, or root-restricting soils is more likely to benefit from splitting N
- Splitting N carries risks that we can't ignore:
  - Inability to apply due to wet periods
  - Delay in N availability to plants due to dry soils
  - Cost, and yield increase needed to cover it

One big lesson we're learning:

- Soils, especially productive soils with good OM levels, medium texture, and no major drainage problems, are an excellent **reservoir and source** for plant nutrients including N
- This, coupled with highly productive corn hybrids with "extractive" root systems and knowledge of "how to do N", means we can have a lot of confidence that the crop will have enough N to produce the yield that (weather) conditions allow

Spring N management: scenario 1

- Weather and soil conditions allow NH_3 application in late March or early April:
  - Apply deep enough to get good cover
  - Nitrapyrin may be needed only if forecast is for warm and wet conditions between 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 apply 6-8 inches from the (new) row rather than 15” (midway between rows)
- Consider lowering rate to accommodate some planting-time N

Spring N management: scenario 2

- Soils stay too wet to apply NH_3 until past mid-April, and soils dry fast, starting to be ready to plant by late April:
  - Could still apply NH_3 off-row, before or right after planting
  - Unless NH_3 is applied near-row and soils are warming, consider 10-12 gallons 28 or 32% as herbicide carrier broadcast pre, and decreasing the NH_3 rate by that amount
  - Instead of UAN pre, could apply N 2 x 2 (in-furrow only will not provide enough)
- If NH_3 is out, could apply all or most N as UAN broadcast, probably better before last tillage pass
- Could also consider using urea (worked in or with Agrotain) or SuperU broadcast before or after planting
  - Should apply some early N if dry N will be delayed

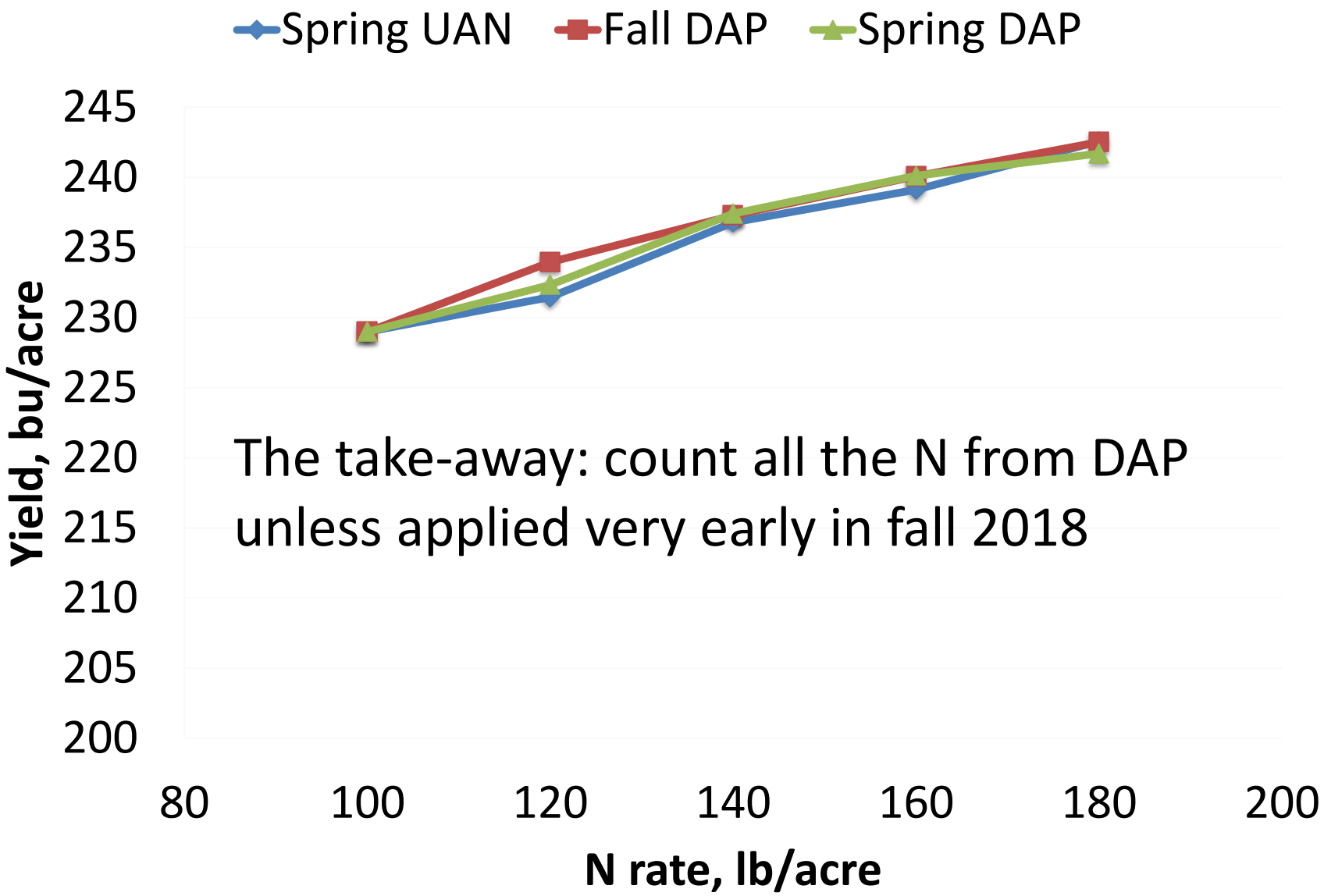
Spring N management: scenario 3

- Soils stay too wet to apply NH_3 until late April, and planting becomes possible only in early May:
  - Apply all or most N as UAN broadcast, best if worked in (applied before last tillage pass)
  - Use urea (worked in or possibly with Agrotain) or SuperU broadcast before or after planting
    - In this case, need to apply some early N if dry N will be delayed
  - Apply 30-50 lb as UAN starter or broadcast with herbicide, then apply the rest as:
    - broadcast urea as soon as possible after planting
    - UAN (injected 6-10 inches off row if possible)
    - NH_3 by stage V2-V3 – could be delayed if soils warm fast

Spring N management: scenario 4

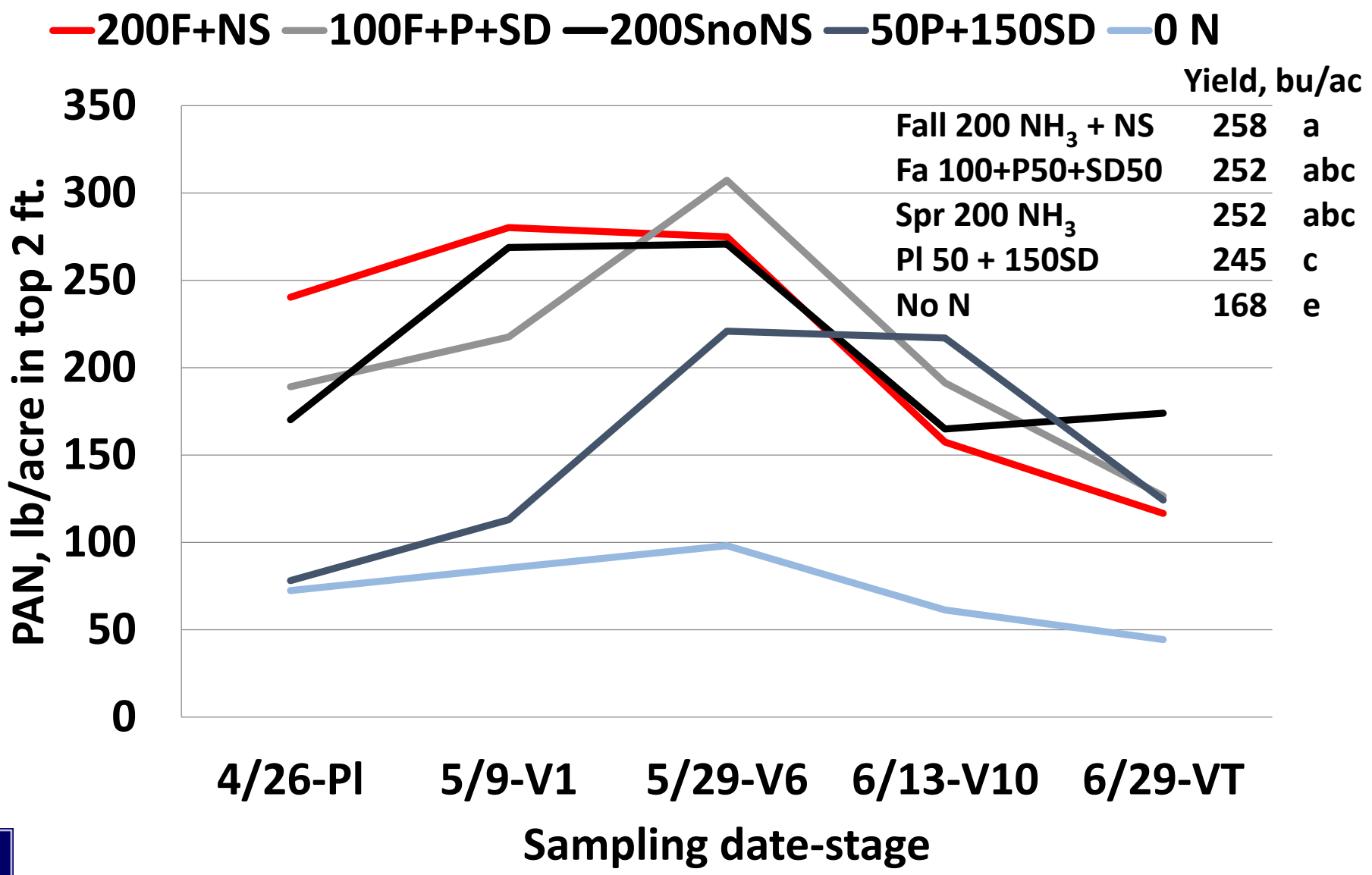
- Soils stay too wet into mid-May, and planting takes priority over everything else including N application; the need for upfront N decreases some with N coming from mineralization in warmer soils, but some needs to be there
  - Broadcasting N as UAN or urea (with Agrotain if not tilled in) right before or right after planting
  - Apply at least 40-50 lb N at planting, then sidedress with NH_3 or UAN (injected or dribbled in-row), or topdress with protected urea, anytime up to V6-V8
  - If wet weather delays in-season application past V8, use high-clearance equipment to do in-row dribble or broadcast urea (maybe with Agrotain is it's getting dry, but not slow-release)

DAP as an N source, 6 site-years

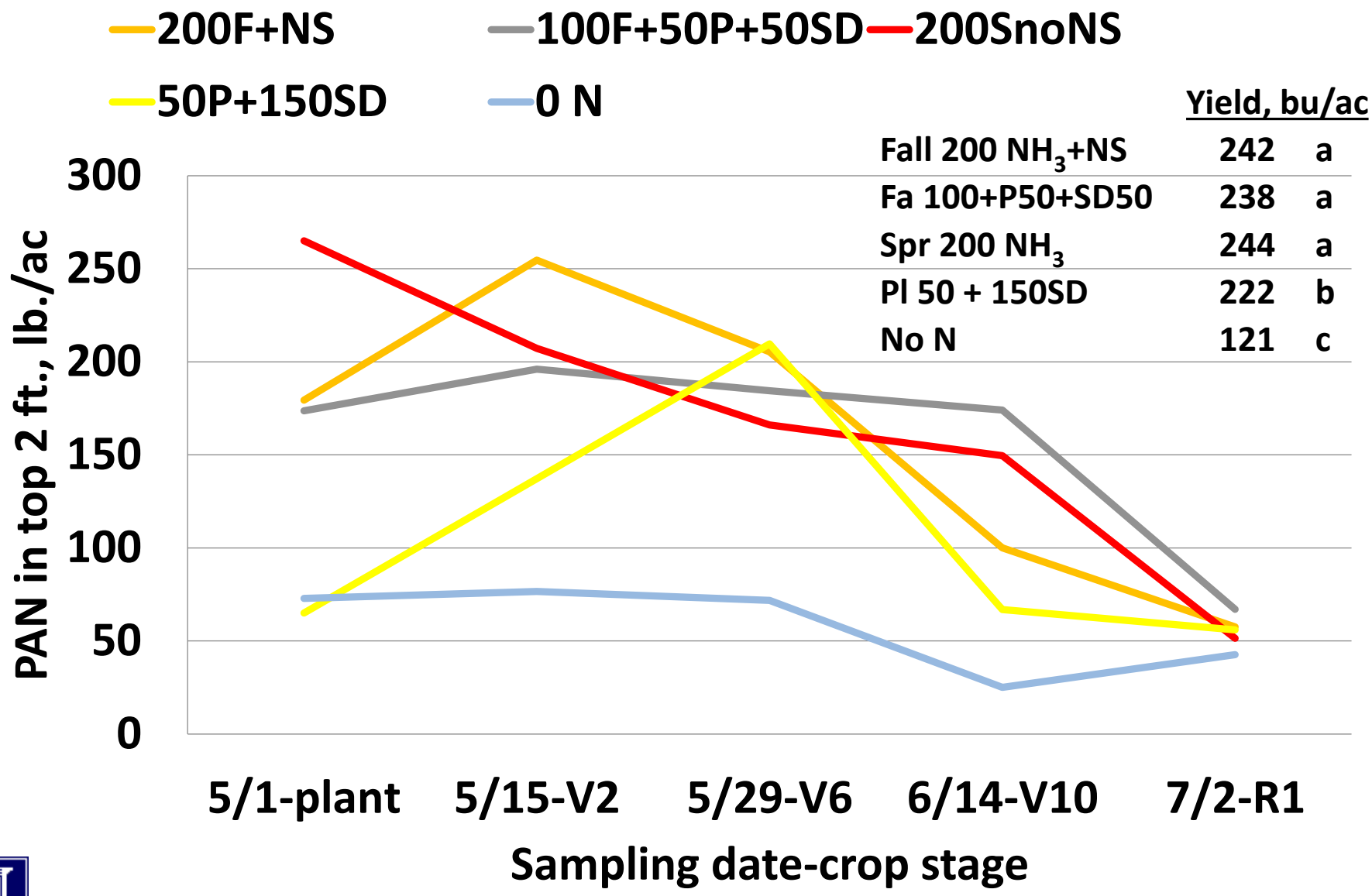


The take-away: count all the N from DAP unless applied very early in fall 2018

Monmouth N-tracking 2018

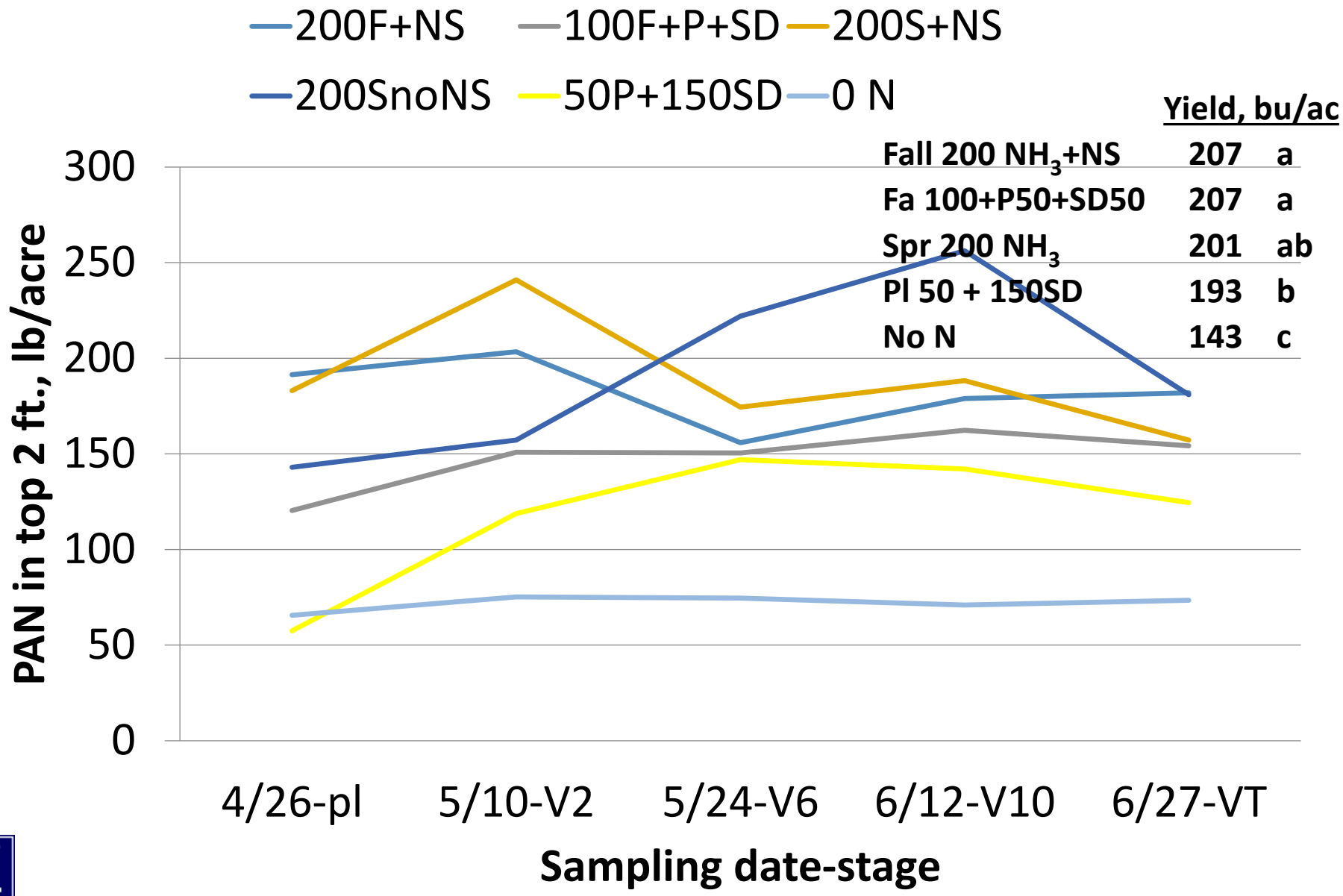


Soil N-tracking, Urbana 2018



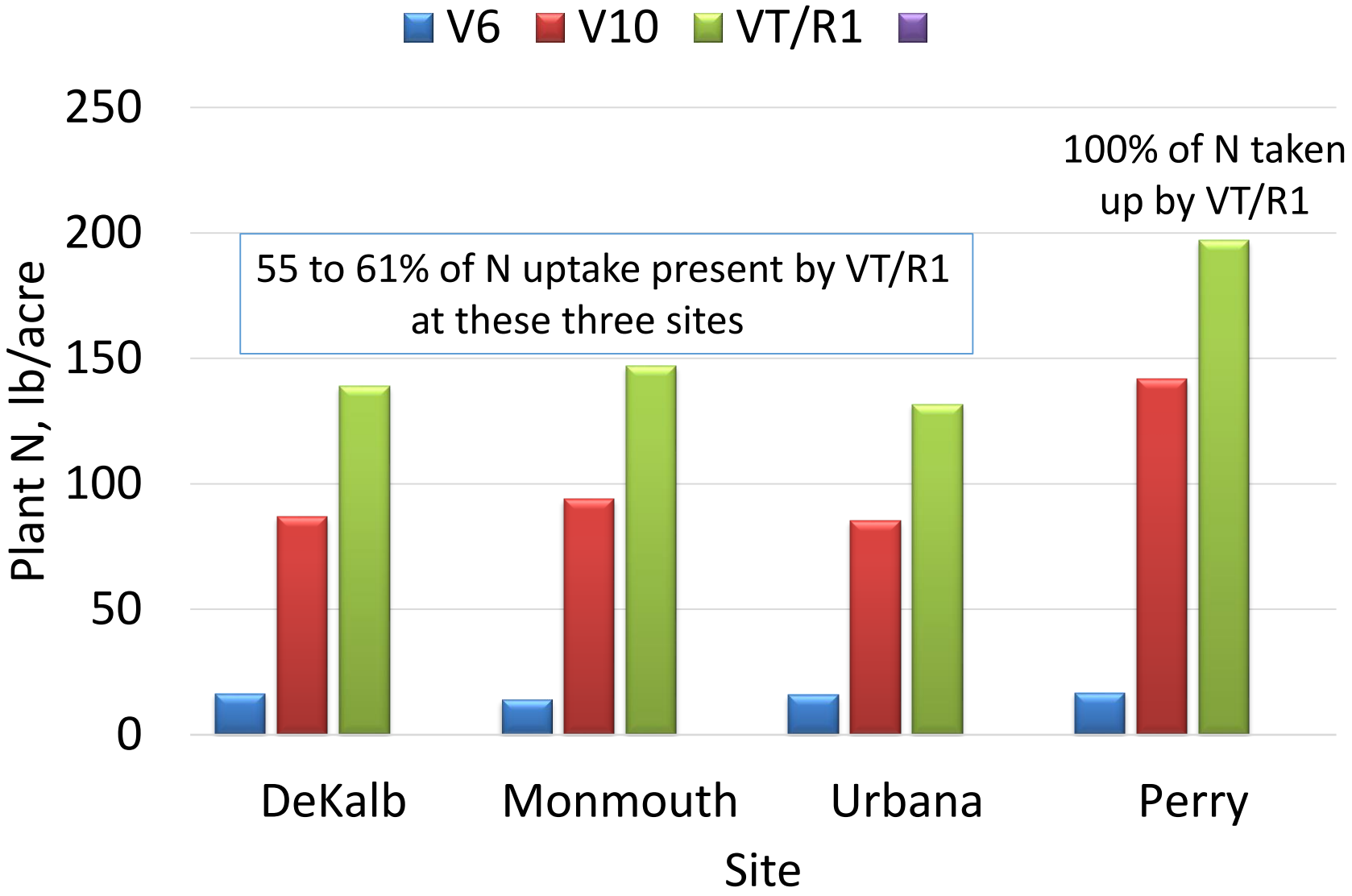
	Yield, bu/ac	
Fall 200 NH_3+NS	242	a
Fa 100+P50+SD50	238	a
Spr 200 NH_3	244	a
Pl 50 + 150SD	222	b
No N	121	c

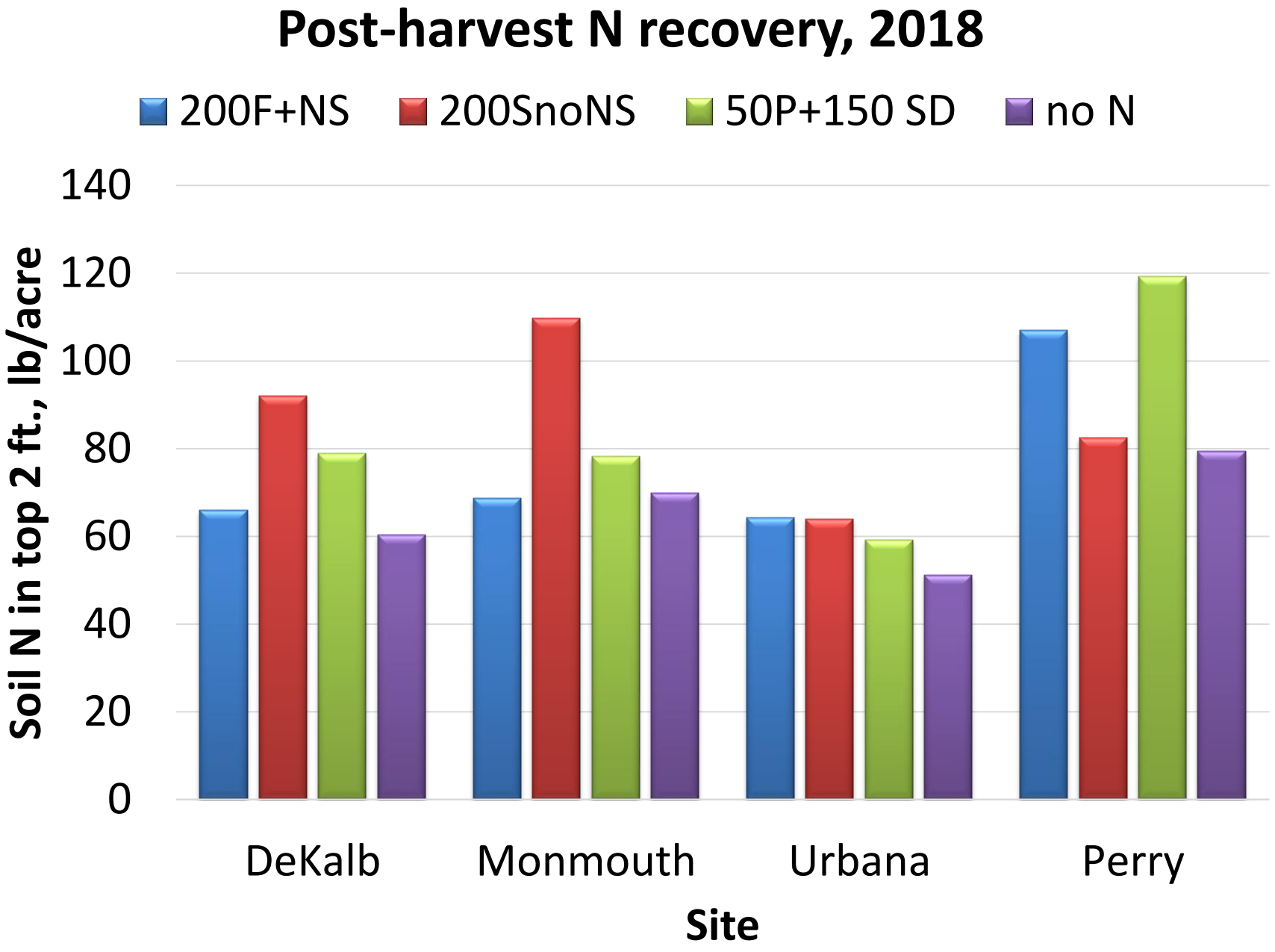
N-tracking, Perry, 2018 (dry early)



	Yield, bu/ac	
Fall 200 NH_3+NS	207	a
Fa 100+P50+SD50	207	a
Spr 200 NH_3	201	ab
Pl 50 + 150SD	193	b
No N	143	c

Plant N with 200 lb spring NH_3, 2018




Post-harvest N recovery, 2018
200F+NS
200SnoNS
50P+150 SD
no N
Soil N in top 2 ft., lb/acre
140
120
100
80
60
40
20
0
DeKalb
Monmouth
Urbana
Perry
Site

THANK YOU

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