

Moving Through the Nitrogen Jungle: Form, Timing & Additives

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I ILLINOIS

Crop Sciences

COLLEGE OF AGRICULTURAL, CONSUMER
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Emerson Nafziger
Crop Sciences
University of Illinois
ednaf@illinois.edu

Outline for today:

- Recap of the crop year and N responses in 2017
- Comprehensive N management (started in 2014):
 - Research Center (small-plot) trials currently with 28 treatments, focusing on N times, forms, and additives
 - Grouping yield data by site to try to untangle weather effects
- Brief mention of 2017 N-tracking results



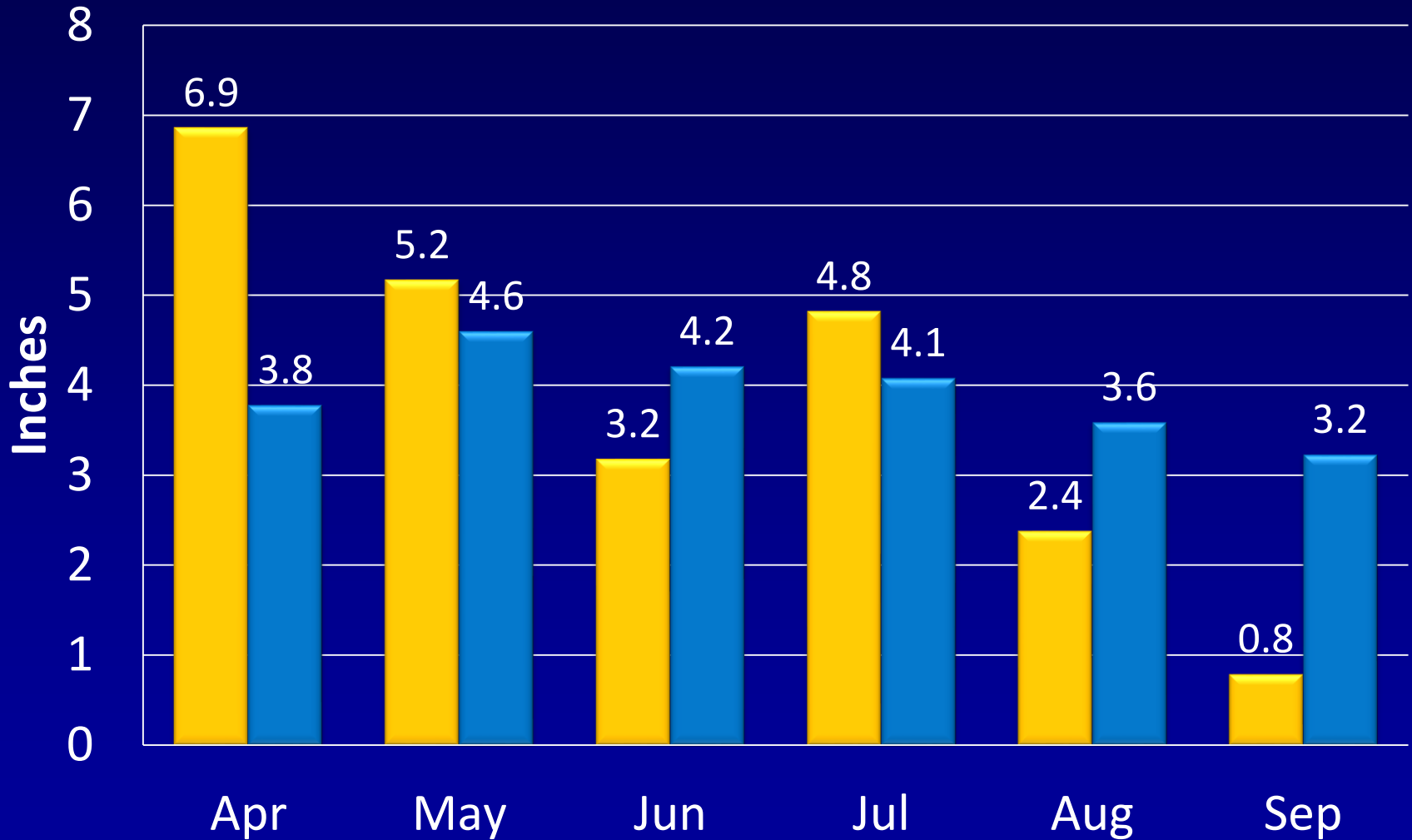
The 2017 Illinois corn crop:

- Planting started well, but planted crop was hammered by 4 to 10+ inches of rain late April through first week of May; there was a huge amount of replanting
- Weather highlights:
 - After the deluge, May rainfall and temperatures about normal
 - June was mostly dry with temperatures a little above normal
 - July rainfall was about normal, but not uniform; temperatures slightly above normal, but variable
 - August rainfall was below-normal, but temperatures averaged some 3 degrees below normal
 - September was very dry and warm early
- Final corn yield estimate is 201 bu/ac, a new IL record



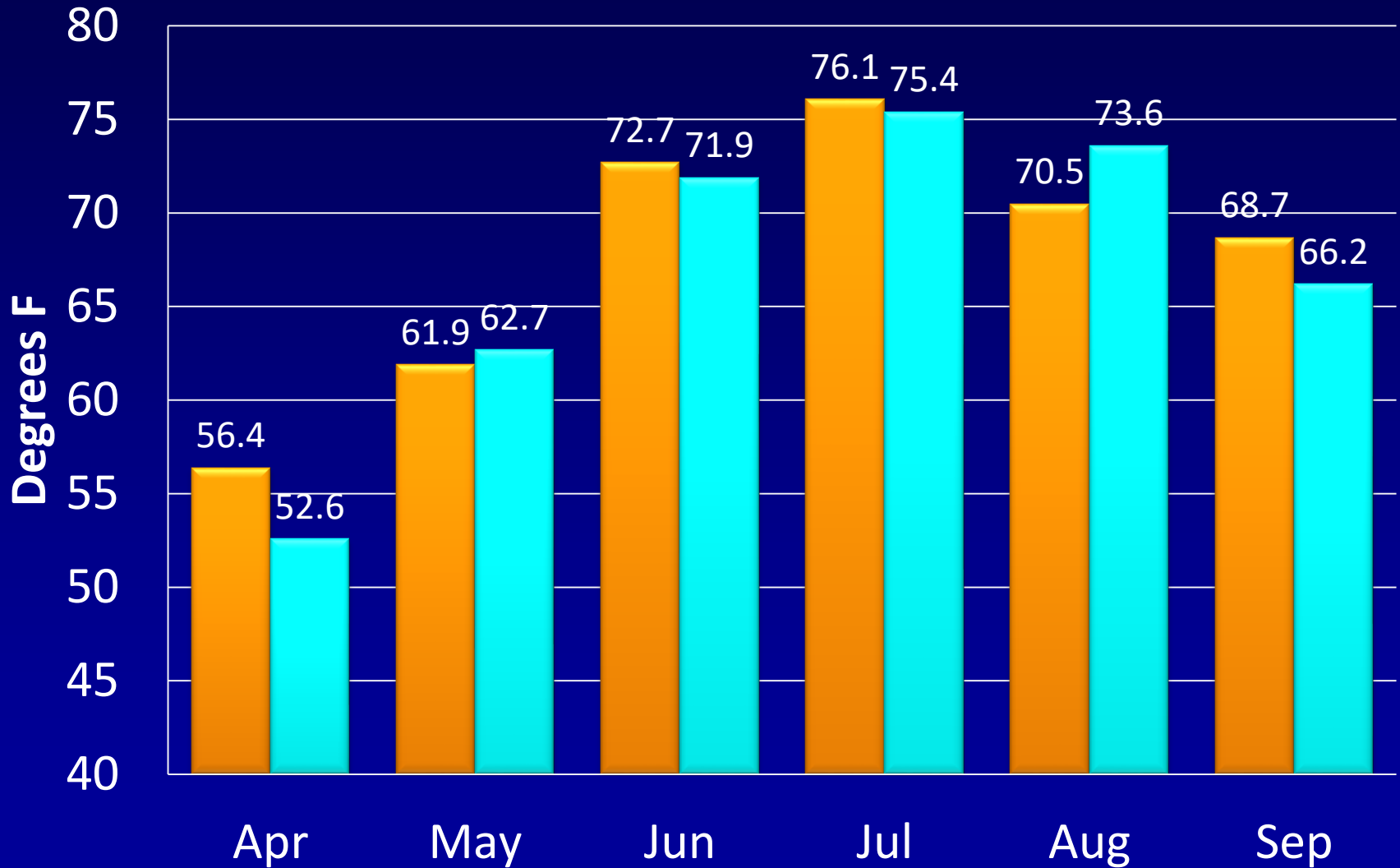
Illinois rainfall

■ 2017 ■ Normal



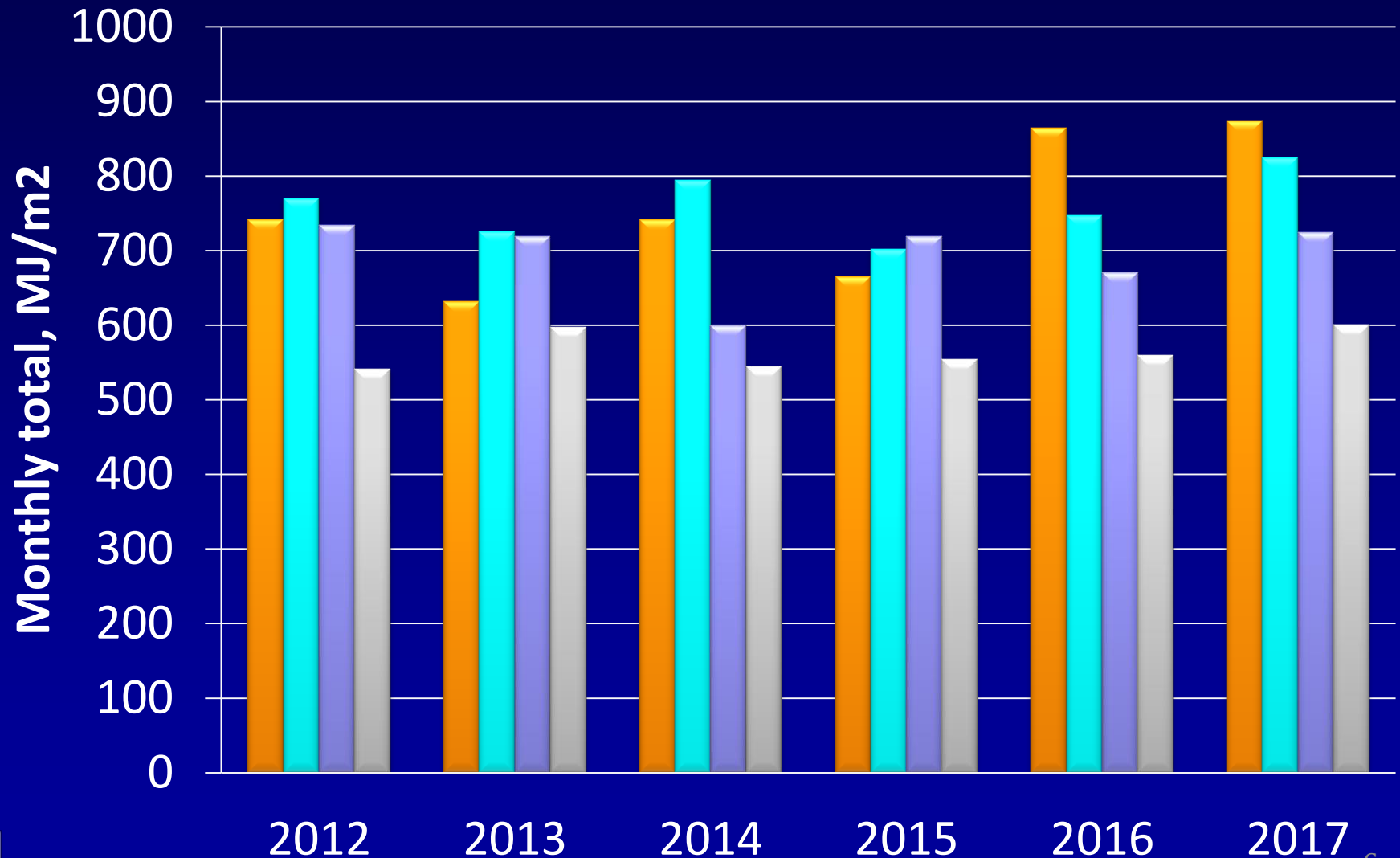
Illinois temperature 2017

2017 Normal



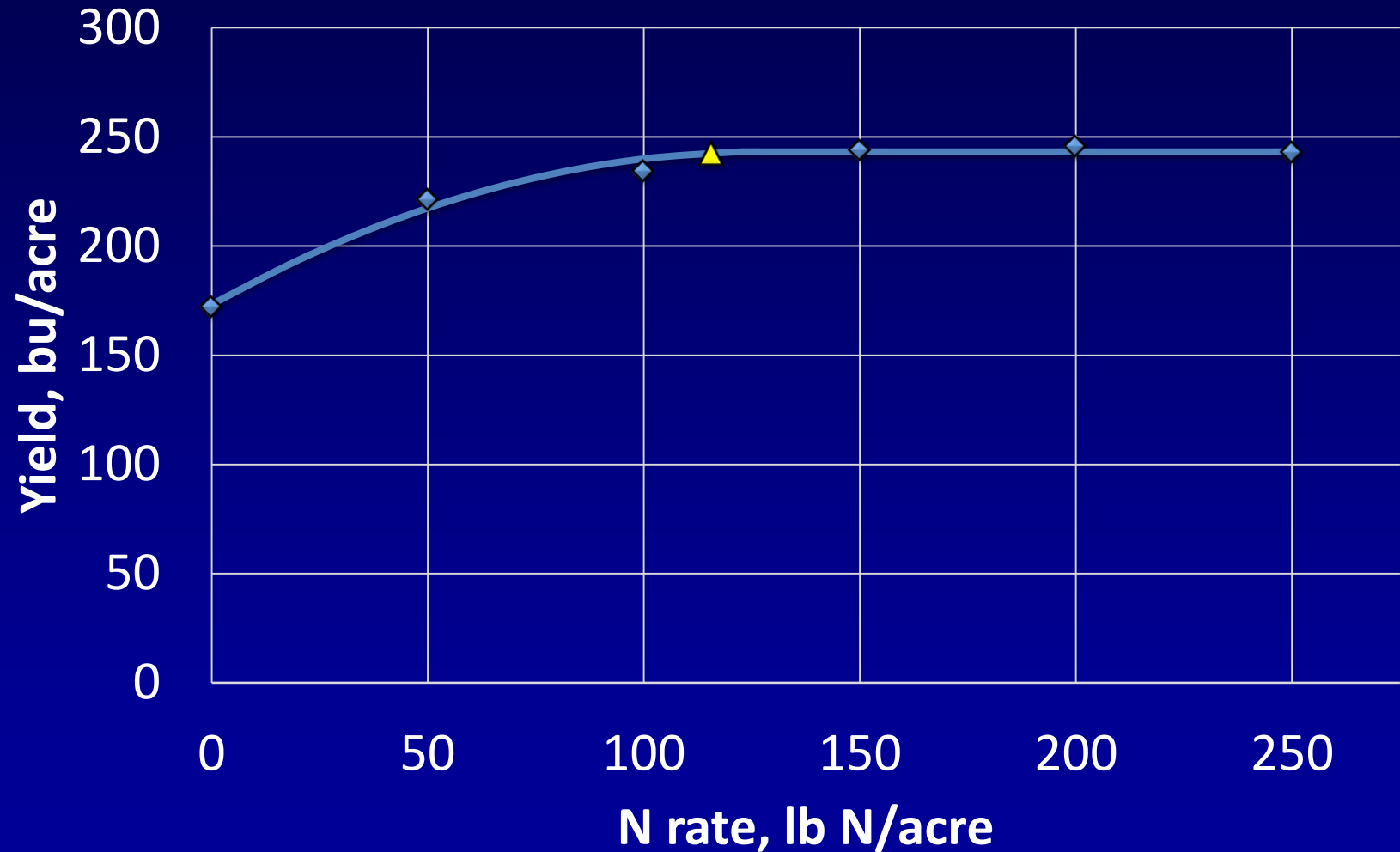
Sunlight at Bondville, Champaign Co.

June July Aug Sep



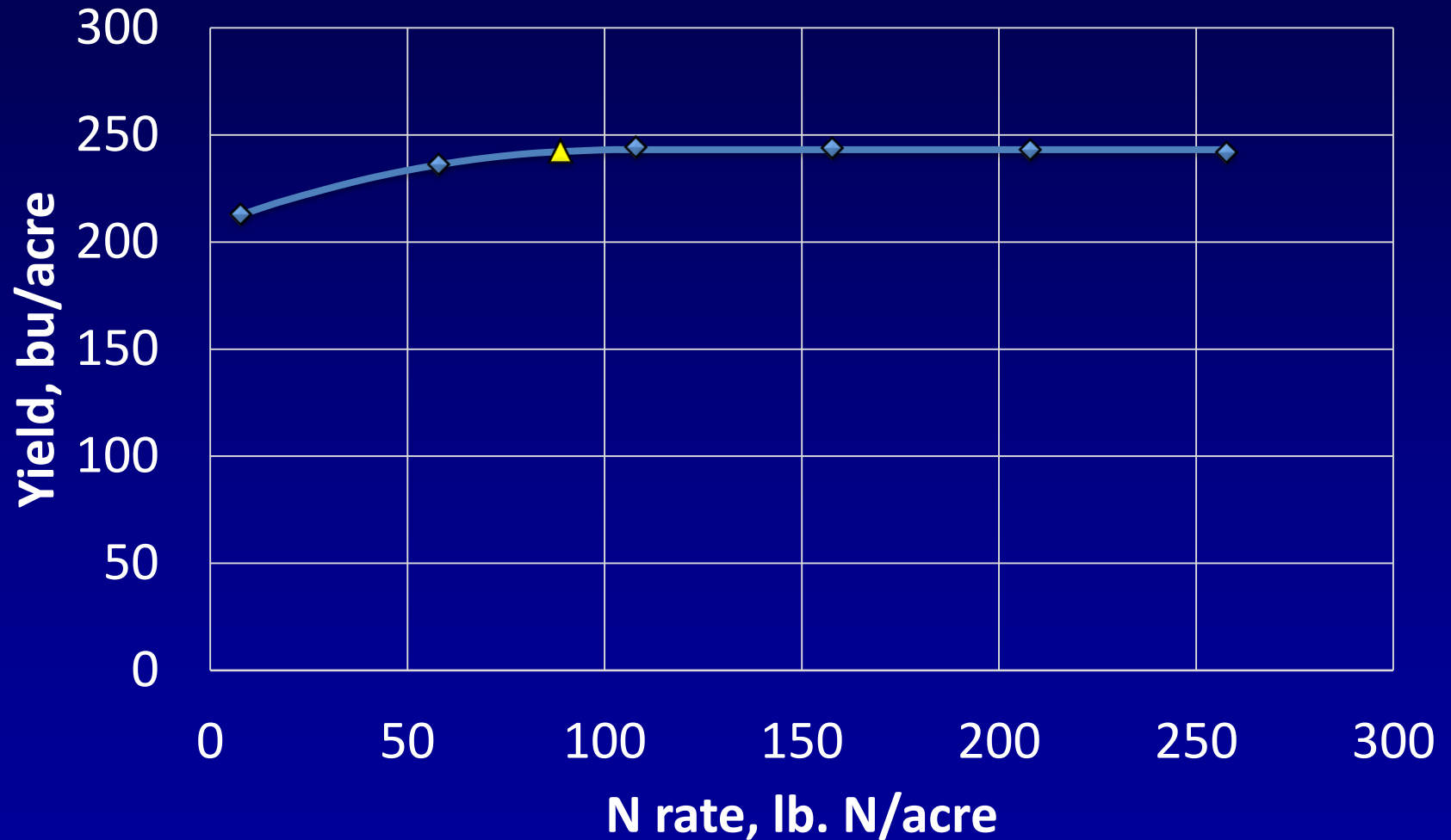
Christian County Soy-Corn 2017

◆ Fall NH₃ ▲ Optimum

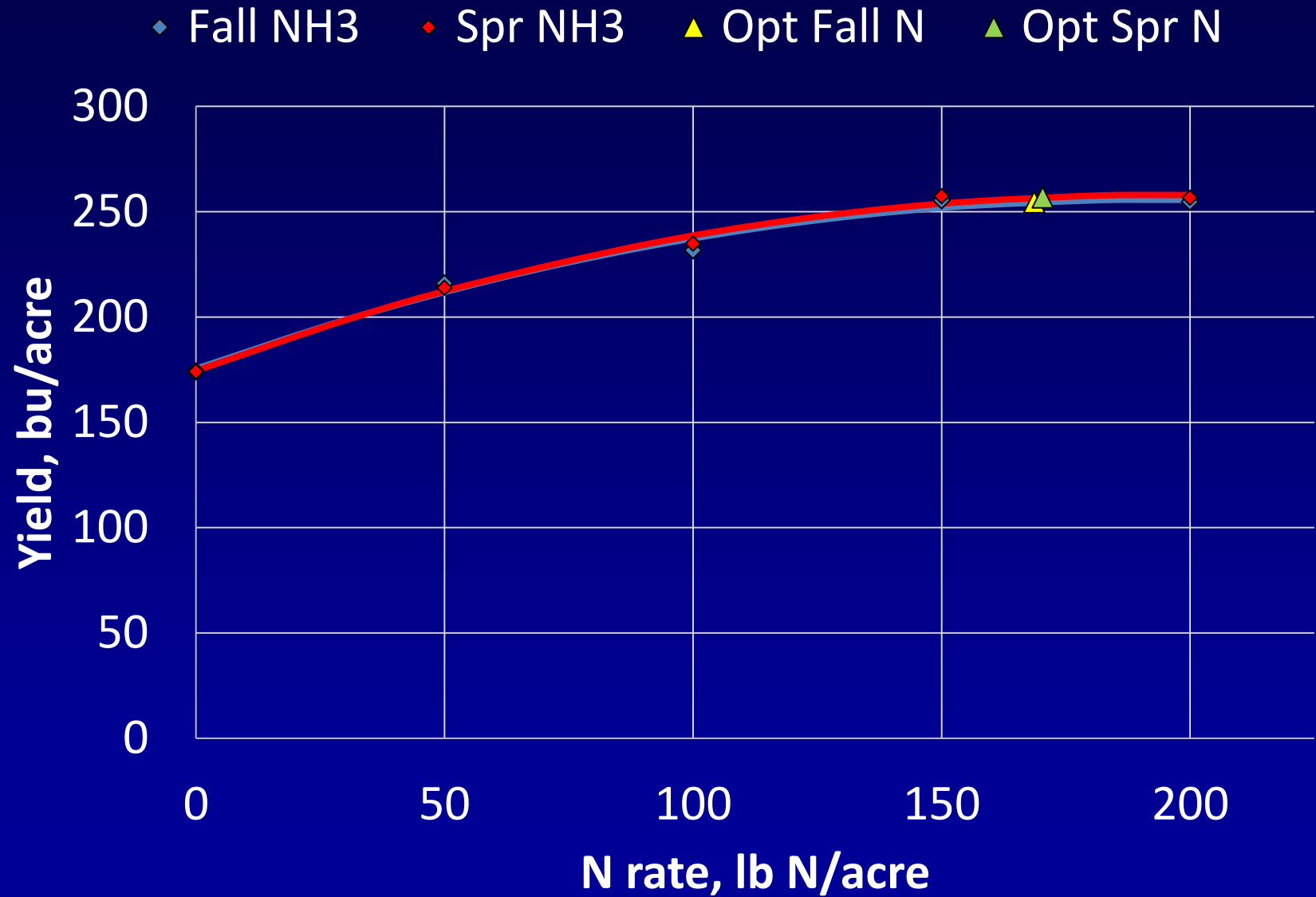


Champaign County Soy-Corn 2017

◆ UAN SD V2 ▲ Optimum

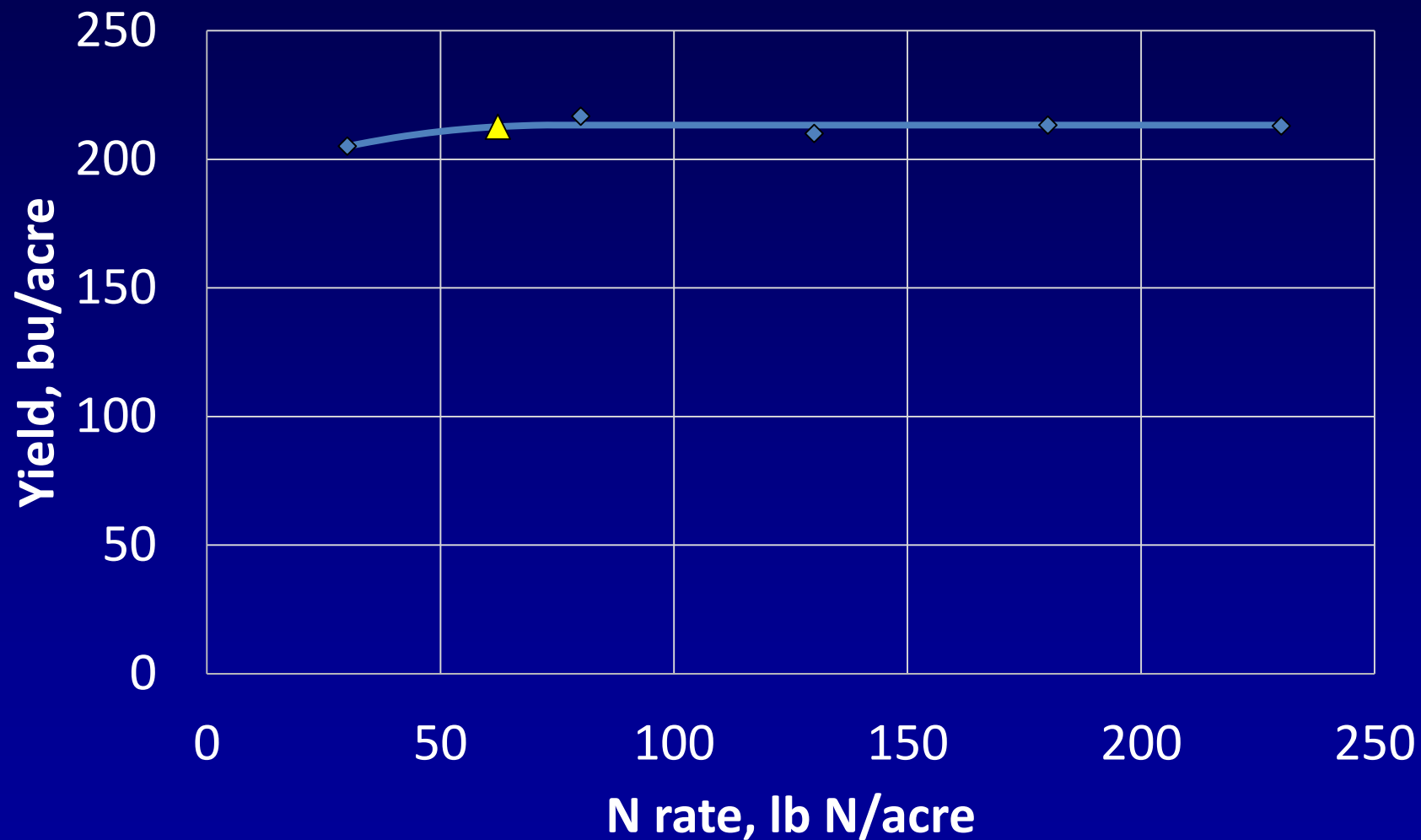


Sangamon Co. Soy-Corn 2017



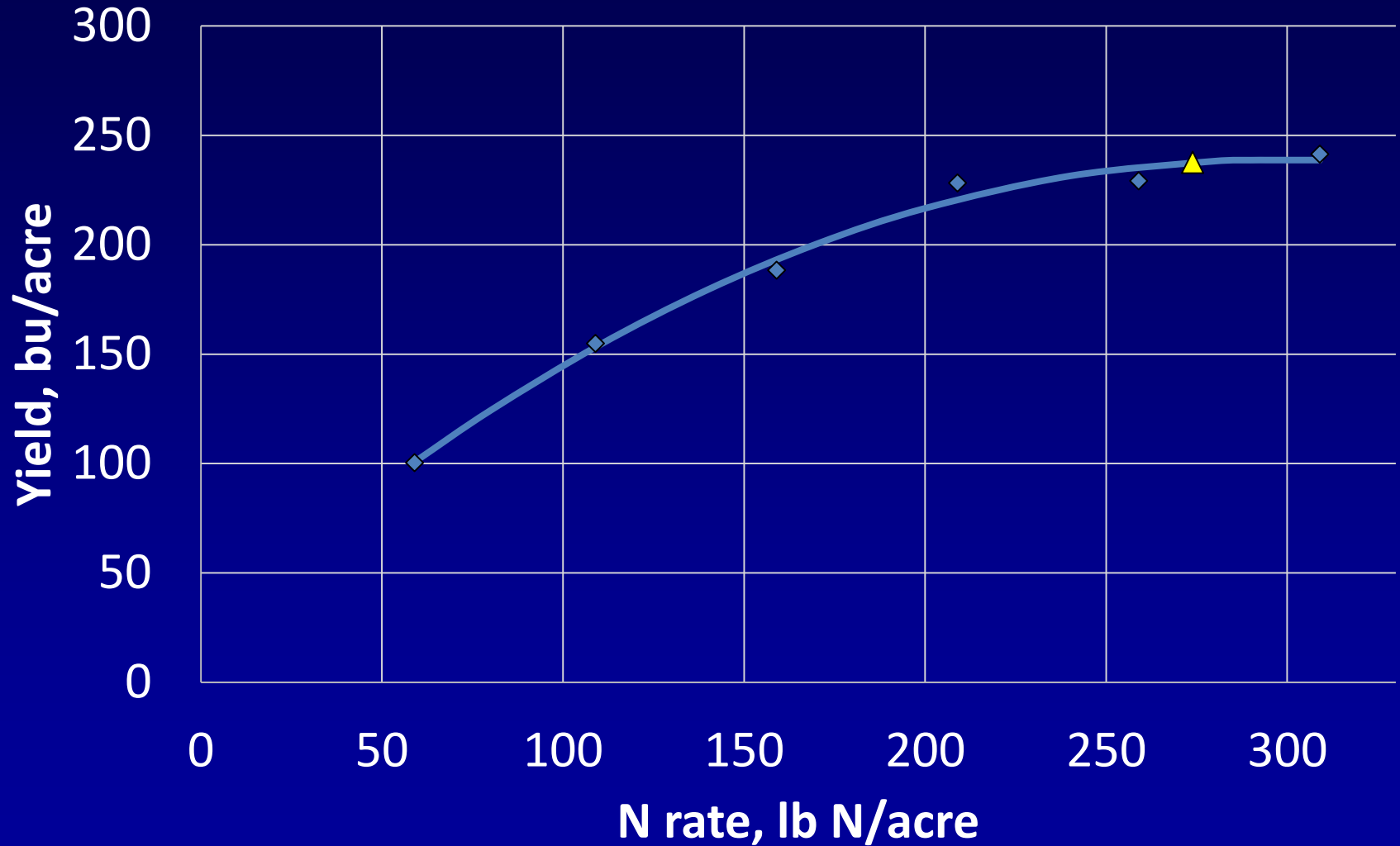
Sangamon County Corn-Corn 2017

◆ Fall NH3 ▲ Optimum



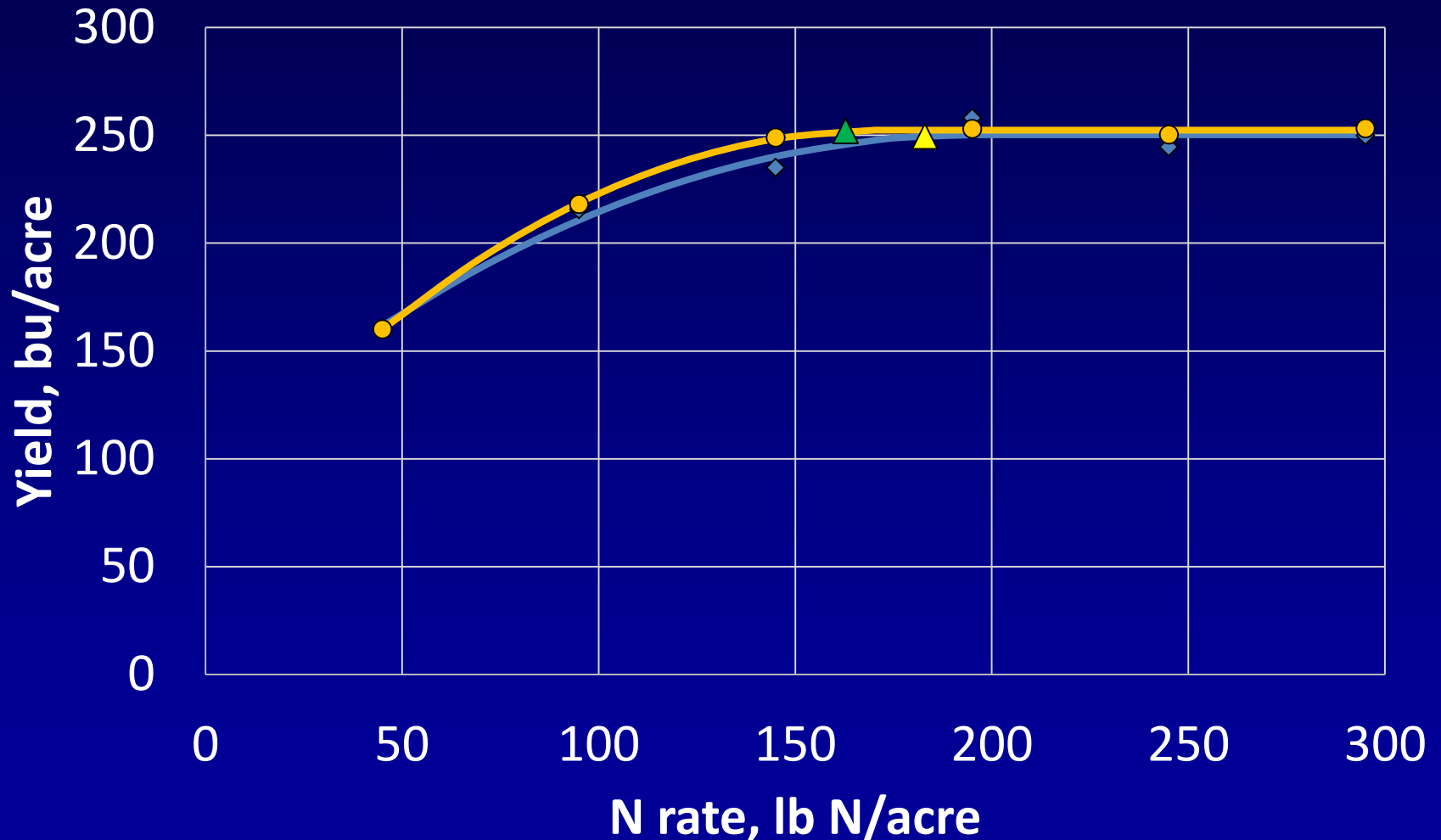
Vermilion County Soy-Corn

◆ NH3 SD V4 ▲ Optimum



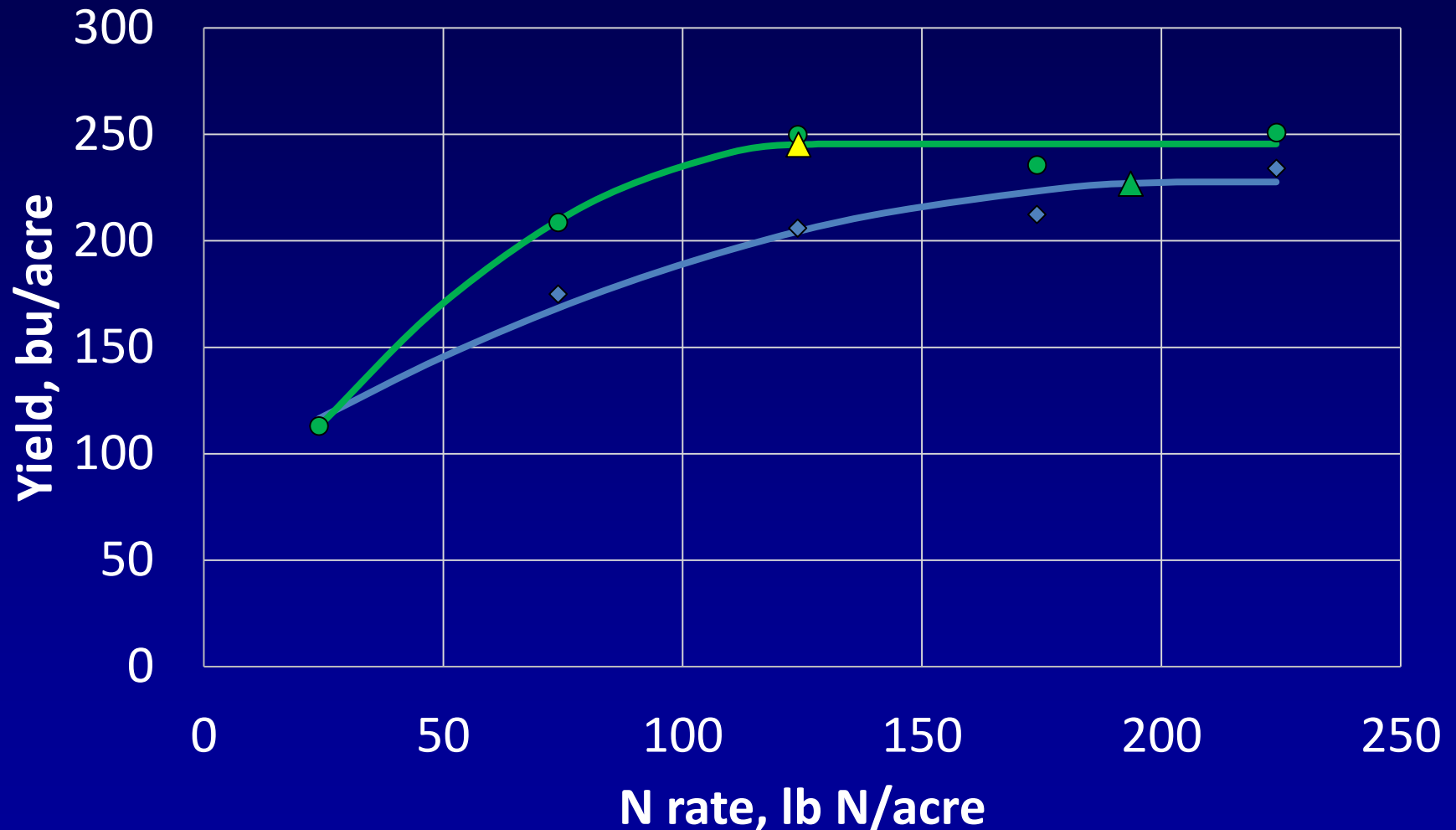
Piatt County Soy-Corn 2017

◆ Fall NH₃ ● Spring NH₃ ▲ Optimum Fall N ▲ Opt. Spring N



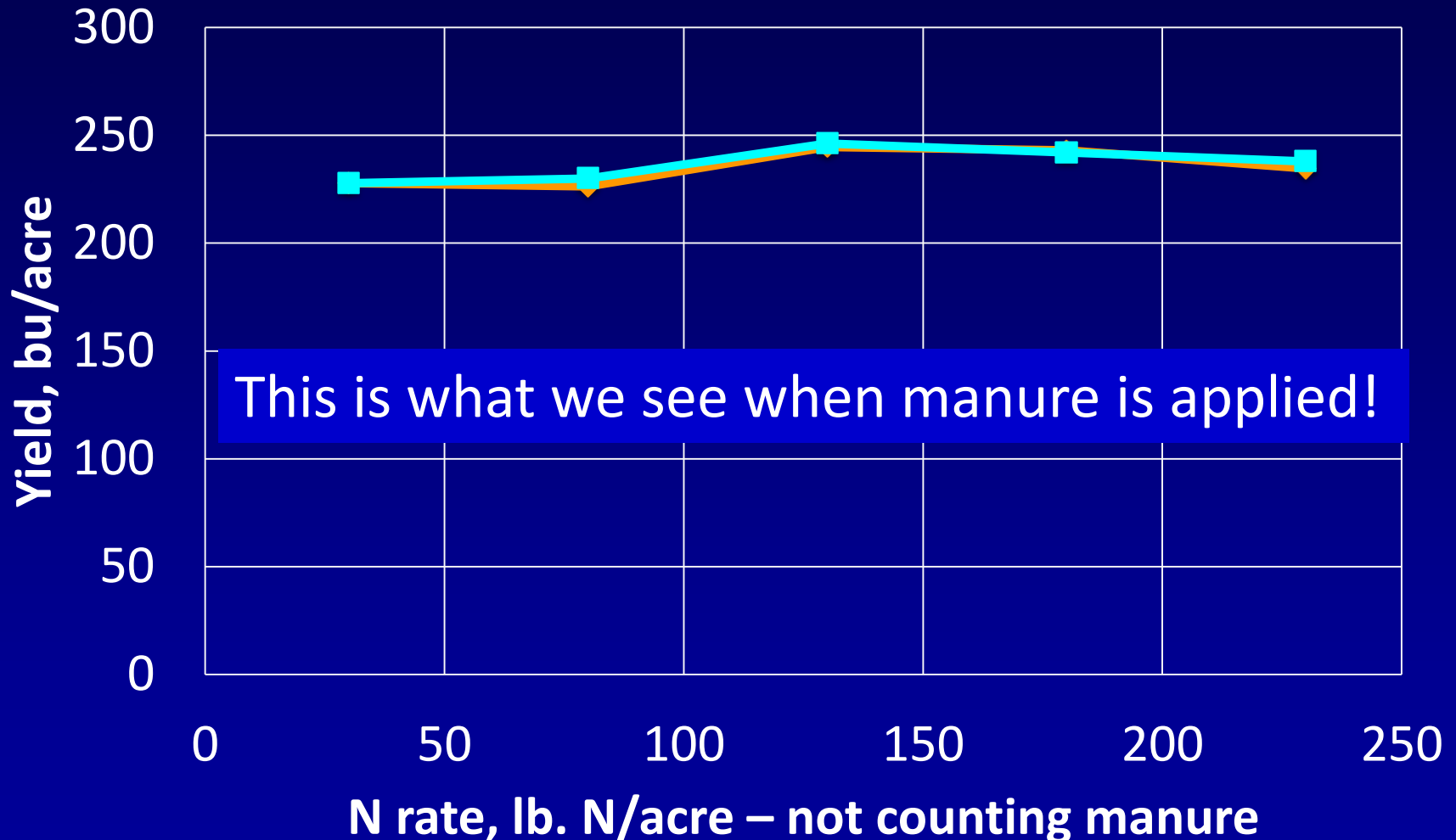
Pike County Soy-Corn 2017

◆ Fall NH₃ ● Spring NH₃ ▲ Optimum Fall N ▲ Opt. Spr N



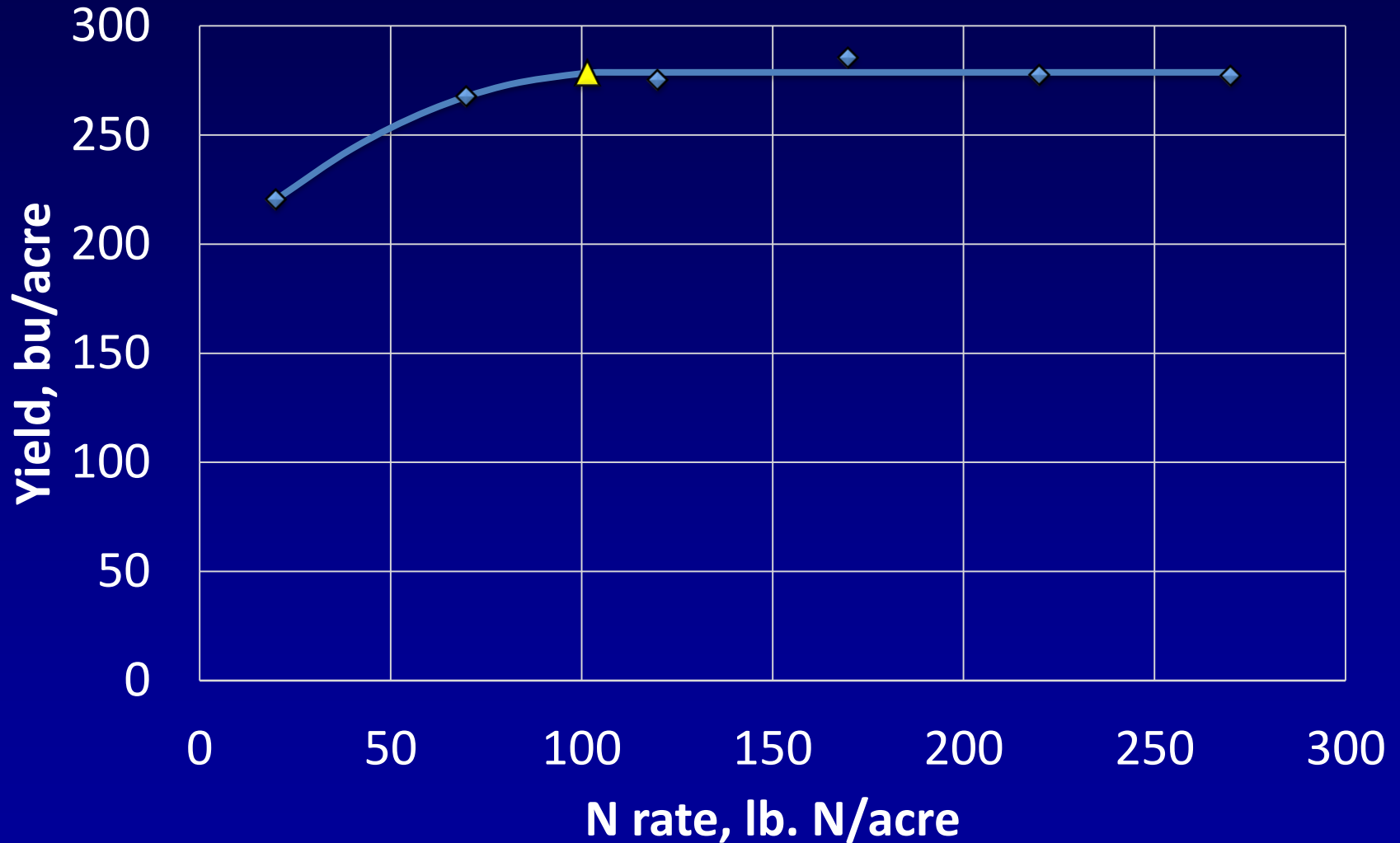
Champaign Co., Soy-Corn 2017

—♦— Fall NH3 —■— Spr NH3 SD V7



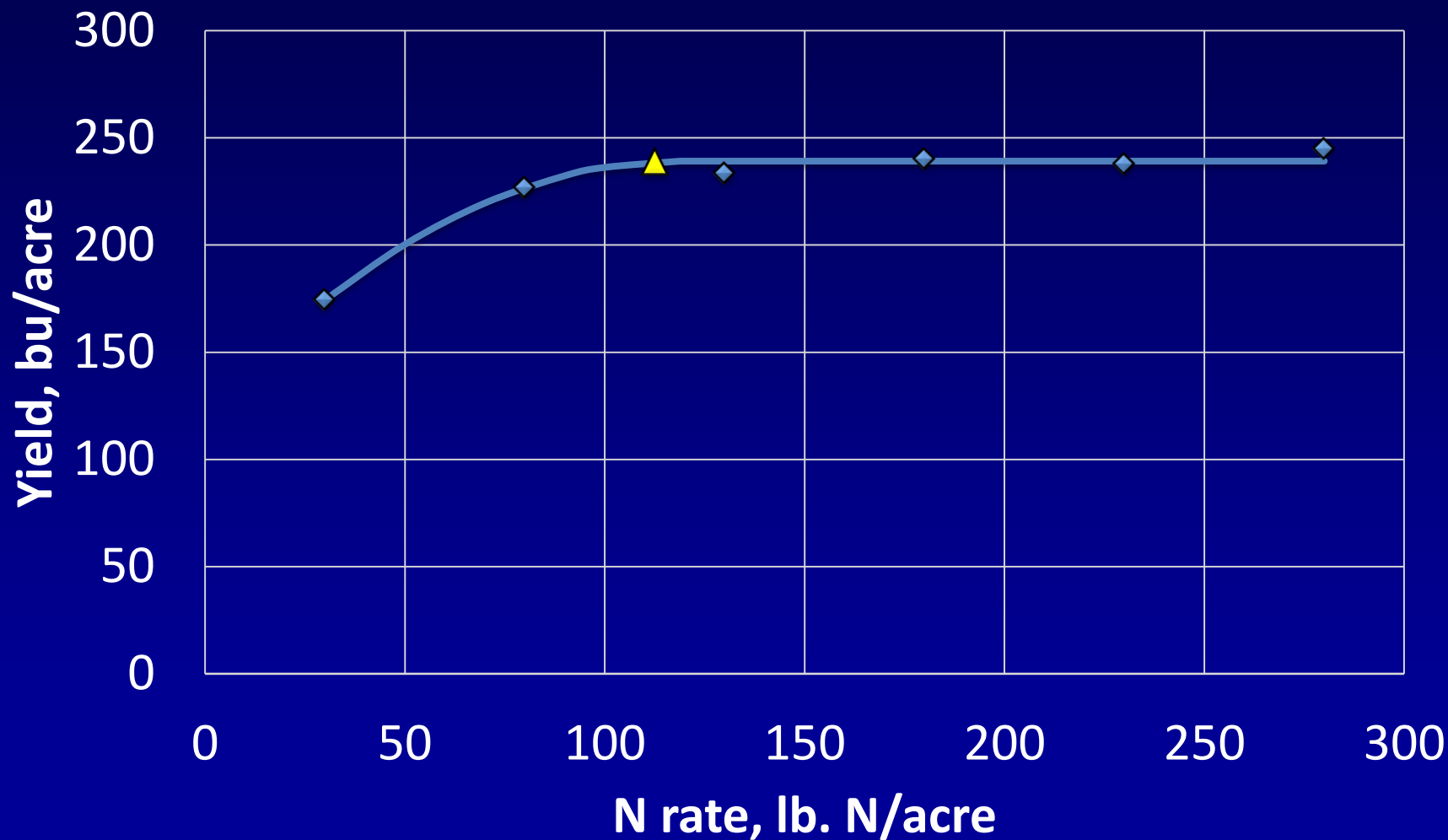
Rock Island County Soy-Corn 2017

◆ Spring pre-plant NH₃ ▲ Optimum



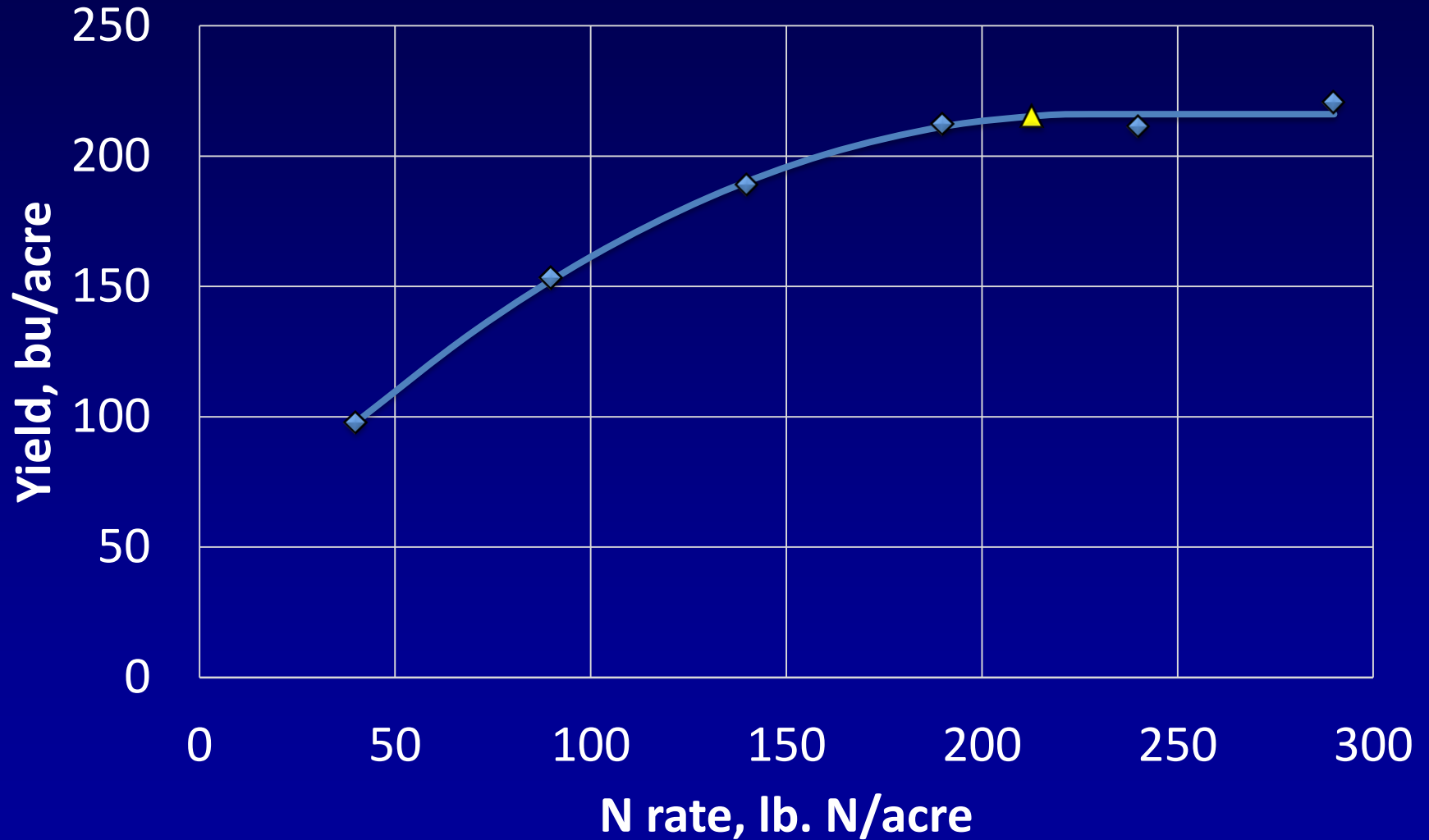
Bureau County Soy-Corn 2017

◆ UAN sidedress V4 ▲ Optimum



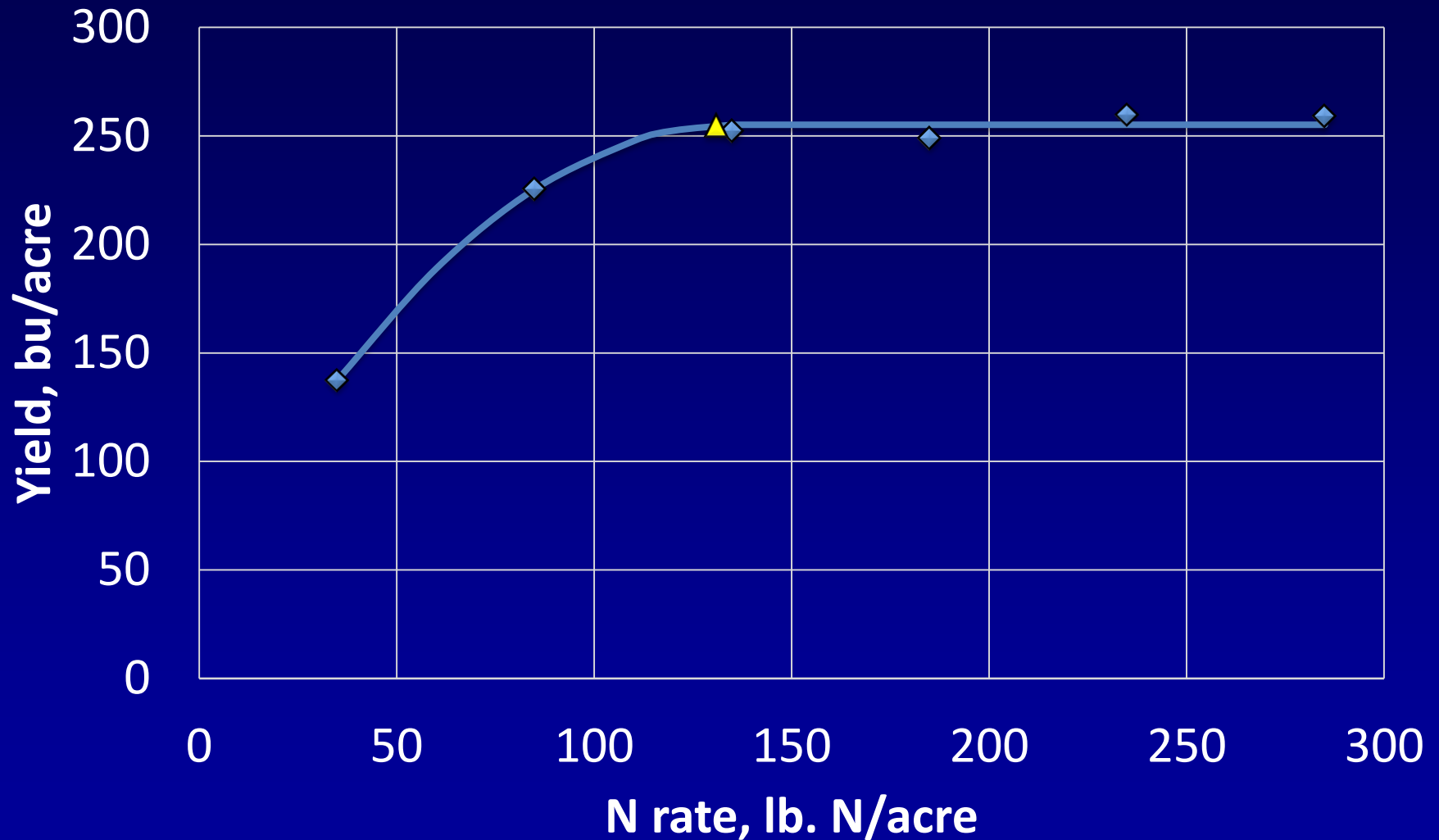
White County Soy-Corn 2017

◆ Sidedress NH₃ V5-6 ▲ Optimum



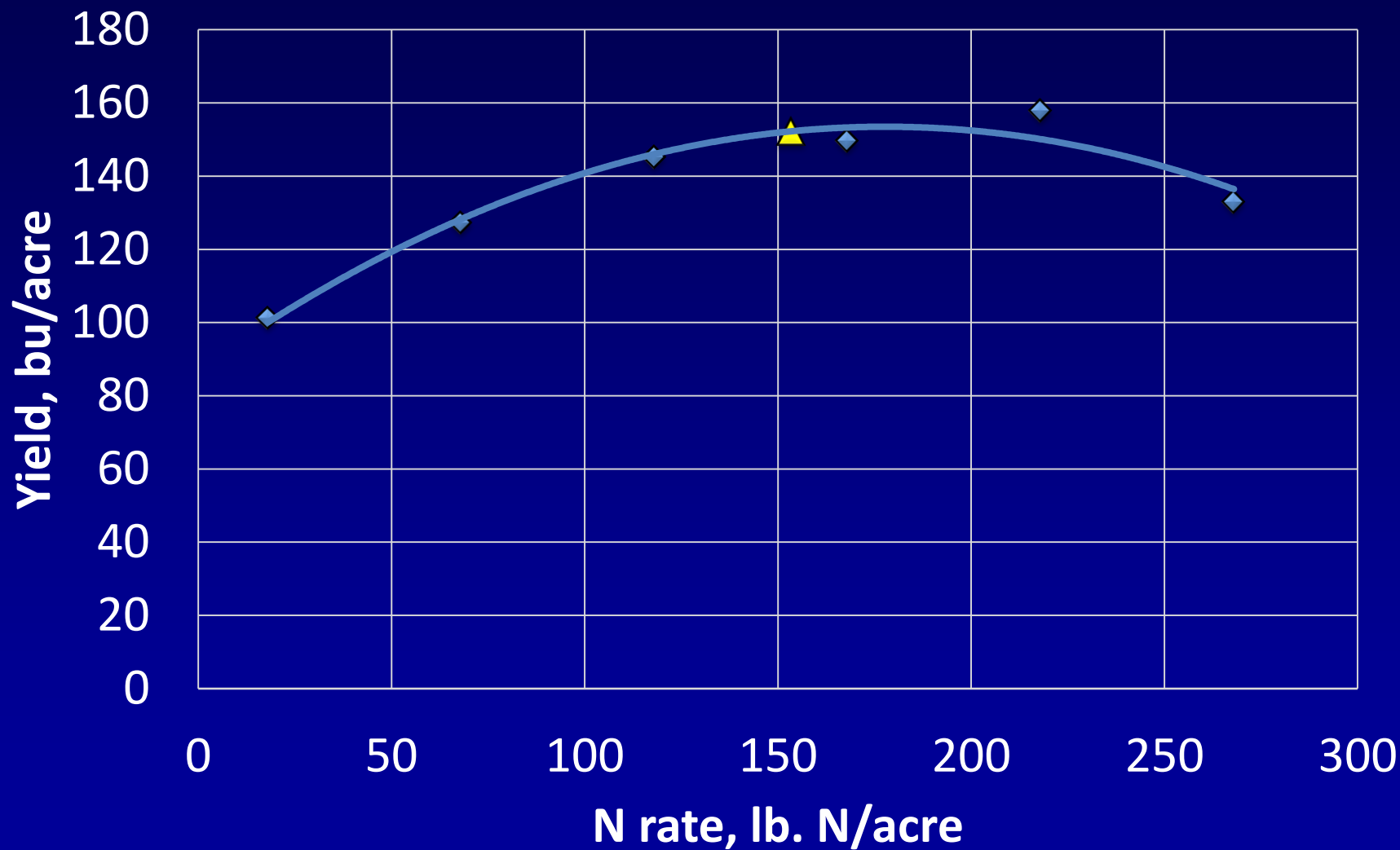
Hamilton County Soy-Corn 2017

◆ UAN Sidedressed V5 ▲ Optimum



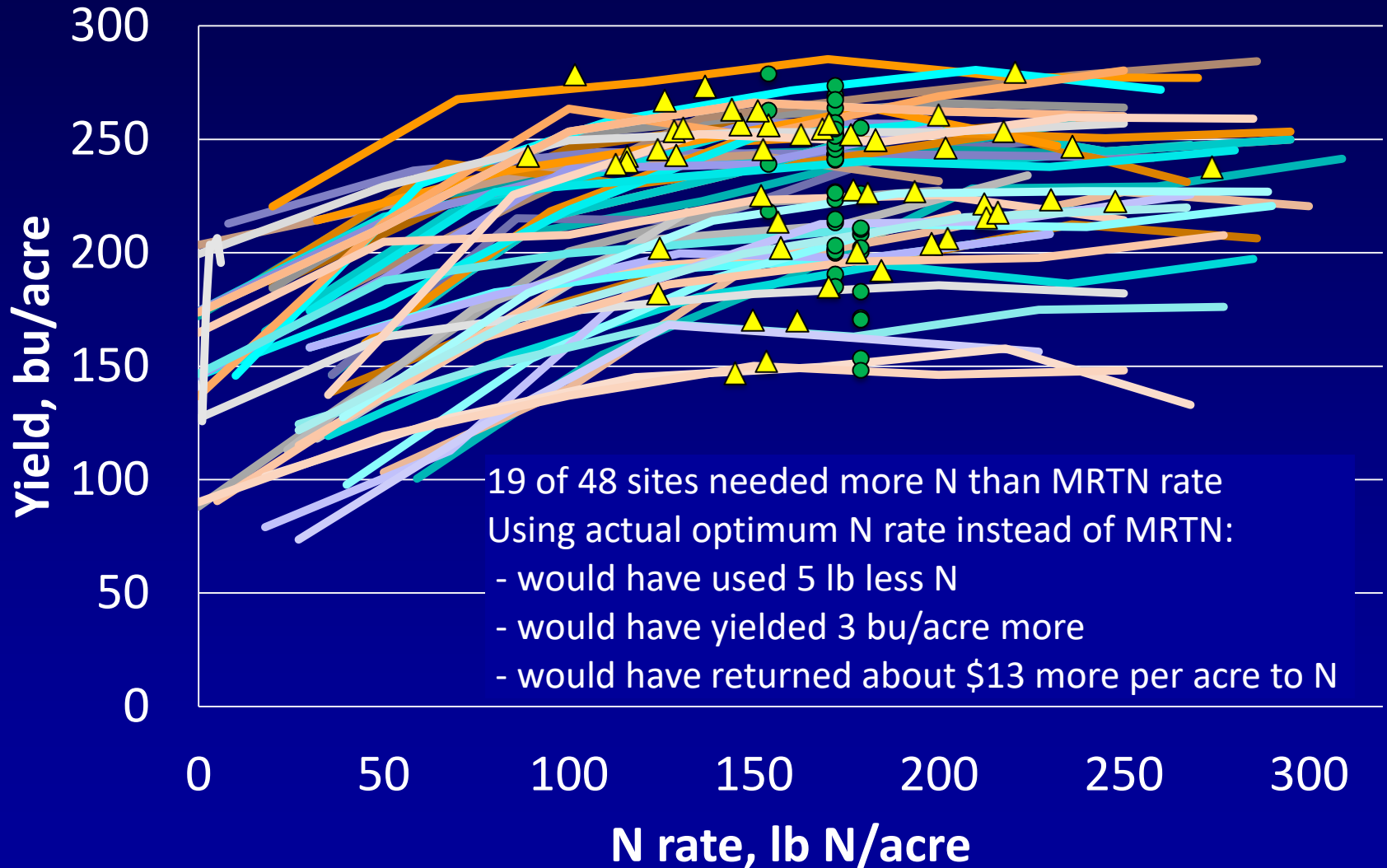
Randolph County Soy-Corn 2017

◆ NH3 sidedress V4-5 ▲ Optimum



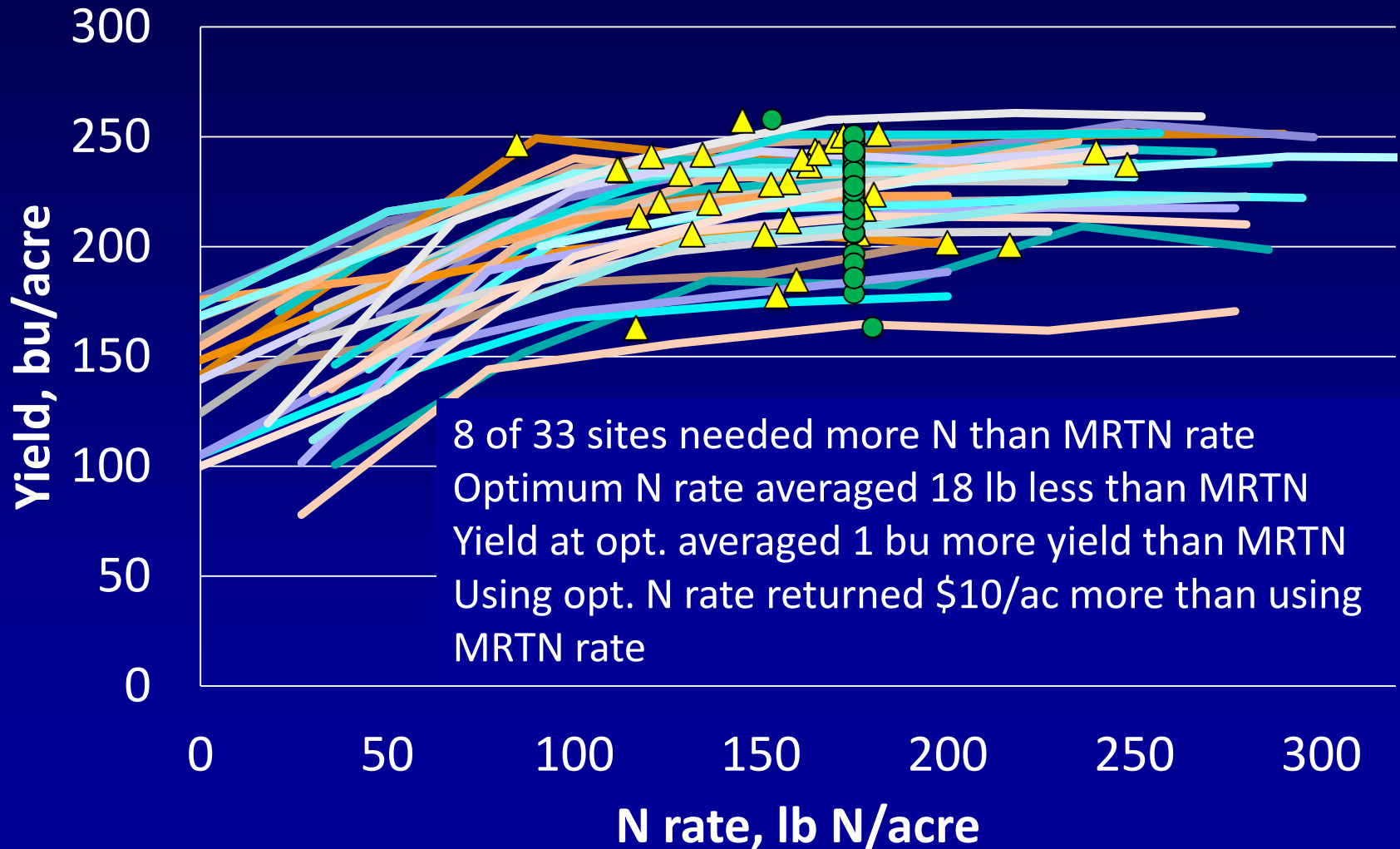
49 on-farm N trials, soy-corn, 2017

● MRTN ▲ Optimum



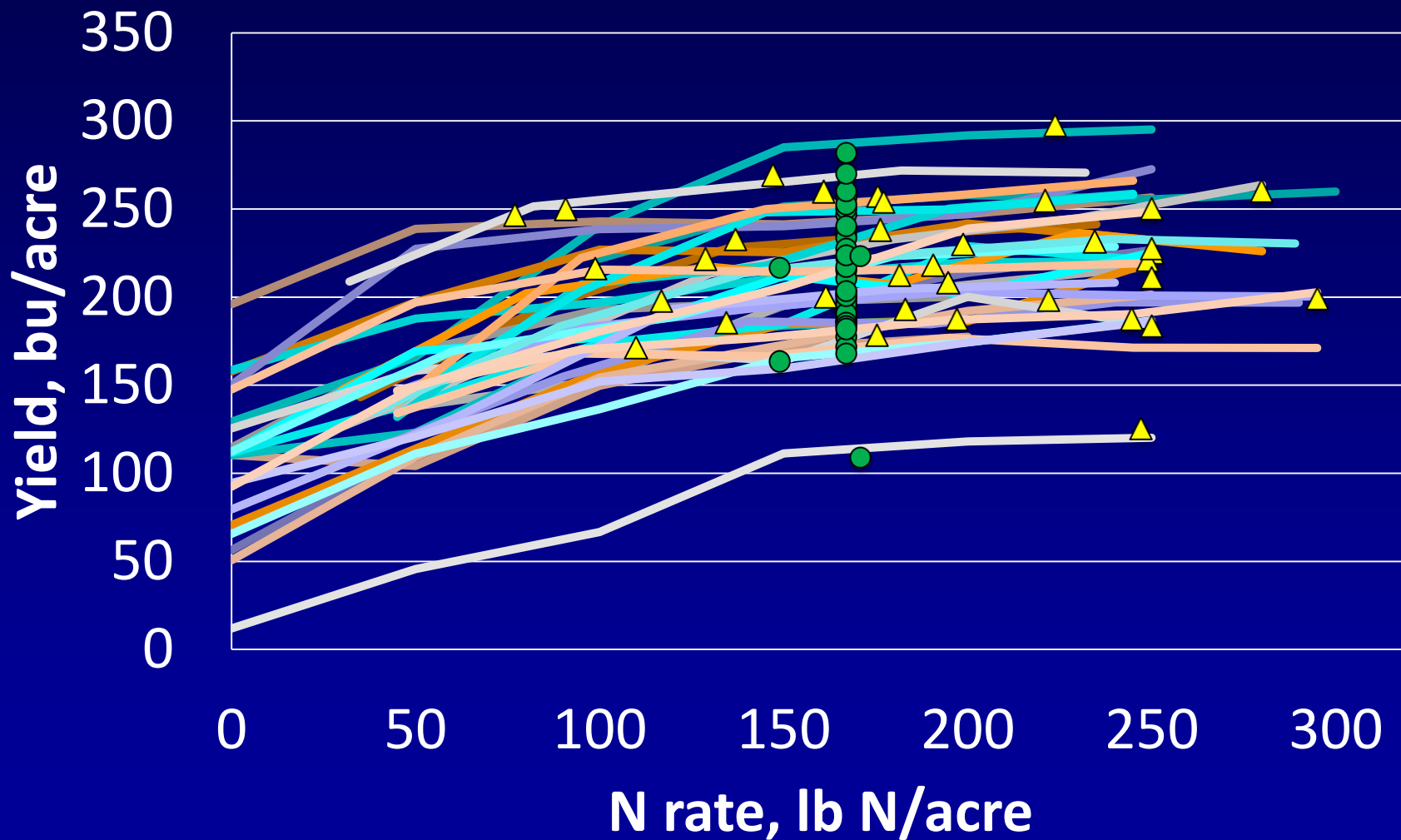
33 on-farm N trials soy-Corn 2016

▲ Optimum ● MRTN



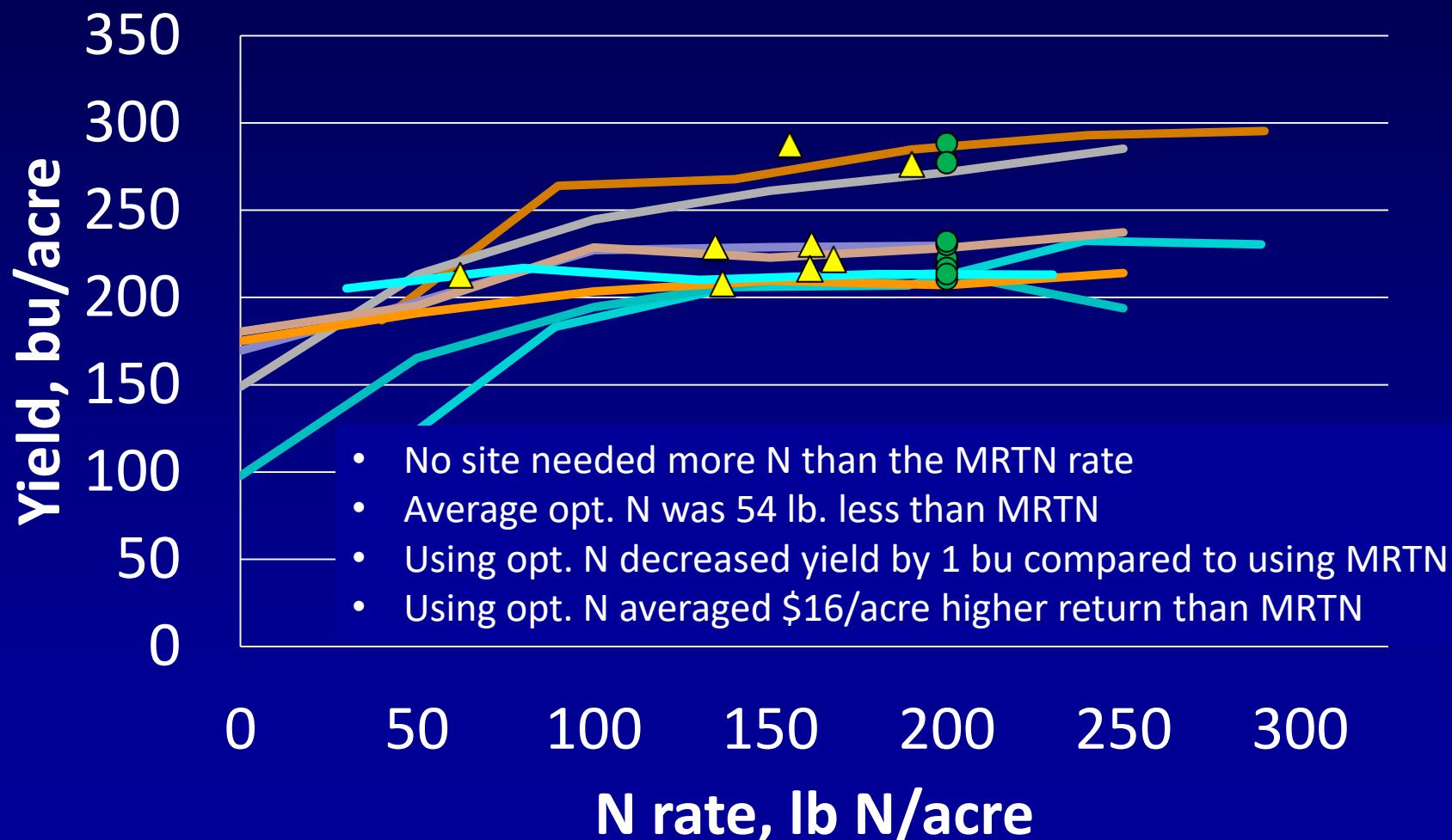
35 on-farm trials Soy-Corn 2015

▲ Optima ● MRTN



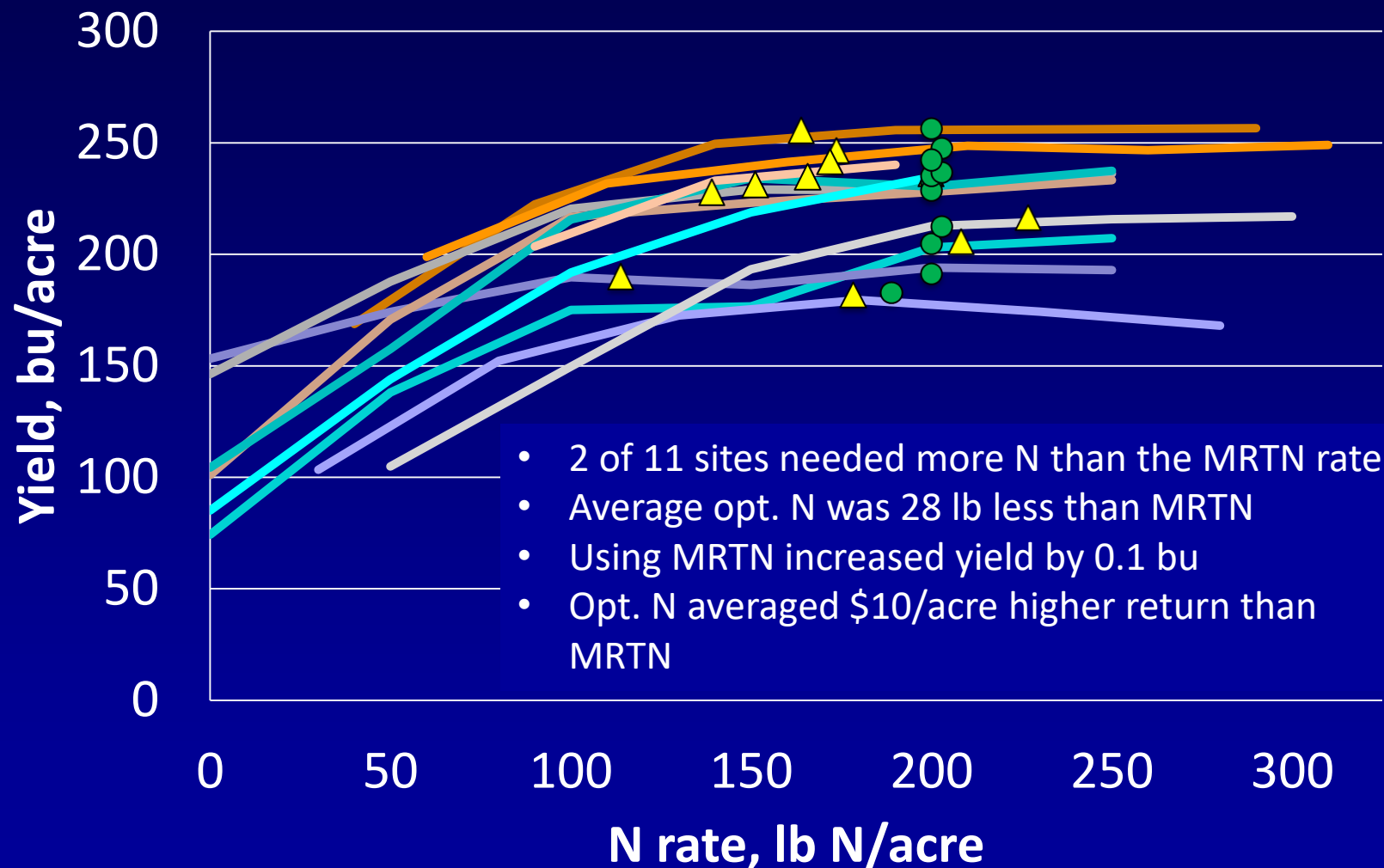
8 on-farm N trials, corn-corn, 2017

▲ Optimum ● MRTN



11 on-farm N trial Corn-Corn 2016

▲ Optimum ● MRTN



Current MRTN N rate guidelines from the N rate calculator

- Based on N price = \$0.35/lb and corn price = \$3.50/bu

IL region	Soy-corn	Corn-corn
North	154 ₍₈₁₎	200 ₍₈₃₎
Central	172 ₍₂₄₅₎	200 ₍₁₅₂₎
LSW	166 ₍₂₂₎	202 ₍₁₀₎
South	179 ₍₁₁₆₎	189 ₍₄₈₎



The rate “jungle” – no big news

- Heavy rainfall after planting (and early N application) was followed by on-and-off dry weather
- N responses were not unusual, but:
 - Corn-corn had unusually high yields at low N and limited response to N
 - Some wetter areas showed high optimum N rates, but on average ONR values were less than MRTN rates
 - The MRTN N rate calculator update for 2018 will not mean a large change

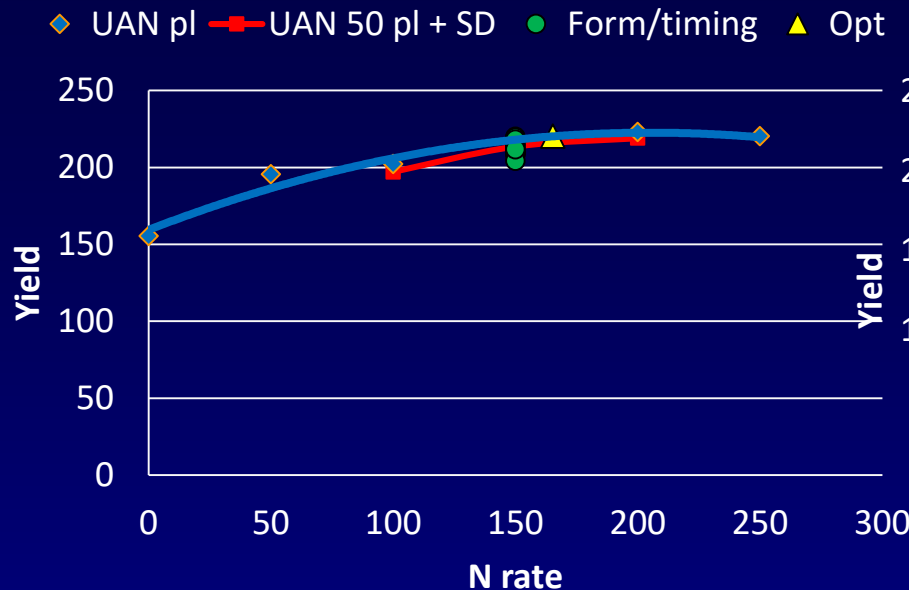


Form and timing trials

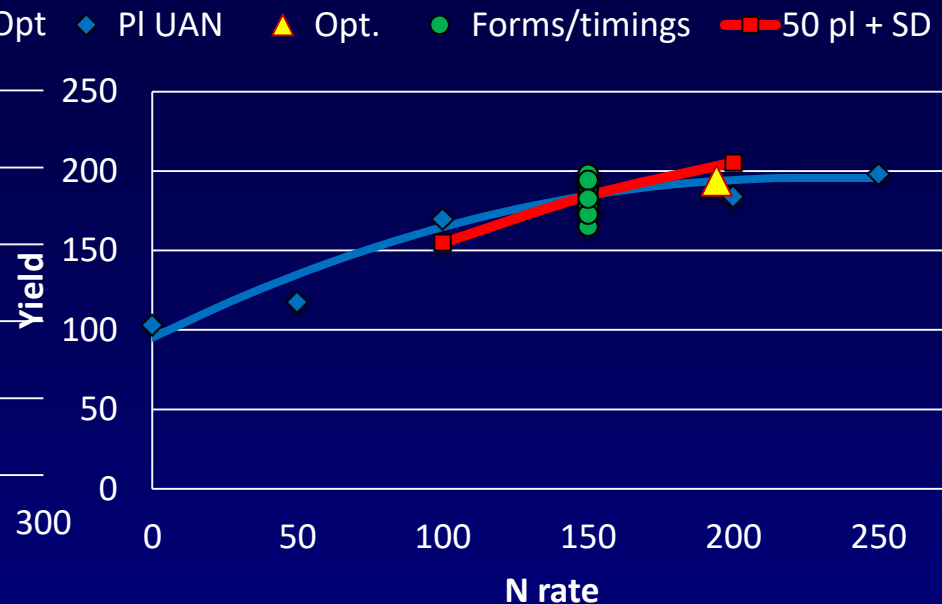
- At 5 research sites, corn following soybean
- Base rates of injected UAN at most sites:
 - 0, 50, 100, 150, 200, 250
- Set of rates with 50 lb N as broadcast UAN at planting and 50, 100, 150 lb as injected UAN at sidedress
- And ~20 different ways to apply 150 lb N



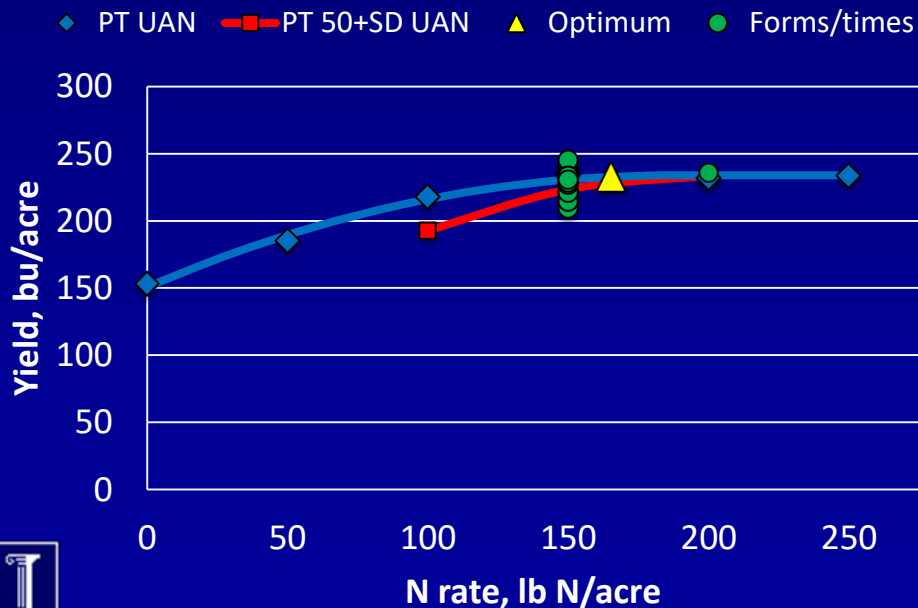
DeKalb N form x timing 2014



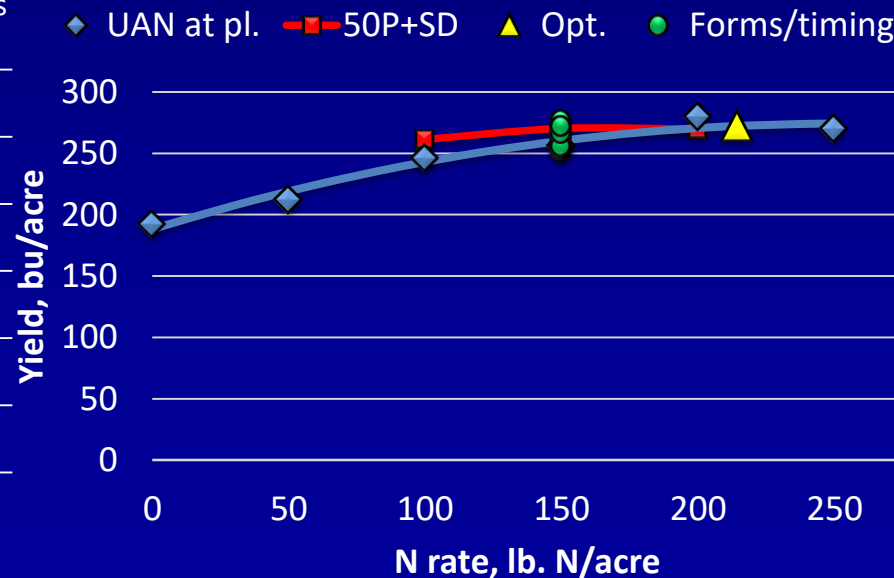
DeKalb N Study 2015



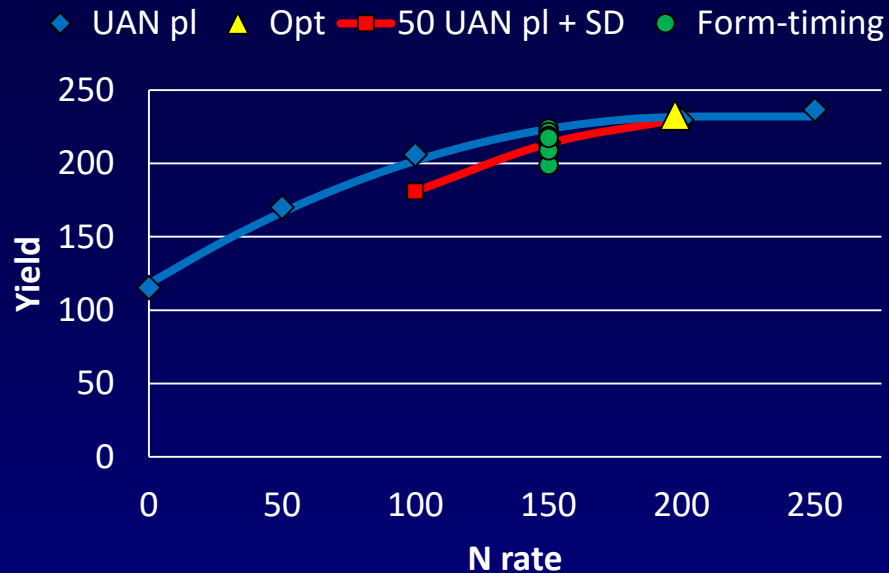
DeKalb 2016



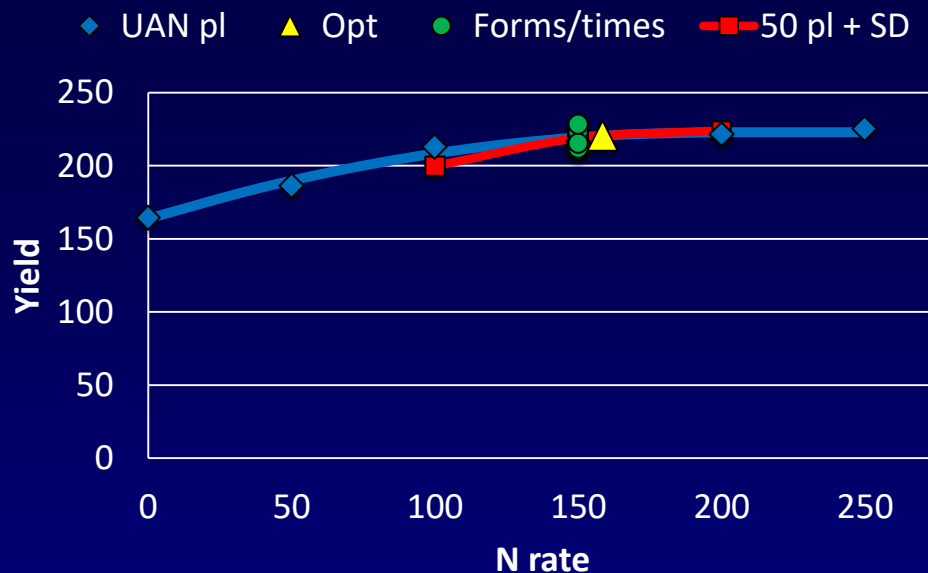
DeKalb 2017



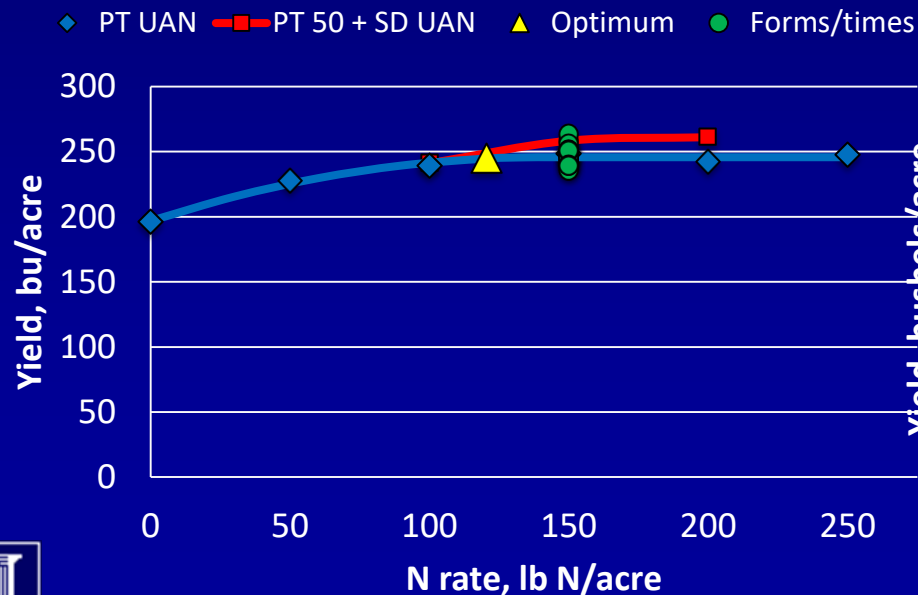
Monmouth N form x timing 2014



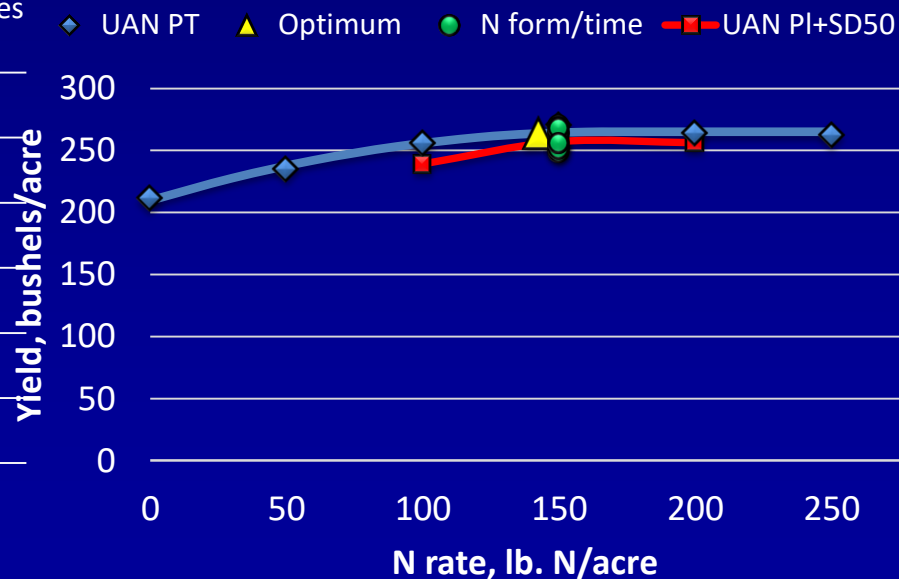
Monmouth N Study 2015



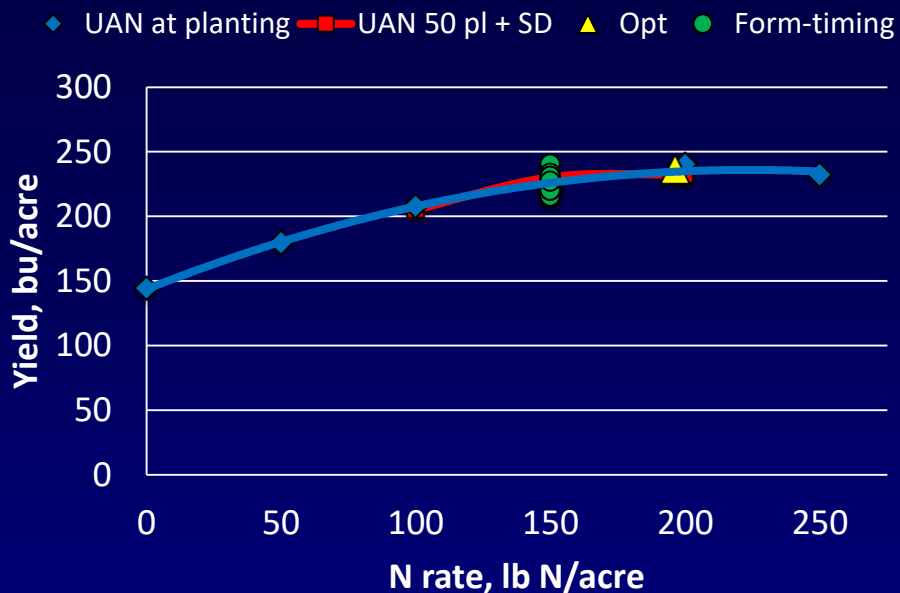
Monmouth N study 2016



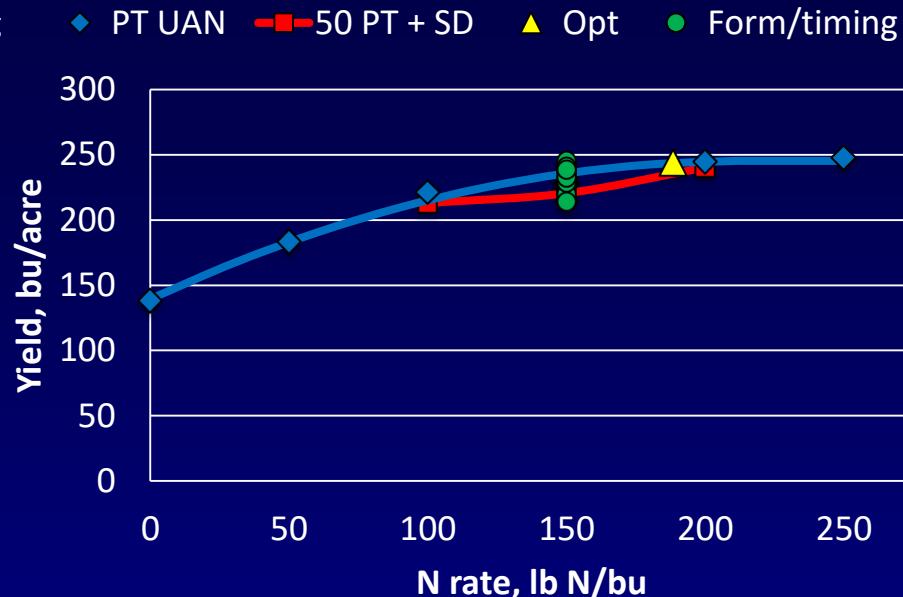
Monmouth N study 2017



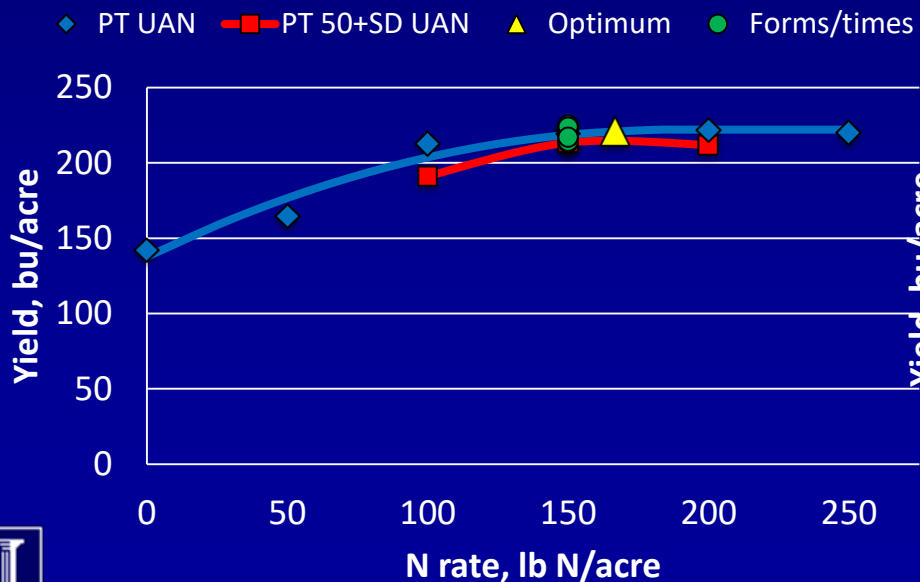
Urbana Form x timing 2014 Soy-Corn



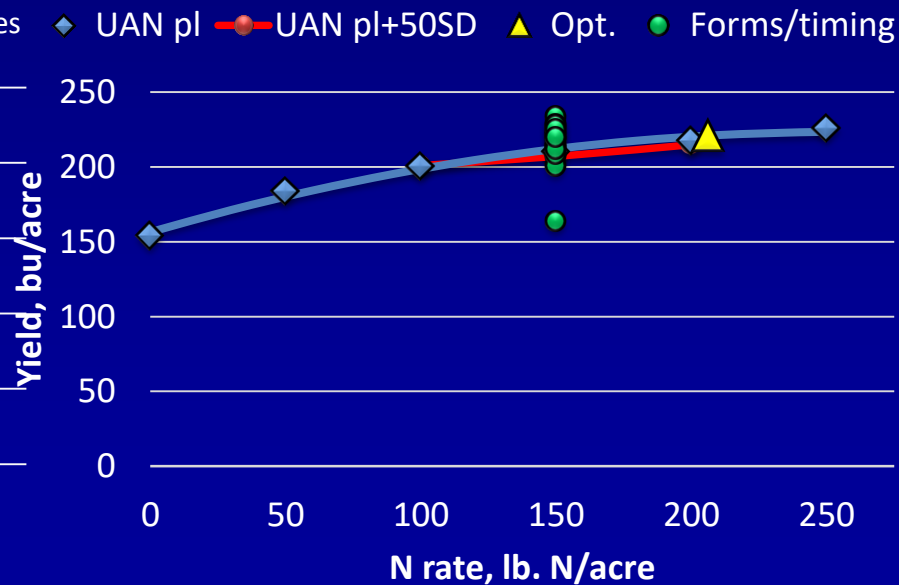
Urbana N Study 2015



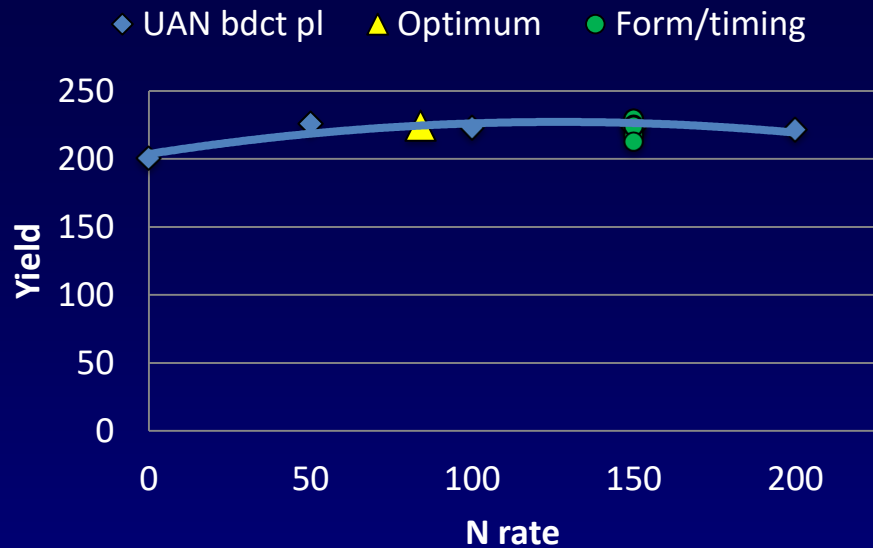
Urbana N study 2016



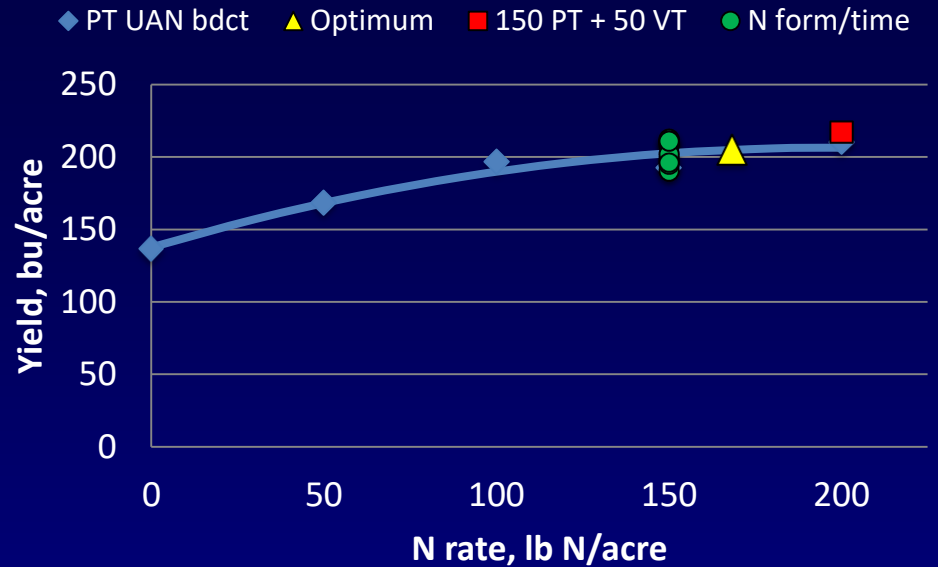
Urbana N Study 2017



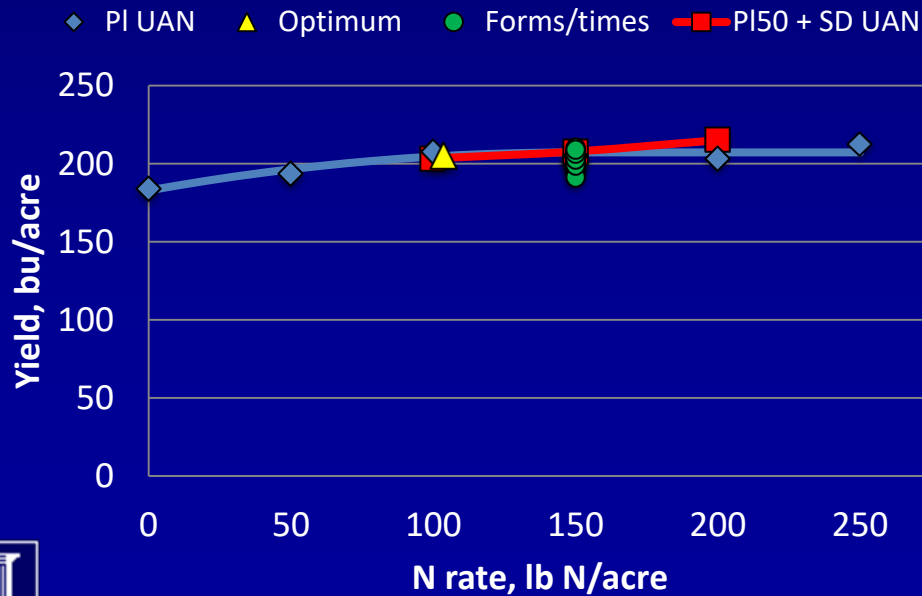
Perry 2014



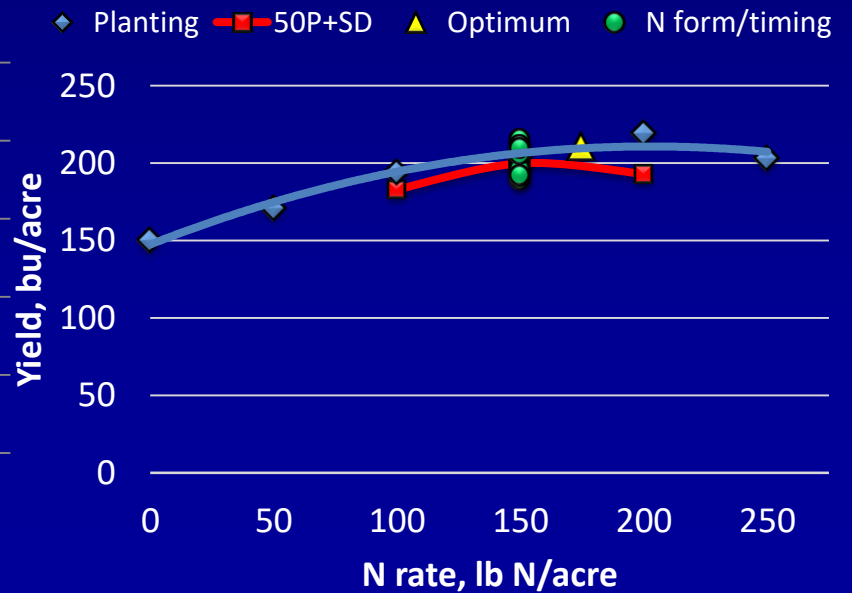
Perry 2015



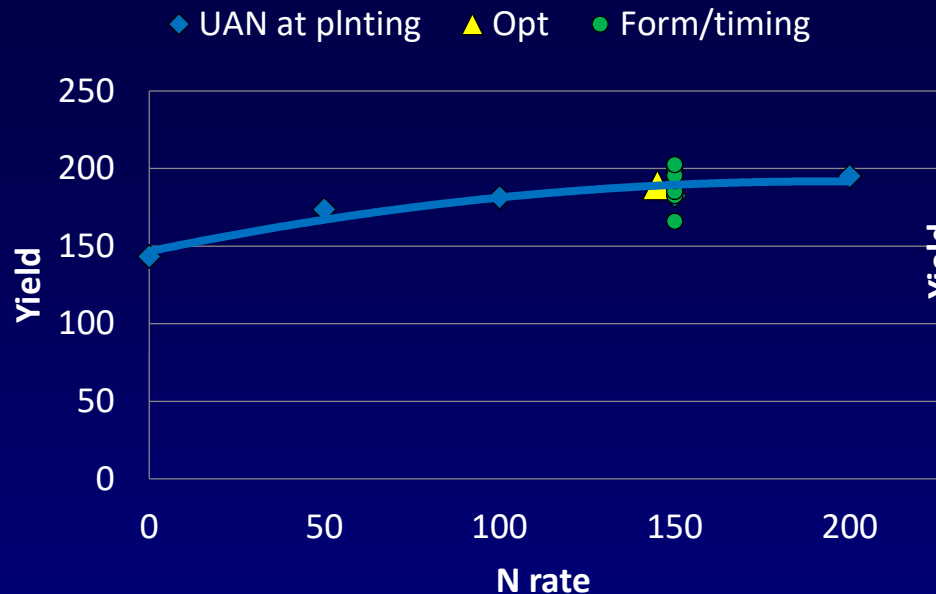
Perry 2016



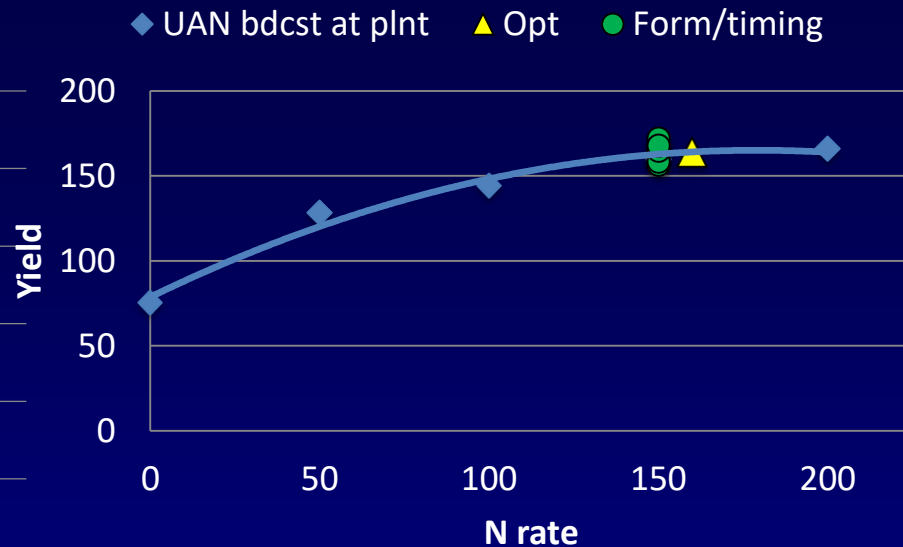
Perry 2017



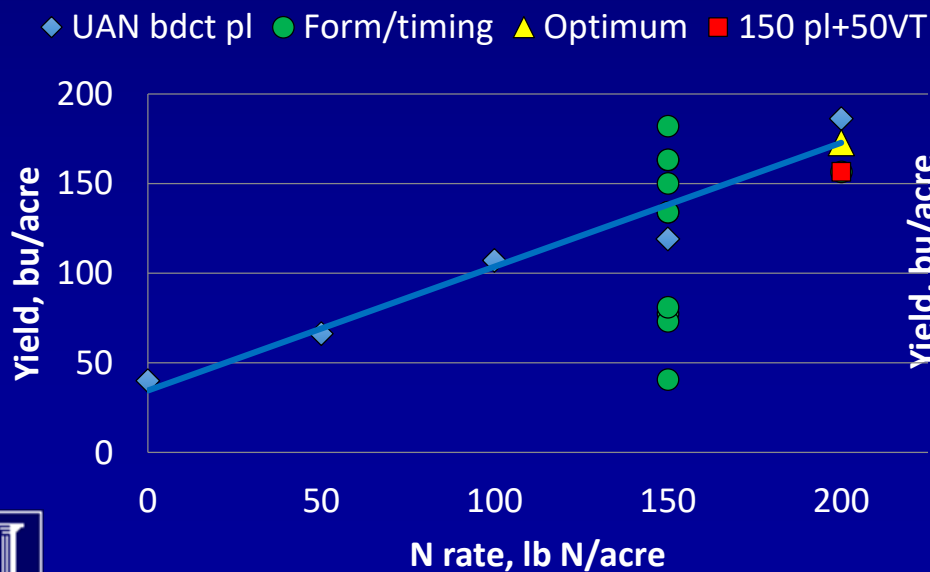
Brownstown Soy-Corn 2014



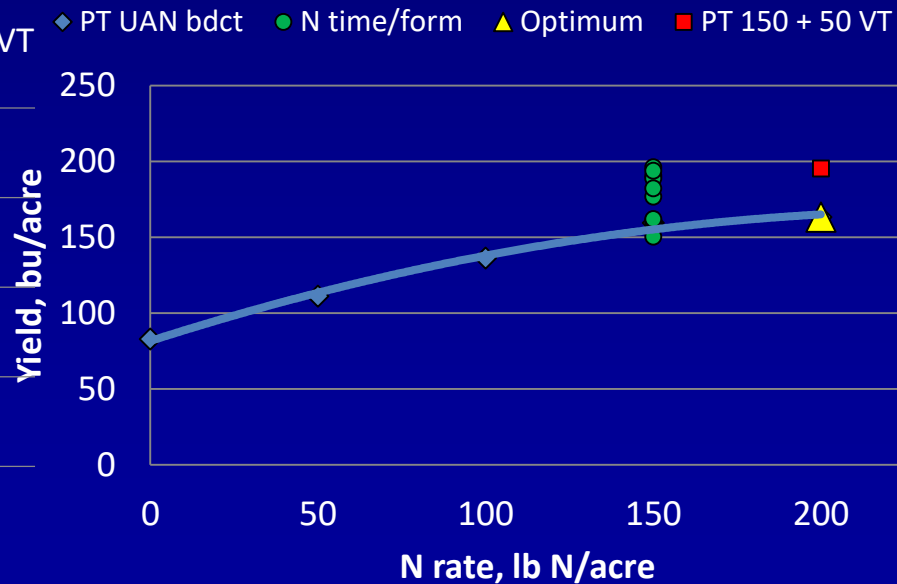
Dixon Springs Soy-Corn 2014



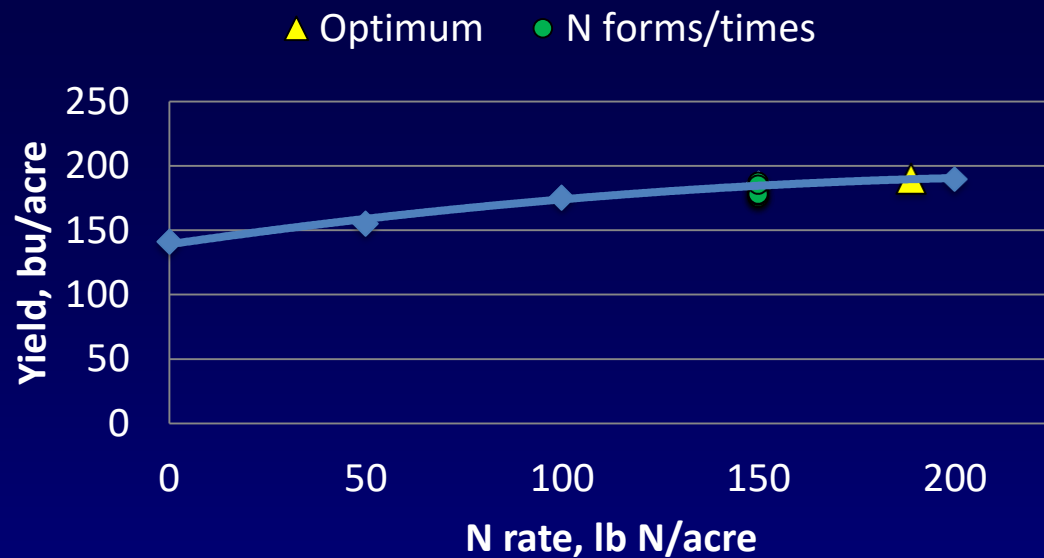
Brownstown, 2015



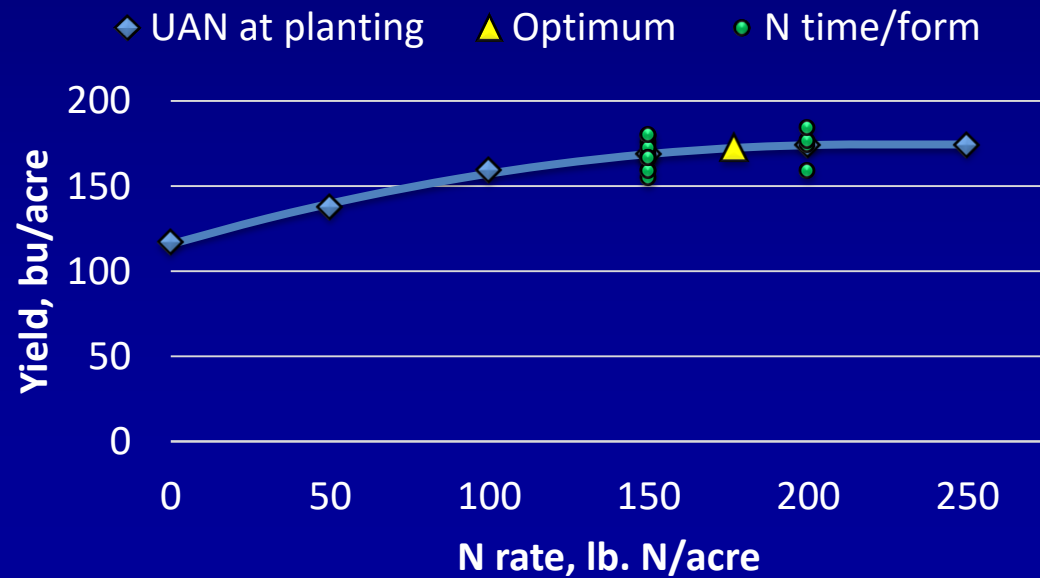
Dixon Springs N form x timing 2015



Neoga 2016

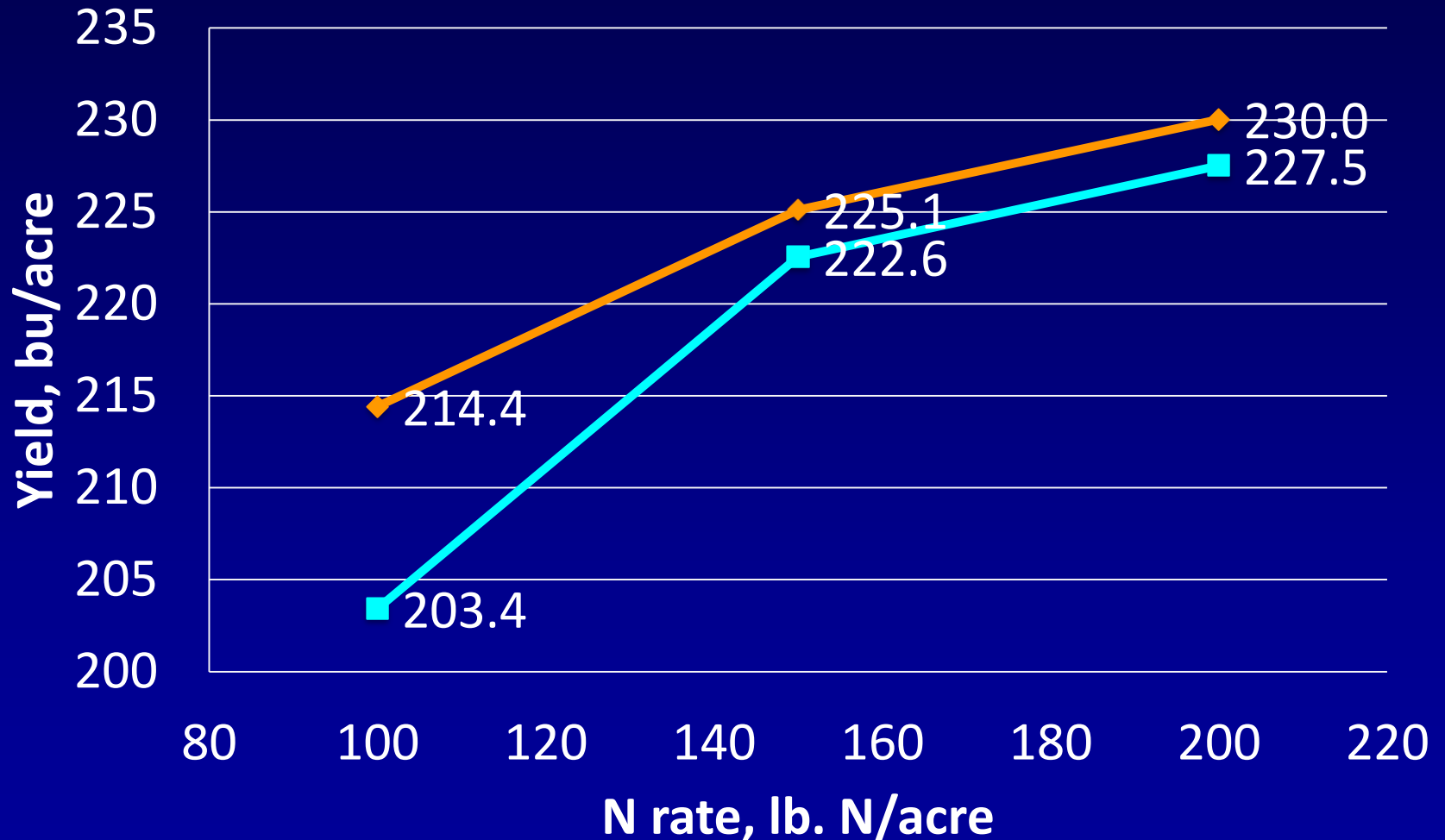


Neoga, 2017

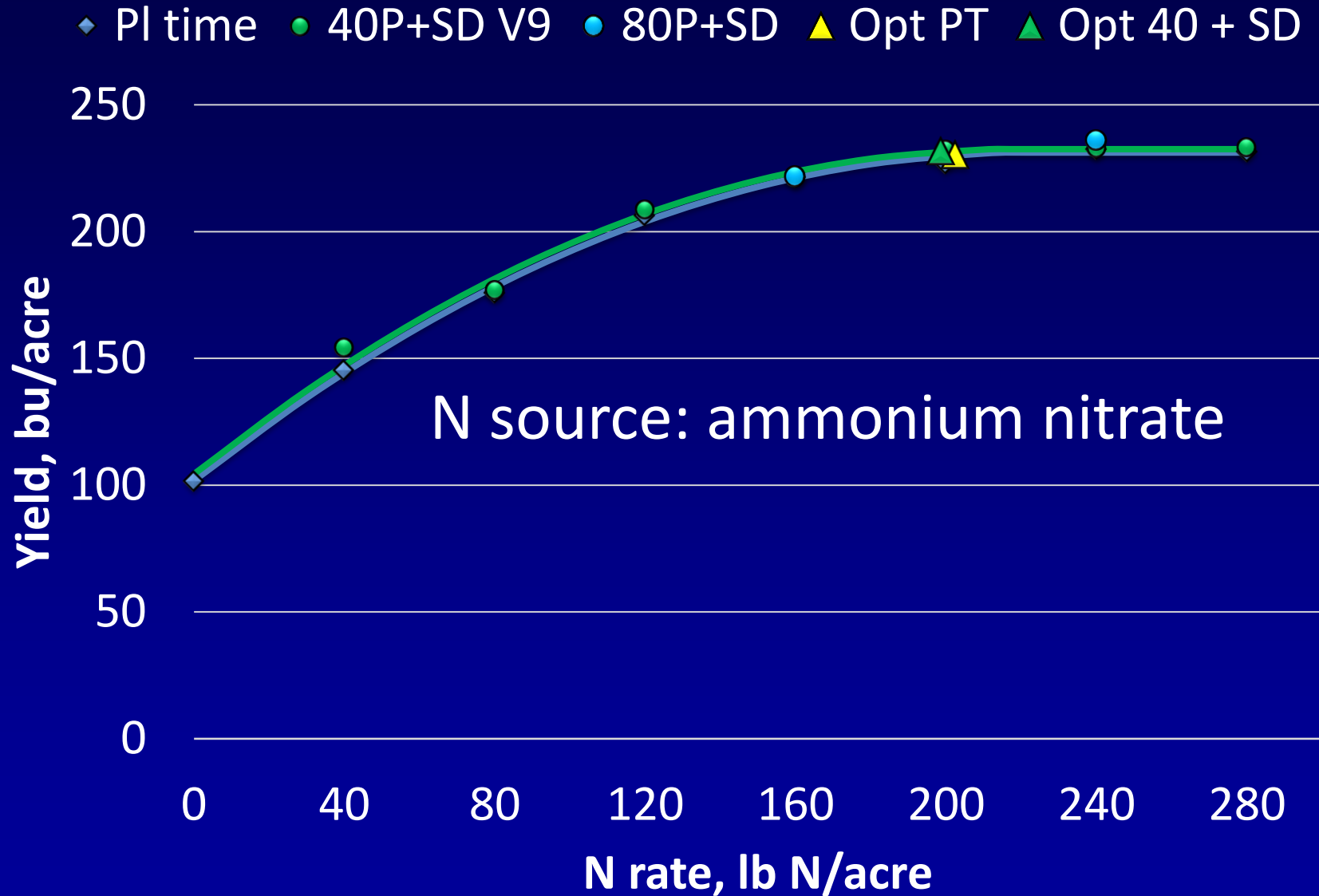


14 site-years, 2014-17

—◆— Planting —■— 50 Pl bd + Sidedress V5-6



Urbana Soy-Corn, 3-yr avg 2014-16



Split/sidedress N – better or not?

- Across site-years, split-N treatments (at 150 lb N total) have not yielded consistently more than UAN injected between the rows at planting time
- There are hints that not having all of the N available early may sometimes mean lower yields, even when sidedress is added
- A separate study showed no advantage applying 40 lb at planting and the rest at V9 compared to all at planting
- It's likely that we lose less N from medium- to heavy-textured soils than we think



Splitting N in different ways, 4 IL sites

Treatment-all 150 lb. N	Rank	avg 10 sites
2014-2016	out of 15	bu/acre
<u>All N applied at planting:</u>		
UAN injected mid-row (check)	4	220
<u>Split N application (1st at planting):</u>		
UAN 50 broadcast+UAN 100 injected V5	9	218
UAN 100 inj+UAN 50 injected V5	5	220
UAN 100 inj+Urea/AT 50 broadcast V5	7	219
UAN 100 inj+UAN 50 dribbled in-row V9	3	221
UAN 100 inj+Urea/AT 50 broadcast V9	10	218
<u>All N sidedressed:</u>		
UAN injected mid-row at V5	6	220
UAN dribbled mid-row at V9	14	214



Same idea, more splits, 4 IL sites

11 site-years, 2015-17 all at 150 lb N/acre

All N applied at planting:

UAN injected mid-row (check)

<u>Yield</u>	<u>Rank</u>
bu/ac	1 to 19

226	5
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Split N application (1st at planting):

UAN 50 broadcast+UAN 100 injected at V5

224	13
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UAN 100 inj+UAN 50 injected at V5

226	9
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UAN 100 inj+Urea+AT 50 broadcast at V5

228	3
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UAN 100 inj+UAN 50 dribbled in-row at V9

228	2
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UAN 100 inj+Urea+AT 50 broadcast at V9

226	7
-----	---

UAN 100 inj+UAN 50 dribbled in-row at V5

226	8
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UAN 100 inj+UAN 50 dribbled mid-row at VT

226	6
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UAN 100 inj+UAN 50 dribbled in-row at VT

226	4
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All N sidedressed:

UAN injected mid-row at V5

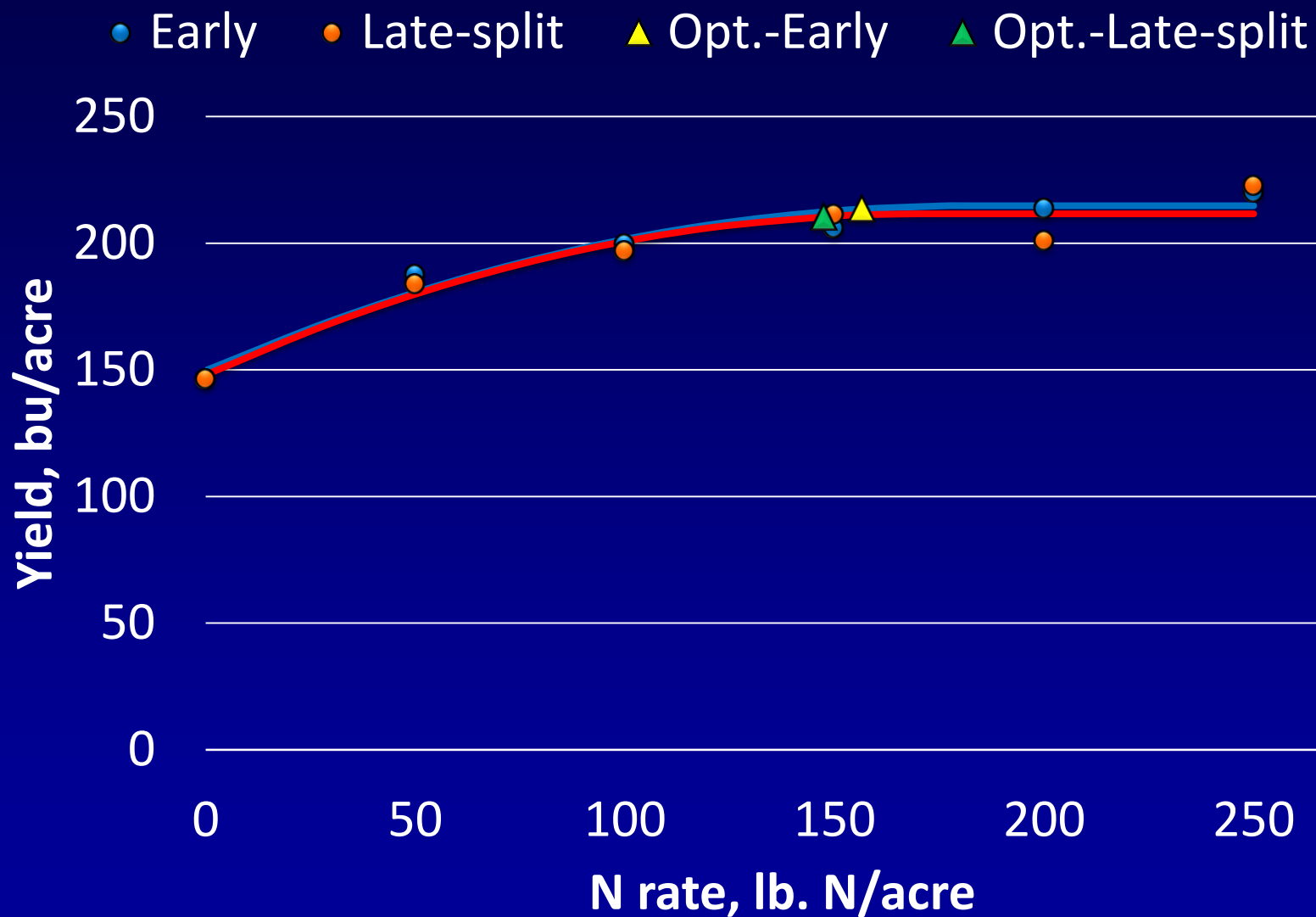
225	11
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UAN dribbled mid-row at V9

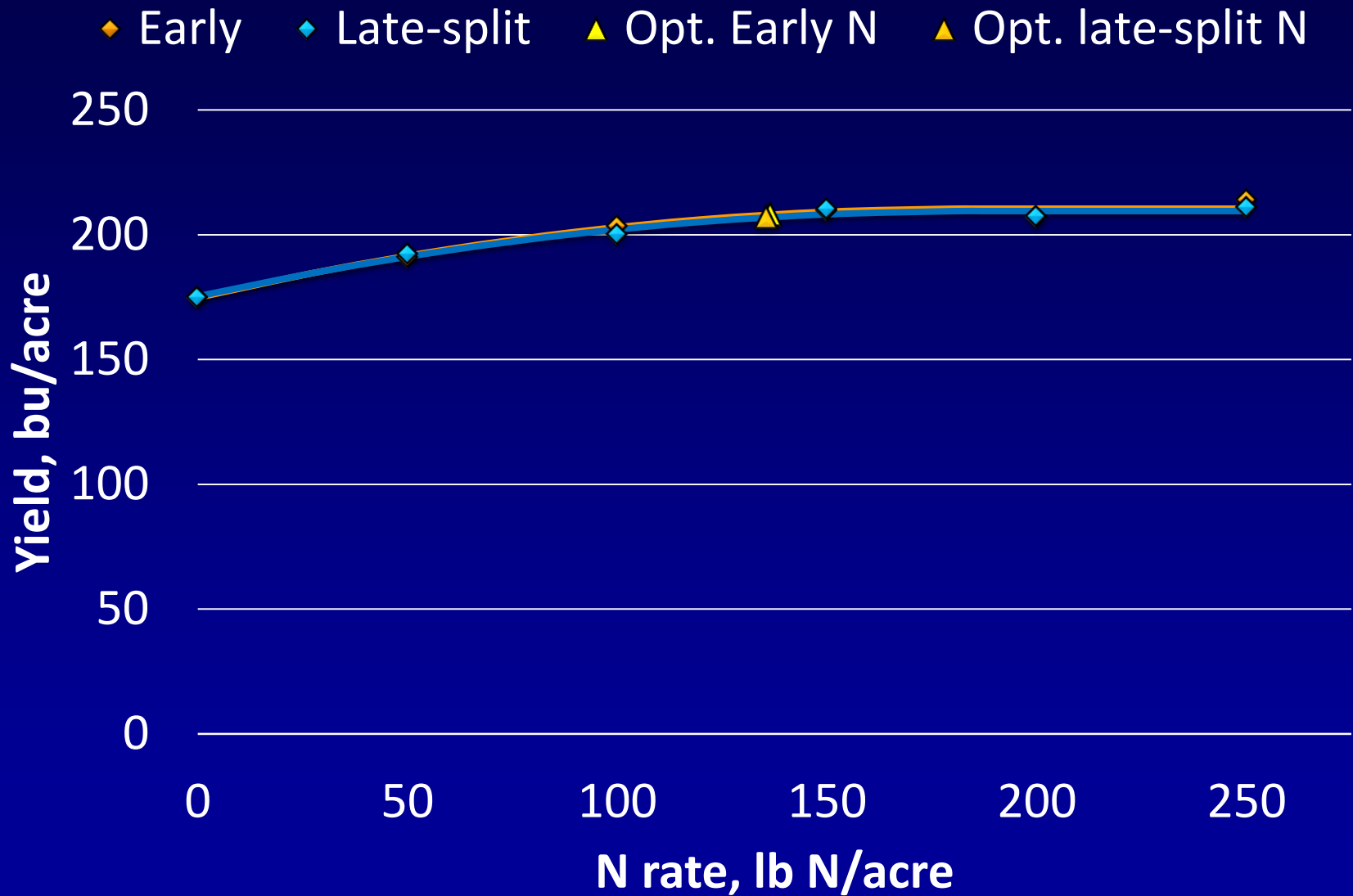
219	19
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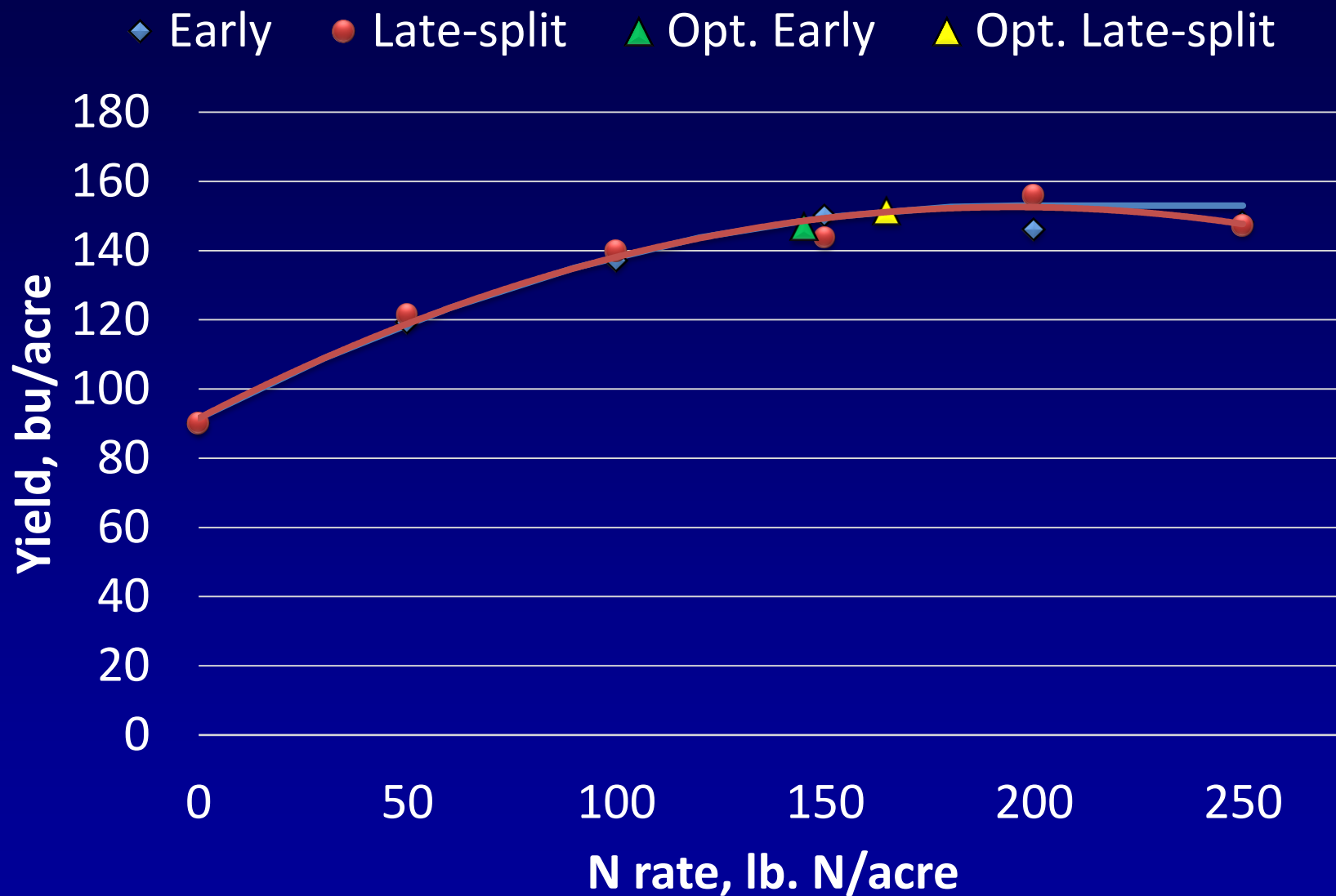
Urbana Soy-Corn 2017



Urbana Corn-Corn, 2017



Neoga Soy-Corn 2017



Late-split N, soy-corn

Site	Optimum N rate		Yield at opt. N		RTN advantage to late-split N
	Early	Late-split	Early	Late-split	
	lb/ac		bu/acre		\$/acre
DK 16	191	163	236	231	-\$6.85
MN 16	112	131	235	238	\$5.68
UR 16	129	124	233	234	\$6.24
OR 16	112	138	235	238	-\$0.04
DK 17	151	208	262	265	-\$11.93
MN 17	128	153	254	253	-\$9.75
UR 17	157	148	214	210	-\$7.71
OR 17	152	139	225	222	-\$6.10
NEO 17	145	165	147	151	\$9.13
Avg.	142	152	227	227	-\$2.37



Late-split N, corn-corn

Site	Optimum N rate		Yield at opt. N		RTN advantage to late-split N
	Early	Late-split	Early	Late-split	
	lb/ac		bu/acre		\$/acre
MN 16	151	128	231	233	\$15.13
UR 16	166	175	235	235	-\$2.91
OR 16	139	152	228	227	-\$7.20
MN 17	162	147	230	223	-\$21.22
UR 17	137	136	208	207	-\$3.71
OR 17	161	159	216	215	-\$3.98
Avg.	153	149	225	223	-\$3.98



Late-split N

- When planting-times rates are low, applying 50 lb N at tassel is necessary, BUT the yield after doing that is only the same as if all the N had been applied early
- Returns to N are not improved by a late-split approach, even with no cost assigned to late application
- If we used MRTN rates instead of finding optimum rates, we would have found the same thing: actual EONR values in these studies have typically been lower than MRTN rates



2015, 150-lb. rate

All N applied at planting:

	DeKalb	Monmouth	Urbana	3 sites		
				Rank	yield	
UAN injected mid-row	198	217	228	7	214	ab
UAN dribbled mid-row	173	211	222	19	202	c
Urea/Agrotain broadcast	190	213	237	9	213	ab
SuperU broadcast	193	216	245	1	218	a
ESN broadcast	183	213	237	12	211	abc
UAN/Agrotain broadcast	174	212	226	17	204	bc
NH3 injected mid-row	165	223	219	18	202	c
NH3/N-Serve injected mid-row	180	219	214	16	204	bc
UAN/Instinct II injected	178	225	229	13	211	abc

Split N application (1st at planting):

UAN 50 broadcast+UAN 100 inj V5	184	219	220	15	208	abc
UAN 100 inj+UAN 50 injected V5	198	219	227	4	215	a
UAN 100 inj+Urea/AT 50 brdcst V5	188	225	231	5	215	ab
UAN 100 inj+UAN 50 drbl in-row V9	198	213	230	8	214	ab
UAN 100 inj+Urea/AT 50 bdcst V9	182	219	232	11	211	abc
UAN 100 inj+UAN 50 drbl in-row V5	194	223	233	2	217	a
UAN 100 inj+UAN 50 drbl mid-row VT	173	215	241	14	210	abc
UAN 100 inj+UAN 50 drbl in-row VT	183	228	238	3	216	a

All N sidedressed:

V5 UAN injected mid-row V5	194	223	226	6	214	ab
UAN dribbled mid-row V9	190	218	227	10	211	abc



2016, 150-lb. rate

All N applied at planting:

	DeKalb	Monmouth	Urbana	Perry	4 sites		
					Rank	yield	
UAN injected mid-row	223	248	219	205	7	226	ab
UAN dribbled mid-row	223	248	216	197	13	224	abc
Urea/Agrotain broadcast	220	263	221	201	1	230	a
SuperU broadcast	222	256	223	206	2	230	a
ESN broadcast	239	250	214	210	3	230	a
UAN/Agrotain broadcast	212	251	219	191	18	219	bc
NH3 injected mid-row	209	251	222	210	11	225	ab
NH3/N-Serve injected mid-row	--	247	219	199	15	223	abc
UAN/Instinct II injected	213	246	214	203	16	222	abc

Split N application (1st at planting):

UAN 50 broadcast+UAN 100 inj V5	214	258	213	208	9	226	ab
UAN 100 inj+UAN 50 injected V5	216	240	220	201	14	223	abc
UAN 100 inj+Urea/AT 50 brdcst V5	223	244	223	201	10	226	ab
UAN 100 inj+UAN 50 drbl in-row V9	225	247	222	202	5	228	ab
UAN 100 inj+Urea/AT 50 bdcst V9	221	243	223	205	8	226	ab
UAN 100 inj+UAN 50 drbl in-row V5	208	250	222	203	6	227	ab
UAN 100 inj+UAN 50 drbl mid-row VT	218	251	225	206	4	229	ab
UAN 100 inj+UAN 50 drbl in-row VT	218	240	224	209	12	225	ab

All N sidedressed:

V5 UAN injected mid-row V5	215	245	218	202	17	222	abc
UAN dribbled mid-row V9	195	236	216	194	19	214	cd



2017, 150-lb. rate

All N applied at planting:

	<u>DeKalb</u>	<u>Monmouth</u>	<u>Urbana</u>	<u>Perry</u>	<u>4 sites</u>		
					rank	yield	
UAN injected mid-row	256	270	210	204	11	235	bcde
UAN dribbled mid-row	266	264	222	202	4	239	abcde
Urea/Agrotain broadcast	252	265	209	191	18	230	ef
SuperU broadcast	257	259	226	203	7	236	abcde
ESN broadcast	263	263	164	211	19	229	efg
UAN/Agrotain broadcast	276	269	219	205	1	242	ab
NH3 injected mid-row	257	263	228	198	6	237	abcde
NH3/N-Serve injected mid-row	265	249	214	196	15	231	def
UAN/Instinct II injected	254	253	208	206	17	230	ef

Split N application (1st at planting):

UAN 50 broadcast+UAN 100 inj V5	270	257	207	200	13	233	bcdef
UAN 100 inj+UAN 50 injected V5	262	250	233	203	10	236	abcde
UAN 100 inj+Urea/AT 50 brdcst V5	270	264	223	200	3	239	abcde
UAN 100 inj+UAN 50 drbl in-row V9	267	265	228	204	2	240	abc
UAN 100 inj+Urea/AT 50 bdcst V9	263	254	219	215	5	237	abcde
UAN 100 inj+UAN 50 drbl in-row V5	270	251	214	190	14	231	cdef
UAN 100 inj+UAN 50 drbl mid VT	256	256	225	210	9	236	abcde
UAN 100 inj+UAN 50 drbl in-row VT	266	268	212	192	12	234	bcde

All N sidedressed:

V5 UAN injected mid-row V5	264	255	214	213	8	236	abcde
UAN dribbled mid-row V9	271	251	201	198	16	230	ef



Treatment

Rank (1 to 19)

Yield p=0.1

2015

2016

2017

3-yr

bu/acre

All N applied at planting:

UAN injected mid-row	7	7	11	5	226	abcd
UAN dribbled mid-row	19	13	4	16	223	cdef
Urea/Agrotain broadcast	9	1	18	10	226	abcde
SuperU broadcast	1	2	7	1	229	a
ESN broadcast	12	3	19	12	225	abcdef
UAN/Agrotain broadcast	17	18	1	14	223	bcdef
NH3 injected mid-row	18	11	6	15	223	cdef
NH3/N-Serve injected mid-row	16	15	15	18	221	ef
UAN/Instinct II injected	13	16	17	17	222	def

Split N application (1st at planting):

UAN 50 broadcast+UAN 100 injected V5	15	9	13	13	224	bcdef
UAN 100 inj+UAN 50 injected V5	4	14	10	9	226	abcde
UAN 100 inj+Urea/AT 50 broadcast V5	5	10	3	3	228	abc
UAN 100 inj+UAN 50 dribbled in-row V9	8	5	2	2	228	ab
UAN 100 inj+Urea/AT 50 broadcast V9	11	8	5	7	226	abcde
UAN 100 inj+UAN 50 dribble in-row V5	2	6	14	8	226	abcde
UAN 100 inj+UAN 50 dribble mid-row VT	14	4	9	6	226	abcd
UAN 100 inj+UAN 50 dribble in-row VT	3	12	12	4	226	abcd

All N sidedressed:

UAN injected mid-row V5	6	17	8	11	225	abcde
UAN dribbled mid-row V9	10	19	16	19	219	f

Treatment	Rank	avg 14 sites
15 treatments, 14 sites, 2014-17	1 to 15	bu/acre
<u>All N applied at planting:</u>		
UAN injected mid-row	6	220 abc
UAN dribbled mid-row	12	215 def
Urea/Agrotain broadcast	3	223 a
SuperU broadcast	1	223 ab
ESN broadcast	11	219 abcde
UAN/Agrotain broadcast	13	213 f
NH ₃ injected mid-row	10	216 cdef
NH ₃ /N-Serve injected mid-row	14	216 cdef
<u>Split N application (1st at planting):</u>		
UAN 50 broadcast+UAN 100 injected V5	9	218 bcde
UAN 100 inj+UAN 50 injected V5	5	220 abc
UAN 100 inj+Urea/AT 50 broadcast V5	4	219 abcd
UAN 100 inj+UAN 50 dribbled in-row V9	2	221 abc
UAN 100 inj+Urea/AT 50 broadcast V9	8	218 cde
<u>All N sidedressed:</u>		
UAN injected mid-row at V5	7	220 abc
UAN dribbled mid-row at V9	15	214 ef



The deep jungle: N timing & form

- Treatments never very good:
 - NH_3 with or without N-Serve injected at planting
 - UAN with Instinct II injected at planting
 - UAN 50 broadcast at planting + 100 UAN injected at V5-6
 - UAN 150 dribbled mid-row at V9
- Treatments consistently good:
 - UAN 150 injected at planting
 - SuperU 150 broadcast at planting
 - UAN 100 injected at planting + urea/Agrotain broadcast at V5
 - UAN 100 injected at planting + UAN 50 in-row dribble at V9

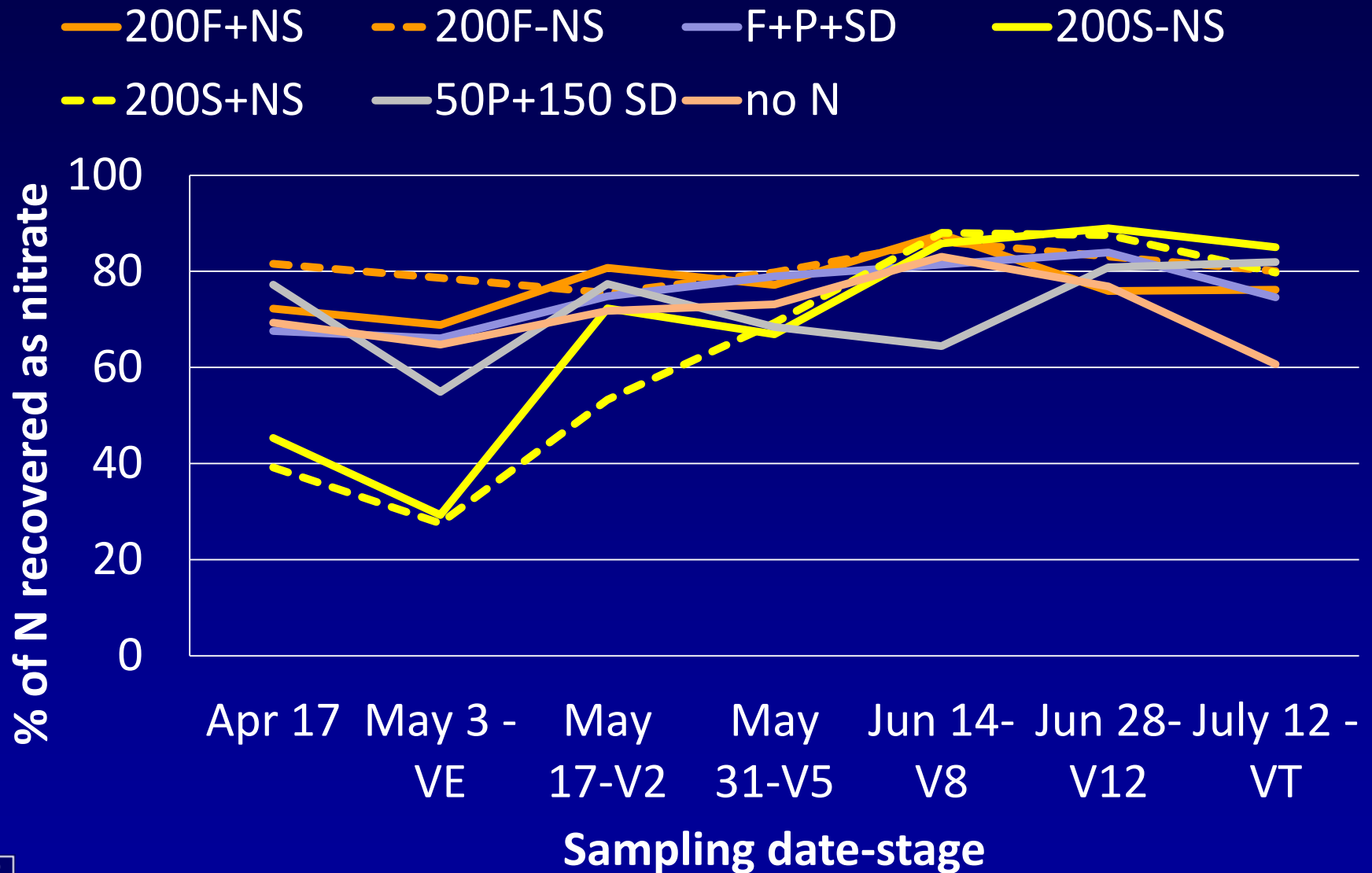


The deep jungle: N timing & form

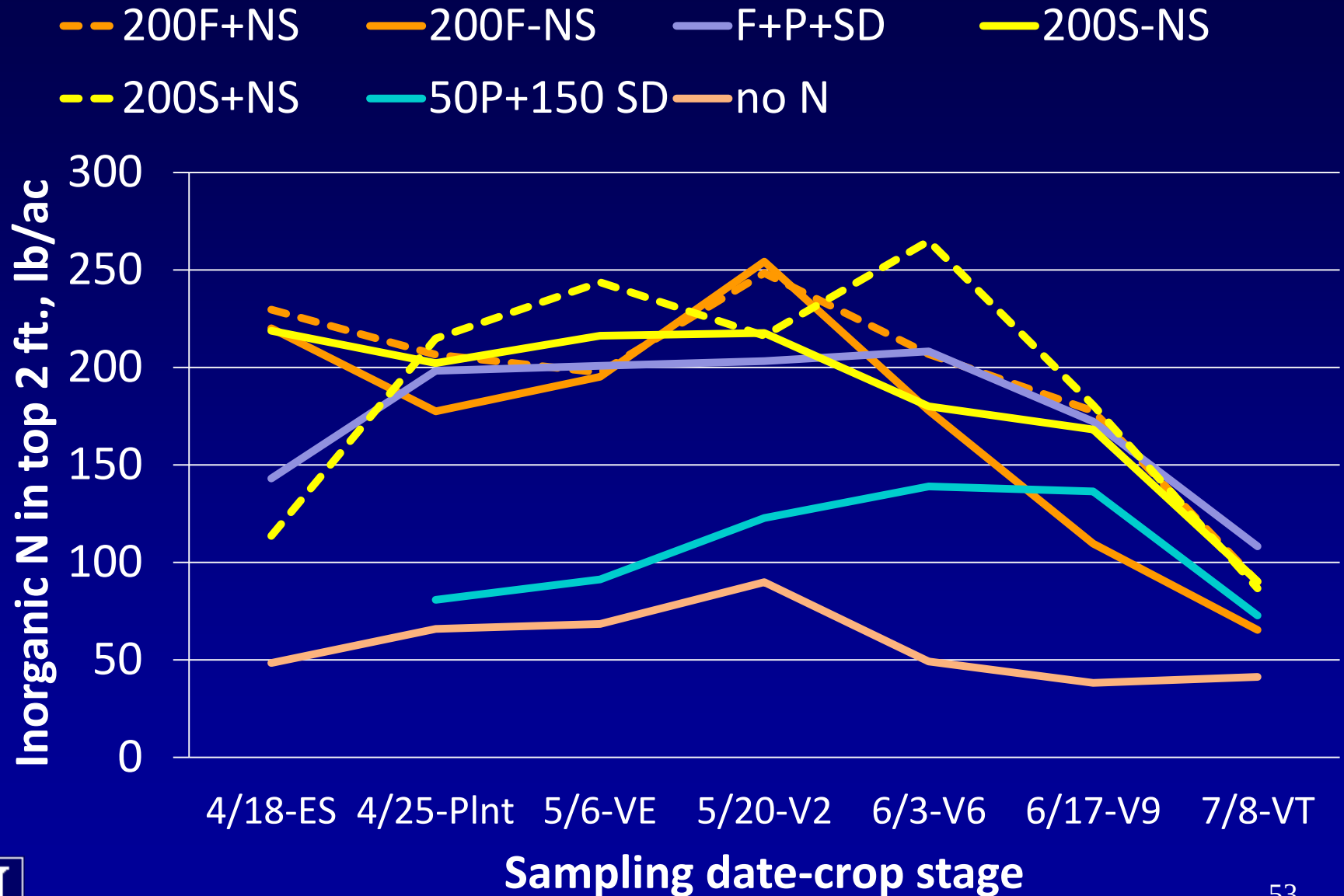
- Treatments giving variable results, with average overall response:
 - ESN 150 broadcast at planting
 - Urea 150+Agrotain broadcast at planting
 - UAN 100 injected at planting + UAN 50 injected at V5
 - UAN 100 injected at planting + UAN 50 dribbled in-row at V5
 - UAN 100 injected at planting + UAN 50 dribbled mid-row at VT
 - UAN 100 injected at planting + UAN 50 dribbled in-row at VT
 - UAN 150 injected mid-row at V5



Urbana 2017

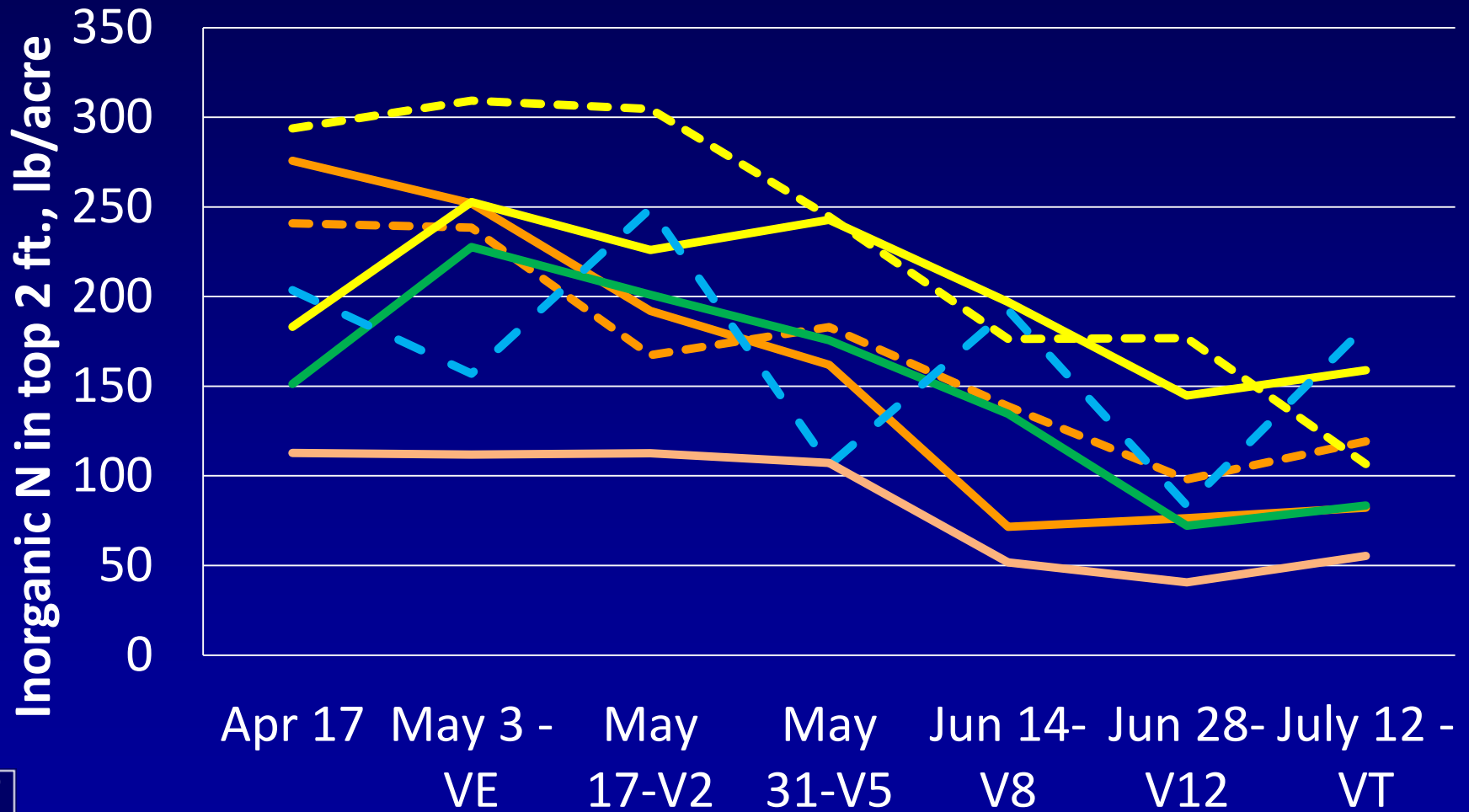


Urbana N tracking 2016

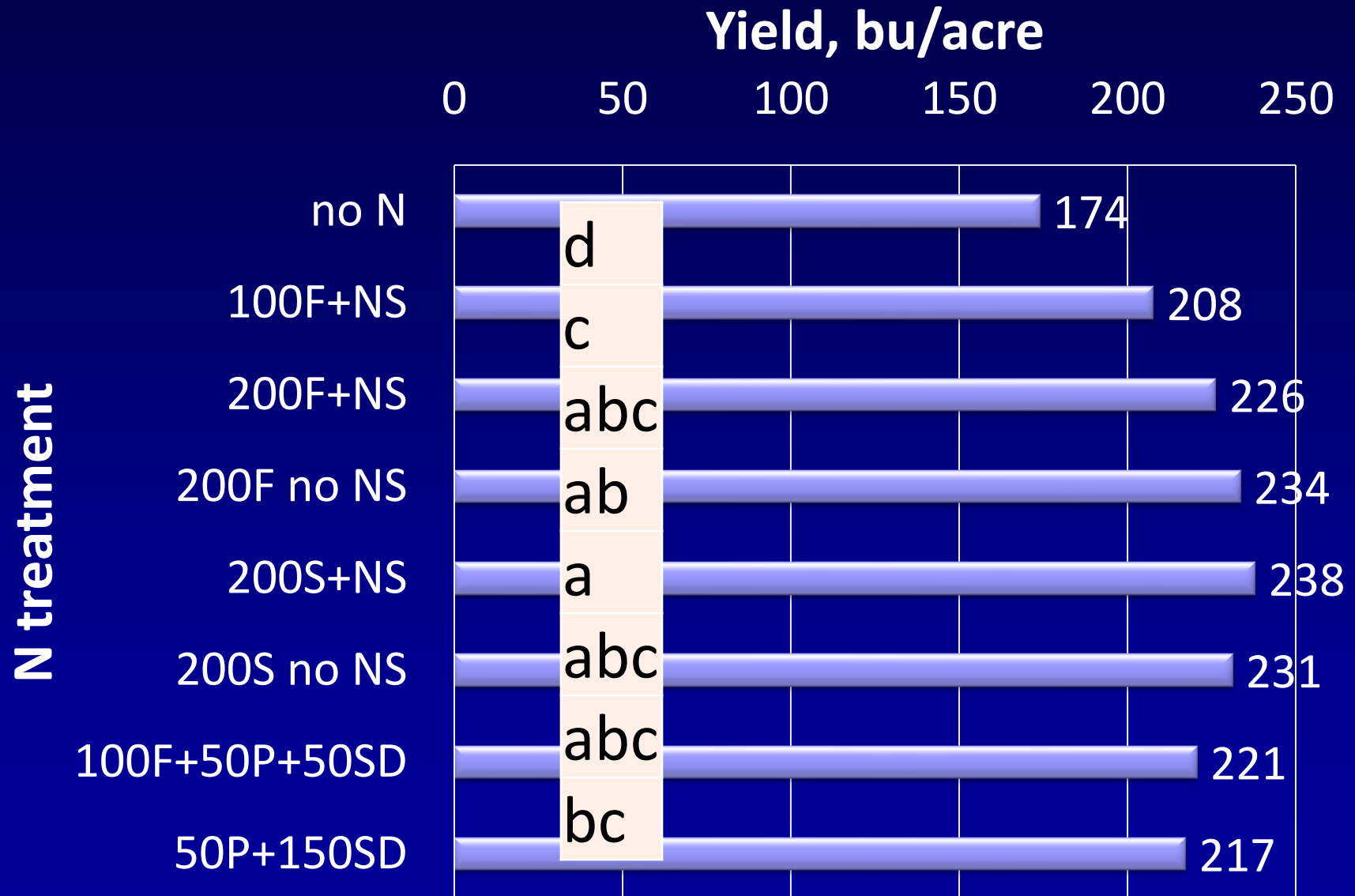


Urbana 2017

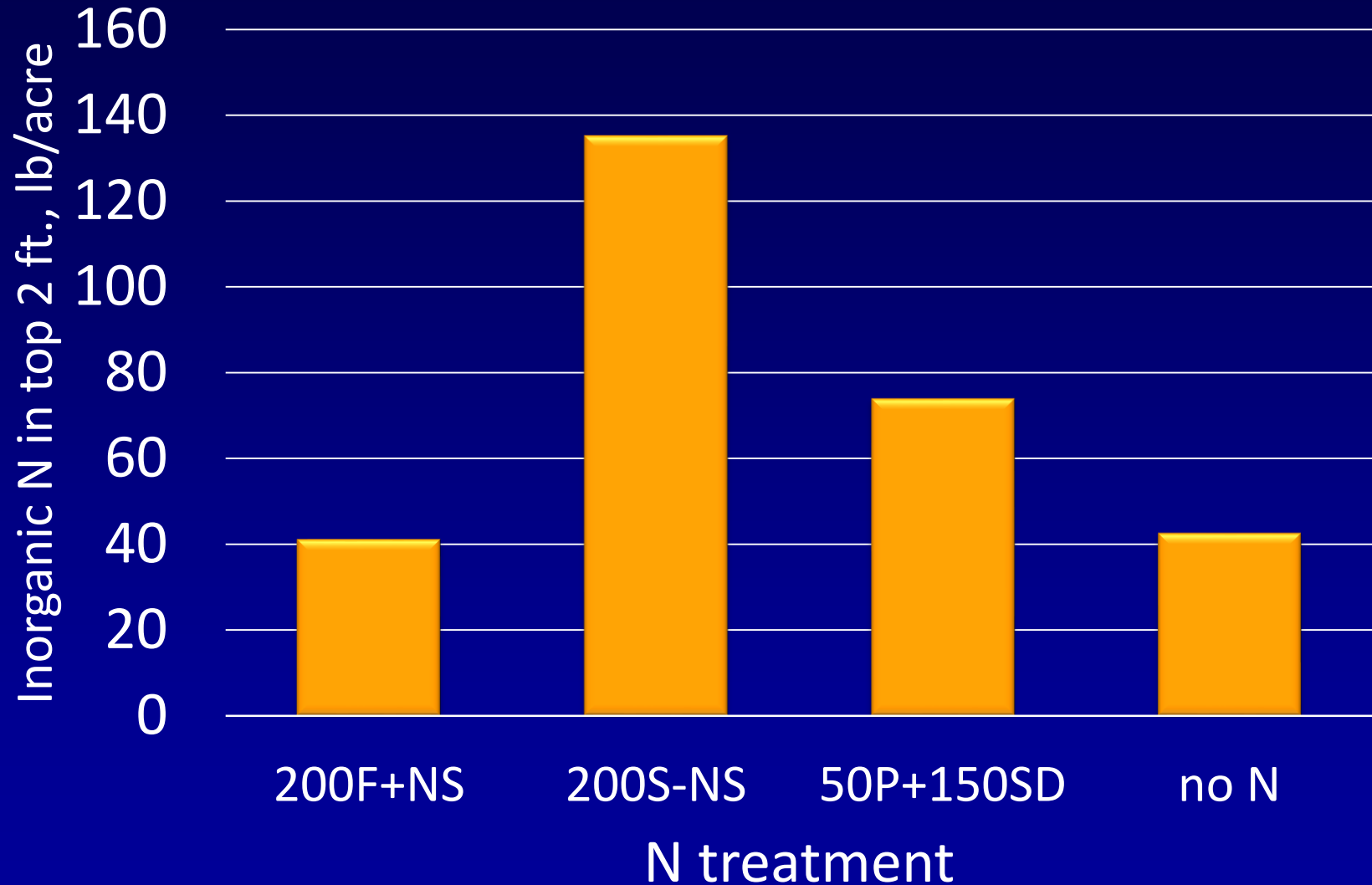
— 200F+NS - - 200F-NS — F+P+SD — 200S-NS
 - - 200S+NS - - 50P+150 SD — no N



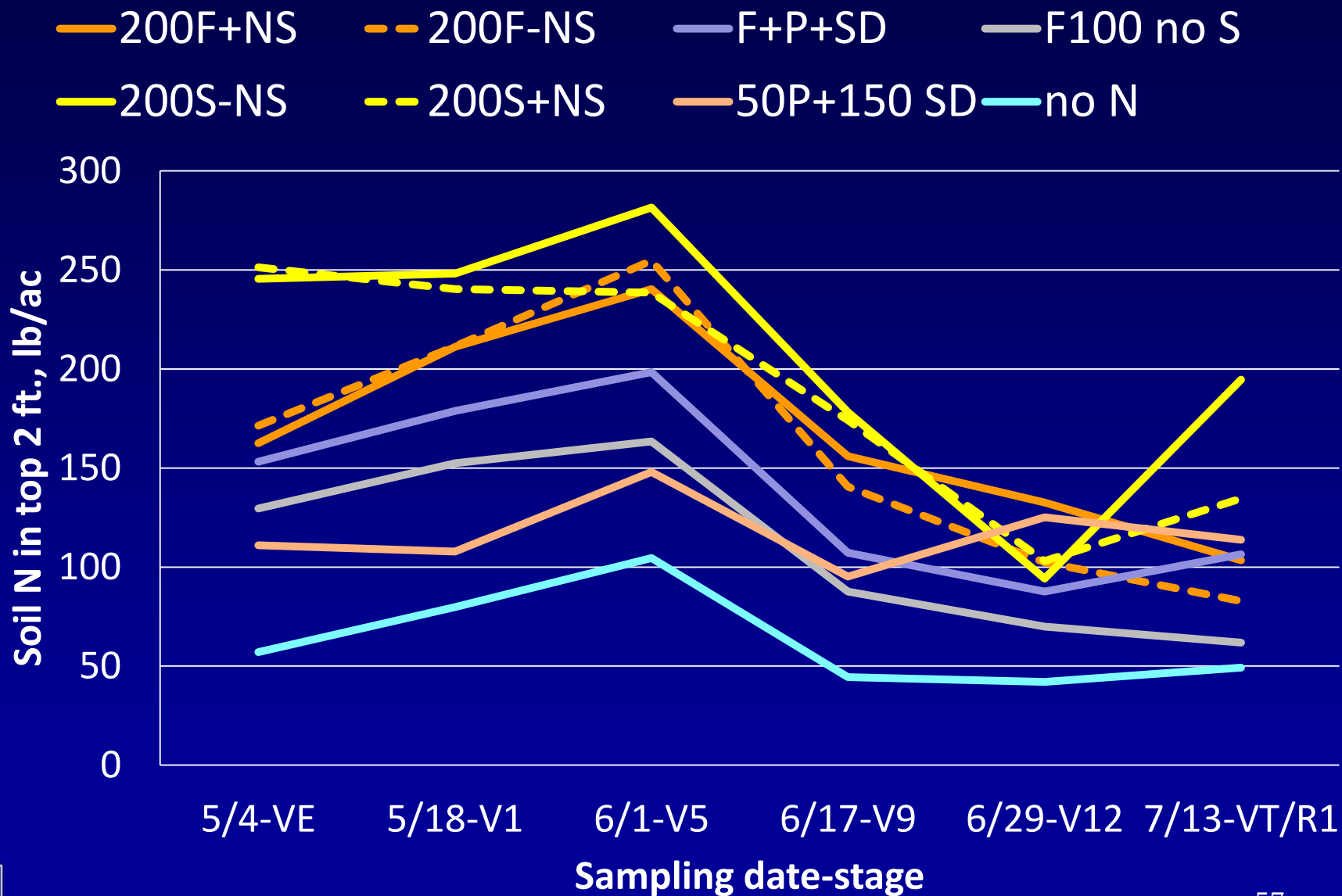
Urbana N-tracking yields 2017



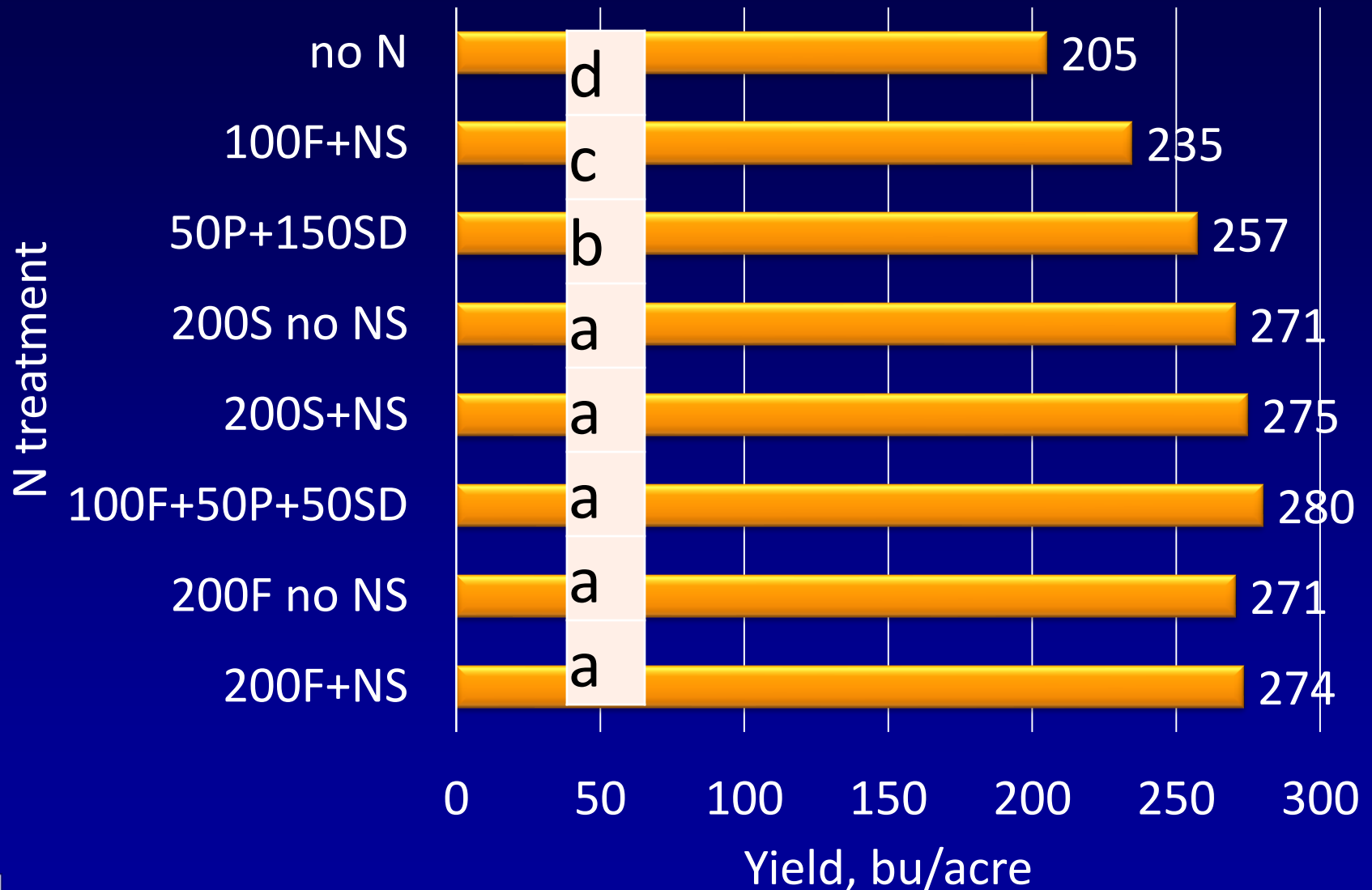
Urbana soil N at maturity, 2017



Monmouth 2017

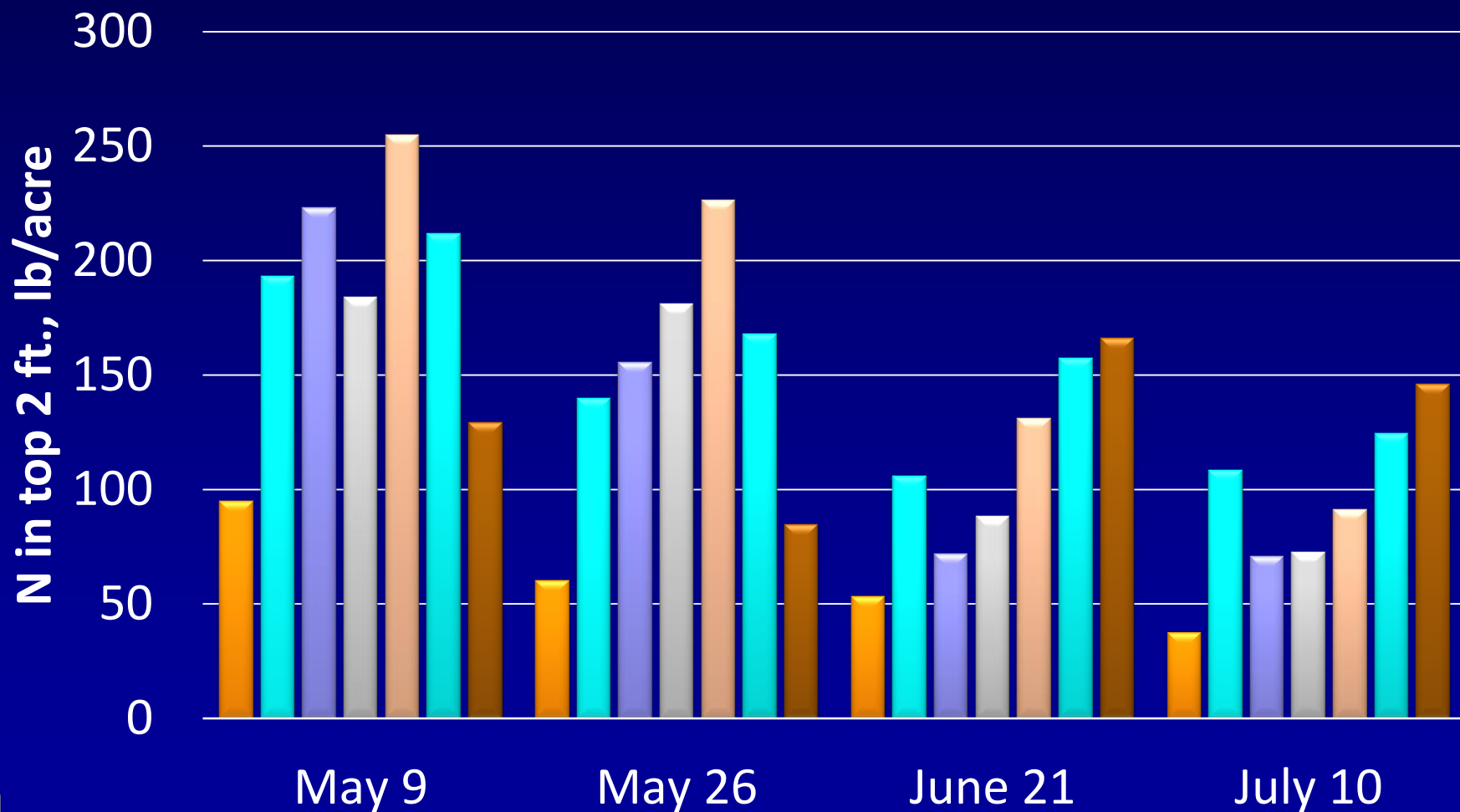


Monmouth N-tracking yields, 2017

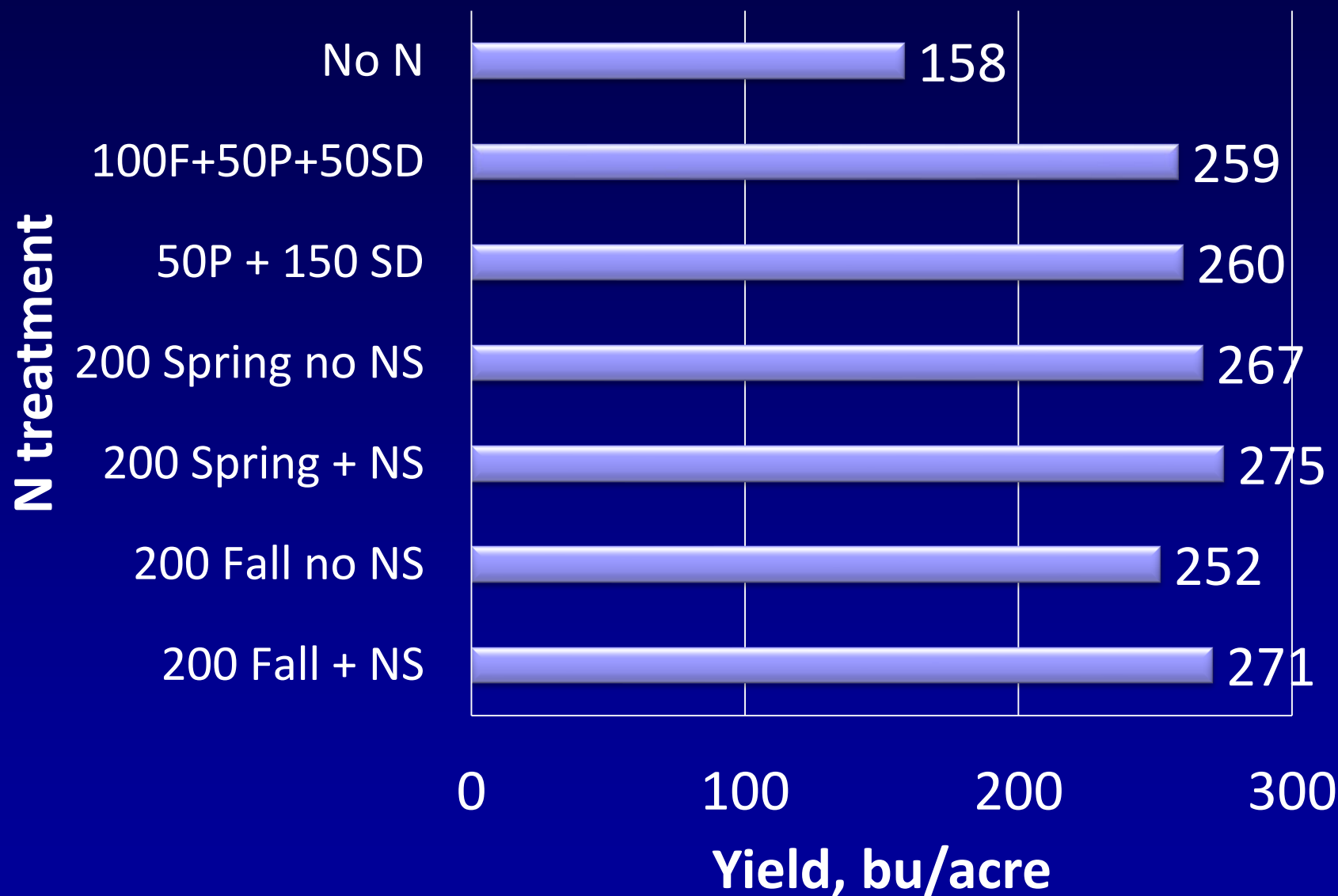


On-farm N tracking 2017, avg 3 sites

■ No N ■ 100F+P+SD ■ 200F no NS ■ 200F + NS
■ 200S no NS ■ 200S + NS ■ 50P+150 SD



Average of 3 on-farm S-C trials, 2017



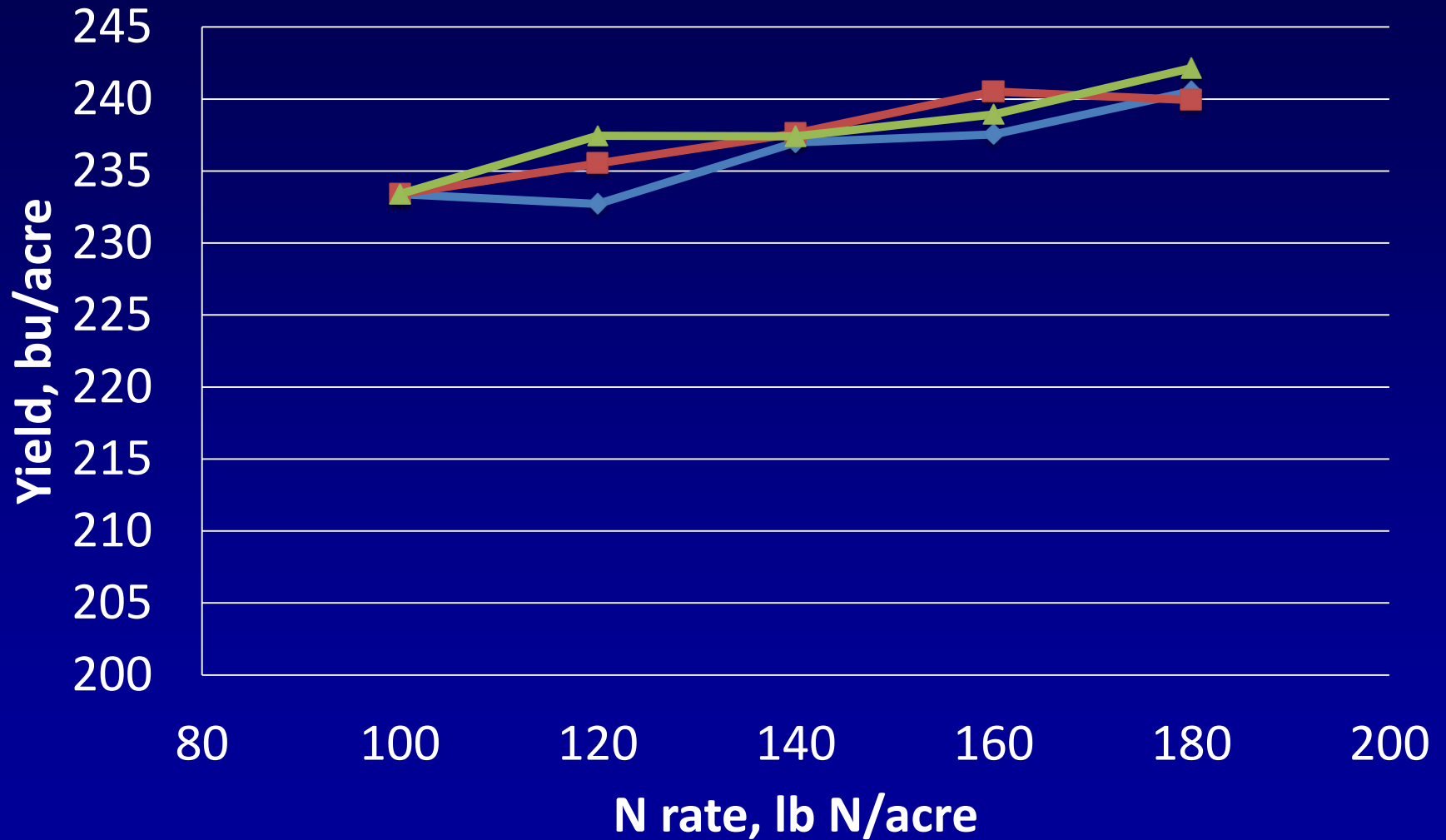
Soil N and yield-it's not simple

- The amount of soil N available prior to certain growth stages may be more critical than the amount of N at that stage – a temporal factor that won't be easy to untangle
- But a crop well-supplied with up to VT has no need for added N: late season N stress is almost always associated with inadequate soil water, not lack of soil N
- N timing (and form) studies generally show no yield benefit to delaying some N (which increases soil N in late vegetative stages)



DAP as N Source, 4 sites

◆ Spr UAN ■ Fall DAP ▲ Spr DAP





THANK YOU

