Deep banded phosphorus: plants digging deeper for P use efficiency

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Under well-watered conditions, deep P banding can improve plant growth, but surface banding is more effective

Background

Globally, soil phosphorus (P) deficiency is a major constraint to agricultural production and application of P fertiliser is relied upon to meet global food demands. In many cropping systems, P fertiliser use efficiency is low (PUE; i.e. units of P exported within crop biomass per unit of P applied as fertiliser; McLaughlin et al., 2011). Banding of P fertiliser to create a more concentrated zone of P in the soil (often near the seed at sowing) is an effective strategy for improving PUE because it increases the rate of P diffusion to plant roots. Many plant species proliferate roots in response to zones of concentrated P, which further improves P uptake from bands because of the increase in root surface area. Dual placement of P fertiliser, where P is placed in a band near the seed and also at depth (~20 cm) is being investigated as a strategy to improve P use efficiency in agricultural systems (Bell et al., 2022).

Objectives

This study aimed to determine how three crop species respond to dual placement of P fertiliser in order to evaluate the potential of this strategy for improving PUE in different crop types.

Results

Shoot growth

Plants grown with a moderately deficient surface P band increased shoot biomass in response to increasing rates of deep P application. But, even at high rates of deep P, shoot biomass was not equivalent to that achieved when grown with sufficient surface P.

Root growth

When grown with sufficient surface P, all species proliferated more root length in the surface band relative to the deep band. This was with the exception of wheat, which, at high rates of deep P, achieved the same root length density in the surface and deep bands.

When grown with moderately deficient surface P, canola proliferated the same amount of roots in the deep band as the surface band; this was regardless of the rate of P in the deep band. Wheat and chickpea preferentially proliferated roots in the deep band (cf. the surface band) at moderate to high rates of deep P; this response occurred at a lower rate of deep P for wheat cf. chickpea.

Methods

Wheat (*Triticum aestivum),* canola (*Brassica napus*), and chickpea (*Cicer arietinum)* were grown in pots of P-deficient soil that had been amended with P to create two surface P treatments (i.e. a 'moderately' P deficient surface band, and a 'high' P surface band), and five deep P treatments (i.e. nil through the 'high' rates of P).

Plants were grown for five weeks in a controlled environment cabinet. Shoot and root growth were measured.

Conclusions

(i) Canola and wheat are more effective at exploiting banded P fertiliser than chickpea; this includes when P is banded at depth

(ii) While all three species can benefit from deep placed P, under well-watered conditions, dual placement of P was not as efficient at surface placed P

(iii) Dual placement of P may not be an efficient fertiliser strategy under scenarios where the surface soil remains moist during P uptake periods of crop growth

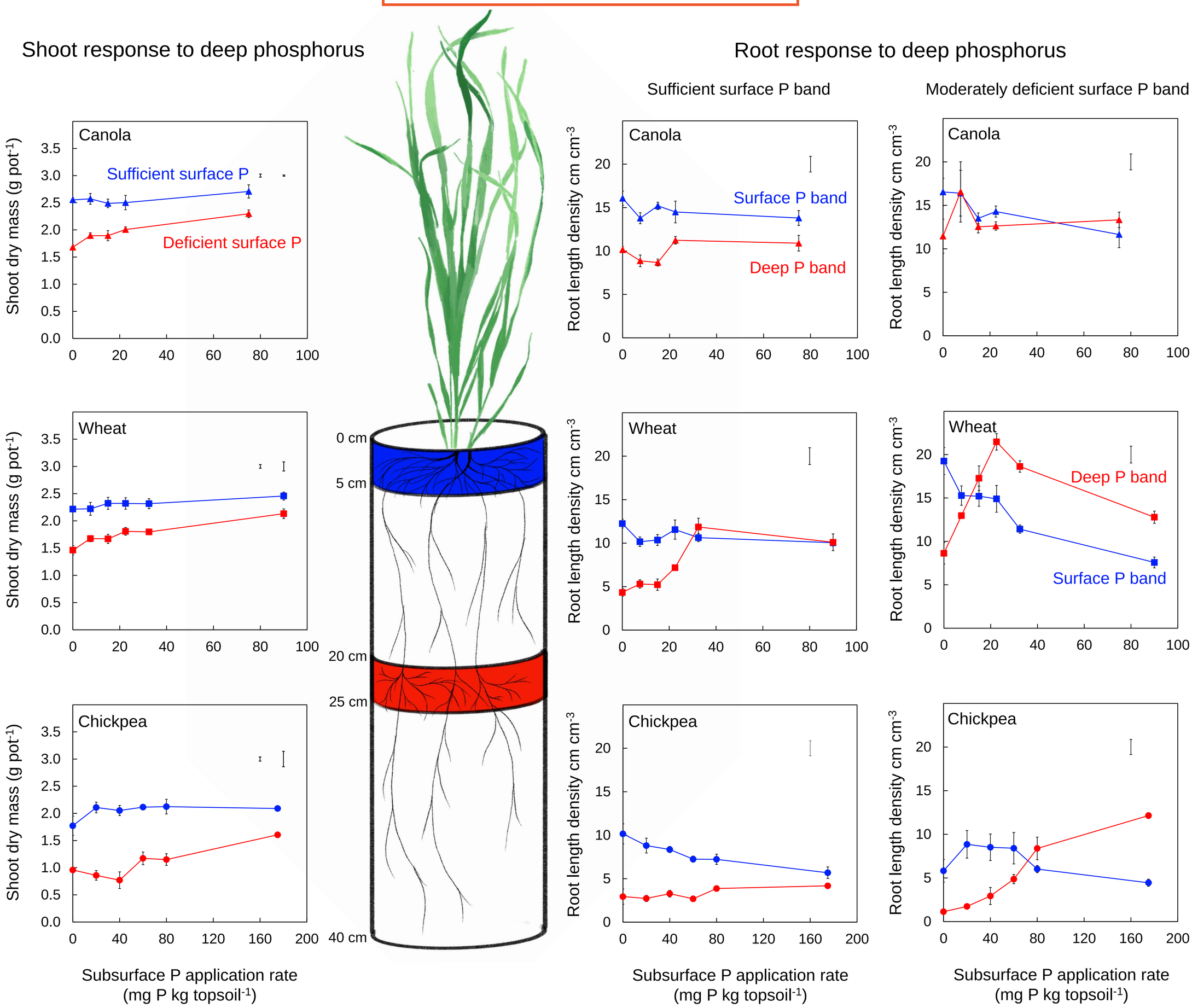

Figure 1. Shoot dry mass and root length density of canola, wheat, and chickpea in the surface P band and the deep P band in response to P applied in the deep band when grown with sufficient surface P and moderately deficient surface P.

References

Bell et al (2022). *Proceedings of the 20th Agronomy Australia Conference.*
McLaughlin et al (2011). *Plant and Soil, 349*(1), 69-87

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