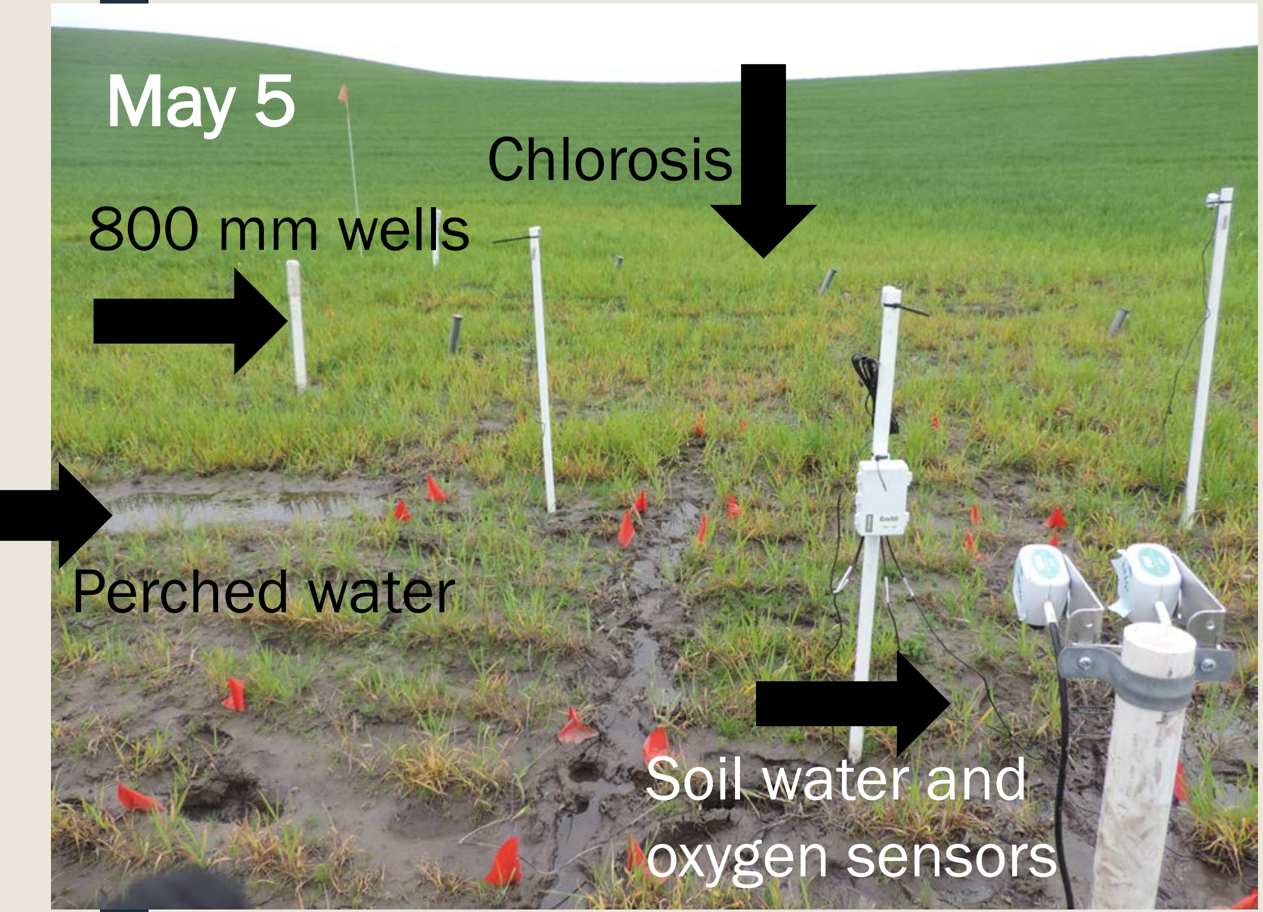
NITROGEN DEFICIENCY IN WATERLOGGED WHEAT

Kristina Estrada

Introduction

- Wetter springs lead to seasonal flooding in poorly drained soil
- Roots exposed to periods of water cause differences in growth of winter wheat (Herzog et al., 2016; Ghobadi et al., 2016)
- Waterlogging lead to chlorosis, but plants green up when soils drain
- Is the soil deficient in nitrogen (N) or can waterlogged plants not take up the N? What role do roots play?

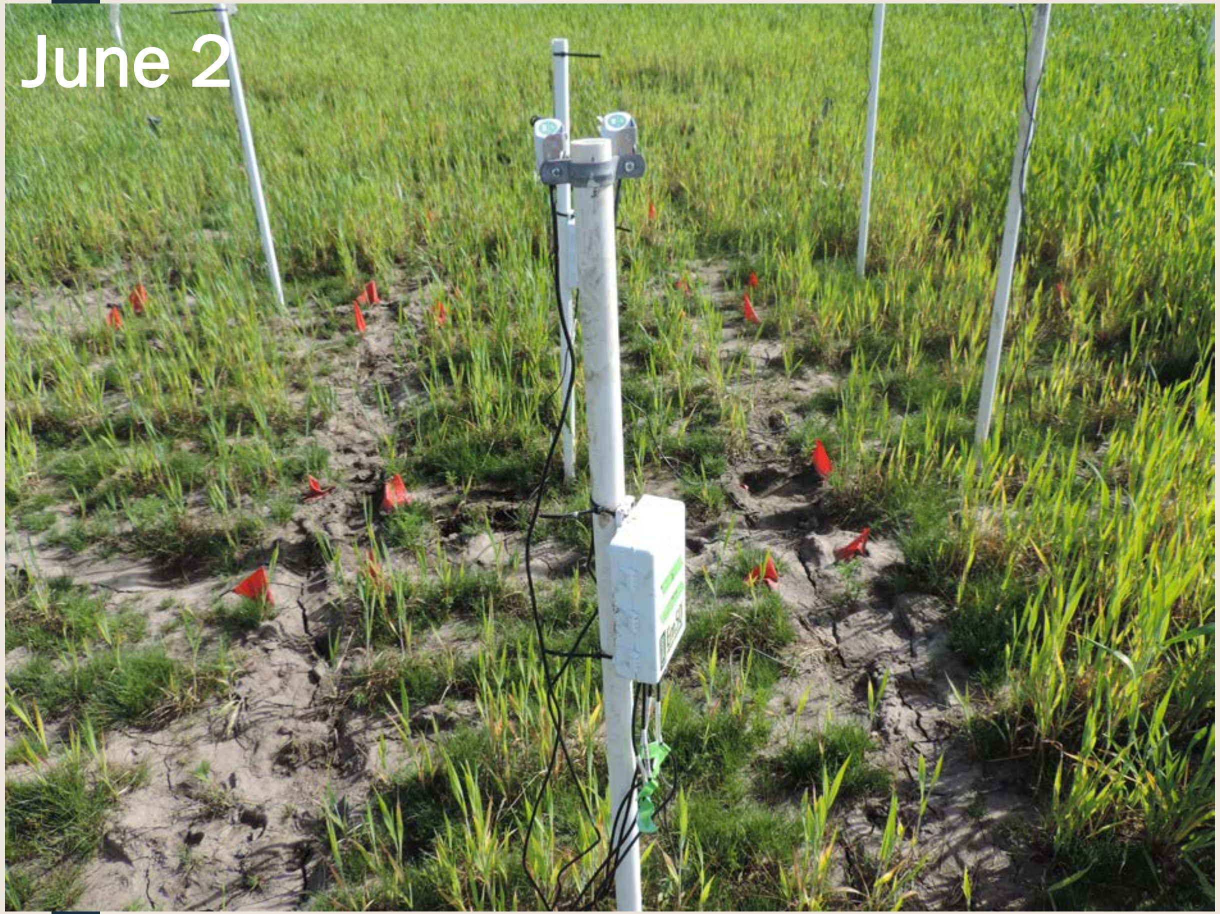
Waterlogging



Waterlogged

Aerated

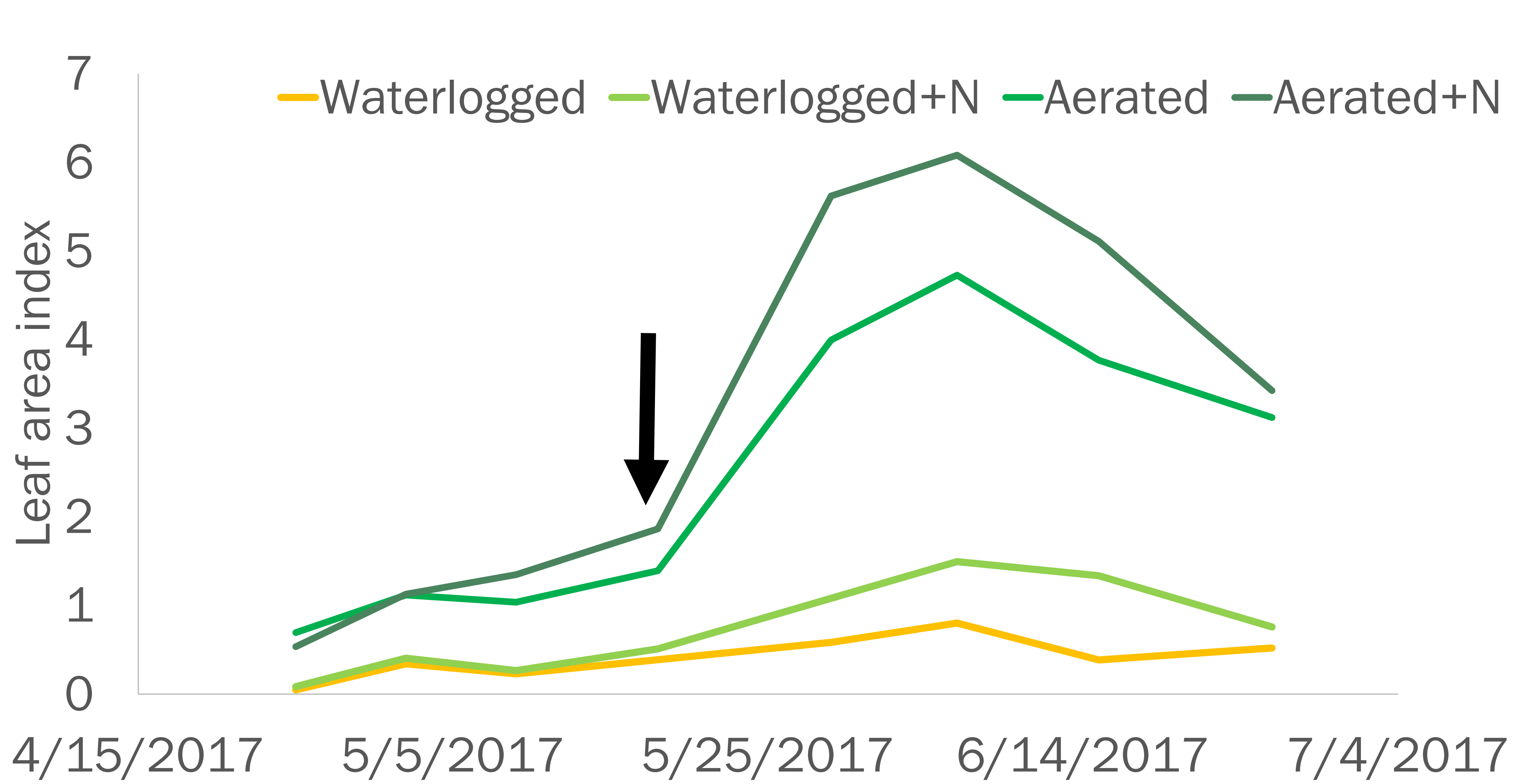
Drying Up



After waterlogging

Always aerated

Background: When did soils begin to dry out?

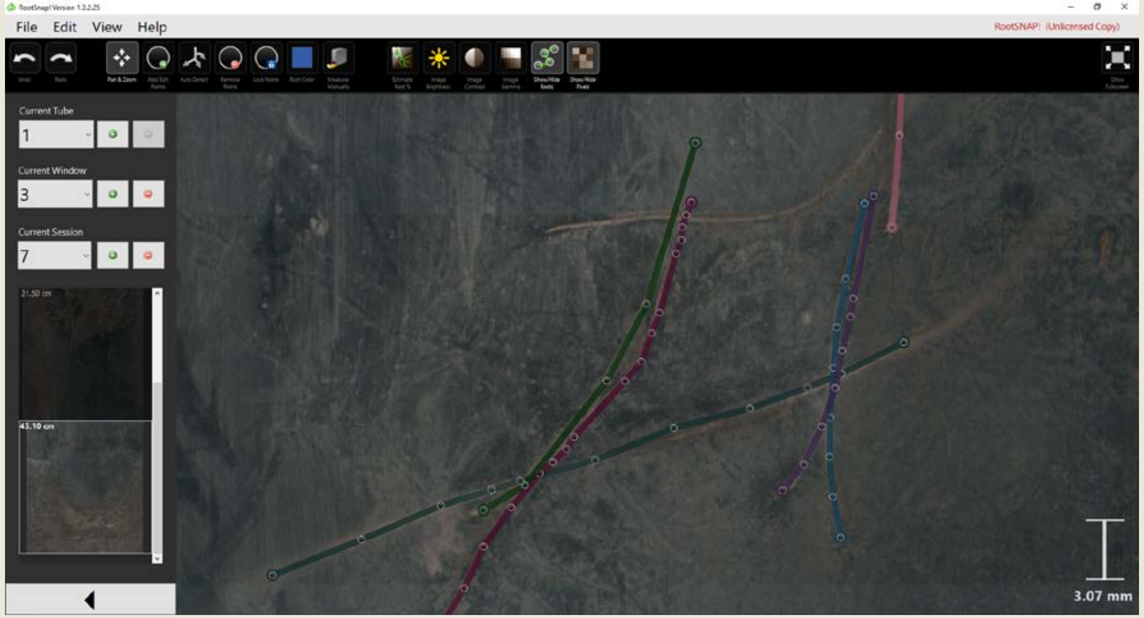


Hypotheses

- Waterlogging restricts rooting depth (Shao et al., 2013), but aerenchyma helps the wheat survive (Huang et al., 1994).
- Aerated wheat has more new appearances of roots early on, but as the water table recedes, waterlogged wheat catches up.
- Spring nitrogen fertilization will stimulate plant growth (Horchani et al., 2010) and more appearances of roots in flooded soil.

Methods

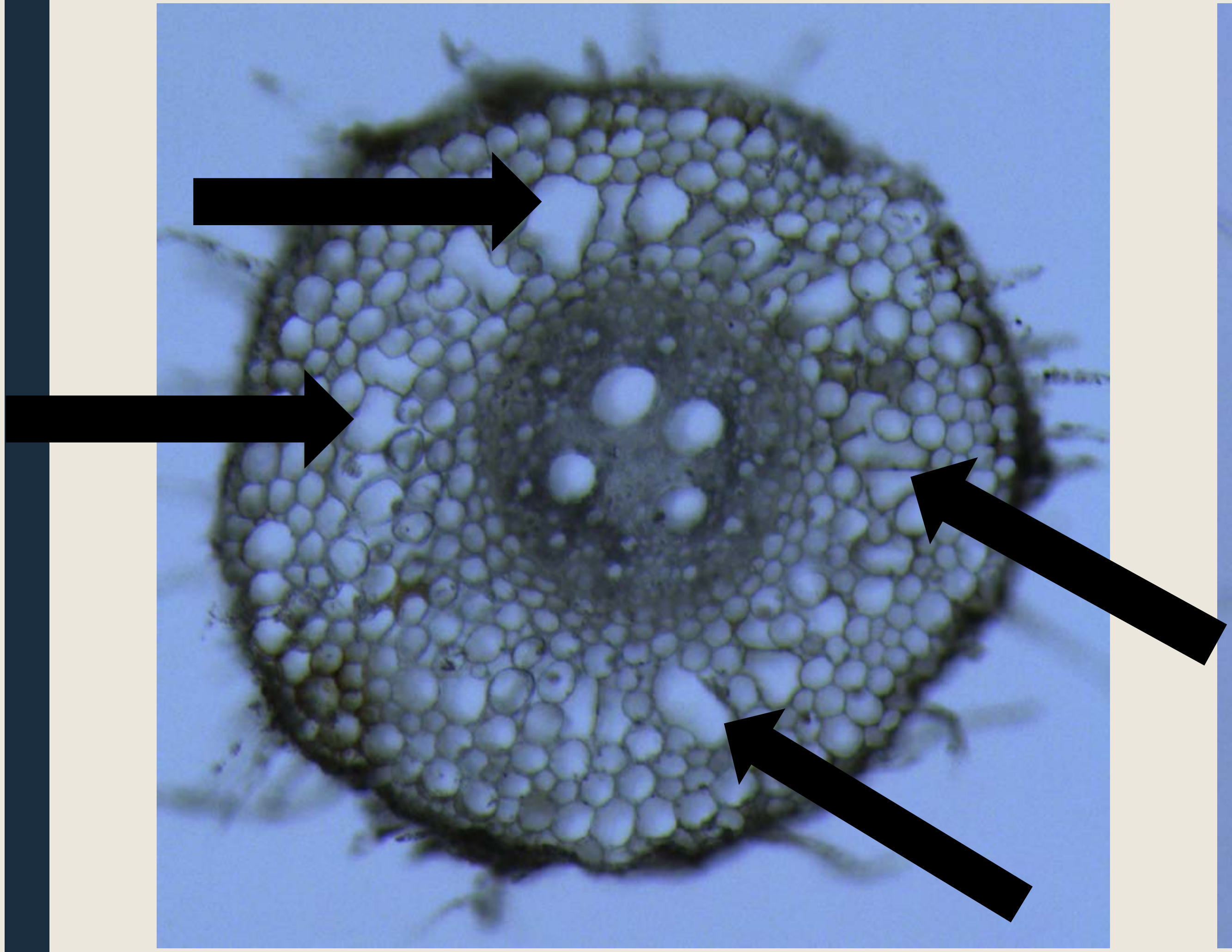
- Mini rhizotron
- RootSnap Software
- Slicer
- Microscope

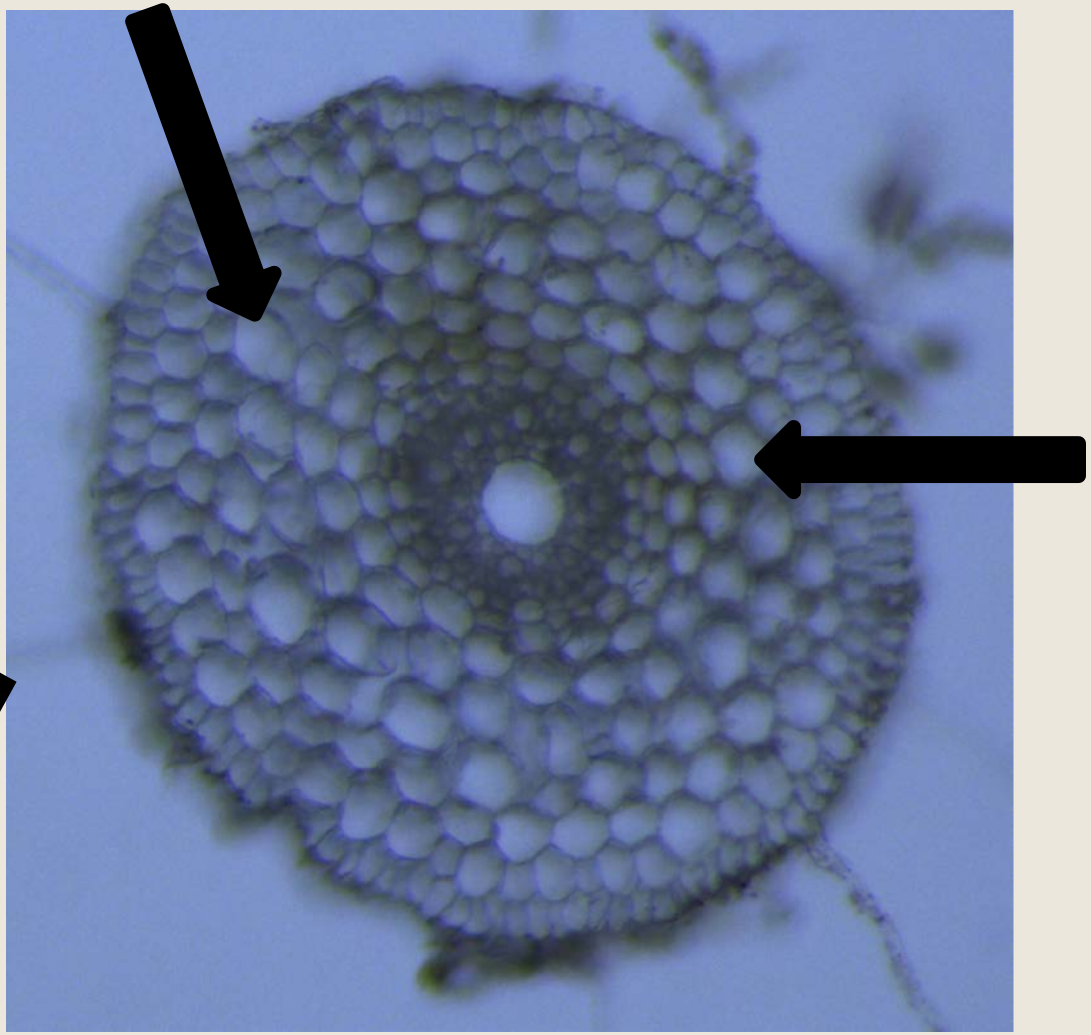


https://www.bhphotovideo.com/images/images500x500/Swift_SM3_124_SM3C_SM3_124_Series_Three_Stereoscopic_448864.jpg

Results: Qualitative Data

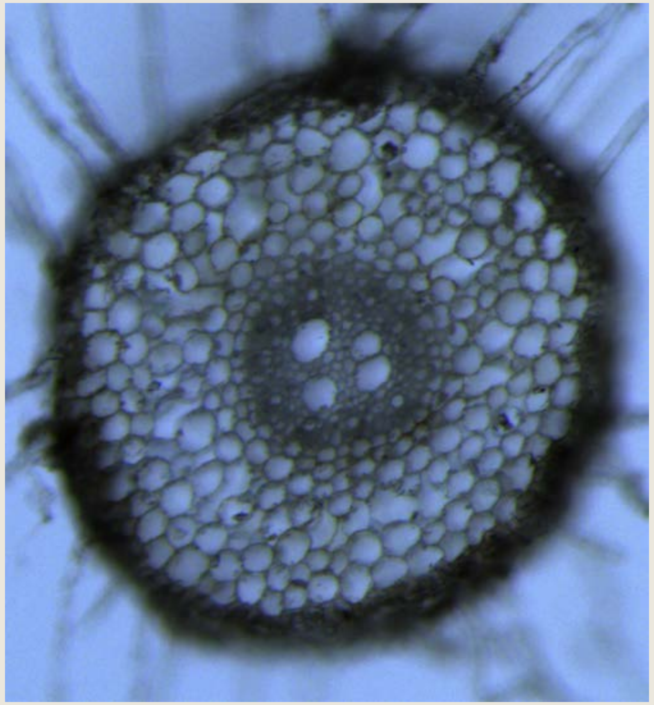
- Aerynchyma in waterlogged roots vs good structure in aerated roots



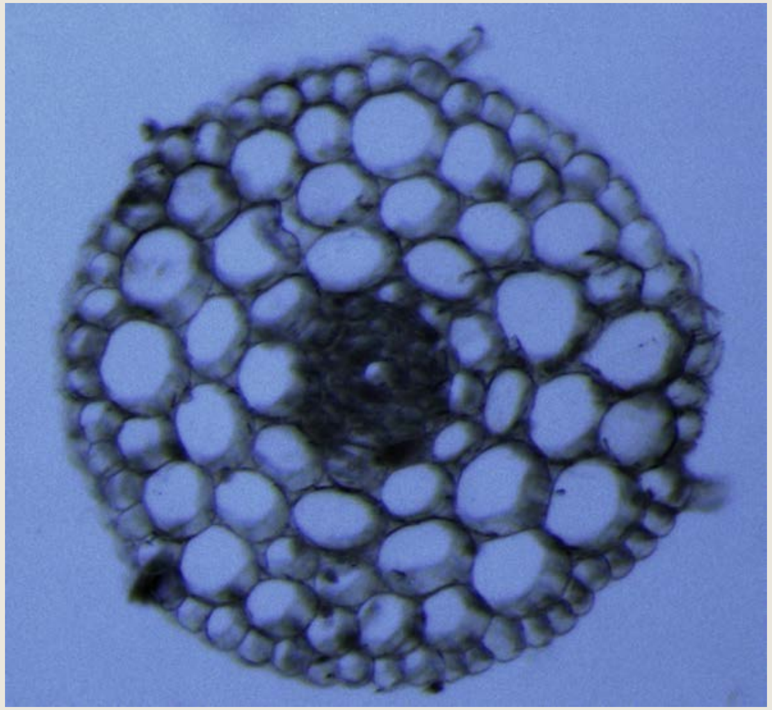


Microscope: Qualitative Data

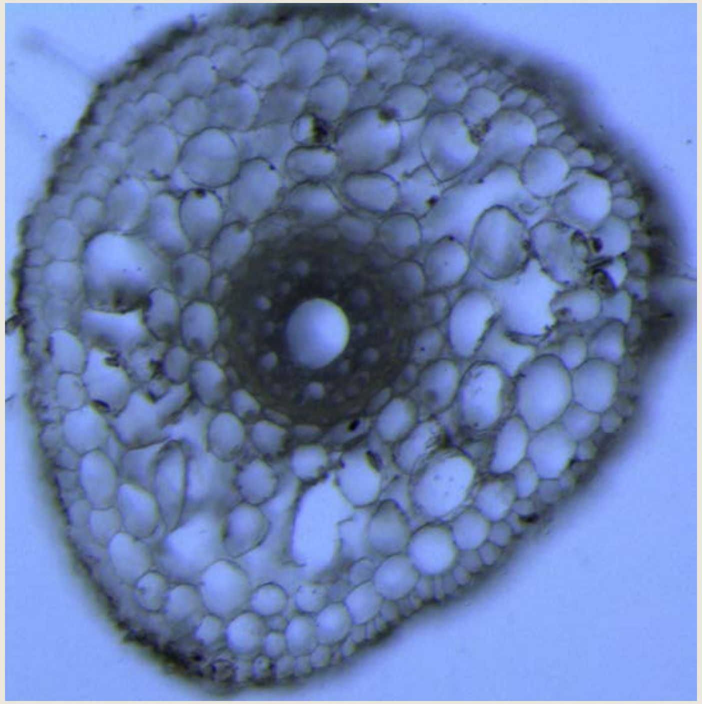
- Outliers leave some uncertainty



Waterlogging aerenchyma uncertain in two of the samples

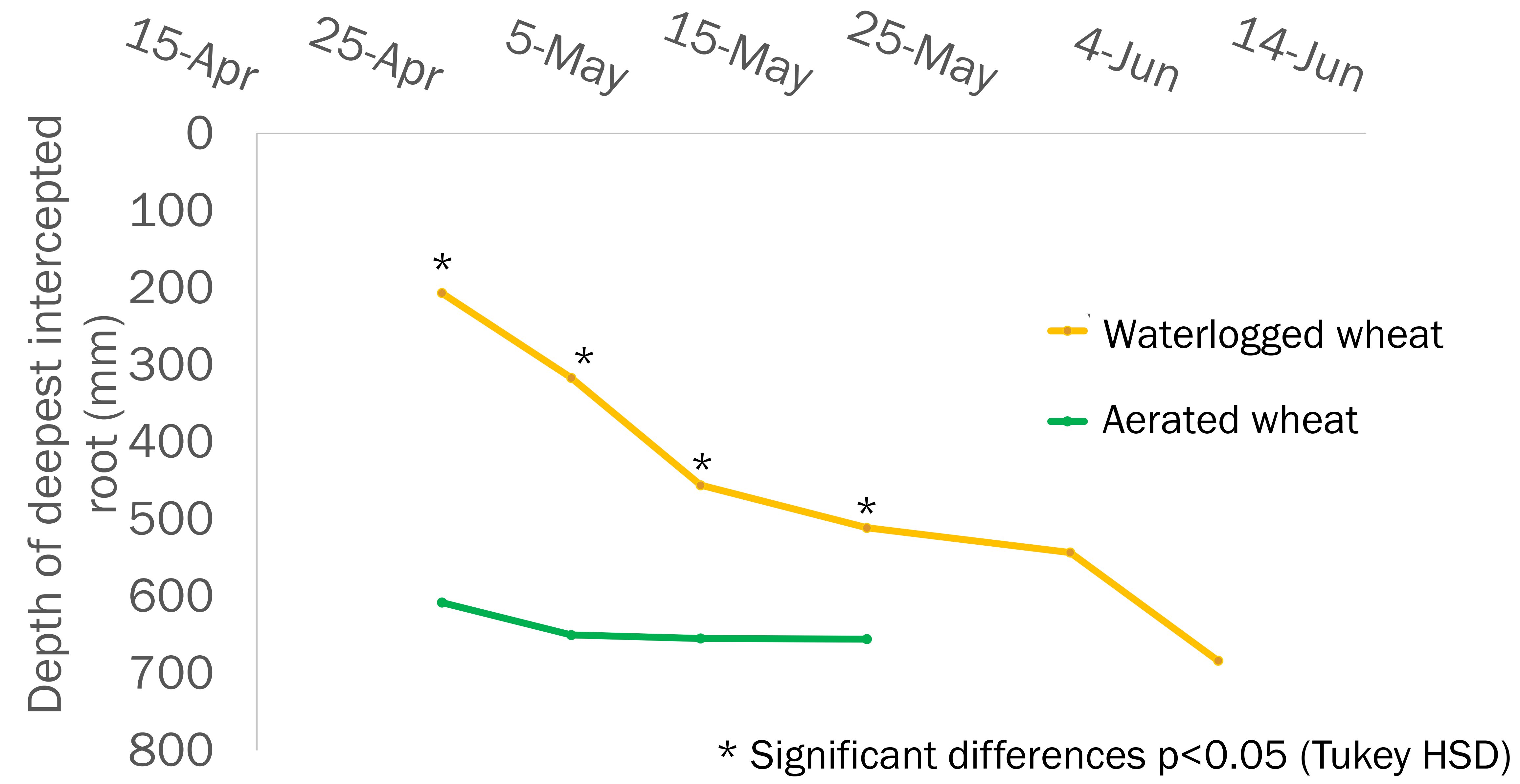


Large cell space in aerated root, but all relatively even in size

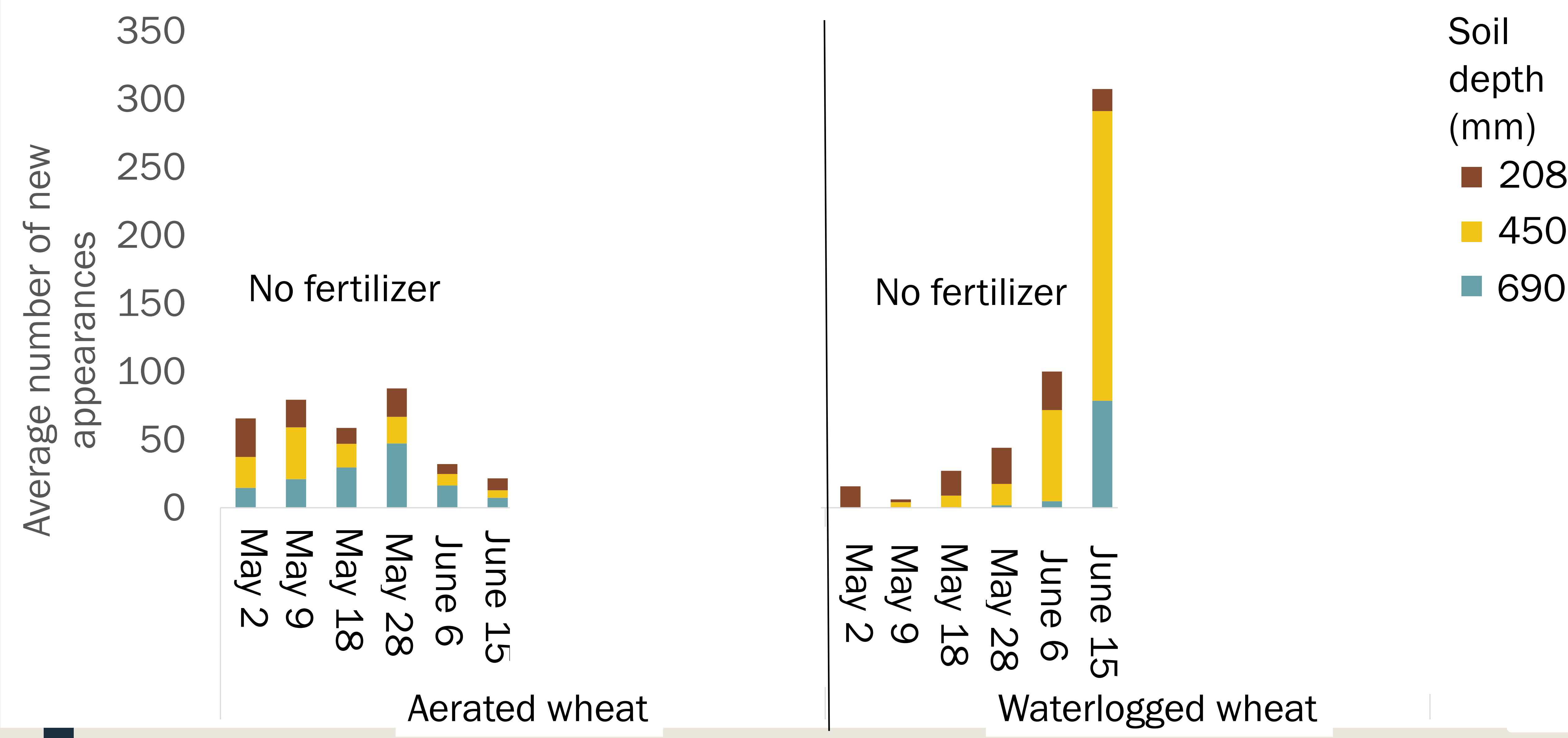


Misshapen root cells in aerated roots may be aerenchyma, or a result of breakdown

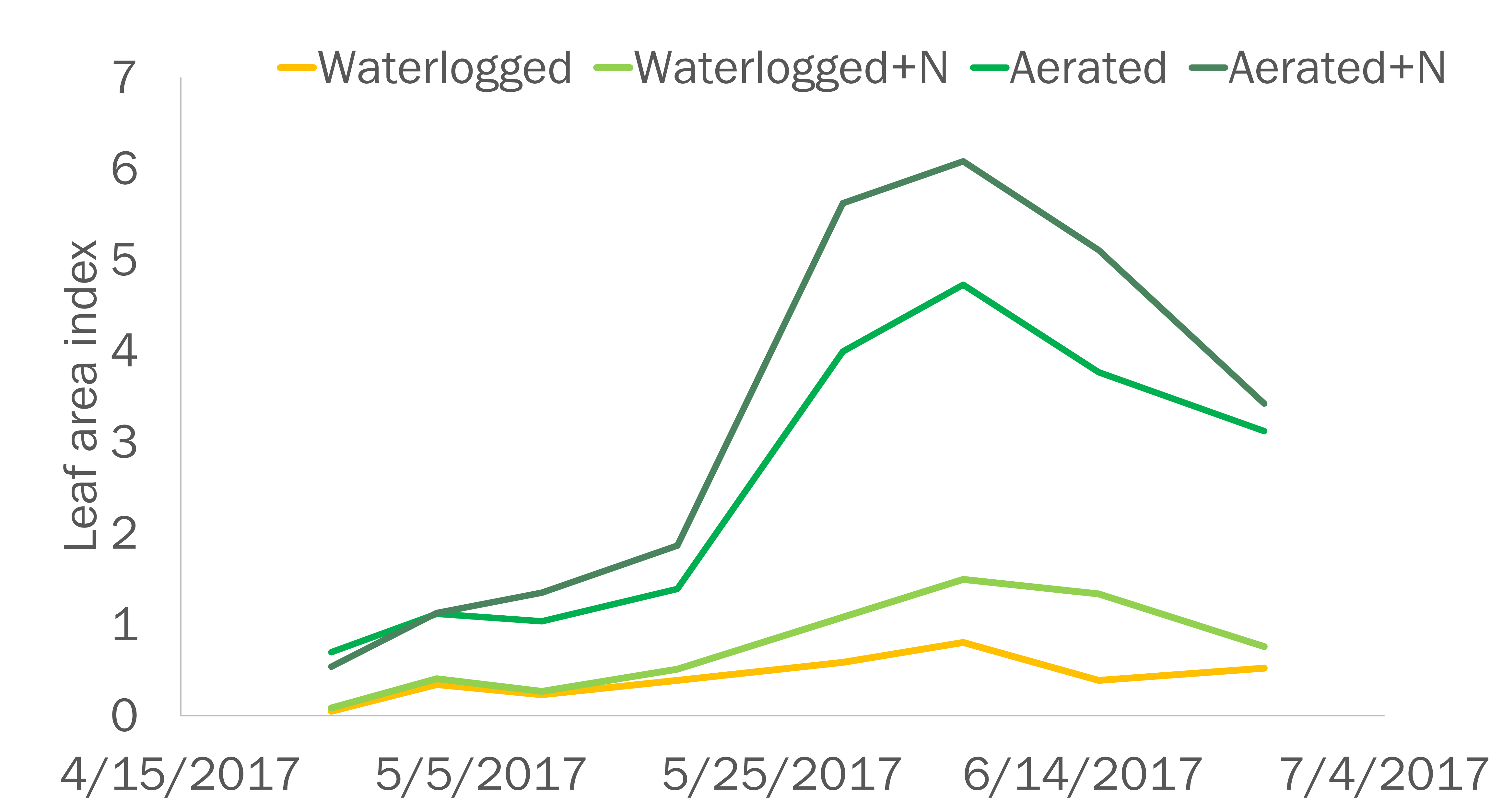
Results: Rooting depth



Appearances of new roots



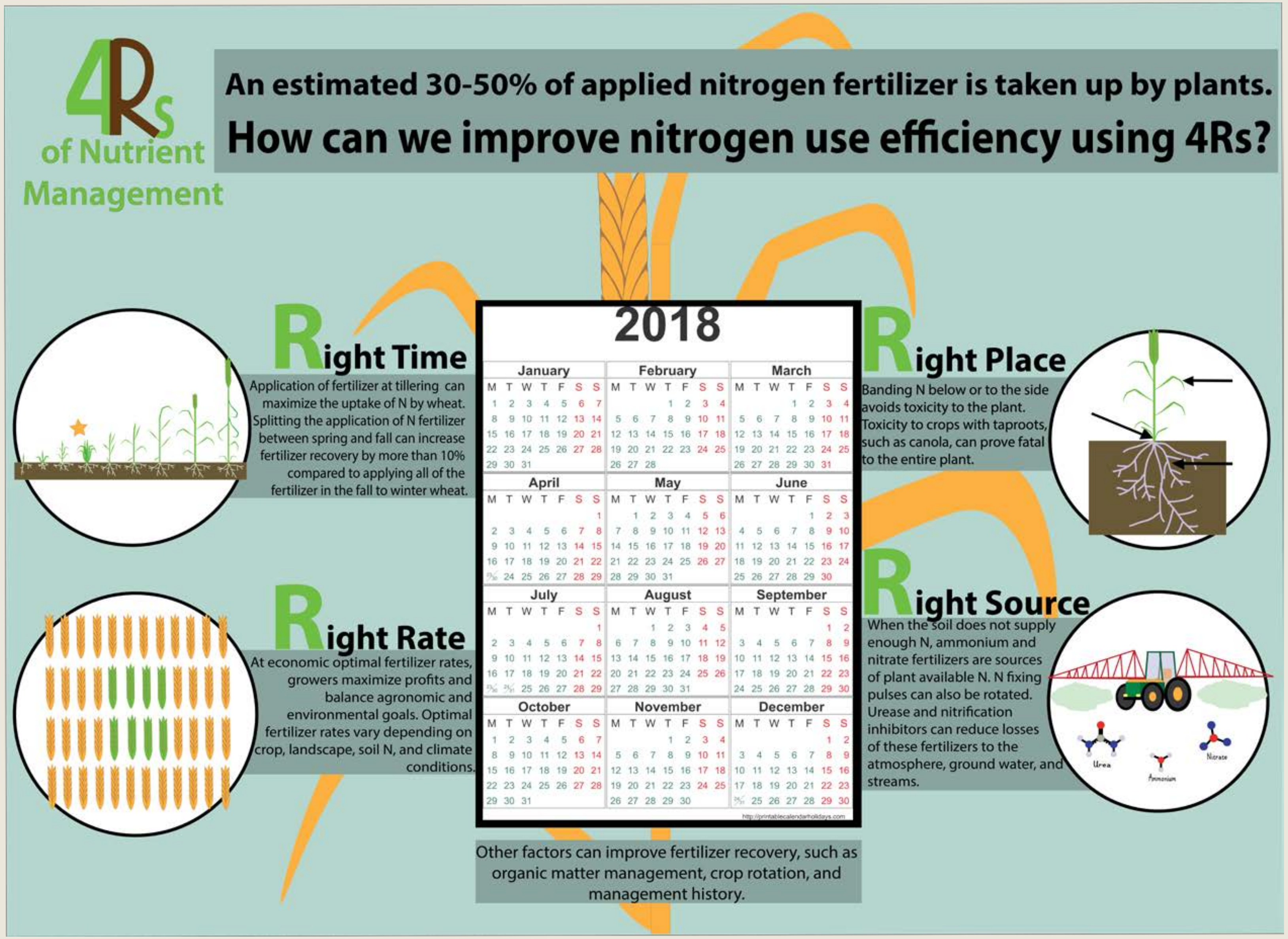
Relationship to “greening up” of wheat



Conclusions

- Aerenchyma *may* have helped plants survive waterlogging
- Waterlogging restricted rooting depth
- After soils drained, roots began to appear and plants greened up
- However, plants were injured and leaf area did not recover
- Spring application of N reduced injury and *may* have stimulated new roots, especially shallower roots in waterlogged soils

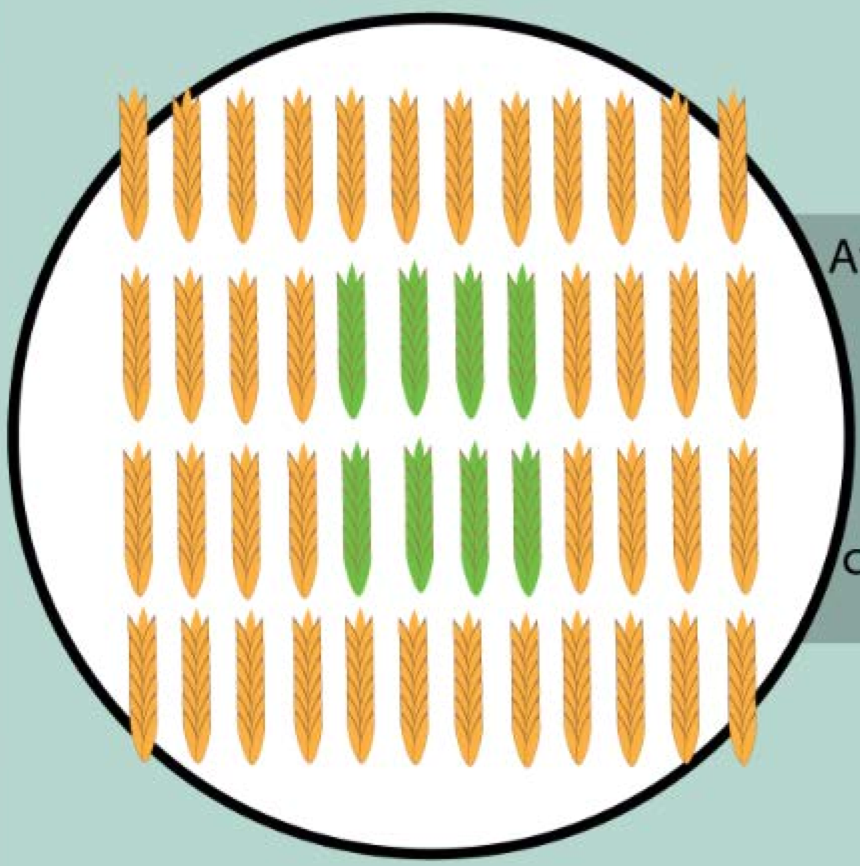
Extension Project



4Rs of Nutrient Management

An estimated 30-50% of applied nitrogen fertilizer is taken up by plants.

How can we improve nitrogen use efficiency using 4Rs?

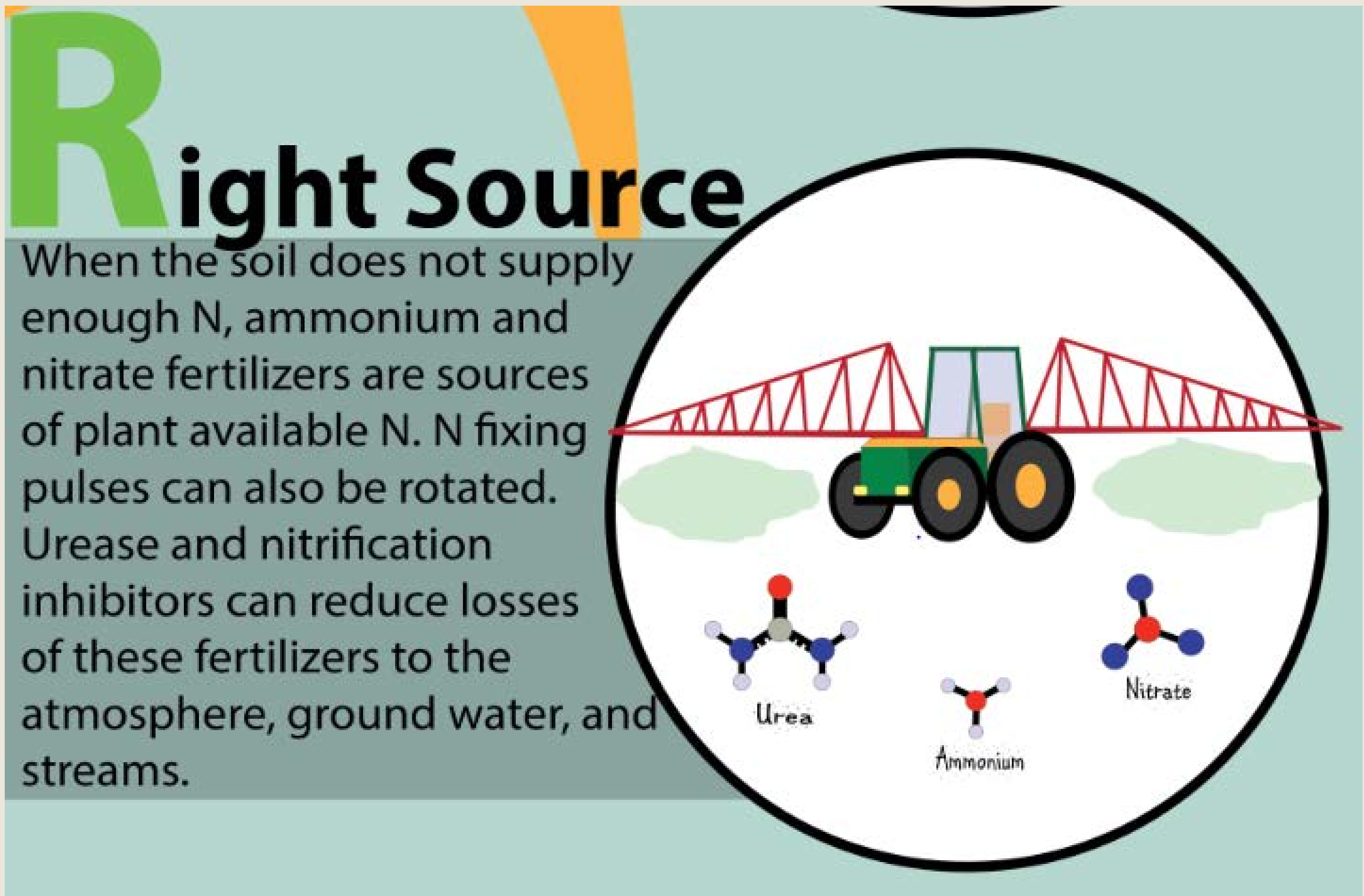


Right Rate

At economic optimal fertilizer rates, growers maximize profits and balance agronomic and environmental goals. Optimal fertilizer rates vary depending on crop, landscape, soil N, and climate conditions.

Fiez et al., 1994
Gardner and Drinkwater, 2009
Cassman, Doberman & Walters 2002
Smil, 1999

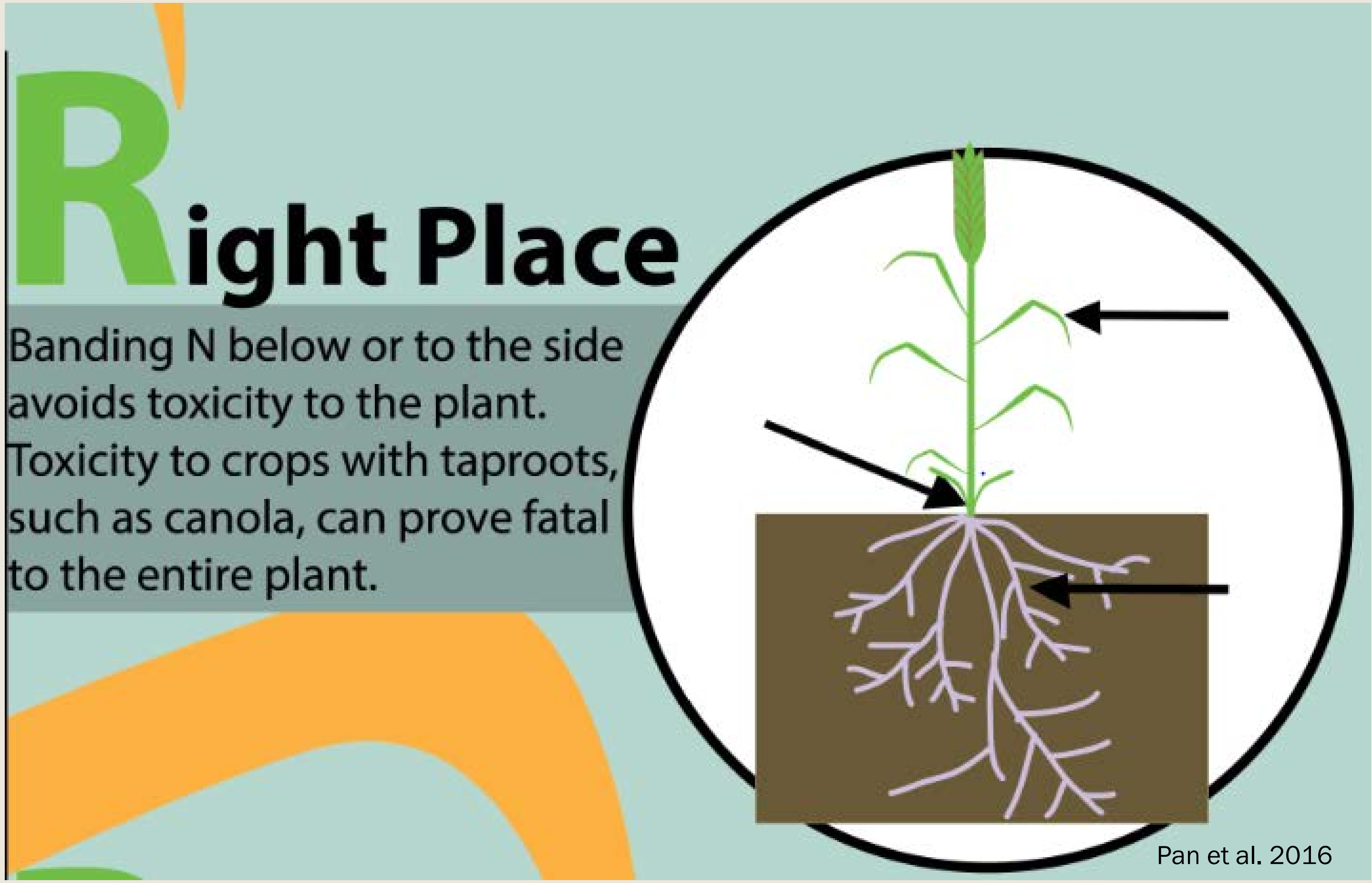
Extension Project: The 4 R's



Extension Project: The 4 R's

Melaj et al., 2003
Sowers et al., 1994
Gardner and Drinkwater, 2009

Extension Project: The 4 R's




Questions?

THANK YOU!

Acknowledgements

Washington State University, University of Idaho

Pan Lab: Dr. Bill Pan, Dr. Tai Maaz

Sanguinet Lab: Dr. Karen Sanguinet, Thiel Lehman

Ian Clark

Gillian Gavino

This work was supported by the National Institute of Food and Agriculture (NIFA), USDA Award Number:2016-67032-25012

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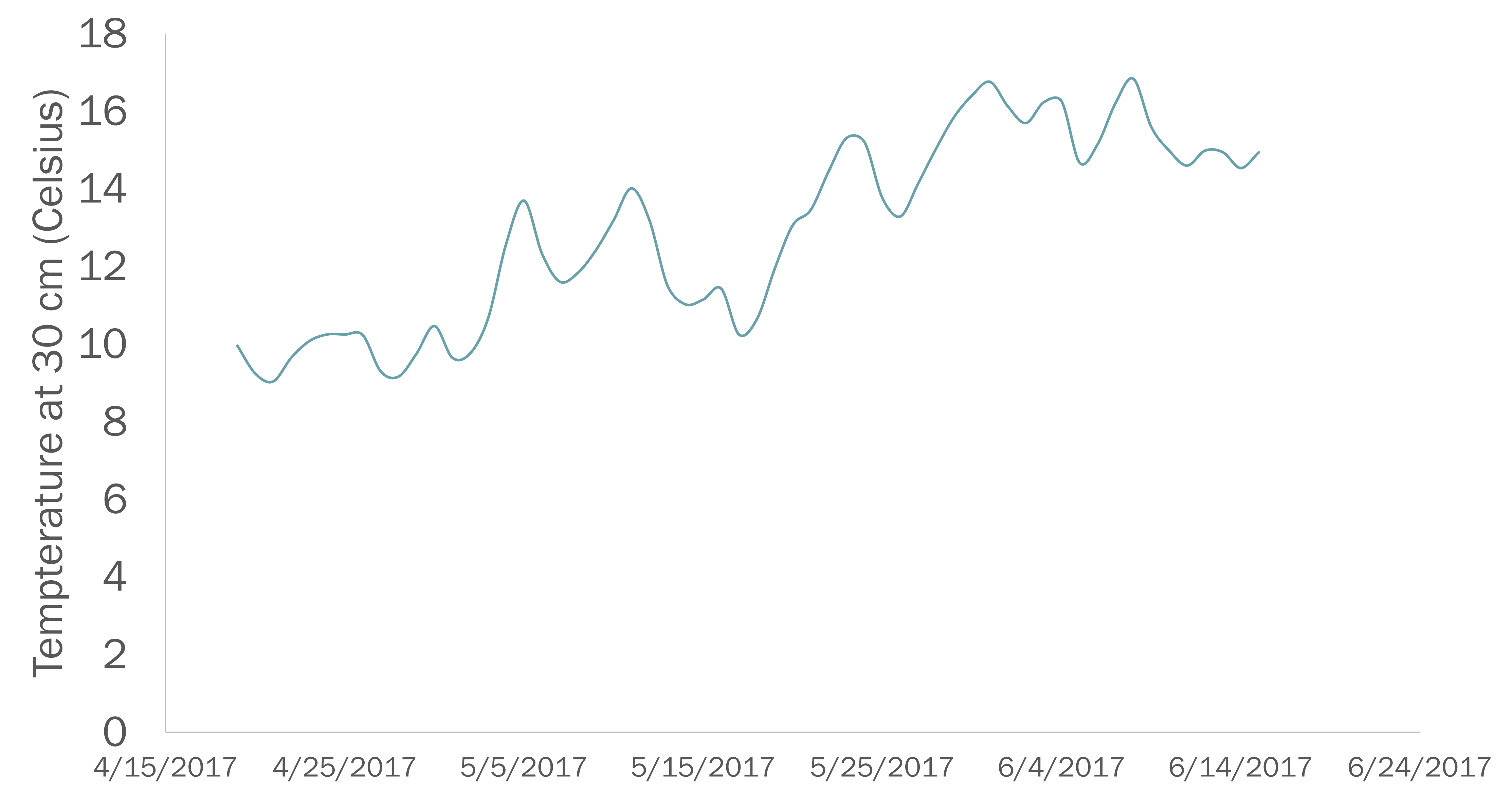
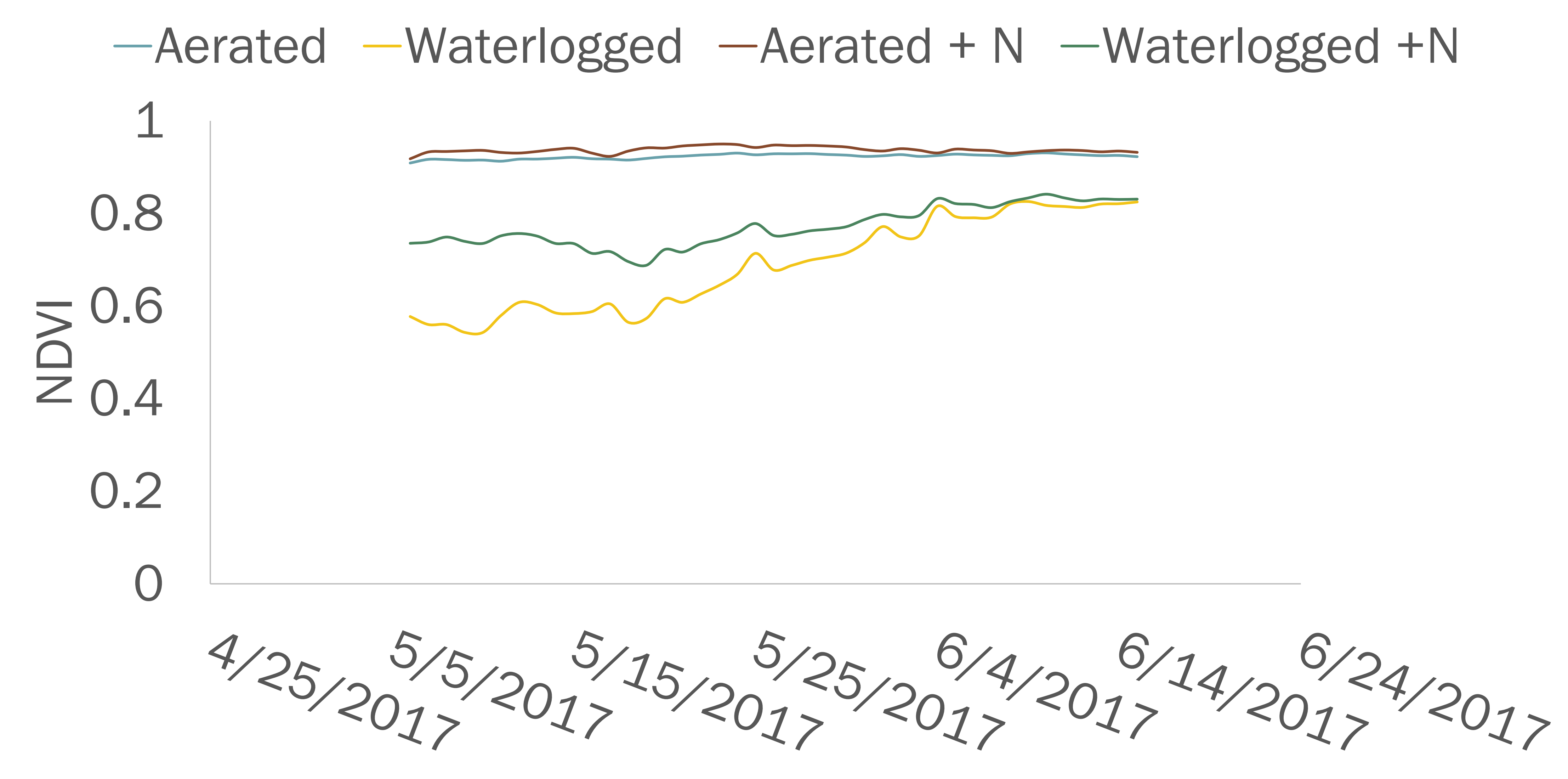
Temperature

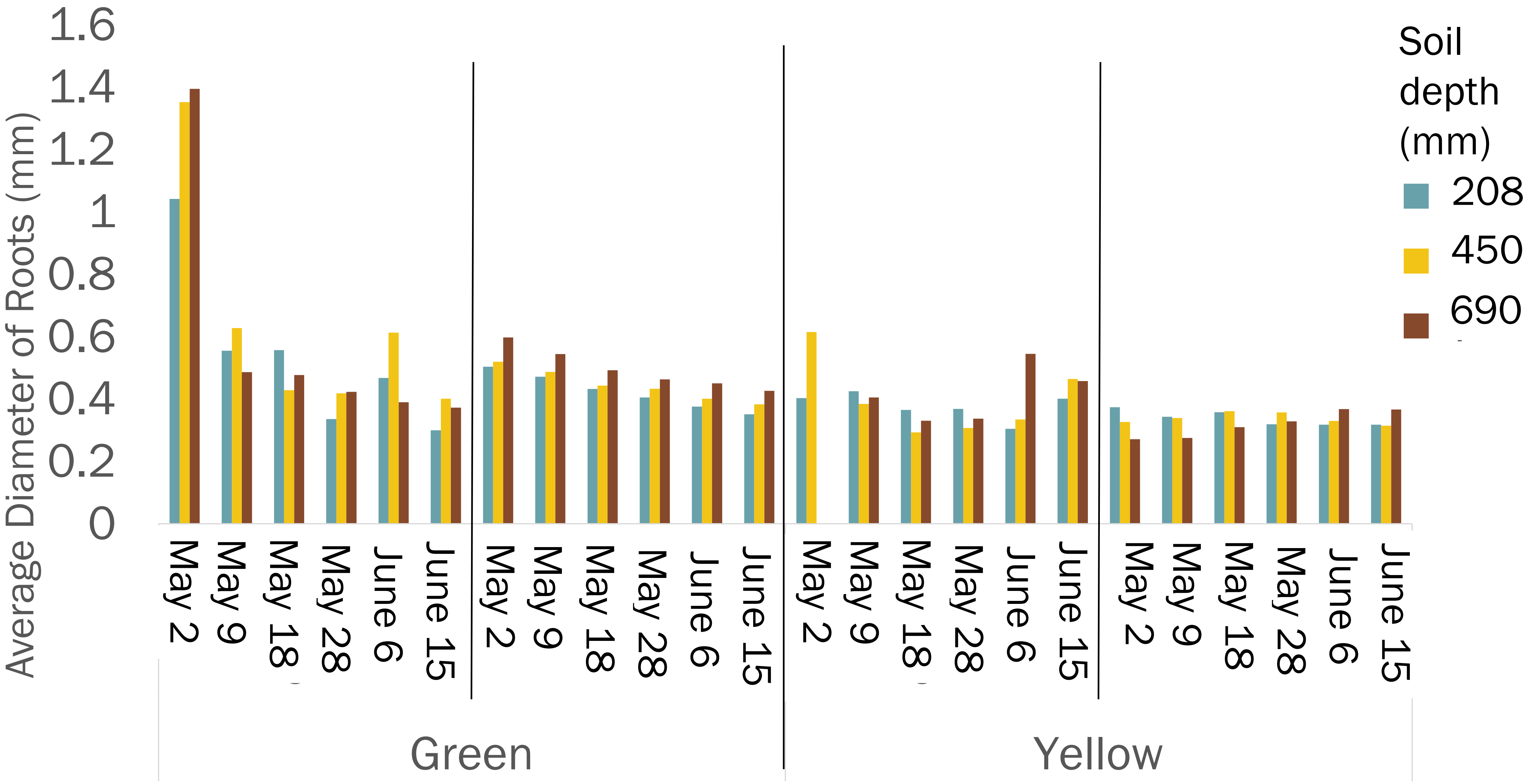


NDVI



Aerated
Waterlogged
Aerated + N
Waterlogged +N
NDVI
1
0.8
0.6
0.4
0.2
0
4/25/2017
5/5/2017
5/15/2017
5/25/2017
6/4/2017
6/14/2017
6/24/2017

Average Diameter



Volumetric Water Content