Managing P and K Applications – What to Do with Changing Economics

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Overview

- Soil concepts
  - Nutrient movement
  - Critical levels
  - Temporal variability
- Fertilizer decisions
  - Philosophy of fertilization
  - Economic considerations
  - Placement differences

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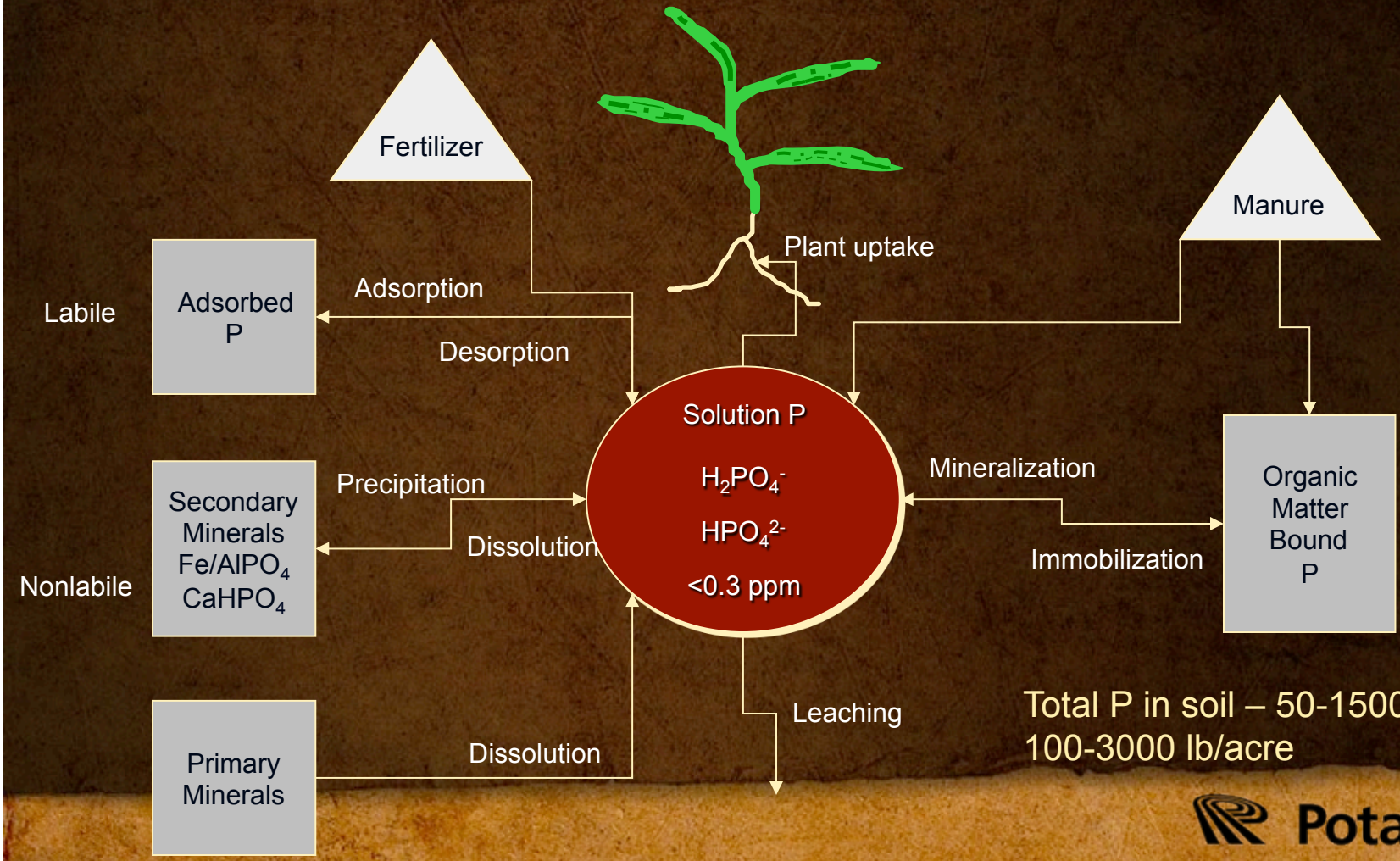
Soil Concepts

Nutrient Movement

- Phosphorus and potassium are typically considered relatively immobile
  - Due to their nature and behavior in soils



Total P in soil – 50-1500 ppm ~ 100-3000 lb/acre

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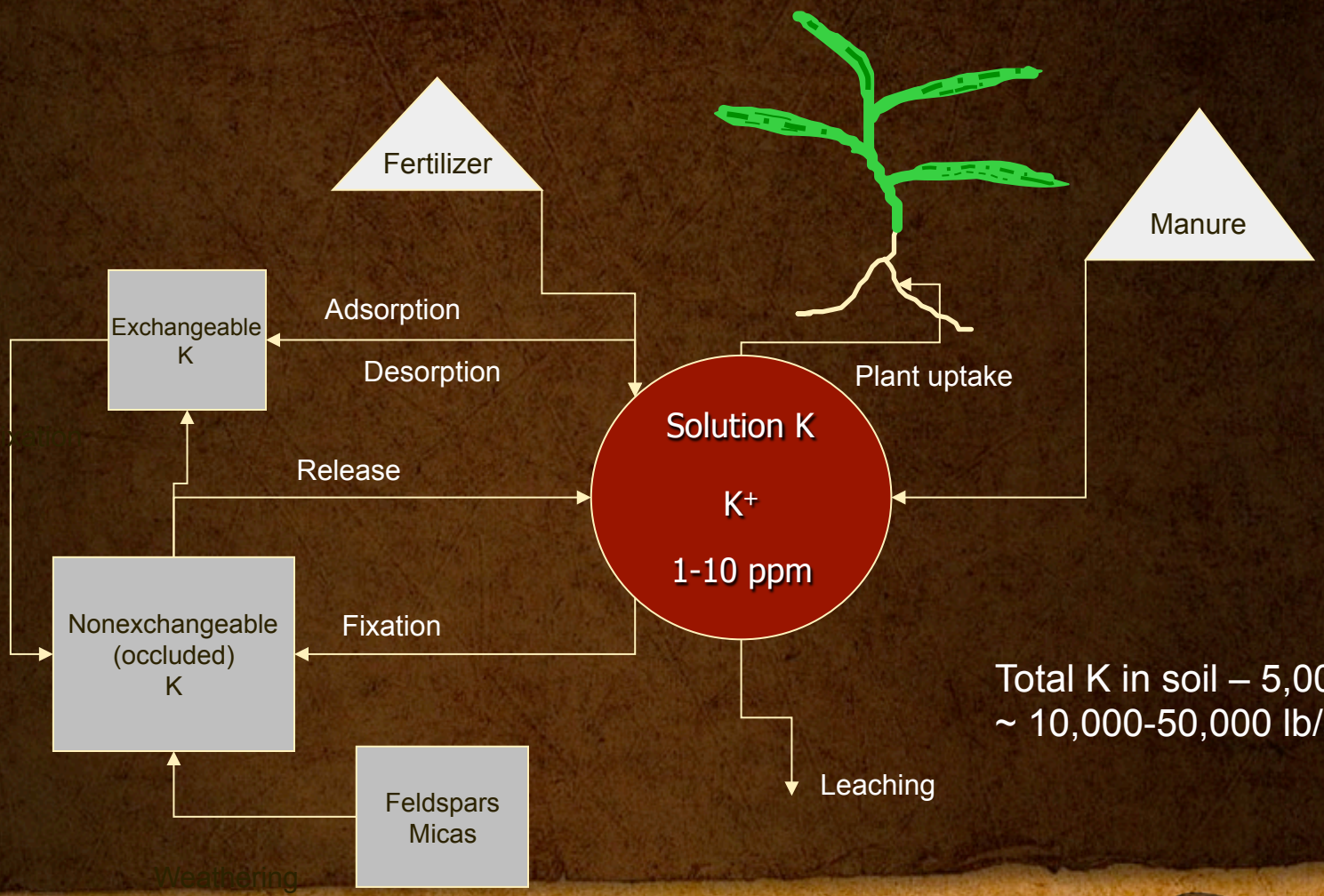
Nutrient Movement

- Potassium cycle



Total K in soil – 5,000-25,000 ppm
~ 10,000-50,000 lb/acre

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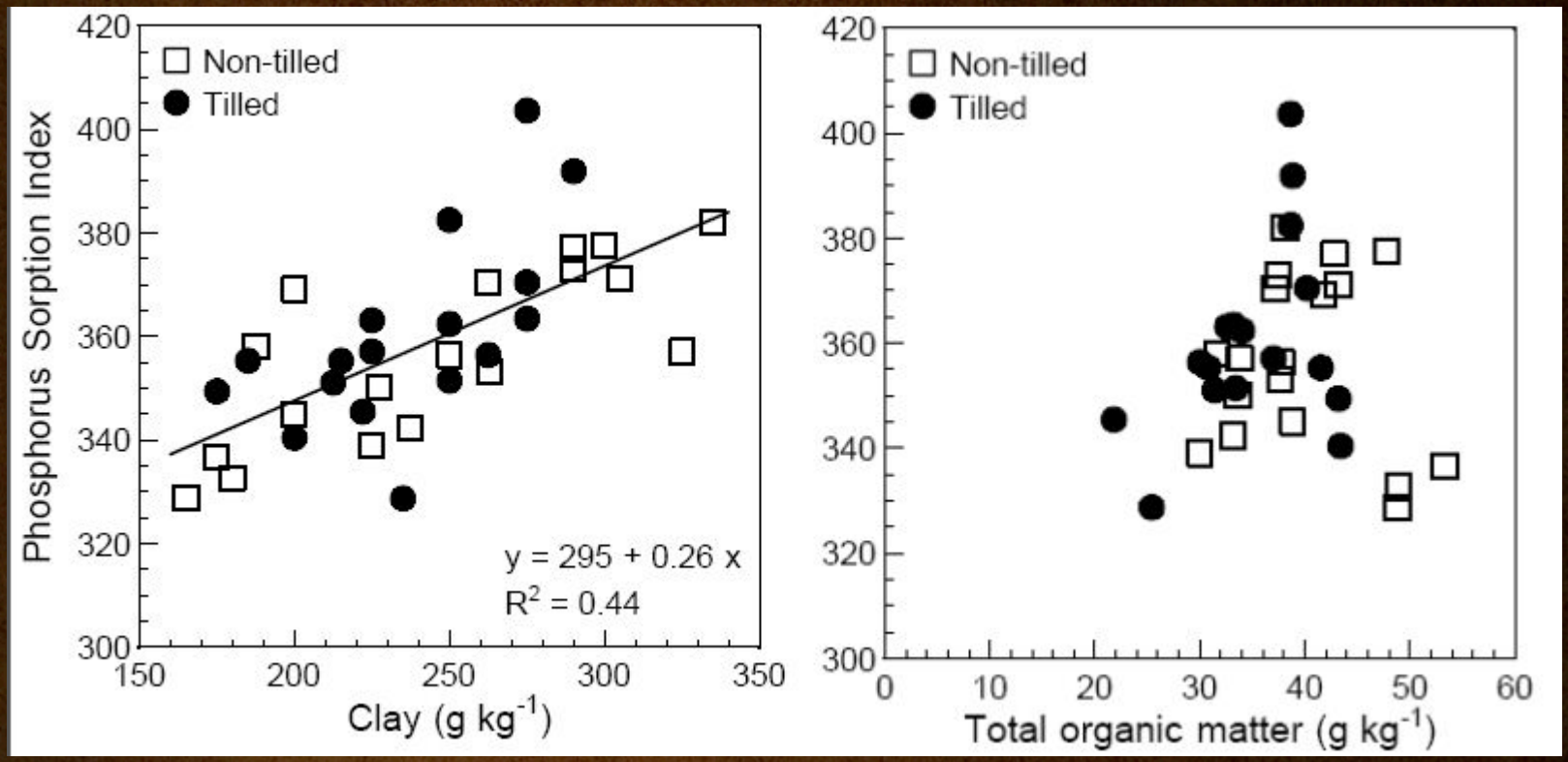
Nutrient Movement

- Neither moves very far, but can they move?
- How are they taken up in the plant if they are not mobile?
- What factors affect movement?
- Because they are relatively immobile how does that affect fertilizer recommendations?

Nutrient Movement

- Can they move?
  - Yes. Largest deciding factors are soil texture and nutrient concentration (tillage is a factor as well, obviously)



Boem et al., SSSAJ, 2008

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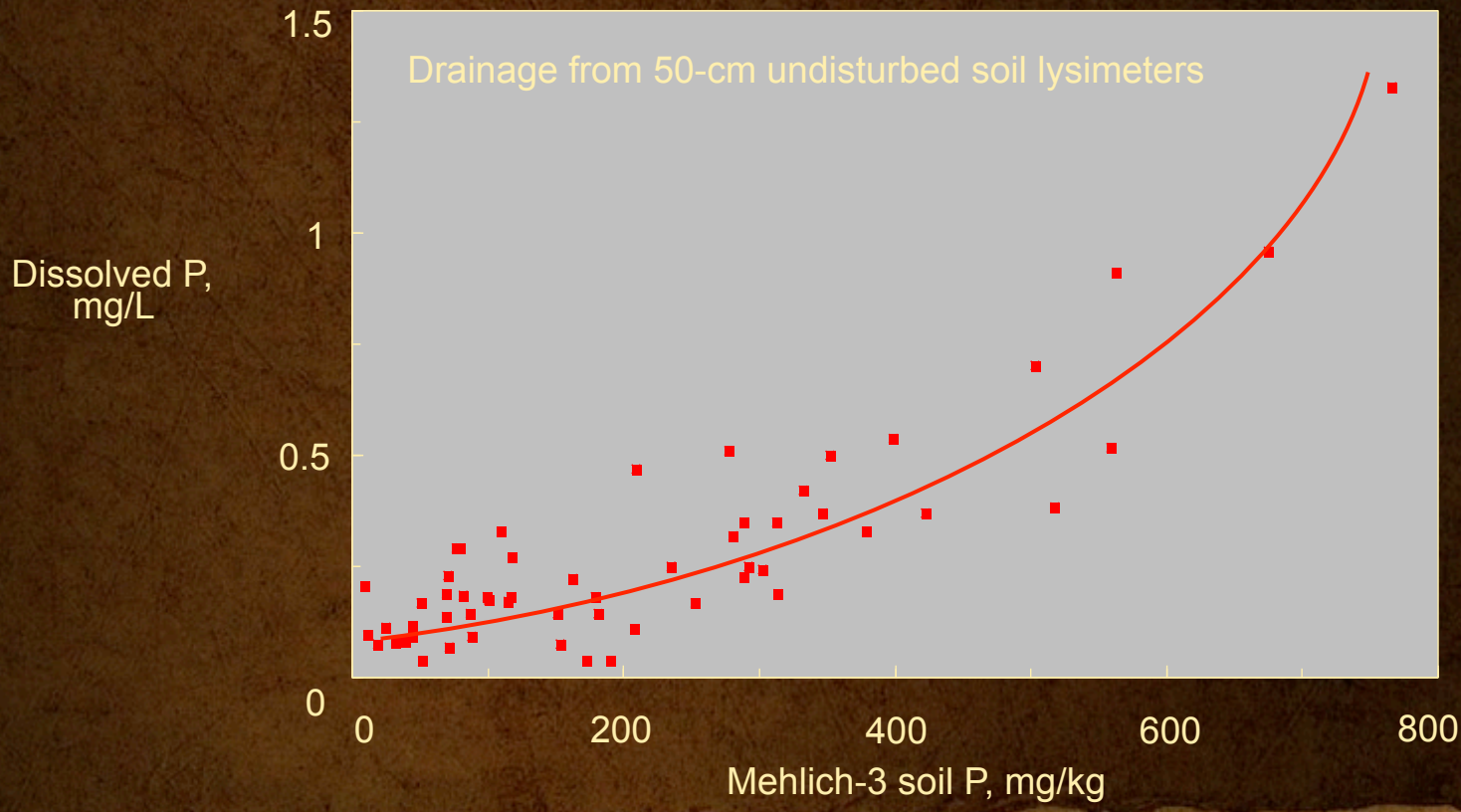
Nutrient Movement

- Nutrient concentration causing nutrient leaching



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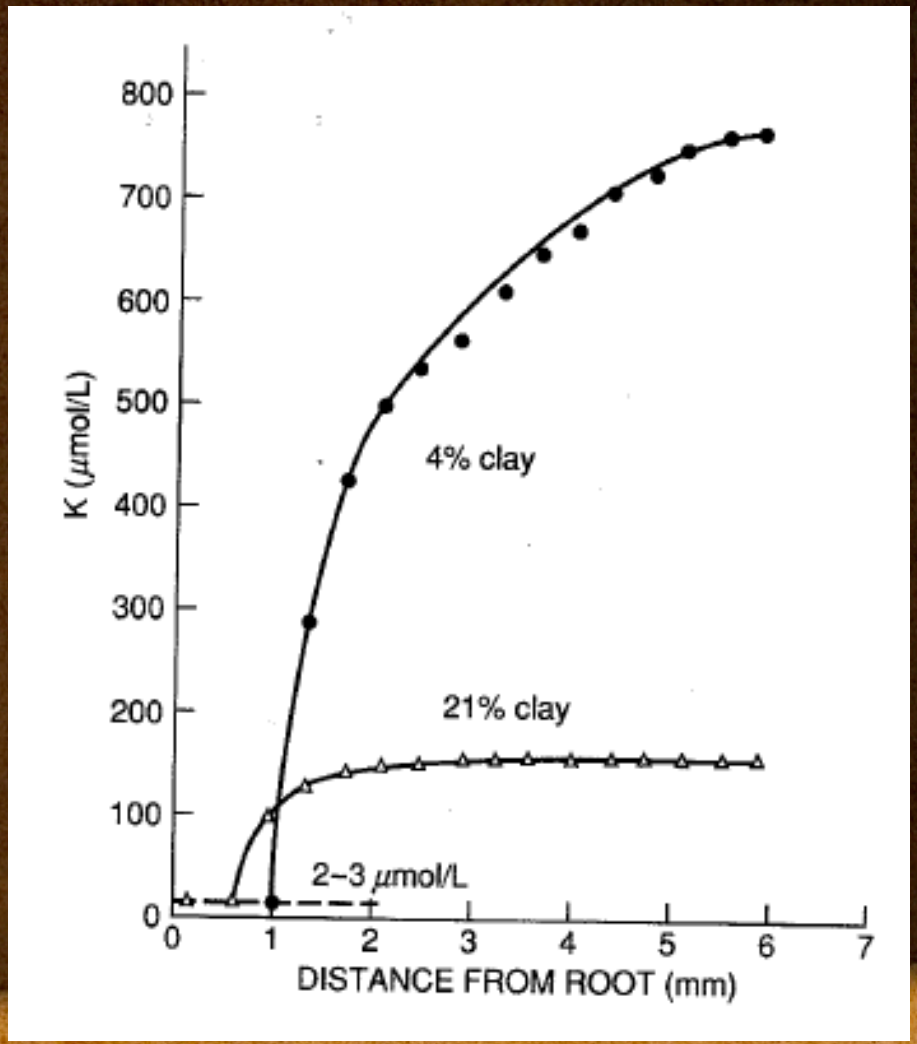
Nutrient Movement

- Soil textural influence on K movement



Claasen and Jungk,
SSSAJ, 1982

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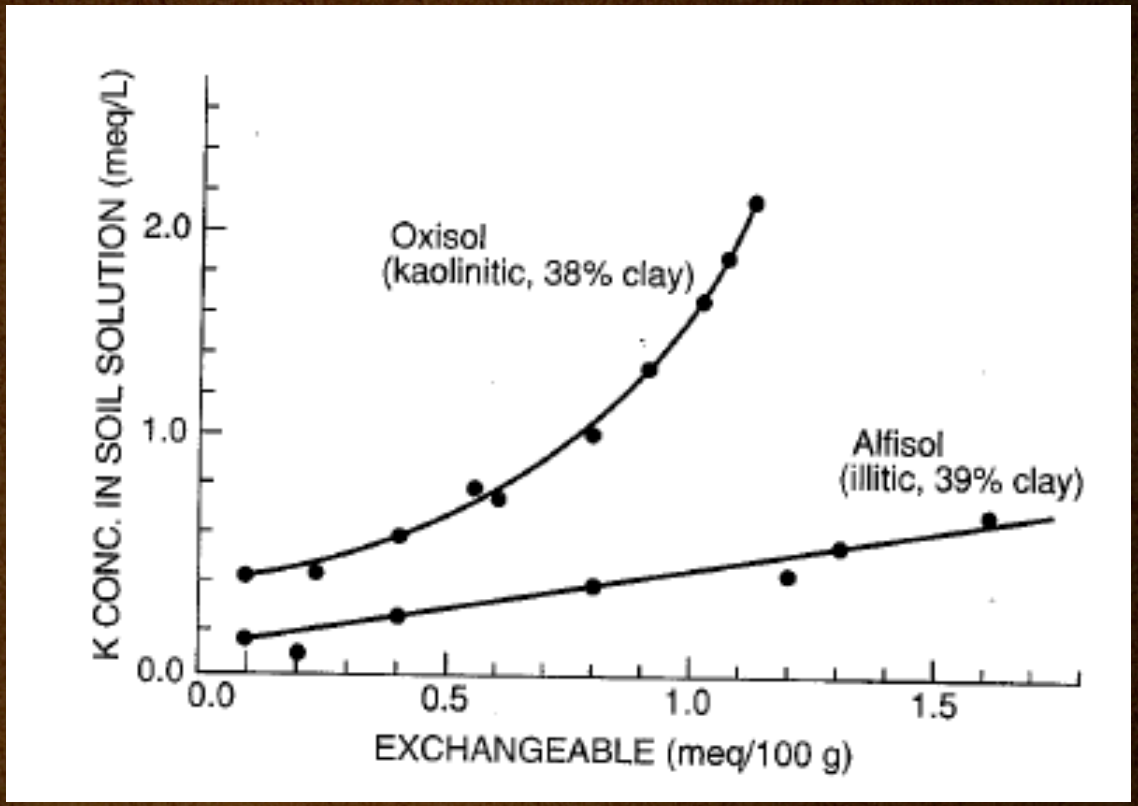
Nutrient Movement

- For K, it is not just clay that matters, but the type of clay is important as well (1:1 versus 2:1 clays)



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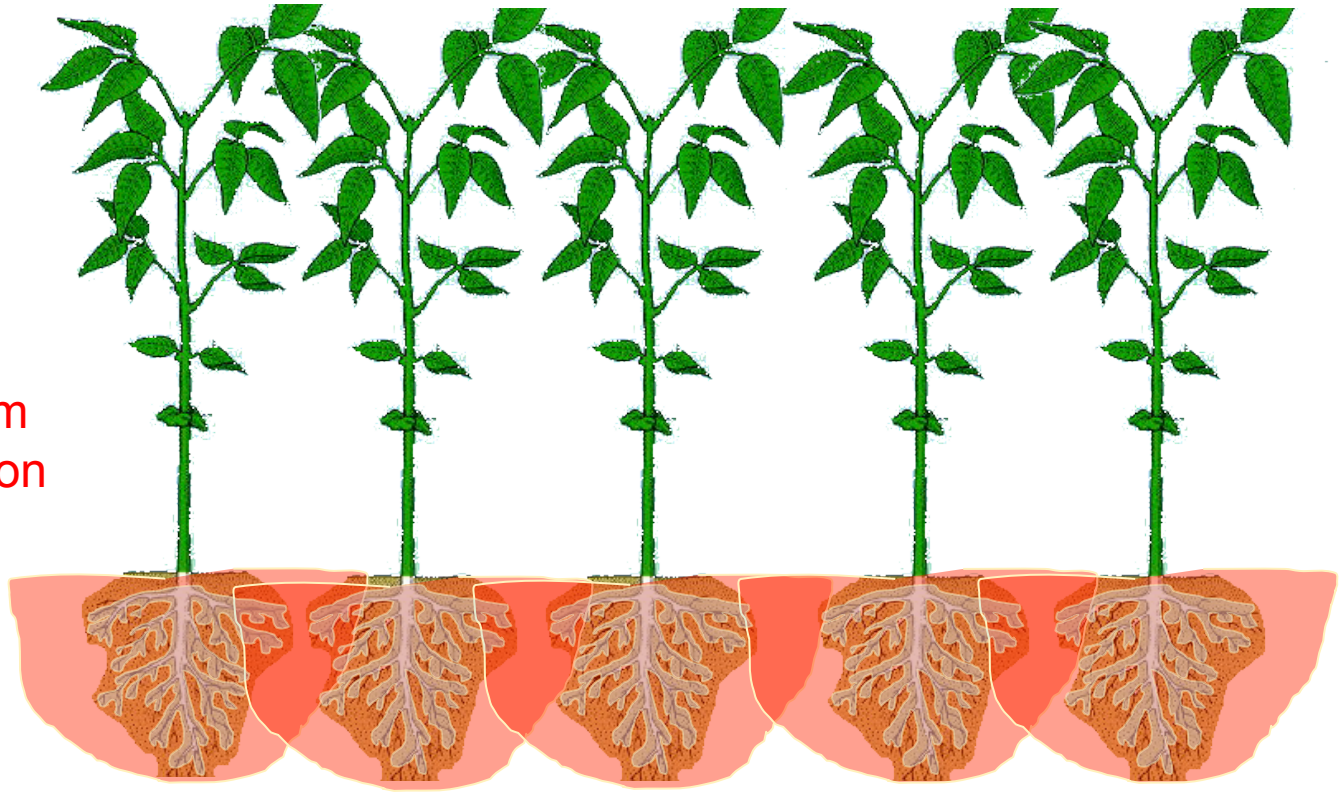
Nutrient Movement

- So, P and K do not move much, so what; how does that influence things like soil testing?
- Before we go there, let's see how these immobile nutrients are taken up.

Nutrient Movement and Uptake

- Nutrient mobility and competition



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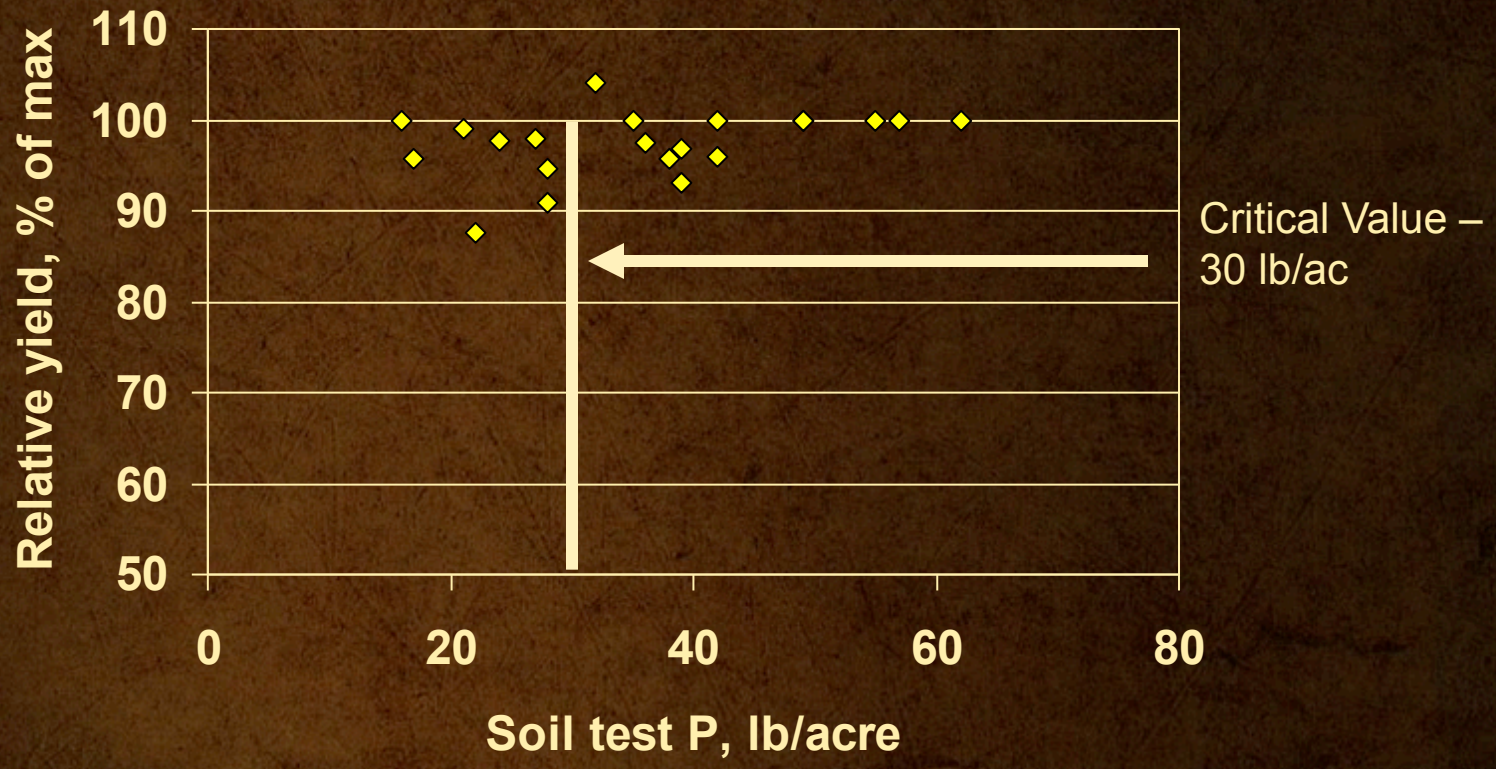
Nutrient Uptake

- Since they are available from a relatively small volume of soil, is there much competition between plants for these nutrients?
  - Think about a nodal root system for corn
- There may be some competition, but not like for a mobile nutrient like nitrogen
- This is important, due to a lack of competition between plants, the amount of nutrient required is not related to yield level
- All we need to do is achieve a nutrient concentration to ensure adequate availability!

Critical Levels

- Ohio State data – relative corn yield and STP



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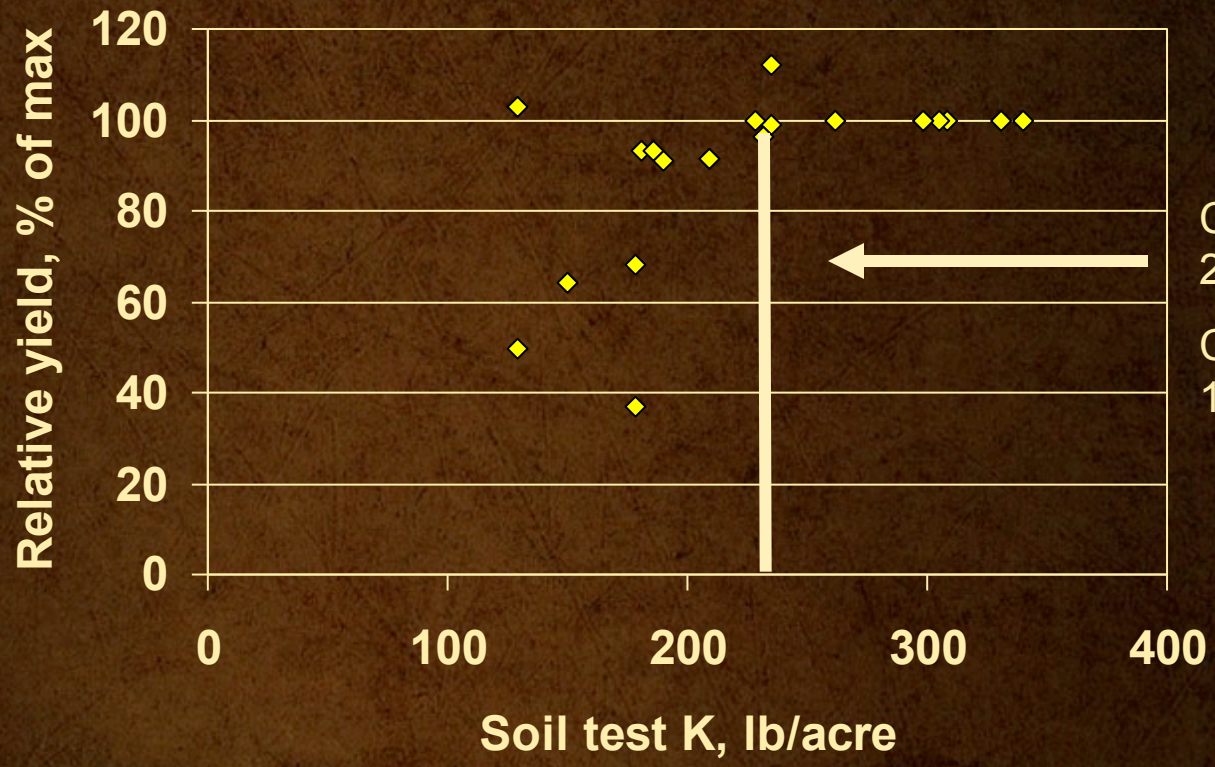
Critical Levels

- Ohio State data – relative corn yield and STK



Critical Value – 220 lb/ac

CEC – 12 meq/ 100g

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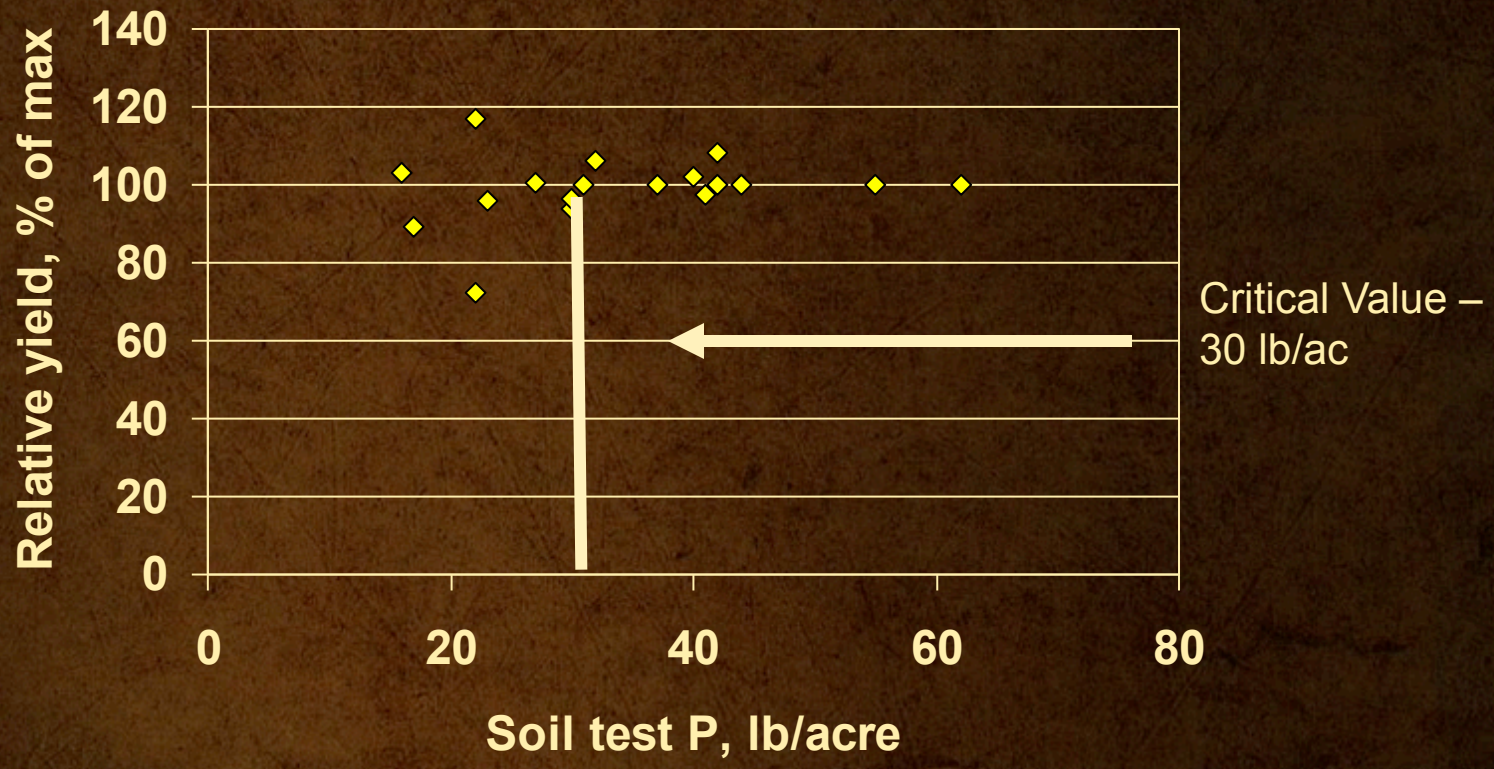
Critical Levels

- Ohio State data – relative soybean yield and STP



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Critical Levels

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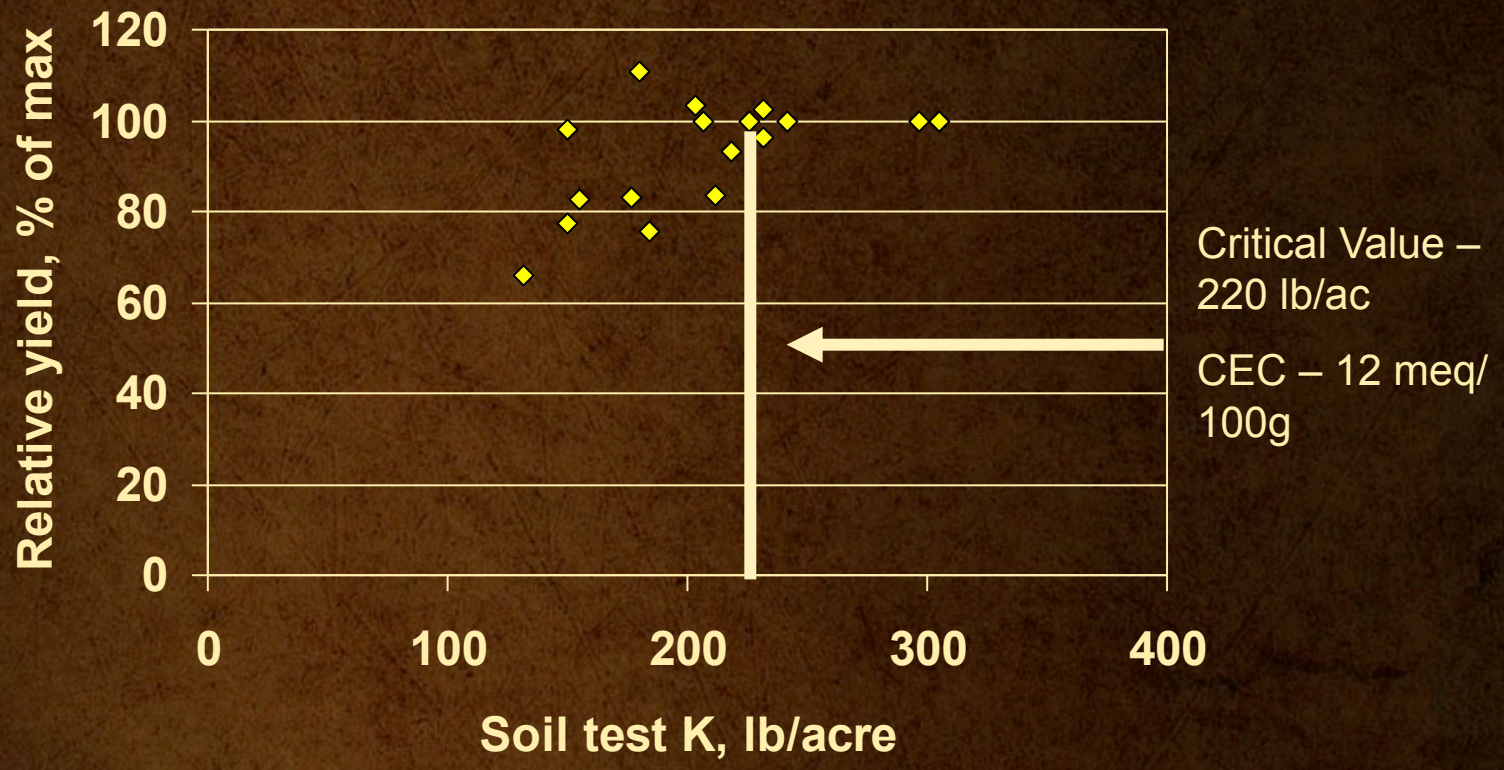

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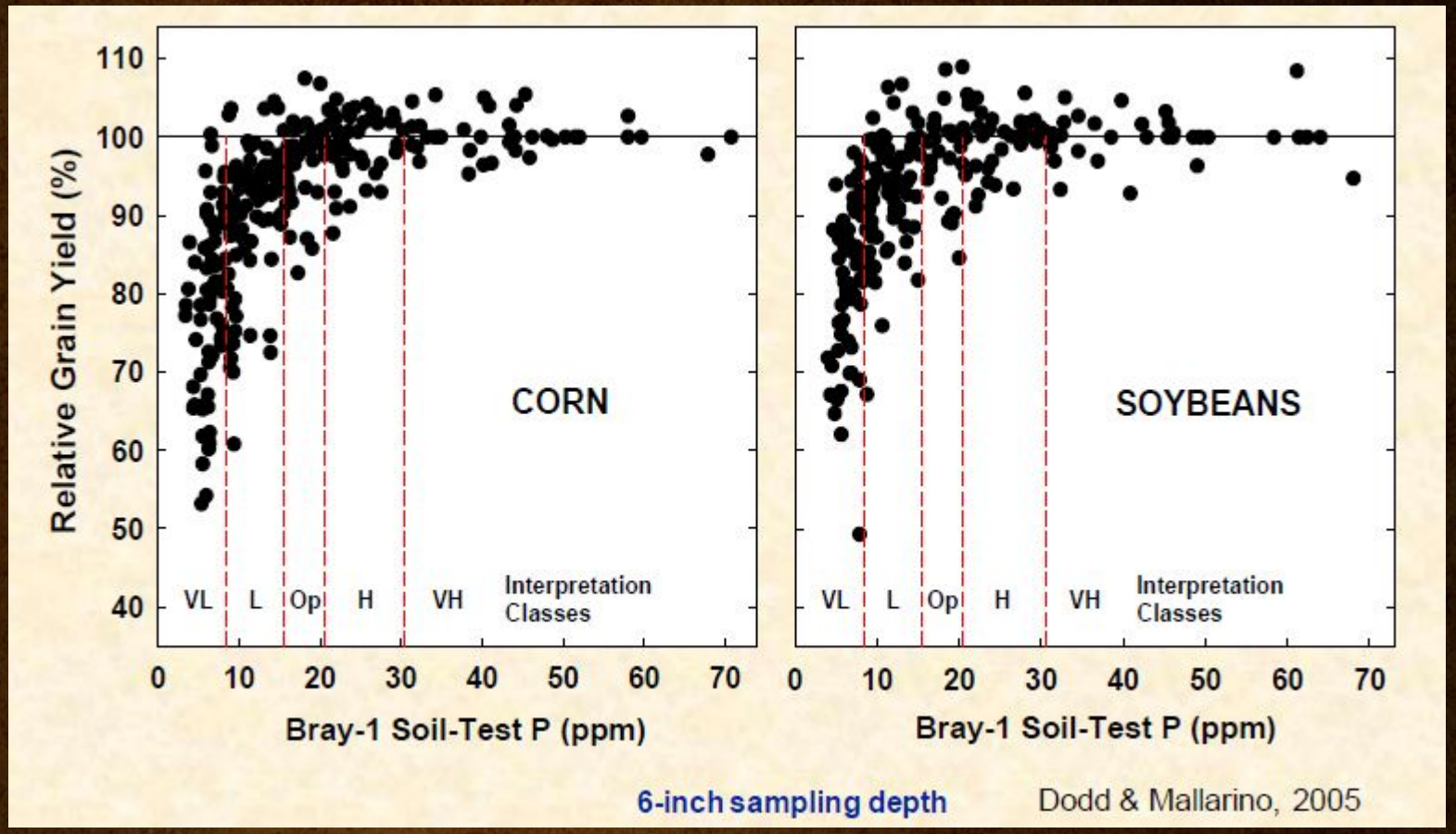
Critical Levels

- Iowa State data – relative yield versus STP



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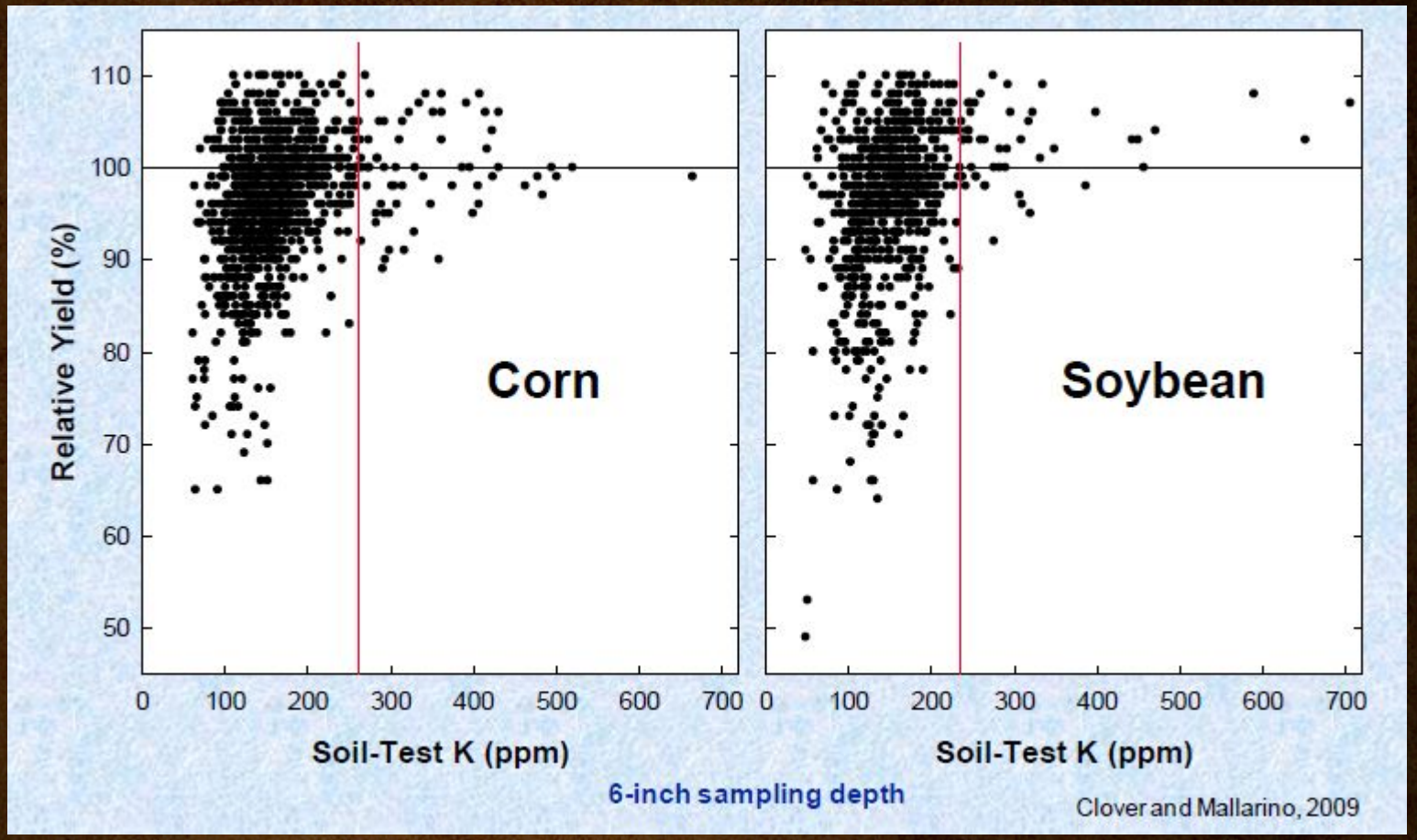
Critical Levels

- Iowa State data – relative yield versus STK



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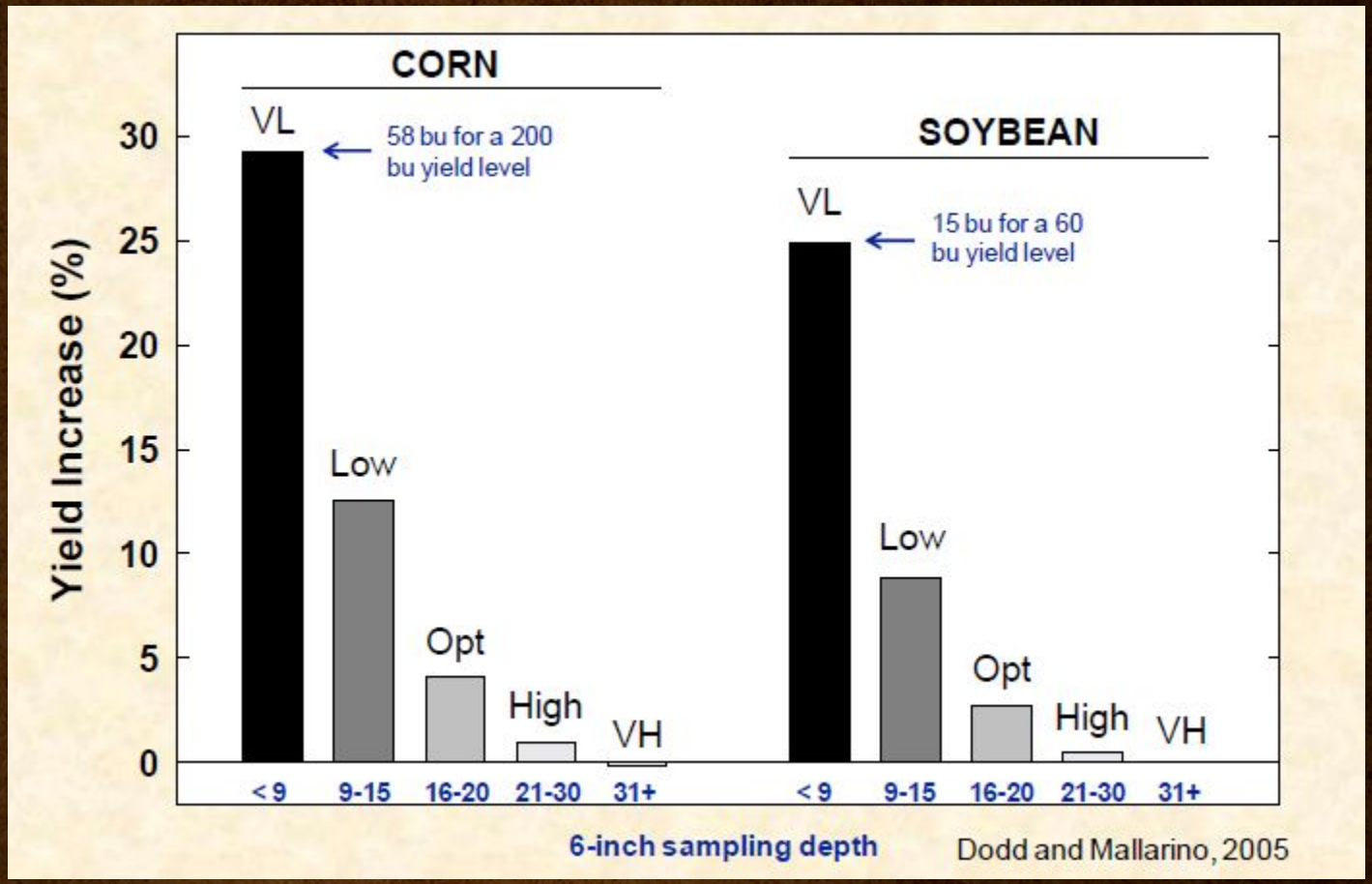
Critical Levels

- Yield response as a function of soil test - P



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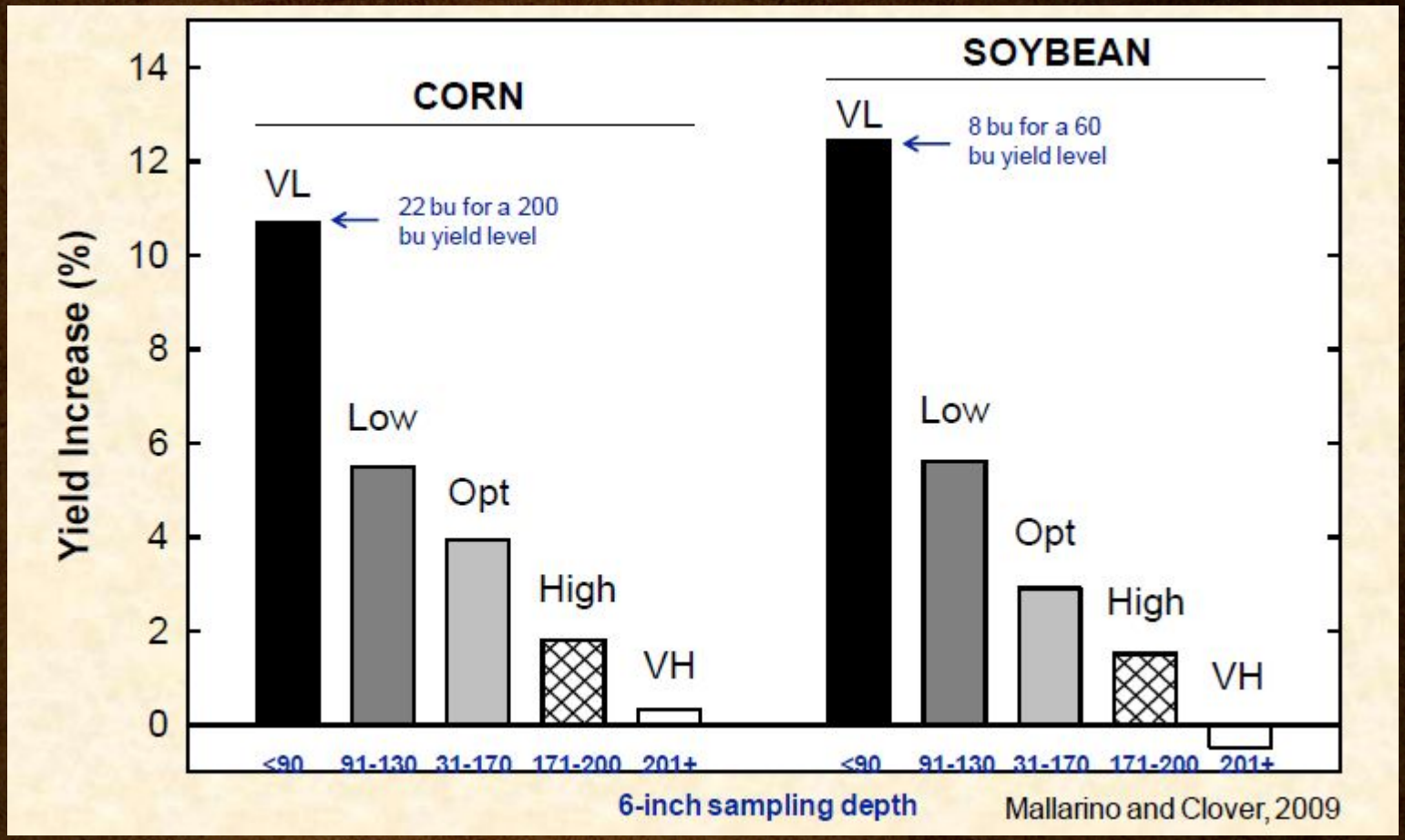
Critical Levels

- Yield response as a function of soil test - K



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Critical Levels

- It is not just the relative magnitude of the yield response, but also the probability of response

STP (ppm)	Probability of response (%)
< 9	80
9-15	65
15-20	25
20-30	5
30 +	<1

STK (ppm)	Probability of response (%)
< 90	80
90-130	65
130-170	25
170-200	5
200 +	<1

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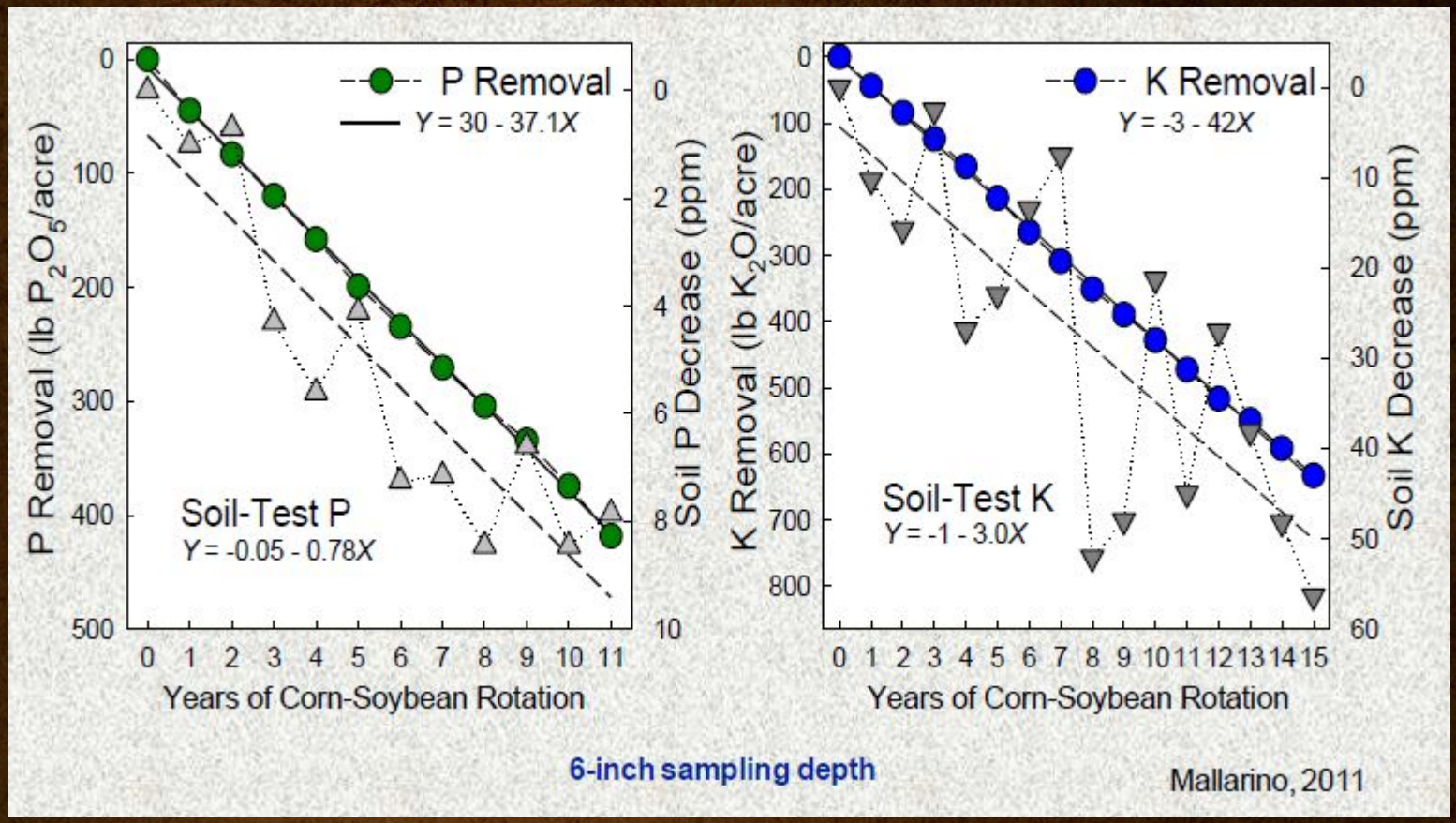
Temporal Variability

- Trends in soil test levels



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Summary of Soil Concepts

- P and K are relatively immobile
- Soil testing can be used as a management tool
- Soil testing is not perfect
  - Spatial variability, error in sampling/analysis, and temporal variability in analysis (conditions at sampling time)
  - It is, by far, our best tool

Fertilizer Decisions

Philosophy of Fertilization

- What is the goal of fertilization…
- To maximize net return on inputs each year?
- To assure that fertility limitations do not exist within a production year/ rotation?
- To maximize short-term or long-term productivity?

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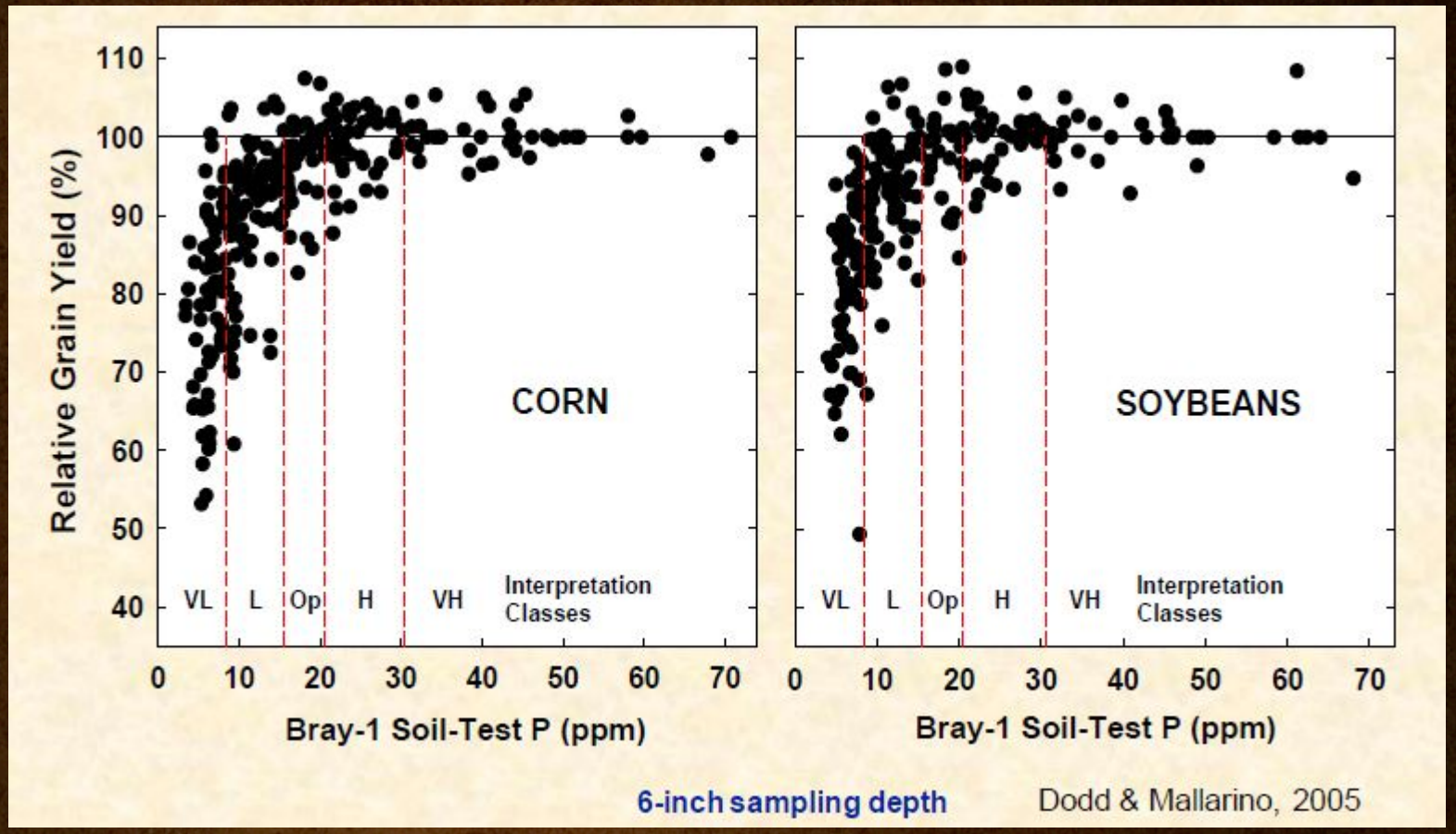
Philosophy of Fertilization

- Let's revisit this data and put some economics to it



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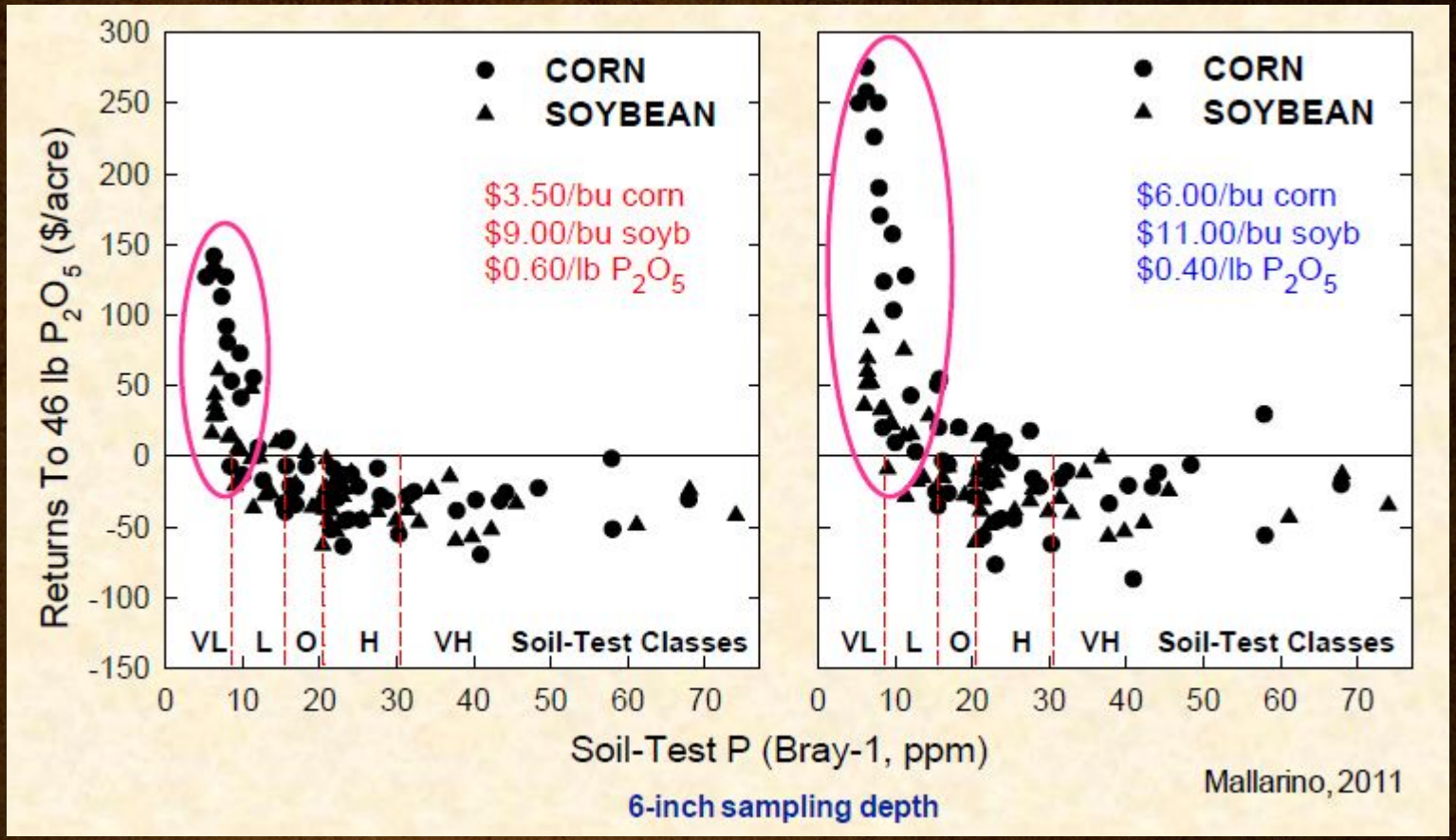
Philosophy of Fertilization

- Net return to P application



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Philosophy of Fertilization

- Let's look at two scenarios
- Scenario 1: low-testing P soil with a high probability of response
- Scenario 2: soil test near critical level with a low probability of response

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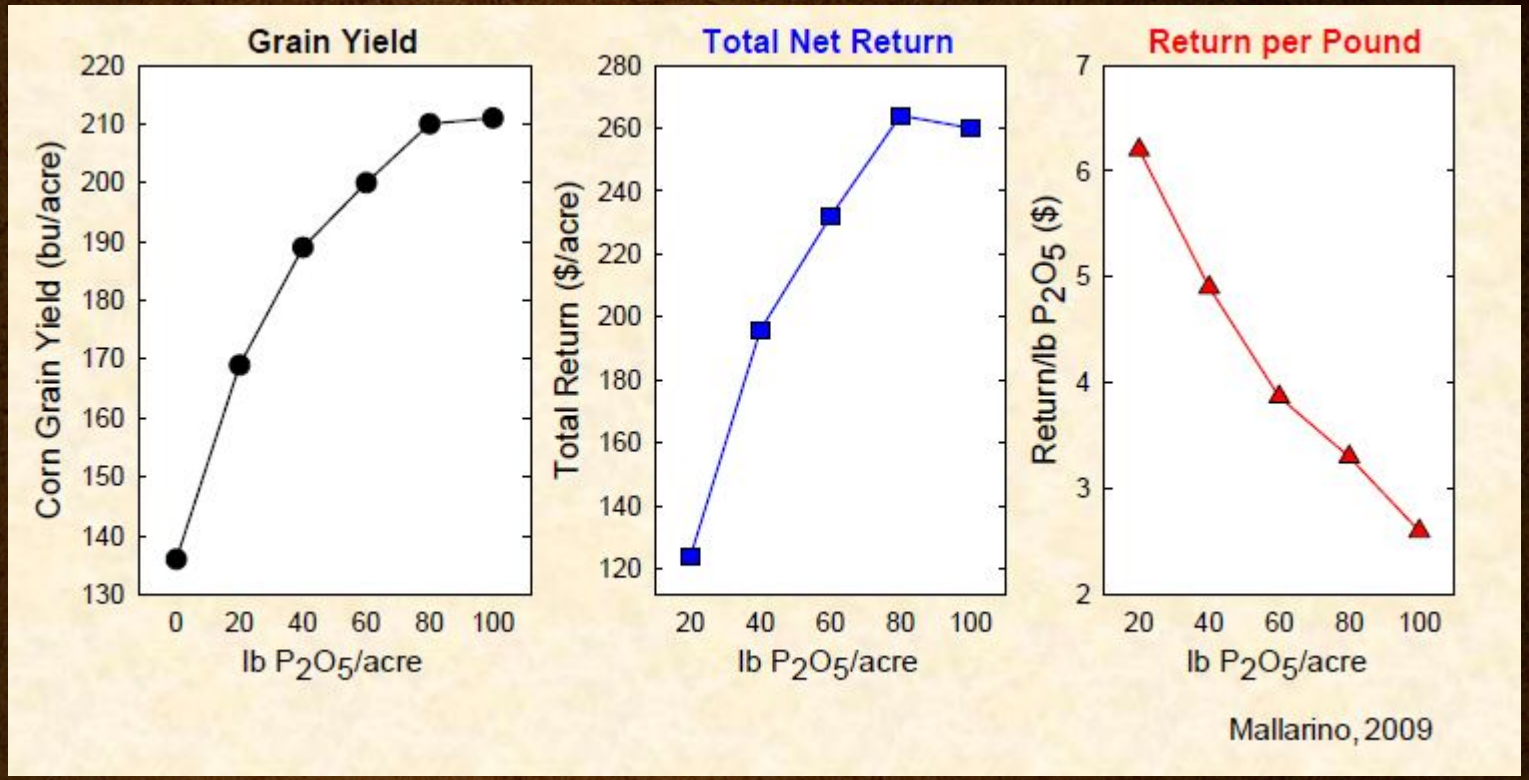
Economic Considerations - Scenario 1

- What kind of return?



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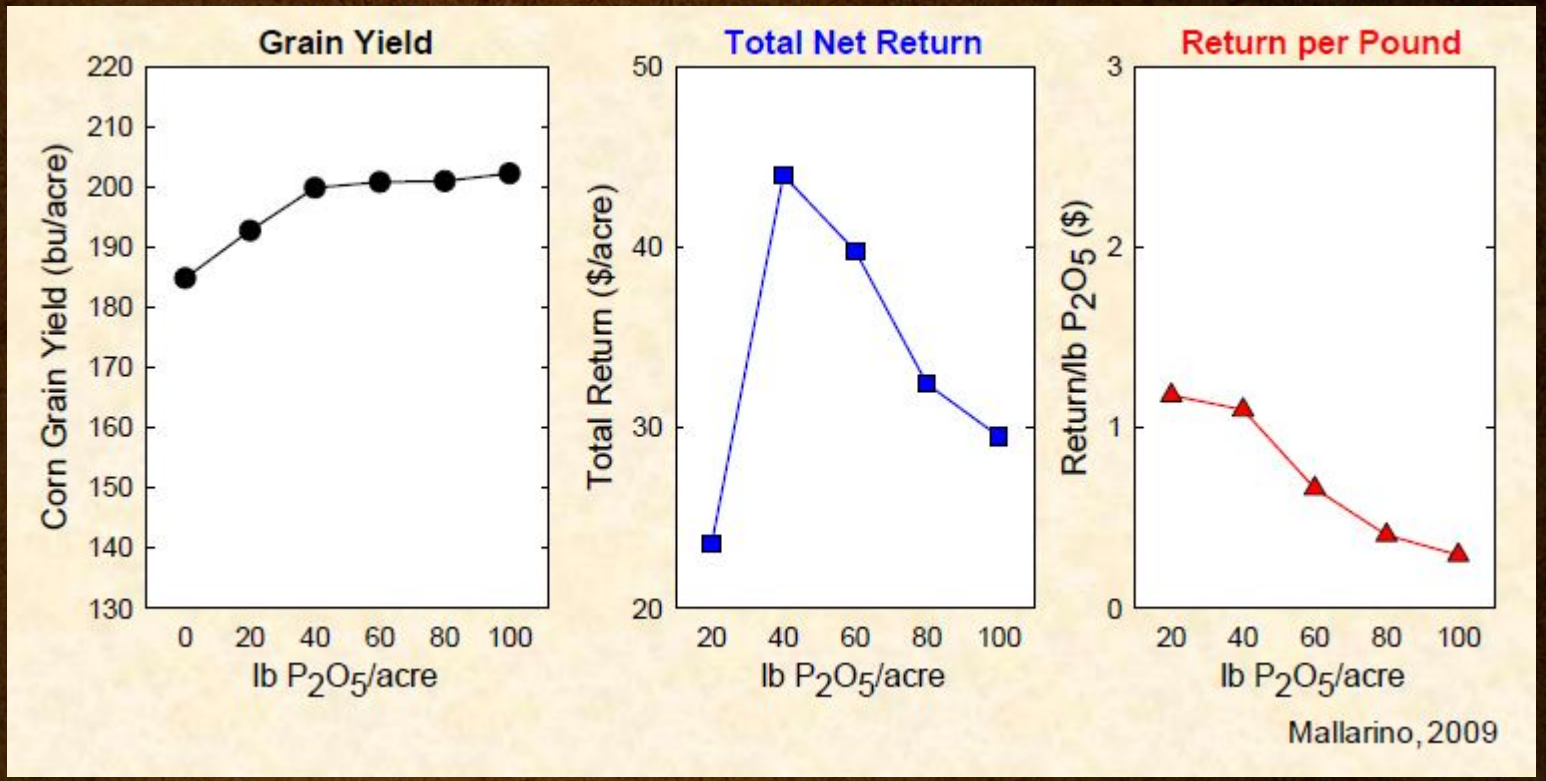
Economic Considerations - Scenario 2

- What kind of return?



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Tri-State Philosophy

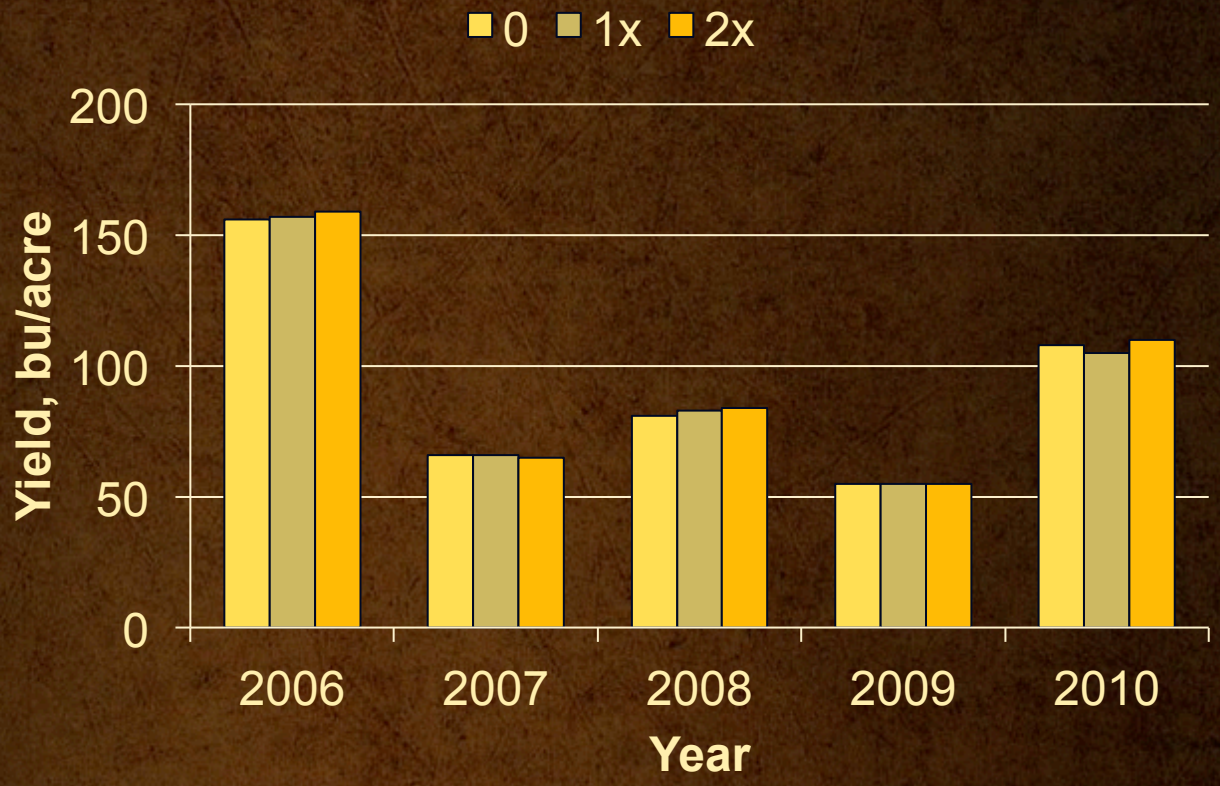
- Designed to limit risk of yield loss due to inadequate nutrition
  - Due to the maintenance approach
- Building soil test may not be the most economical choice for short-term land tenure
  - Rates can be decreased in the short-term, but producers absorbs risk of yield loss
    - Really a function of soil test level
  - Skipping fertilization not a good idea on very low testing soils
    - Good probability of return on investment and large yield risk
- If applying maintenance rates, removal rate increases as yield increases!

Are Current Critical Levels Still Valid?

- Northwest Research Station near Custar, Ohio
- Initial soil test levels
  - P – 39 ppm; K – 272 ppm; CEC – 24 meq/100 g
  - Critical levels – 15 ppm (P) and 135 ppm (K)
- Would you expect much response at this location?

Are Current Critical Levels Still Valid?

- Phosphorus response in corn-soybean rotation



1x and 2x rate in CS – 85 and 170 lb/acre, respectively

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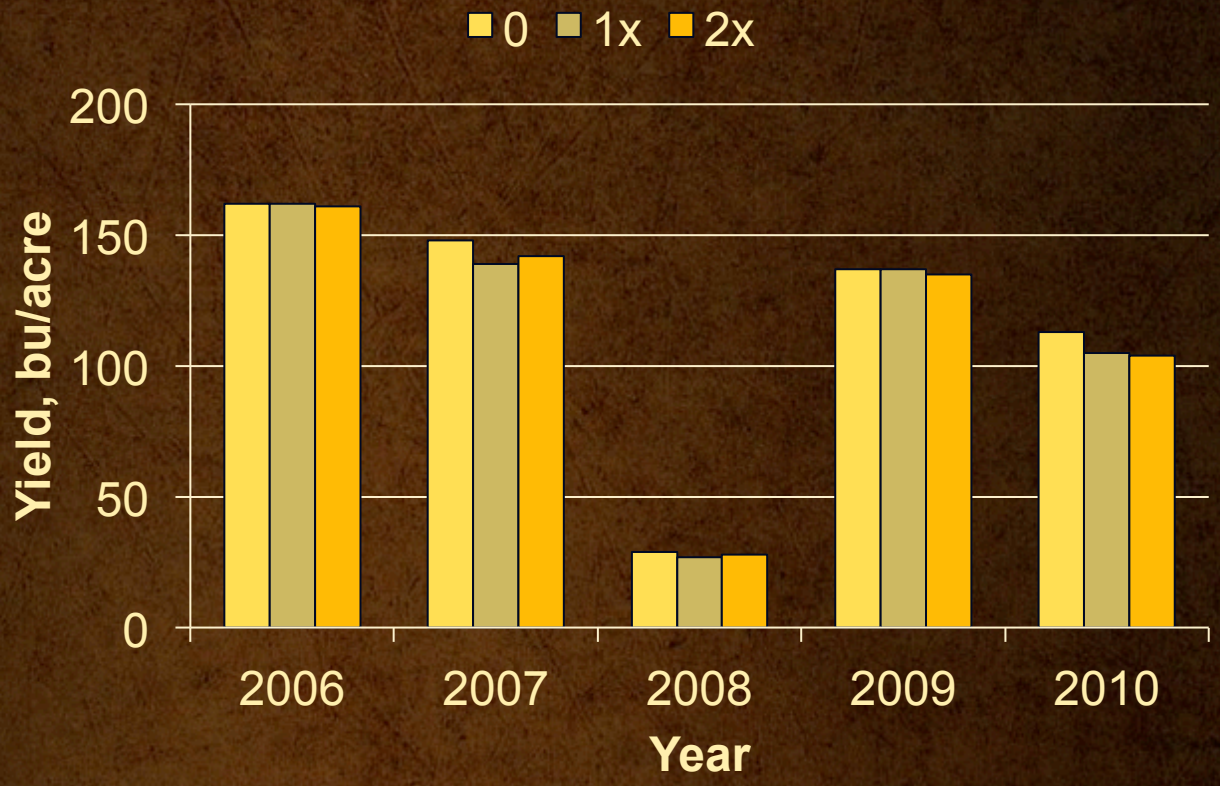
Are Current Critical Levels Still Valid?

- Phosphorus response in corn-corn-soybean rotation



1x and 2x rate in CCS – 140 and 280 lb/acre, respectively

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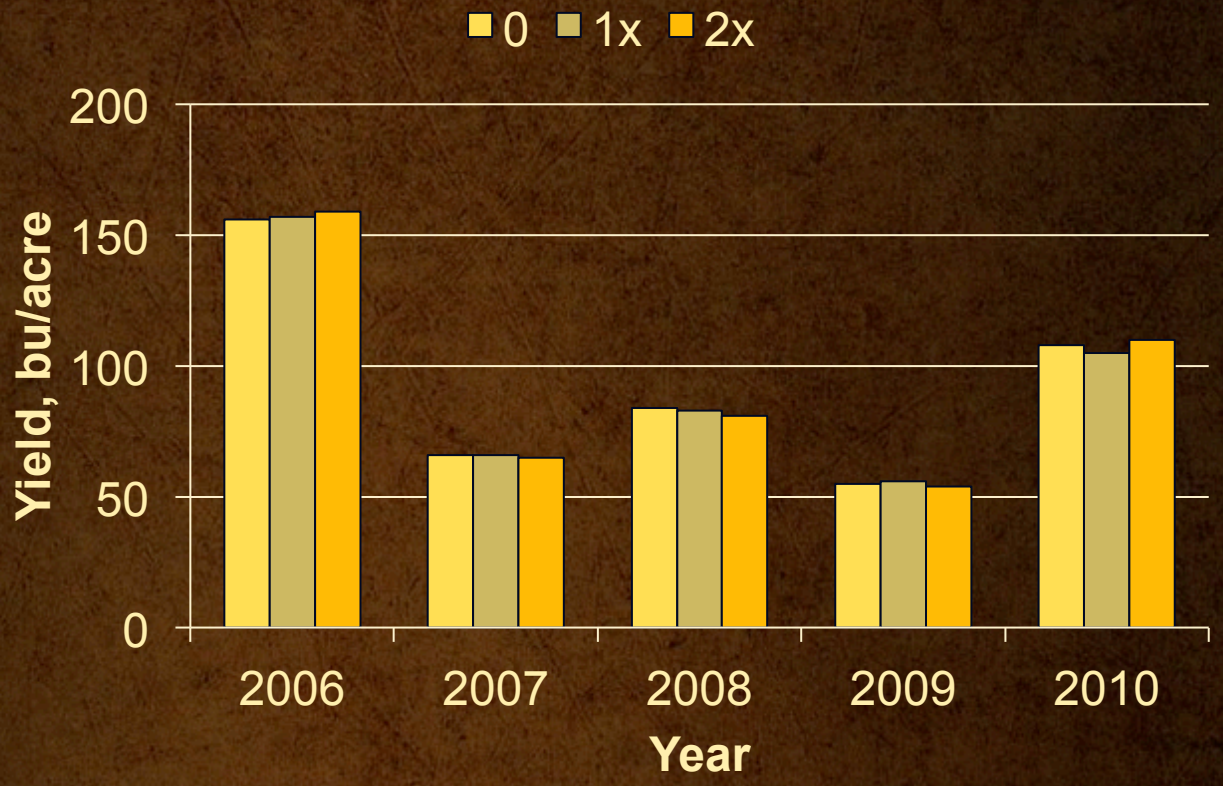
Are Current Critical Levels Still Valid?

- Potassium response in corn-soybean rotation



1x and 2x rate in CS – 95 and 190 lb/acre, respectively

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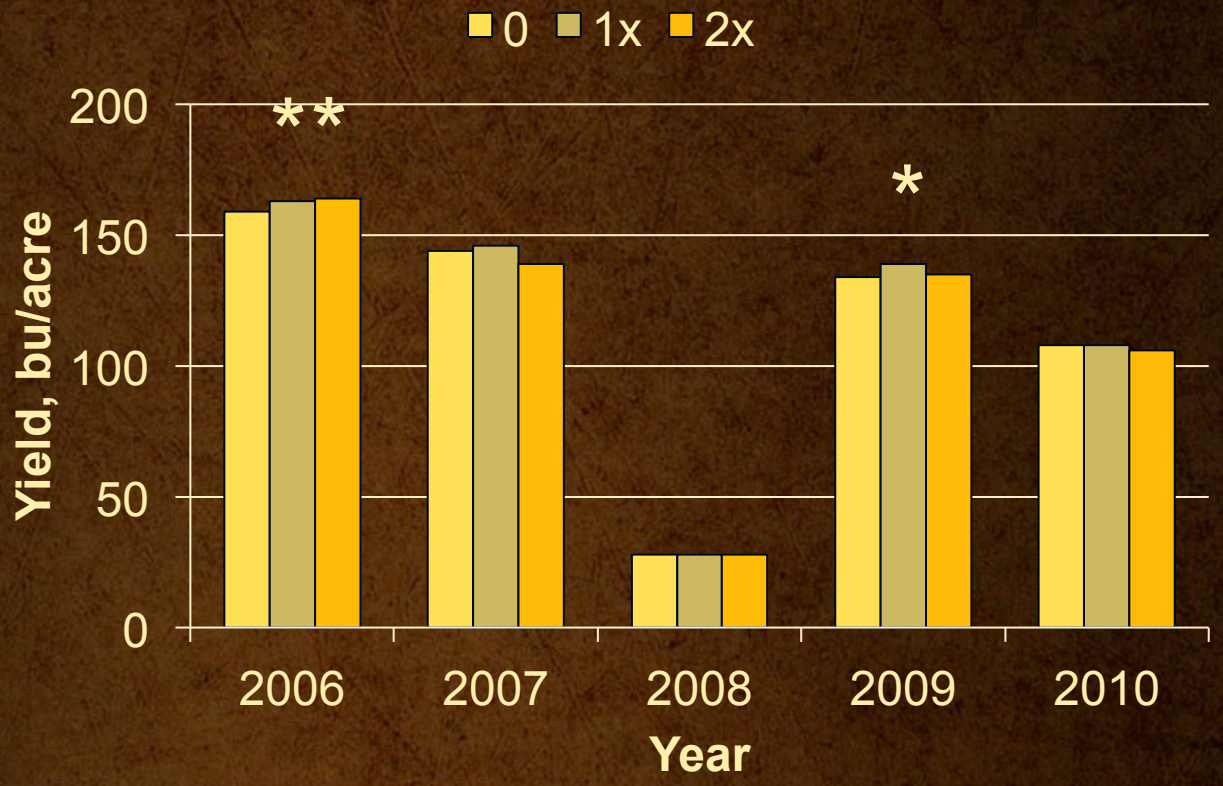
- Potassium response in corn-corn-soybean rotation



1x and 2x rate in CCS – 140 and 280 lb/acre, respectively

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Are Current Critical Levels Still Valid?

- Western Research Station near Springfield, Ohio
- Initial soil test levels
  - P – 20 ppm; K – 102 ppm; CEC – 14 meq/100 g
  - Critical levels – 15 ppm (P) and 110 ppm (K)
- Would you expect much response at this location?

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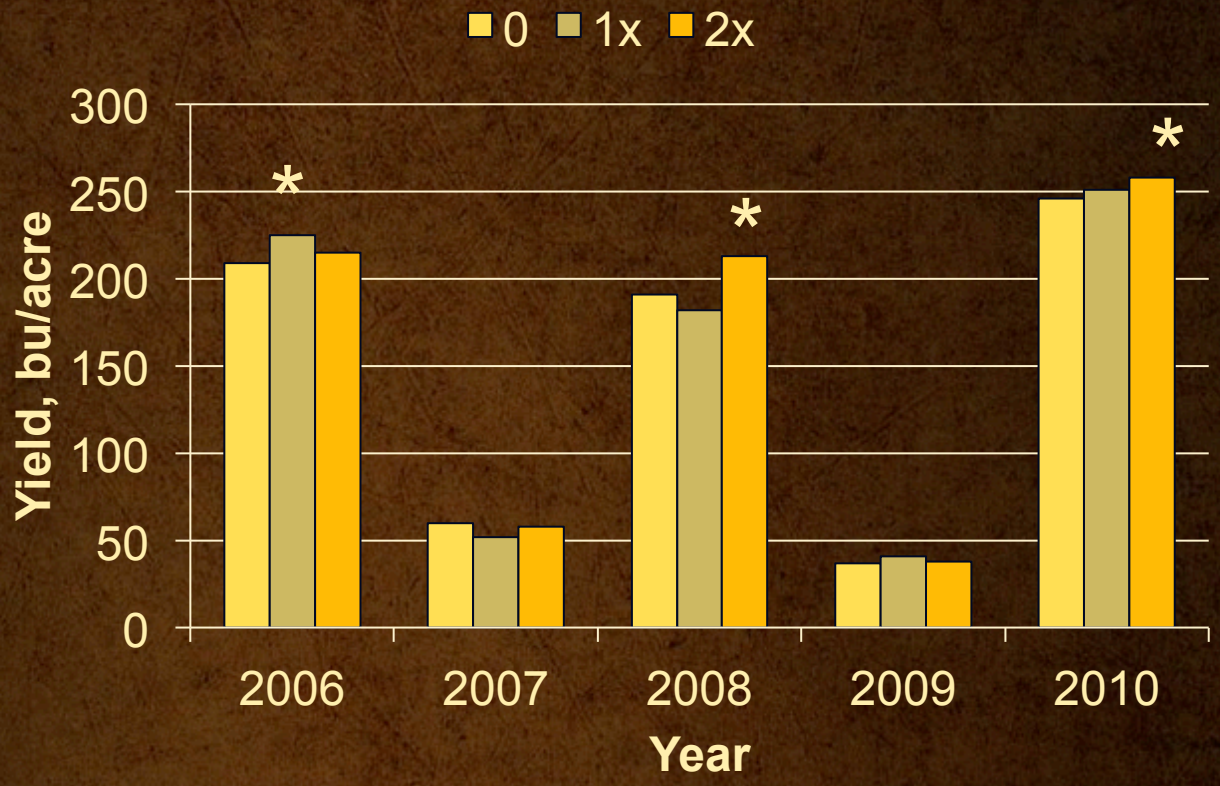
Are Current Critical Levels Still Valid?

- Phosphorus response in corn-soybean rotation



1x and 2x rate in CS – 85 and 170 lb/acre, respectively

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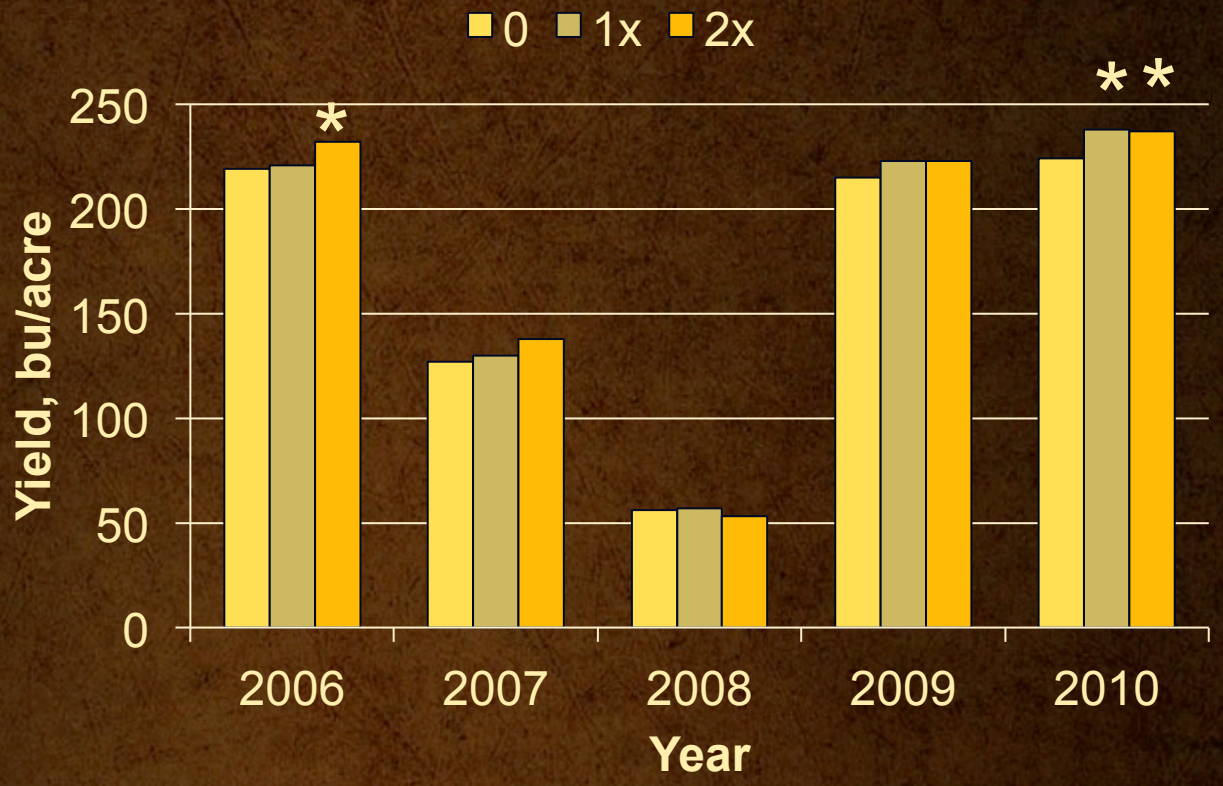
Are Current Critical Levels Still Valid?

- Phosphorus response in corn-corn-soybean rotation



1x and 2x rate in CCS – 140 and 280 lb/acre, respectively

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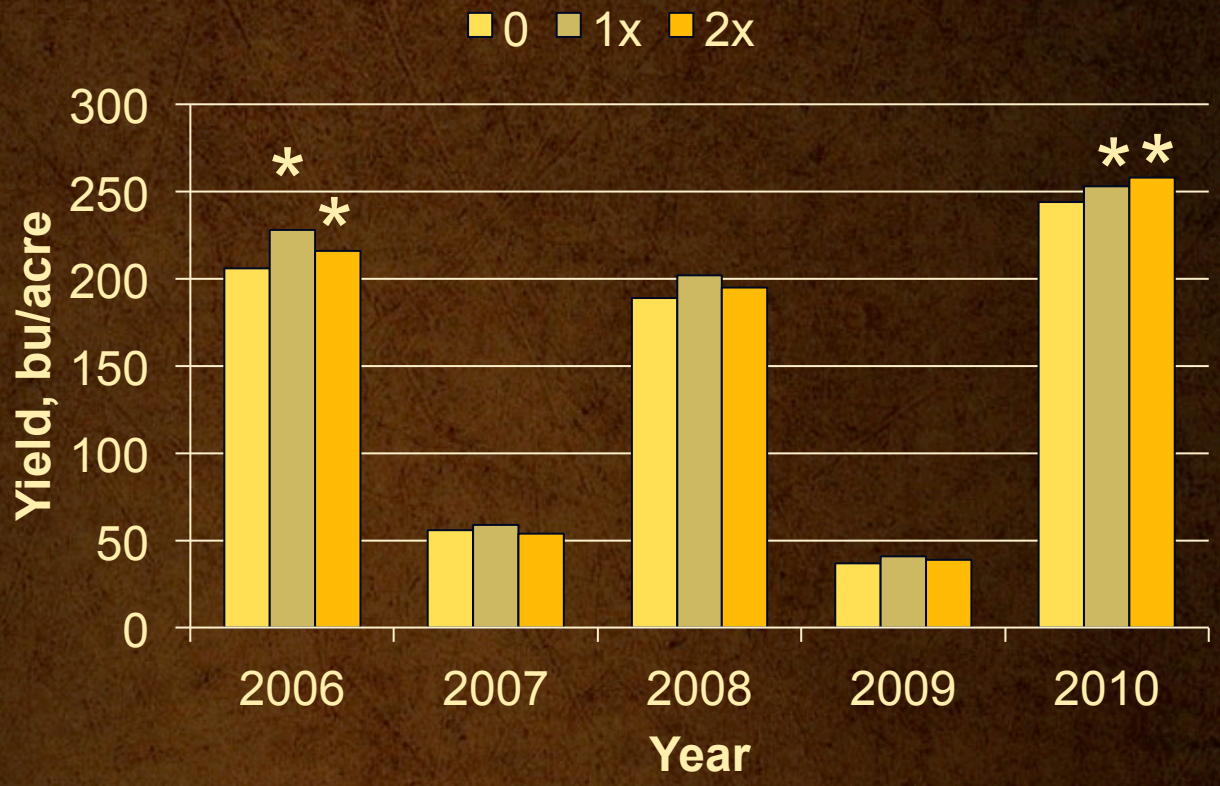

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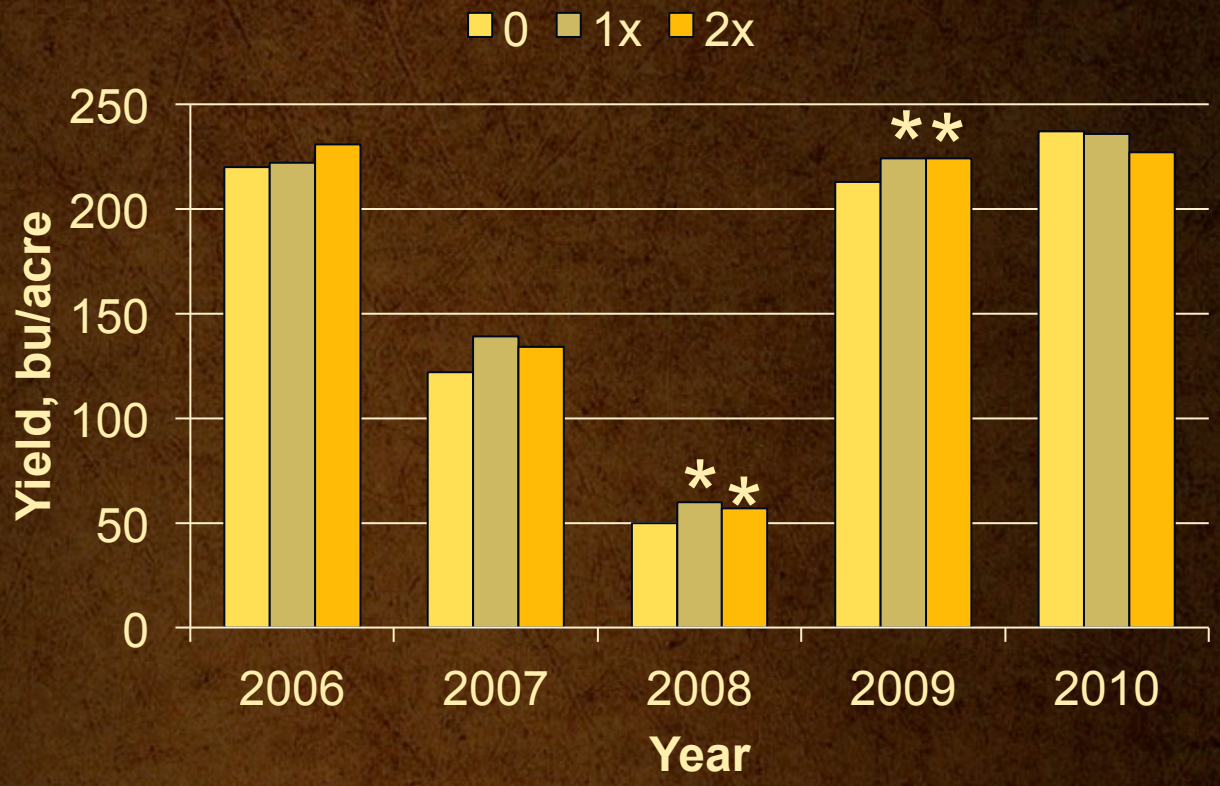

1x and 2x rate in CCS – 140 and 280 lb/acre, respectively

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Are Current Critical Levels Still Valid?

- East Badger Farm near Wooster, OH
- Initial soil test levels
  - P – 17 ppm; K – 109 ppm; CEC – 11 meq/100 g
  - Critical levels – 15 ppm (P) and 103 ppm (K)
- Would you expect much response at this location?

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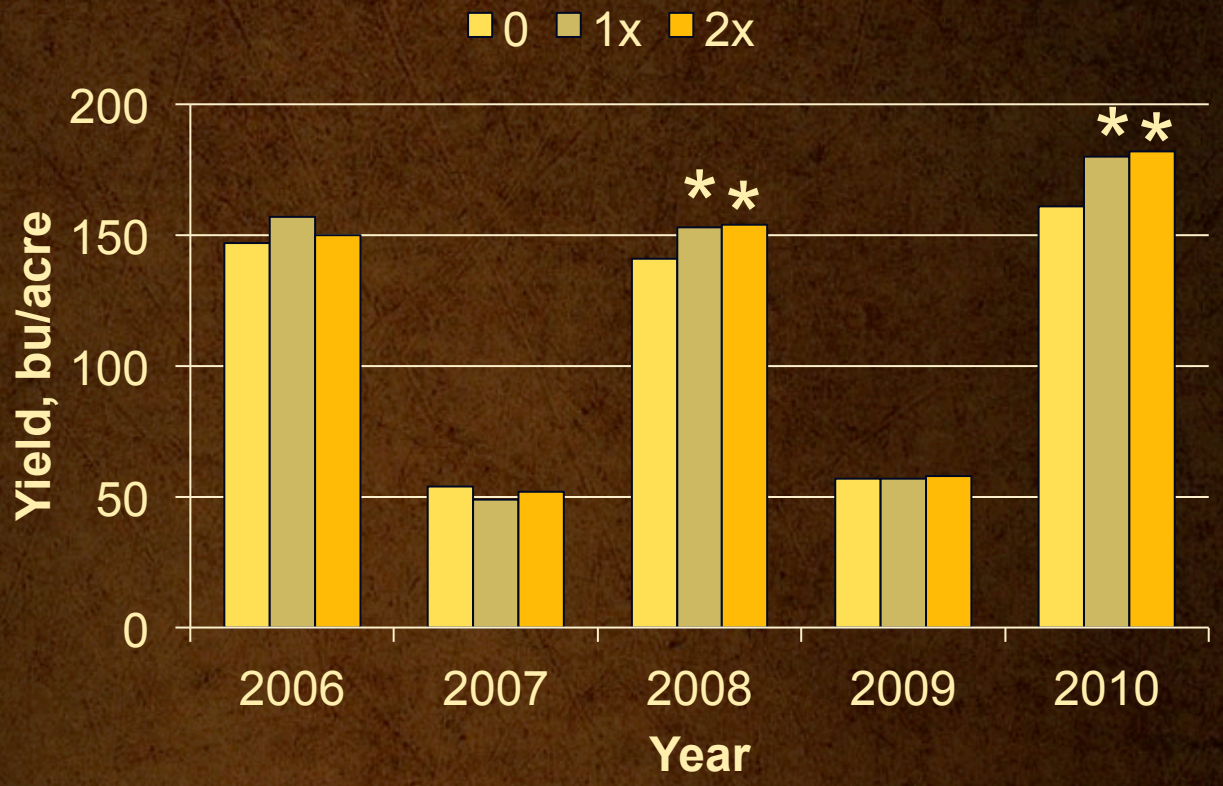
Are Current Critical Levels Still Valid?

- Phosphorus response in corn-soybean rotation



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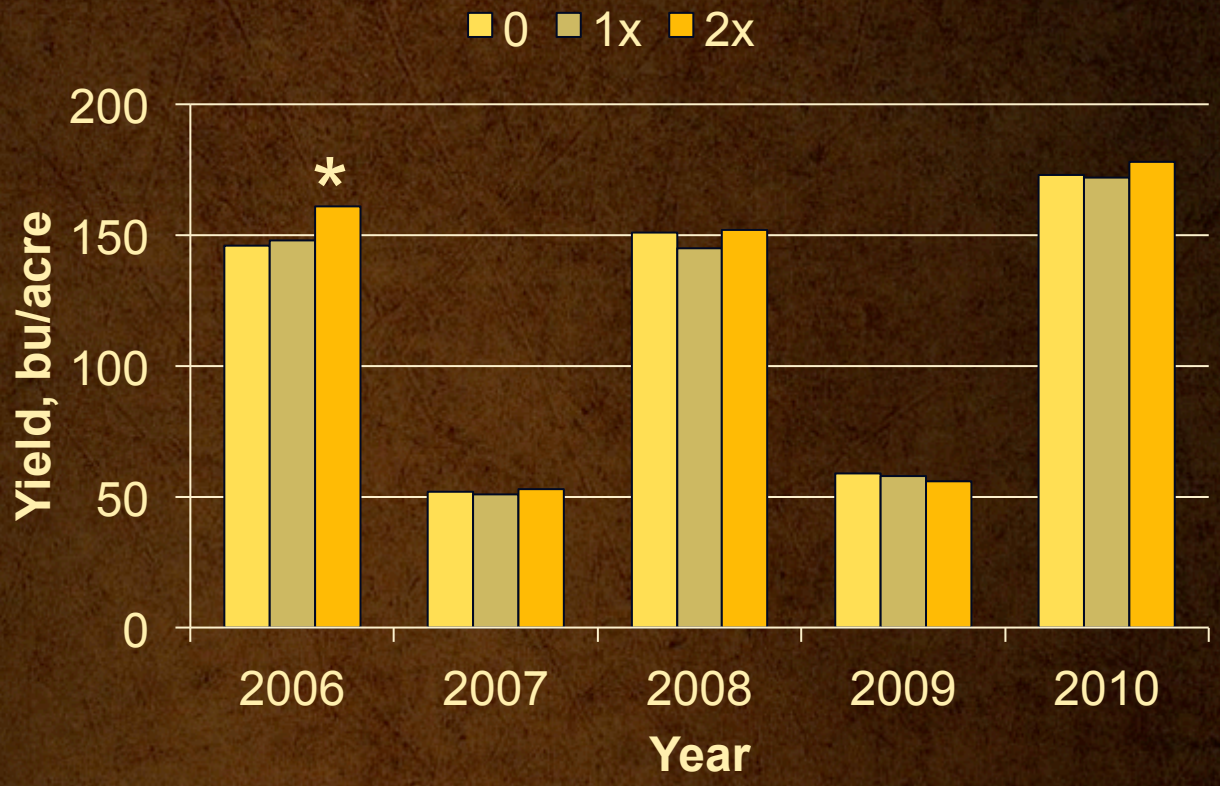

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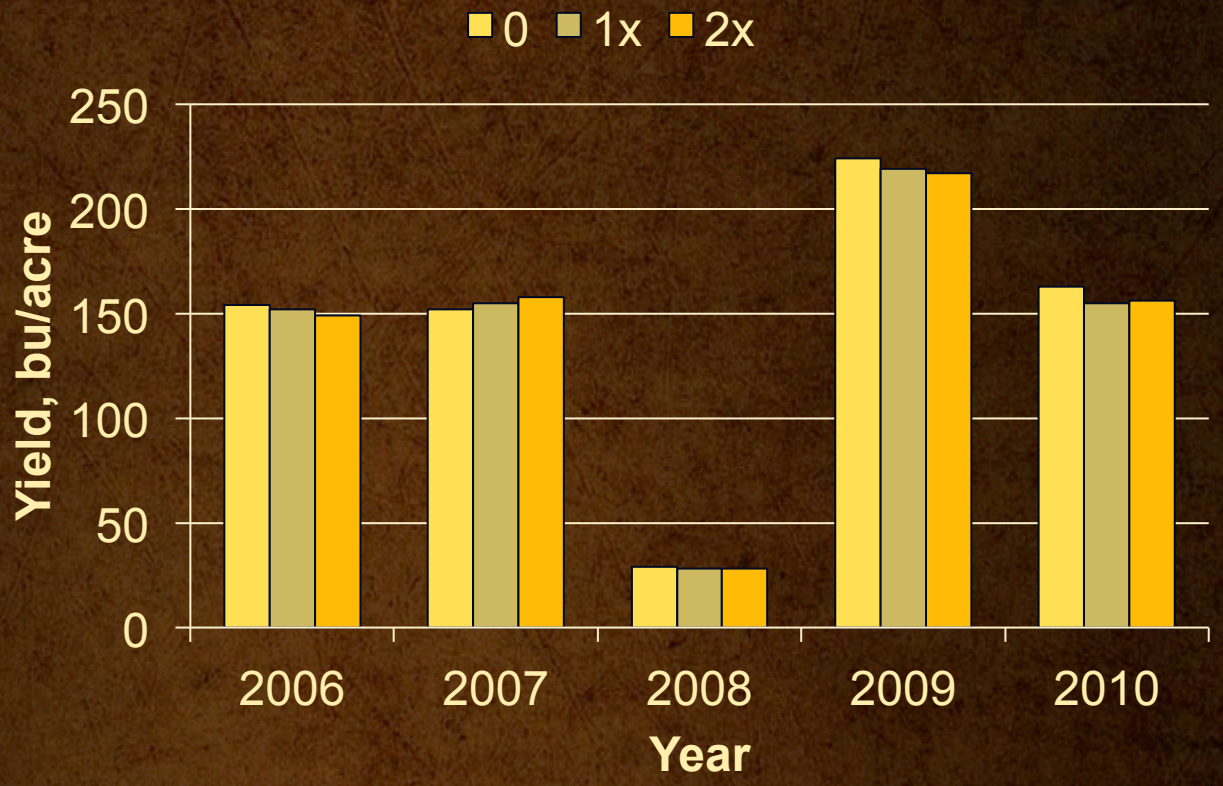

1x and 2x rate in CCS – 140 and 280 lb/acre, respectively

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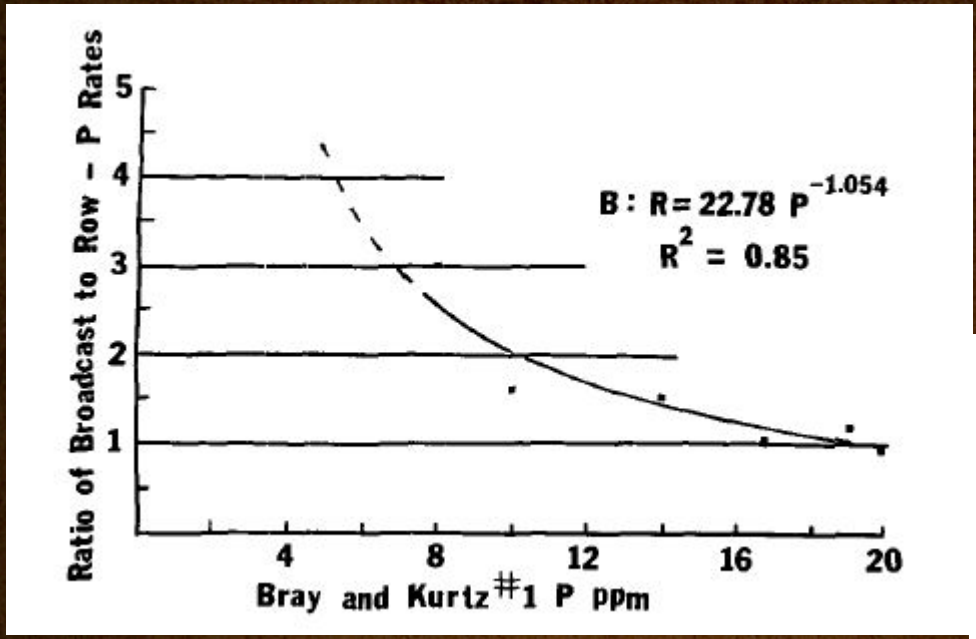
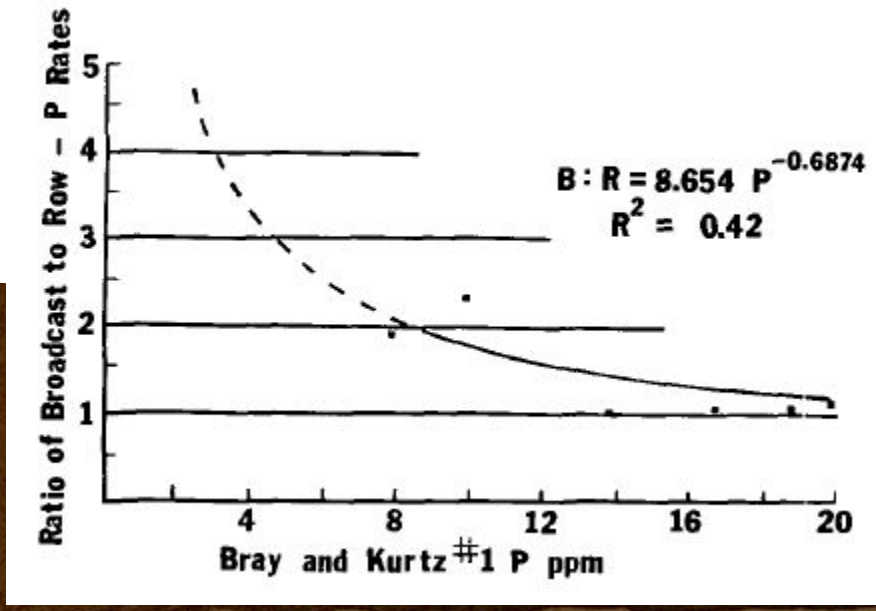
Placement Effects on Efficiency of Use

- Is banding more efficient than broadcast applications?





Peterson et al., AJ, 1982

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Placement Considerations

- Rates can be decreased for placement if soil test level is really low (perhaps 25% decrease in rate for band placement)
- Otherwise no difference in rate between broadcast and band applications

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Summary

- Soil testing is our best tool, it is not perfect
- You (and your clients) need to figure out the approach that best fits their goals and economic desires
- Applying same maintenance rates as practiced historically is likely not maintaining current soil test levels

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Thank You!

Questions?

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