Using ^{33}P to quantify phosphorus accumulation below-ground by canola and the contribution to following wheat

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Why canola root P?

1) Most profitable cropping option - occupies 6% of the cropped area in Australia (Norton et al. 2013)

2) In rotation canola is a valuable disease break for cereals

3) Canola releases organic acids from its roots (Norton et al. 2013; Misra et al. 1988; Foehse & Jungk 1984)

Very recent pot studies show:

- 70% of P in mature canola stem residue is orthophosphate (Noack et al. 2012)

- P released from young canola roots has a high P availability to wheat (Tabal 2008 PhD thesis Uni of Adelaide)
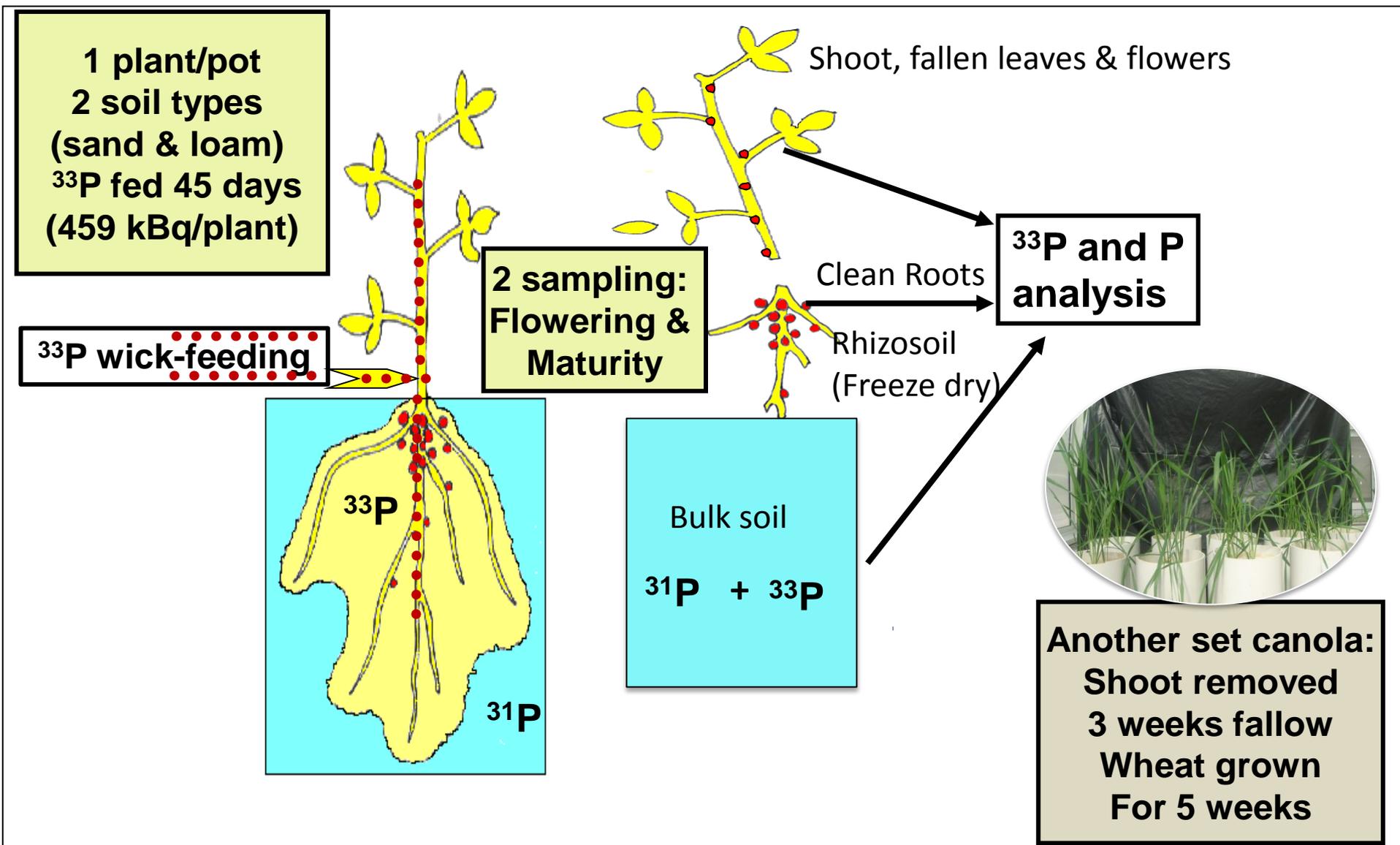
What is the magnitude of canola root P in field soils?

Dry matter and P content of roots from field cores (0-10cm)

Crop	Dry matter Recovered roots (kg/ha)	P content Recovered roots (kg/ha)
Canola	404 ± 198	**3.75 ± 1.05**
Lupin	237 ± 115	0.70 ± 0.26
Rye	346 ± 182	1.21 ± 0.30

How to quantify all of the P accumulated in root systems below-ground?

^{33}P stem-feeding to label P below-ground

1 plant/pot
2 soil types
(sand & loam)
^{33}P fed 45 days
(459 kBq/plant)

^{33}P wick-feeding

2 sampling:
Flowering &
Maturity

Shoot, fallen leaves & flowers

Clean Roots

^{33}P and P analysis

Rhizosoil
(Freeze dry)

^{33}P

^{31}P

Bulk soil

^{31}P + ^{33}P

Another set canola:
Shoot removed
3 weeks fallow
Wheat grown
For 5 weeks

Modified version of diagram provided by Fillery & Peoples CSIRO Plant Industry

Distribution (%) and recovery of ^{33}P by canola

	Flowering				Maturity			
	Shoot	**Root**	**Soil**	**Total**	**Shoot**	**Root**	**Soil**	**Total**
Sand	23 b	50 a	20 b	93	18 b	36 a	34 b	88
Loam	34 a	36 b	23 a	93	27 a	23 b	40 a	90

Recovery 95 - 99.9%
(Including wick sorption 6.9%)

Resin extractable P: 6 - 10%
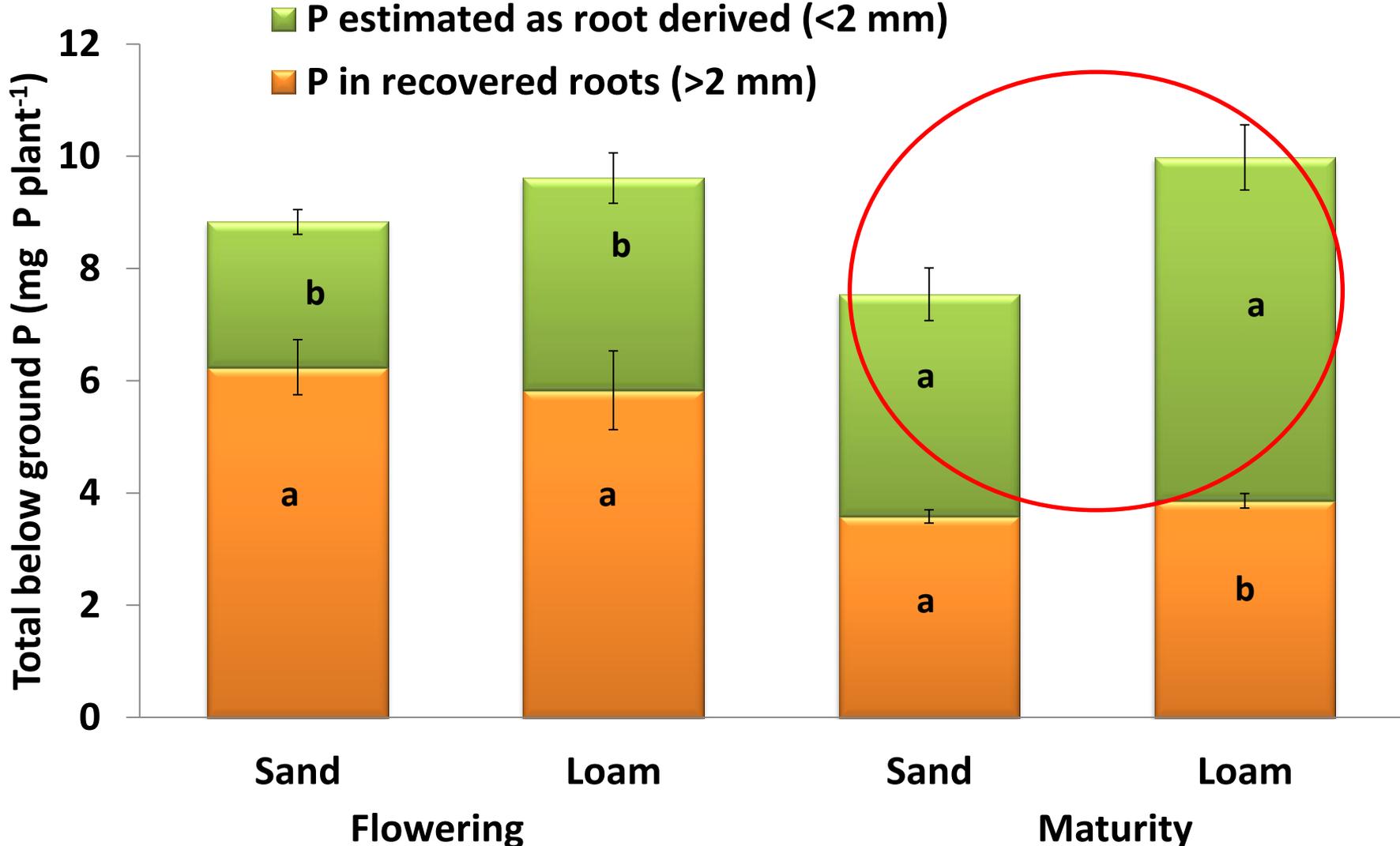**Microbial P: 3 - 5%**

Estimating root P in soil

Specific activity (SA) of recovered root =
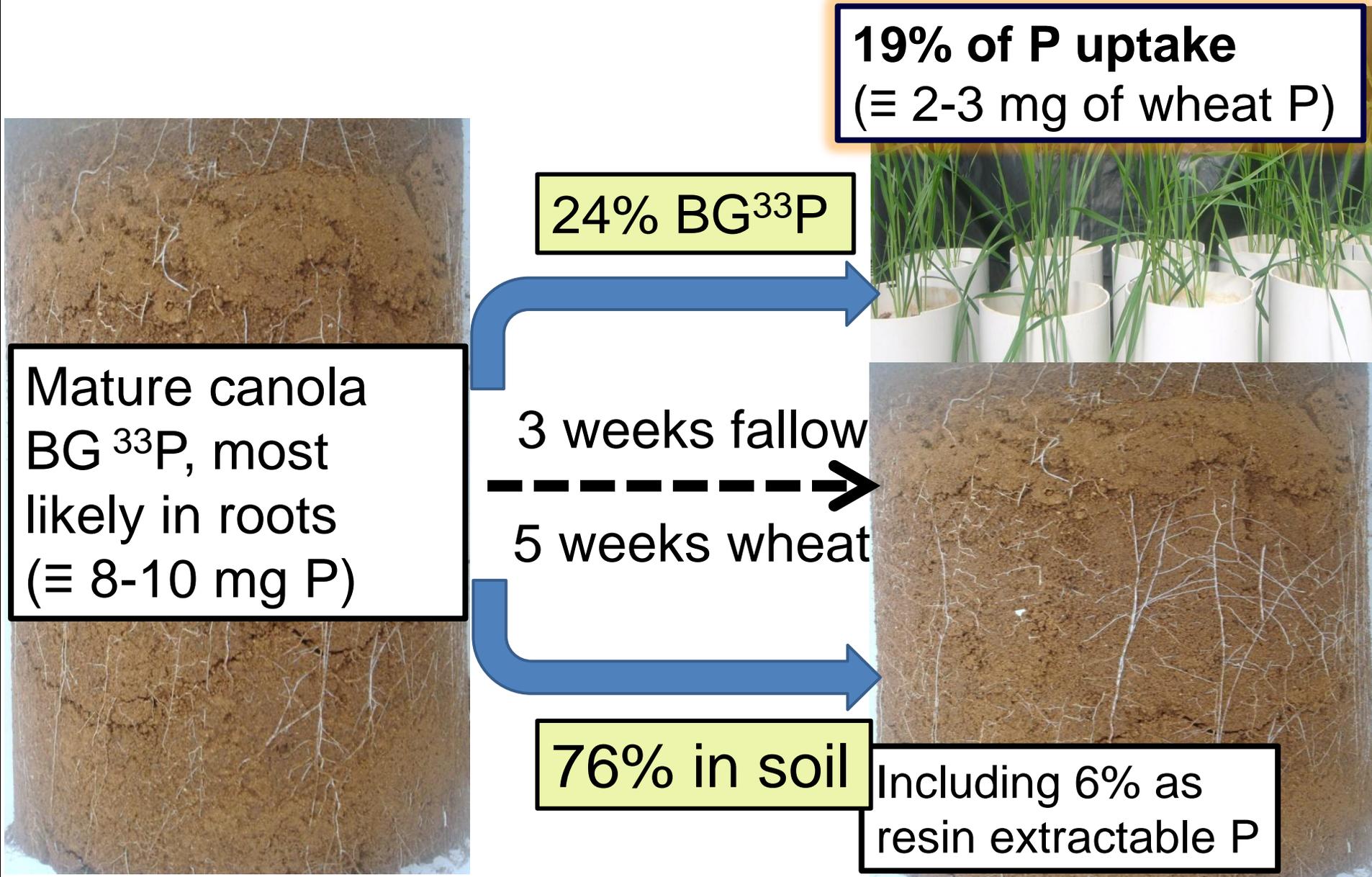 ^{33}P activity of recovered root/P content of recovered root

Estimated amount of root P in soil =
            total ^{33}P activity in soil / SA of recovered root

Total Below Ground (BG) P = P content of recovered root +
                                    estimated root P in soil

Canola root P input- more than we think!

Fate of that root-derived ³³P

19% of P uptake
(≡ 2-3 mg of wheat P)

24% BG³³P

Mature canola
BG ³³P, most
likely in roots
(≡ 8-10 mg P)

3 weeks fallow

5 weeks wheat

76% in soil

Including 6% as
resin extractable P

Uniform allocation of ^{33}P

- With increasing root mass ^{33}P allocation to roots increases

- Linear relationship

- Likely uniform distribution of ^{33}P in root system
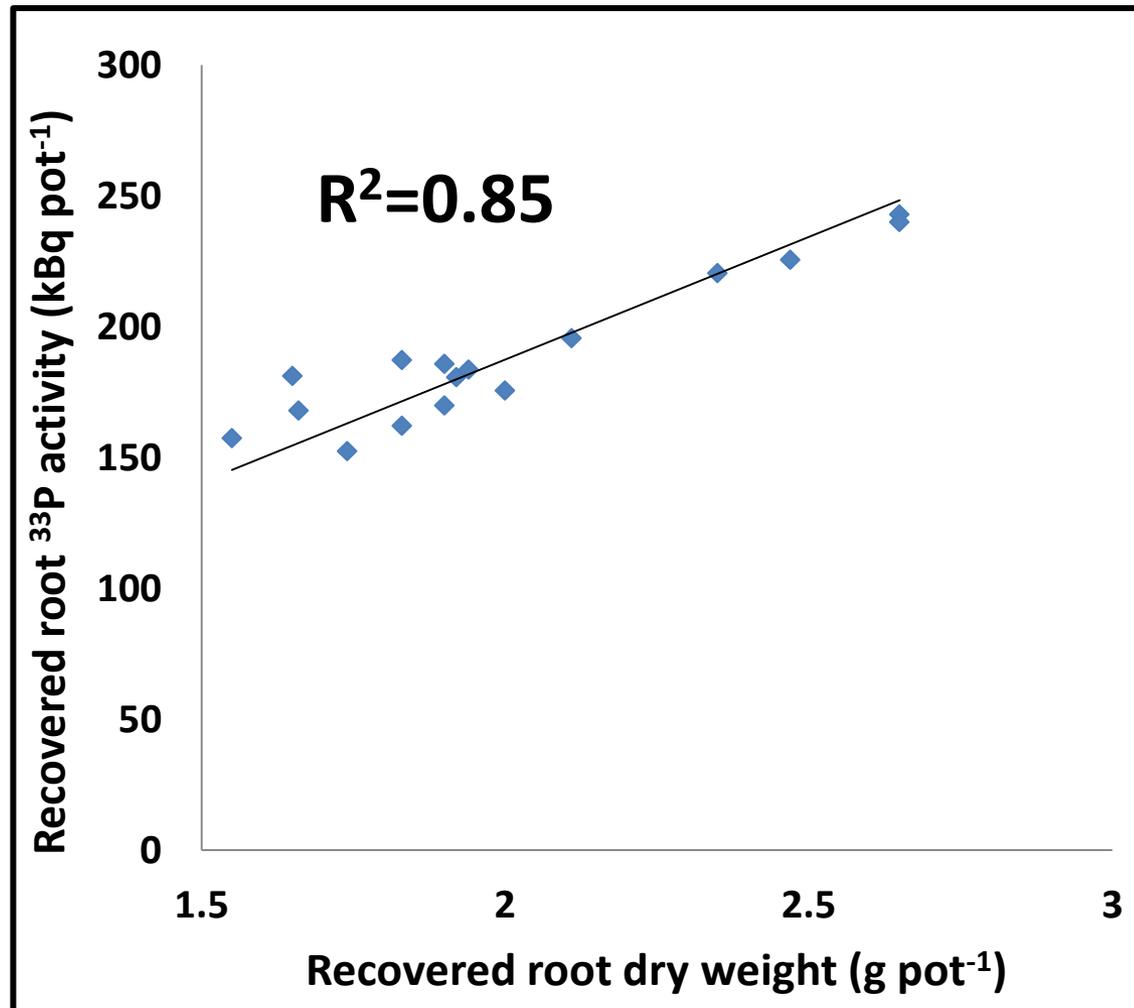
Take home message

- 90% recovery of ^{33}P fed to canola with 59-70% going below ground

- Apparent uniform distribution of ^{33}P in roots

- More BG - P than measured by standard root recovery methods – likely in fine roots

- Potential for root P to cycle rapidly and contribute to following crops

Acknowledgments

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- Technical staff

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Thank you