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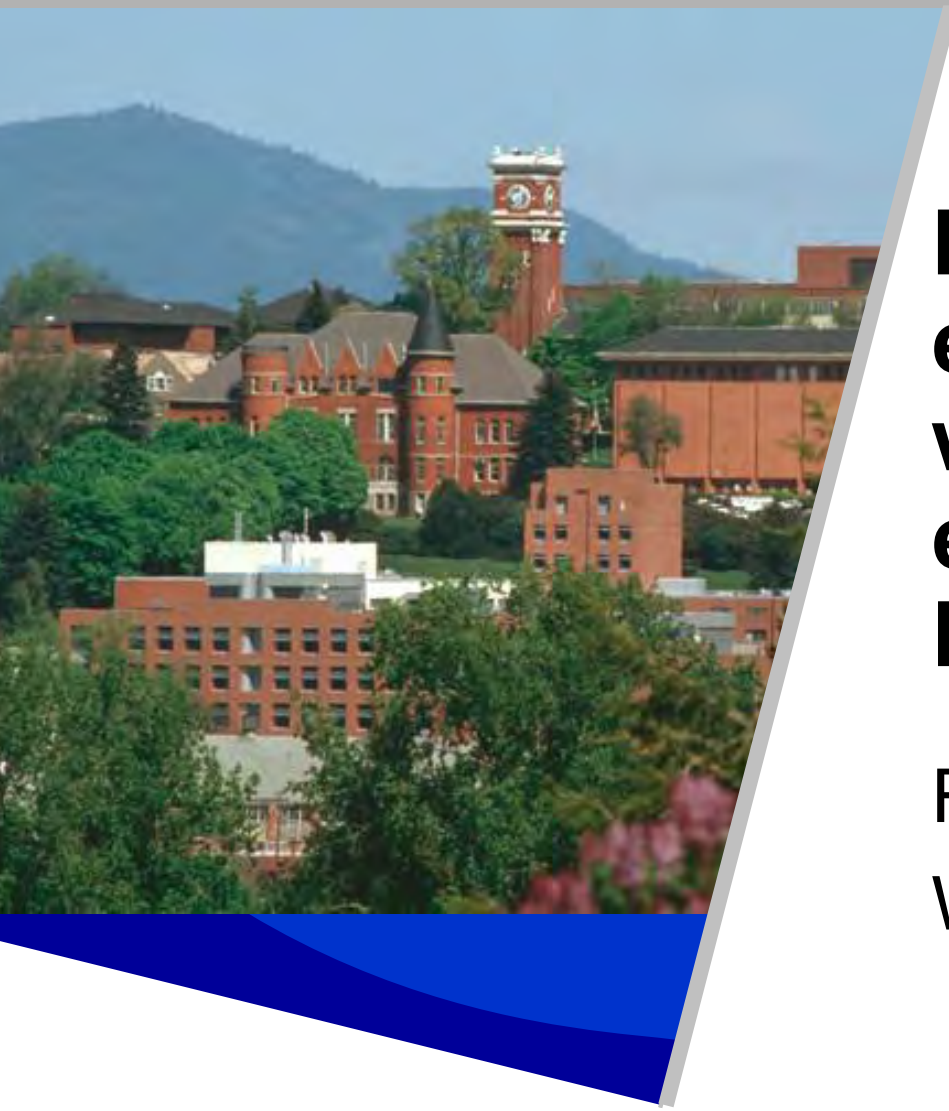

Phosphorus source effects on dryland winter wheat in eastern Washington Final report

Rich Koenig

WA State University

Contrasts

Acknowledgments

- Fluid Fertilizer Foundation for funding
- Western Laboratories for tissue analysis
- International Plant Nutrition Institute
  - funding of a longer term, basic research effort to understand basic phosphorus chemistry and management in recently acidified soils of eastern Washington State

Renewed opportunities for nutrient management

- Roger Beachy, Director NIFA and other authors
- "The heart of new agricultural paradigms for a hotter and more populous world must be systems that close the loop of nutrient flows from microorganisms and plants to animals and back"
  - From: *Radically Rethinking Agriculture for the 21st Century* (Science Magazine, Feb 12, 2010)
    - http://www.sciencemag.org/cgi/content/full/327/5967/833

Wheat production in WA

- 2.2 +/- million acres (6th in U.S.)
- Mediterranean climate (70% of precipitation occurs November through April)
- Yields highly dependent on annual precipitation and stored soil moisture
  - <30 to >130 bu/acre dryland or rainfed
- Fluids are alive and well in this area
  - N, P, S, Cl, other micros

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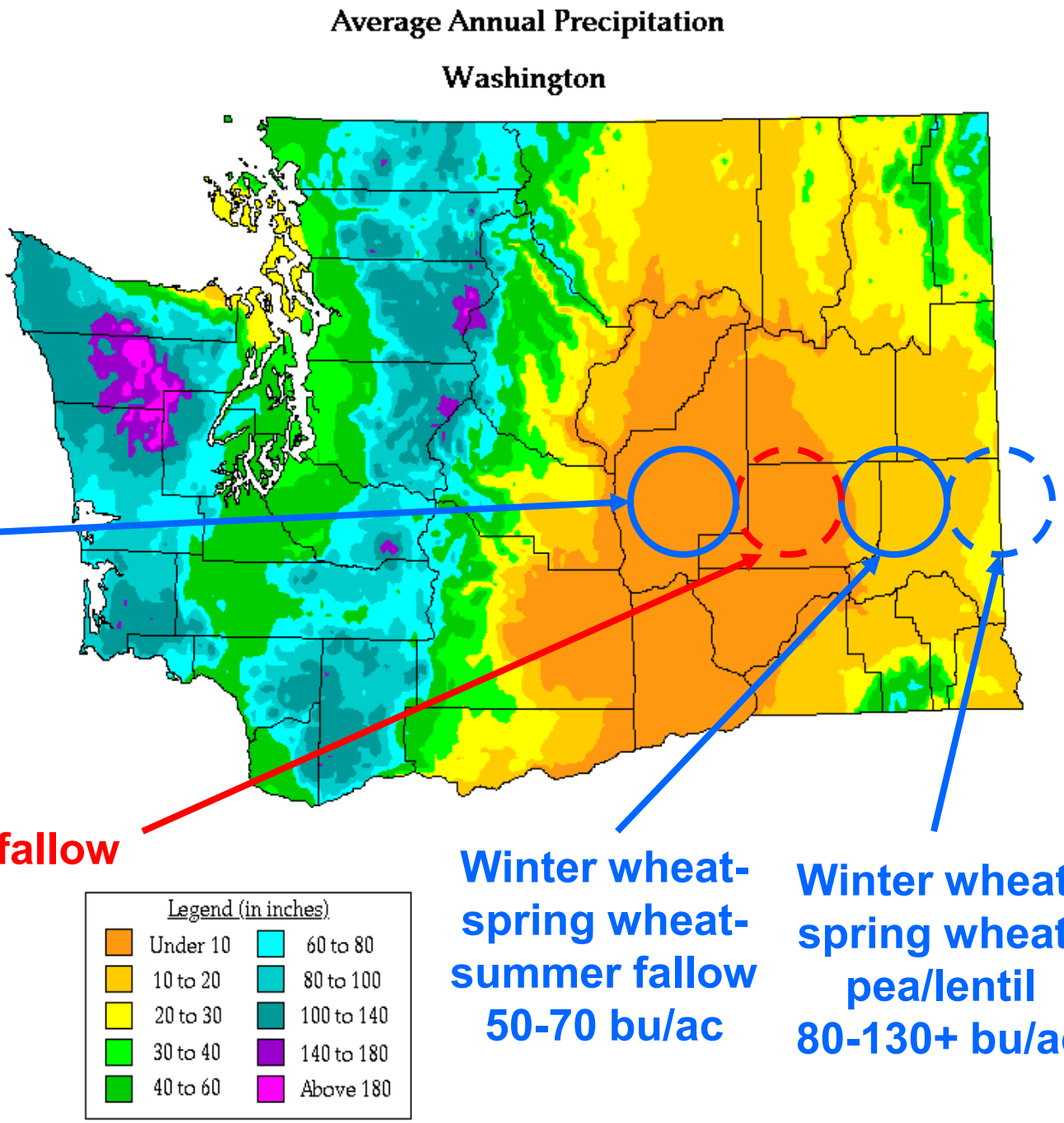

Irrigated
>100 bu/ac

Winter wheat-summer fallow
30-50 bu/ac

Winter wheat-spring wheat-summer fallow
50-70 bu/ac

Winter wheat-spring wheat-pea/lentil
80-130+ bu/ac

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Low rainfall zone, crop-tillage fallow rotations

Fertilizer applied in April-June of the fallow year

Seeding occurs in late August


Late October, 2009

<u>Low rainfall, summer fallow areas</u>

Few use phosphorus in traditional tillage fallow

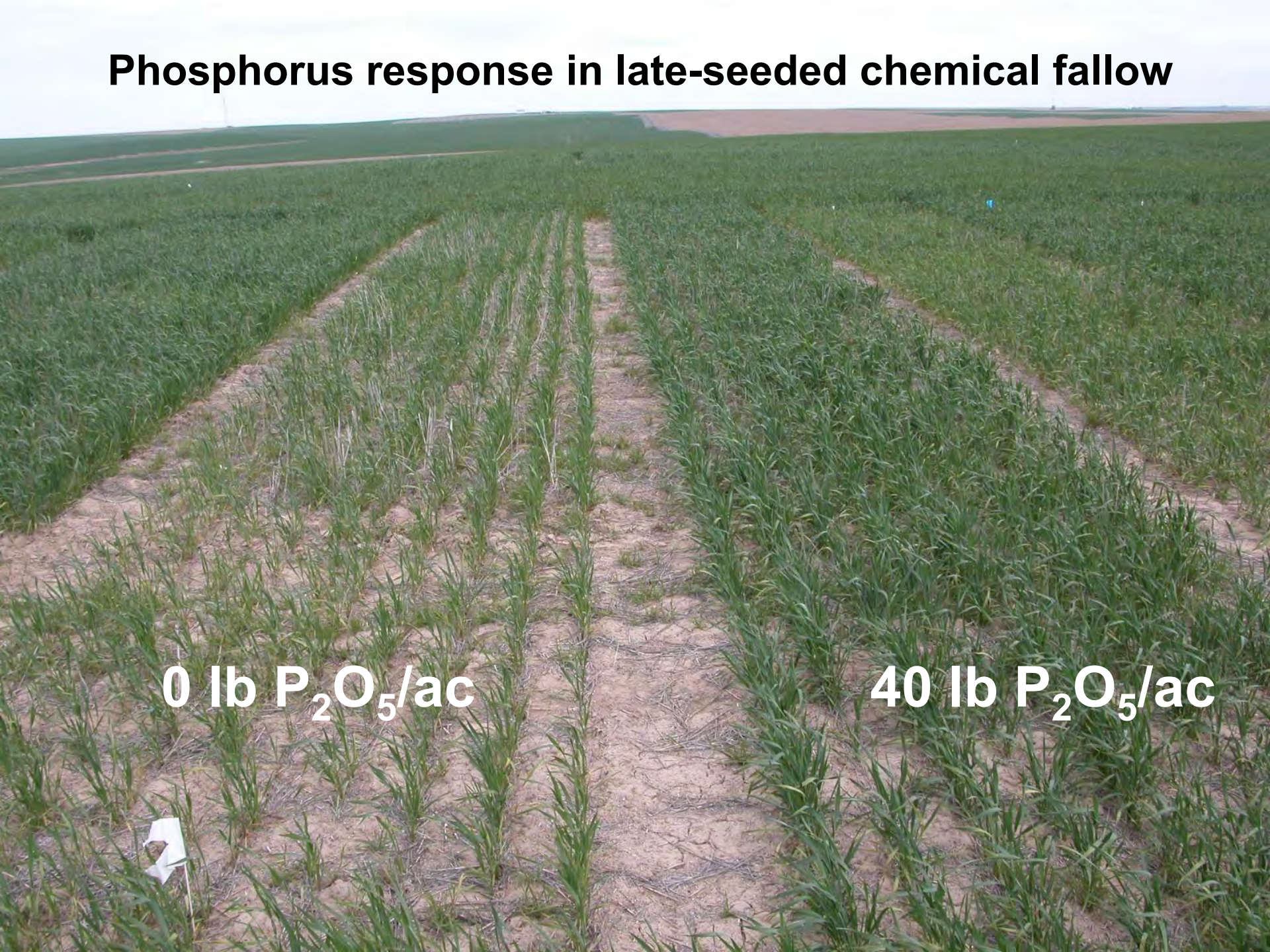
Many claim no benefit or return on investment

This may be an issue of timing and method of application

More phosphorus use in chemical fallow

Application rates are below removal

Phosphorus response in late-seeded chemical fallow



Objective

- Evaluate winter wheat responses to P in wheat-fallow zones
  - Compare sources (dry MAP vs. fluid APP)
  - Rate response with fluid

- Document and explain observations of growers

  - Long term: improve recommendations
    - Soil test-based
    - Precision management

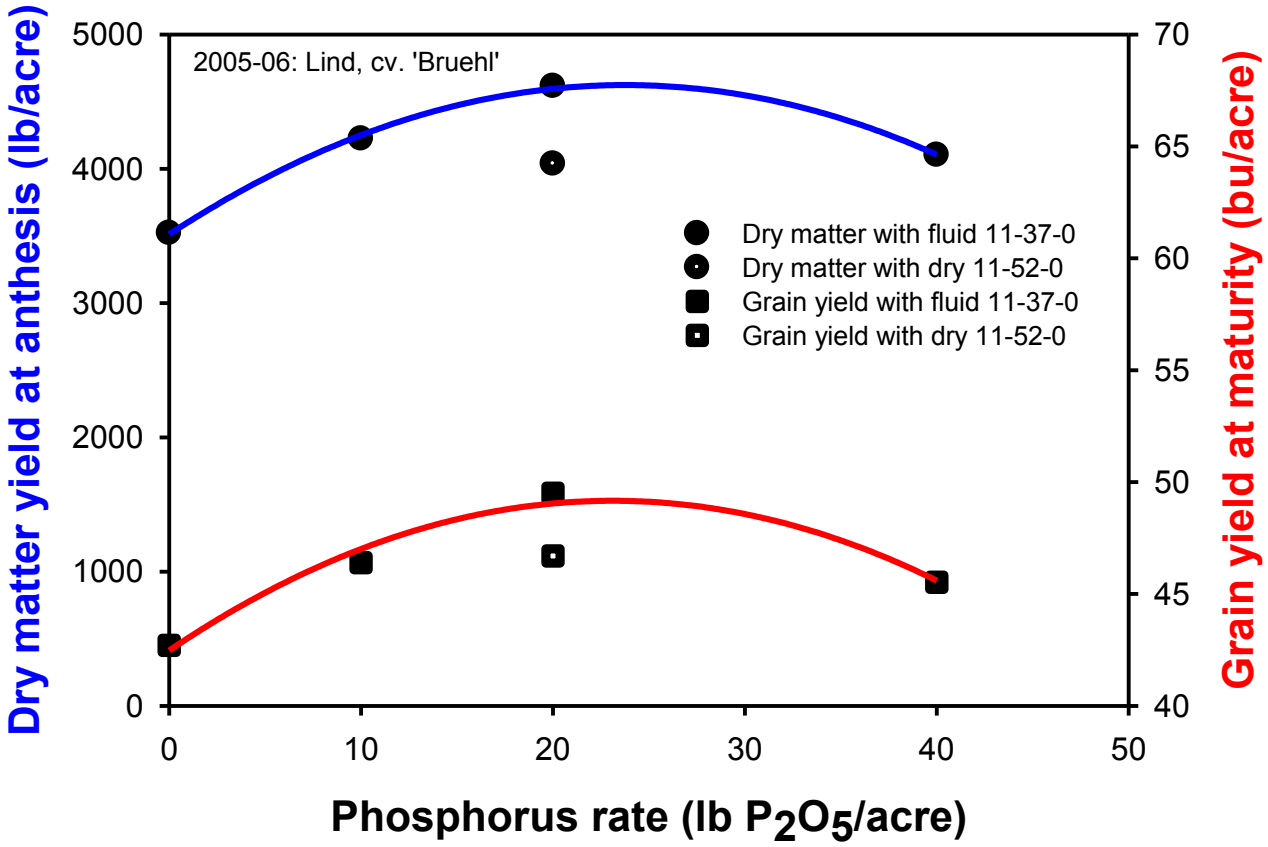
Brief methods

- Two low rainfall zone locations x 3 years
- P source-rate treatments
  - 0, 10, 20 and 40 lb P_2O_5/ac fluid APP
  - 20 lb P_2O_5/ac as dry MAP
- Deep band application at or shortly before planting
- Biomass yield
- Tissue P
- Grain yield and test weight at maturity

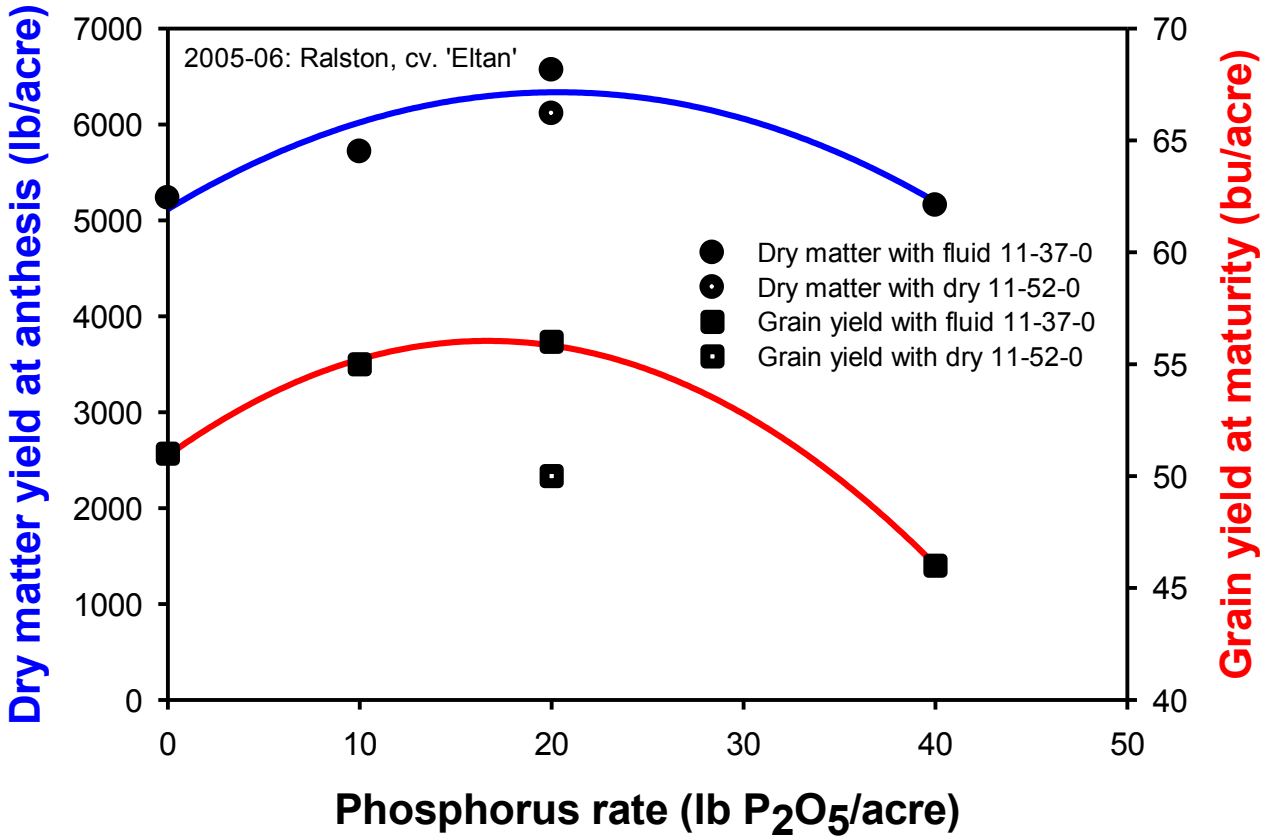
Soil Test Phosphorus (0 to 12-inch depth)

Location	Year	Acetate P, ppm	Bicarbonate P, ppm
Lind	2005-06	7.3	12.1
	2006-07	3.9	11.0
	2007-08	3.3	14.3
Ralston	2005-06	5.8	17.8
	2006-07	5.5	22.5
	2007-08	5.4	27.0

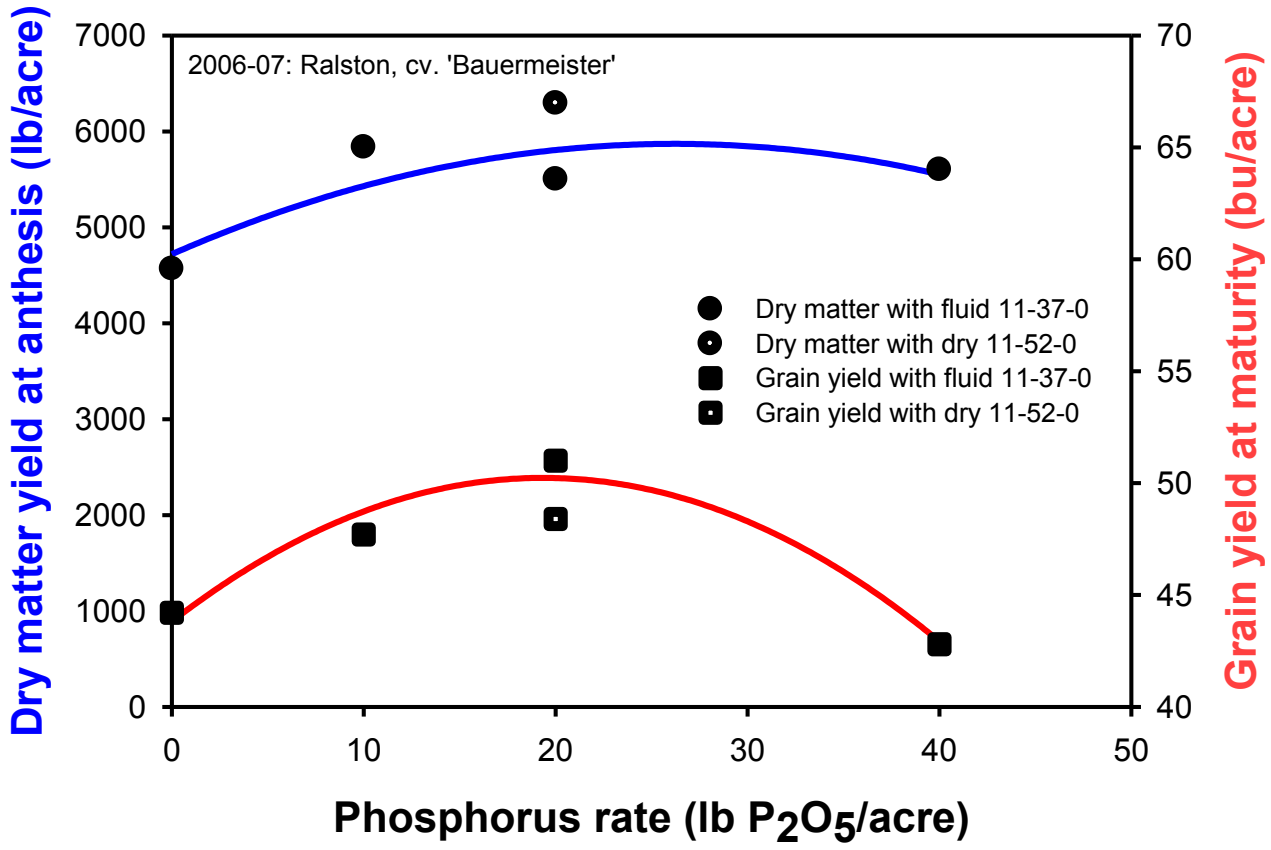
Lind site in 2006



Ralston site in 2006



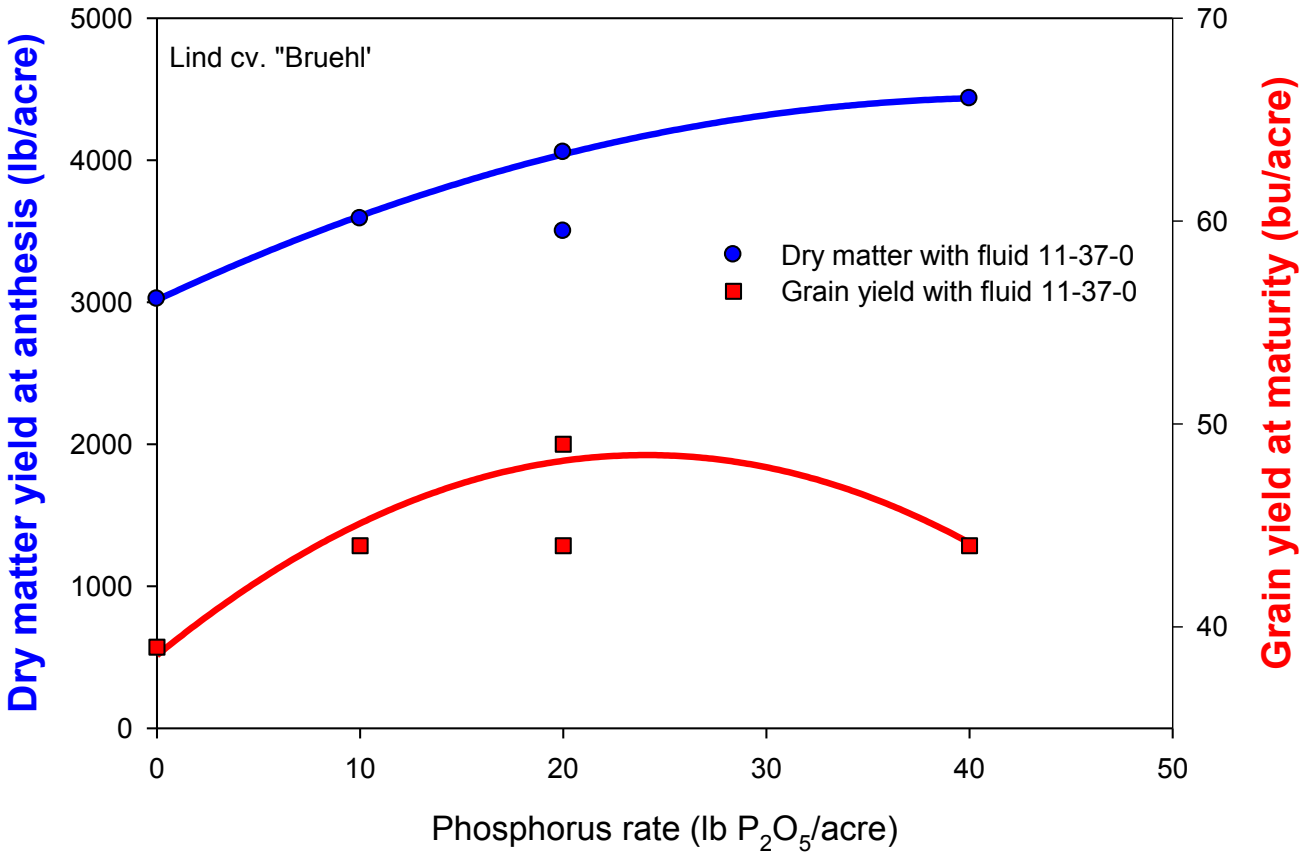
Ralston site in 2007



Why a negative response to higher rates of P?

- Crop-fallow rotations are severely moisture limited
- Excessive vegetative growth can be detrimental
  - Leads to “haying off”
  - Early depletion of stored soil moisture leading to stress during grain filling
    - Low test weight
    - Low yield

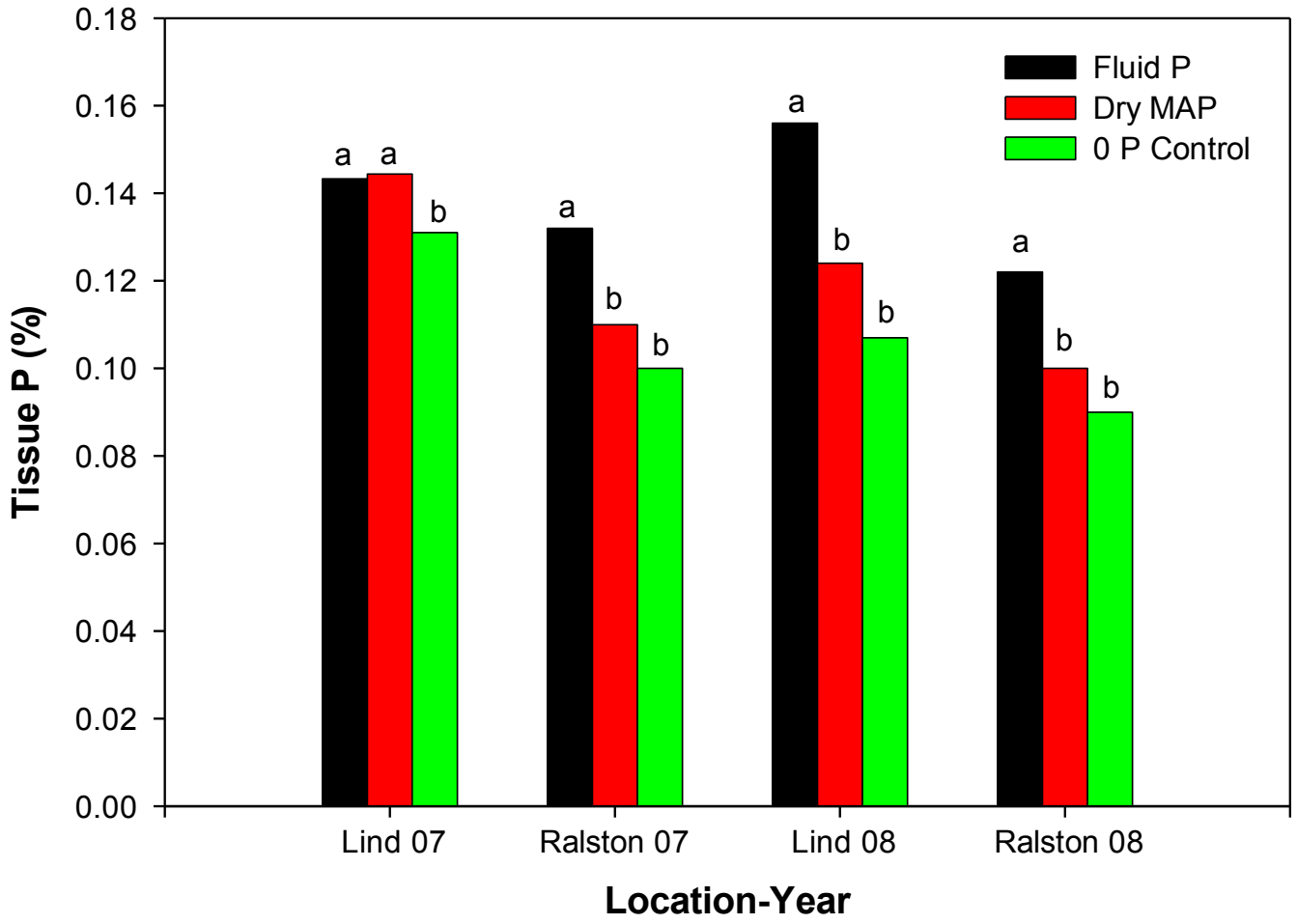
Lind site in 2008



Why difference between APP and MAP?

- Issues of availability of MAP P

Tissue Analysis (boot/head emergence)



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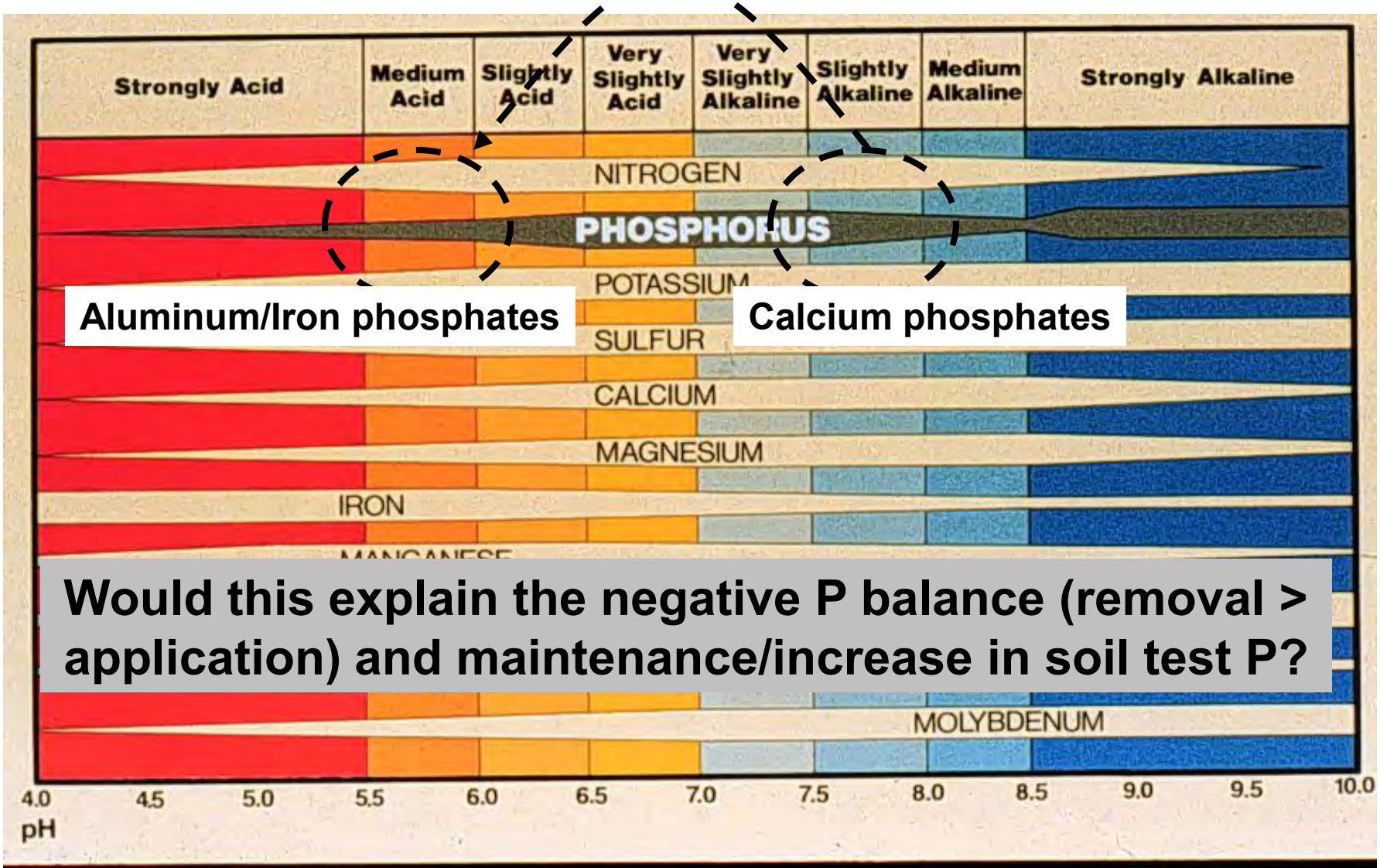
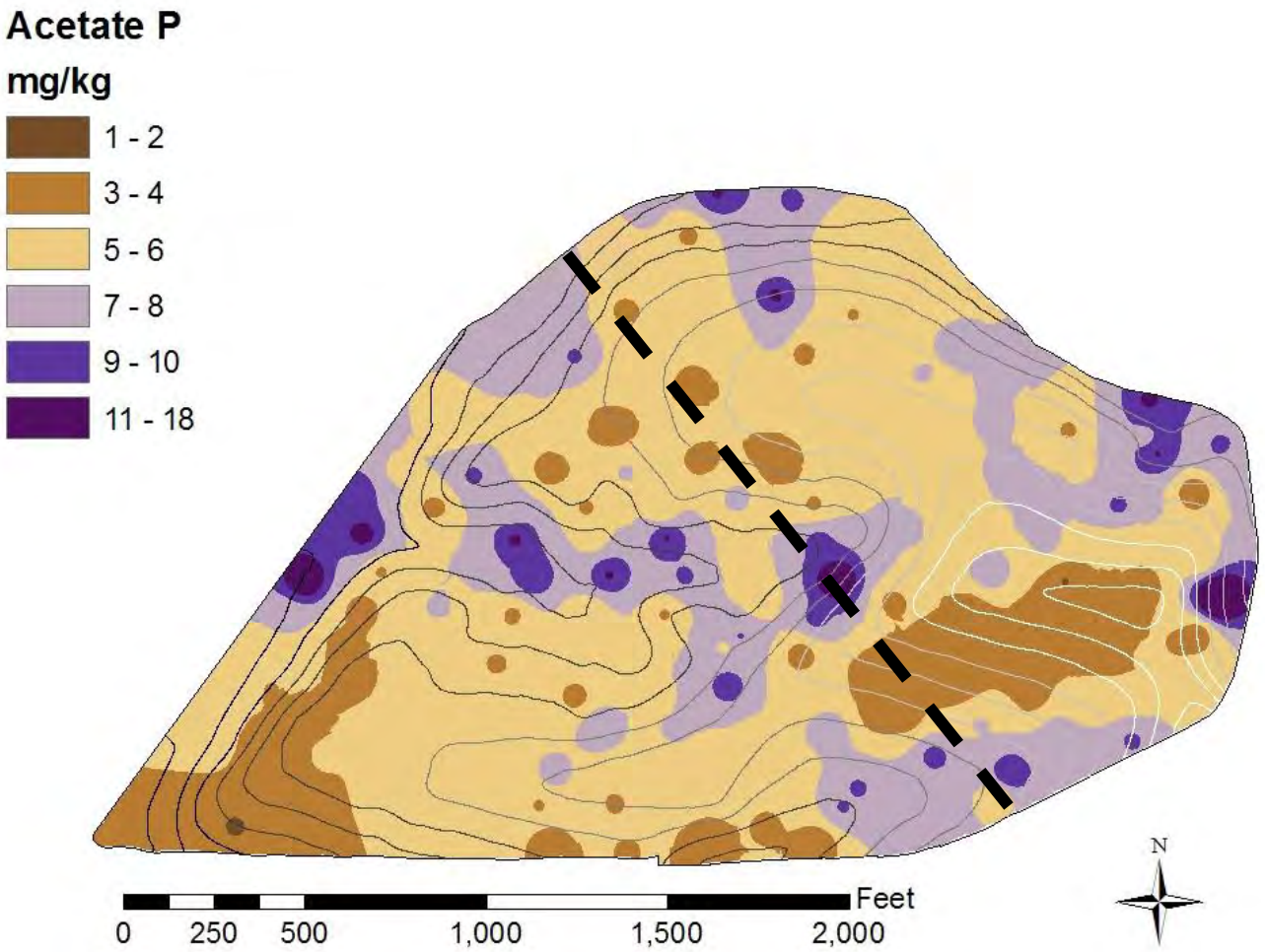
Recently acidified soils

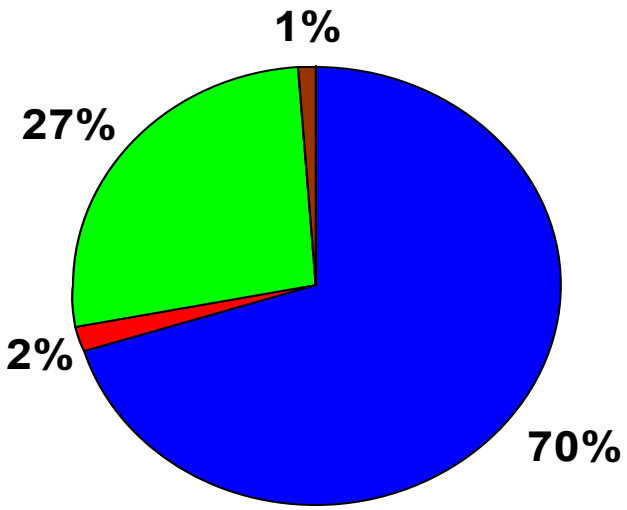
- Soil pH 6.0-7.6 in original 1970s surveys; 4-6 now
- Transition-phase chemistry?
  - Thermodynamics predict dissolution of calcium phosphates and formation of iron/aluminum phosphates
  - Kinetics?
  - Sorption reactions?


Strongly Acid
Medium Acid
Slightly Acid
Very Slightly Acid
Very Slightly Alkaline
Slightly Alkaline
Medium Alkaline
Strongly Alkaline
NITROGEN
PHOSPHORUS
POTASSIUM
SULFUR
CALCIUM
MAGNESIUM
IRON
MOLYBDENUM
Aluminum/Iron phosphates
Calcium phosphates
Would this explain the negative P balance (removal > application) and maintenance/increase in soil test P?
4.0 4.5 5.0 5.5 6.0 6.5 7.0 7.5 8.0 8.5 9.0 9.5 10.0
pH

Phosphorus Transect – 80 acre field



Forms of soil phosphorus



Average of 10 samples;
average pH = 5.4

Field data on a mineral stability diagram

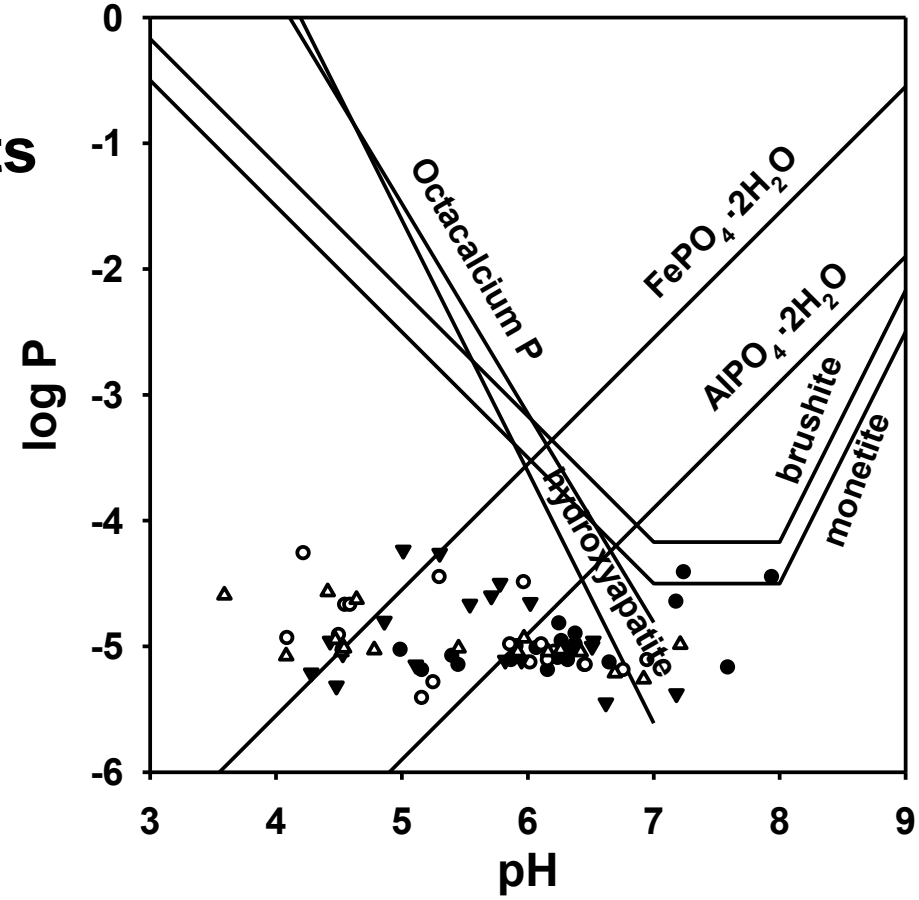
Water and dilute $CaCl_2$ extracts

Equilibrium P activities

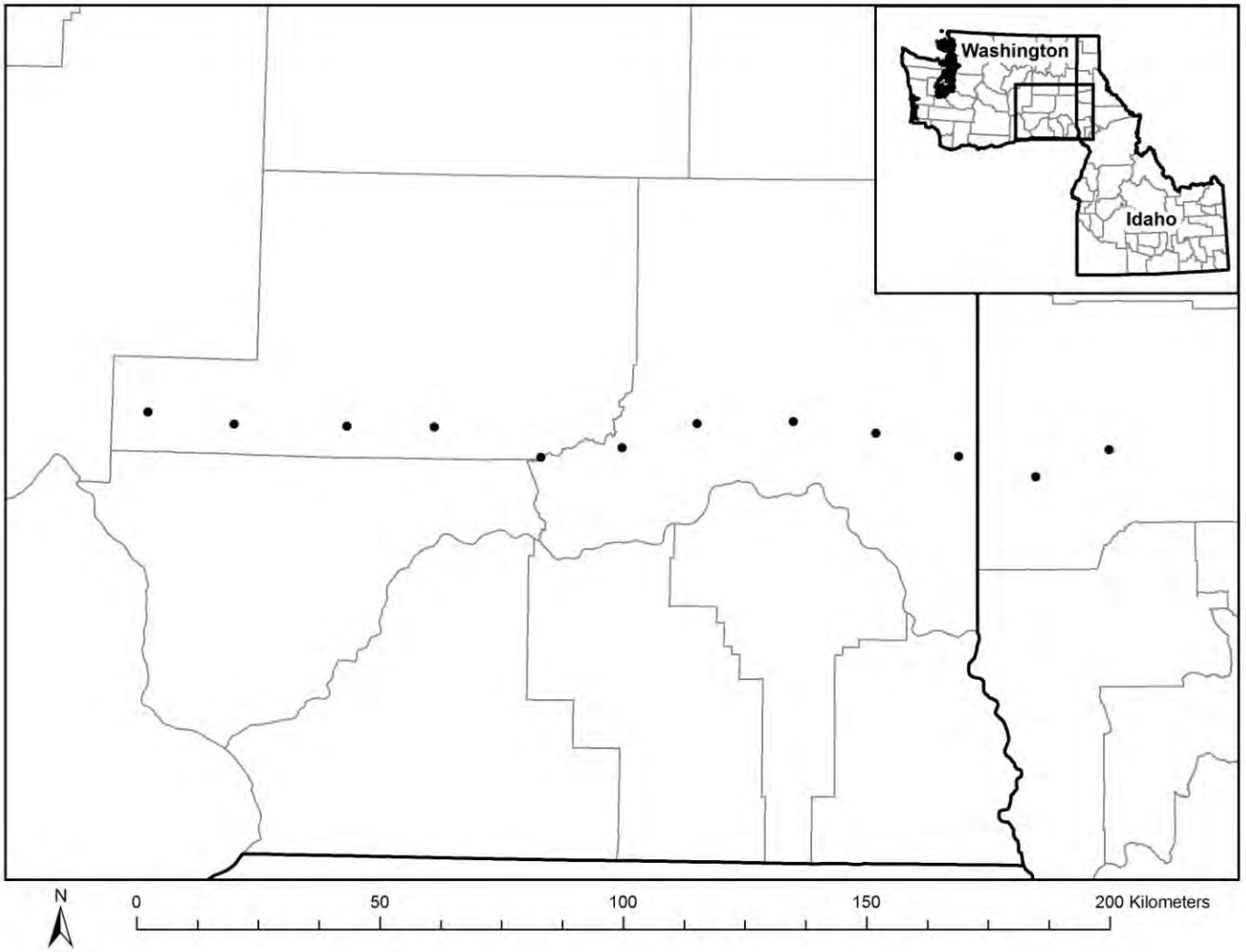
Data don't fall along any line

P sorption to oxide surfaces?

Kinetics?



200 km Phosphorus Transect



Preliminary data

- Soil pH range 4.3 to 7.1
- Total P <0.05% to 0.15%
- Differences in P fractions across transect, particularly at extreme ends
- Implications?

Summary

- Good evidence for response to moderate rates of P in low rainfall, crop-fallow areas
  - Inconsistent responses to dry MAP above 0 P control
  - Fluid P is clearly an advantage here
- Questions on soil test methods
- Ongoing work to explain chemistry and implications of recent soil acidification

Questions?