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OKLAHOMA STATE UNIVERSITY EXTENSION

Variable Rate Phosphorus

Brian Arnall

Precision Nutrient Management | Oklahoma State University

Great Anticipation

- MSU RCSC One of my favorites
- Darrin and Bobby
- This gives me a chance to test run this topic.

Overview

- Share current on goings in US
- Phos Management Concepts
- VRT recs How and Why

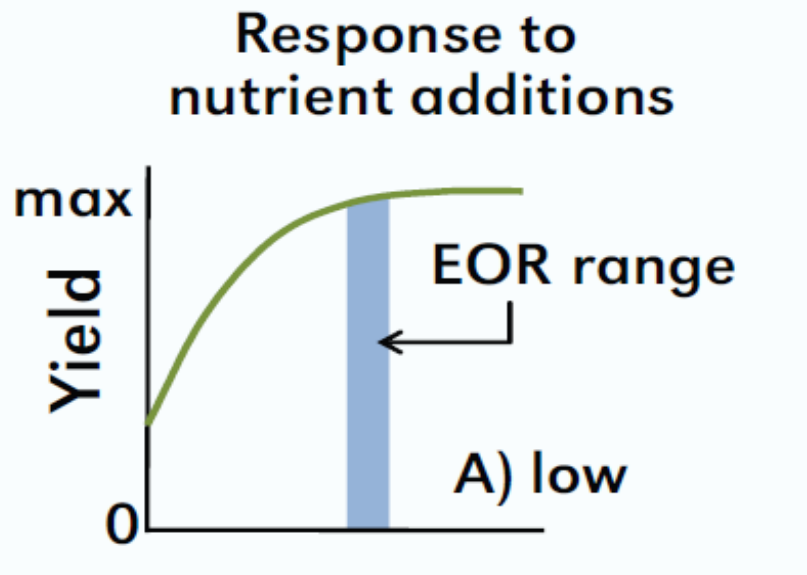
- There is NOT a consensus

- Hopefully sometime down the road it causes some thought.
- Don’t Be complacent

US IMPACT

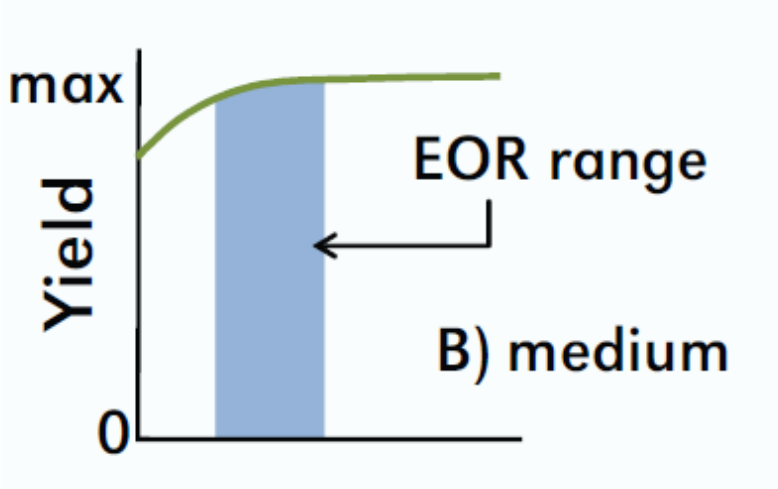
- In past
  - Chesapeake Bay
  - Oklahoma Sues Arkansas
- News is about Lake Erie
  - Was bad,
  - Then good
  - No bad again
    - The Problem
    - The Fix?
- Impact elsewhere

Understanding Crop Response to Fertilizer
Low Soil Test Levels



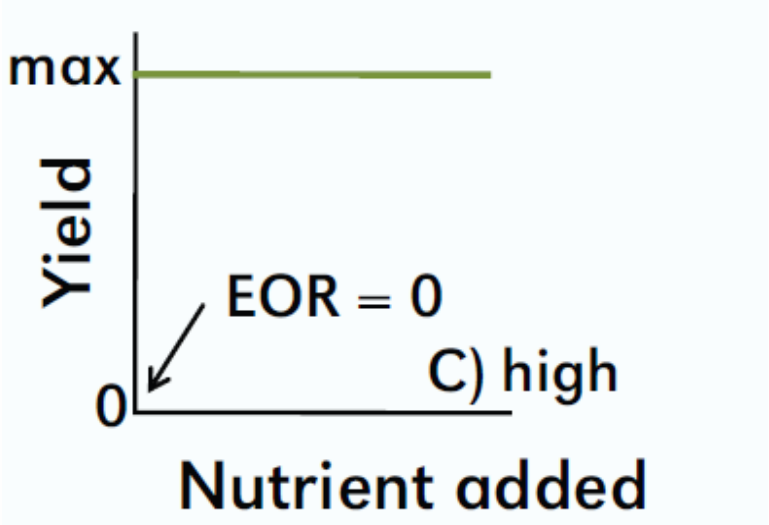
- Low yields without additional fertilizer
- EOR range is narrow
- Optimum rate is minimally affected by grain:nutrient price ratio

Understanding Crop Response to Fertilizer Medium Soil Test Levels



- Expected yield without fertilizer is higher
- Range of potentially optimal rates is wider
- In a single-year decision framework, EOR is very sensitive to grain:nutrient price ratio
- As price ratio↓ EOR ↑

Understanding Crop Response to Fertilizer
High Soil Test Levels



- No or minimal response to added fertilizer

Understanding Sufficiency vs. Build-Maintain Programs for P

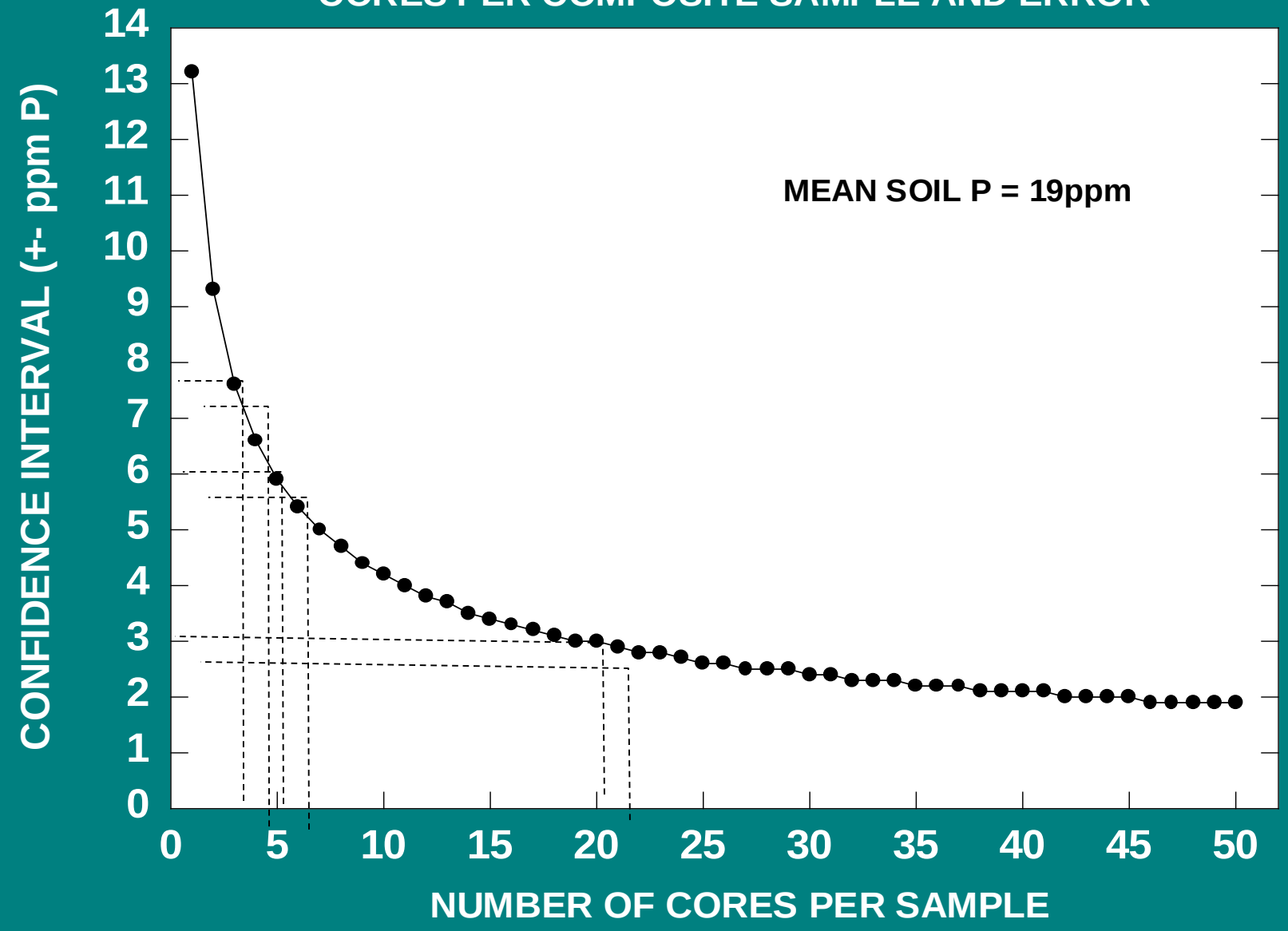
- Sufficiency fertility programs
  - Intended to estimate the long-term average amount of fertilizer P required to, on average, provide optimum economic return in the year of application. There is little consideration for future soil test values

Sufficiency does work for P and K

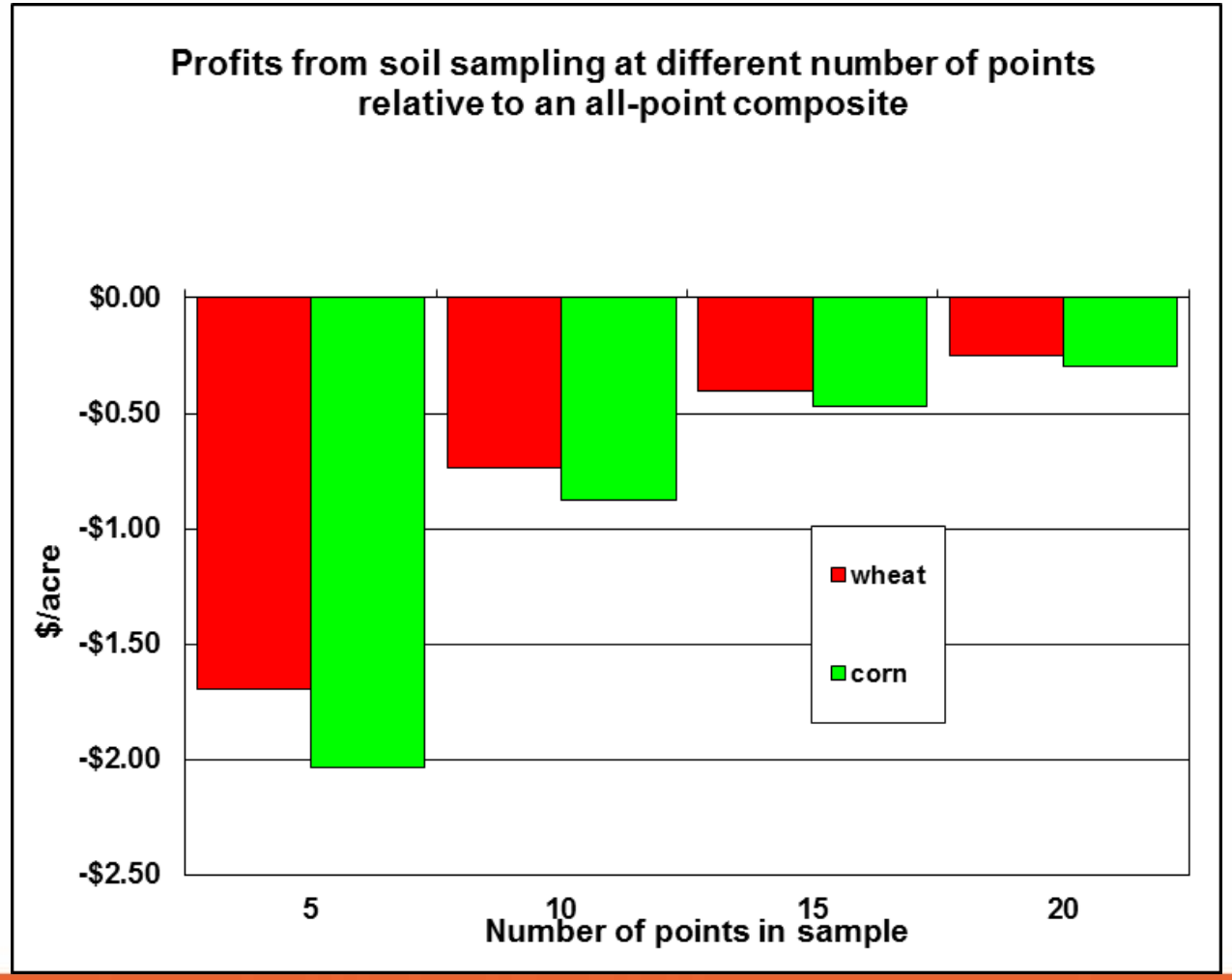
			Applied Phosphorus (kg P ha^{-1})											
Year	Location	OSU Rate	OSU	0	4.9	9.8	14.7	19.6	24.5	29.4	34.3	39.2	44.1	48.9
		kg P ha^{-1}	yield Mg ha^{-1}											
2014														
	Stillwater	36.2	2.93	2.84	2.71	2.57	3.01	2.85	2.88	2.43	3.02	3.00	2.86	2.50
	Red Rock 1	19.5 *	2.02 abc	1.34 c	1.46 c	1.44 c	2.02 abc	2.30 abc	1.81 bc	3.06 a	2.79 ab	2.37 abc	2.98 ab	2.84 ab
	Red Rock 2	11.3 *	3.52 abcd	2.87 d	2.99 cd	3.38 bcd	3.40 abcd	3.71 abc	3.58 abcd	3.59 abcd	4.16 a	3.83 ab	3.59 abcd	3.99 ab
	Red Rock 3	10.2 *	3.46 abcd	2.97 de	2.84 e	3.19 bcde	3.21 cde	3.93 ab	3.59 abcde	3.39 abcde	3.75 a	3.83 abc	3.68 abcd	3.76 ab
	Waukomis1	0 *	2.06 ab	1.86 b	2.39 a	1.94 b	2.06 ab	2.02 ab	2.22 ab	1.92 b	2.05 ab	2.08 ab	2.16 ab	1.98 ab
	Waukomis 2	19.6	1.82 abc	1.29 d	1.58 cd	1.68 bc	1.72 bc	1.84 abc	1.81 abc	2.03 a	1.83 abc	1.84 abc	1.97 ab	1.95 ab
2015														
	Garber	0	3.33	3.20	3.13	3.19	3.30	3.47	3.79	3.21	3.20	3.14	3.20	3.25
	Stillwater	29.4	2.23	2.34	2.53	2.24	2.75	2.60	3.74	2.72	2.68	2.97	2.84	3.03
	Waukomis 3	7.4 *	3.31	3.24	3.57	3.29	3.48	3.41	3.72	3.59	3.65	3.56	3.80	3.69

Means in each row with different lettering beneath are significantly different at $p \leq 0.05$.
OSU Rate with * indicates that current recommendations would have required an additional 14.68 kg P ha^{-1} application due to soil pH.

EXAMPLE OF THE RELATIONSHIP BETWEEN NUMBER OF SOIL CORES PER COMPOSITE SAMPLE AND ERROR



Economics of Accuracy

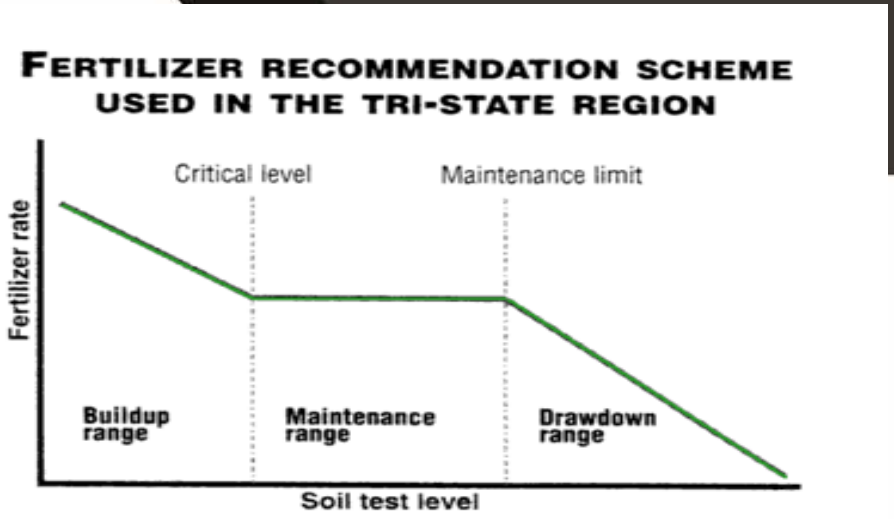


Build-Maintenance

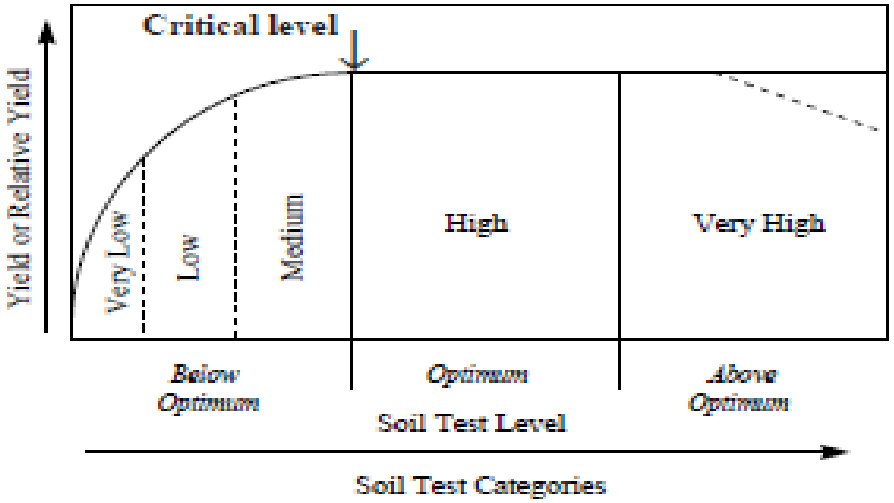
- Apply enough P to or K to build soil test values to a target soil test value over a planned timeframe (e.g. 4-8 years), then maintain based on crop removal and soil test levels
- NOT intended to provide optimum economic returns in a given year, but minimize the probability the P or K will limit crop yields while providing for near maximum yield potential

Crop	Harvest unit	P in yield
Corn	Bushel	.38
Soybean	Bushel	.8
Wheat	Bushel	.5

Crop	Harvest unit	P in yield
Peanut	Cwt	.55
Cotton	Bale	13
Sorghum	Bushel	.42



Build-up maintain fertilizer scheme suggested by the Ohio State University.



Nutrient response curve based on soil test, Rutgers Cooperative Extension.

- Sounds good and makes sense right.
- If we are using this approach.
- Does rate matter.

Variable Rate Phos Recs

- How is it done?
- Soil : Yield : Soil x Yield: Yield : Soil

- Grid/Zone Sample, Yield Goal 3-5 yr
- Grid/Zone, Multi Year Yield, 3 yr
- Grid/Zone, Update Yield each year.

One Company's Math

- Equation for soils below optimum is:

P Rec = (Optimum P – Observed P) *16 / build years + Crop Removal

- For soils test in the optimum range:

Prec = Crop Removal

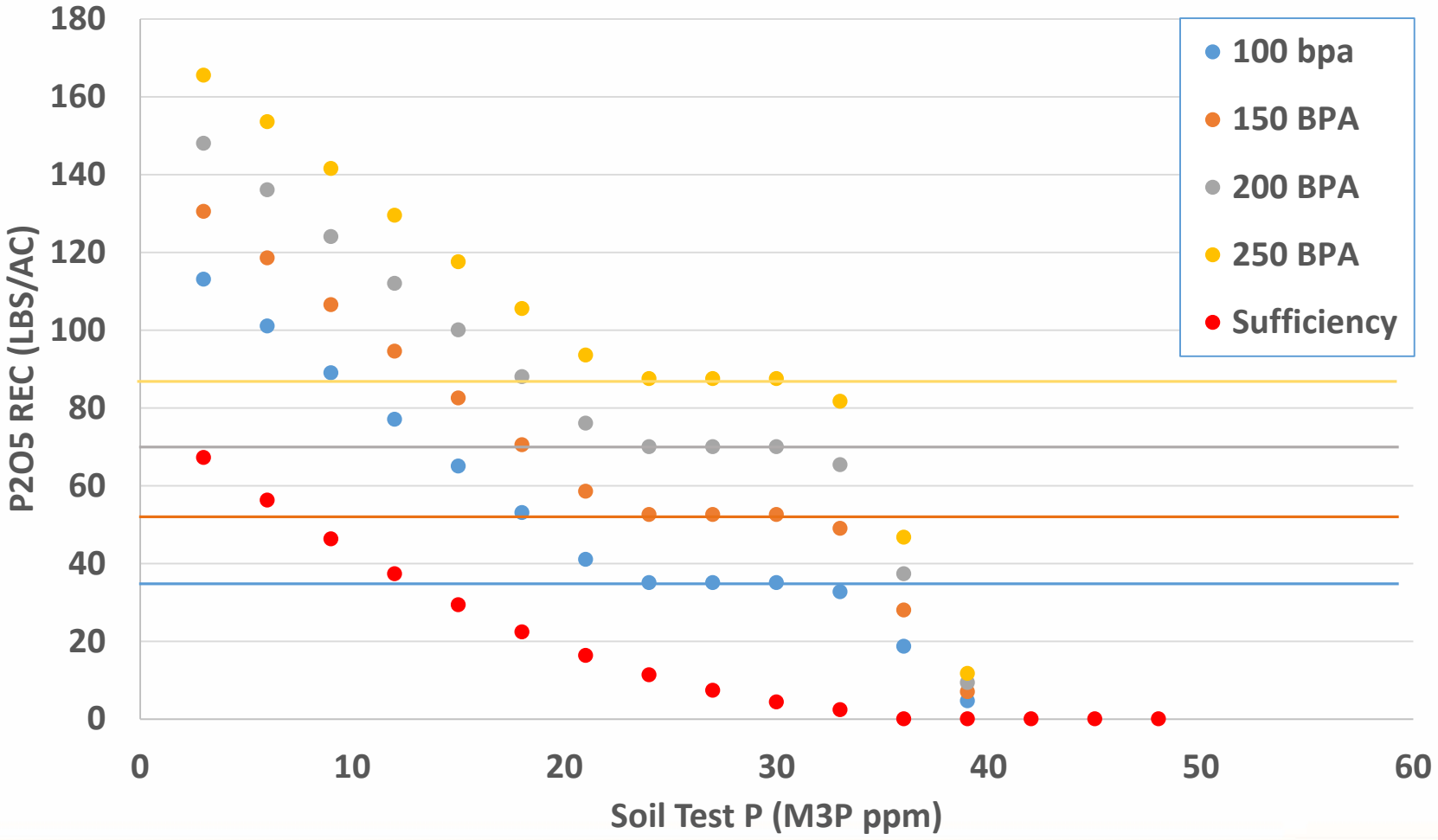
- For Soils in High Range

Prec = Crop Removal *(((Optimum P level + 12.5) – observed P)/7.5)

  - This gradually tapers the rec to 0 once we are 12.5 ppm above optimum

- Optimum Range is 22.5-27.5 ppm for Row Crops , 20-25ppm for cool season grass and similar, 15-20ppm for Warm Season grass and similar

Phos Recs

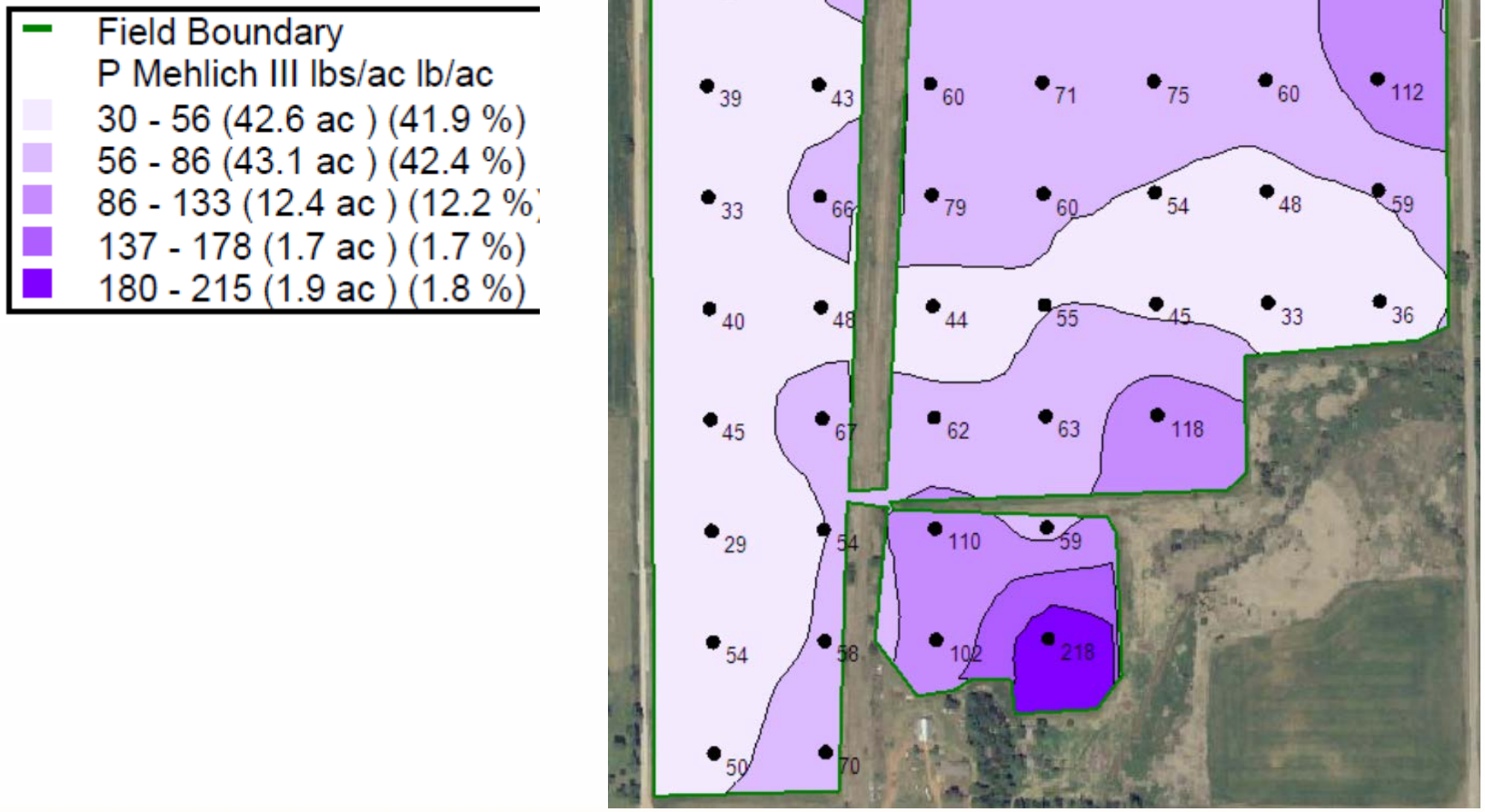

180
160
140
120
100
80
60
40
20
0
P2O5 REC (LBS/AC)
0
10
20
30
40
50
60
Soil Test P (M3P ppm)
100 bpa
150 BPA
200 BPA
250 BPA
Sufficiency

Grid Soil Sample Results from SGP

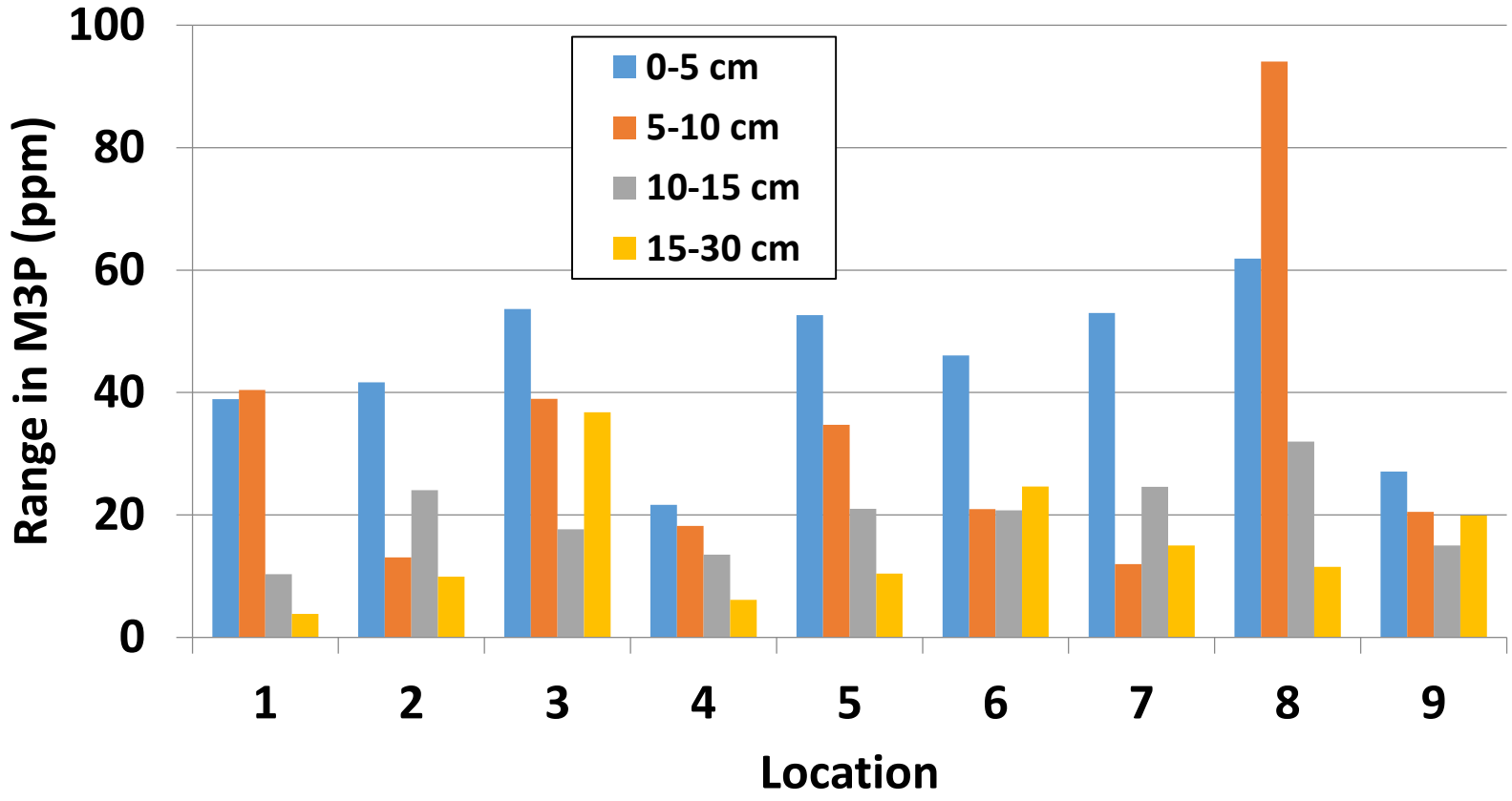
	Soil pH		Buffer Index		P		K	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Count	268		266		257		257	
Average	6.0	1.9	6.8	0.5	28.4	54.5	190	209
Min	4.6	0.4	5.9	0.0	4.3	4.0	28	14
Max	7.7	3.8	13	5.4	93	318	674	4640

	OM		Ca		Mg		S	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Count	176		199		233		102	
Average	2.6	2.0	1546	1877	314	351	14	26
Min	0.5	0.3	396.1	0.0	45.5	20.0	5.9	0.0
Max	123	121	5099	12750	1208	1201	87	597

Making Maps / Interpolation



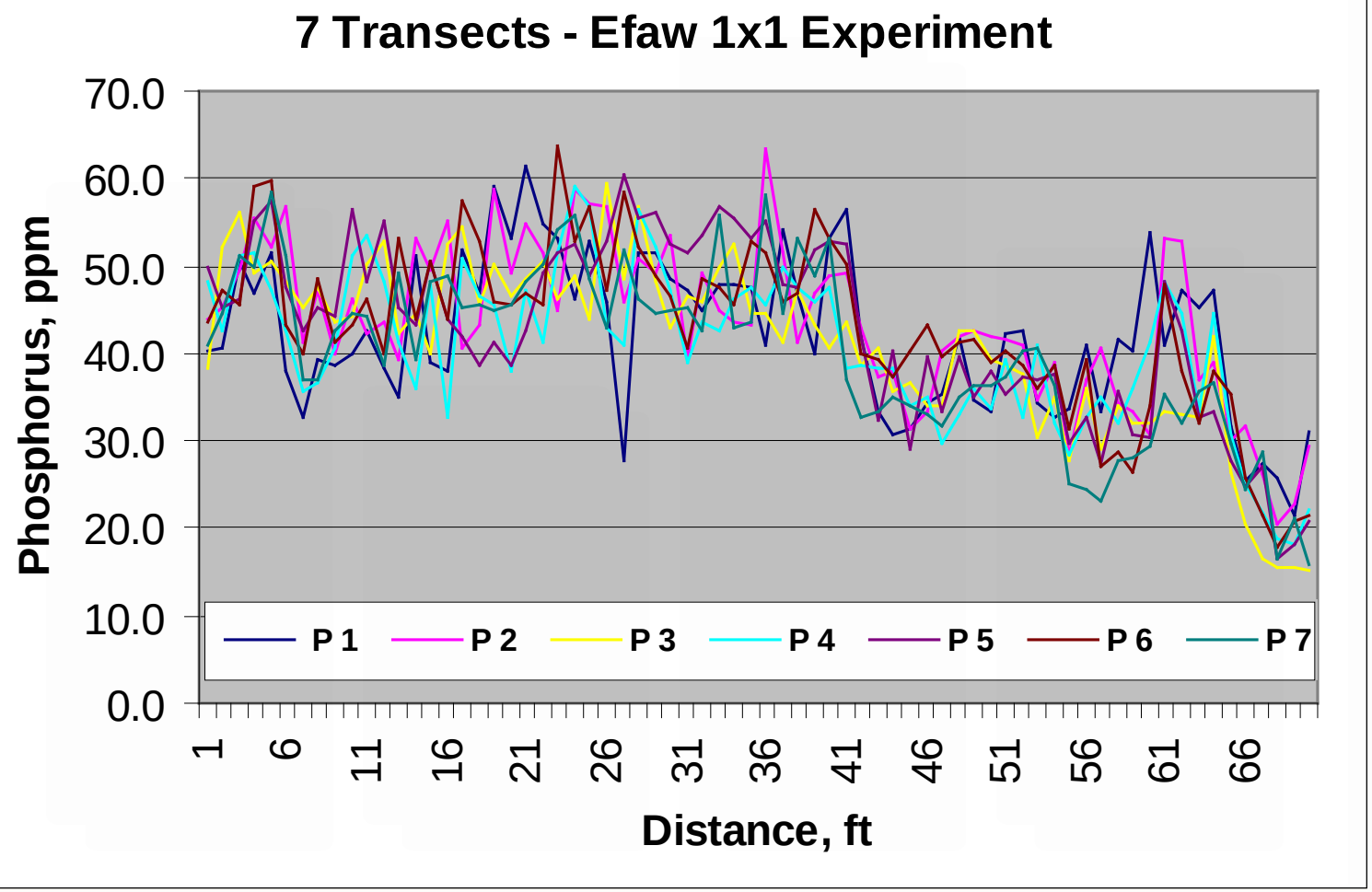
9 On farm No-till Wheat P Response Studies



Year	Location	Sampling Depth	Mehlich III Extractable P			Soil pH		
			Min	Max	Ave	Min	Max	Ave
		cm	Mg P kg^{-1}					
2014	**Stillwater**	0 -5	***2.2***	***41.1***	11.8	***5.9***	***8.1***	6.9
		5 -10	***2.9***	***43.3***	7.3	***6.3***	***8.2***	7.3
		10 -15	2.3	12.7	4.9	6.2	5.2	7.3
		15 -30	1.5	5.3	2.7	6.6	9.1	7.8

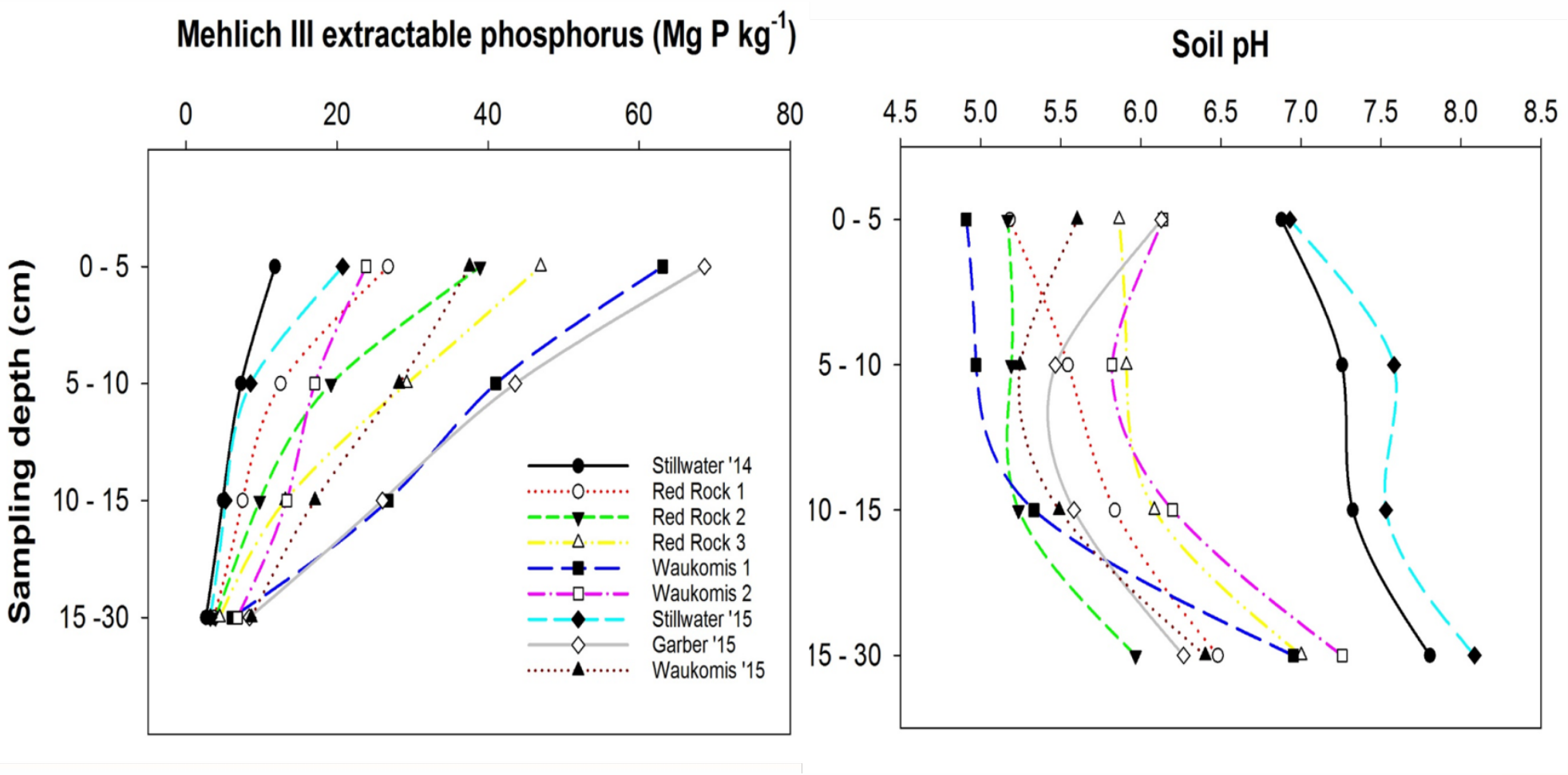
How Variable is the Soil?

Microvariability in Soil Test, Plant Nutrient, and Yield Parameters in Bermudagrass. 1997
W. R. Raun et al.
Vol. 62 No. 3, p. 683-690

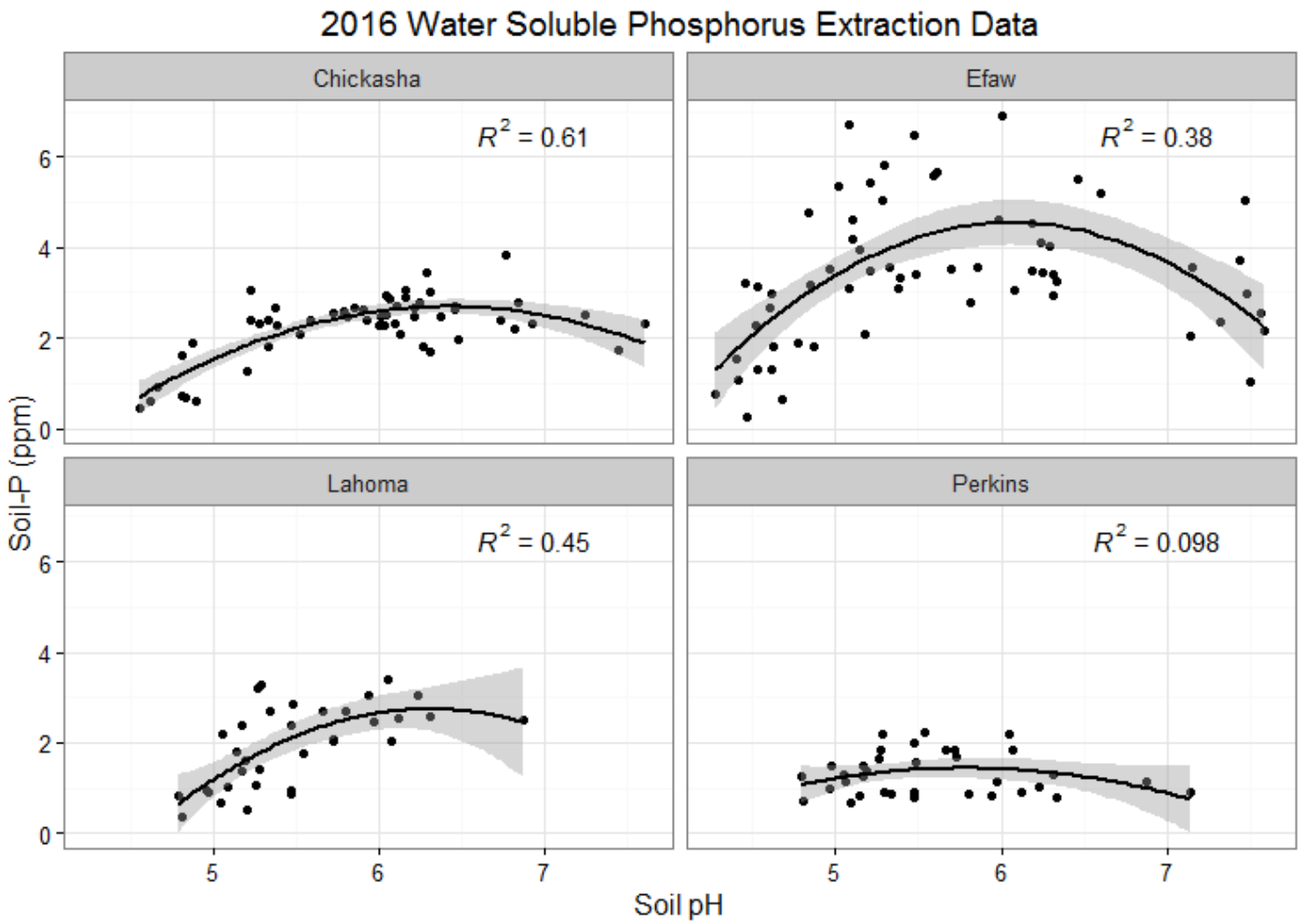


Soil pH ranged from 4.37 to 6.29 within the 2.12 by 21.33 m area at Burneyville and 5.37 to 6.34 at Efaw. Significant differences in surface soil test analyses were found when samples were <1 m apart for both mobile and immobile nutrients

Sampling

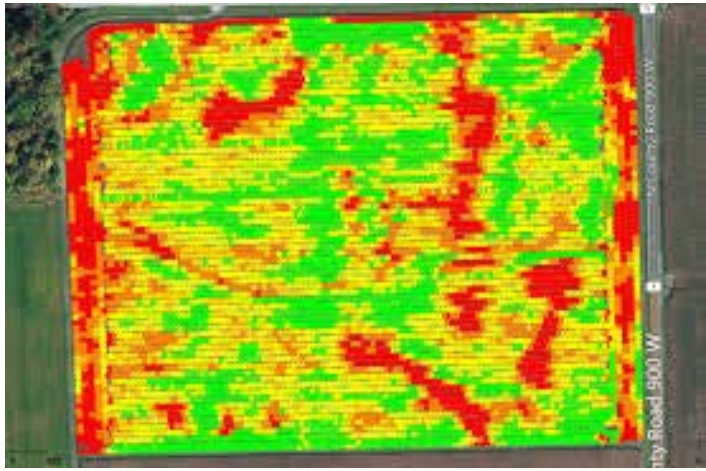

Mehlich III extractable phosphorus (Mg P kg-1)
0
20
40
60
80
Sampling depth (cm)
0 - 5
5 - 10
10 - 15
15 -30
Stillwater '14
Red Rock 1
Red Rock 2
Red Rock 3
Waukomis 1
Waukomis 2
Stillwater '15
Garber '15
Waukomis '15
Soil pH
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
0 - 5
5 - 10
10 - 15
15 - 30

Water Soluble P and pH



VRT Take Home

- Likelihood of VRT based on Sufficiency being off is high.
- Interpolation of P based on grid is a stretch.
- Yield monitor data has a higher resolution of positional accuracy.
- Current VRT using a Course Knob to adjust P.
- If replacement rates are used soil testing is essential



Nutrient Rich Strips

Use your cover crops!!!

Thank you!!!

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