Assaying canola seedling root development for improved establishment

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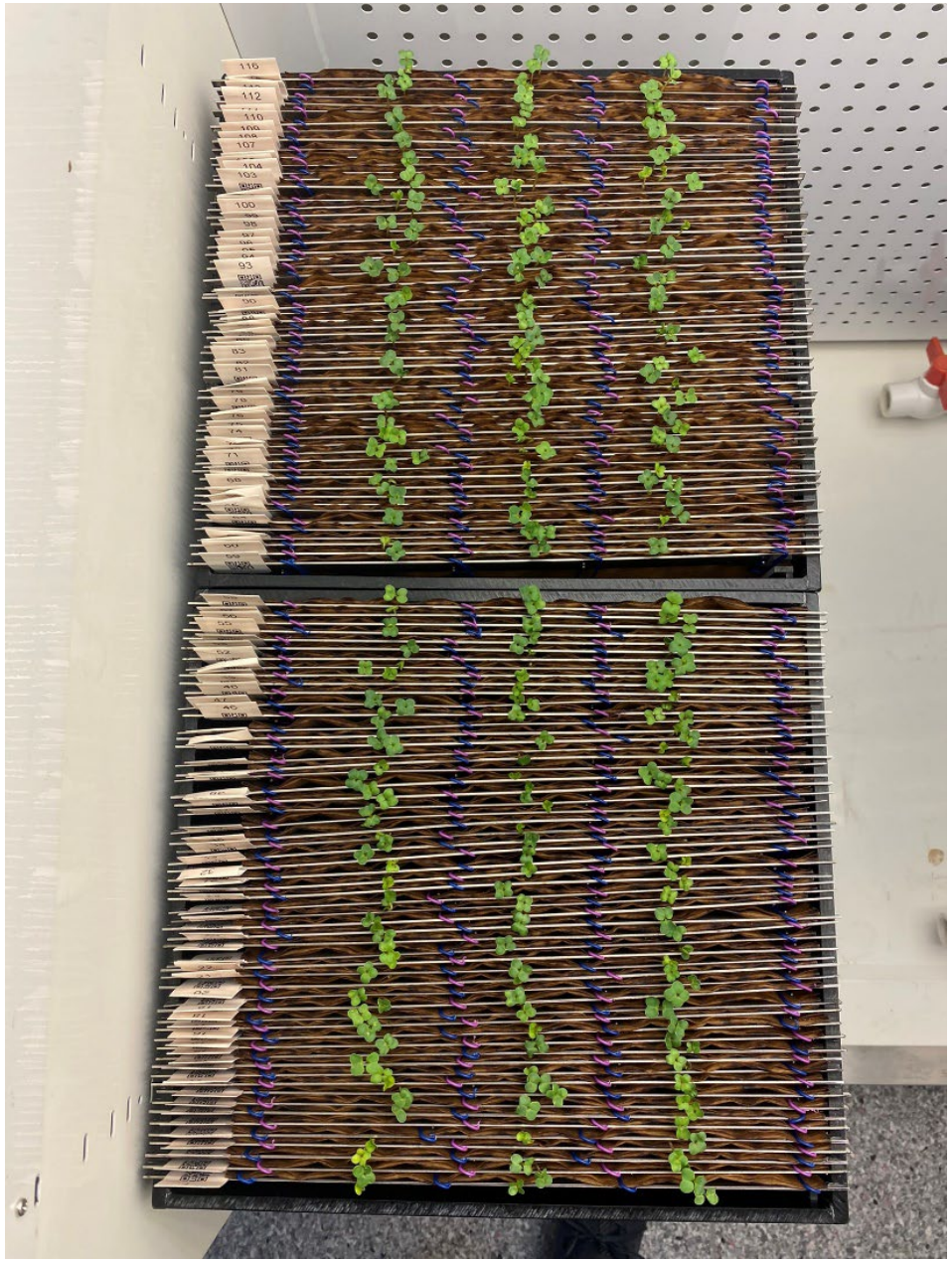
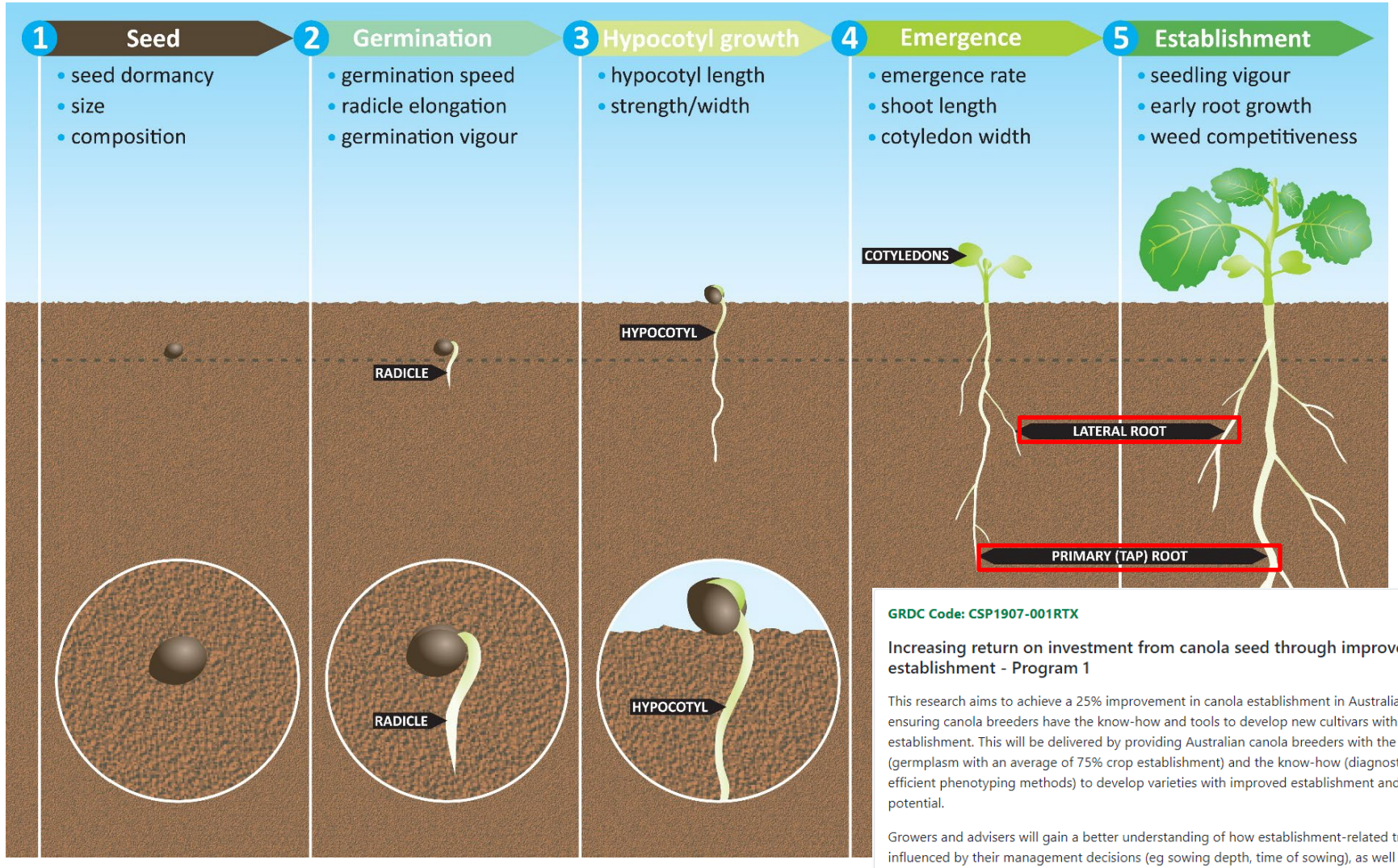
Photo cred. Anton Wasson

Background

- Canola is an important crop
- Poor establishment leads to reduced yield
- Increasingly difficult conditions – climate change
- Improving establishment is important to improving yield and viability of canola as a crop



Root Traits in Establishment



GRDC Code: CSP1907-001RTX

Increasing return on investment from canola seed through improved establishment - Program 1

This research aims to achieve a 25% improvement in canola establishment in Australia by 2030 by ensuring canola breeders have the know-how and tools to develop new cultivars with improved establishment. This will be delivered by providing Australian canola breeders with the genetics (germplasm with an average of 75% crop establishment) and the know-how (diagnostic markers and efficient phenotyping methods) to develop varieties with improved establishment and early growth potential.

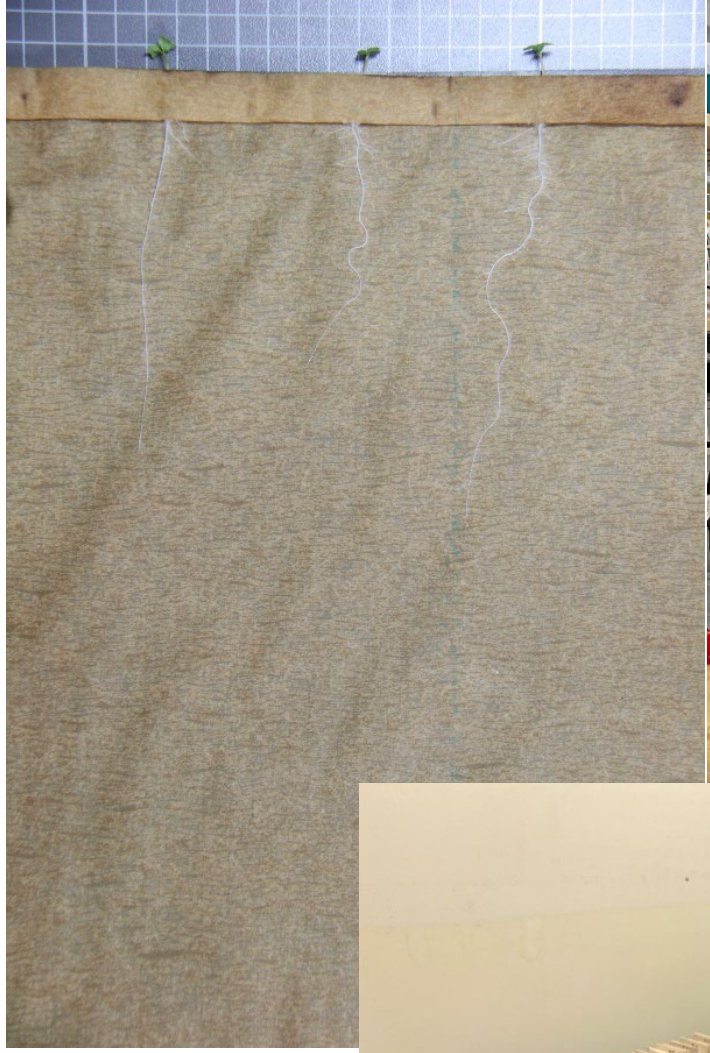
Growers and advisers will gain a better understanding of how establishment-related traits are influenced by their management decisions (eg sowing depth, time of sowing), as well as benefiting from the overall outcome of better canola establishment.

Project start date:	01/07/2019
Project end date:	30/06/2023
Crop type:	Canola/Rapeseed
Region:	National
Organisation:	CSIRO
Key Investment Target:	1.5

Nelson *et al.* Strategies to improve field establishment of canola: a review. *(2022)*

Novel Pouch Assay

- OzCanola population:
  - 256 varieties of canola
  - SNP mapped
- 8 replicates
- 5 days of growth
- Seeds pre-weighed
- Roughly **2000** seedlings!



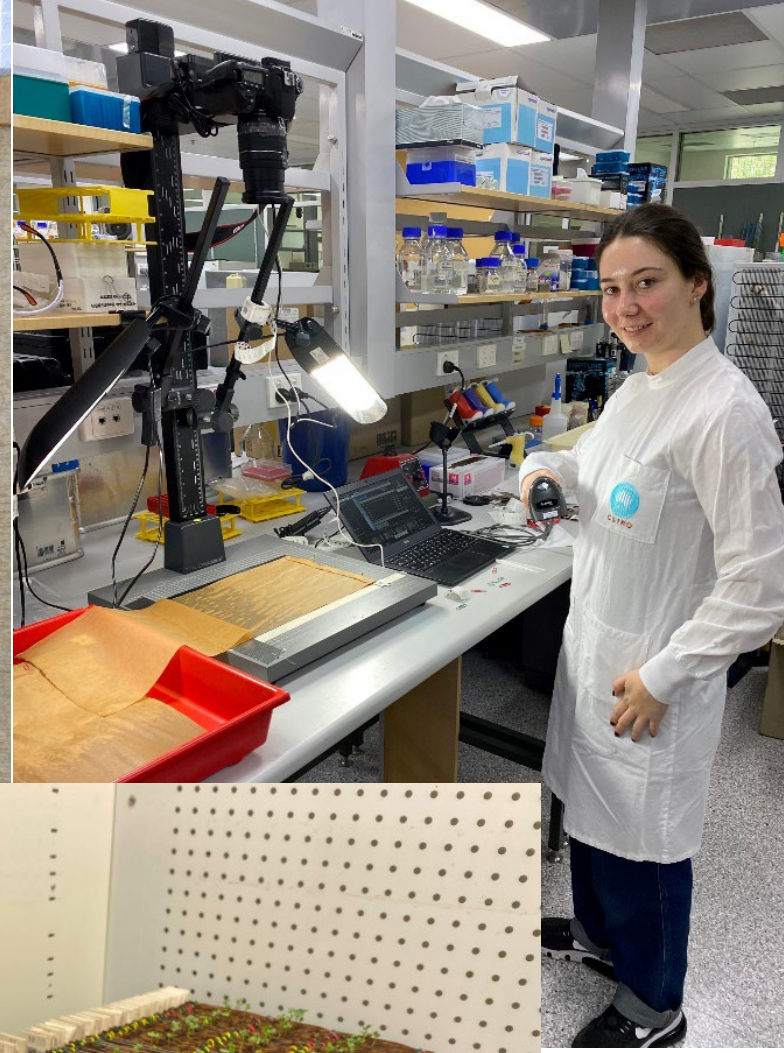
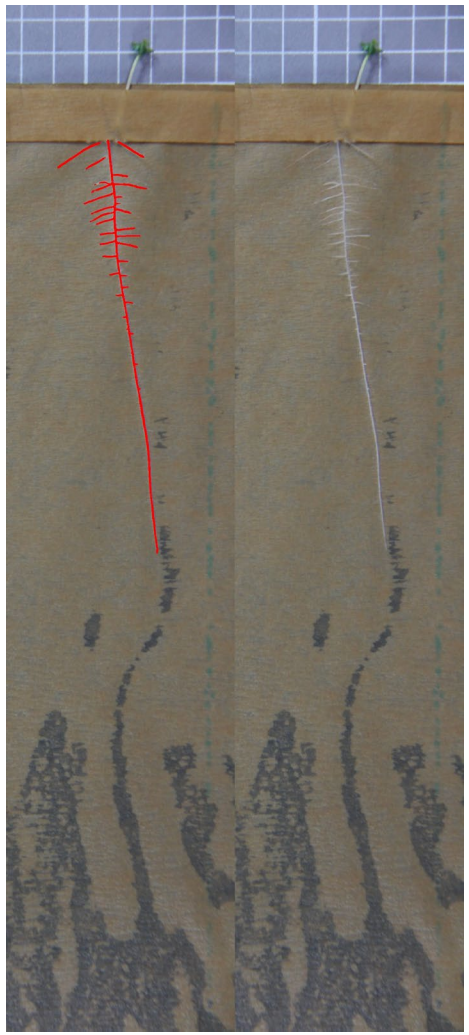


Photo cred. Anton Wasson

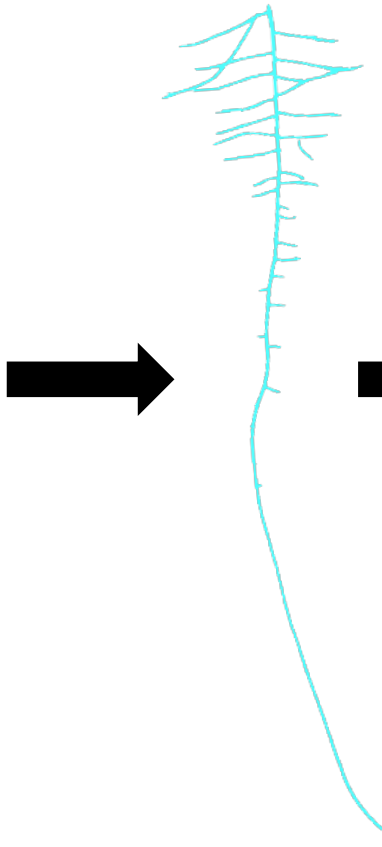
Root Painter

- Deep learning neural network
- Open-source software
- Involves user annotation of ‘foreground’ and ‘background’ (root + not root)

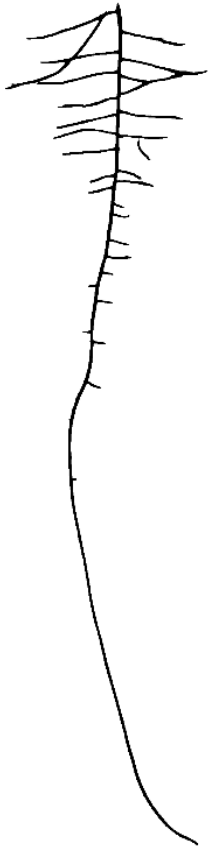
Rootpainter model overlaid on original image



Rootpainter segmentation



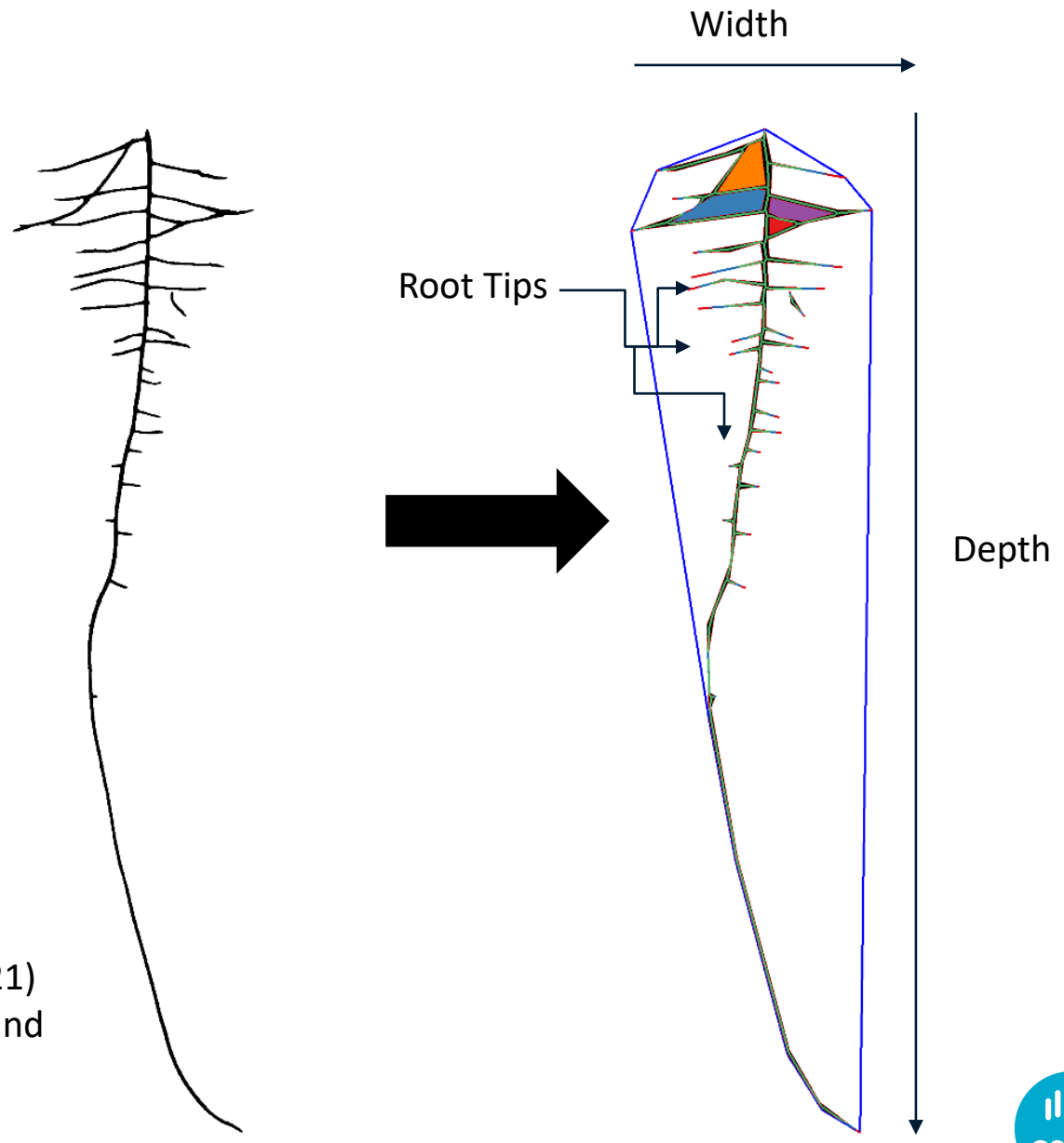
Rootpainter binarized segmentation



Smith AG, Han E, Petersen J, Olsen NAF, Giese C, Athmann M, Dresbøll DB, Thorup-Kristensen K (2020) ‘RootPainter: Deep Learning Segmentation of Biological Images with Corrective Annotation’ *bioRxiv* 2020.04.16.044461. doi:10.1101/2020.04.16.044461

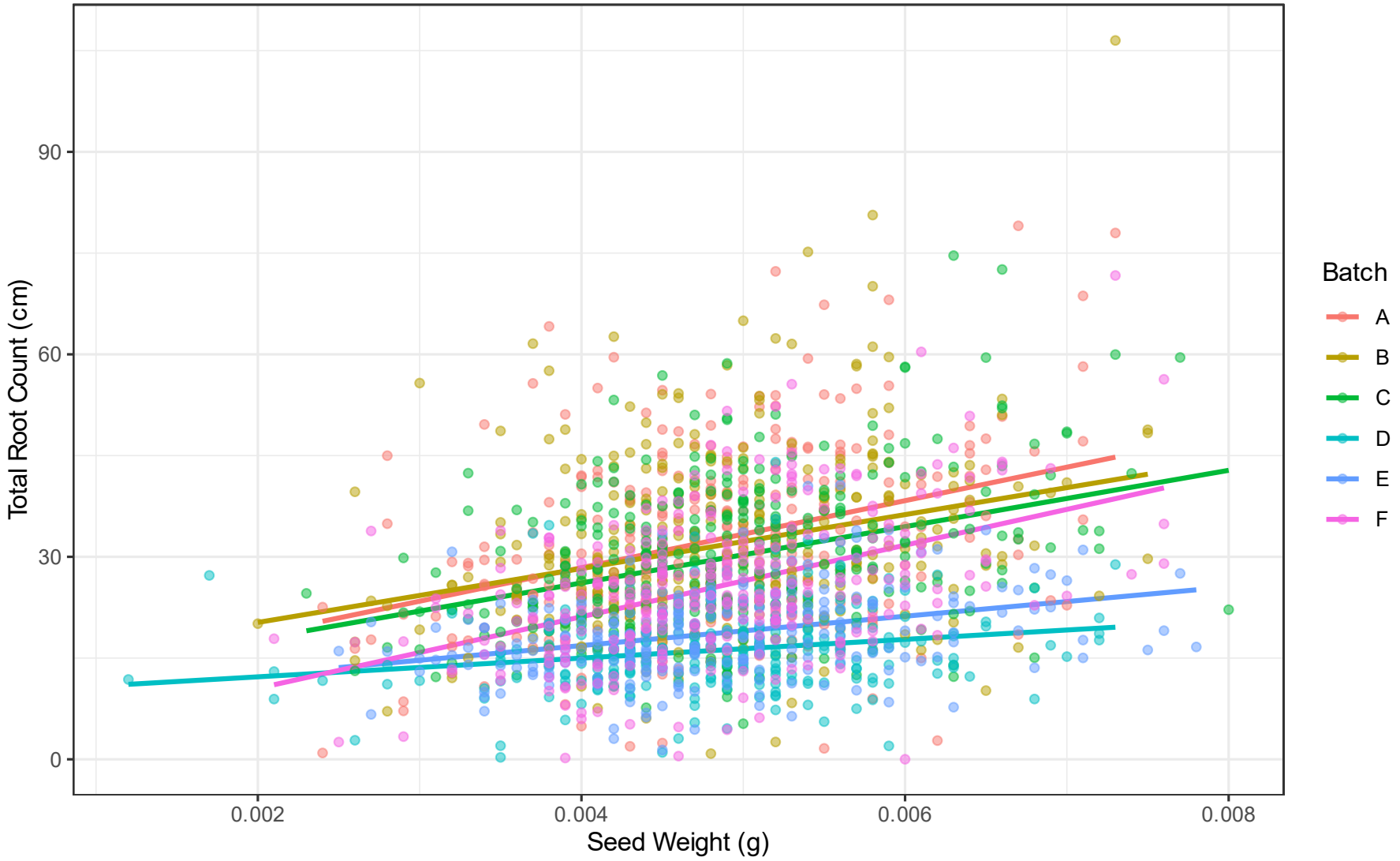
Rhizovision Analysis

- Open source software for analysing features such as:
- **Total root length**
- No. of root tips
- Depth
- Depth/width ratio

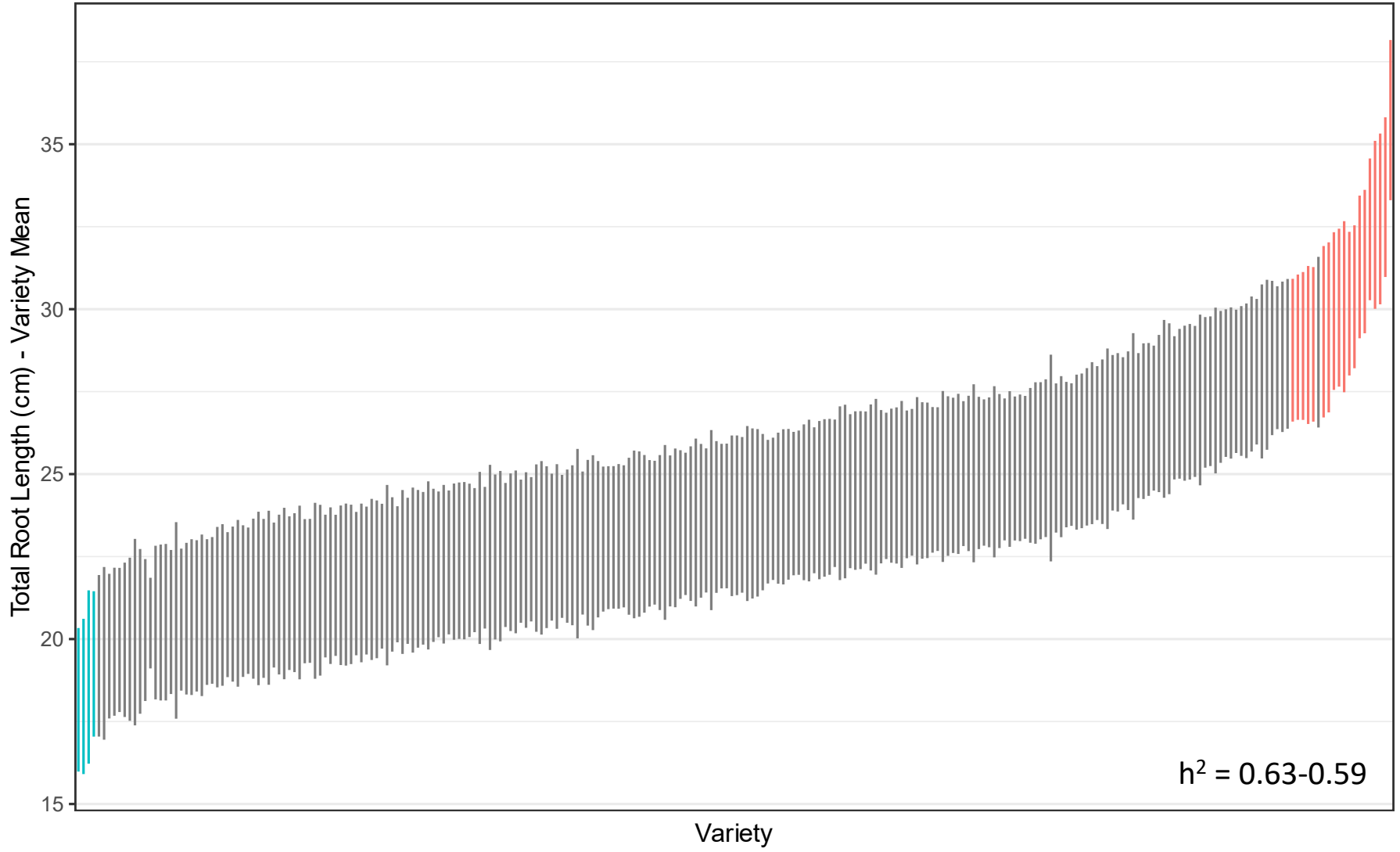


Seethepalli A, Dhakal K, Griffiths M, Guo H, Freschet GT, York LM (2021) 'RhizoVision Explorer: open-source software for root image analysis and measurement standardization' *AoB PLANTS* **13**, plab056. doi:10.1093/aobpla/plab056

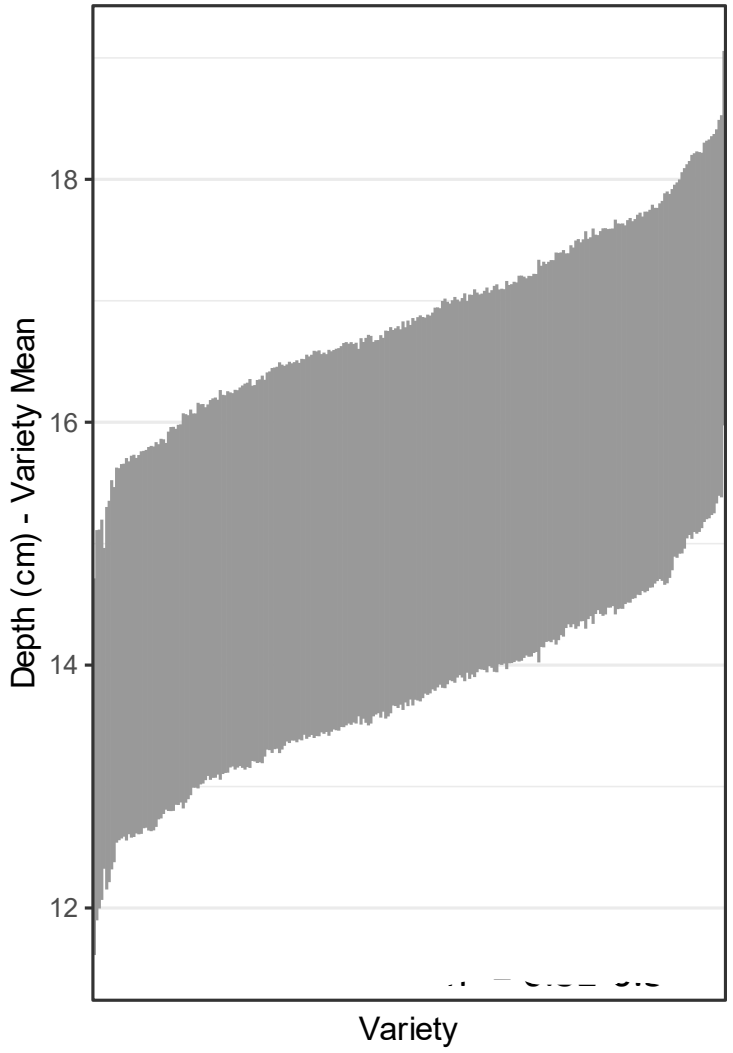
Need for modelling

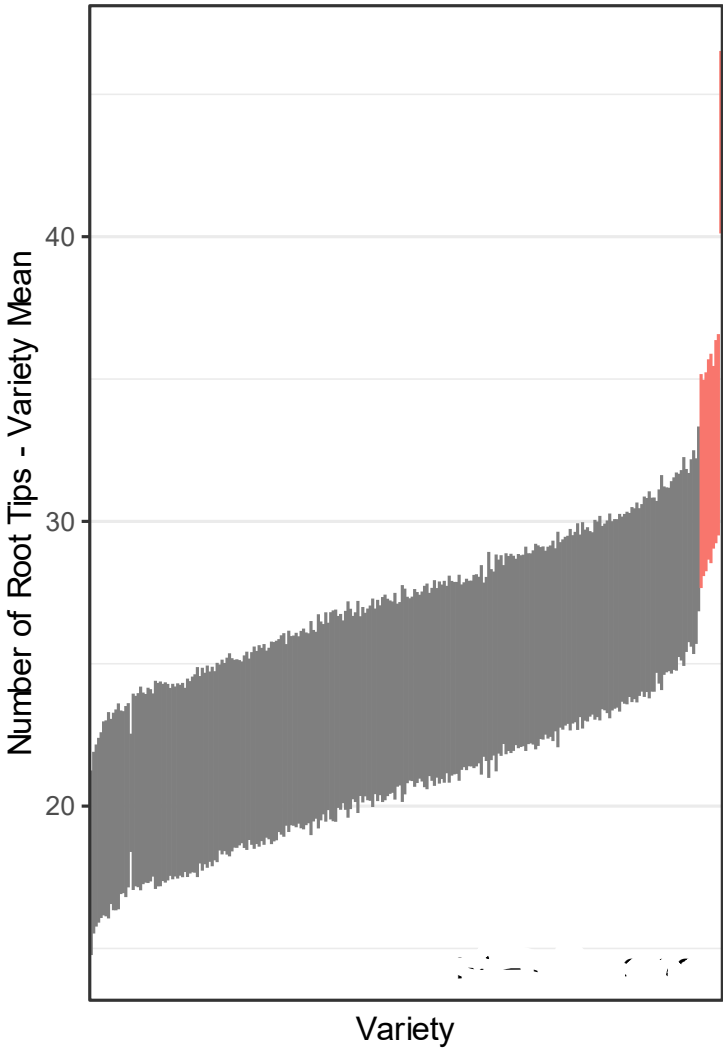


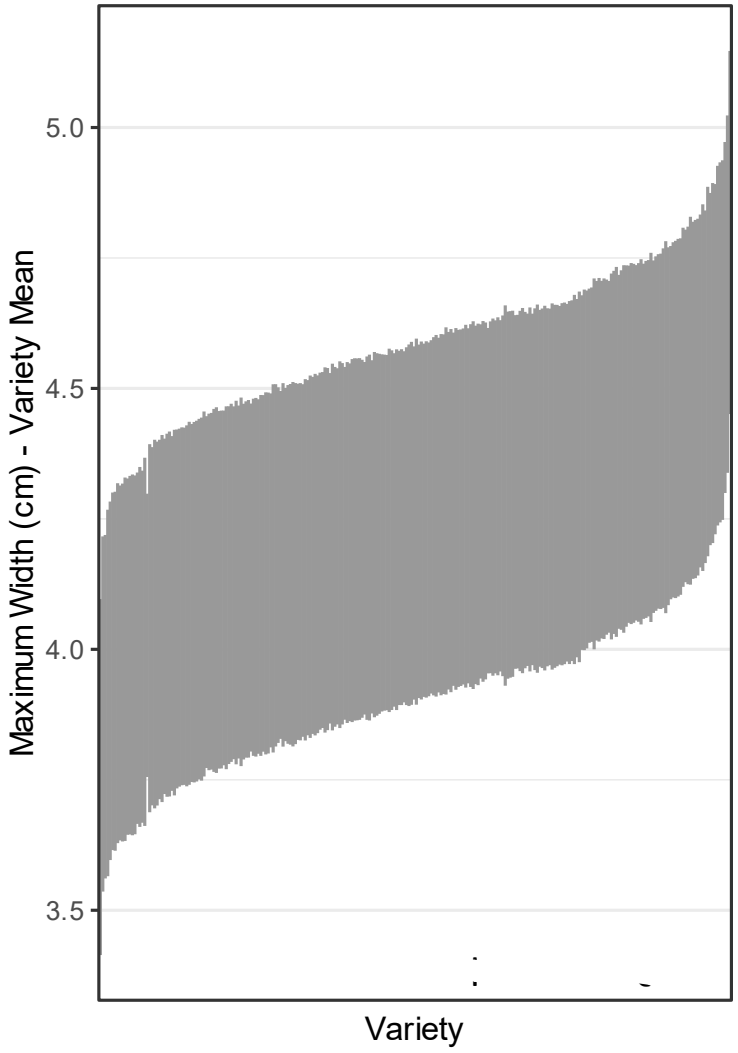
Variation between varieties



Variation between varieties







What's next?

- Genome-wide association study (GWAS) → QTL associated with root traits
- Seedling dry weights measured – tissue density
- Data available for use - Canola Establishment Project – attempting to fill some gaps in knowledge of the genetic contribution to early root growth

Acknowledgements

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