

Nutrient management for organic farms: Lentil focus

Prepared for Timeless Seeds
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Objectives today

- Review soil fertility basics including changes in organically farmed nutrient levels
- Discuss strategies for enhancing nutrient availability organically (manure, certified products, inoculants, legume green manures, mixed cover crops)
- Show effects of different management practices on organic small grain and lentil yields in Montana

What is your primary approach for maintaining or increasing your farm's available nutrient levels?


- Manure
- Certified products (bone meal, rock phosphate, etc.)
- Legume green manure
- Crop rotation other than LGM
- Other

There are 14 mineral nutrients that have been found to be essential for growth of most plants:

Macronutrients	Micronutrients
Nitrogen (N)	Boron (B)
Phosphorus (P)	Chloride (Cl)
Potassium (K)	Copper (Cu)
Sulfur (S)	Iron (Fe)
Calcium (Ca)	Manganese (Mn)
Magnesium (Mg)	Molybdenum (Mo)
	Nickel (Ni)
	Zinc (Zn)

The macronutrients are simply needed in larger amounts by the plant than the micronutrients.

Nutrient deficiencies of the bolded nutrients have been observed in Montana



How many of these 14 can be 'grown'
(and won't need to be replaced with
organic fertilizer)?

Do you observe nutrient deficiencies on your farm?

- No
- Yes, mainly nitrogen (N)
- Yes, mainly phosphorus (P)
- Yes, mainly sulfur (S)
- Yes, mainly micros

How to increase N fixation?

- Use appropriate inoculant (what do you use?)
- Maintain availability of other nutrients, especially P, K, S, and iron.

Not Fertilized

Fertilized w/ P, K, and S



Winter Pea, Bozeman, 5/17/07

Winter Pea Roots

Not Fertilized

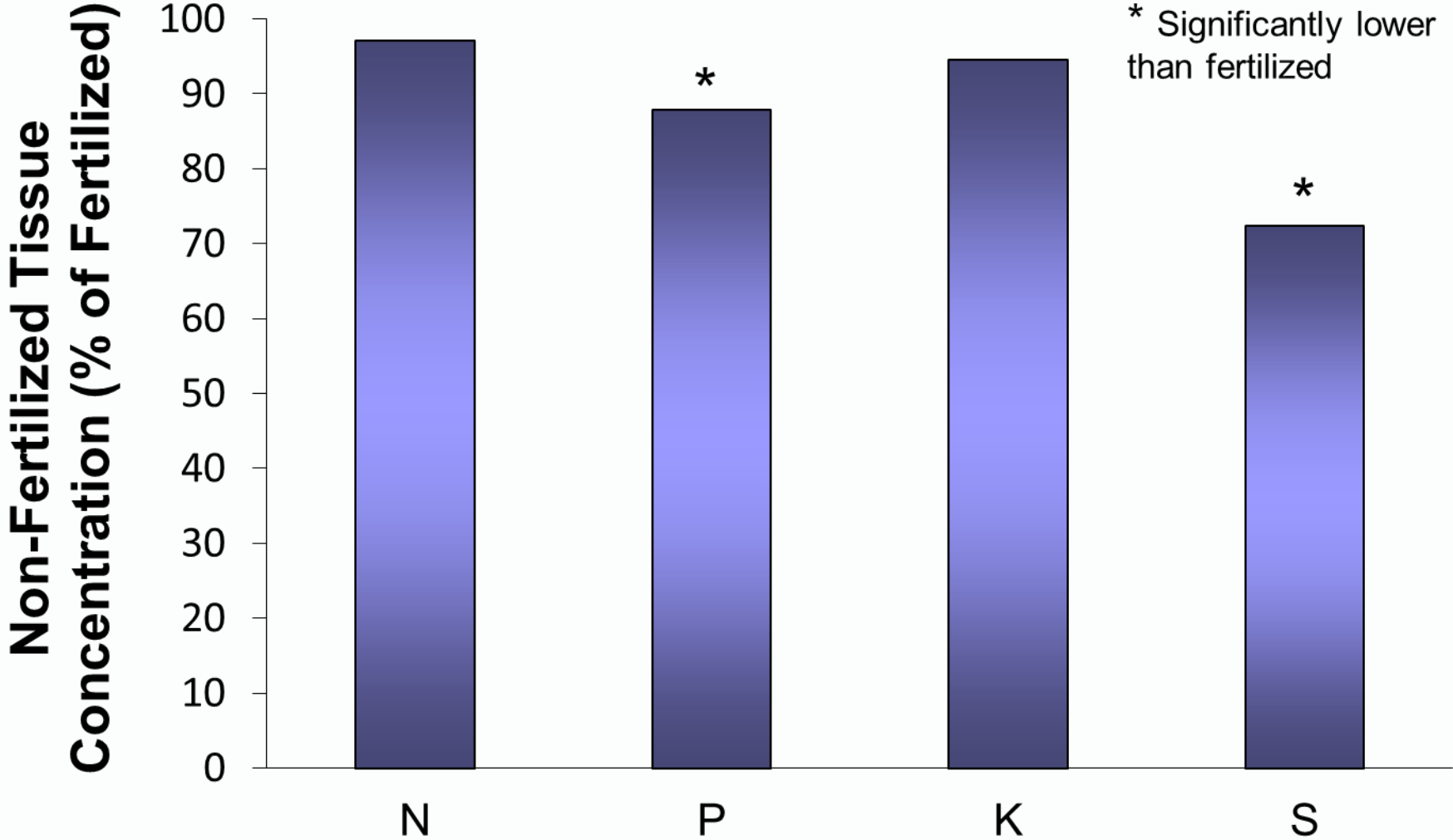
Fertilized with P, K, and S



Winter Pea, Bozeman, 5/17/07

What looks different?

Winter Pea Tissue Concentration



Winter Pea, Bzn
May 2007

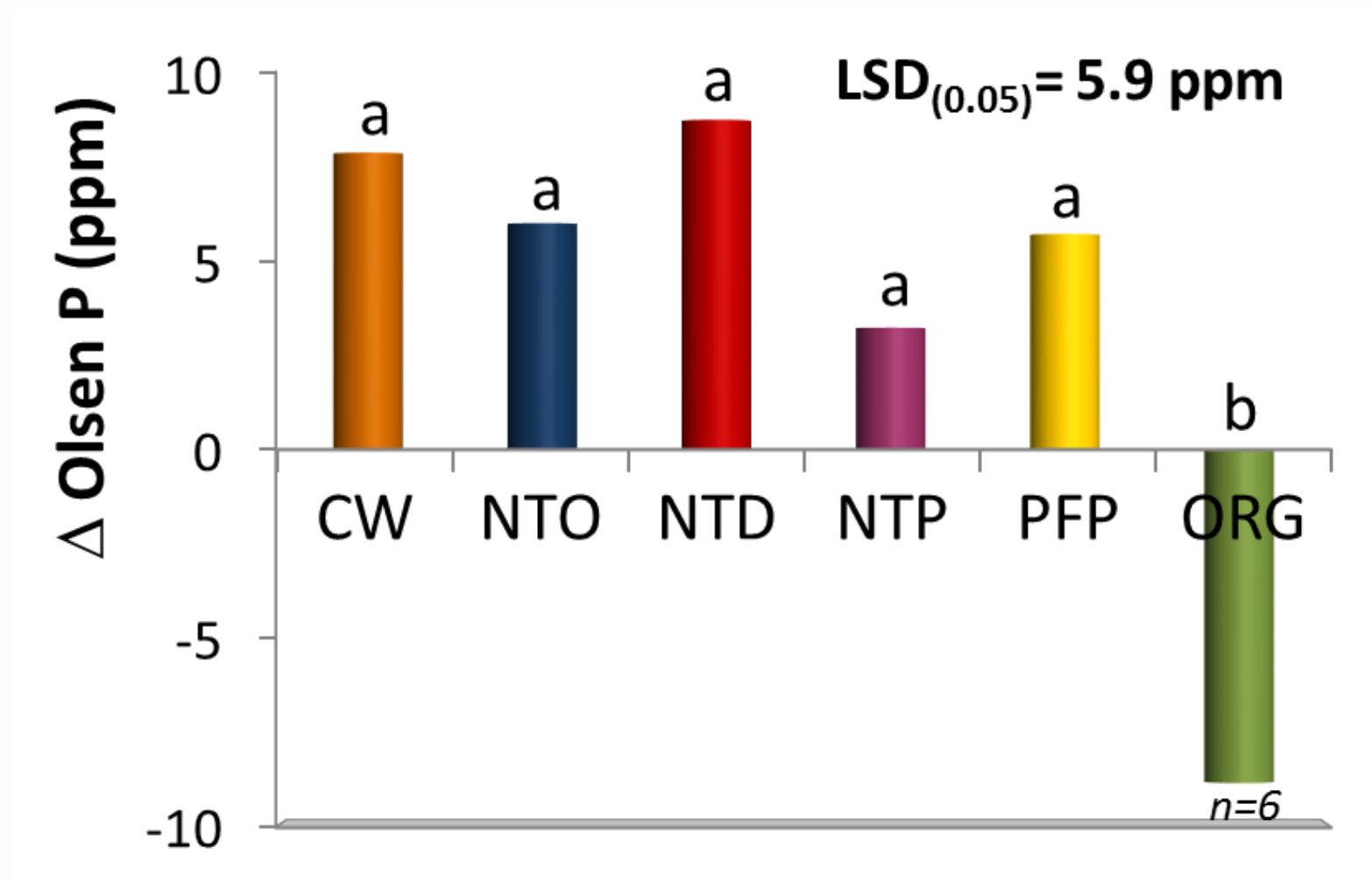
Deficiency?


- Likely S, despite typically high soil tests
- Why?
 - Leached out of surface
- Organic sulfur fertilizers other than manure?

Phosphorus can not be 'grown', needs to be eventually replaced

- In short term, green manures may be able to make P more available.
- In long term, organic P fertilizers such as rock phosphate, bone meal, or manure will need to be added.
- About 50-100 years of P left in Montana soils at typical removal rates. Yields will suffer well before this point.

Available P levels have declined from about 18 ppm in 2004 to 10 ppm in 2012 in organic treatments in a rotation study west of Bozeman (CDRS). Critical level = 16 ppm.



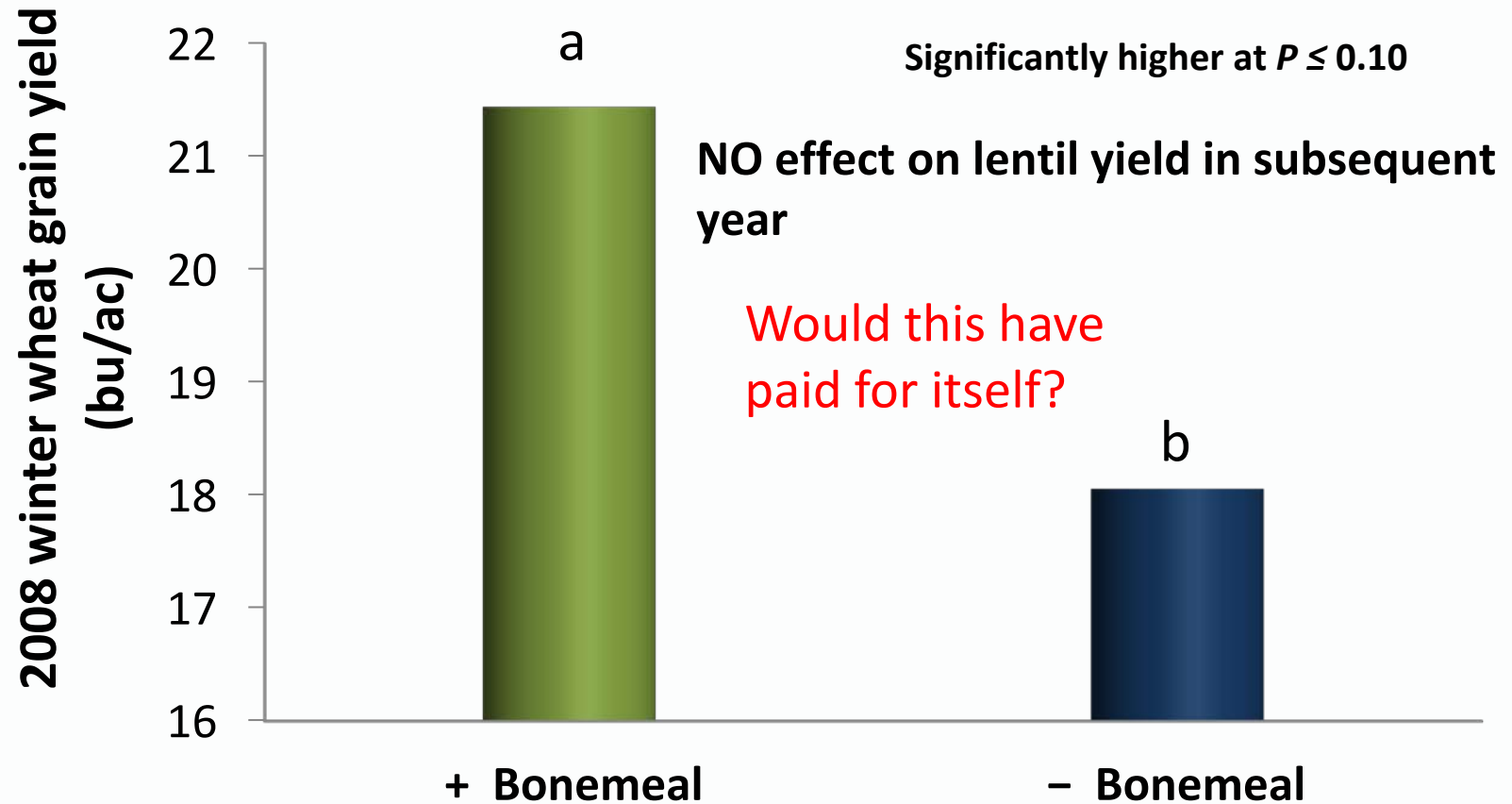


SO, are wheat or lentil yields (1 year later) affected by bone meal or manure in the CDRS organic treatments?

But are yields responsive to an organic fertilizer??

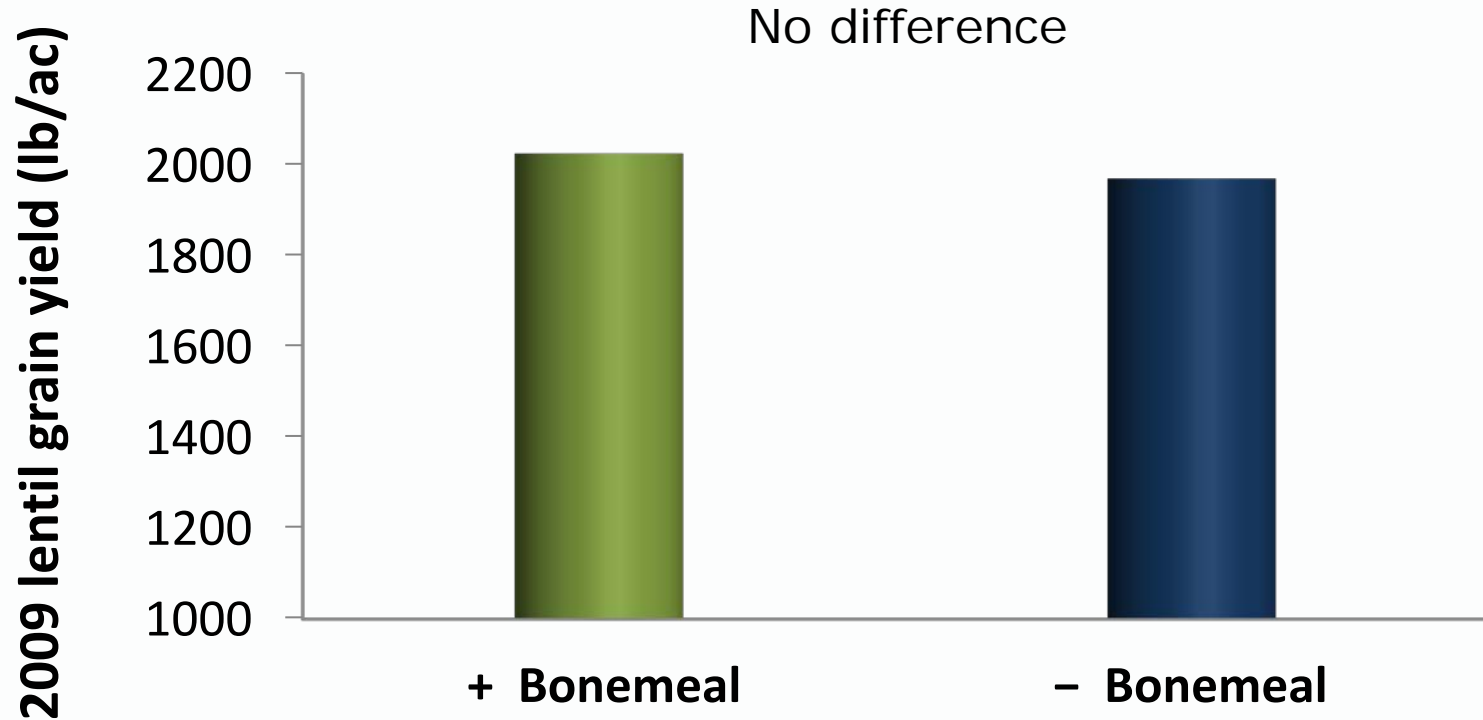
- Tested effects of bone meal (5-10-0) on CDRS organic winter wheat
- In fall 2007, added 250 lb bone meal/ac with seed at a rate of 25 lb P_2O_5 /ac on 1 seeder pass in each ORG WW plot
- Left rest of each ORG WW plot as a control
- On July 22, 2008 wheat was damaged by large hailstorm, but wheat harvested in August

Effect of bone meal on 2008 winter wheat yield



Bone meal (250 lb/ac) applied to organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm, Bozeman.

Effect of bone meal on 2009 lentil grain yield



Bone meal (250 lb/ac) applied to organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm,...

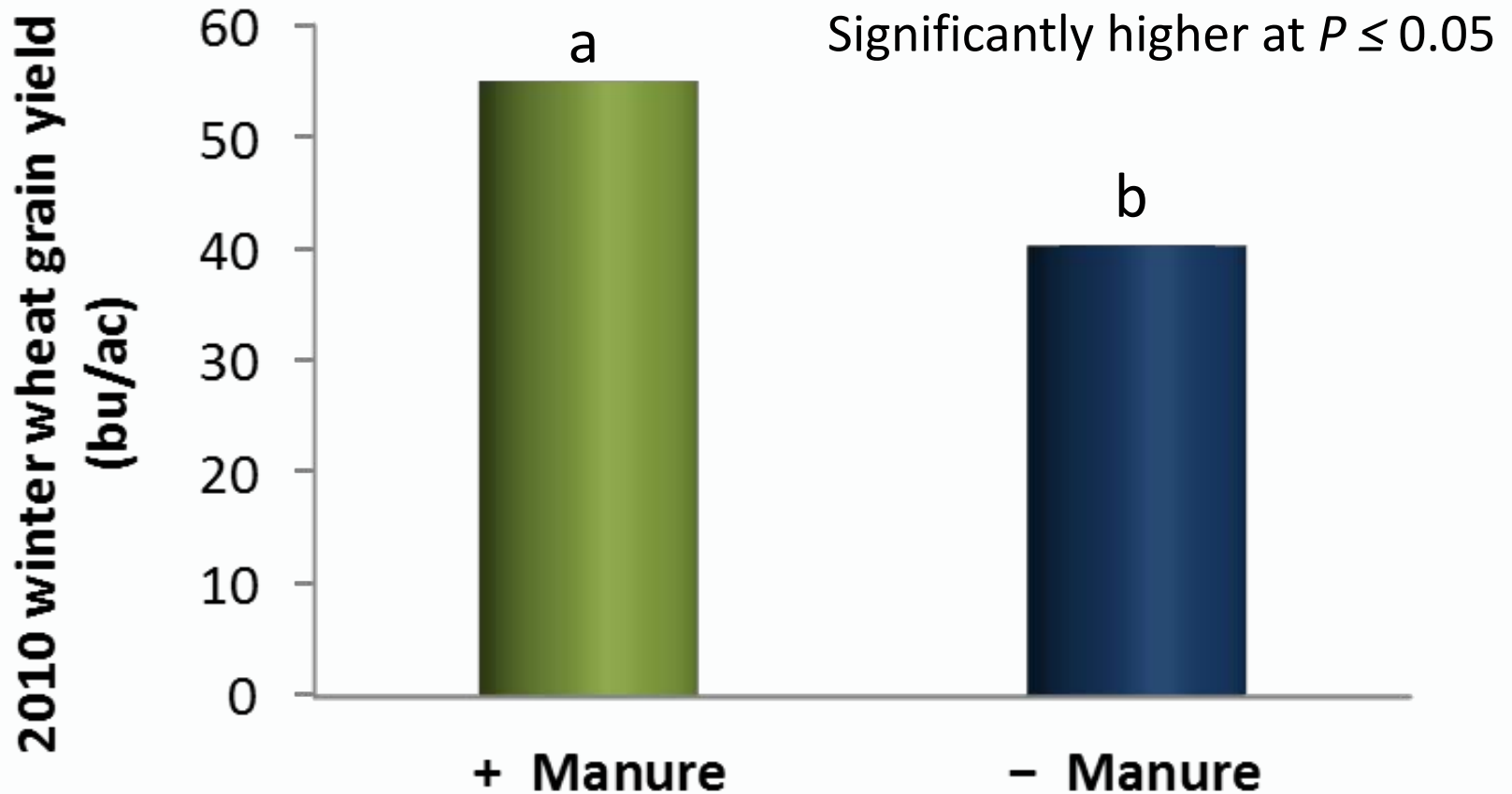
Manure study

- Applied ~9 tons/acre of 3 year aged organic steer manure to one seeder pass of ORG rotation in Sep 2009.
- Equated to 75 lb TOTAL P_2O_5 /acre and ~400 lb TOTAL N/acre



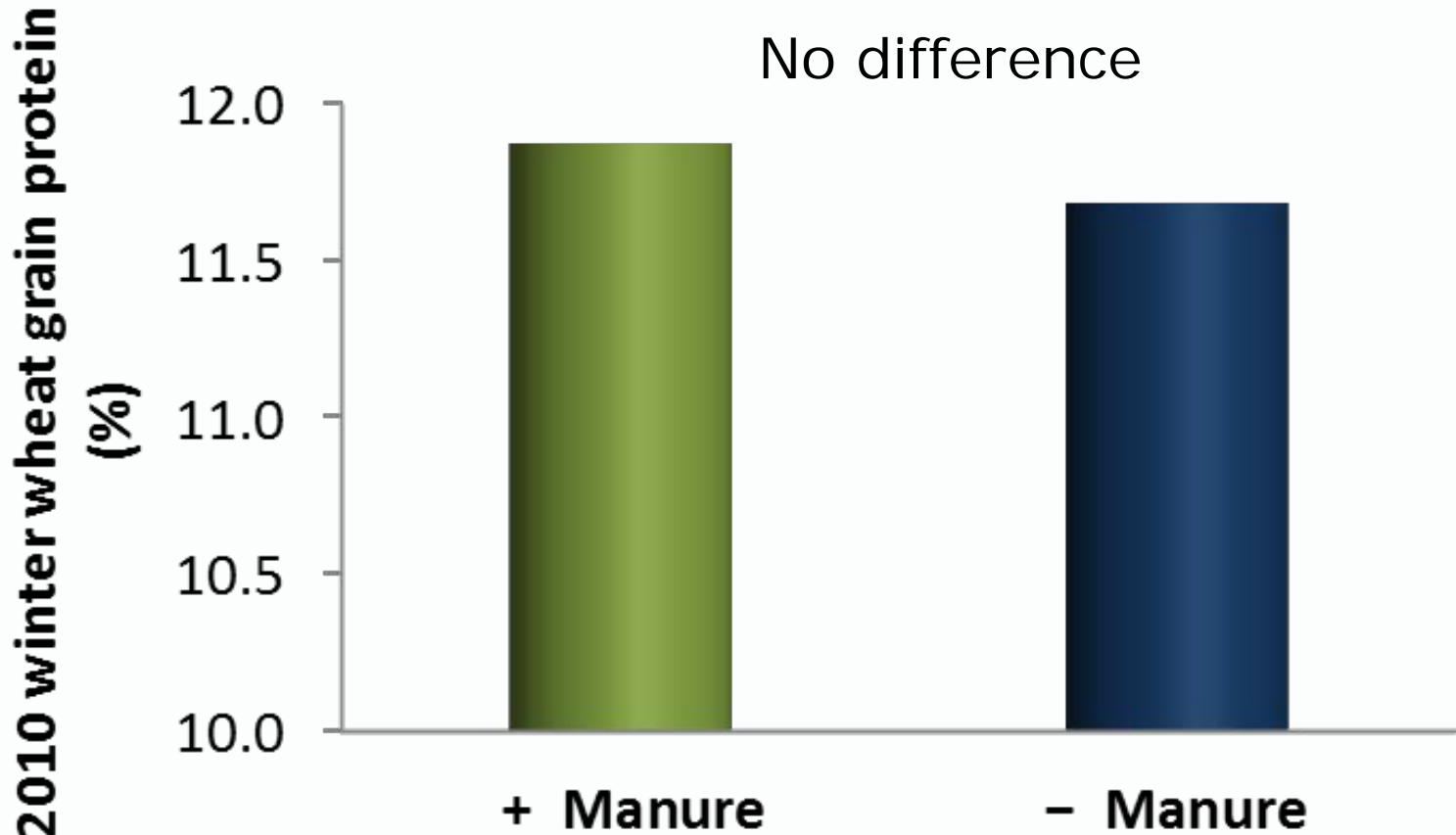
Manure was tilled in prior to seeding winter wheat

Effect of manure on 2010 winter wheat grain yield



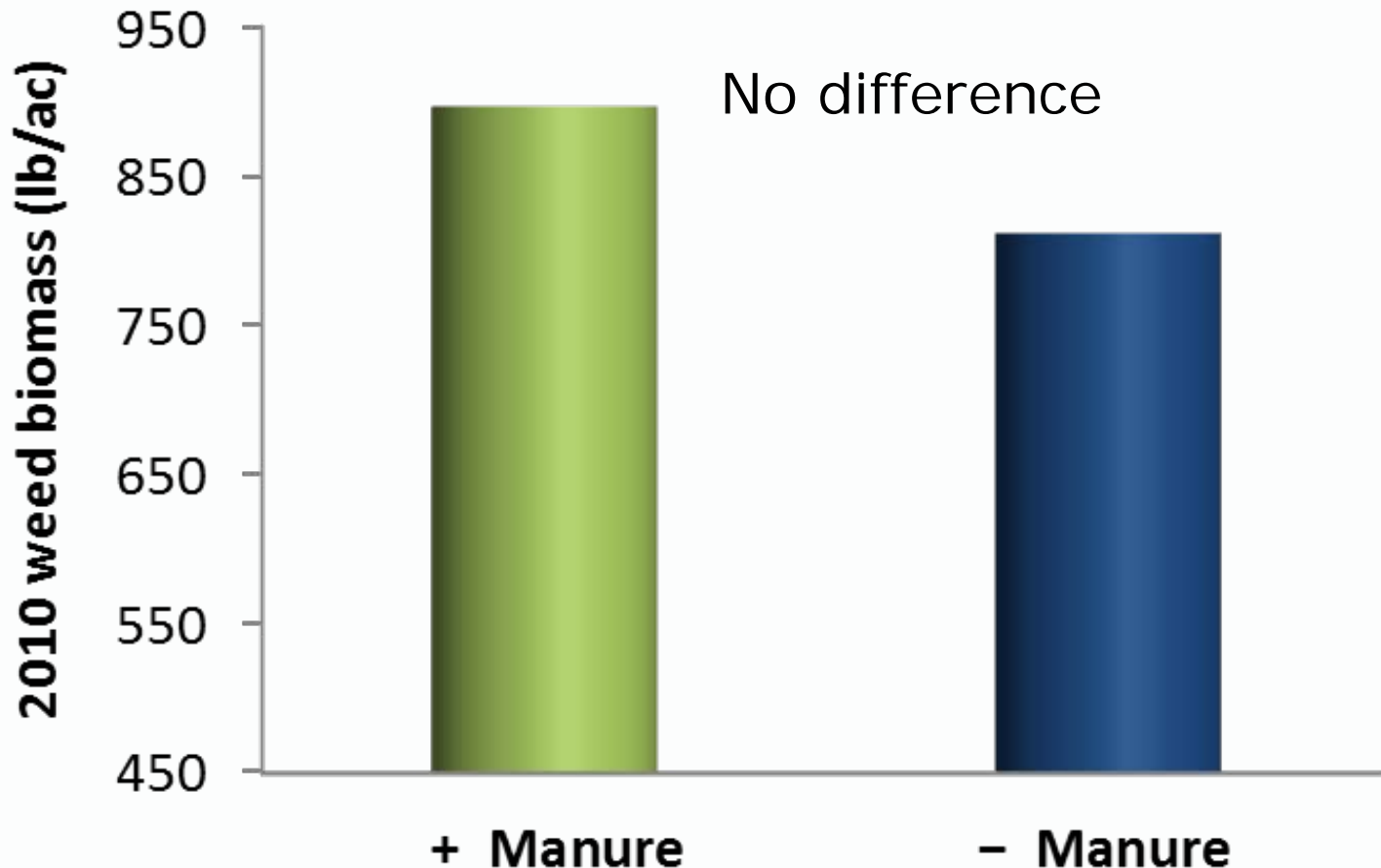
Aged (3-yr) organic steer manure applied (9 ton/ac) Sept. 2009 in organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm, Bozeman.

Effect of manure on 2010 winter wheat grain protein



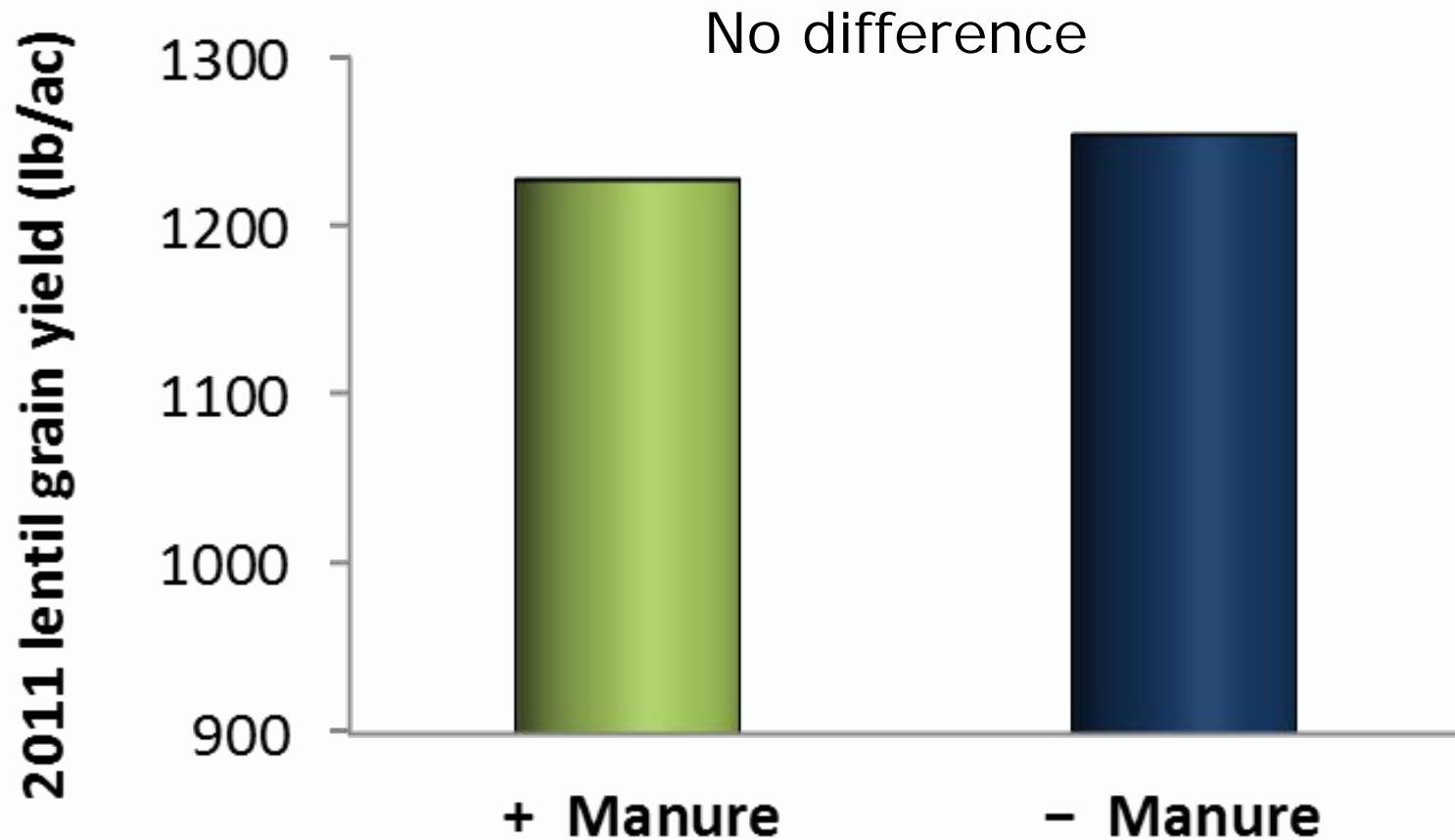
Aged (3-yr) organic steer manure applied (9 ton/ac) Sept. 2009 in organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm, Bozeman.

Effect of manure on 2010 weed biomass



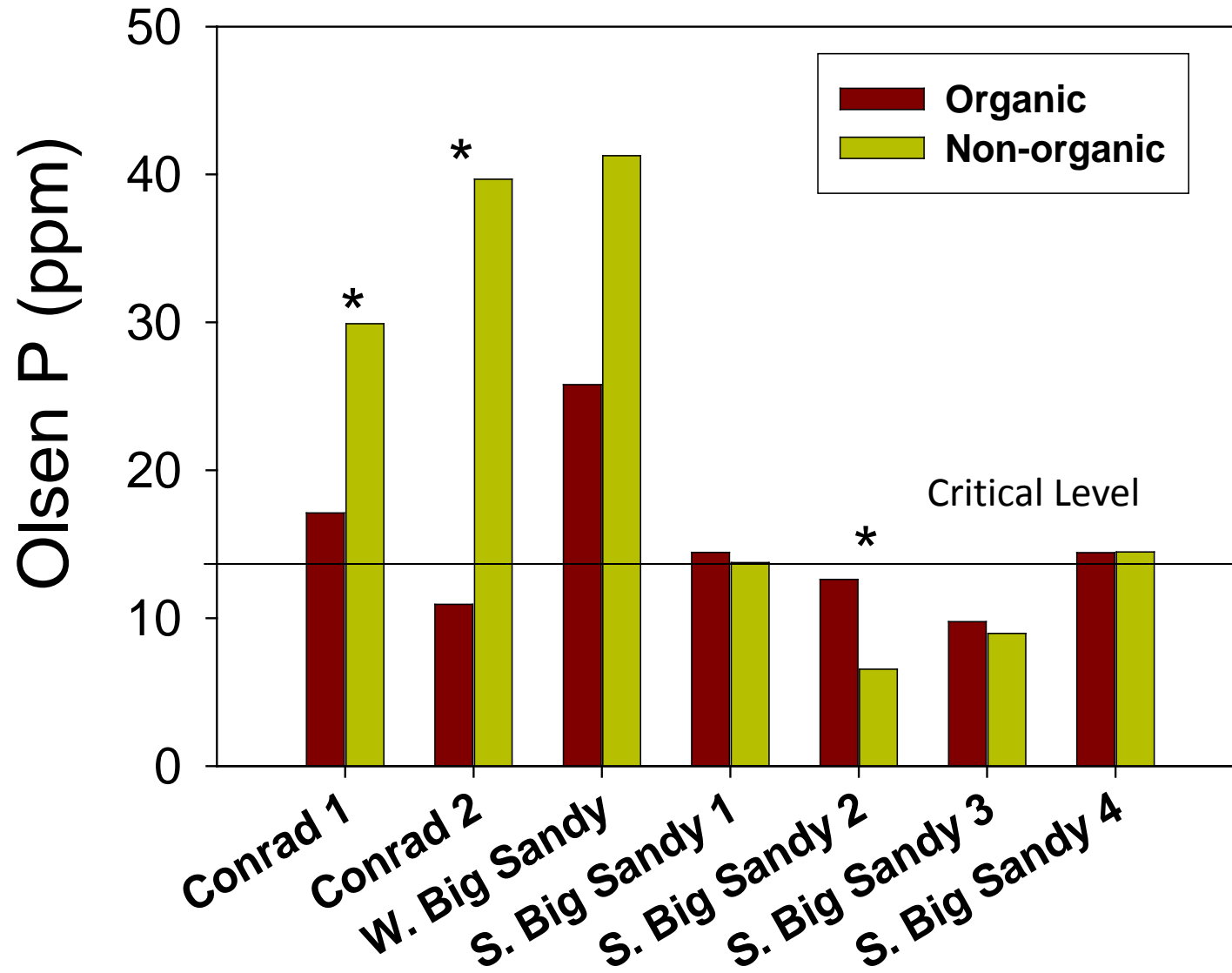
Aged (3-yr) organic steer manure applied (9 ton/ac) Sept. 2009 in organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm, Bozeman.


Effect of manure on 2011 lentil grain yield



Aged (3-yr) organic steer manure applied (9 ton/ac) Sept. 2009 in organic plots of the Crop Diversification Rotation Study, Arthur H. Post Farm, Bozeman.

What about P on 'real' farms?





Could rock phosphate applied with a cover crop increase avail P at S Big Sandy?



Methods

- Location: Organic small grain farm, Big Sandy, MT
- History: Managed organically with intermittent legume green manures for 21 years. No inputs.
- Upper 6 inch soil pH: 6.6
- Upper 6 inch Olsen P: 16.1 ppm



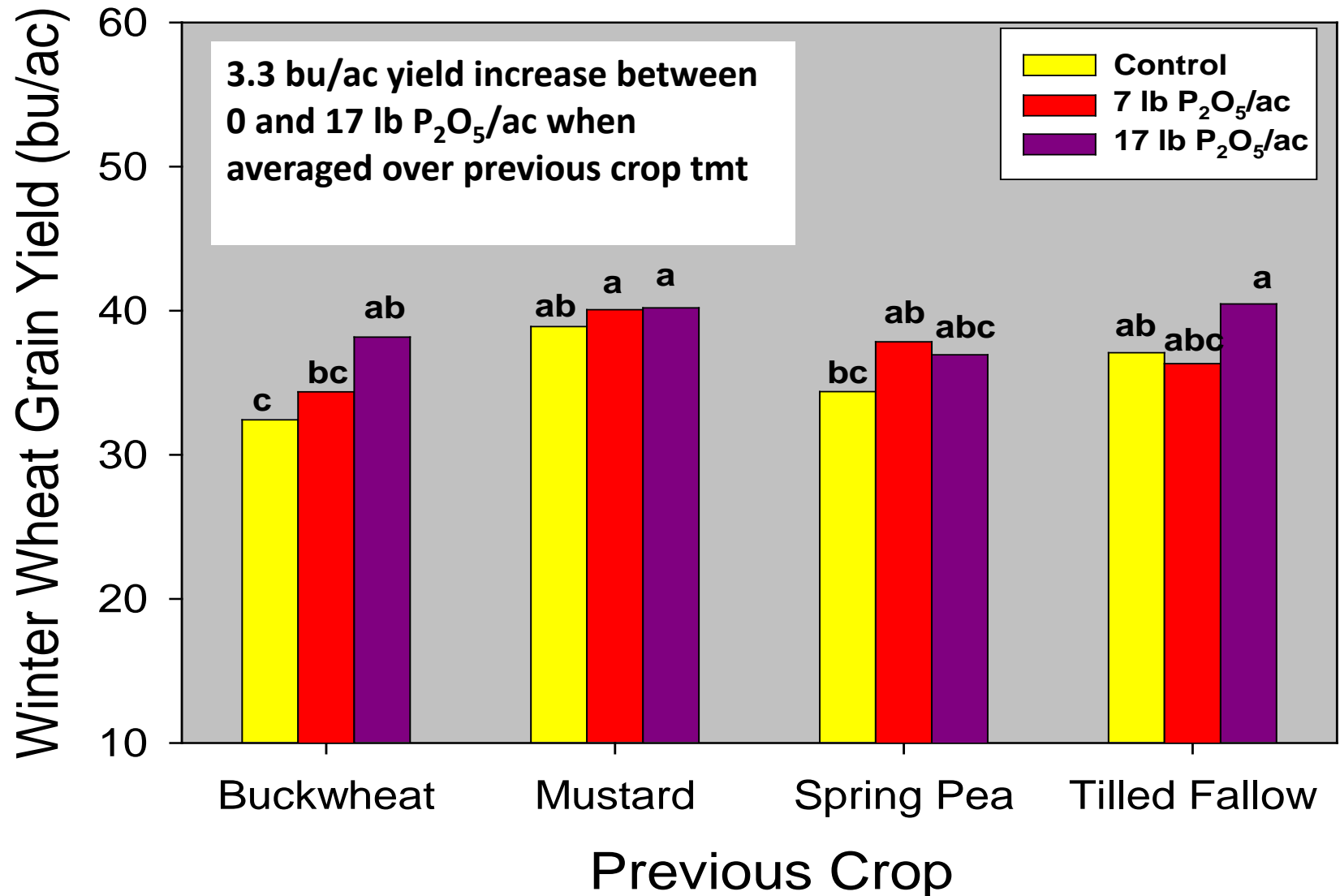
Methods

- First Year (2006) Crop Treatments, terminated at full pod:
 - Buckwheat (Mancan)
 - Yellow Mustard (AC Base)
 - Spring pea (Arvika)
 - Fallow
- April 2006 Broadcast-Incorporated RP (0-2.1-0)
Treatments: 0, 7, 17 lb available P_2O_5 /ac
- Second Year Crop: Winter wheat (Tiber)

Big Sandy Cover Crop Study

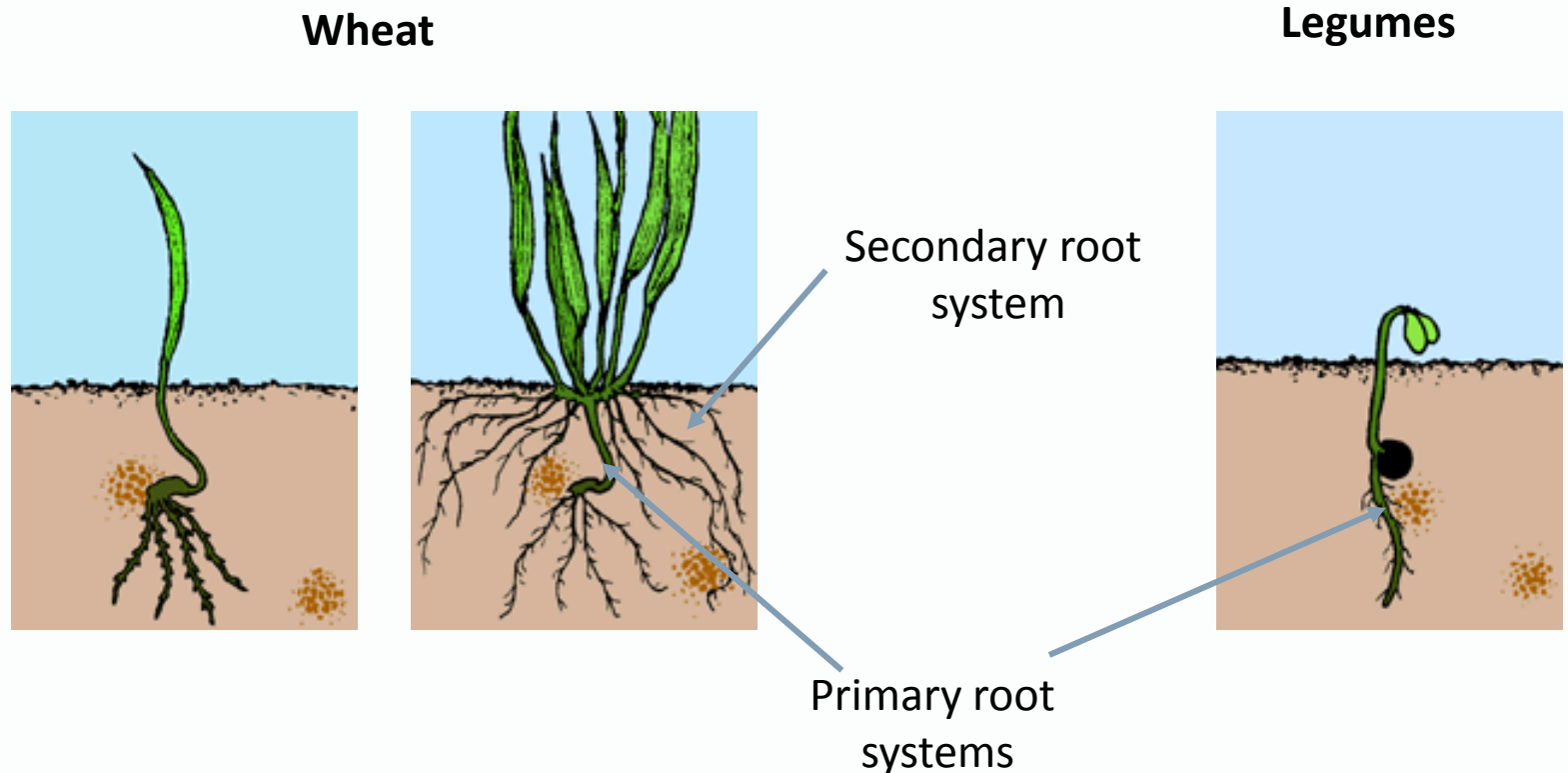


Effect of cover crop and rock phosphate on subsequent winter wheat grain yield, Big Sandy: 2007



If use organic P fertilizer, when and where should it be applied?

- Incorporate prior to seeding
- Place with or near wheat seed (because P is very immobile) and below annual legume seed. Why difference?



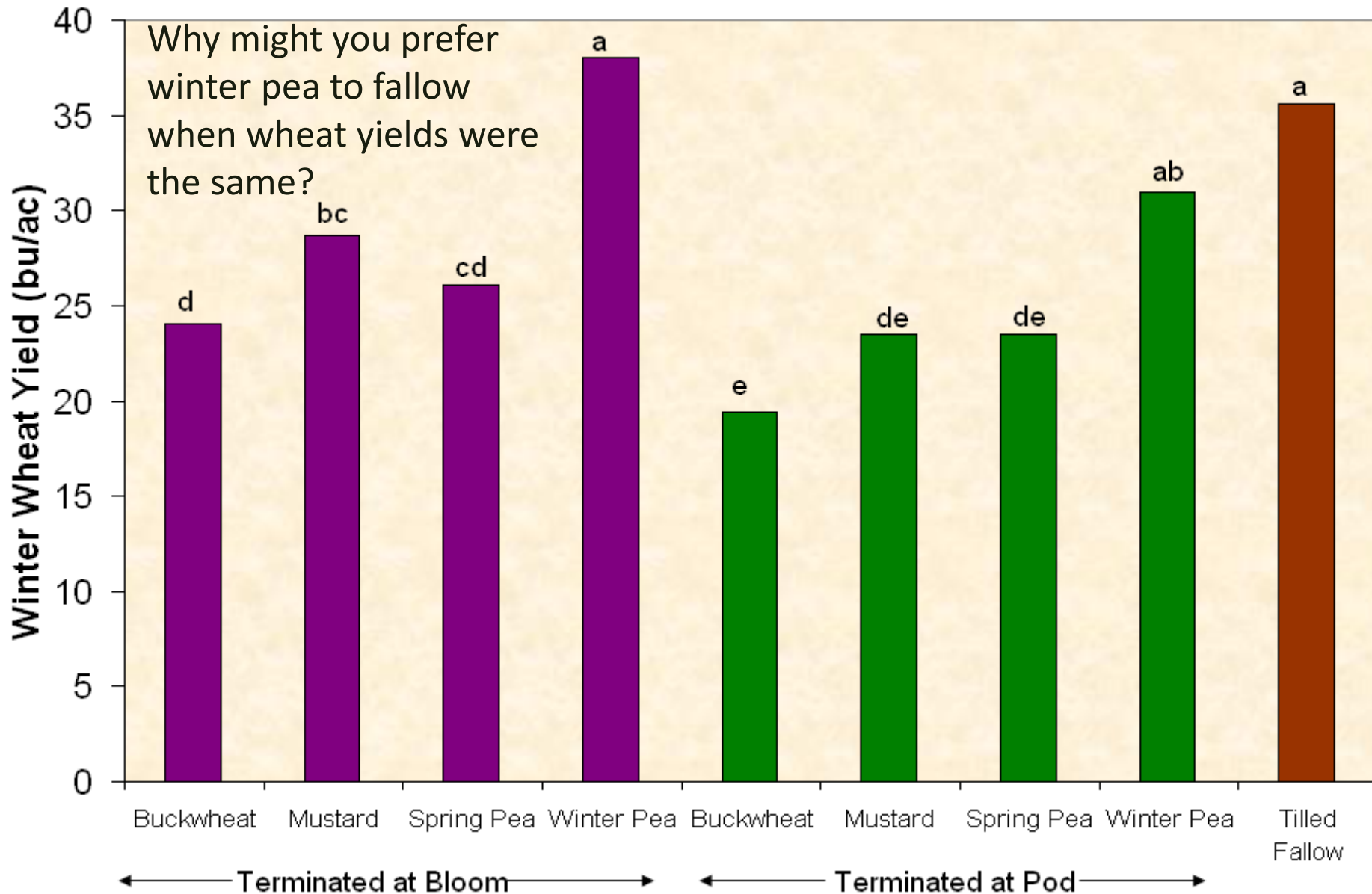
How can I increase available N for my non-legume crops?

Green Manures/Cover Crops (ex: alfalfa, clover, pea)

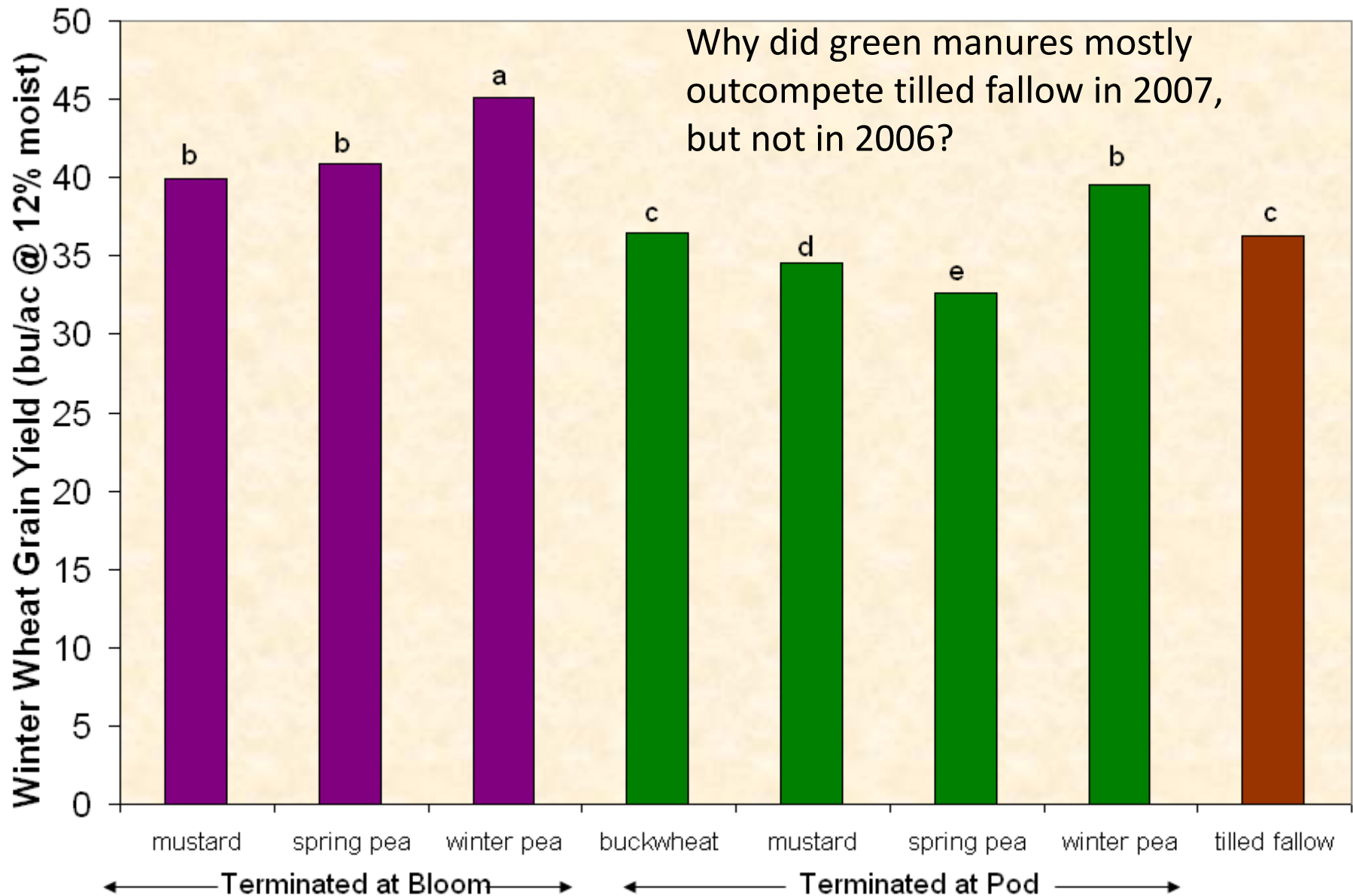
- Positive: Most replenish N supply w/ N fixation
- Positive: May increase P availability?
- Negative: No immediate economic benefit
- Negative: Use soil water, especially perennial legumes



Effect of Green Manure and Termination Timing on Organic Winter Wheat Yields at Big Sandy: 2006



Effect of Green Manure and Termination Timing on Winter Wheat Grain Yield at Big Sandy: 2007



WW yield was higher when green manure terminated at bloom

- Why might you want to terminate at pod anyway?
- Grain protein levels and discounts in small grains can be used to assess whether more legume cover crops or manure need to be included. (R. Engel has found that grain proteins below about 12.5% for WW and 13.2% for SW indicate yields not maximized).



Are there advantages to mixed cover crops
(cover crop cocktails)?

Perry Miller, Cathy Zabinski, and I are currently
trying to answer in conventional systems

Functional Groups & Plant Species

Nitrogen Fixers



Spring Pea
Pisum sativum



Common Vetch
Vicia sativa

Fibrous Root



Oats
Avena sativa



Italian Ryegrass
*Lolium
multiflorum*

Tap Root



Safflower
Carthamus tinctorius



Purple Top Turnip
Brassica

Brassica



Daikon radish
Raphanus sativus



Camelina
Camelina sativa

Crop Treatments

Summer fallow (SF)
PEA (mono crop control)

FULL (all 8 species)
N fixers (NF)
Fibrous roots (FR)
Tap root (TR)
Brassica (BR)
Minus NF
Minus FR
Minus TR
Minus BR

Locations, seeding, and termination timing

- Cover crop mixtures:
 - 2012 and 2014: Conrad and Amsterdam
 - 2013: Dutton and Bozeman (Kelly Canyon)
- Cover crop mixture growing season
 - 2012: Seeded early April, sprayed out mid June
 - 2013: Seeded early/mid-May, sprayed out near mid-July

Some practical findings to date

- Seeding shallow (1/2 inch, all through box) produced more consistent stands than with small seeds shallow and large seeds deep (2012)
- Radish, oat, pea, turnip, safflower all did well. Millet, ryegrass, camelina, and lentil not so well.
- Mid-May seeding (2013) worked better than early April (2012) for weed control

Pleasant surprise #1 (it rained in 2013)



Kelly Canyon



Dutton



Other research findings to date

- Potentially mineralizable nitrogen:
 - Amsterdam: Pea=full mix>fallow
 - Conrad: Pea>full=fallow
- Subsequent wheat yield in 2013 at Conrad:
 - Yield on Fallow > Yield on PEA, NFixers, Brassica
 - Yield on Fallow = Yield on Tap Root and Minus Fibrous
 - Amsterdam hailed out
- Subsequent protein at Conrad: no treatment effect
- Take home to date: No major differences in subsequent yields, protein, or soil quality between pea and other mixes after just one cycle. But stay tuned!

Summary

- Nitrogen can be supplied with livestock manure and legume cover crops.
- Phosphorus can be supplied with manure or certified organic products, yet P availability is often low in those products.
- Cover crops do not appear to affect P availability for subsequent crop.
- Potassium, sulfur and micronutrients can be supplied with manure or certified products (economics??).
- Soil and/or tissue testing can help you decide what nutrient(s) to focus on.

For more information



<http://landresources.montana.edu/soilfertility>

Questions?

