Cultivar differences in root development and depth of forage legumes

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Introduction

Root system development and depth are key to efficient resource use and improved crop agronomic and environmental performances. However, forage legumes are not bred for the belowground traits, and knowledge of cultivar differences in root system development and function is lacking. We investigate cultivar differences in root growth and depth over time of the three important forage legumes: red clover (*Trifolium pretense* L.), white clover (*Trifolium repens* L.), and lucerne (*Medicago sativa* L.)

Methods

Rhizotube experiment
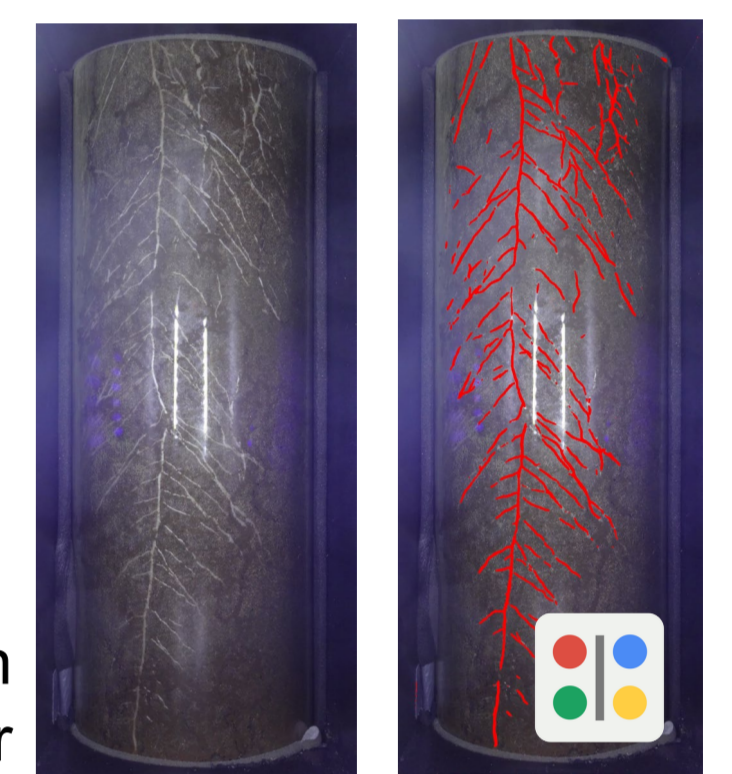2 m and 0.5 m tall and Ø: 10 cm

Measurements

- Early establishment
- Root growth development
- Root image analysis with RootPainter[1] software
- Root system architecture

Tubes at crop harvest at 118 days after transplanting (DAT)

Cultivars

Lucerne (LU)	Red clover (RC)	White clover (WC)
Cigale	Elara	Silvester
Musette	Amos	DLF TRF 3536
Mezzo	Callisto	Brianna

Root segmentation with RootPainter

Results

(1) Early root system architecture

LU Cigale · LU Musette · LU Mezzo · RC Elara · RC Callisto · RC Amos · WC Silvester · WC Brianna · WC DLF-TRF

Figure 1: Roots recovered and washed in 0.5 m rhizotron tubes at 28 DAT
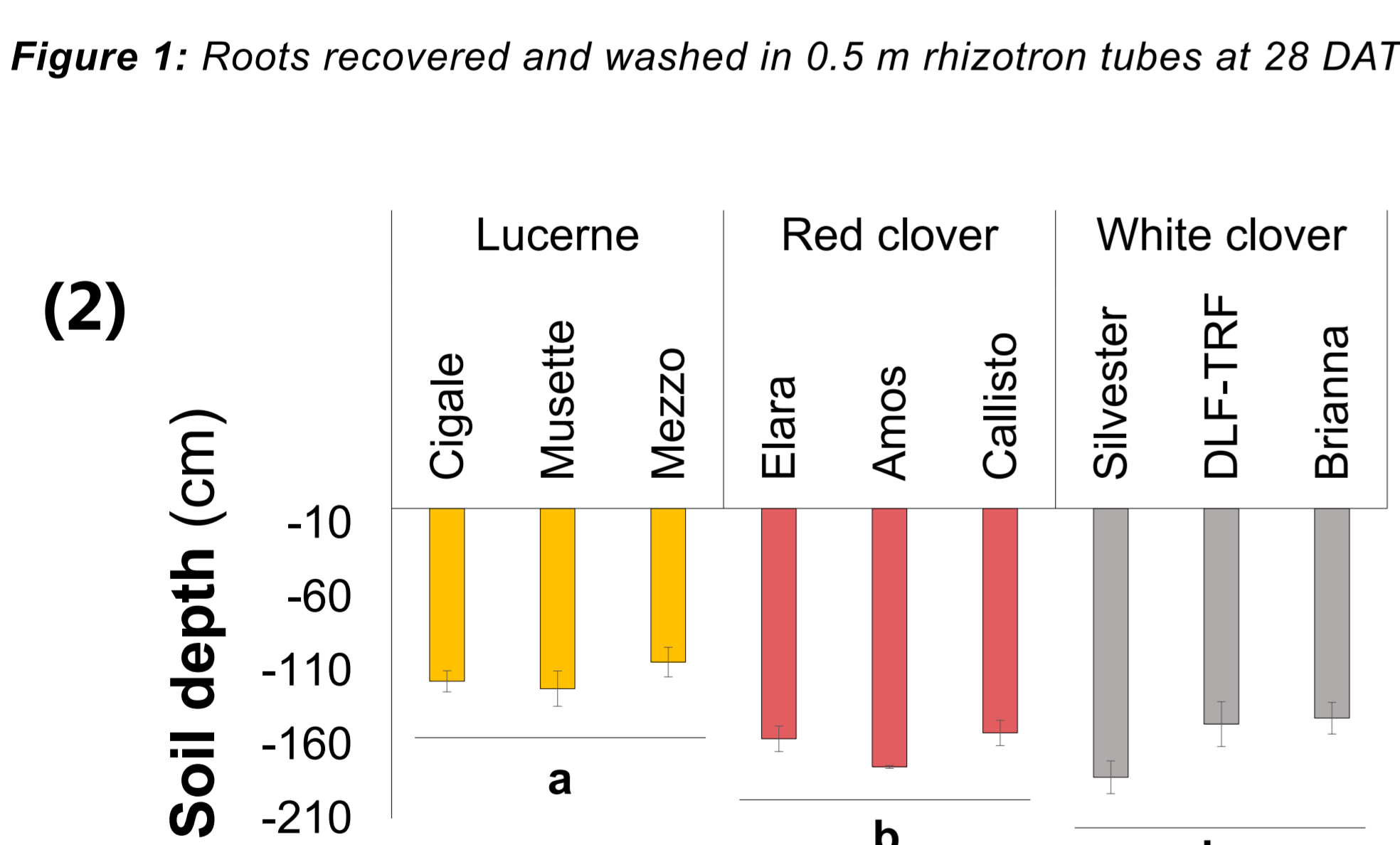
(2)

Figure 2: Maximum root depth at 118 DAT

(1) Faster initial root growth of Lucerne

(Lucerne > Red clover > White clover)

(2) Maximum root depth at DAT 118:

White clover = Red clover > Lucerne. The deepest rooting depth of the white clover cultivar Silvester (1.82 m)

(3) Larger pRLD of Red and White clover compared to Lucerne at soil depths between 0.3 and 1.2 m ($p < 0.001$)

RC-Elara > WC-DLF TRF > RC-Amos

(3) Mean planar root length density
(cm image_area^{-2})

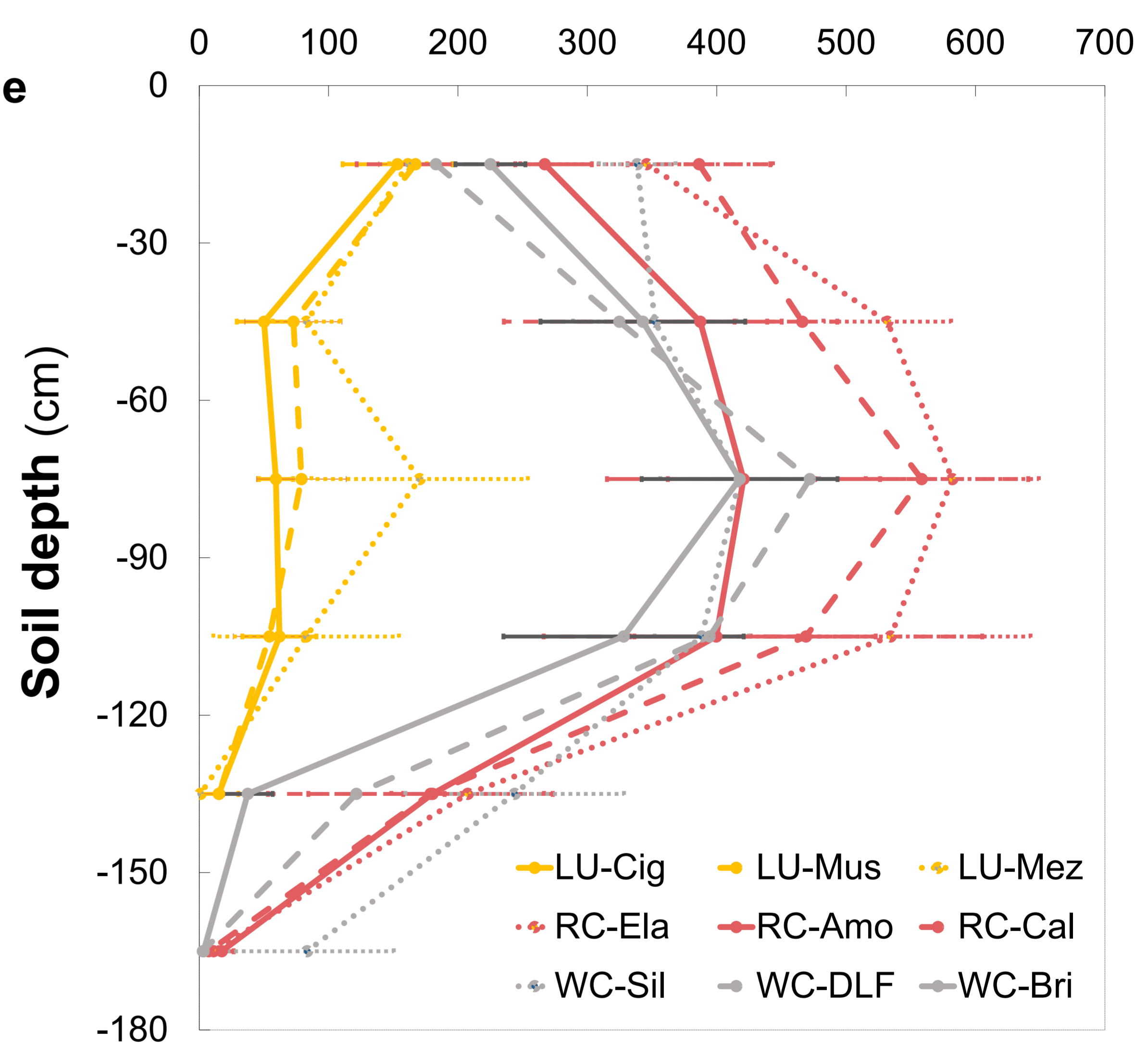Legend: LU-Cig, LU-Mus, LU-Mez, RC-Ela, RC-Amo, RC-Cal, WC-Sil, WC-DLF, WC-Bri

Figure 3: Planar root length density determined from the root images taken in 2 m rhizotron tubes at 118 DAT

Conclusions

Contrary to the general perception, our results showed **deep root growth** of **white clover**. The study provides insights into the **deep-root development** of three forage legumes, with **implications for future breeding**. The rhizotron study is currently being **validated** in the **field** and in **4 m tall rhizoboxes**, including **root function** studies based on **tracer uptake**.

References

[1] Smith et al. (2022) RootPainter: deep learning segmentation of biological images with corrective annotation. *New Phytologist*

Frøafgiftsfonden

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