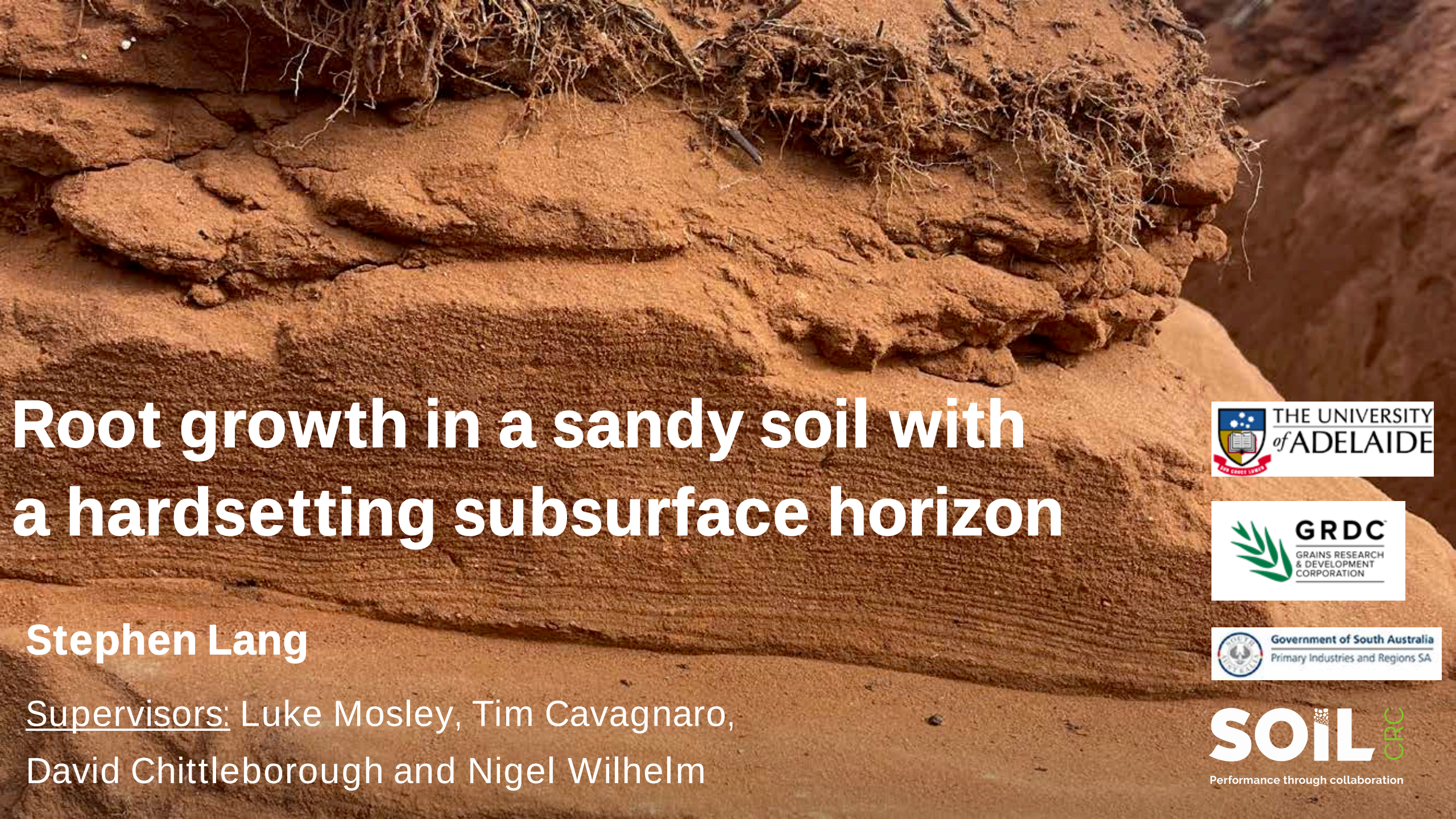

Root growth in a sandy soil with a hardsetting subsurface horizon

Stephen Lang

Supervisors: Luke Mosley, Tim Cavagnaro, David Chittleborough and Nigel Wilhelm

THE UNIVERSITY of ADELAIDE

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION

Government of South Australia
Primary Industries and Regions SA

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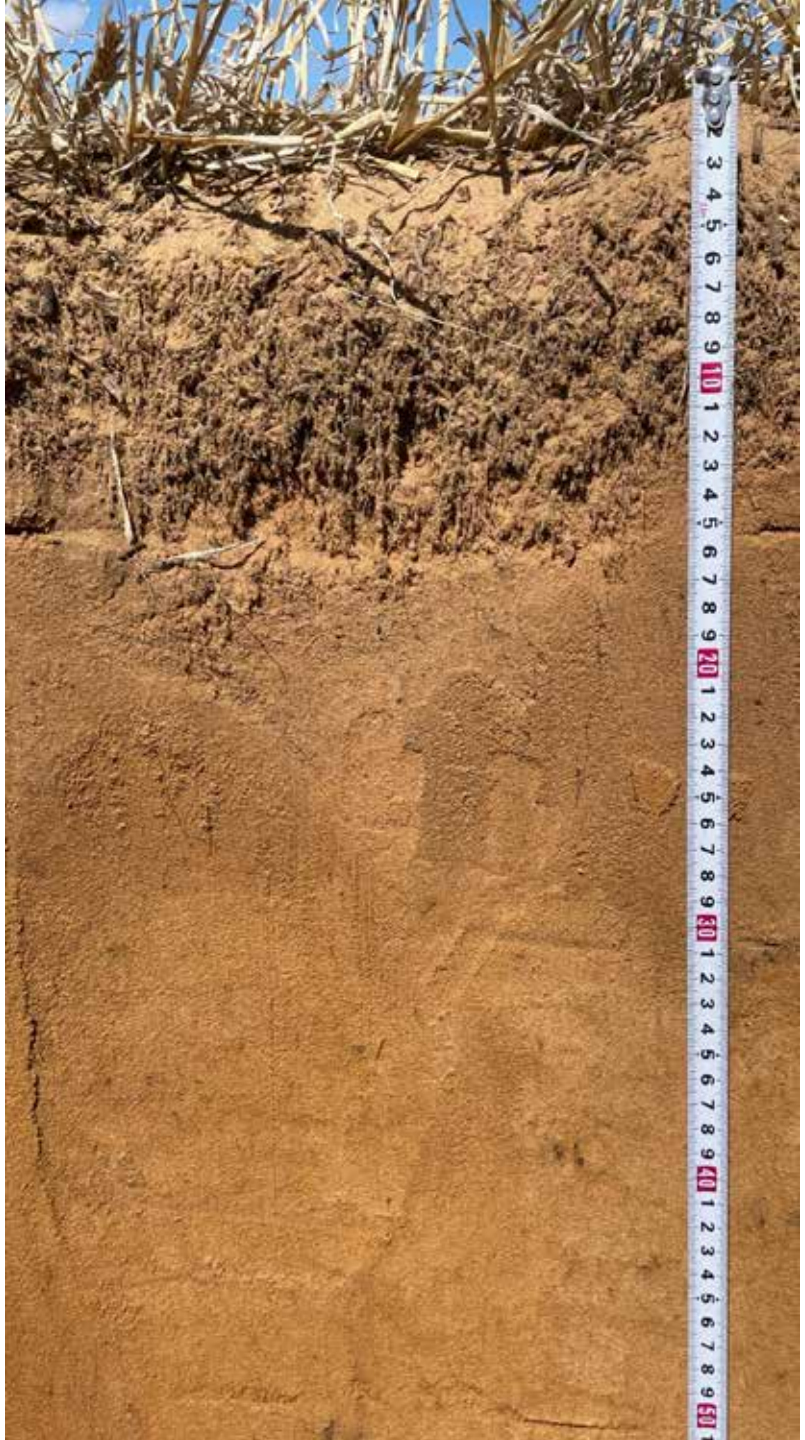
Performance through collaboration

The problem

- High strength restricts root growth in many sandy agricultural soils
- Reduced access to soil resources restricts yield potential and increases vulnerability to water stress
- Dense soil layers can restrict gas diffusion and can reduce yields through plant hormonal responses



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Causes

1. Compaction

-Compression from external load

2. Cementation

- Non-soluble pans

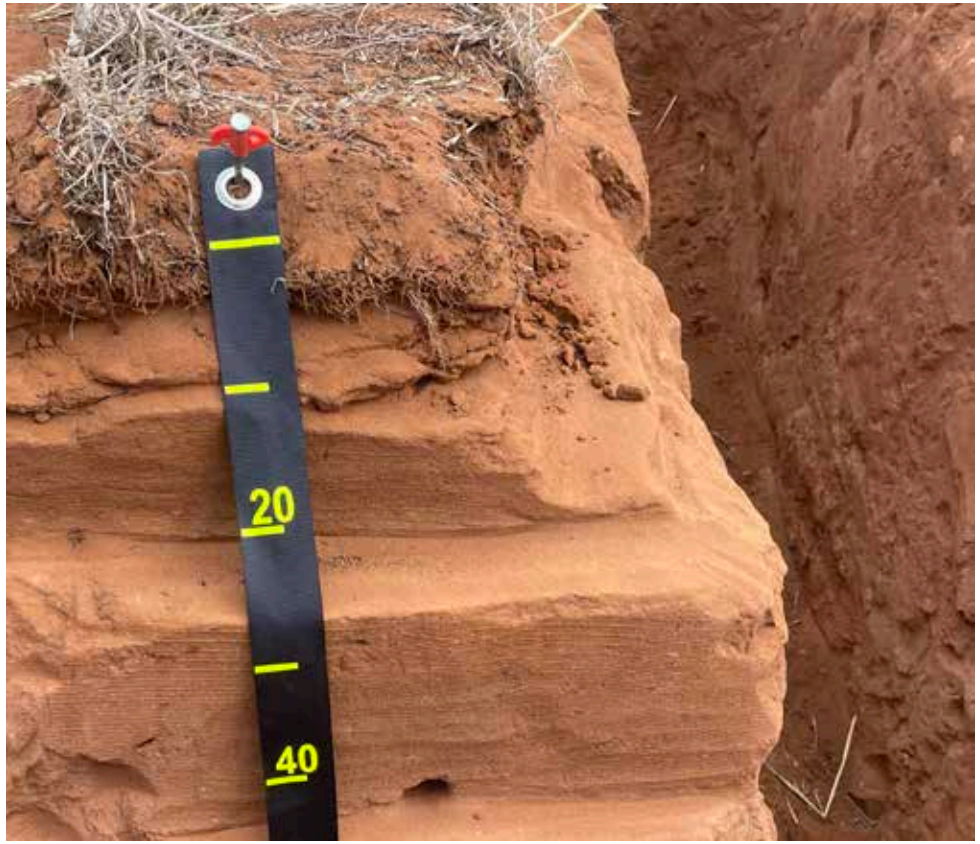
3. Hardsetting

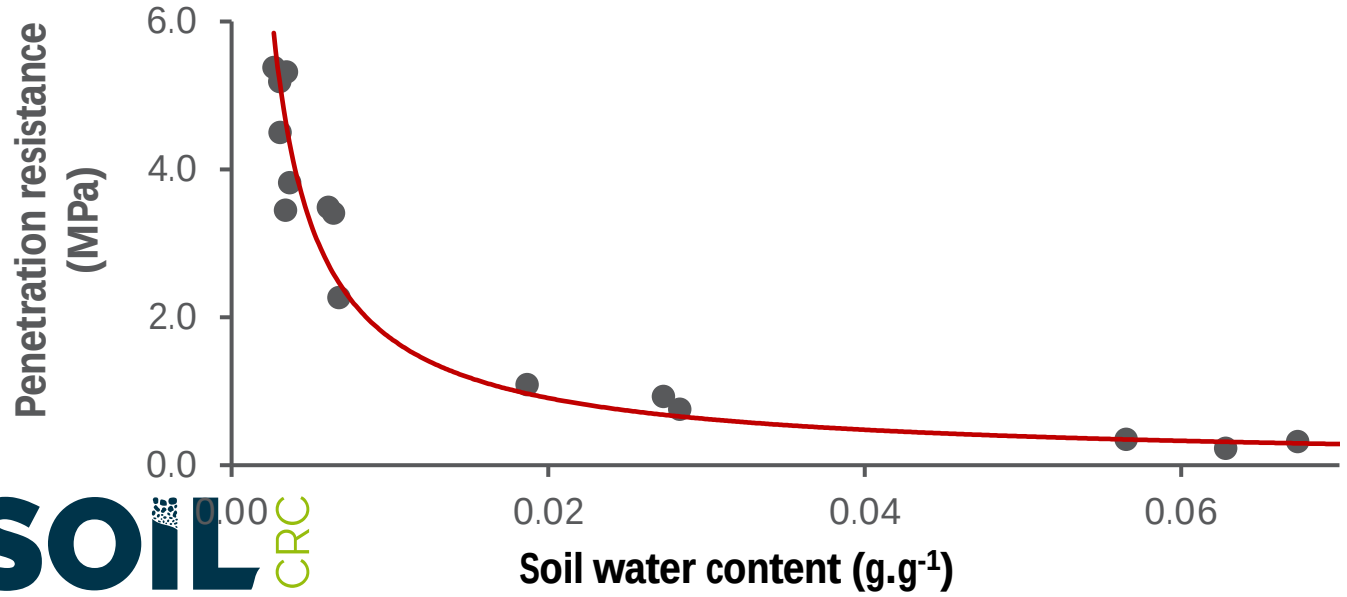
- Moisture dependent, reversible cohesion

High soil strength

Hardsetting

- Hardsetting soils become hard and structureless upon drying
- But collapse (and soften) when re-wet
- May explain some variability in deep ripping effectiveness and longevity





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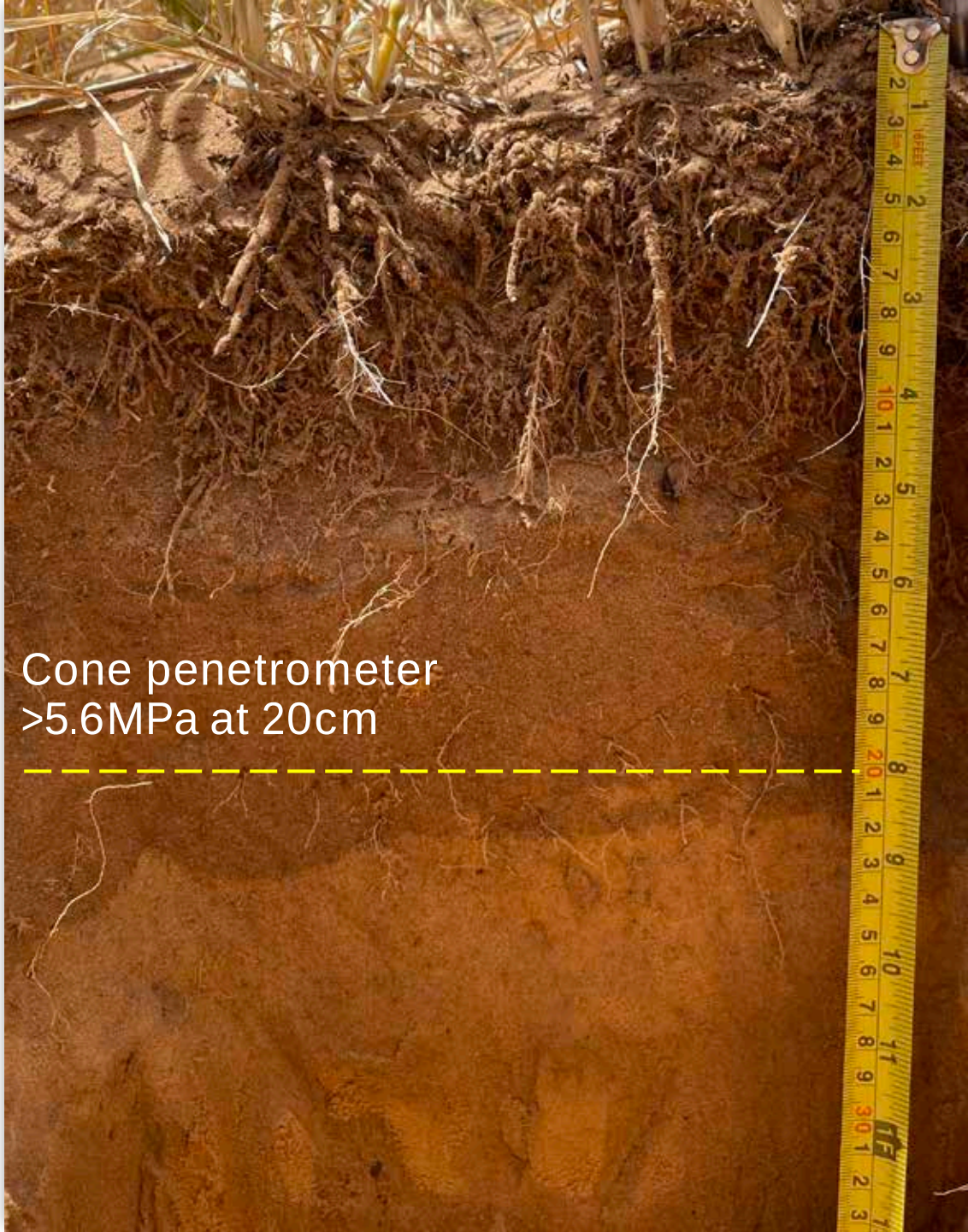
Research questions

How do these soils respond to deep tillage?

- Do they reconsolidate faster?
- Do they require alternative amelioration approaches?

How do these soils restrict root growth?

- What is the interaction between changes in soil moisture, development of soil strength, and root growth?



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Karoonda, SA
SOiL
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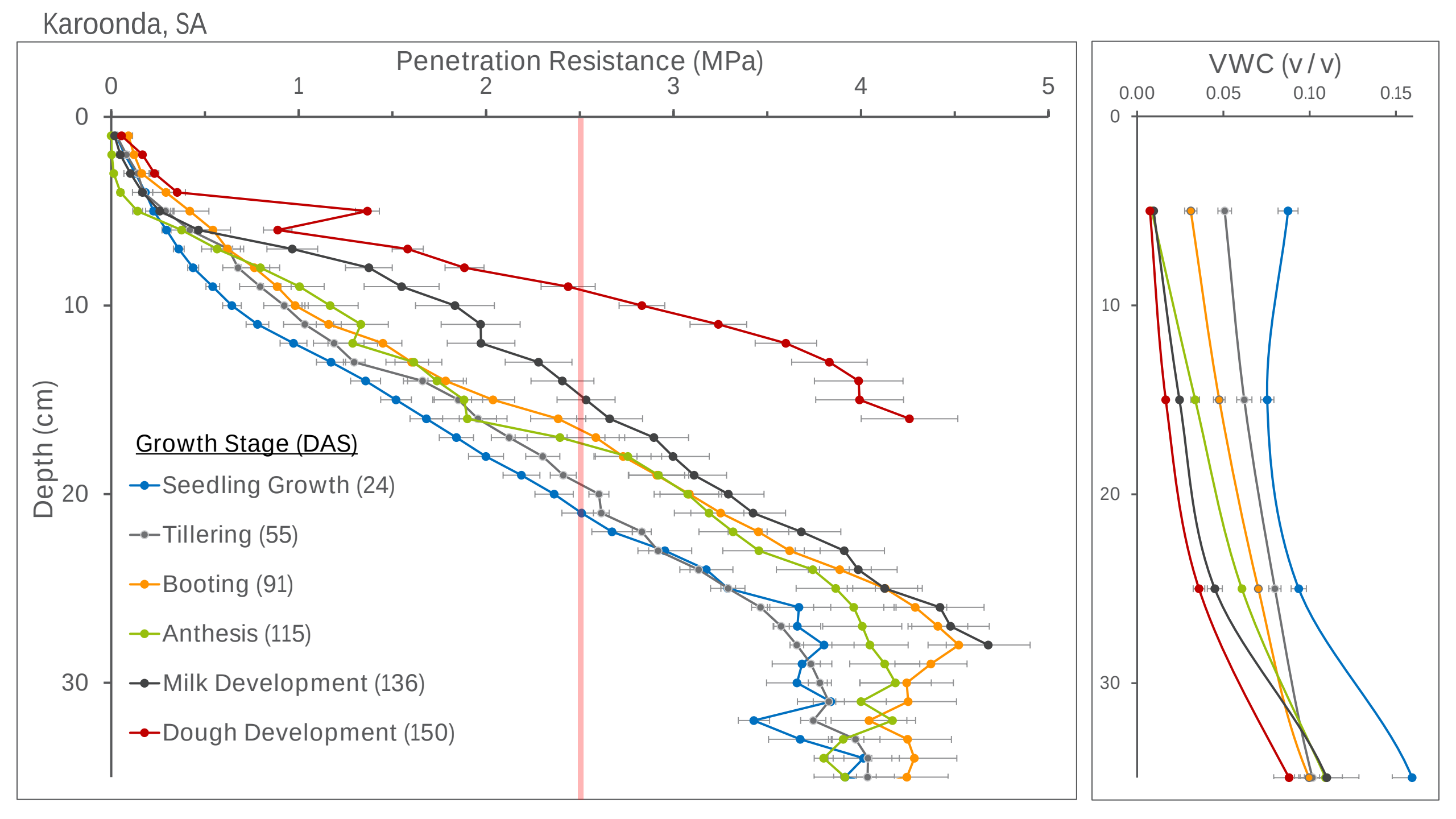
Karoonda, SA
Penetration Resistance (MPa)
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Depth (cm)
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Growth Stage (DAS)
Seedling Growth (24)
Tillering (55)
Booting (91)
Anthesis (115)
Milk Development (136)
Dough Development (150)
VWC (v / v)
0.00
0.05
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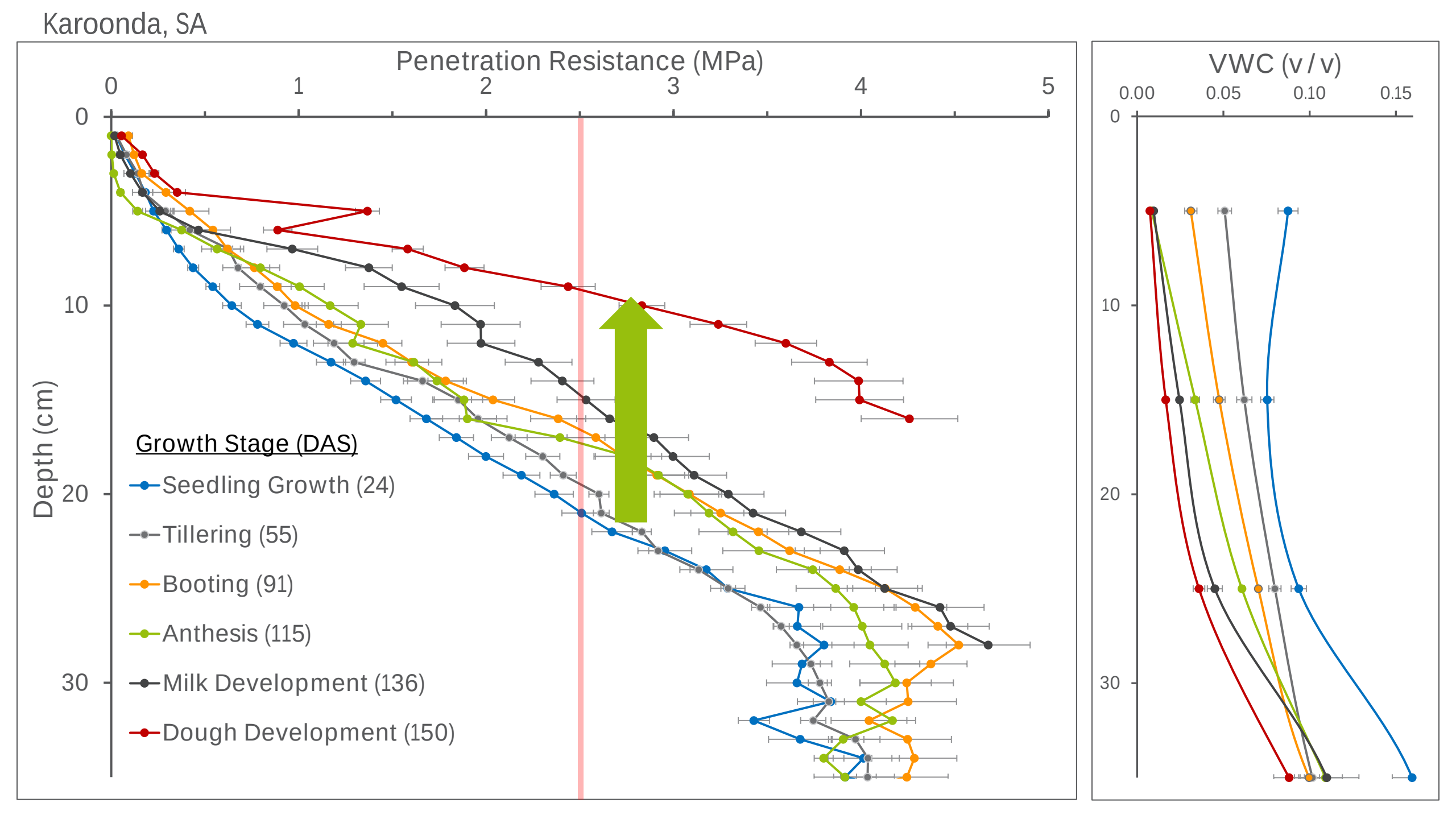
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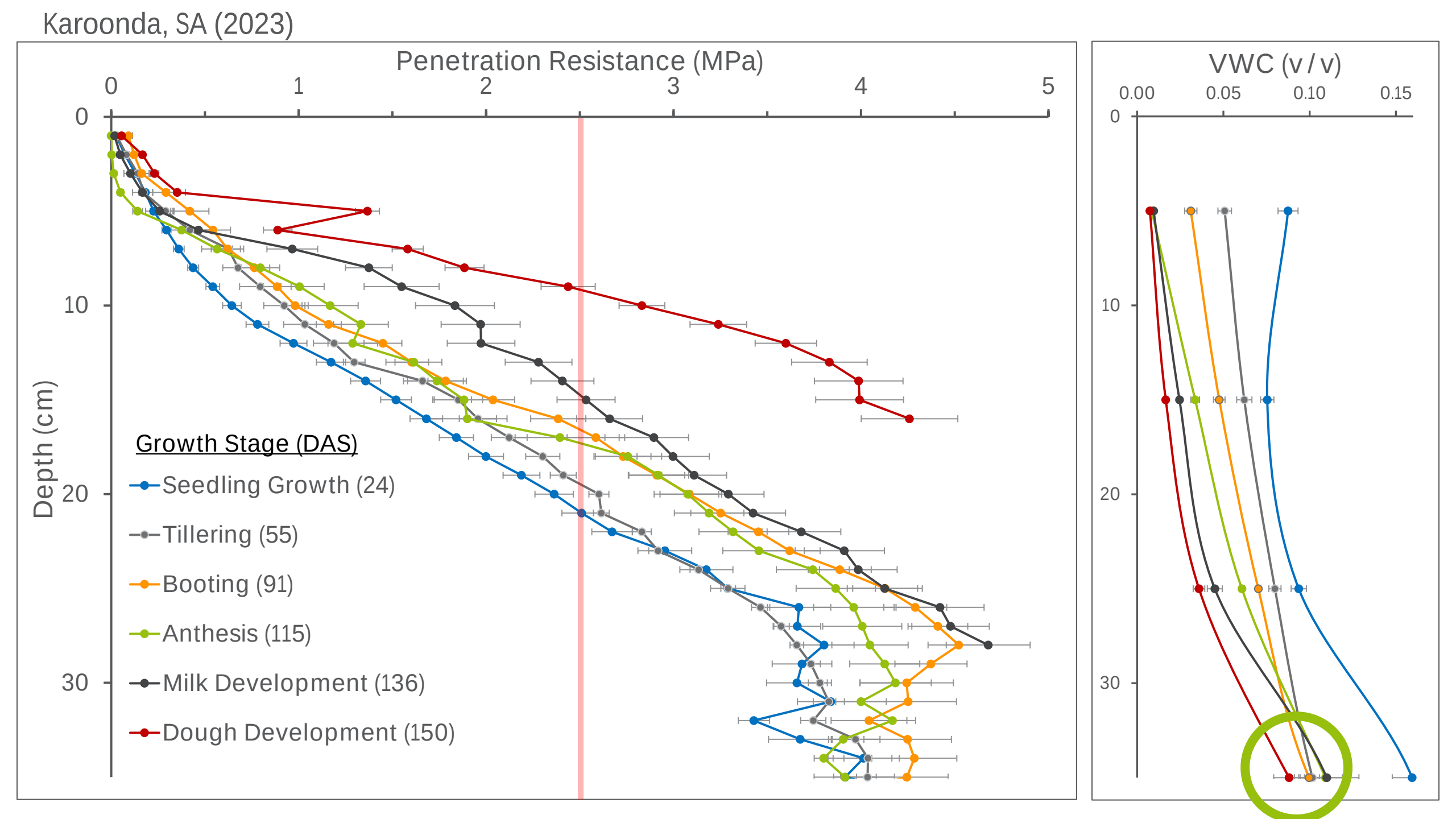
Karoonda, SA (2023)
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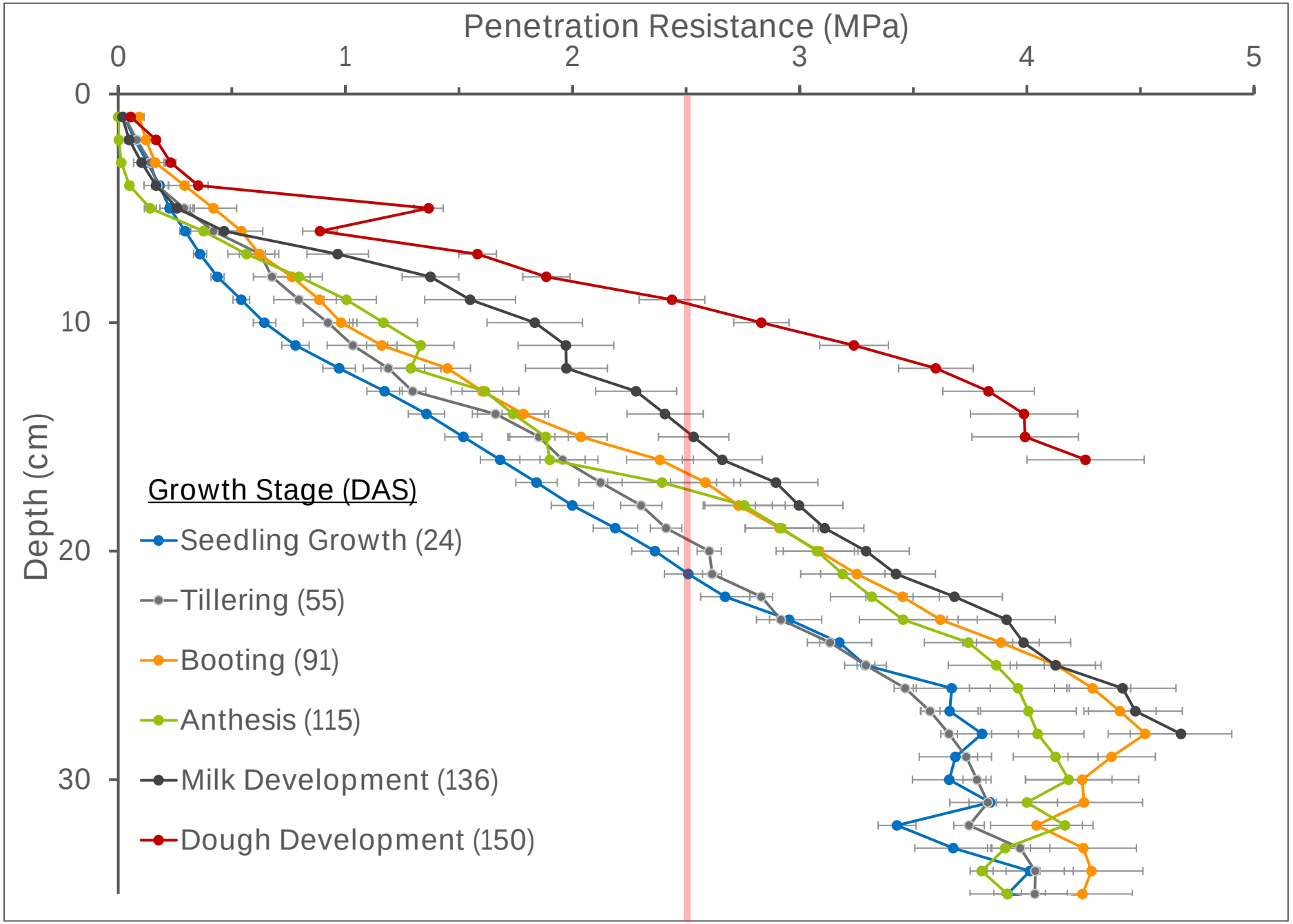
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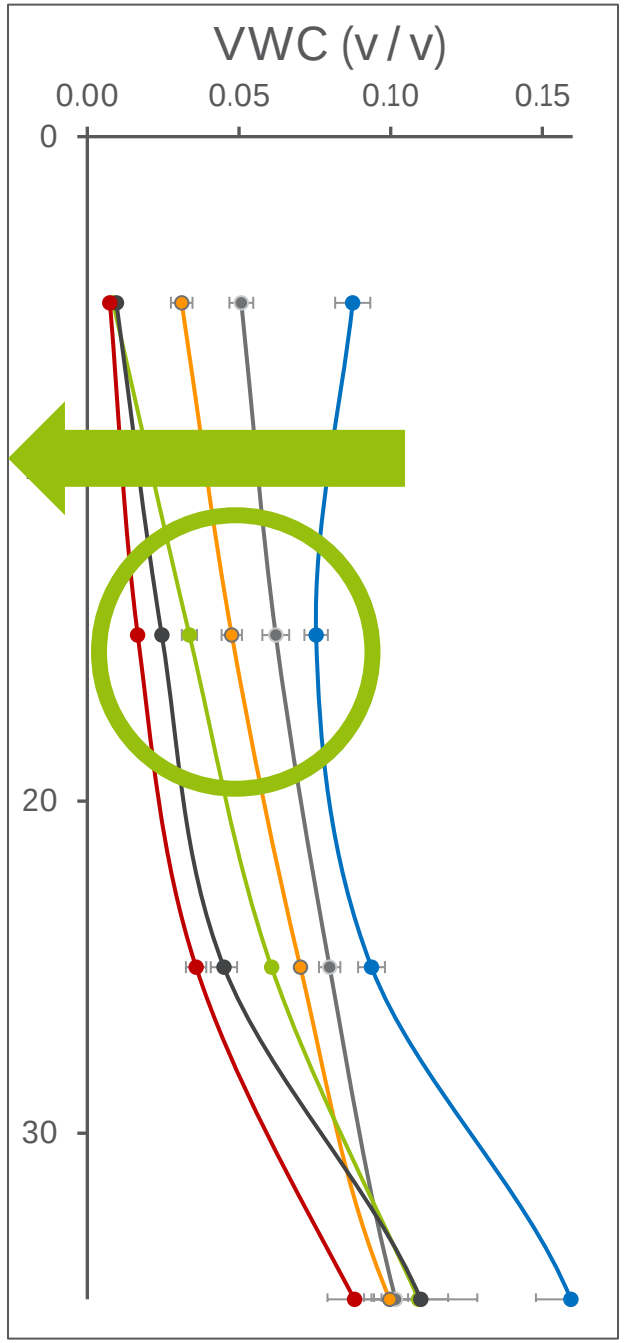
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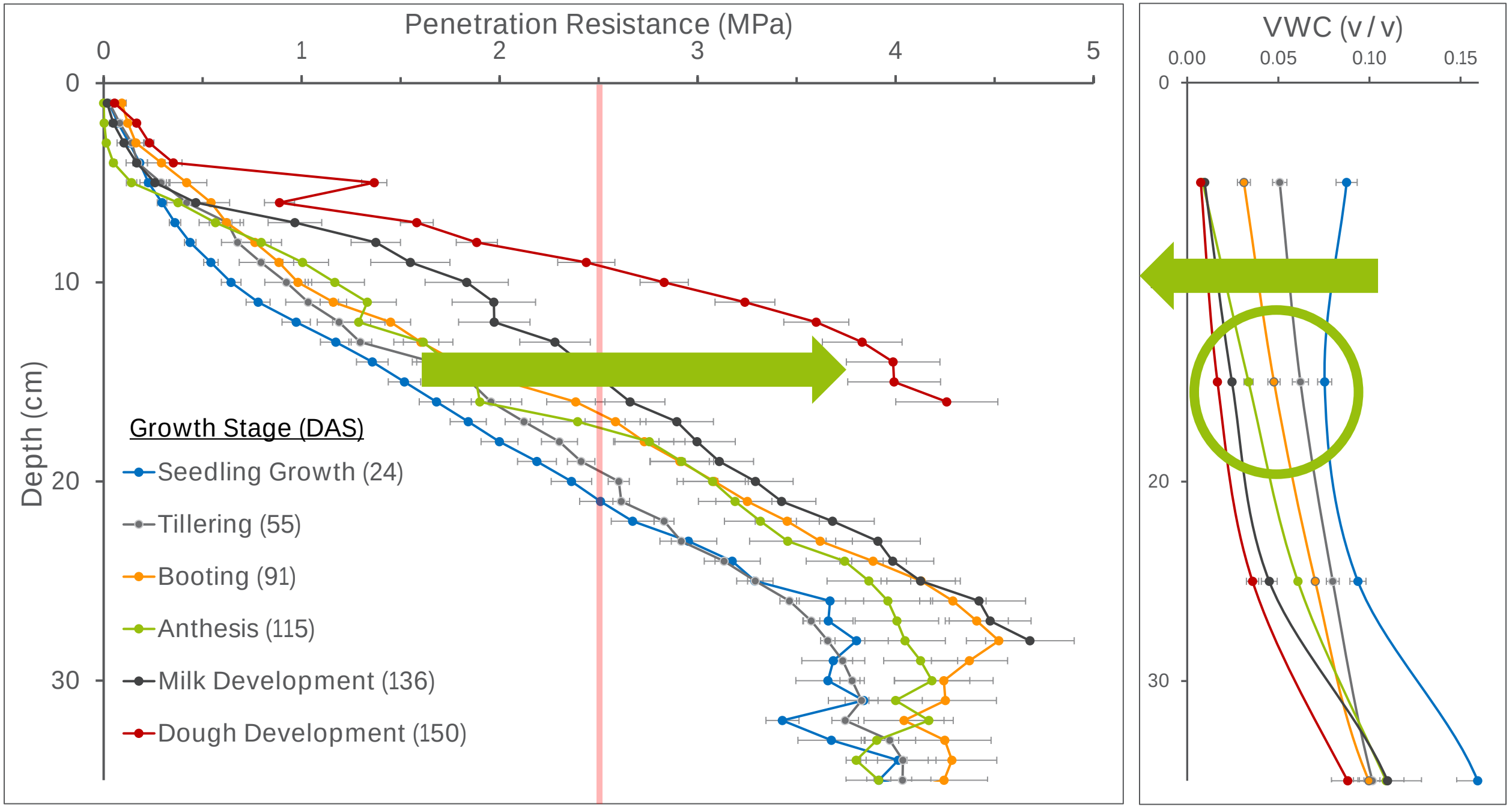
Karoonda, SA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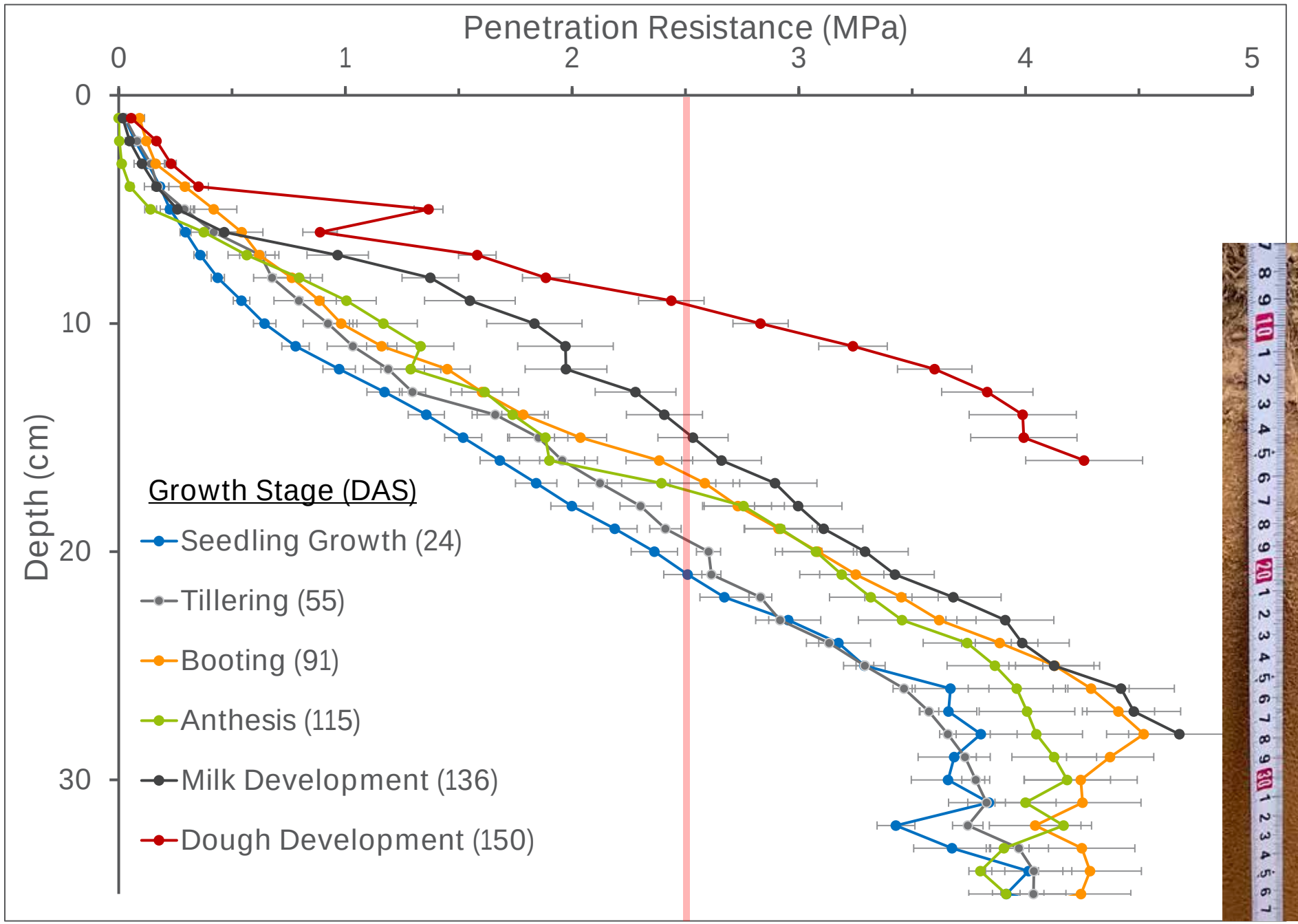
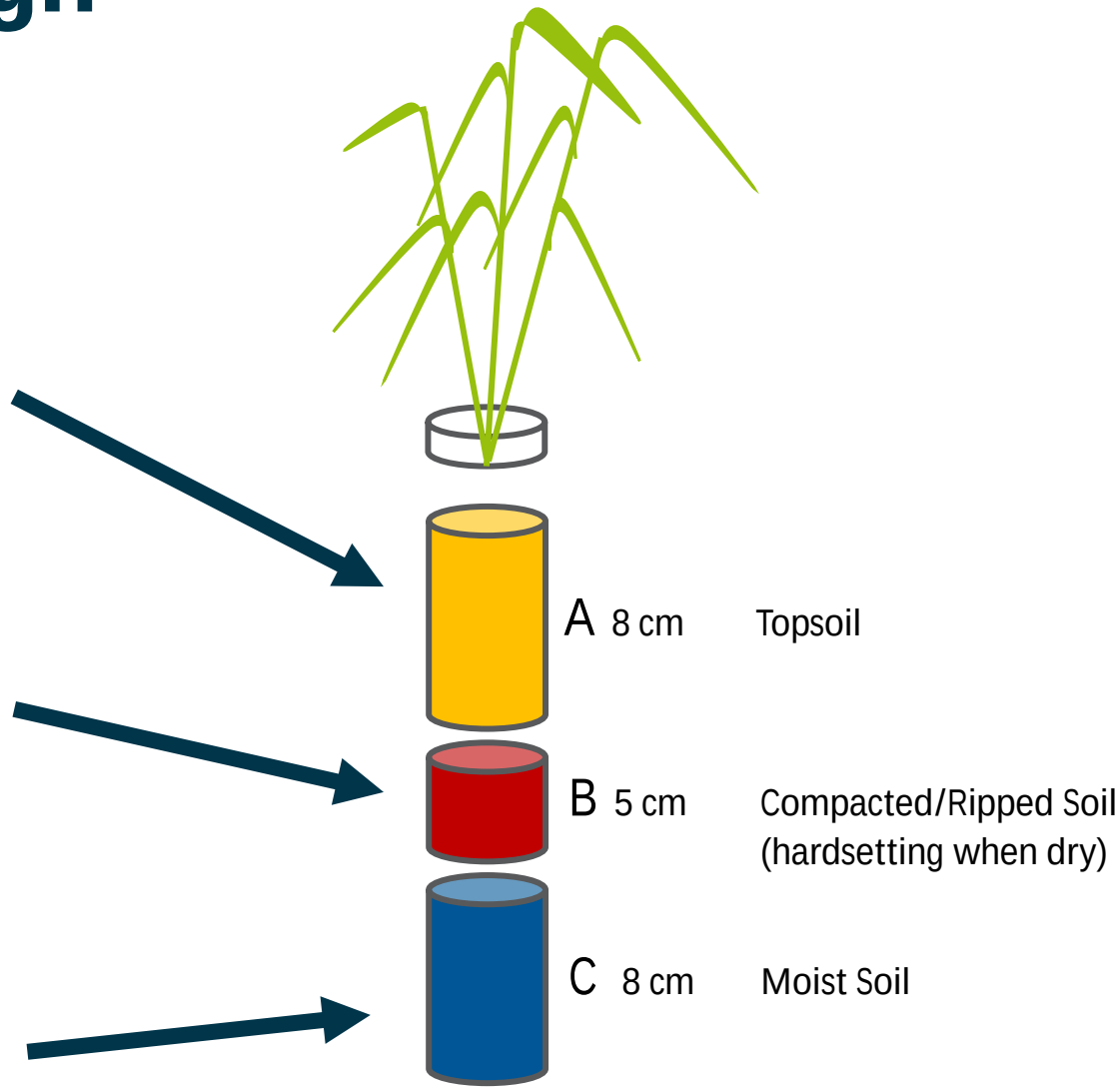


Karoonda, SA

Soil column design



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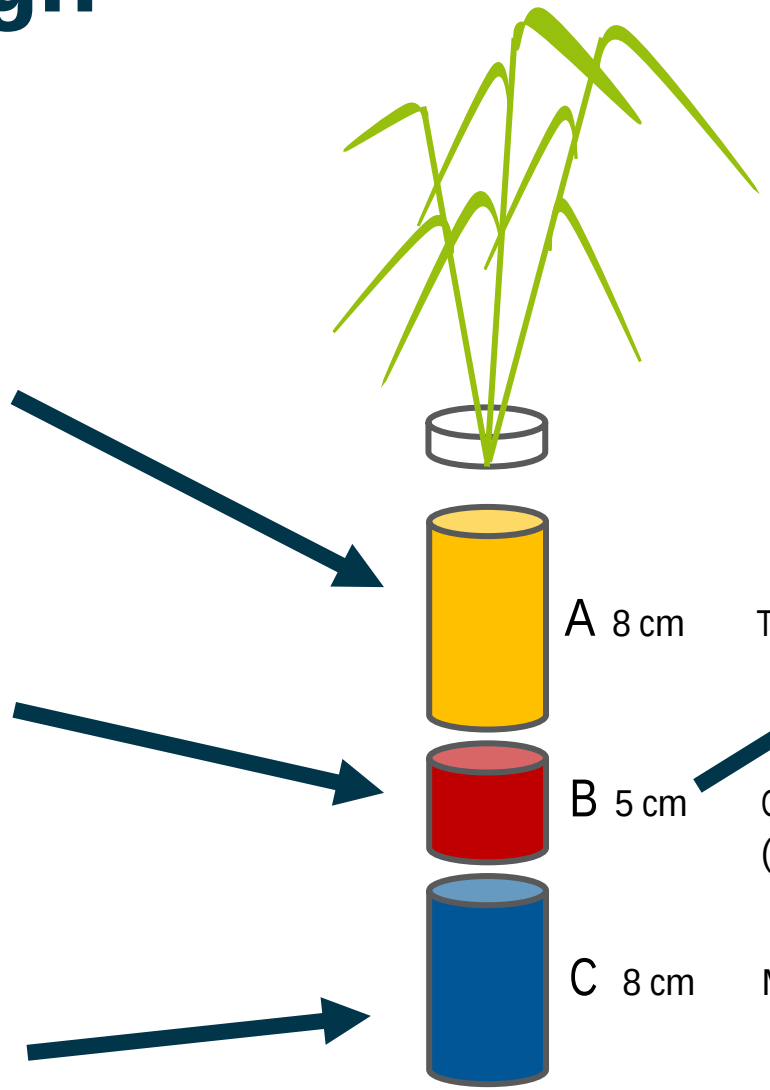
Soil column design



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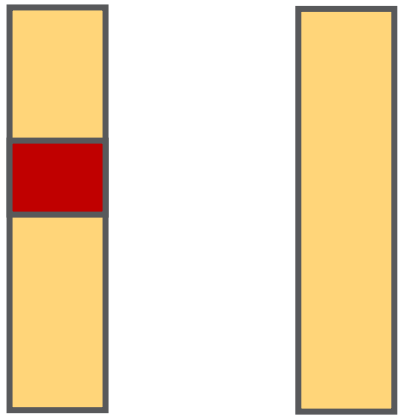
Glasshouse experiment design



Compacted Ripped

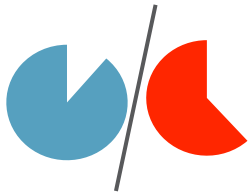
✖

1. “Maintain wet”

Daily watering to 85% FC*

2. “Maintain dry”

Daily watering to 70% FC*



3. “Wet-dry cycle”

Watered to 85% FC when the core dries to 65% FC*

✖

4

Replicates

** Pot targets are based on average water content across the entire soil column*

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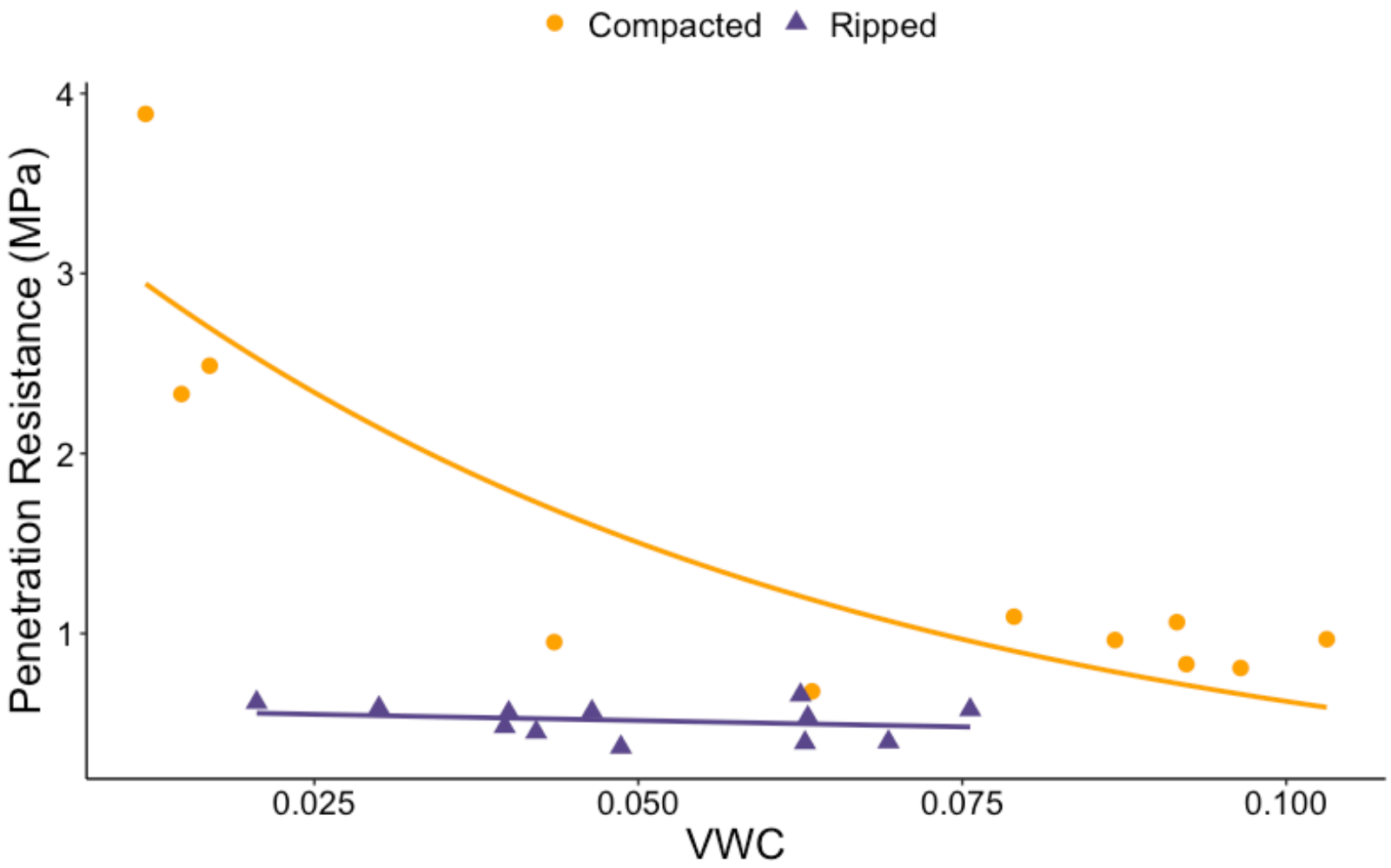
Soil strength



- Average penetration resistance was measured where the hardsetting soil was located (8-13 cm)
- Water content only affected strength in compacted soils

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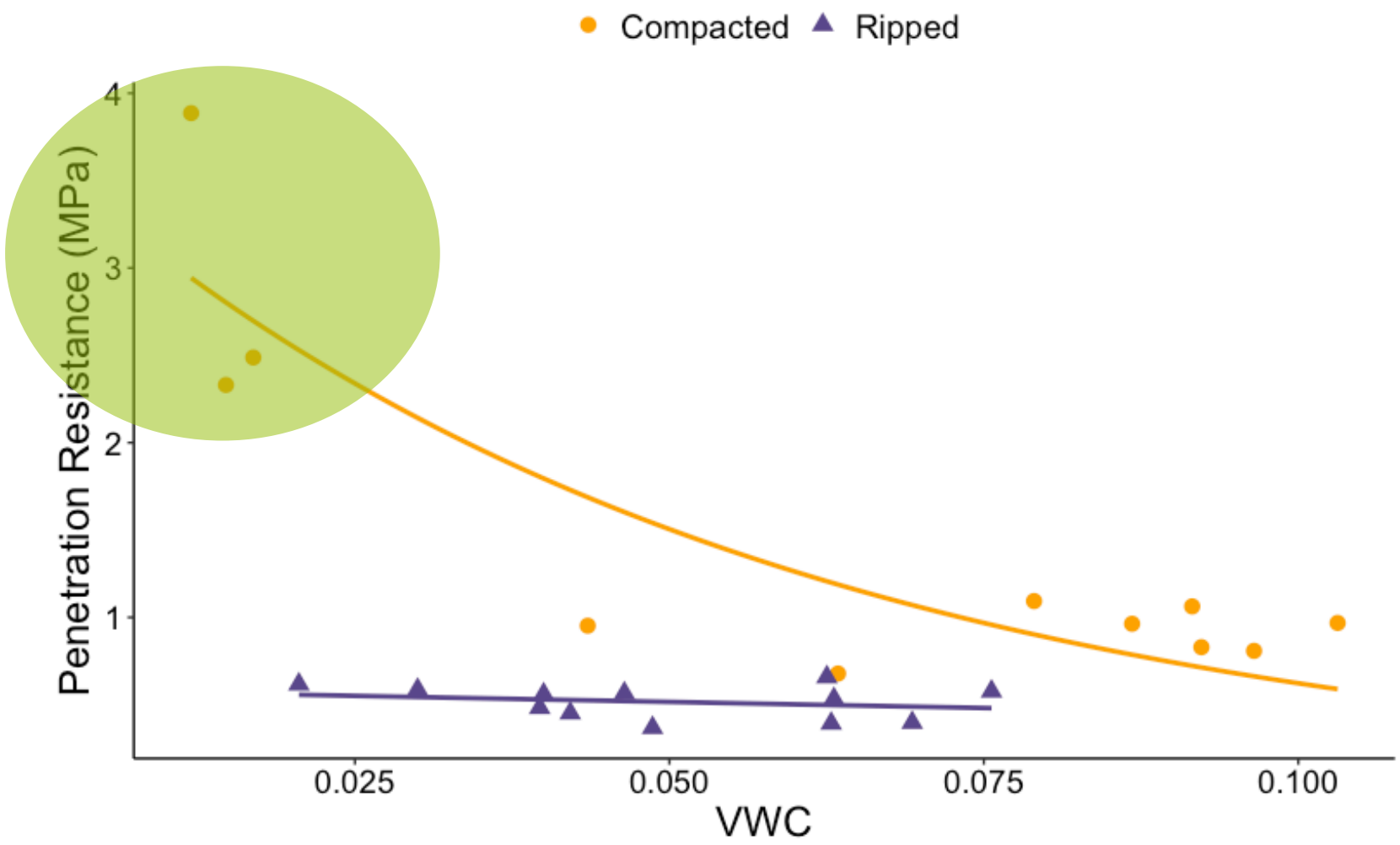
Soil strength



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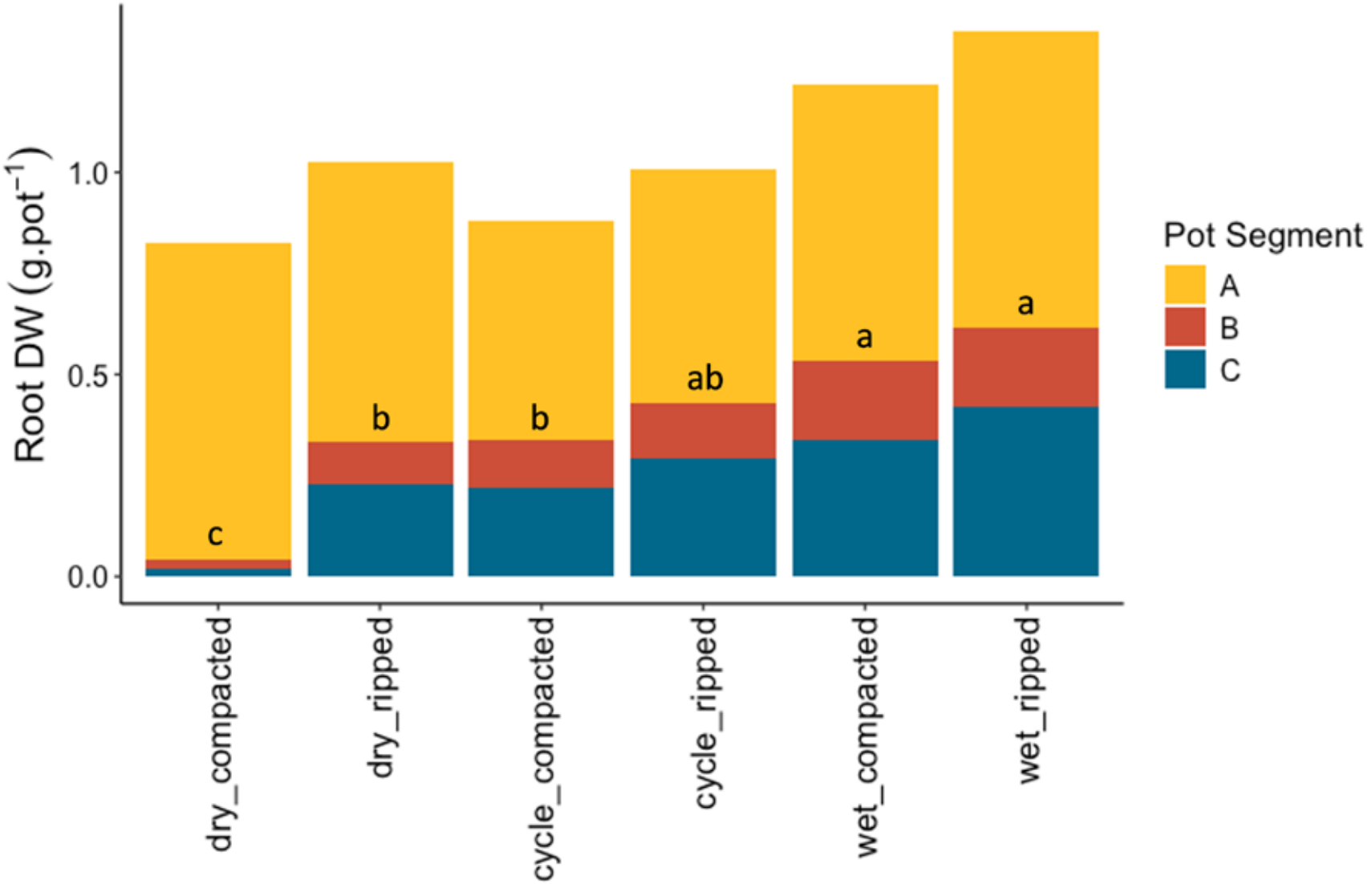
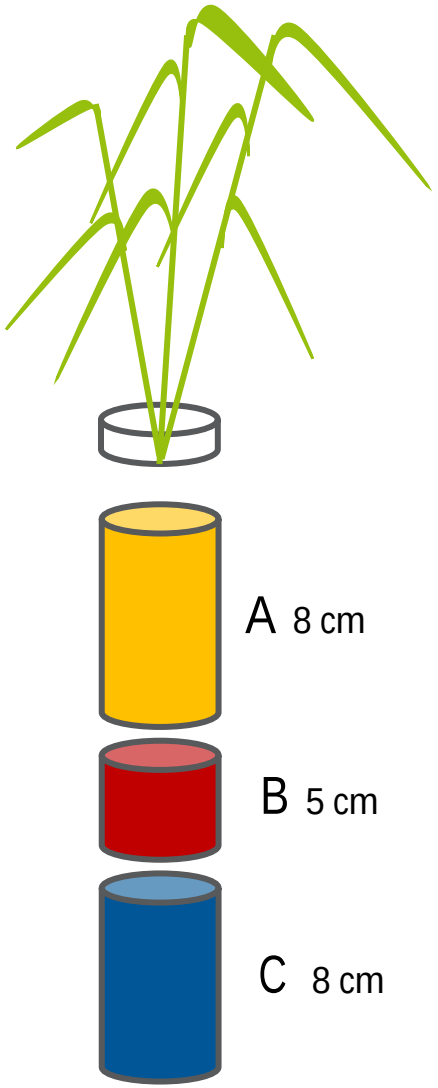
Root distribution





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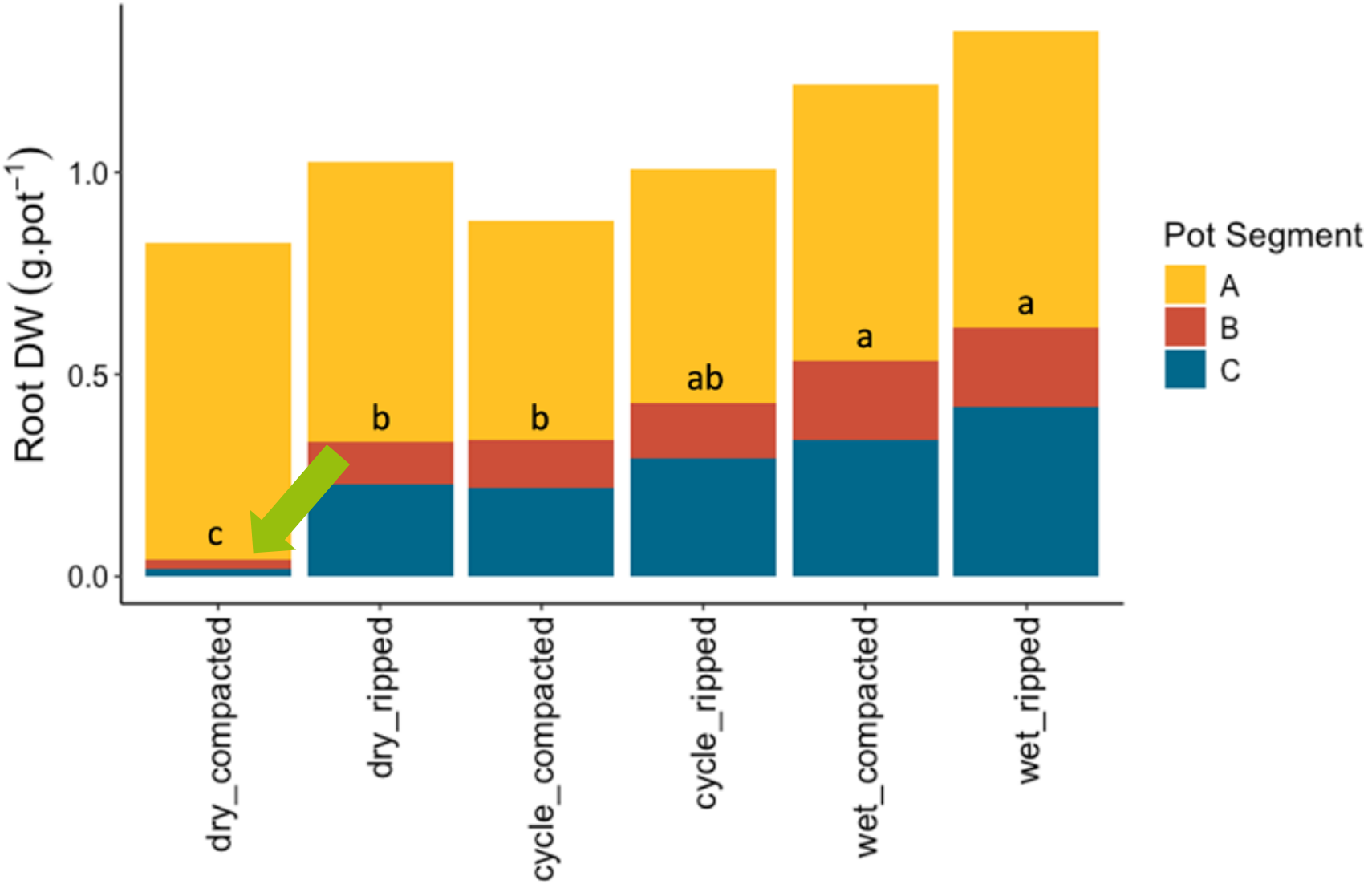

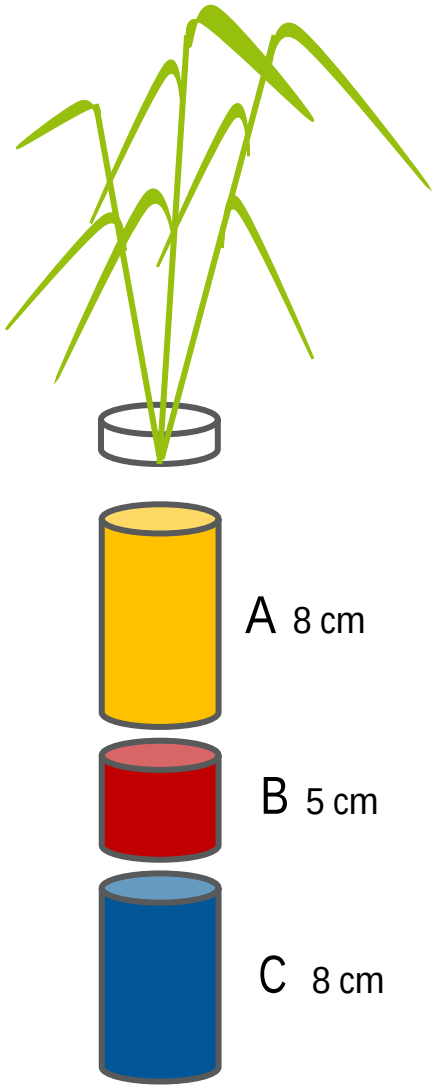

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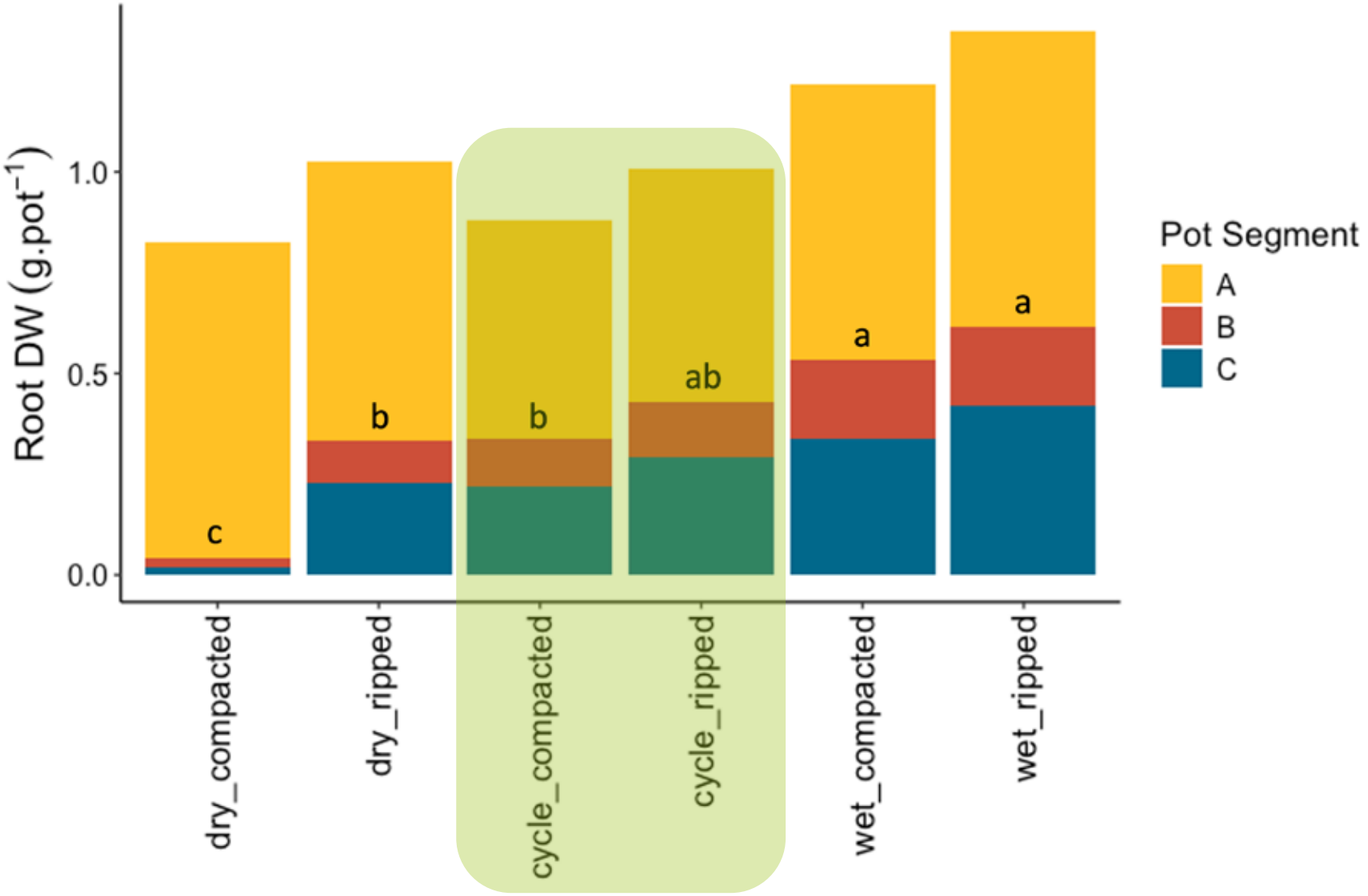

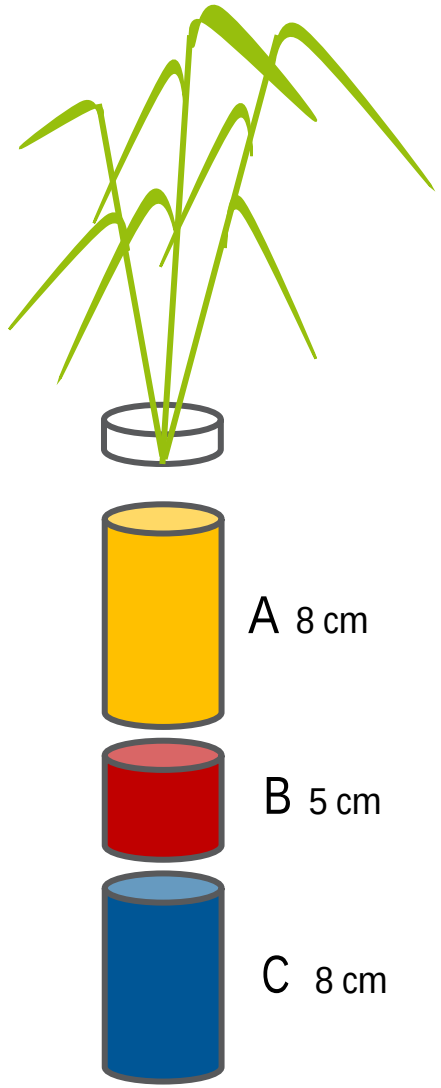

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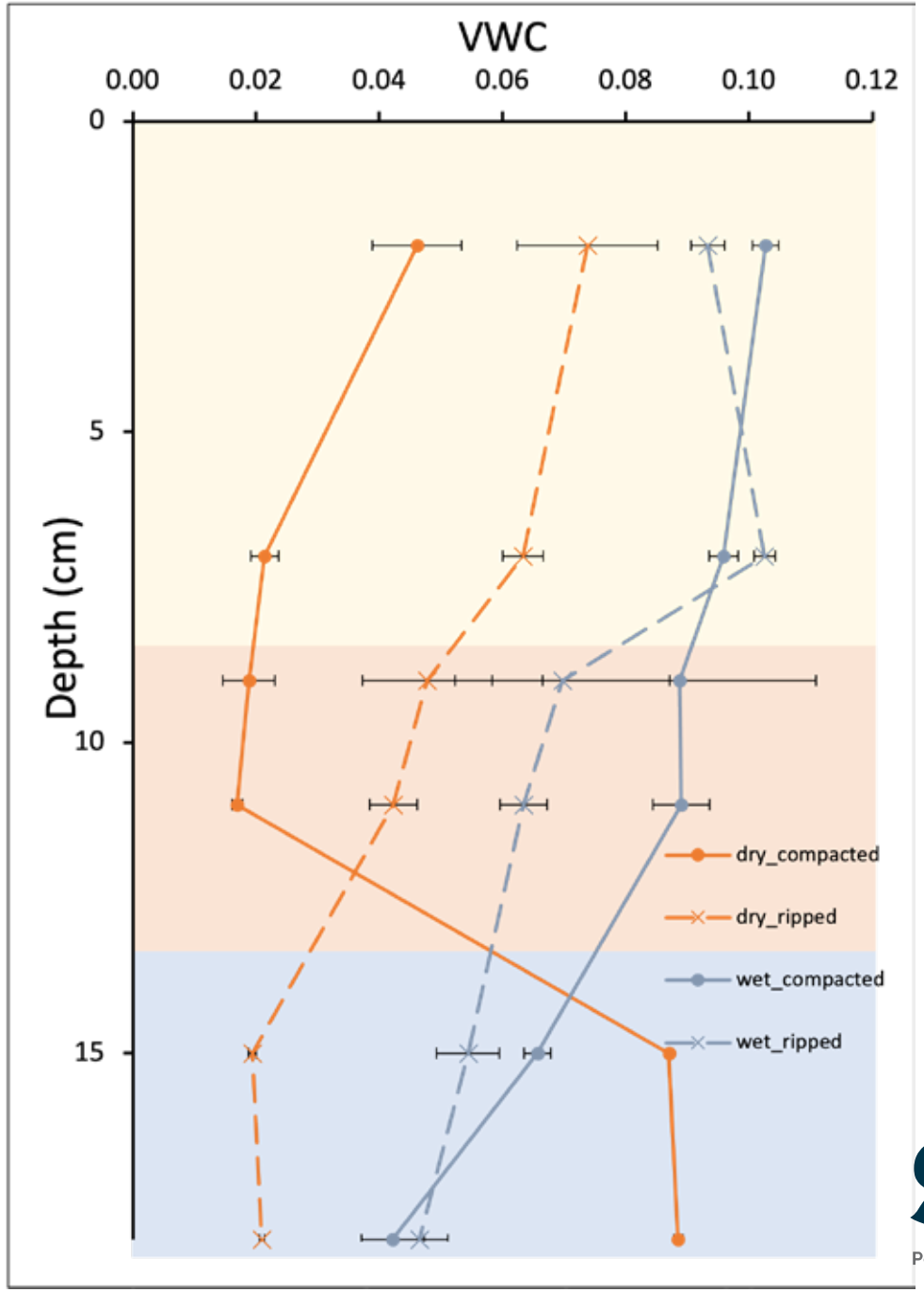
Water distribution

- Soil water content (v/v) was measured at 6 depths at the end of the experiment

- Plants growing under dry conditions depleted the subsoil water only when the soil was ripped



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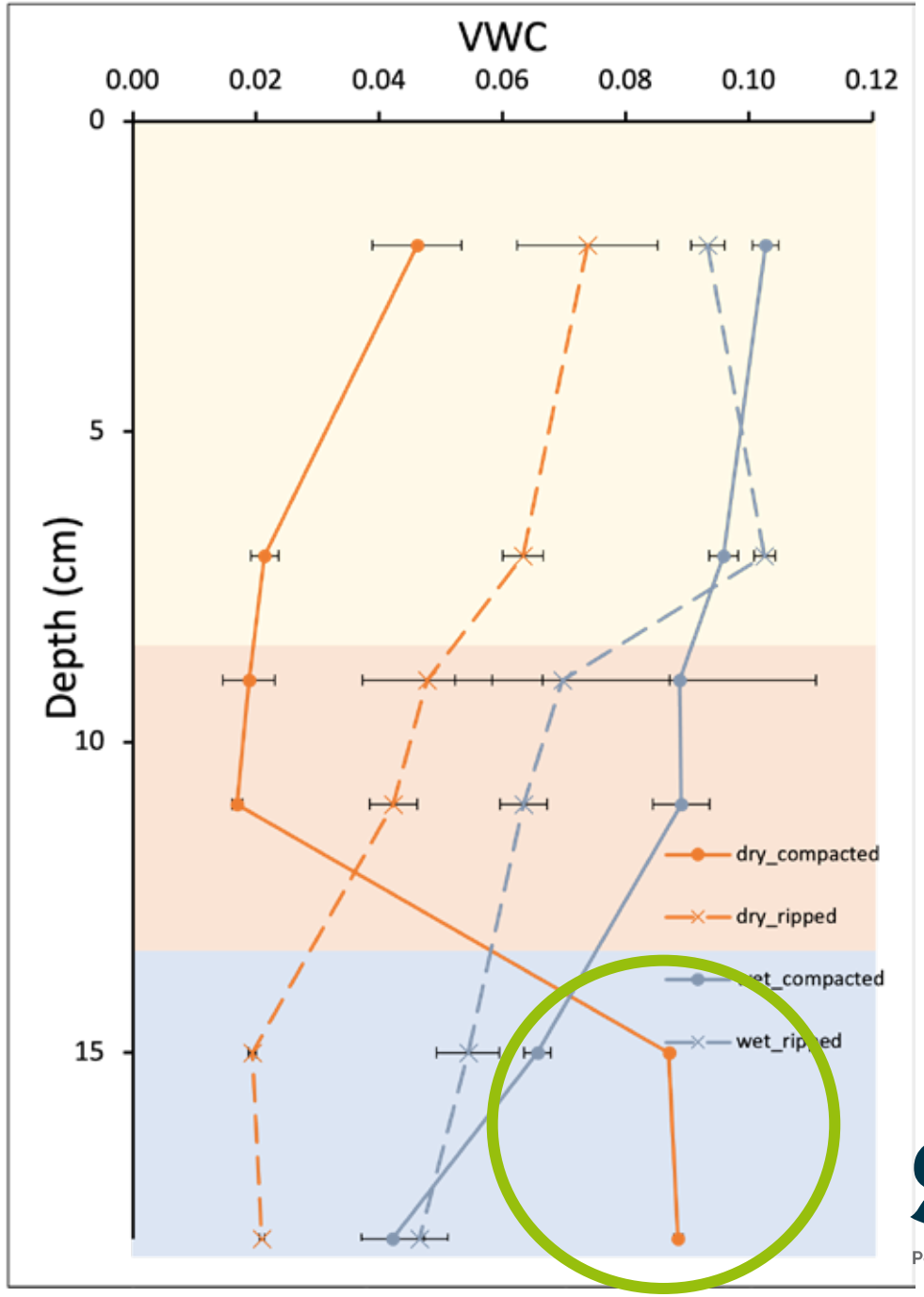

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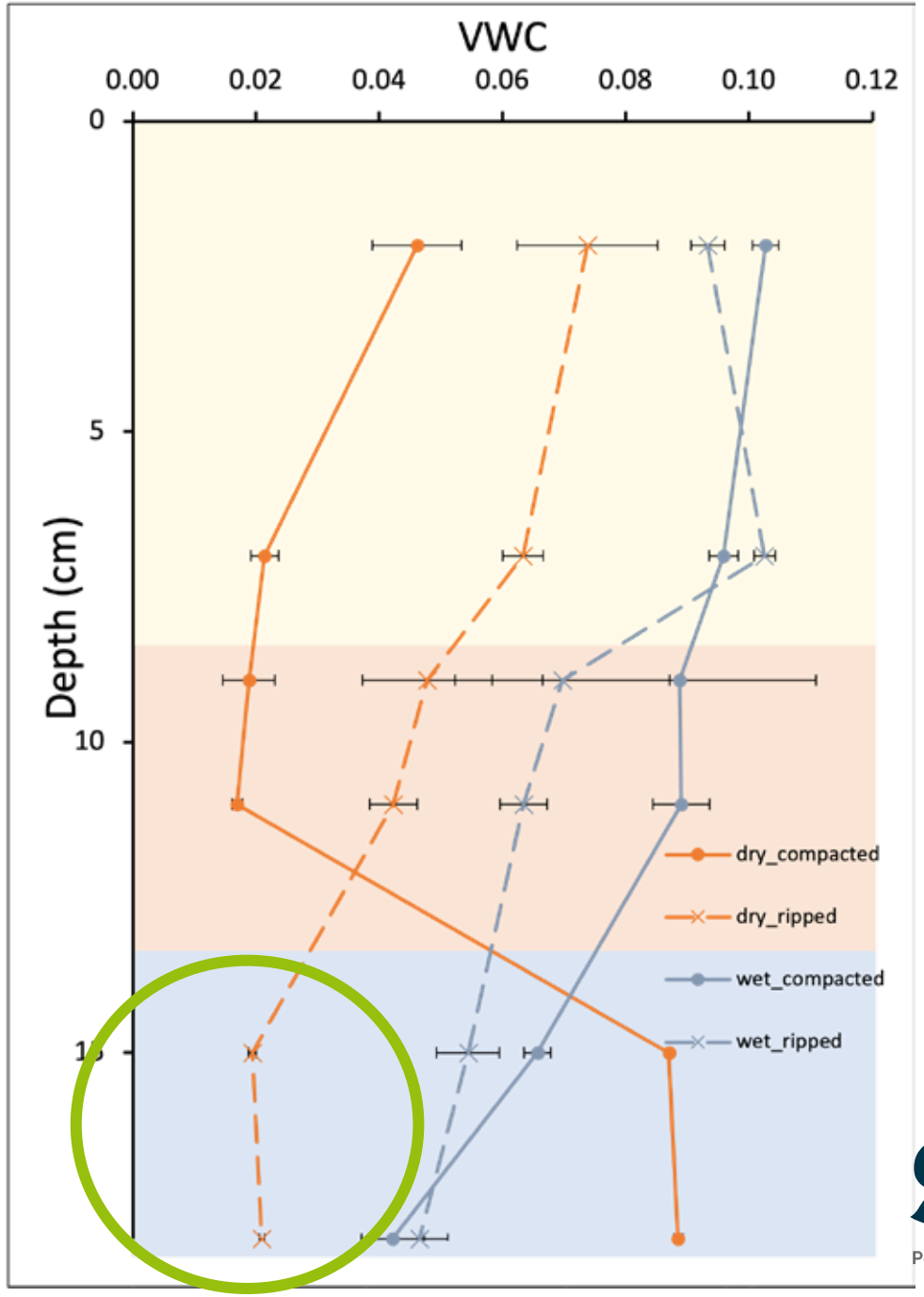

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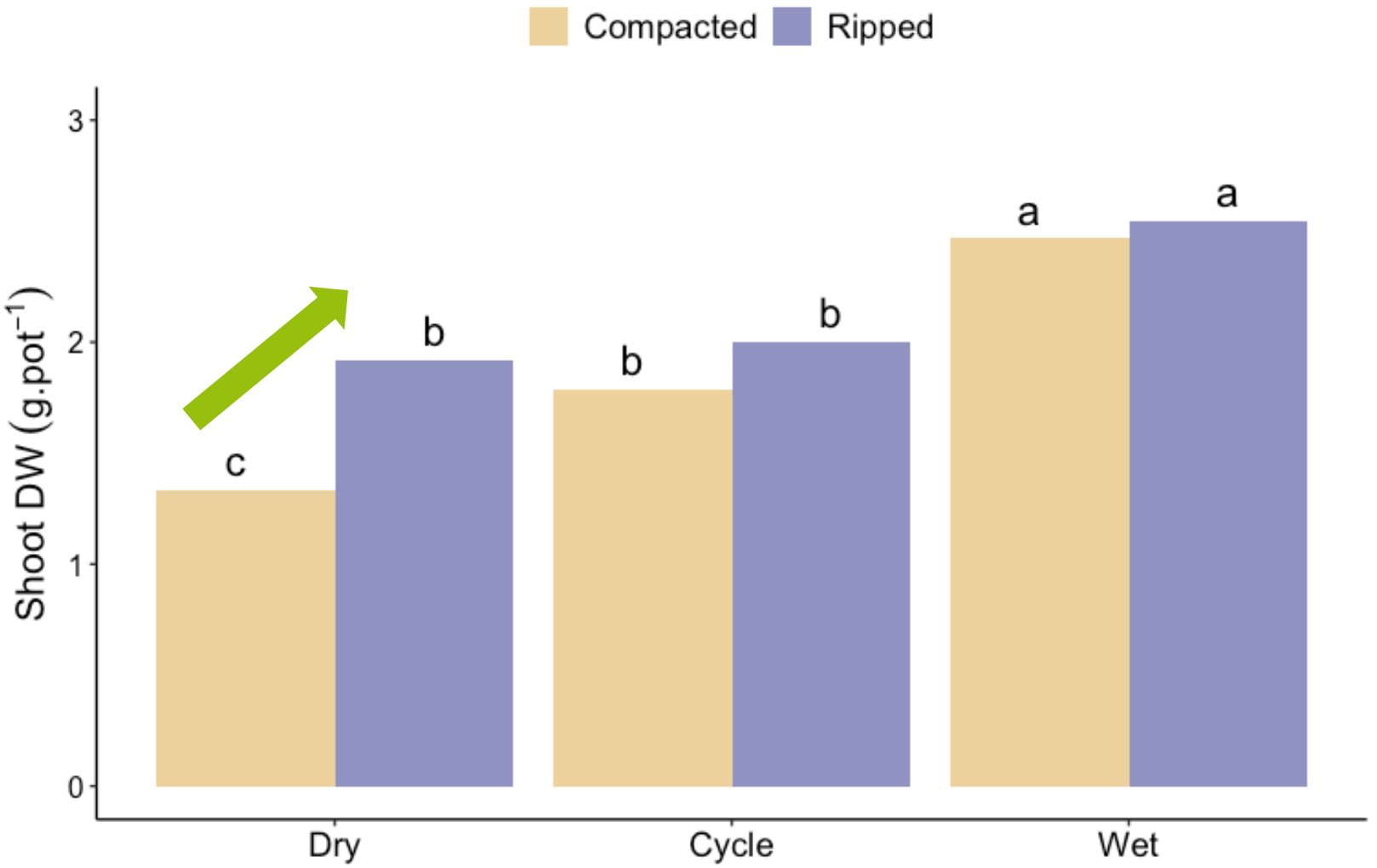
Shoot biomass



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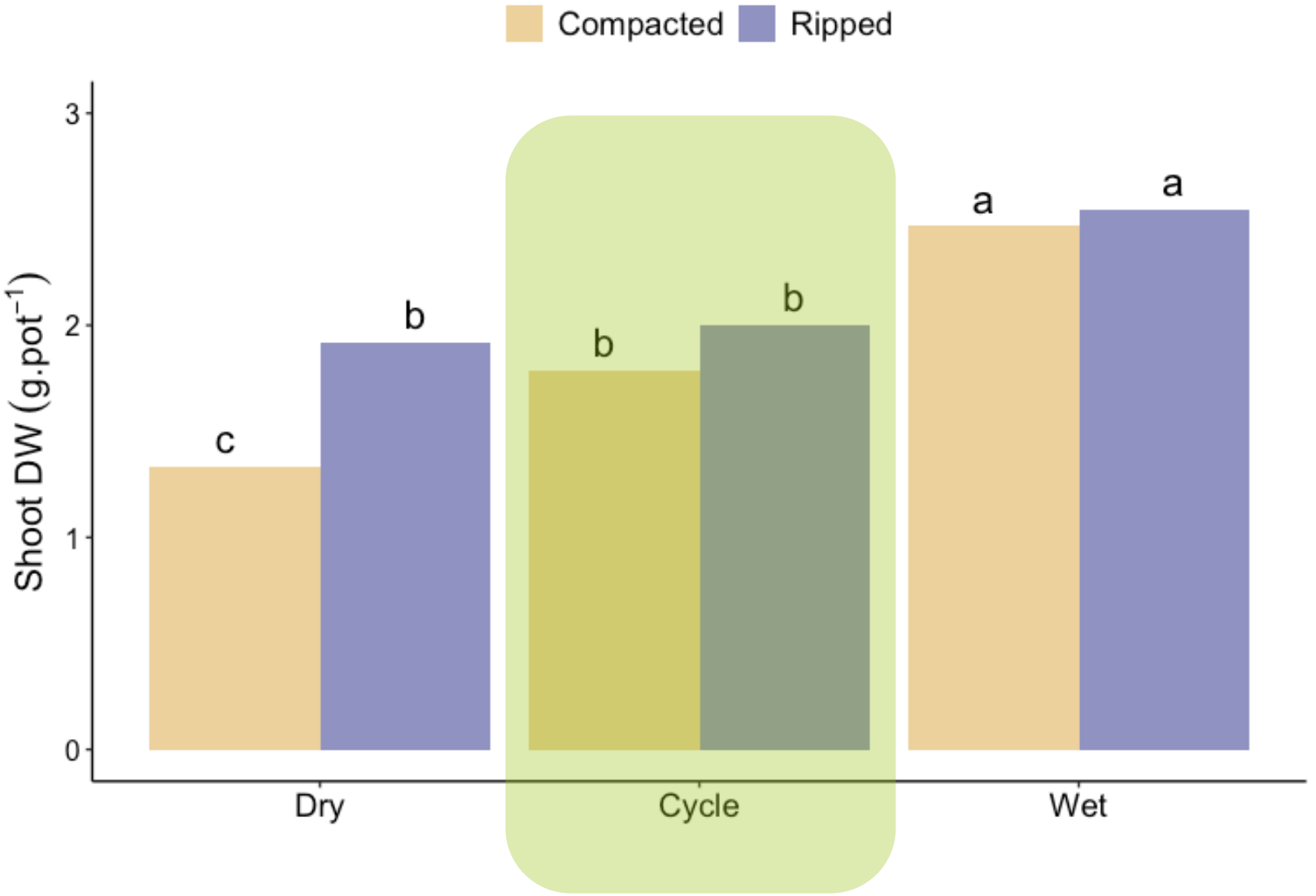

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Next steps

- Monitoring ripped and unripped plots to track changes in soil strength and moisture
- In-situ imaging to compare root growth across multiple time points
- Exploring the effects of soil amendments on hardsetting

+ Clay

+ OM

+ Biochar

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Thank you

- Luke Mosley and my supervisory panel
- The landholders where I collected data and samples
- Soil & Land Co.
- CRC for High Performance Soils
- Grains Research & Development Corporation
- CSIRO Sandy Soils 2 team
- Australian Plant Phenomics Facility

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