The secret life of plant roots: what we can learn from *in situ* imaging of grass roots in soil

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Introduction

Dryland farms in Eastern Washington experience yield losses due to drought stress. In 2014, there was a 20-50% yield decrease caused by drought and heat. Therefore, finding a way of improving the wheat root structure can be very beneficial due to the fact that this will help the plant resist such stress by increasing the access to water. No-till practices need to be taken in consideration as well because they have changed the soil structure and pathogen load, which causes alteration of root and soil-microbe interaction. As a matter of fact, the root system needs to be optimized for the current non-till conditions in order to benefit ourselves by obtaining better yields as well as the quality of wheat.

- **The primary goal for this research project is to identify root architecture in current breeding populations like Drysdale and Hollis which are associated with better yield under drought stress. Hollis in a commonly grown Hard Red Spring Wheat in the PNW, whereas Drysdale is a highly drought tolerant wheat variety. For this particular research project, a state-of-art-digital scanner was used to keep track of the root growth in a non-destructive way over an entire growing season.**

Figure 1.

Figure 1. A hand-held auger was used to create the holes for the 1m acrylic tubes to be planted.

Figure 2.

Figure 2. Each tube was planted in between rows one and two of a six-row plot to ensure they were both clear of equipment and angled towards actively growing roots.

Materials

- CI-600 In Situ Root Imager from CID- Biosciences with PC tablet
- 22 CID-Bioscience acrylic tubes, 1 meter in length
- An auger to make the holes for the tubes
- Flags
- Wheat plants (WSU Dryland Research Station; WSU Spillman Agronomy Farm, WSU Plant Growth Facilities)

Procedures

1. Establish the field site where research will take place (WSU Dryland Research Station)
2. Obtain a map of the wheat varieties that are planted in the field
3. Locate the varieties to be analyzed
4. Use the auger to make a hole
5. Plant the 1m long acrylic tube in the hole
6. Use a flag to keep track of the number of tubes and wheat varieties
7. Serial root scans at different plant growth stages (seedling, bolting, seed fill)
8. Each root tube had four overlapping scanning windows that were scanned with the *in situ* root scanner and PC tablet
9. Analysis of root traits using the RootSnap! software

Results & Conclusions

Plants were sampled every two weeks at the Dryland Research Station in Lind, WA. Plants were not irrigated. At the first sample date (5/14/15), both Hollis and Drysdale roots appear healthy and are actively growing. Also moisture and condensation on the root tubes indicated water present in the soil. However, at the last scan date, we can observe reduced moisture in the soil and root dieback likely caused by lack of water and heat stress. We have begun analysis of quantitative root traits using the RootSnap! Software, but we are still working on the analysis.

Conclusion 1: Soil moisture dramatically reduces in the 1m soil space over the growing season.

Conclusion 2: Roots die back over the course of the growing season.

Conclusion 3: During vegetative growth earlier in the season, roots are actively growing in depth. Even at a few weeks old, wheat roots in non-irrigated conditions grew to 1 m. Thus, deeper root imaging tubes are needed to determine final rooting depth.

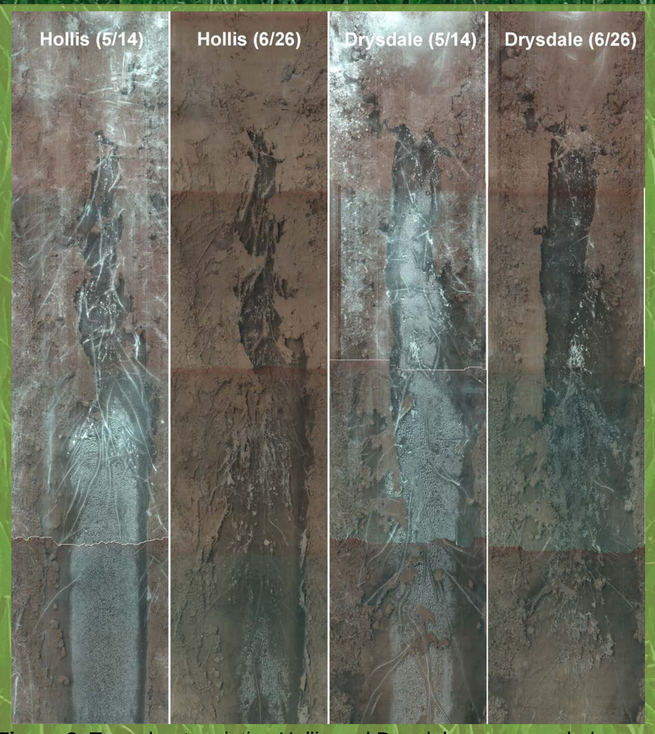

Figure 3. Two wheat varieties Hollis and Drysdale were sampled over the the growing season. Depicted from left to right are Hollis at the first scan date (5/14/15) and final scan (6/26/15) and Drysdale at the first scan date (5/14/15) and final scan (6/26/15)

Figure 4.

Figure 4. Tubes were imaged at 300 dpi using the CI-600 scanner and accompanying tablet PC with four scans per tube. Resulting images were compared for different root traits.

Figure 5.

Figure 5. An example of how the CI-600 scanner system works. The scanner head is lowered into the transparent tube and then scanned with the tablet PC to image roots below the soil surface.

Summary & Acknowledgements

This internship was extremely beneficial in helping me figure out what I would like to do for my career. At first, I was interested in pursuing a degree in Fruit and Vegetable Management, but working with these different varieties of wheat made me change my mind to wanting to study Agricultural Biotechnology. The reason is because I would like to learn about how to create new varieties of any kind of tree fruit or cereal. Therefore, this internship has provided me with the opportunity of gaining valuable research experience which will be of great help later on as I move forward towards obtaining a degree in Agricultural Biotechnology. We would like to thank Dr. Scot Hulbert for helping us plant the root imaging tubes and allowing us to image his wheat varieties. We'd also like to thank Mr. Alex Mojcher for technical assistance. We'd also like to thank CAHNRS, WSU and the Washington Grain Commission for financial support.