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MURDOCH UNIVERSITY
PERTH, WESTERN AUSTRALIA

NUTRIENT MANAGEMENT INITIATIVE

Simulating and understanding crop root growth using ROOTMAP to guide phosphorus fertilizer placement in wider row cropping systems

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Crop production and soils in Western Australia

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- WA produces:81% of lupin, 35% of wheat, 31% of barley, 36% of oats, and 34% of canola;

- Lupin is well adapted to deep acid sandy soils and the Mediterranean climate of WA (French and Buirchell 2005);

- However, most soils in WA are ancient and highly weathered with very low levels of natural phosphorus. Profitable crop production has only been possible by applying phosphorus fertilisers (Bolland 2005).

P deficient lupin leaf showing drying and curling of leaf tip (Bolland 2005)

Phosphorus management in WA

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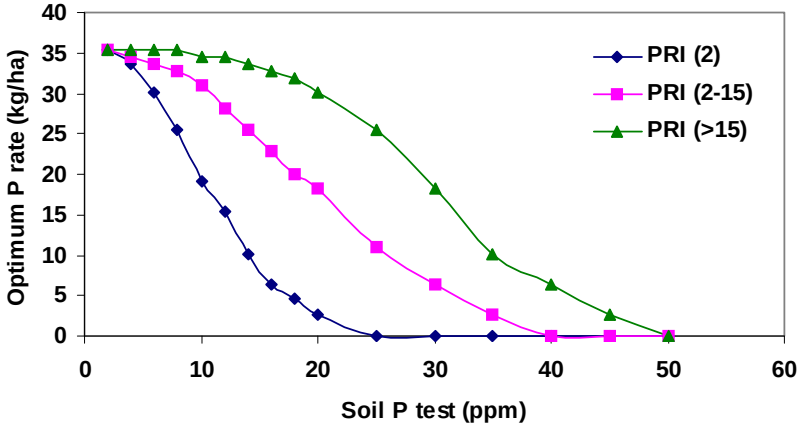
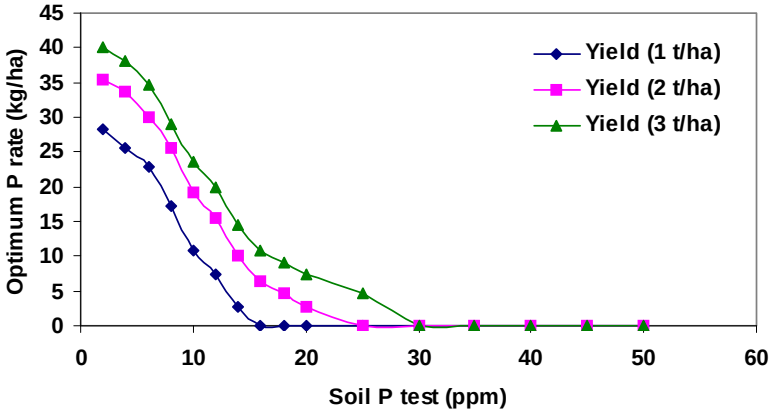
The amount of phosphorus that a lupin crop needs depends on (Nelson, 1995):

- **Soil test P**
- **Soil capacity to fix phosphate (PRI)**
- **Yield potential**





Wide row cropping

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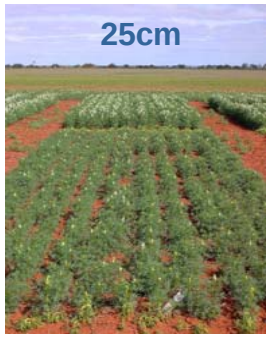
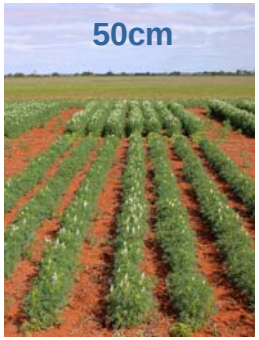
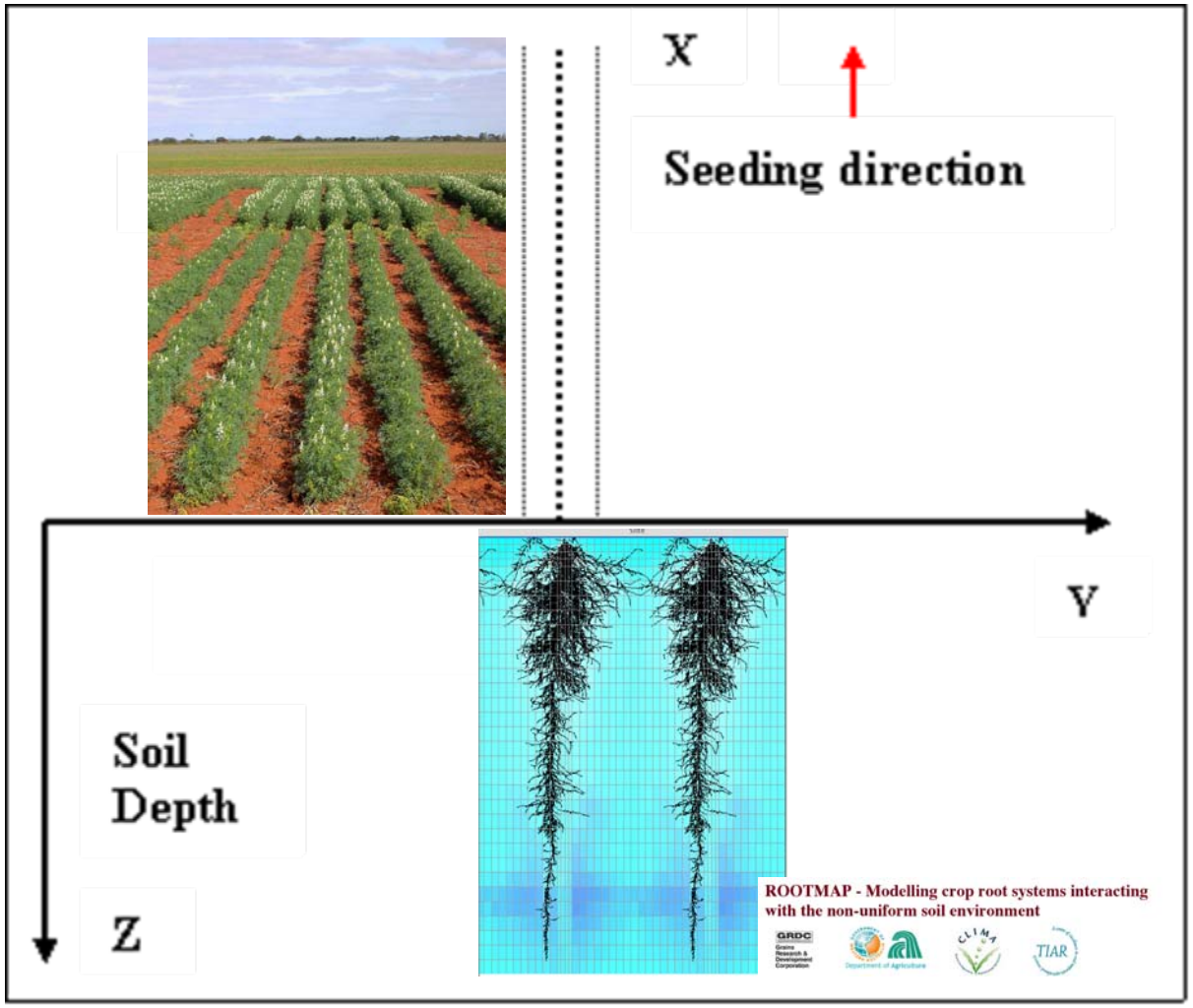
Lupins have traditionally been grown in rows 18 to 25cm. Recent research showed that in low rainfall and warm environments, wider rows could produce better yield of lupins than narrow rows due to improved soil-crop water relations (French et al. 2005) . However, the influence of wider rows on crop nutrition and nutrient management is still unknown.

- **Do we need to change fertilizer rates?**
- **Where do we best place fertilizers?**
- **How do we assess residual value of banded fertilizers by soil testing when row spacing was altered from narrow to wide?**
- **What are effects of wide row lupins on the nutrition of following crops?**





The graph represents the simulation volume containing the three-dimensional parameter values



Simulation experiments

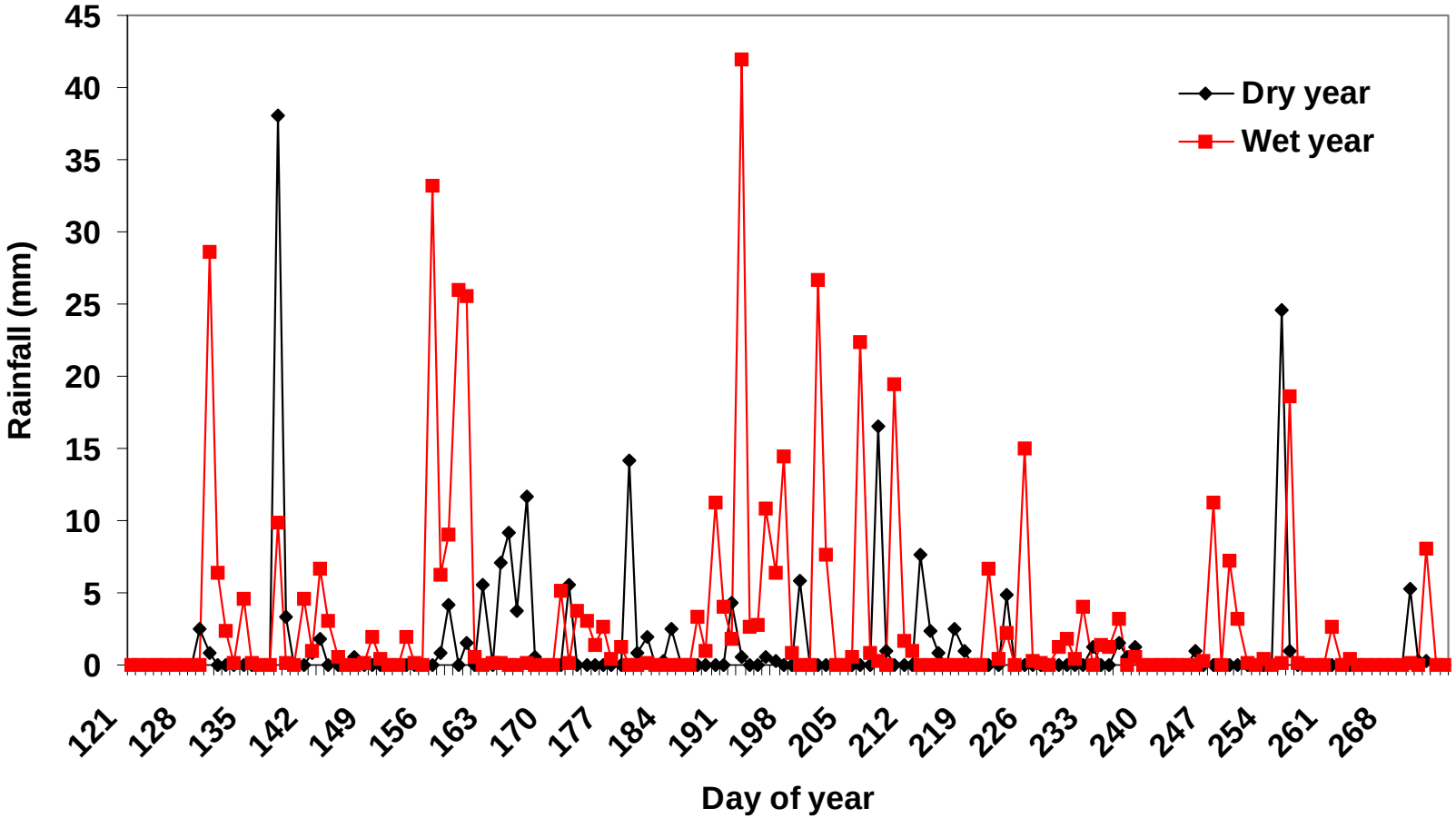
Experiment 1:

- Row spacing: 25, 50cm (standard density is 45 plants/m^2)
- P rate: 10, 30 kg P/ha (P banded in the rows at 5cm depth)
- Season: wet (1995), dry (1969)
- Total of 8 treatments

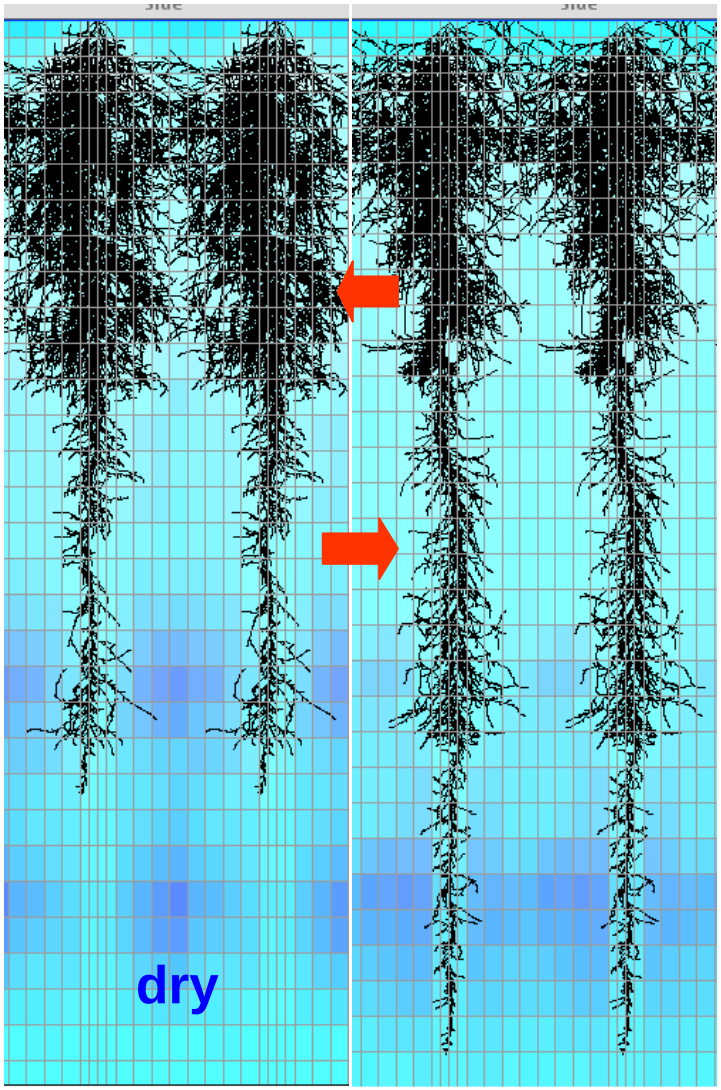
Experiment 2:

- Banding distance: 0, 8, 13, 18 and 23cm (away from the seeding rows
- P rate: 20 kg P/ha
- Season: wet (1995), dry (1969)
- Total of 10 treatments

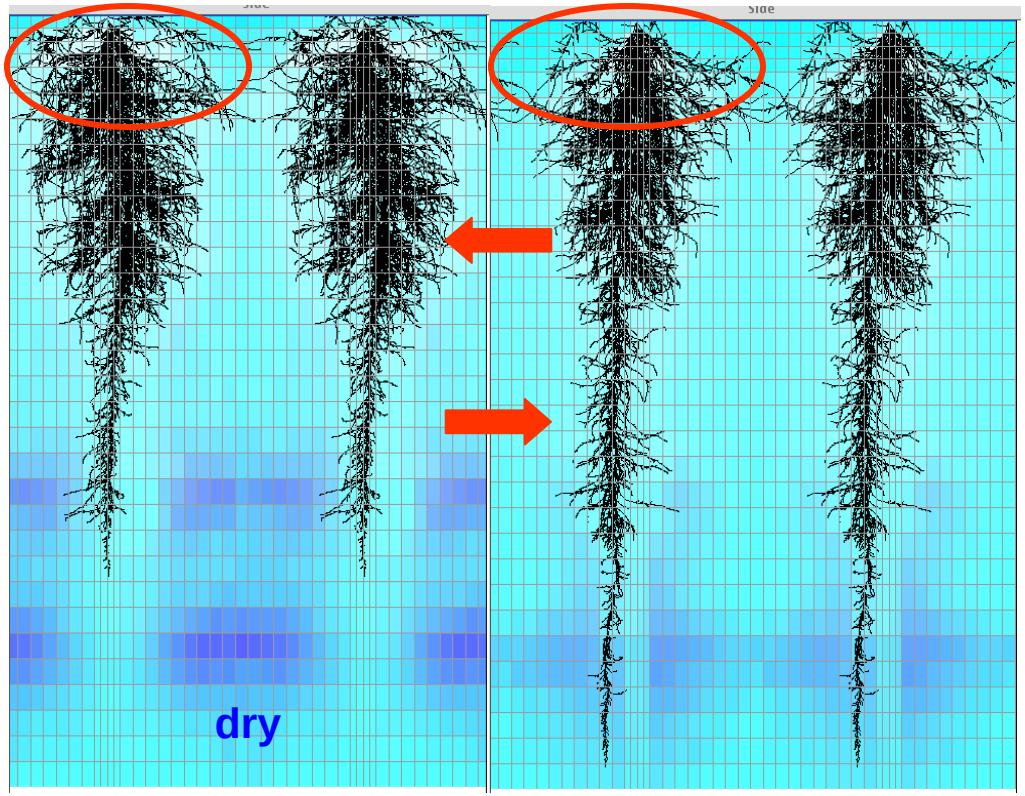
Daily rainfall during May-October in the dry (1969) and wet (1995) year in Moora, WA.



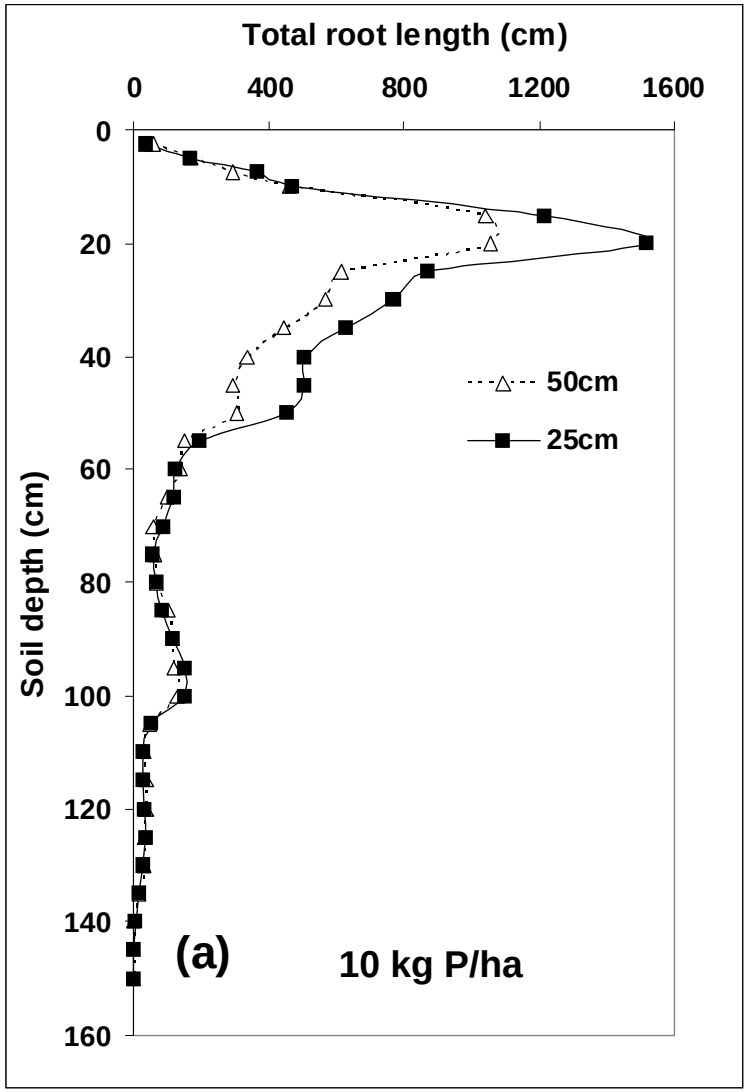
Impact of the season on root architecture when lupin was sown at 25cm row spacing

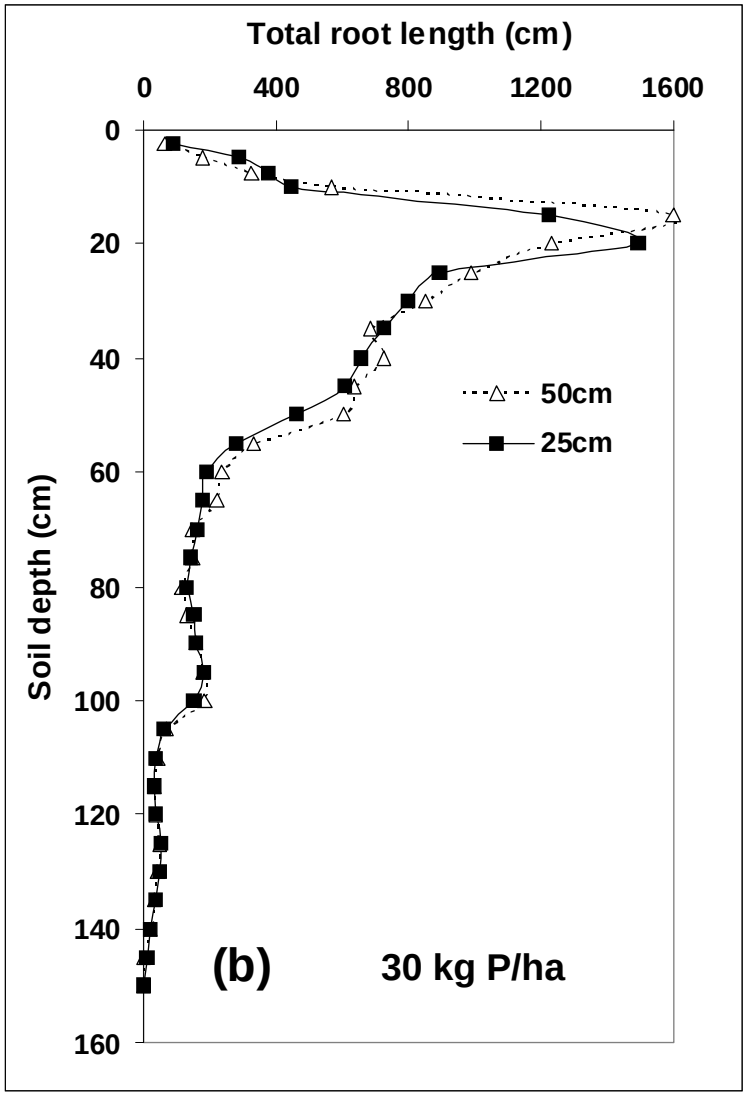


Impact of the season on root architecture and growth when lupin was sown at 50cm row spacing

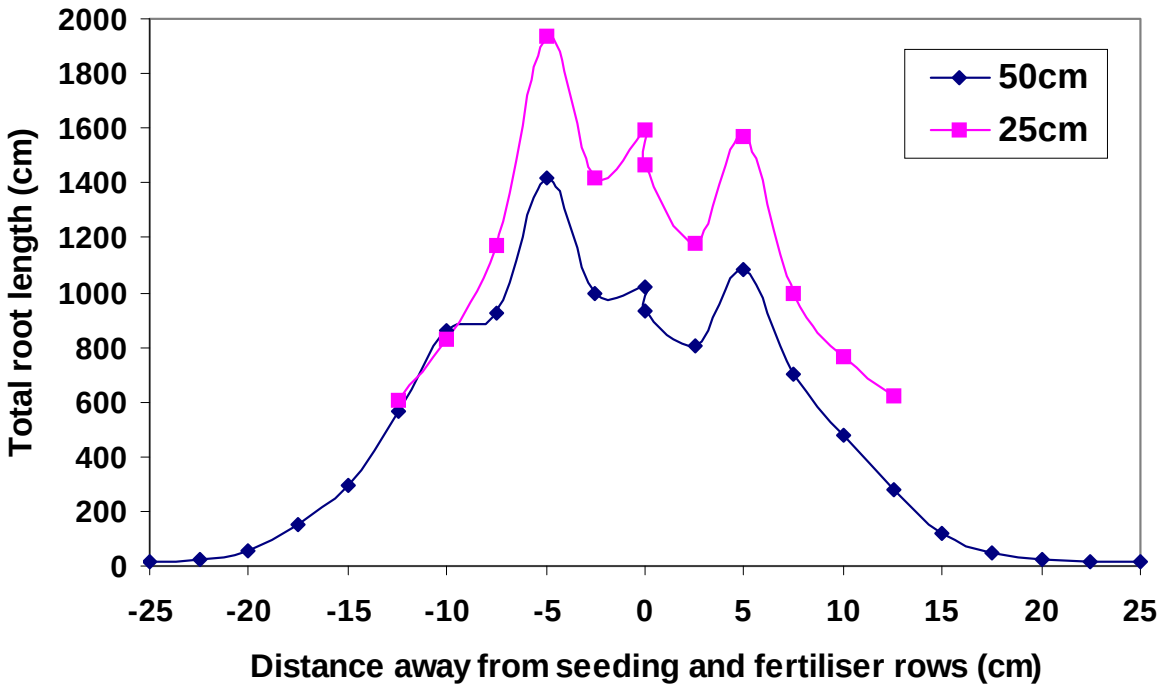


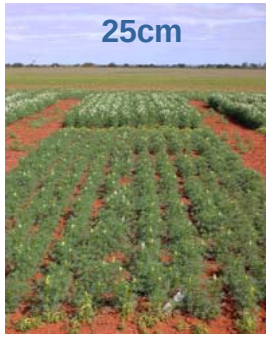
Impact of the row spacing (25 vs. 50cm) on total root length

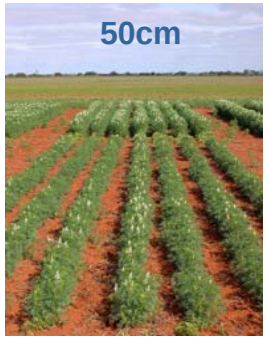




Impact of the row spacing (25 vs. 50cm) on total root length







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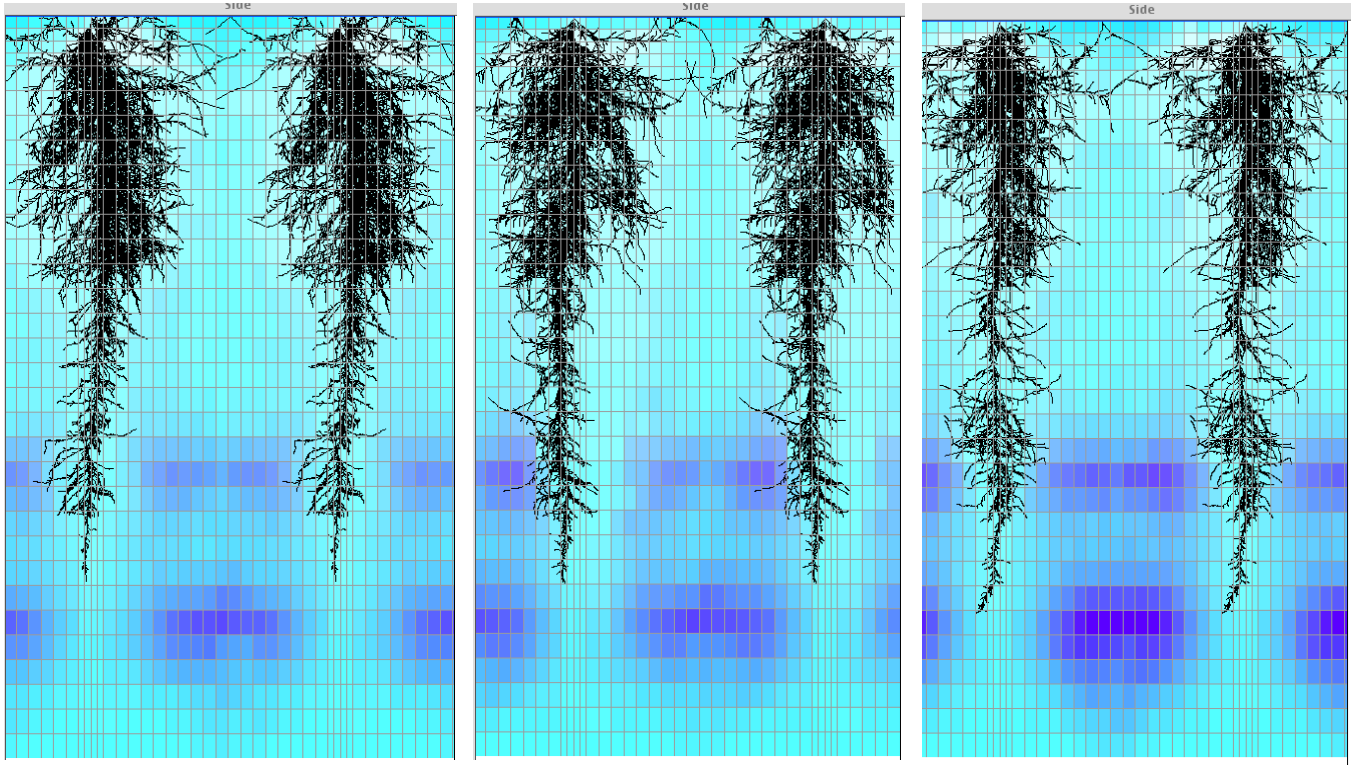
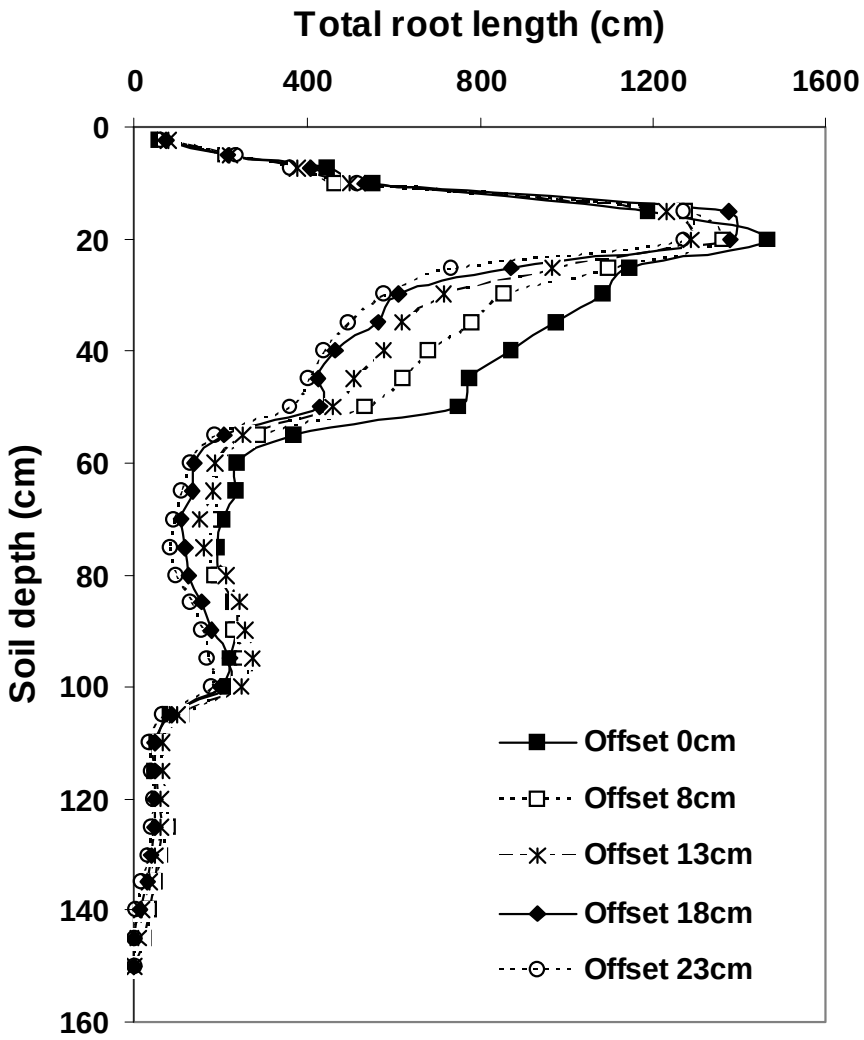
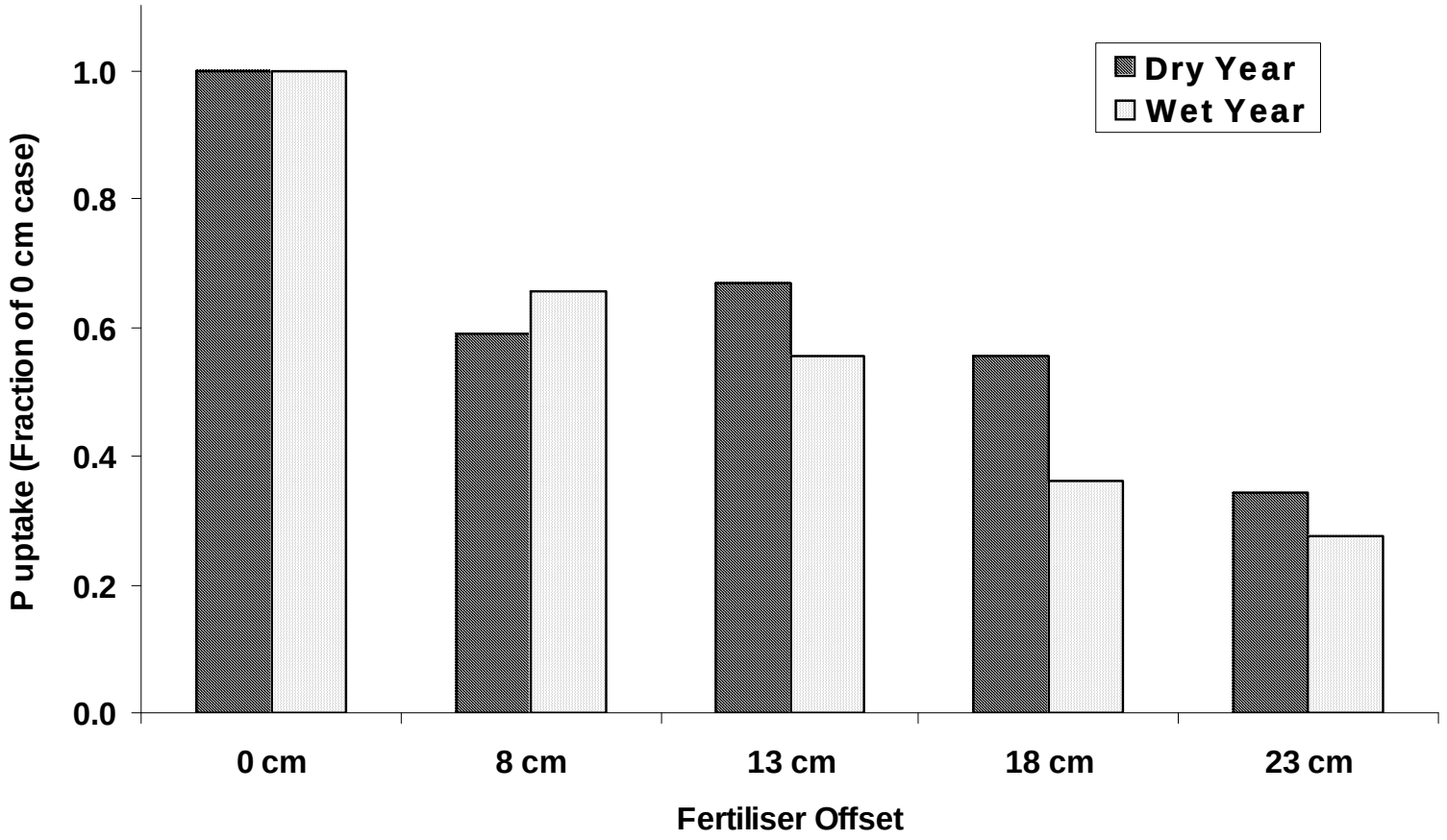
Impact of the P fertilizer banding away from the seeding row on root architecture



Impact of the P fertilizer banding away from the seeding row on total root length



Impact of the P fertilizer banding away from the seeding row on P uptake



Summary

- The season had a significant impact on the root distribution down the soil profile. The rooting depth was restricted in the dry season compared with the wet season, thus a greater proportion of the total root length was present in the top soil profile in the dry season than in the wet season.
- When row spacing was increased from 25cm to 50cm, total root length per plant was reduced.
- At zero offset, the roots had full access to the added P but as the banded P was placed further way from the seeding rows, the chance of the roots encountering the P declined, and thus resulted in the decline of total root length and P uptake.
- In a wide row cropping, having sufficient P supply in the seeding rows was necessary to reduce root competition for soil P and encourage root proliferation.
- However, banding all P in the rows could create P toxicity and may result in increased soil P stratification. Thus best P management options such as deep (>10cm) placement, banding sideway and etc. need to be explored.