Phosphorus Fertility on Organic Farms in Saskatchewan

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Phosphorus deficiency appears to be widespread problem on organic farms:

73 fields sampled:

- 1 field marginal P level (30 lbs acre^{-1}) in the top 6 inches
- 72 field deficient P level (<30 lbs acre^{-1})
  - as low as 4 lbs acre^{-1}
- Deeper soils (to 18 inches) – lower P levels

- BUT. . . crop yields reported by producers should not be achievable with these low P levels

Research Program - two focuses

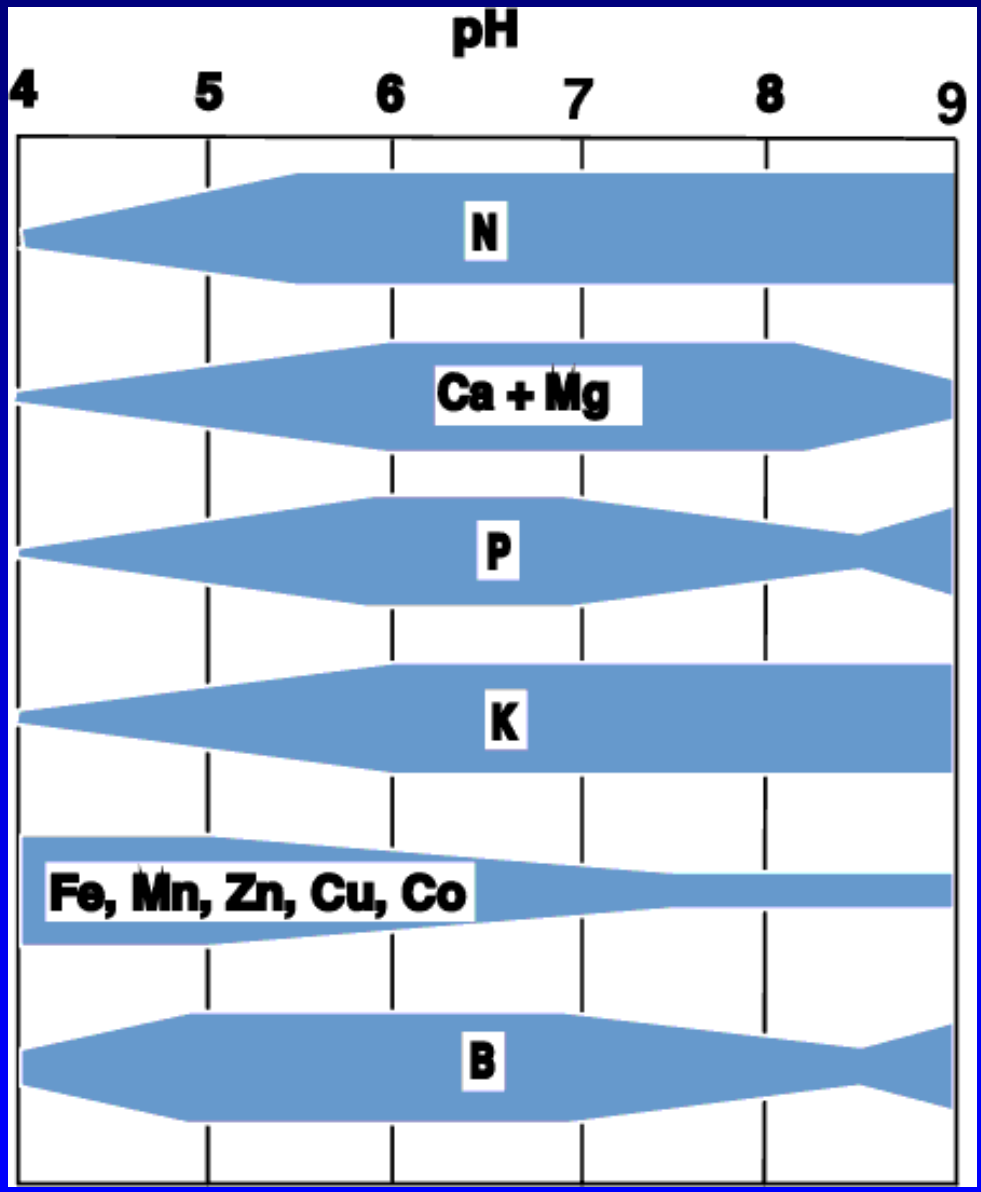
- Evaluating products, management practices aimed at improving P fertility
- Understanding soil P dynamics to better understand P supply in organically managed soils (P pools)

P deficiency in wheat

- Stunted growth
- Purplish colouring
- Poorly developed roots
- Poor tillering
- Small, poor yielding heads

Why is available P so low?

1. Inherent feature of our soils – calcareous (calcium containing) soils with neutral to slightly alkaline pHs (pH 6.8-7.8)
   - Phosphate is extremely insoluble - especially so at pH>6.8
   - Calcium minerals bind P making it very difficult to access


pH
4
5
6
7
8
9
N
Ca + Mg
P
K
Fe, Mn, Zn, Cu, Co
B

Why is available P so low?

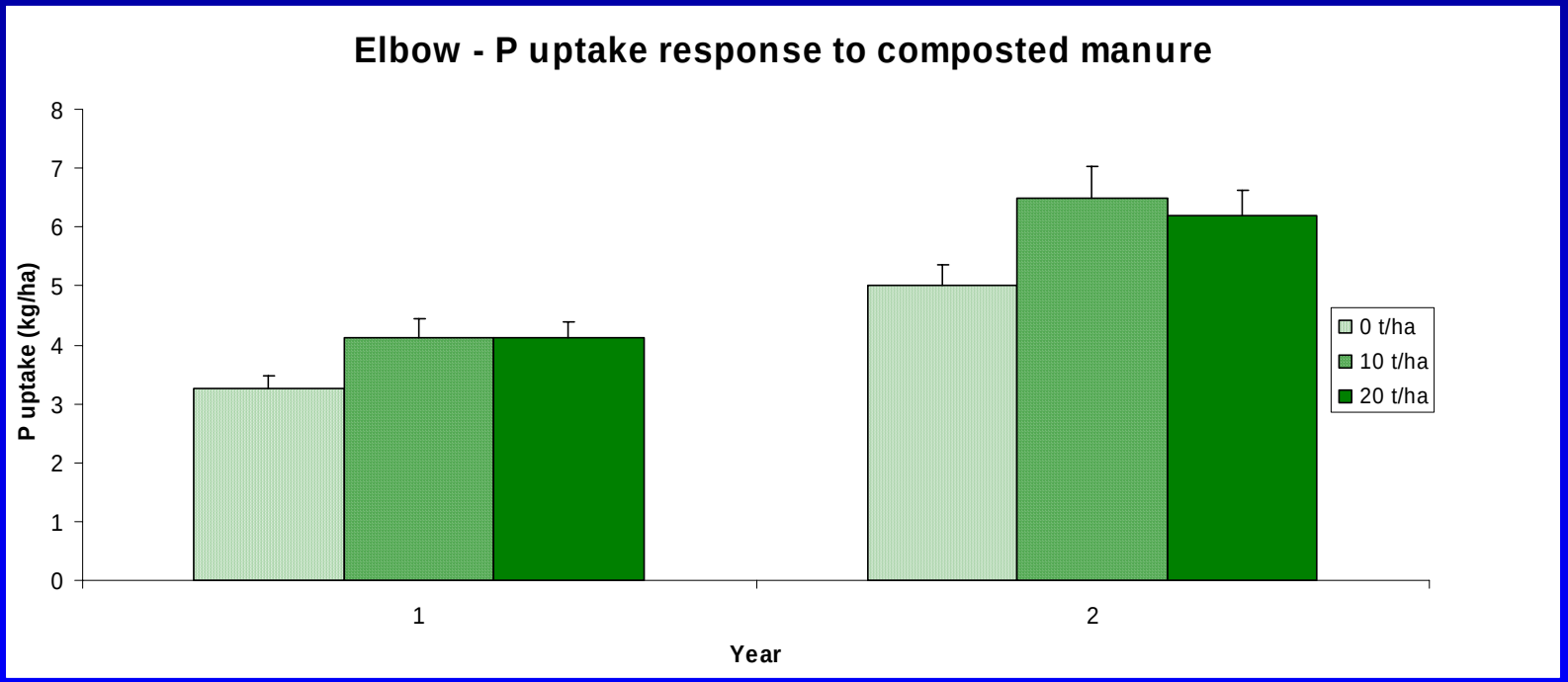
2. No replacement of P after removing through harvesting

		N (lb/A)	P_2O_5 (lb/A)	K_2O (lb/A)	S (lb/A)
Barley (80 bu/A)	Uptake	100-122	40-49	96-117	12-14
	Removal	70-85	30-37	23-28	6-8
Flax (24 bu/A)	Uptake	64-78	18-22	39-48	12-15
	Removal	46-56	14-17	13-16	5-6

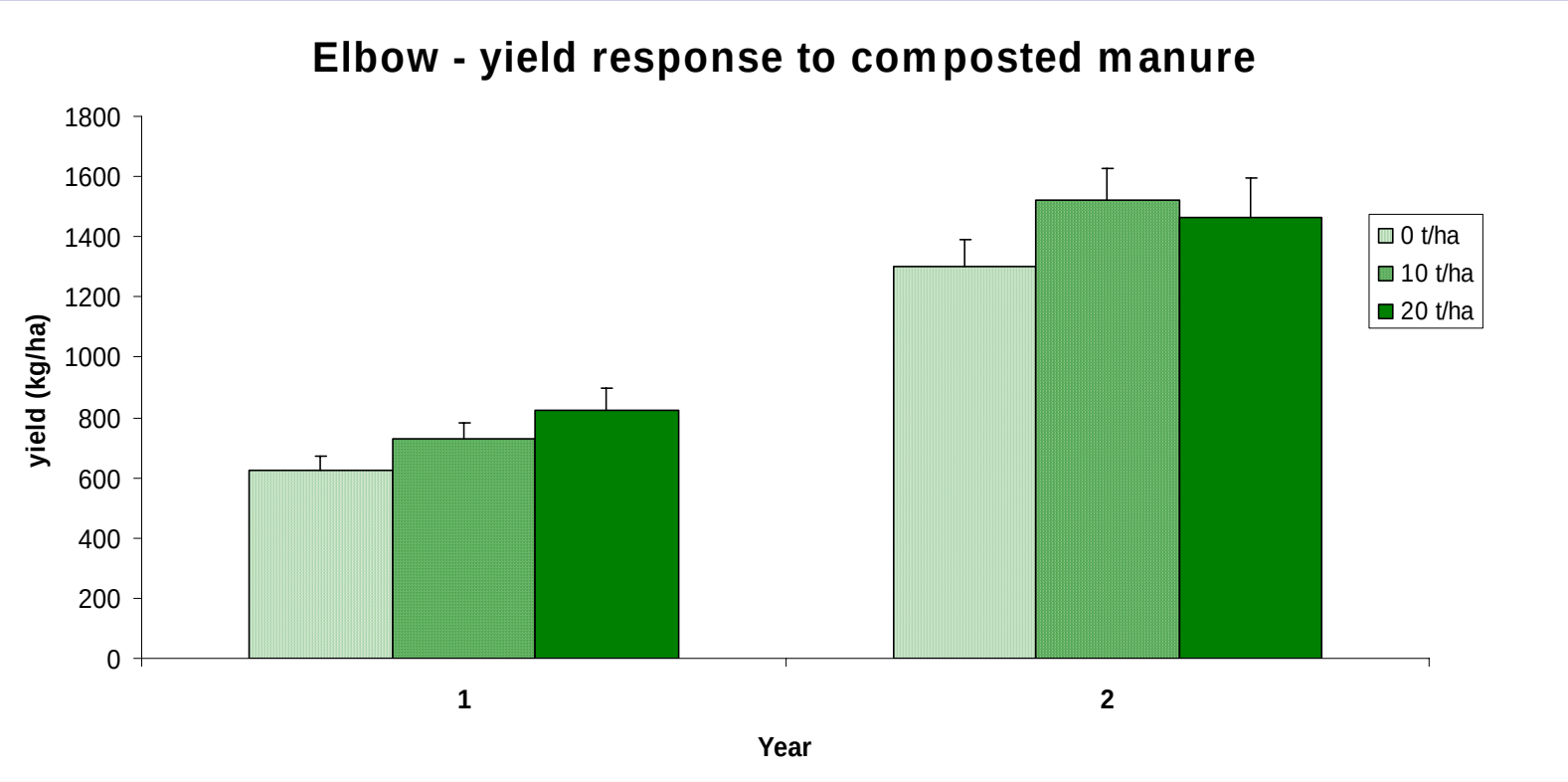
How can P availability be increased?

- Amend soils with P containing organic materials
  - Manures
  - Organic matter
- Acidify soil environment around the roots
  - Natural root systems
  - Fungal inoculants
- Improve access to soil P
  - Green manures
  - AMF

Composted Manure



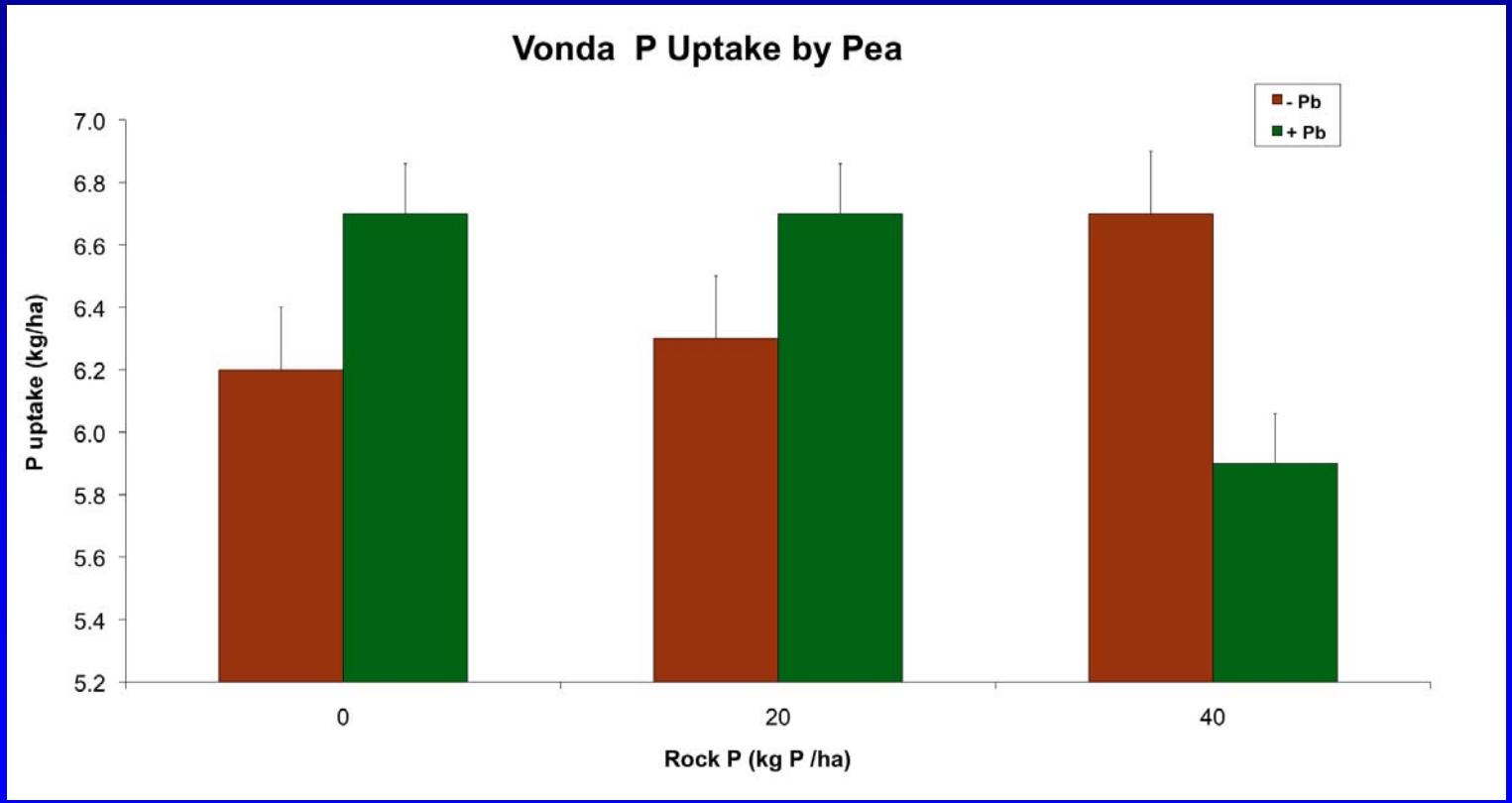
Composted Manure



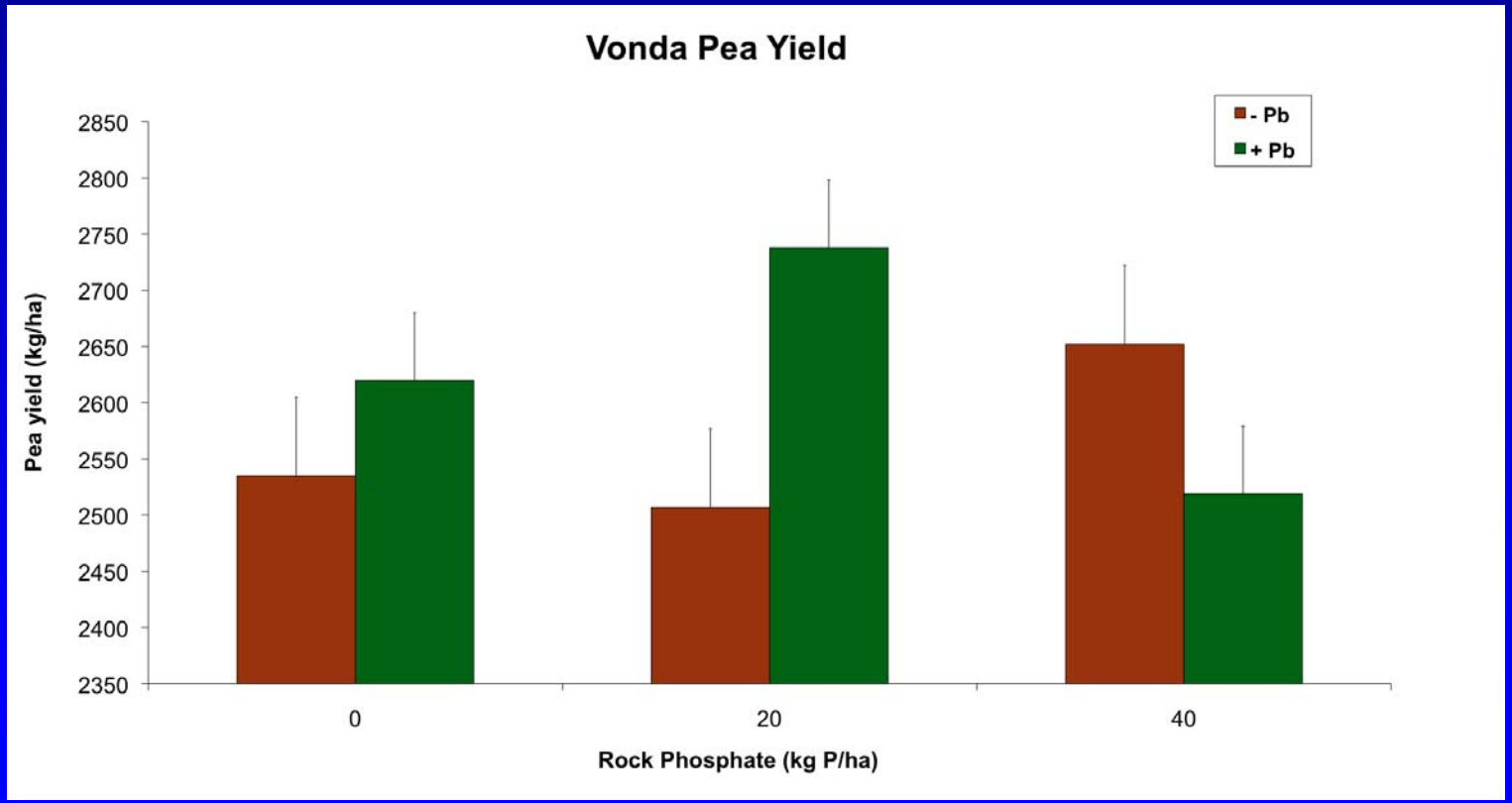
Summary of crop responses to composted manure (6 site-years)

	Response to manure		
	+	0	-
		P uptake	
Year 1 (application)	4	1	1
Year 2 (recrop)	5	0	1
		Yield	
Year 1 (application)	3	2	1
Year 2 (recrop)	4	1	1

Penicillium bilaiae (Jumpstart)



Penicillium bilaiae (Jumpstart)



Summary of crop responses to *P. bilaiae* inoculation (8 site-years)

	Response to *P. bilaiae*		
	+	0	-
Rock P rate		***P uptake***	
0	4	4	0
20	5	1	2
40	4	2	2
		Seed yield	
0	5	3	0
20	5	1	2
40	5	1	2

Green manures – non-legumes

Oilseed radish

Buckwheat

Green manures - legumes

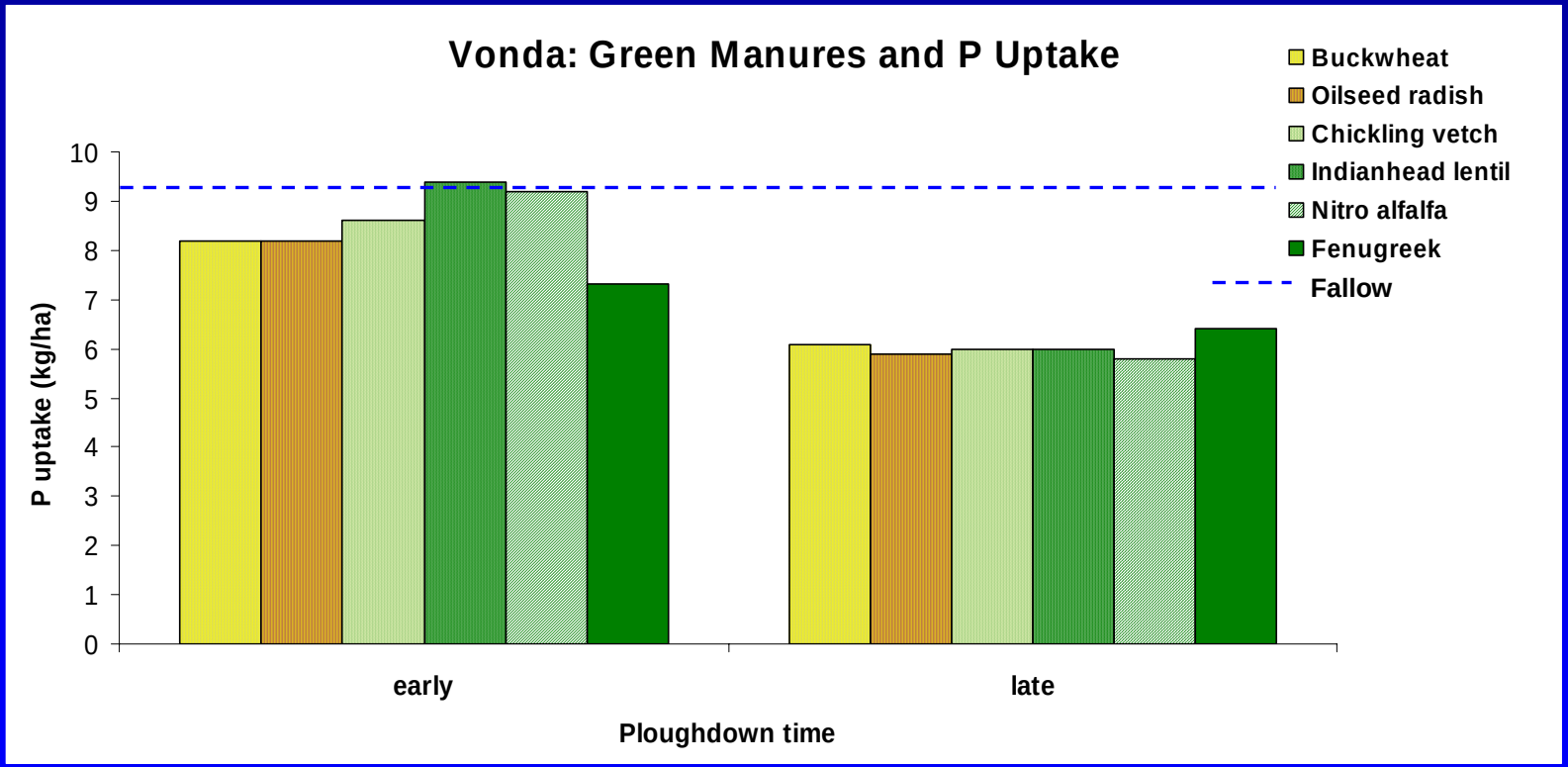
Indian head lentil

Chickling vetch

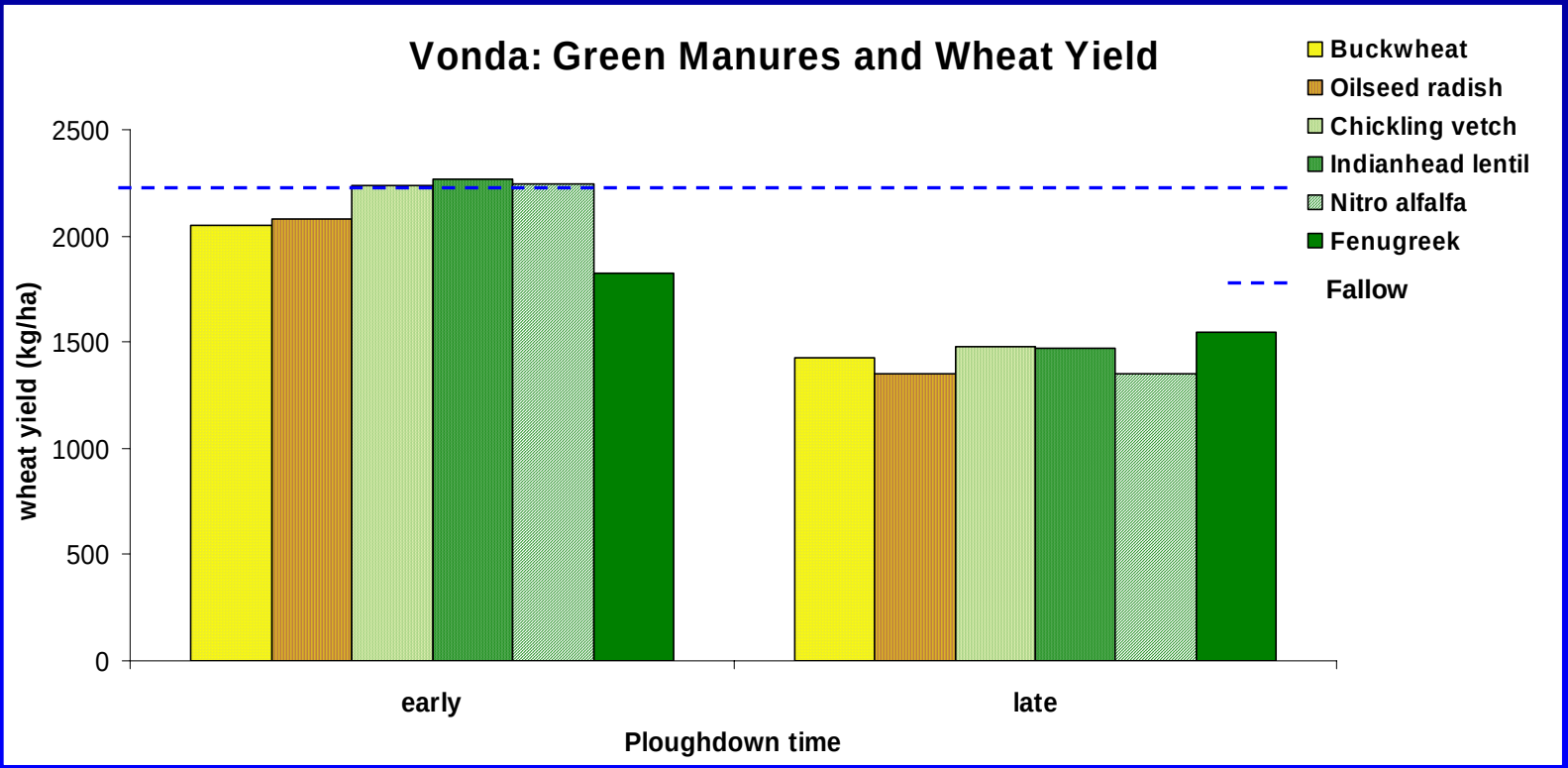
Nitro alfalfa

Fenugreek

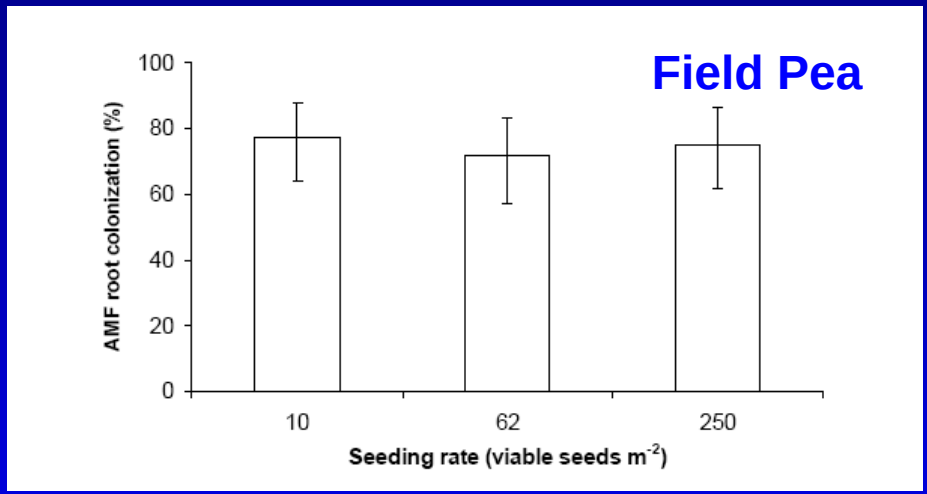
Annual Green Manures

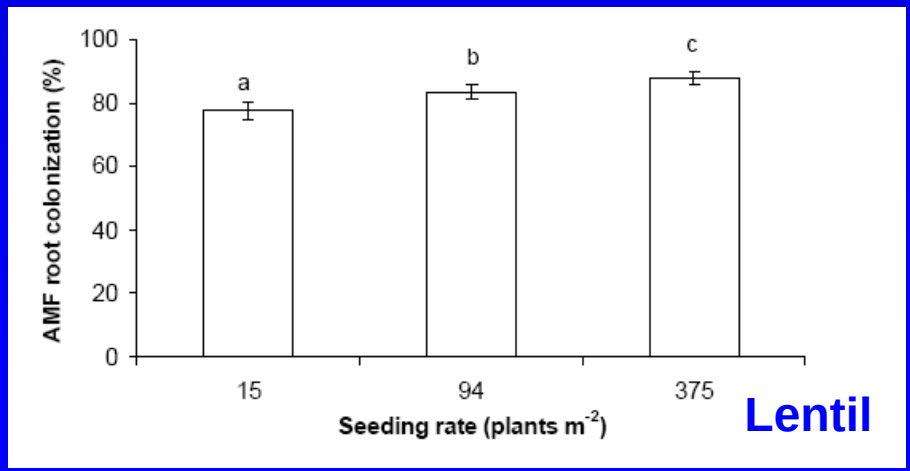


Annual Green Manures



Arbuscular Mycorrhizal Fungi (AMF)





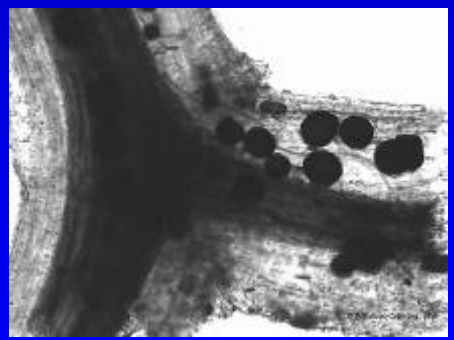
Other projects underway:

Evaluating other amendments for P supply

- Humic acids
- Alfalfa pellets
- Worm castings
- Manure sources
- Bioproducts of oil processing (flax meal, mustard meal)

Microbial studies

- AMF and *P. bilaiae* co-inoculation – effectiveness and survival



AMF

P. bilaiae

Rotational Affects on AMF colonization

Wheat – Lentil; Wheat – Mustard

Mustard – Lentil; Mustard – Wheat

Lentil – Mustard; Lentil – Wheat

Carryover of inoculant from crop to crop

Green Manure Study

- Reduced tillage termination (crimper) – soil nutrient status, nitrogen fixation, microbial diversity
  - Field Pea and Faba Bean

Importance of P for biological N fixation

- Quantify amount of N fixed by pea as a function of P fertilizer
  - Organic treatment – low fertility w/wout *P. bilaiae*

Inherent P supplying ability of organically managed soils

- Soil test extracts for available P
- PRS probes
- Seasonal uptake of P by wheat and pea/lentil
- Mineralization studies examining release of inorganic P over time

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