

N, P, K Fertilizer Opportunities for Better Soybean Yields

Laura Lindsey
Indiana CCA Conference
Dec. 18, 2019



THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL,
AND ENVIRONMENTAL SCIENCES

Do you need N fertilizer on soybean?

- Probably not...

Do soybeans need nitrogen?

- Yes...Soybean seed contain a large amount of protein → High demand for N

Crop	~lb N in seed	~lb N in stover	Total lb N
200 bu corn	156	114	270
60 bu soybean	210	80	290
80 bu soybean	280	~107	~387
100 bu soybean	350	~133	~483

Schmidt, 2013

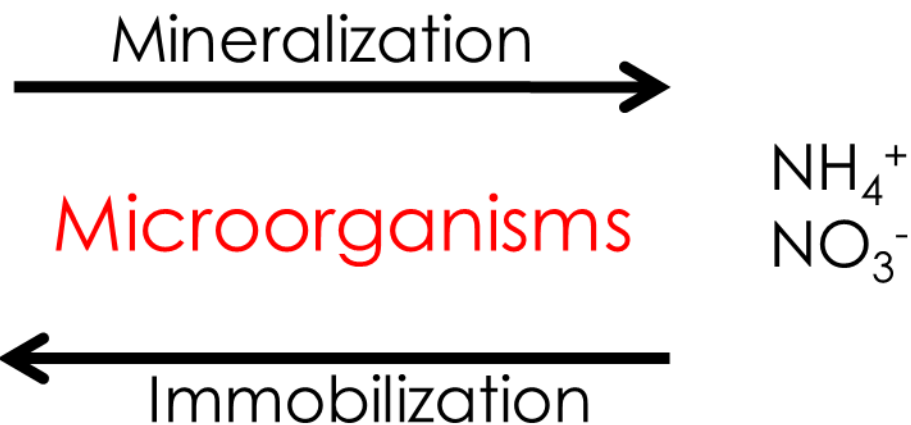
Where does this nitrogen come from?

- N uptake from the soil
- Biological N fixation

N From Soil



Organic nitrogen



Mineralization Depends On:

- Temperature
- Moisture
- Soil pH
- C:N Ratio

Material	C:N Ratio
rye straw	82:1
wheat straw	80:1
oat straw	70:1
corn stover	57:1
rye cover crop (anthesis)	37:1
pea straw	29:1
rye cover crop (vegetative)	26:1
mature alfalfa hay	25:1
Ideal Microbial Diet	24:1
rotted barnyard manure	20:1
legume hay	17:1
beef manure	17:1
young alfalfa hay	13:1
hairy vetch cover crop	11:1
soil microbes (average)	8:1



↑
slower

Relative
Decomposition
Rate

↓
faster



USDA

Nitrogen Mineralization from OM

	Total Nitrogen Per Acre	Amount Released	Plant Available N
Organic Matter	3,500 lb N/acre	3%	105 lb N/acre
Crop Residue	100 lb N/acre	50%	50 lb N/acre
			TOTAL: 155 lb N/acre



Sawyer et al., 2006

How much N from fixation?

- ~110 lb N/acre through N fixation (average of 337 studies)
- Is soil N + fixation enough to meet N requirements in high-yielding situations?
 - (yields > 65 bu/acre)

Salvagiotti et al., 2008

Synthesis Analysis of N Trials

- Data from 1996-2016
- 105 locations from 16 states
- 5,991 plot-specific yield data

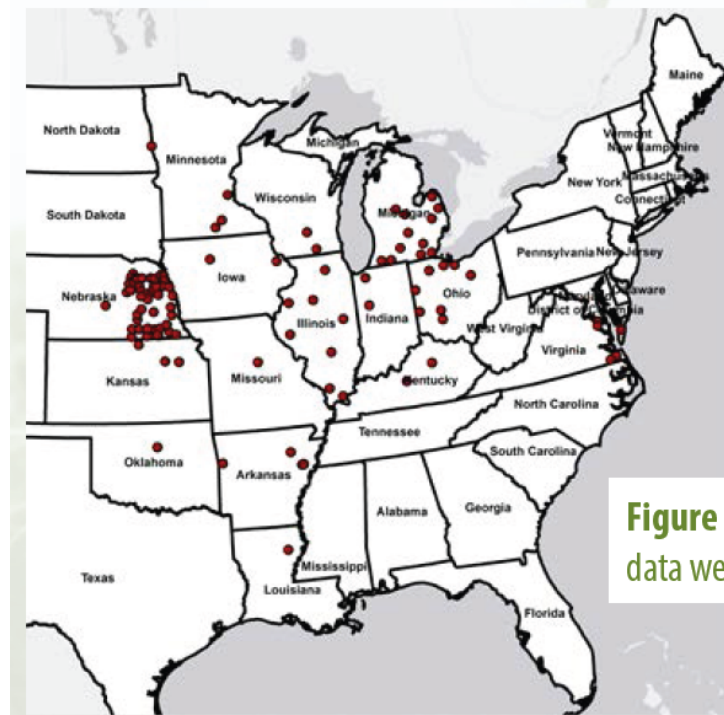
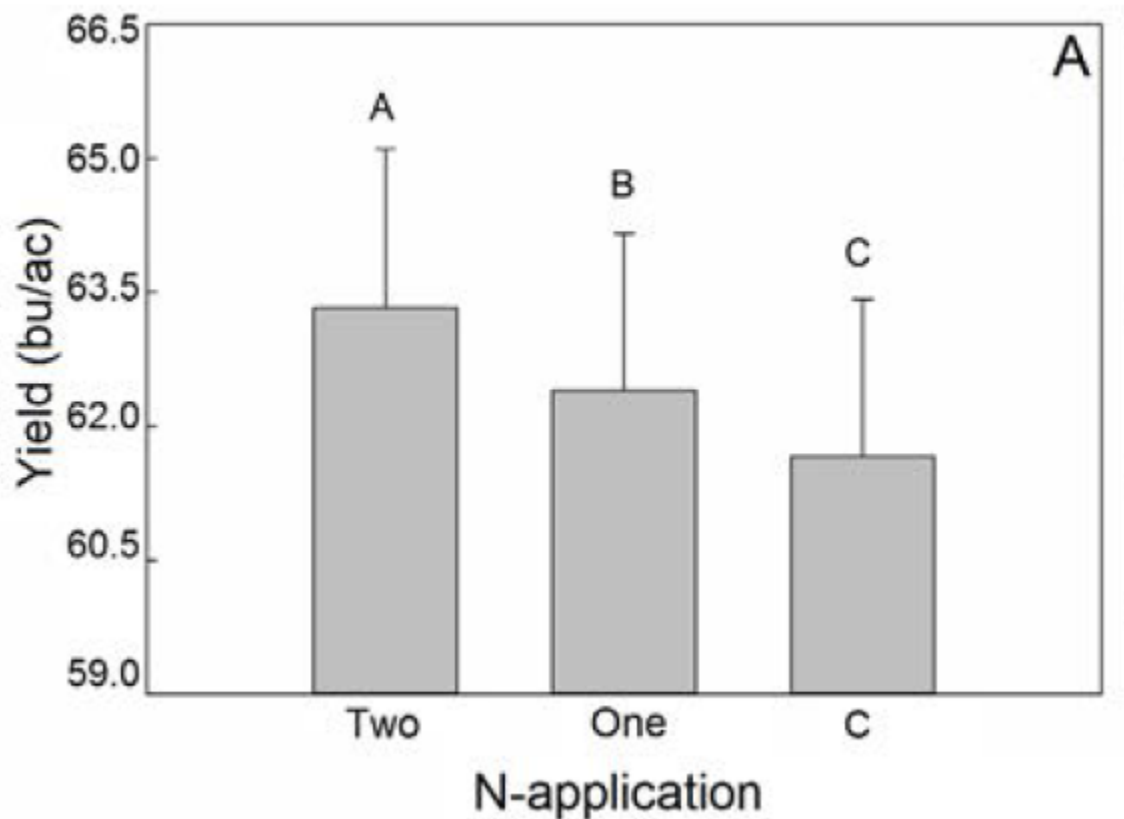


Figure 1. Locations of individual studies from which data were combined into a single database.

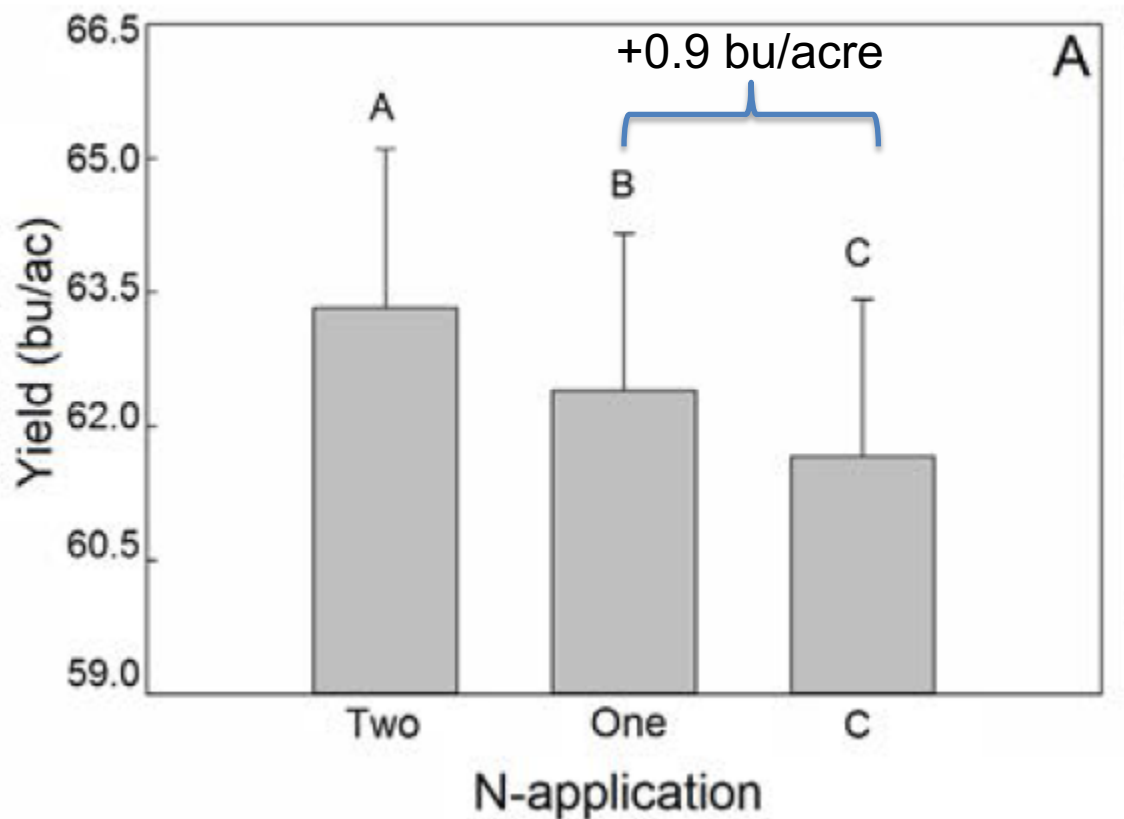
Mourtzinis et al, 2018

Results- Number of Applications



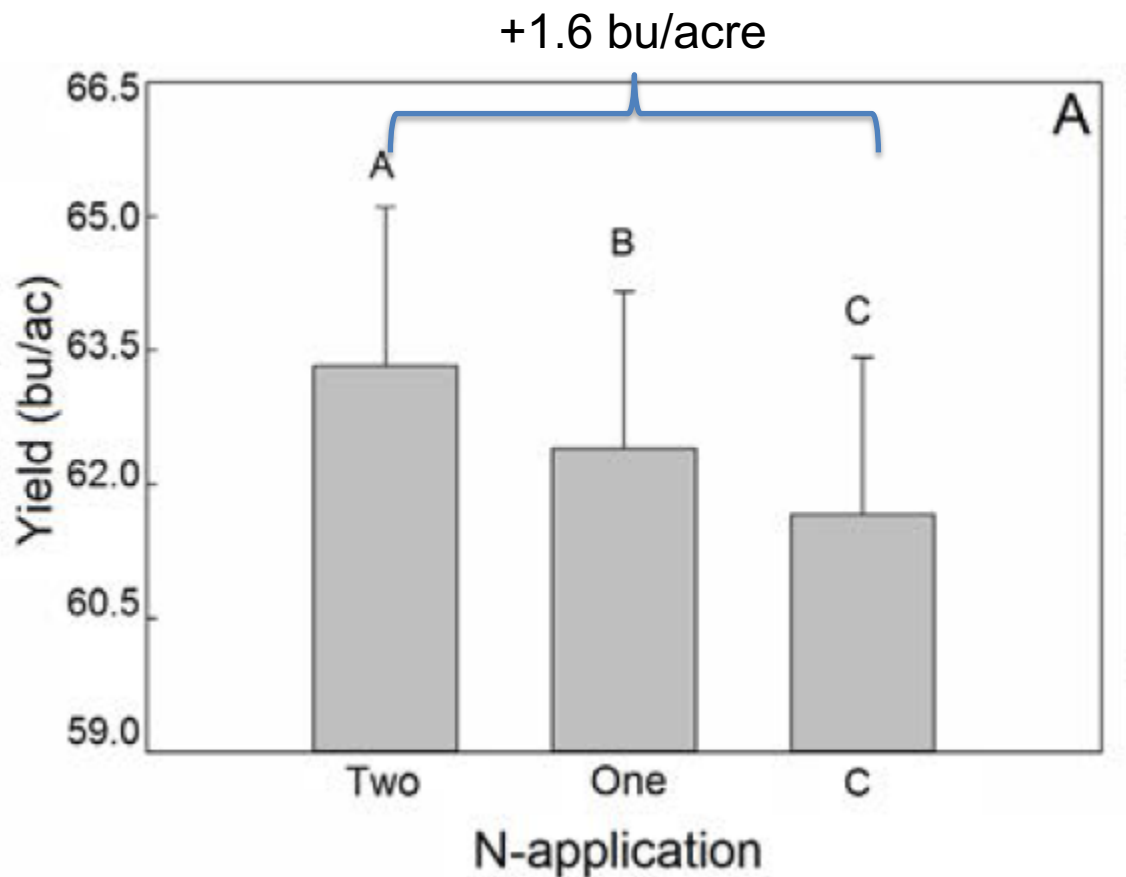
Mourtzinis et al, 2018

Results- Number of Applications



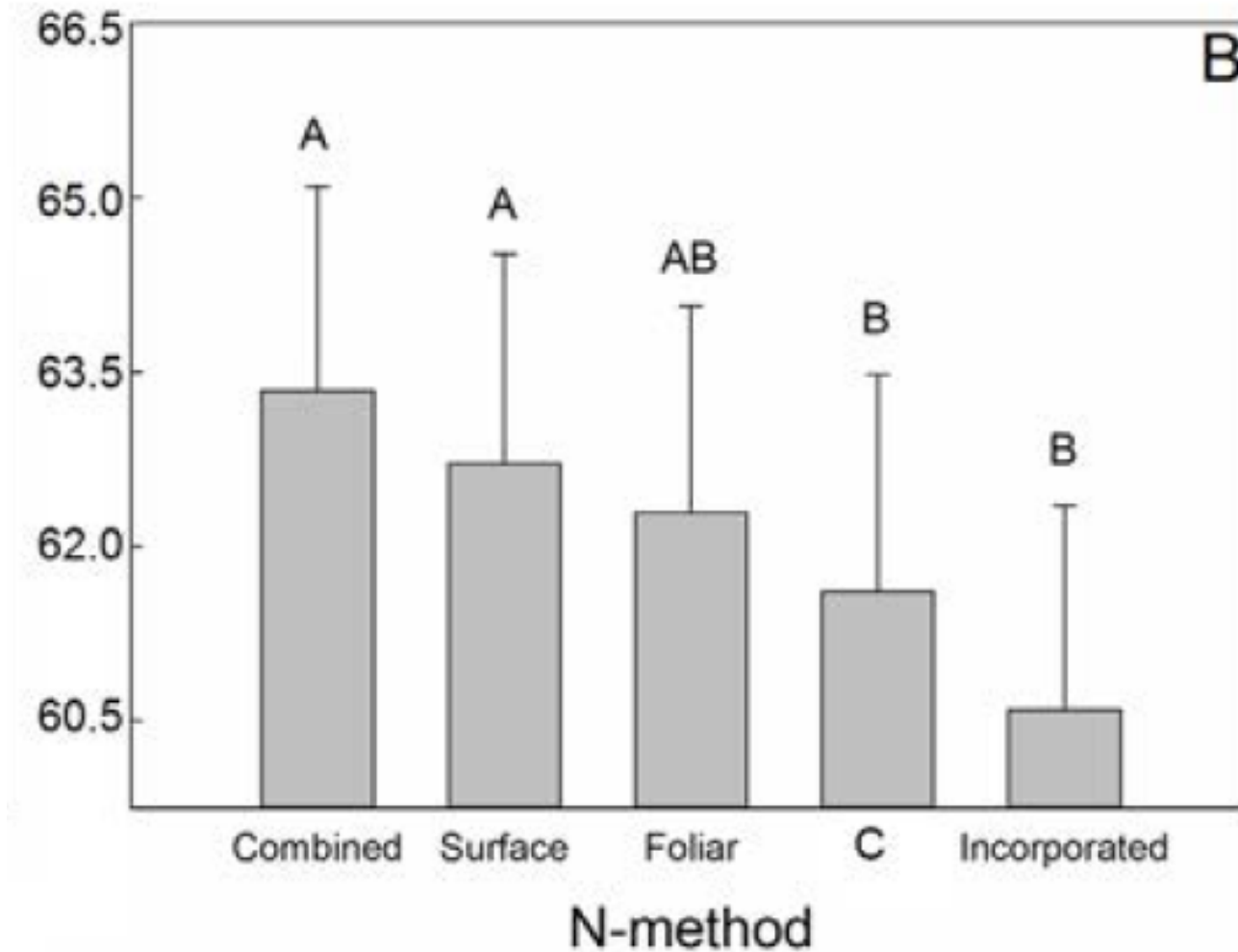
Mourtzinis et al, 2018

Results- Number of Applications



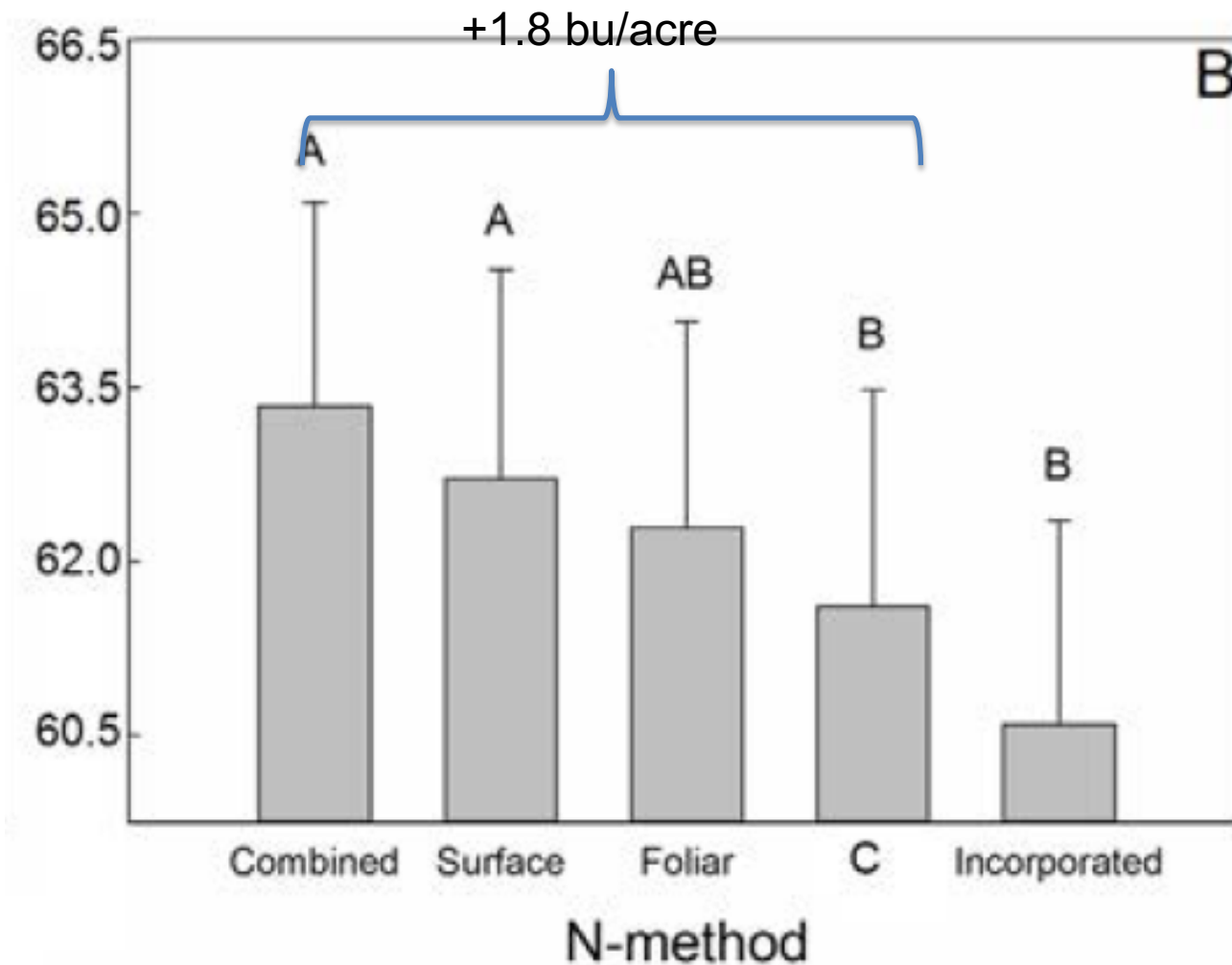
Mourtzinis et al, 2018

Results- N Application Method



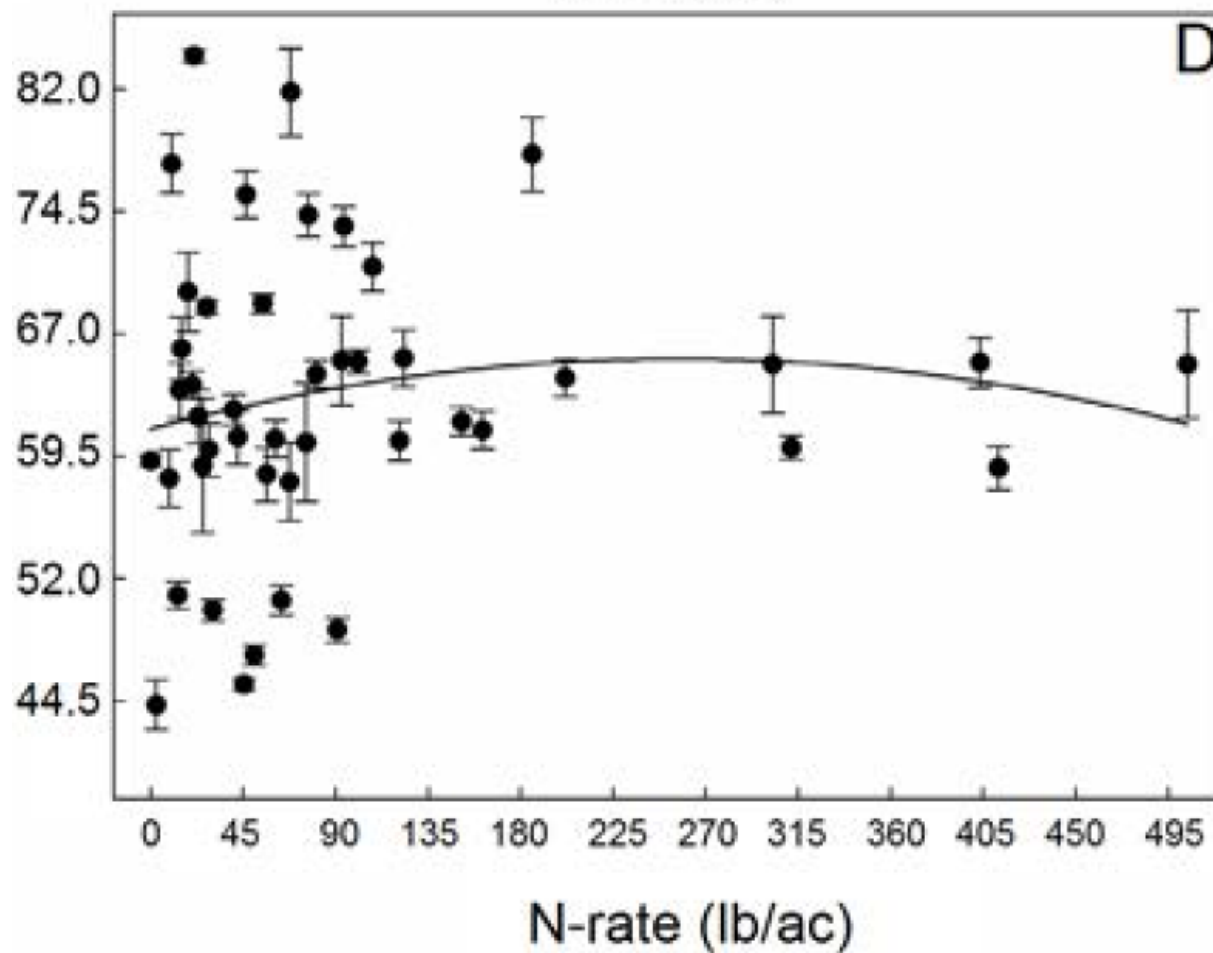
Mourtzinis et al, 2018

Results- N Application Method



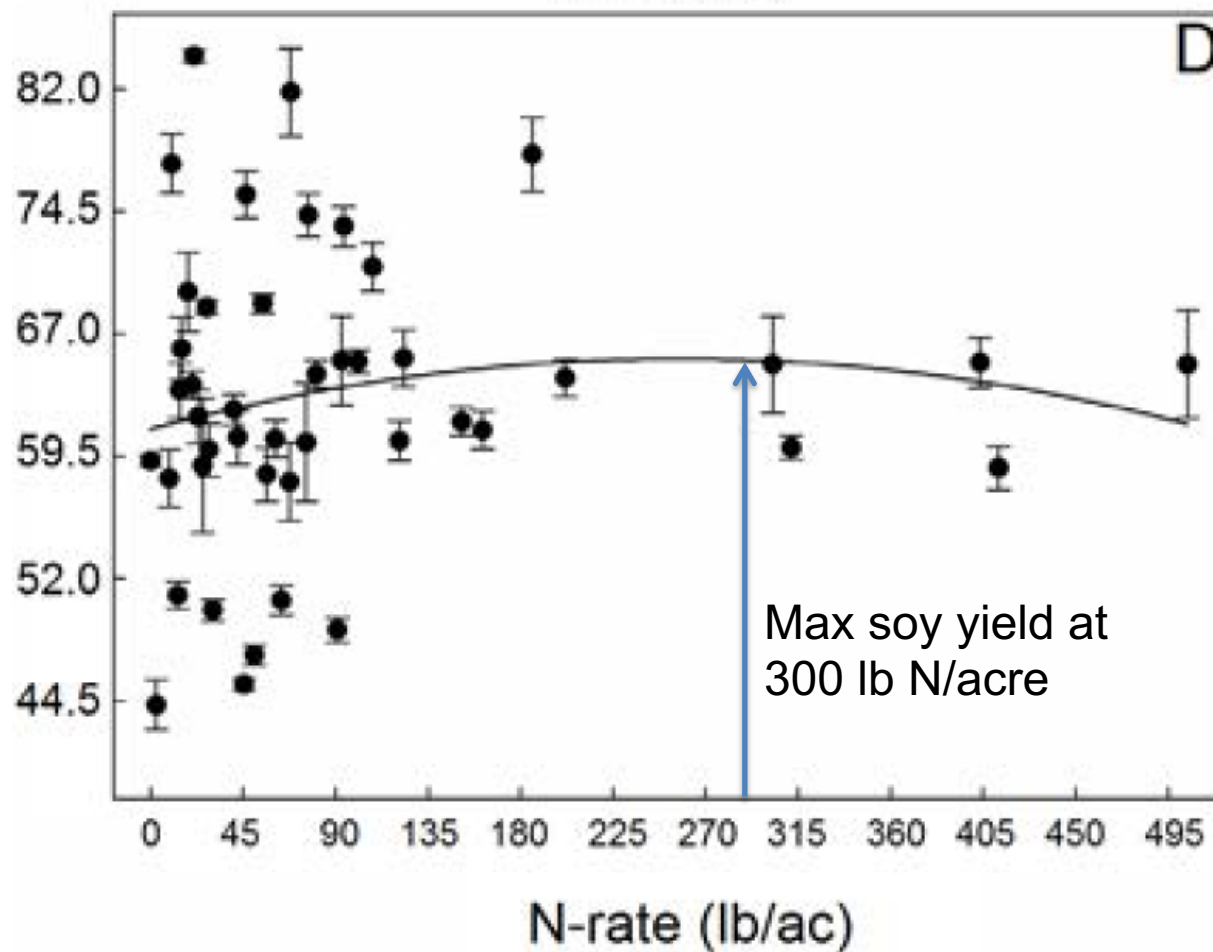
Mourtzinis et al, 2018

Results- N Rate



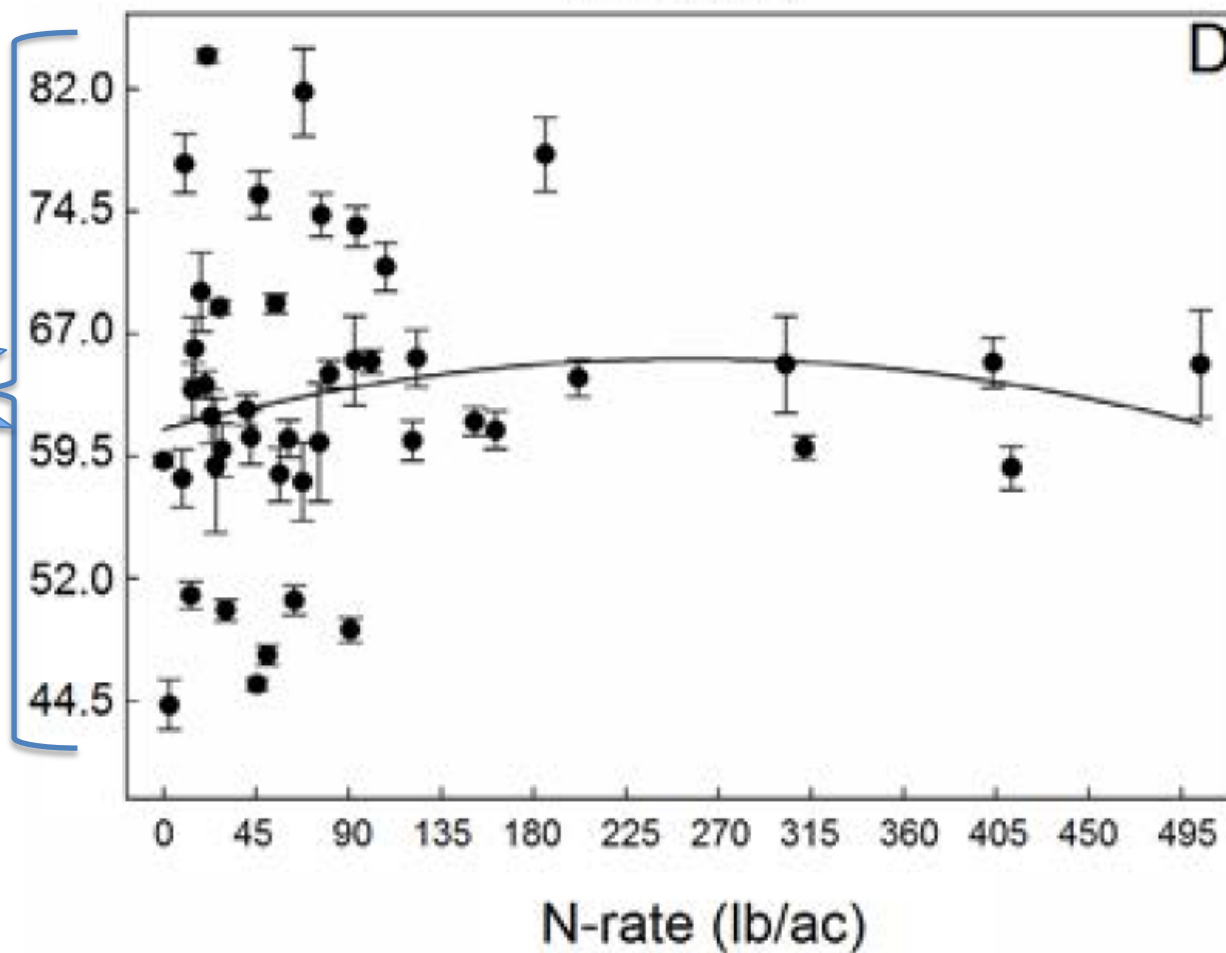
Mourtzinis et al, 2018

Results- N Rate



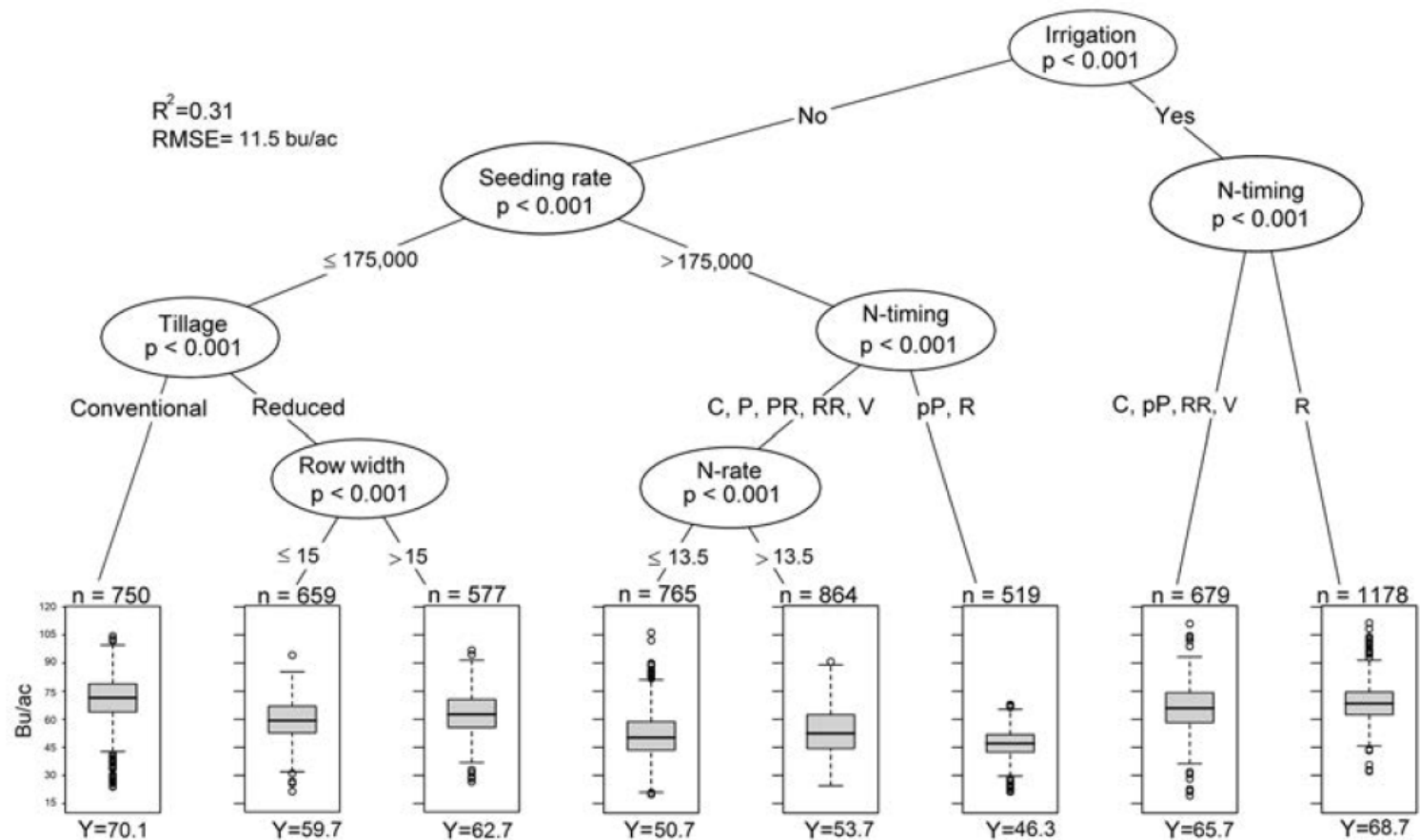
Mourtzinis et al, 2018

Results- N Rate



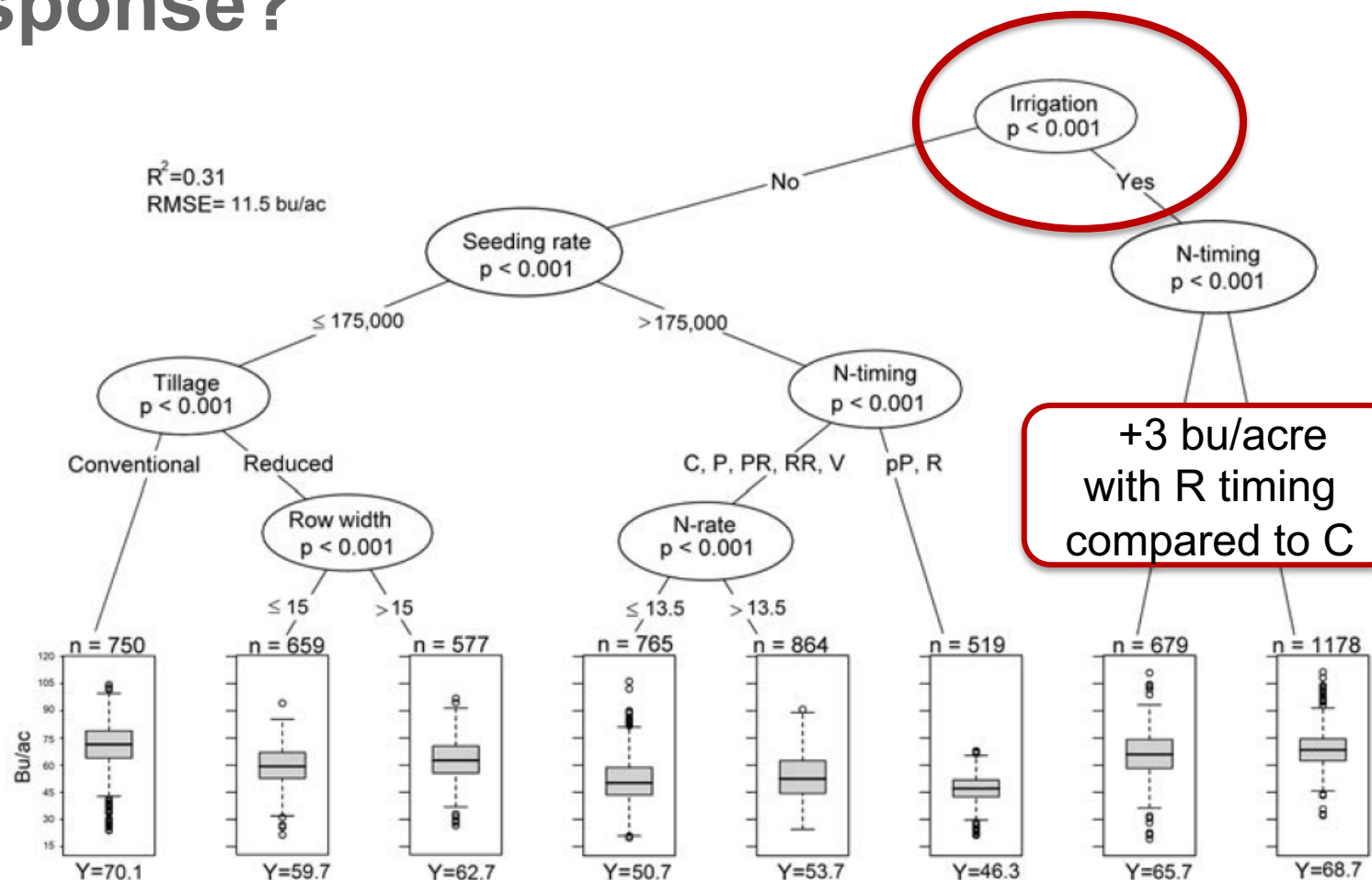
Mourtzinis et al, 2018

Where are you MOST likely to see N response?



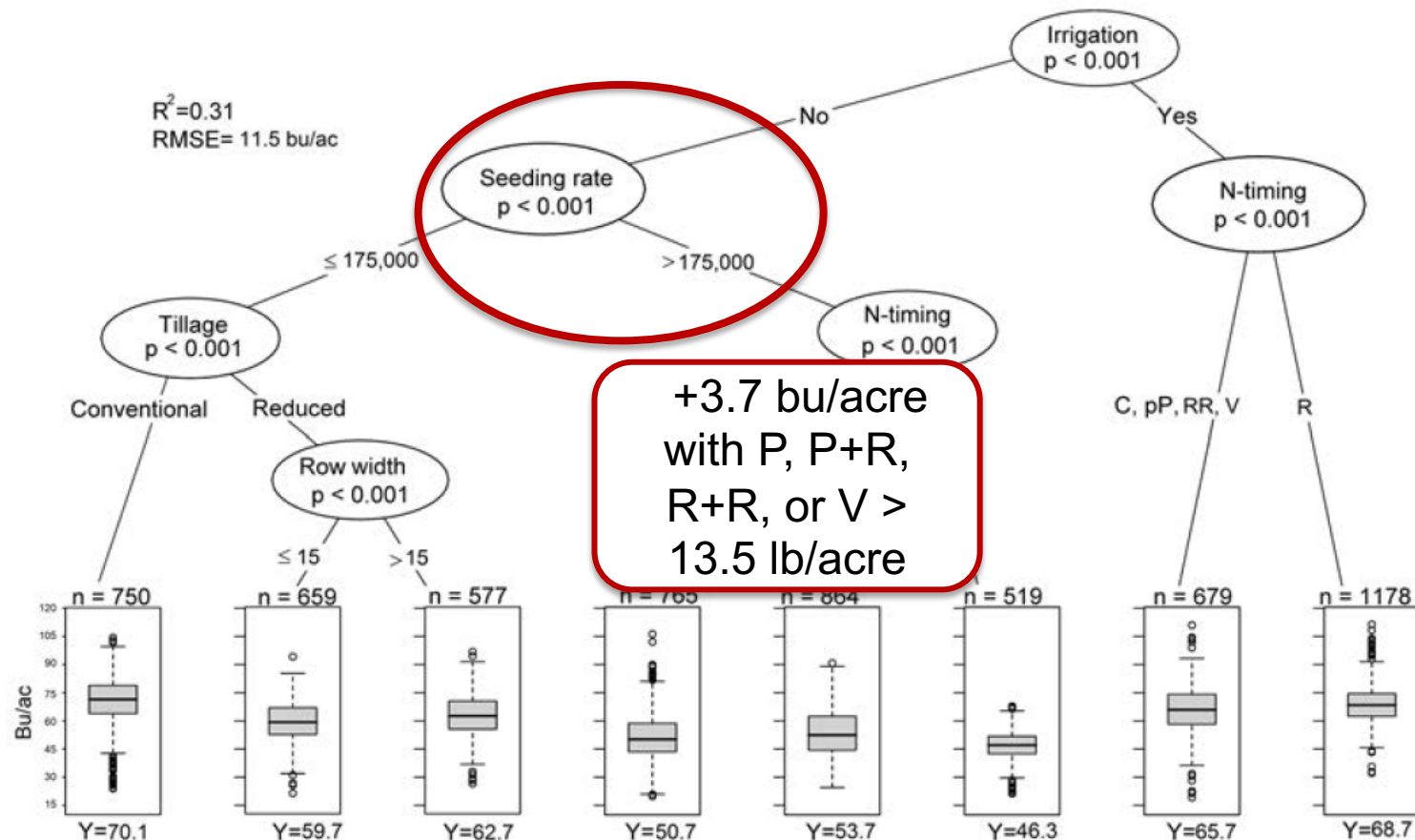
Mourtzinis et al, 2018

Where are you MOST likely to see N response?



Mourtzinis et al, 2018

Where are you MOST likely to see N response?



Mourtzinis et al, 2018

Do you need N fertilizer on soybean?

- Probably not...
- Small effect on soybean yield and unlikely to be economically viable

Rhizobia Inoculant

- ~60% of farmers inoculant soybean every year in corn-soybean rotation or corn-soybean-wheat rotation
- Relatively cheap (\$4-5/acre)

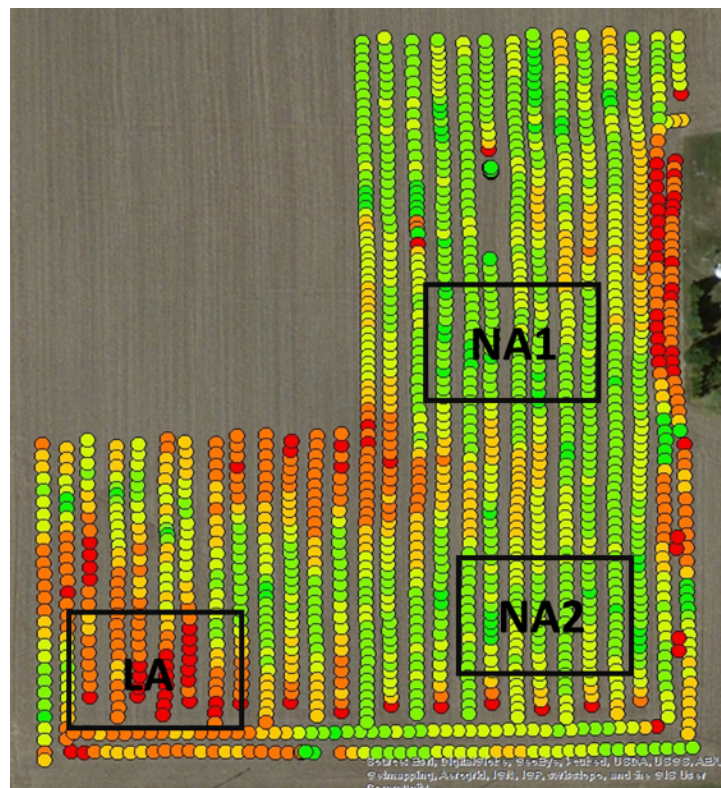
Rhizobia Inoculant

- ~60% of farmers inoculant soybean every year in corn-soybean rotation or corn-soybean-wheat rotation
- Relatively cheap (\$4-5/acre)
- 1.5 bu/acre yield increase at 70% confidence level



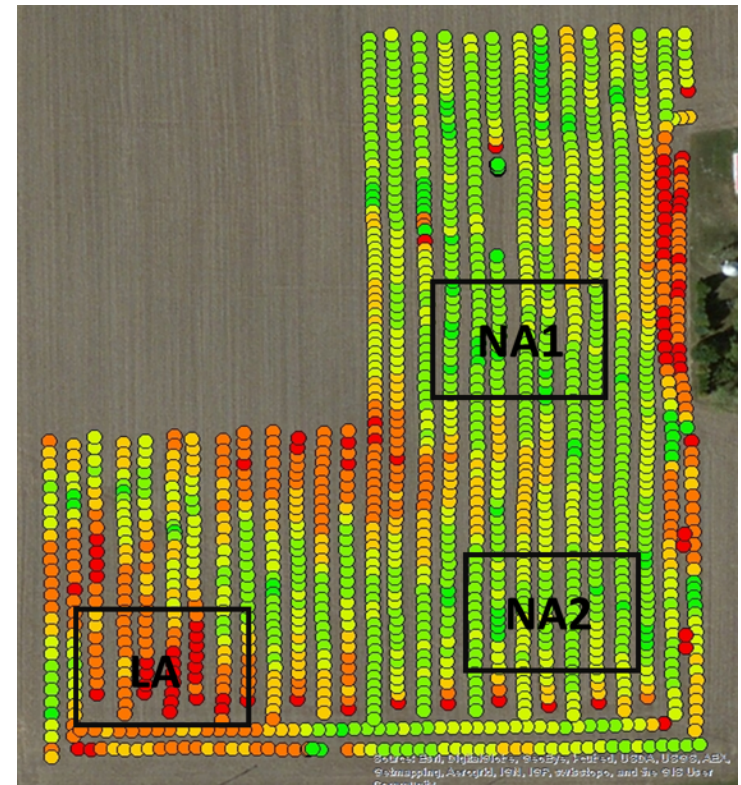
Statewide Survey of Yield-Limiting Factors

- On-farm research in Ohio 2013-2015
 - n = 199 fields
- Cultural practices
- Soil fertility
- Soybean cyst nematode

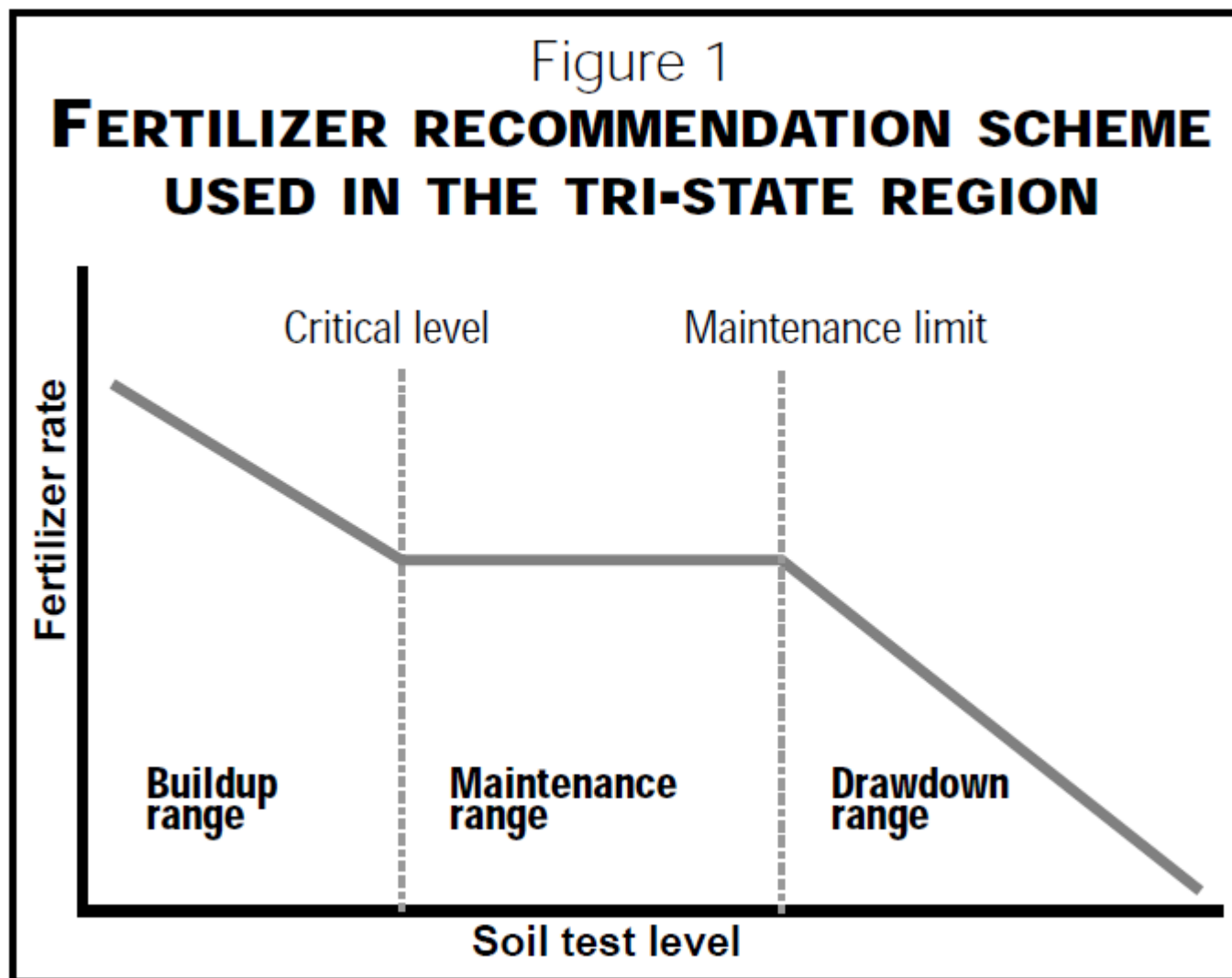


Statewide Survey of Yield-Limiting Factors

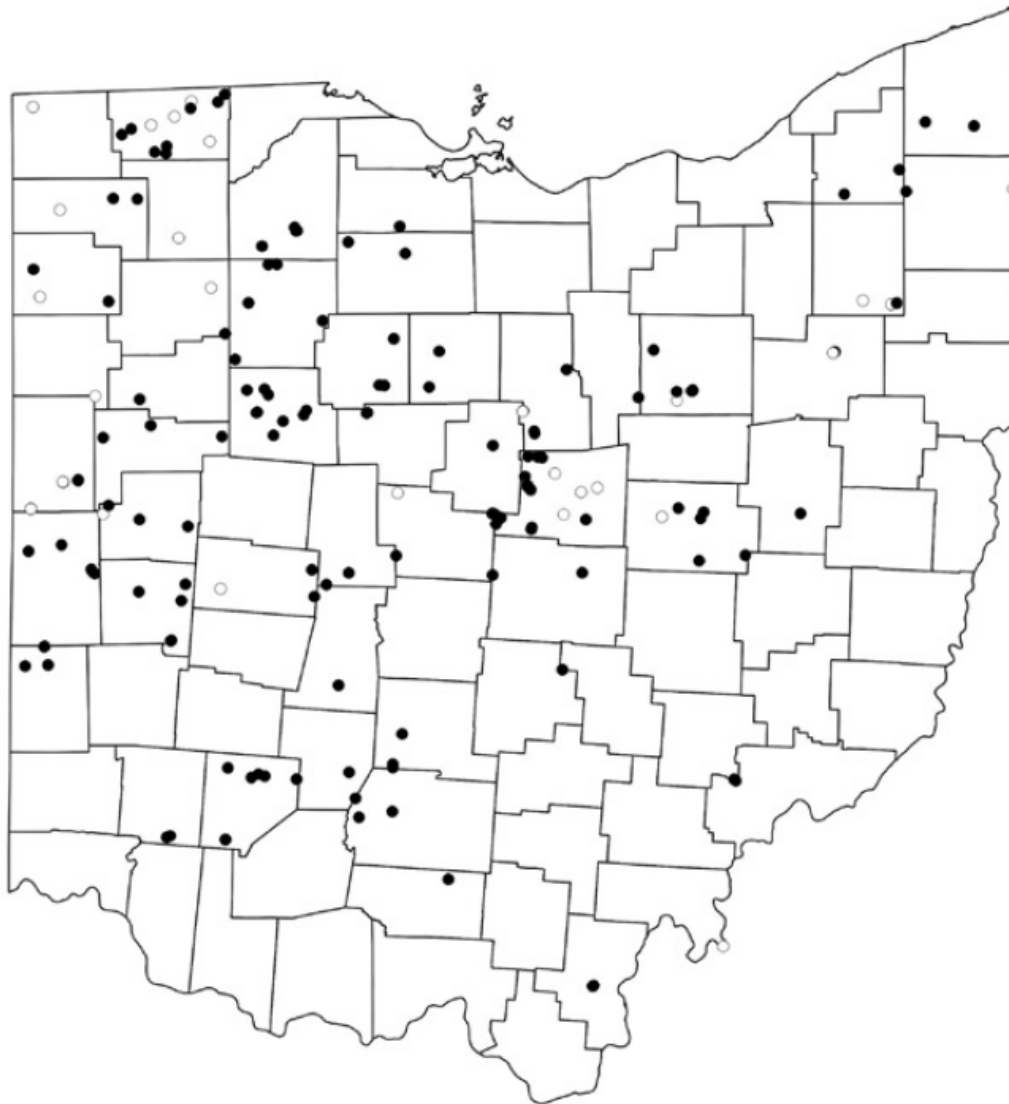
- On-farm research in Ohio 2013-2015
 - n = 199
- Cultural practices
- Soil fertility
- Soybean cyst nematode



Soil Fertility Philosophy

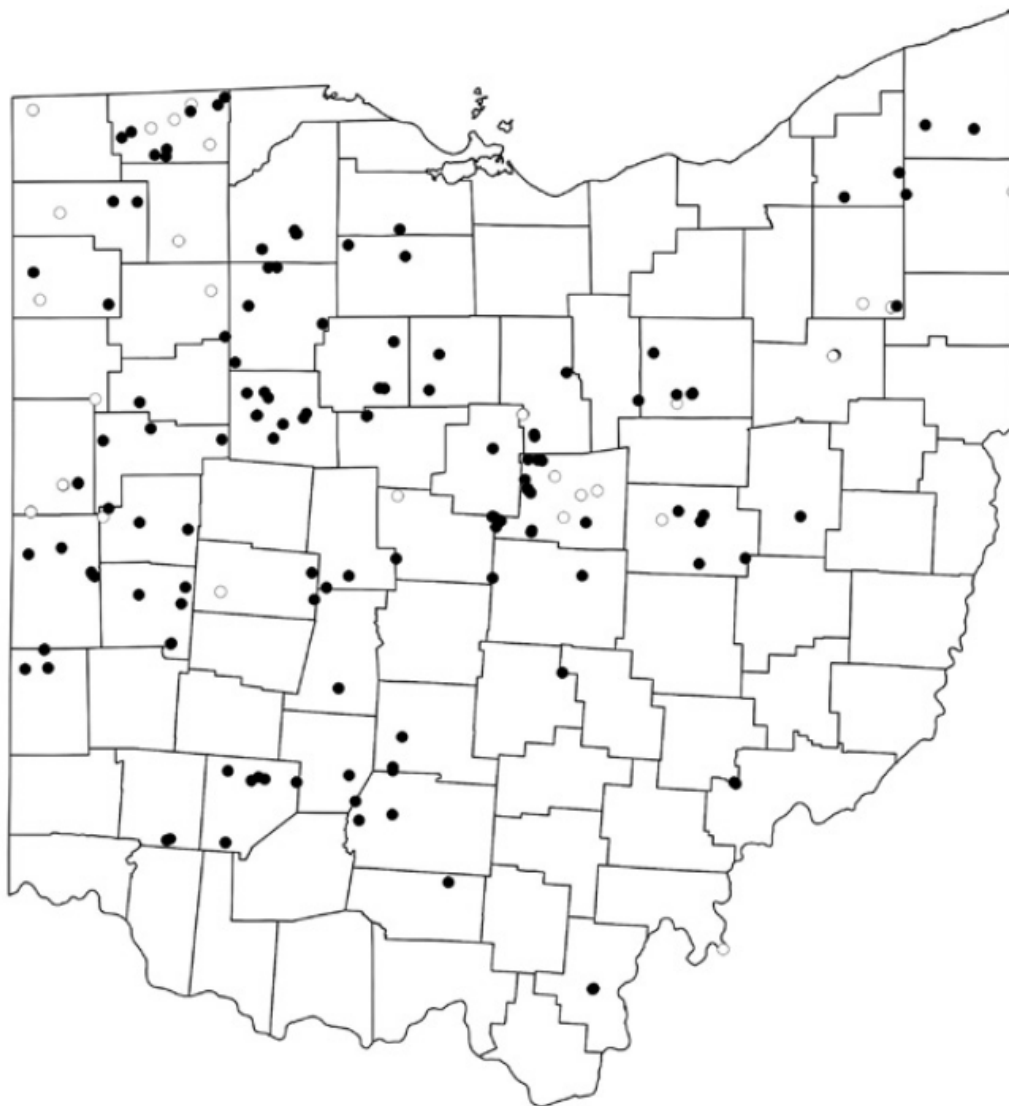


Soil Test P



Brooker et al., 2016

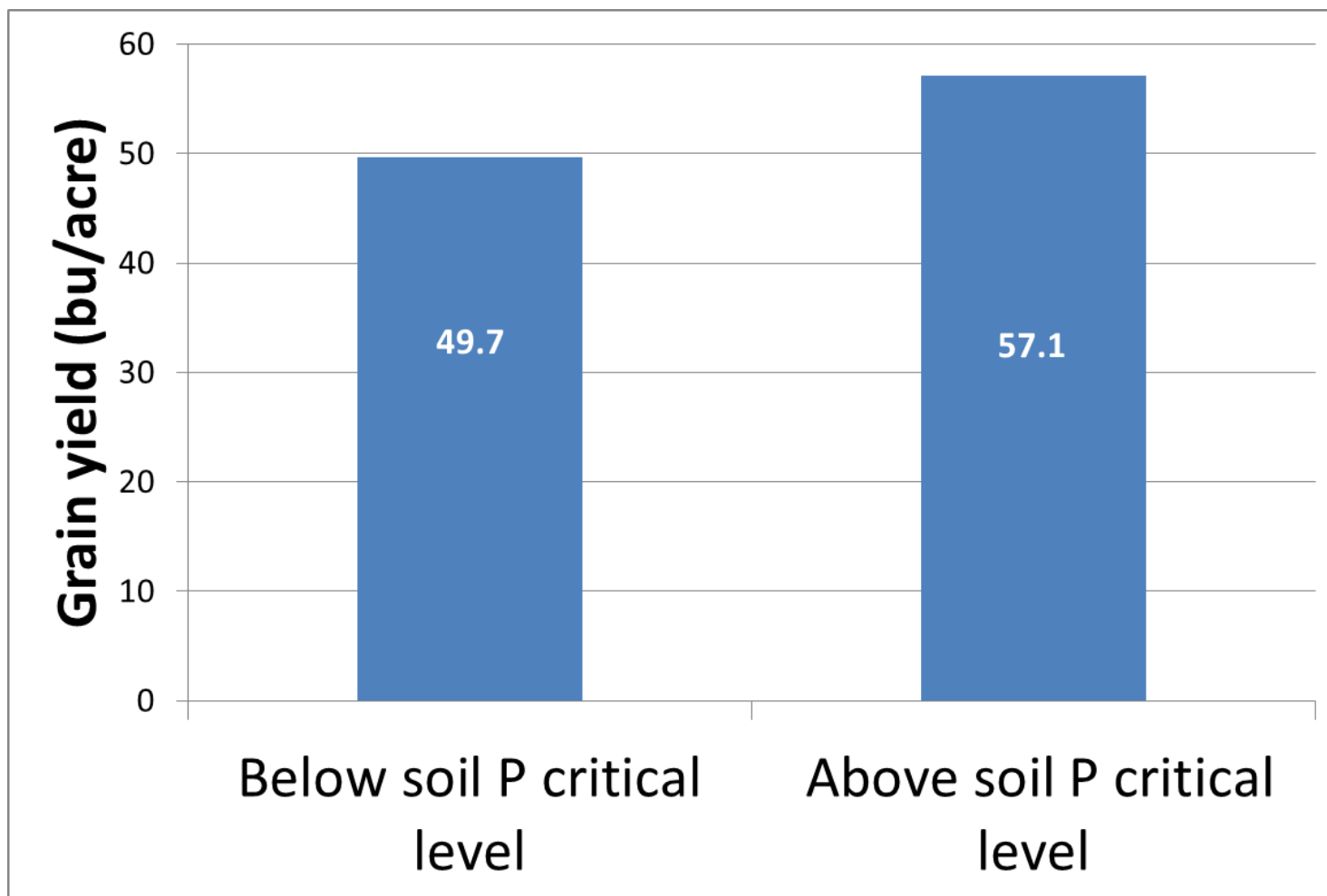
Soil Test P



65% of fields had at least a portion of the field that needed phosphorus fertilizer.

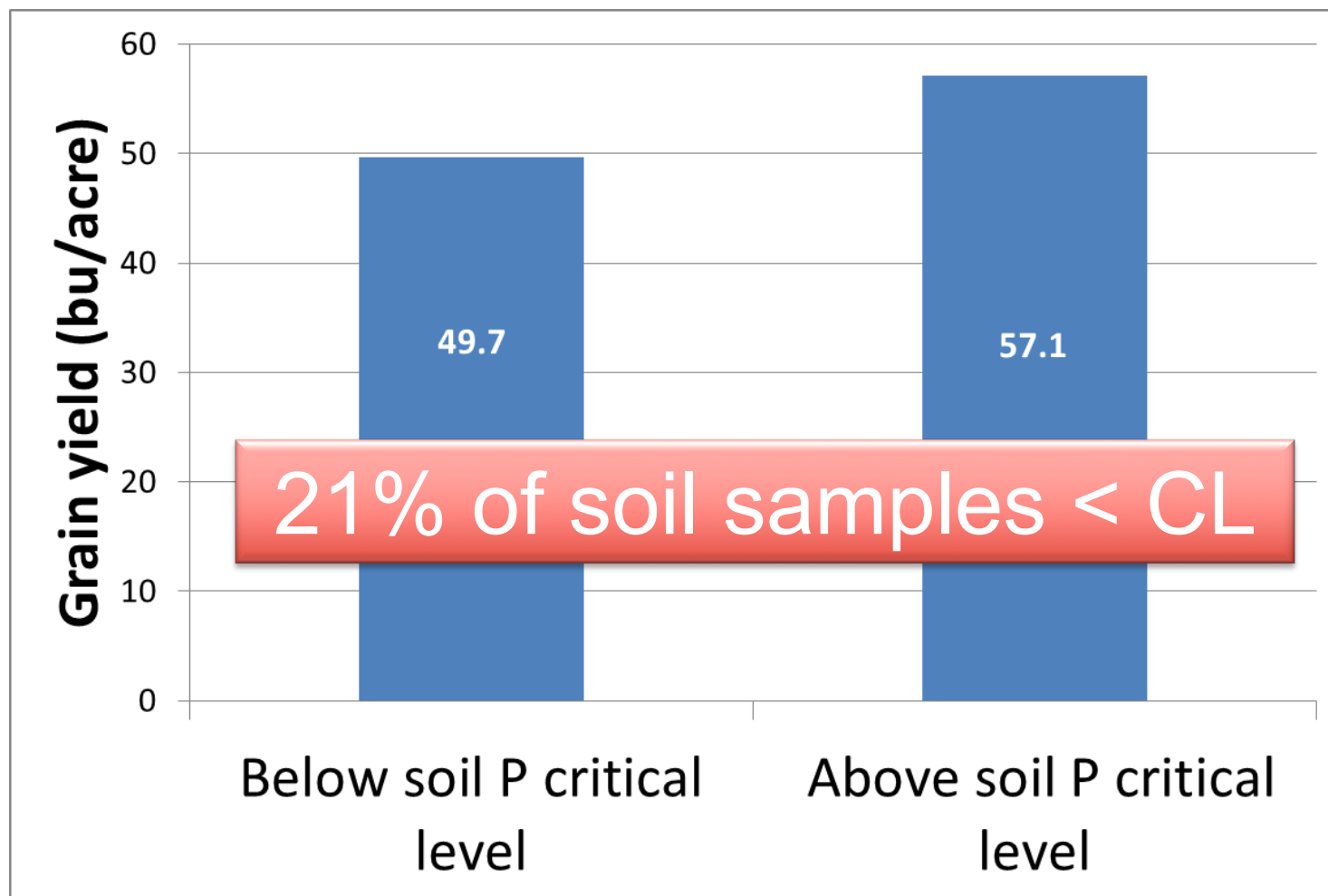
Brooker et al., 2016

Soil Test P



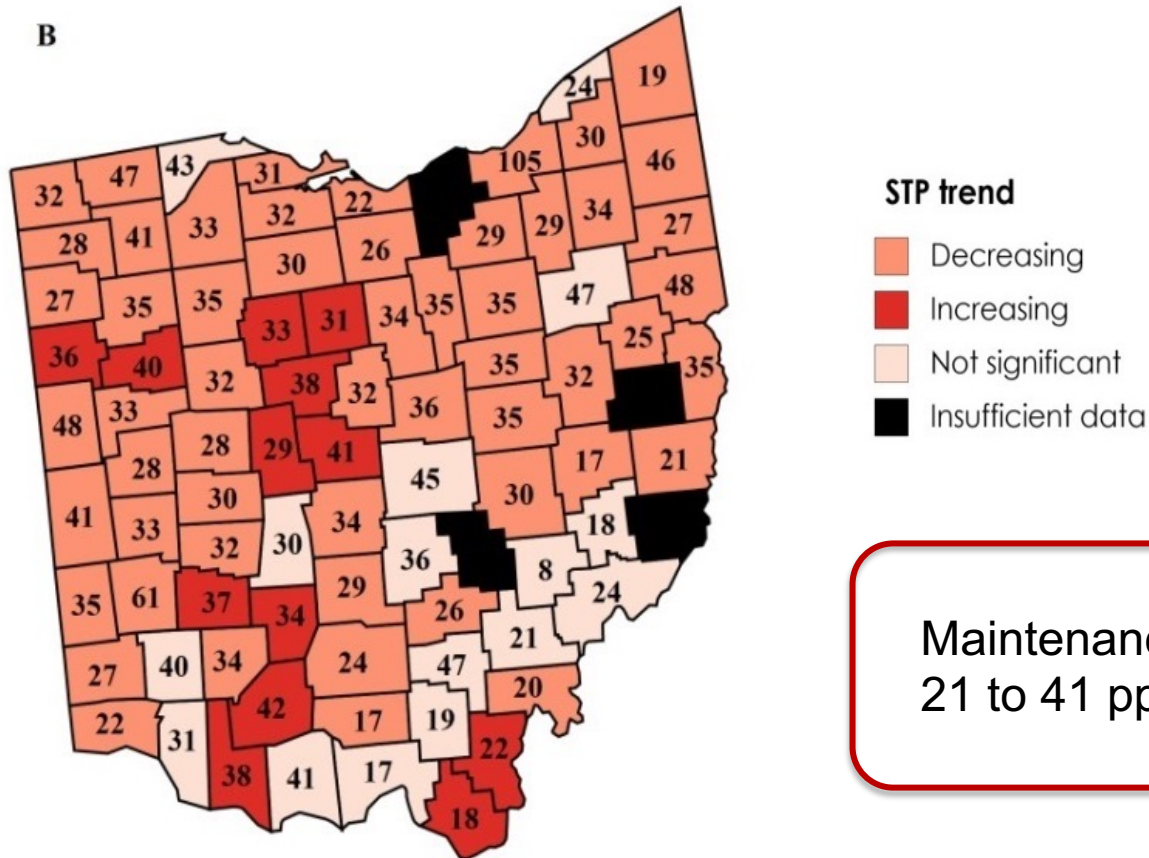
Brooker et al., 2016

Soil Test P



Brooker et al., 2016

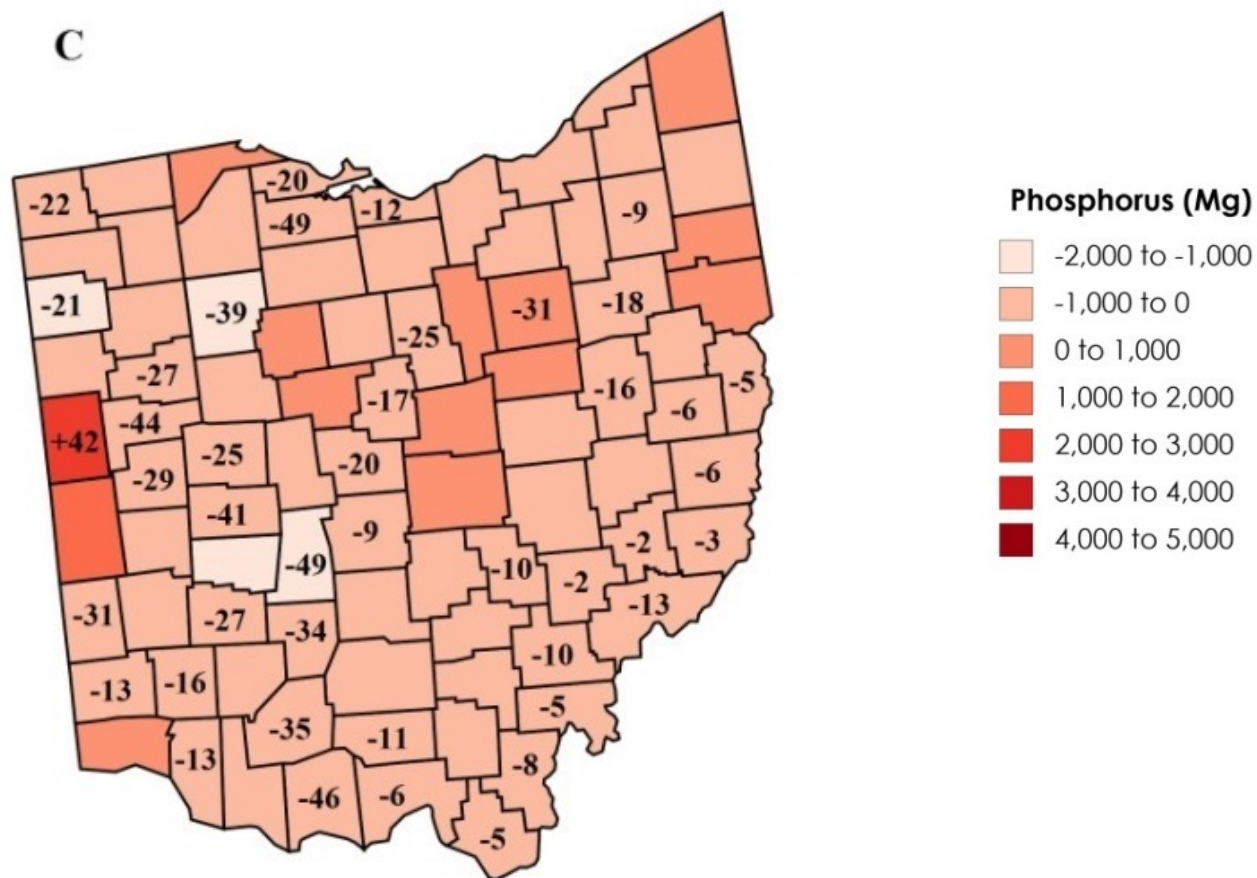
Soil Test P Trends: 1993-2015



Maintenance:
21 to 41 ppm (Mehlich)

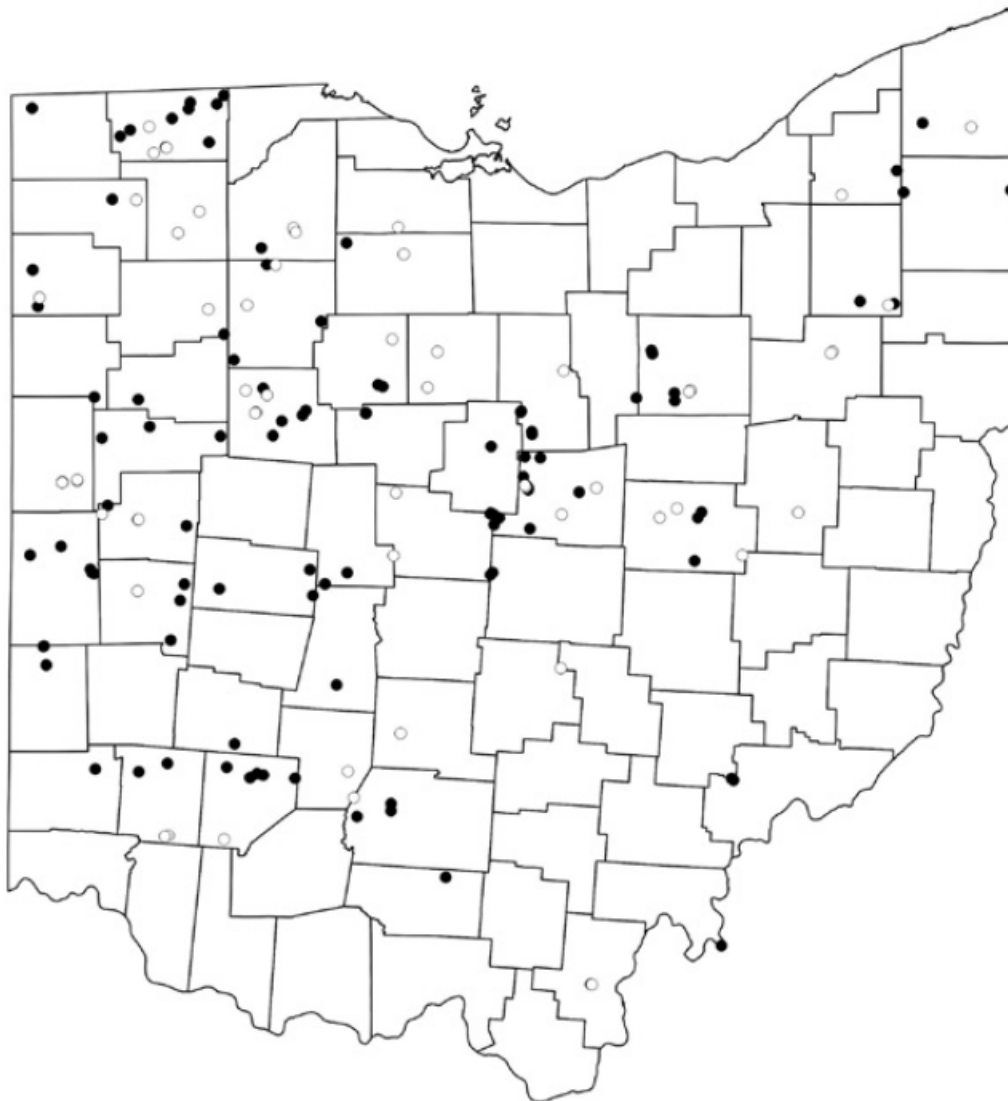
Dayton et al., 2020

Phosphorus Balance



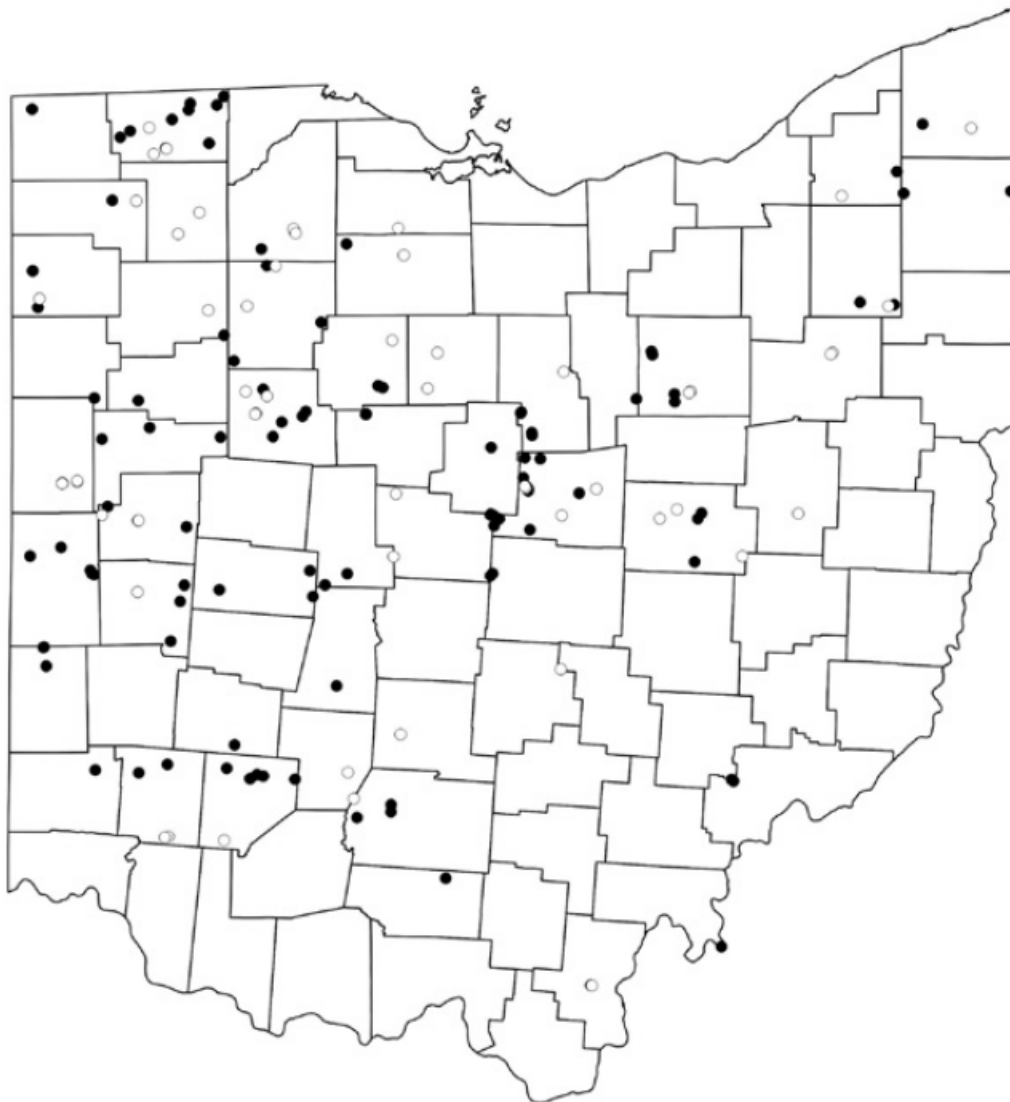
Dayton et al., 2020

Soil Test K



Brooker et al., 2016

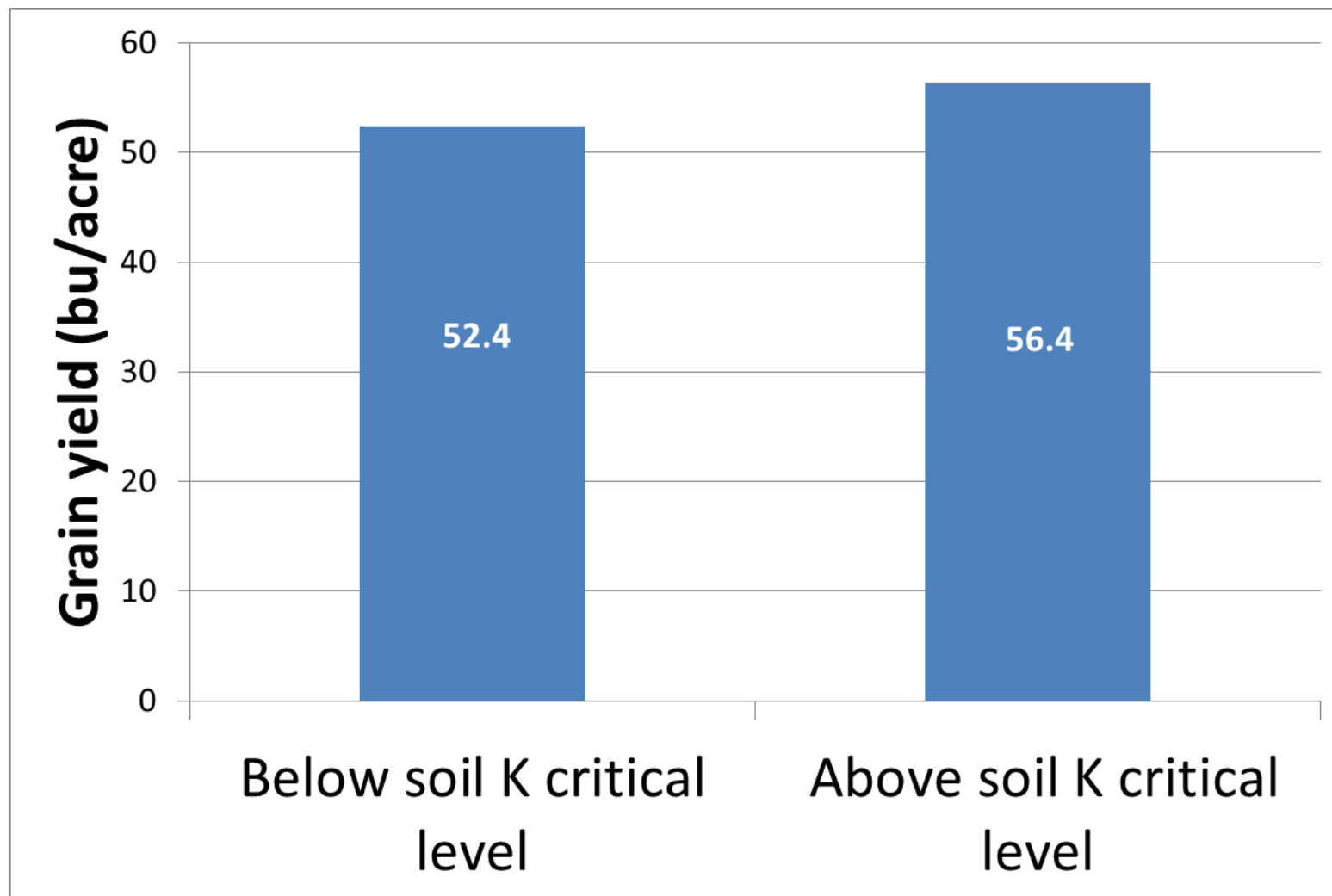
Soil Test K



58% of fields had at least a portion of the field that needed potassium fertilizer.

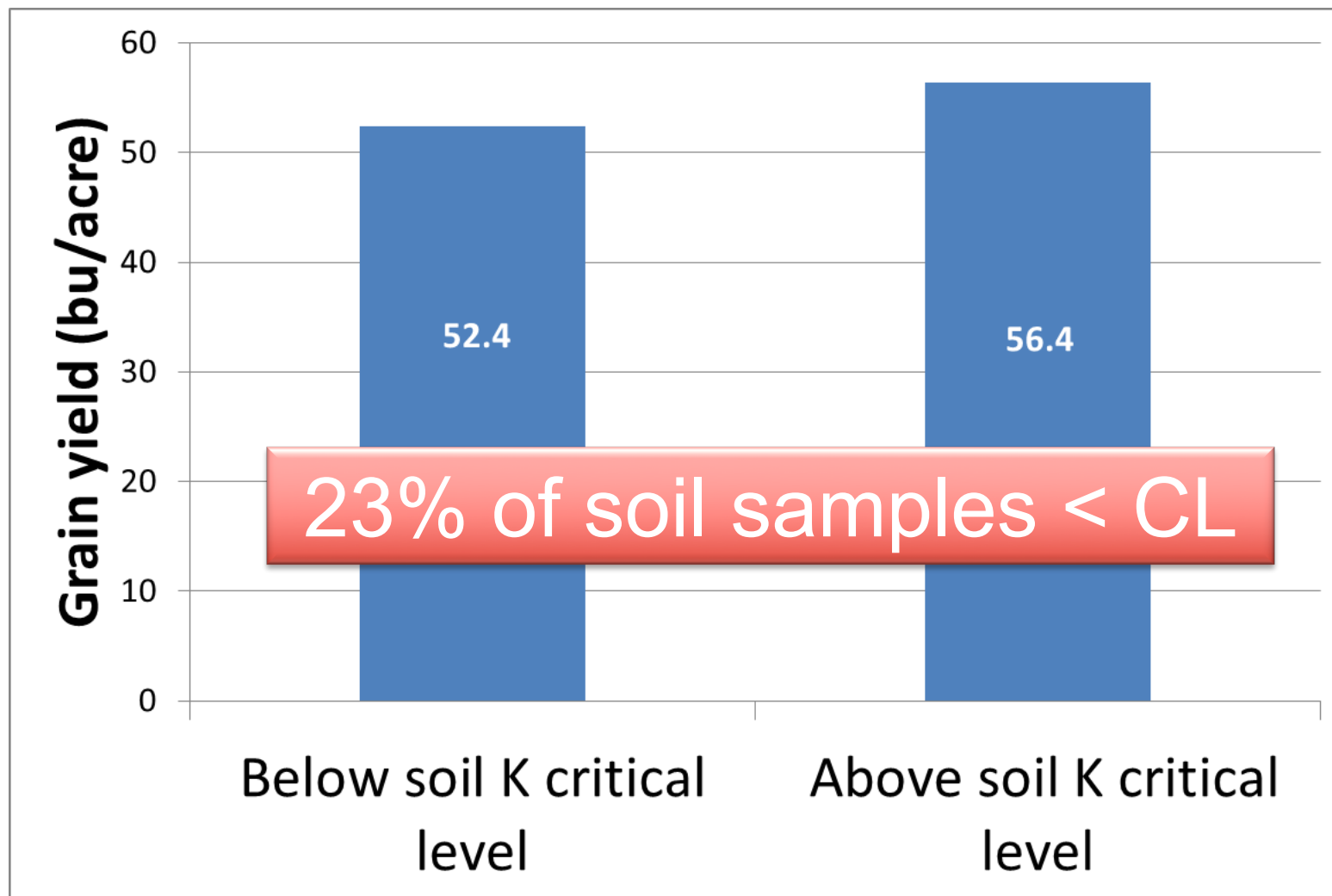
Brooker et al., 2016

Soil Test K



Brooker et al., 2016

Soil Test K



Brooker et al., 2016

So...Is more fertilizer better?

Soybean fertility yield boost

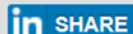
New research shows extra phosphorus can increase yields even in high-testing soils.

David Hest | *Corn+Soybean Digest*

Oct 12, 2015



EMAIL



SHARE



Tweet



G+



Recommend

13

COMMENTS 0

More About: [Soybean Harvest](#)



Extra fertilizer, including phosphorus, potassium, nitrogen and several micronutrients, resulted in faster-growing, greener soybeans in [redacted] plots.

[redacted]

Common wisdom that **soybeans** don't respond to fertilizer is dead wrong. So is the widespread perception that potassium fertility is likely more limiting than phosphorus.

That's according to [redacted]

[redacted]

[redacted] plant physiologist.

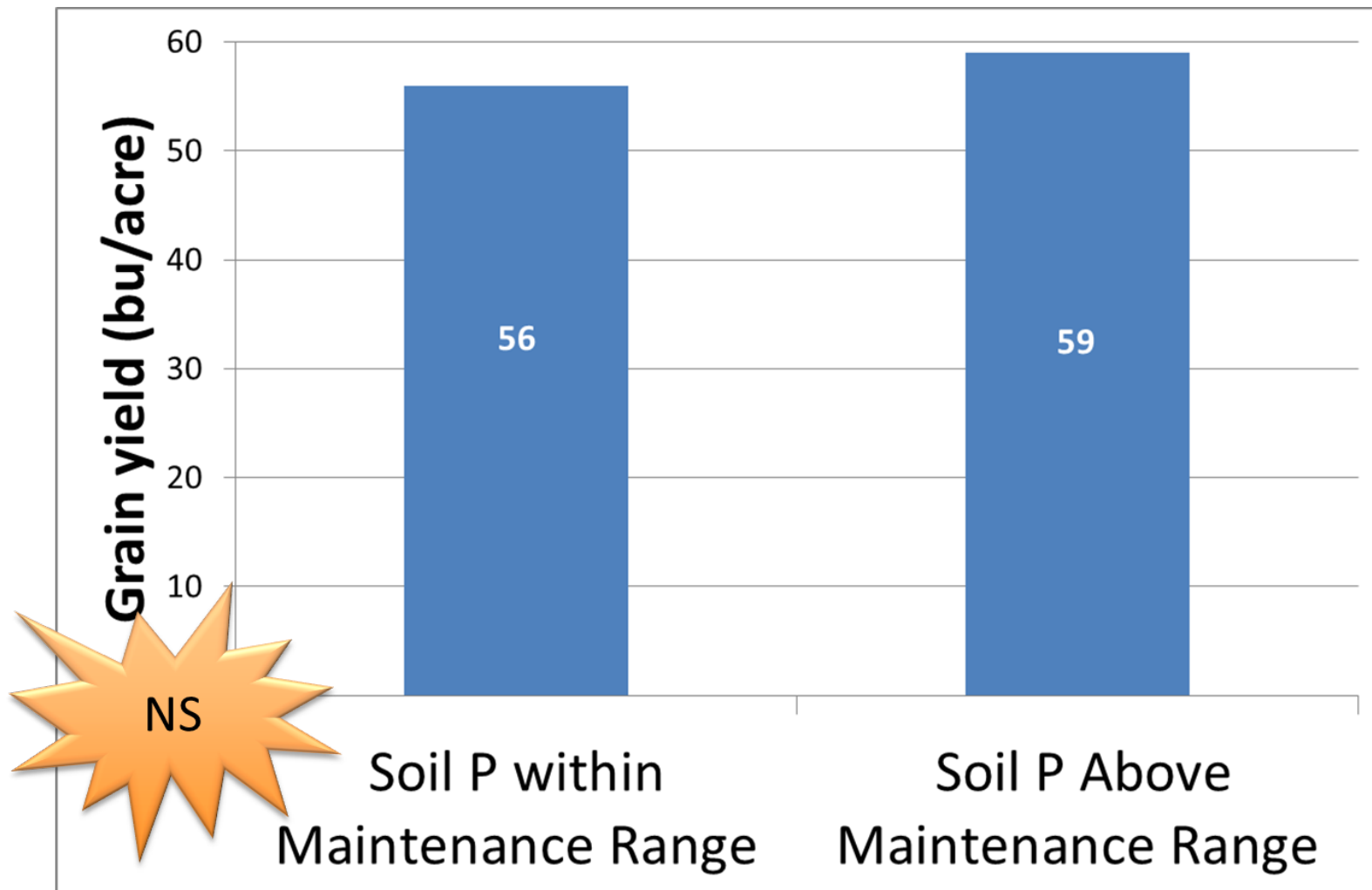
Recent research he conducted with graduate students to break the 100-bushel/acre soybean

yield barrier suggests both notions are in error.

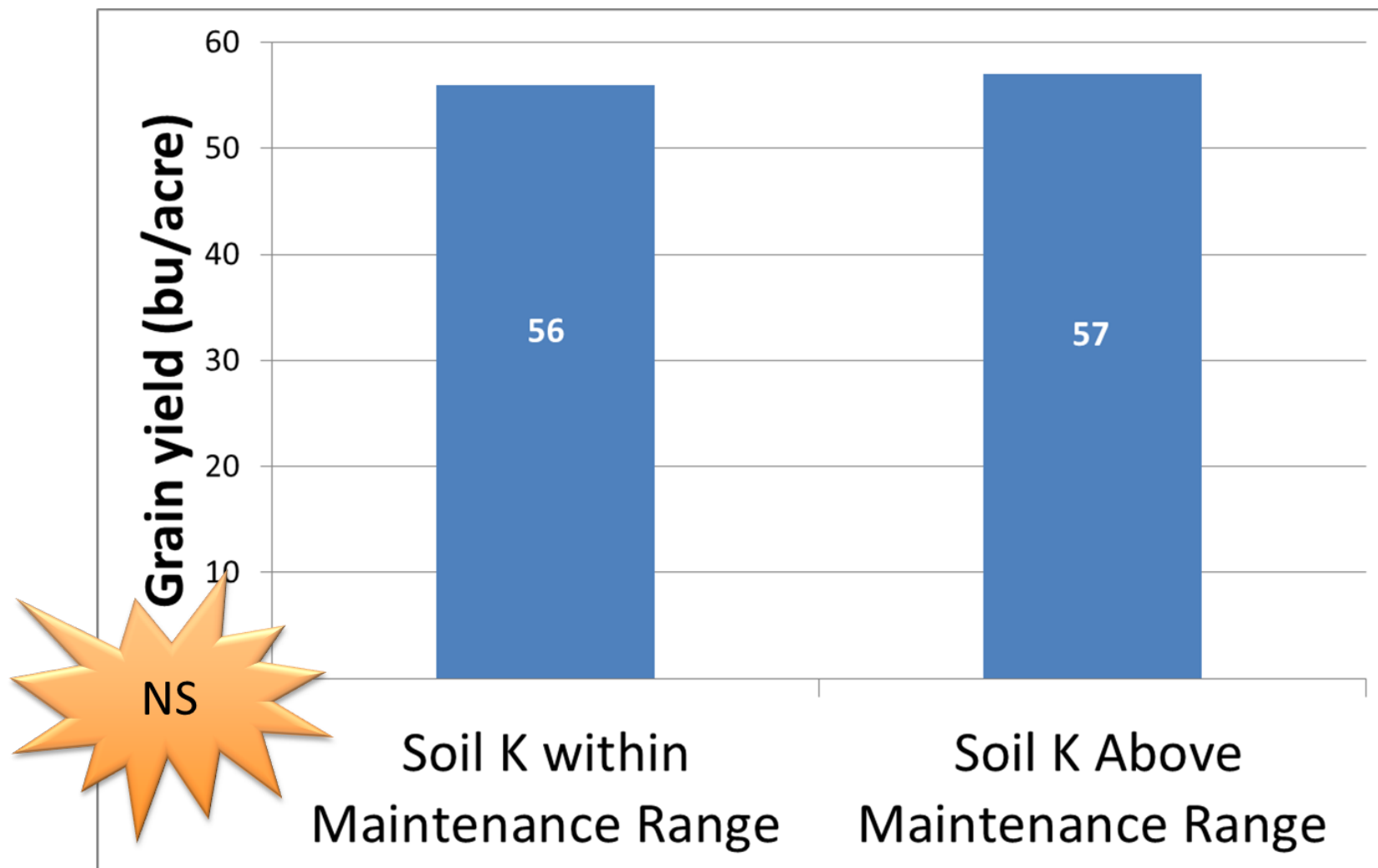
"It's a myth that soybeans don't respond to fertilizer," says [redacted] who adds that

"wisdom" may be a consequence from research on soybean nitrogen fertility, which shows

So...Is more fertilizer better?



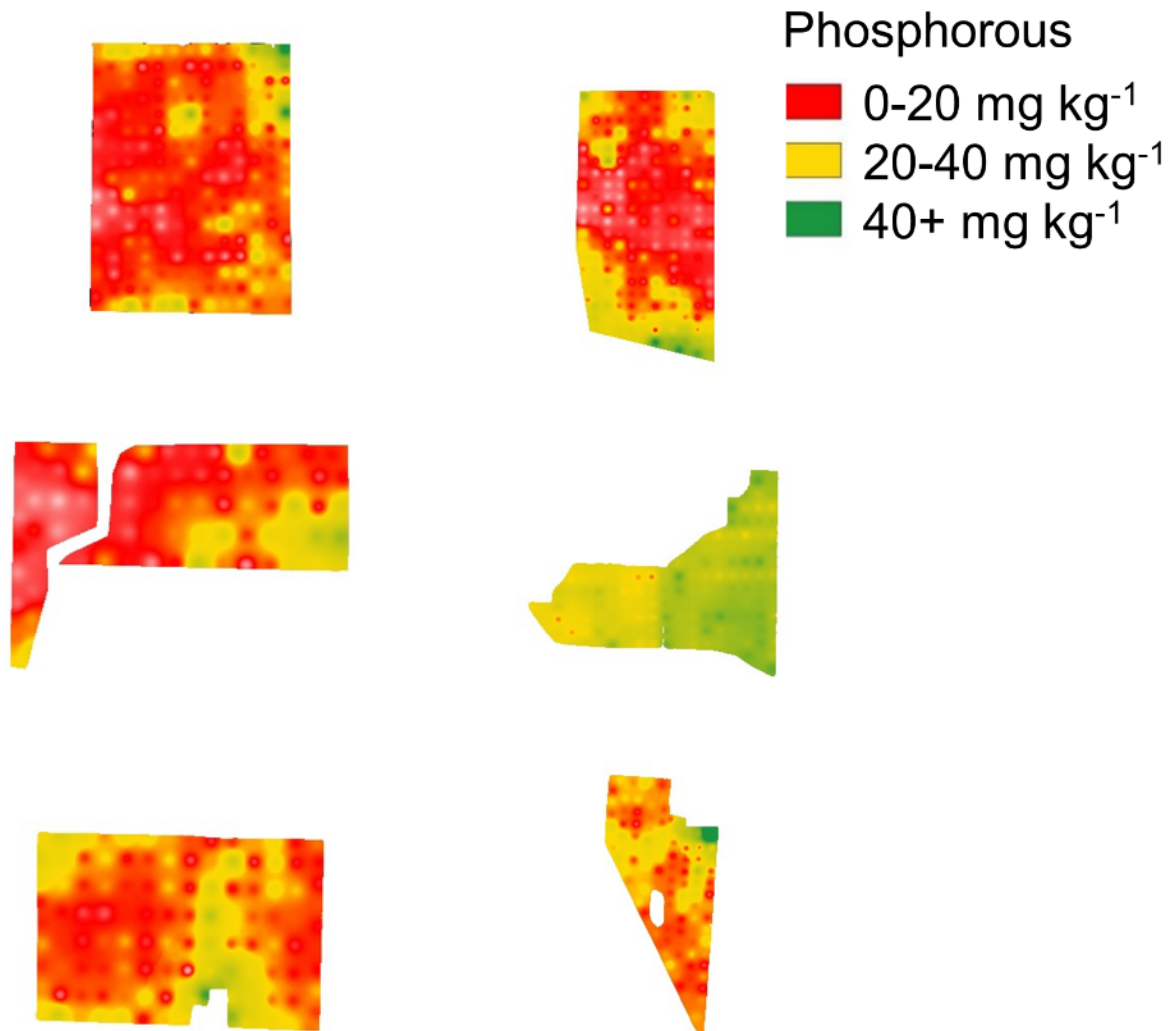
So...Is more fertilizer better?



Soil Test!

- Follow state guidelines
 - New Tri-State Recs coming soon
- P and K more important to worry about compared to N
- Consider grid soil sampling (within-field variability)

Within-Field Variability

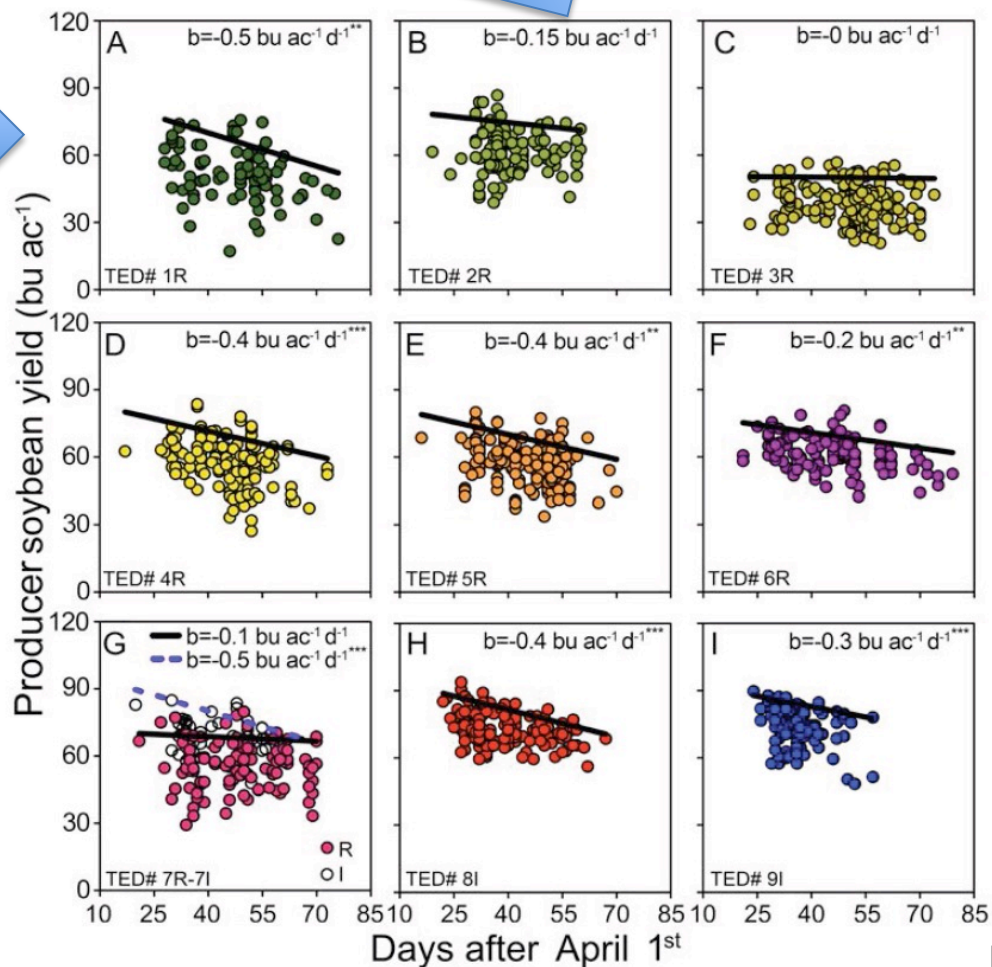


#1 Management Practice that Influences Soybean Yield?

Planting Date!

Central/
South IN

North IN

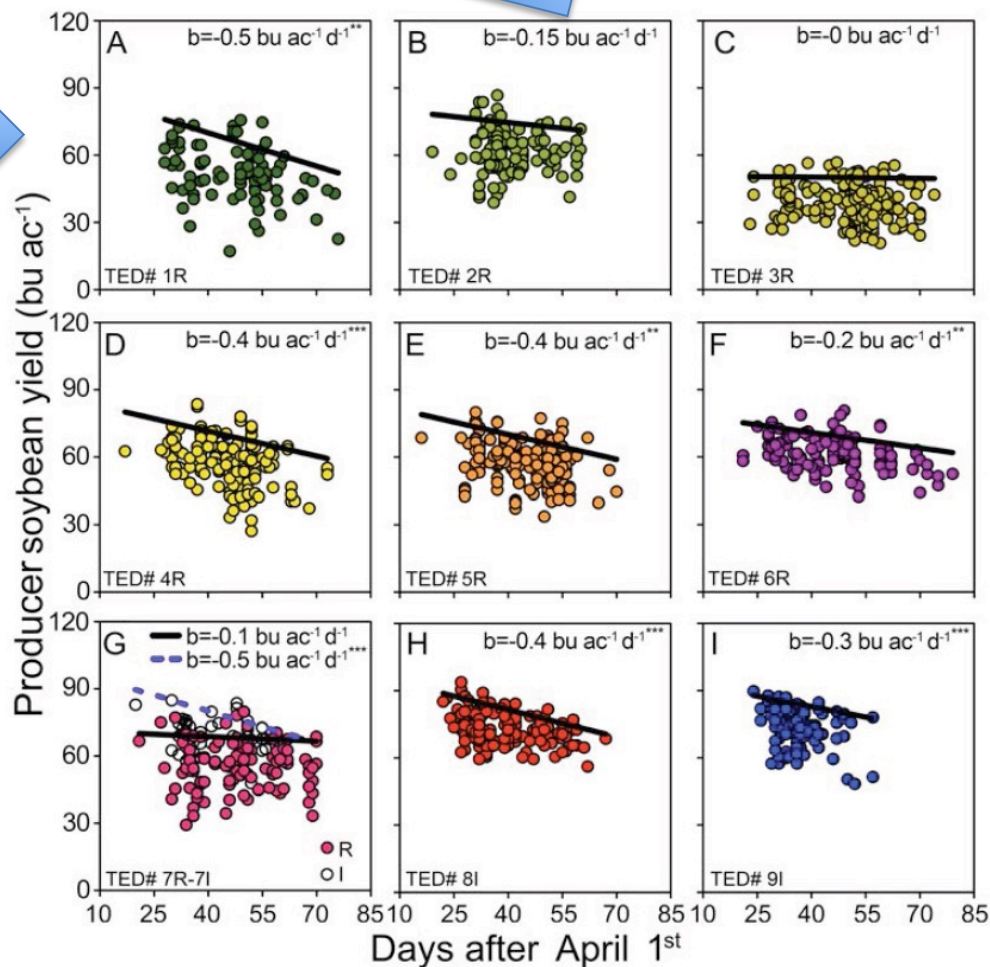


Edreira et al., 2017

Planting Date!

Central/
South IN

North IN



If water isn't limiting during R3-R5.

Edreira et al., 2017

Planting Date x Starter Fertilizer

- 4 planting dates
 - May-early July
- 4 starter fertilizer treatments
 - Urea (30 lb N/acre)
 - TSP (40 lb P₂O₅/acre)
 - Urea + TSP
 - Control



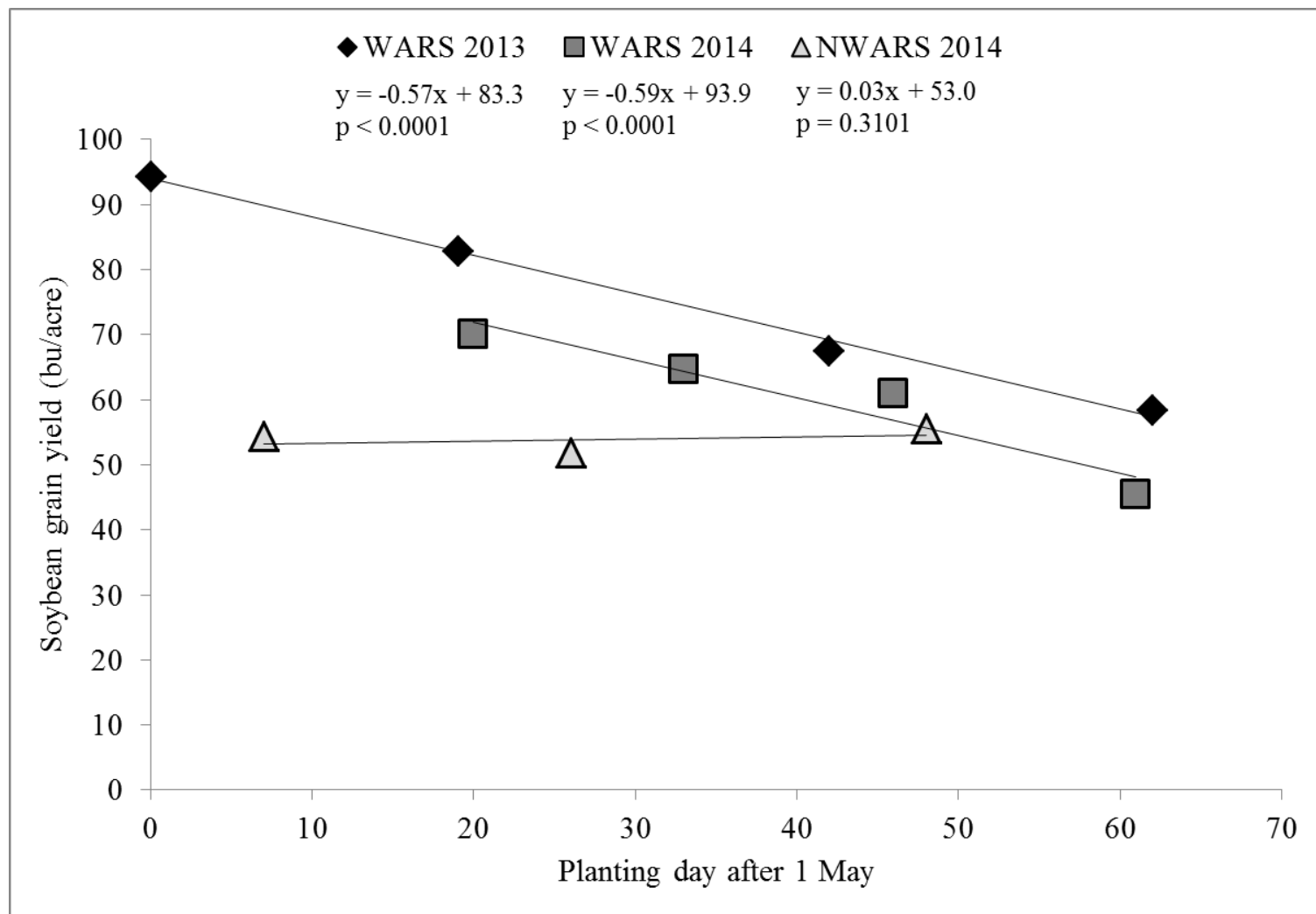
Hankinson et al., 2015

Starter Fertilizer Effect

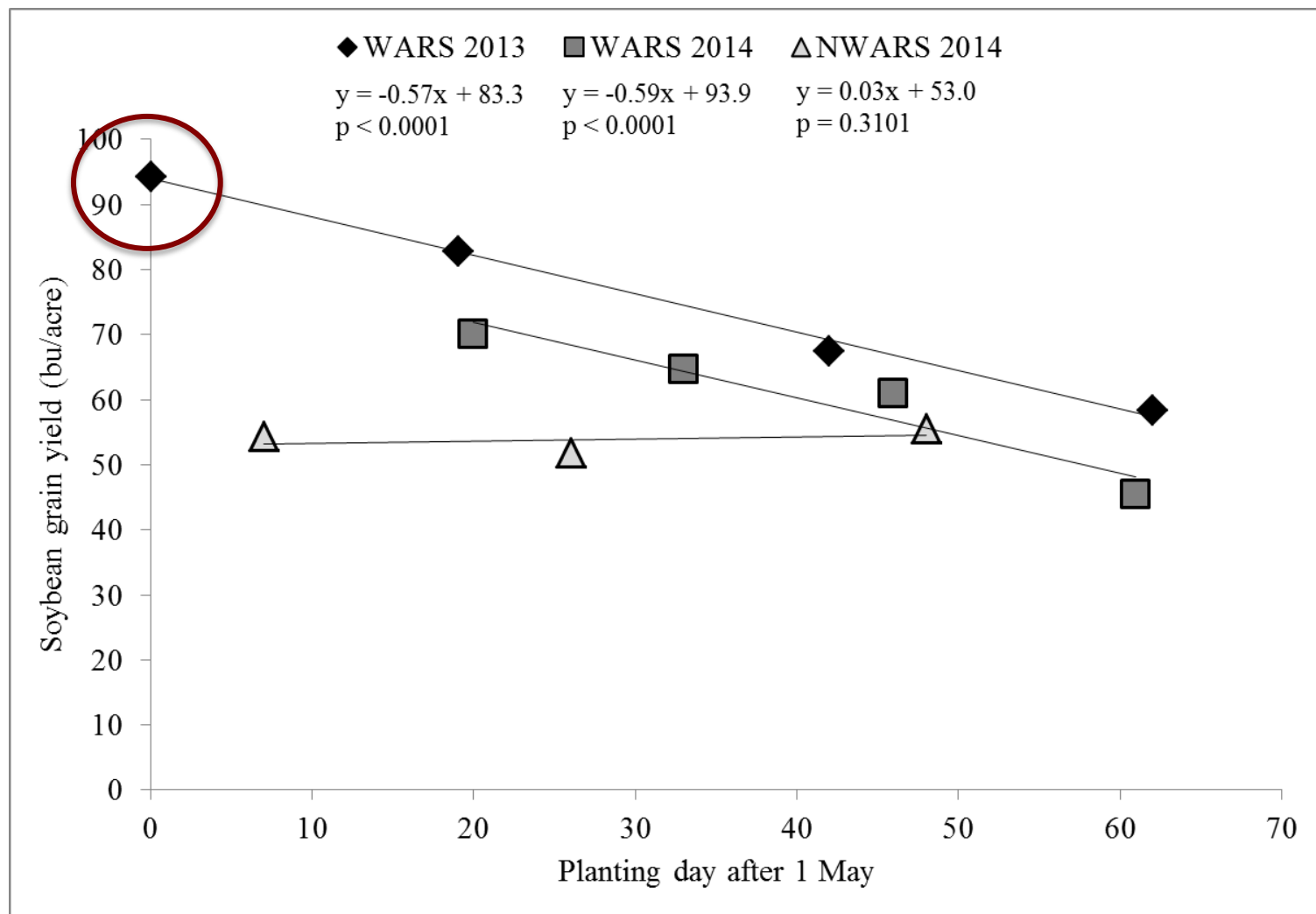
- N fertilizer decreased nodulation at V2 (2 out of 3 site-years)
- No effect on yield
- Soil test P
 - 32 to 84 ppm



Planting Date Effect



Planting Date Effect



Pick the Low Hanging Fruit... Before You Climb The Tree

