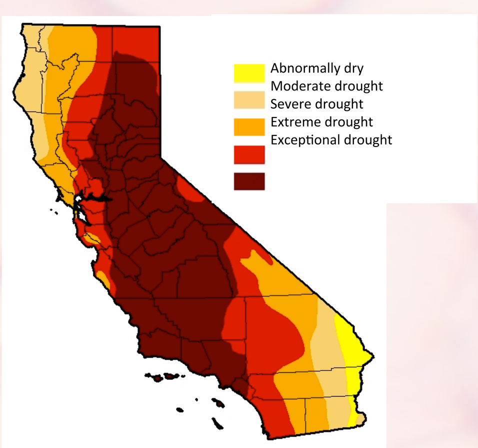
Effects of Soil Conditions on the Anatomical Characteristics of the Adventitious Roots of Tomatoes

Reina Marie Sanz, Ayumi Gothberg, Kaisa Kajala, Siobhan M. Brady
Department of Plant Biology and Genome Center
University of California, Davis

1. Under extreme environmental conditions, phenotypic plasticity of plant roots plays a significant role in a plant's survival



- Crop yield is threatened by the predicted rise in both drought and flooding.
- In flooding conditions, oxygen is depleted in the soil.
- In drought conditions, water is scarce around the surface of the soil, so roots tend to extend deeper into the soil in search for water.
- Adventitious roots exist near the surface of the soil, developing from the stem and hypocotyl of the plant, especially in response to flooding.

Biological question:

- In what ways do plant roots modify their anatomical features in order to adapt to varying environmental soil conditions?

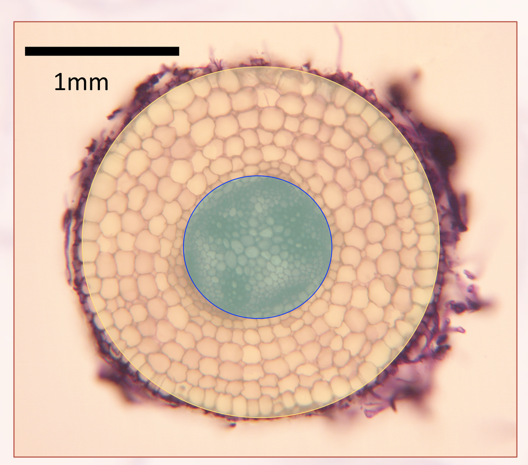
2. The plant roots were imaged and statistically analyzed

- Tomato (***Solanum lycopersicum* cv. M82**) roots from distinct soil conditions (14 days of control, drought, or waterlogging) were sectioned using a vibratome and imaged using a light microscope.

- I analyzed the cross section images using ImageJ for the areas of the vascular and nonvascular tissues.

3. The nonvascular area and cortex layers of the adventitious roots show significant modification in varying soil conditions

The growth of adventitious roots at 35 days old. There is more adventitious roots in the waterlogging treatment.



Highlighted in yellow: Vascular Area
Highlighted in blue: Non-Vascular Area

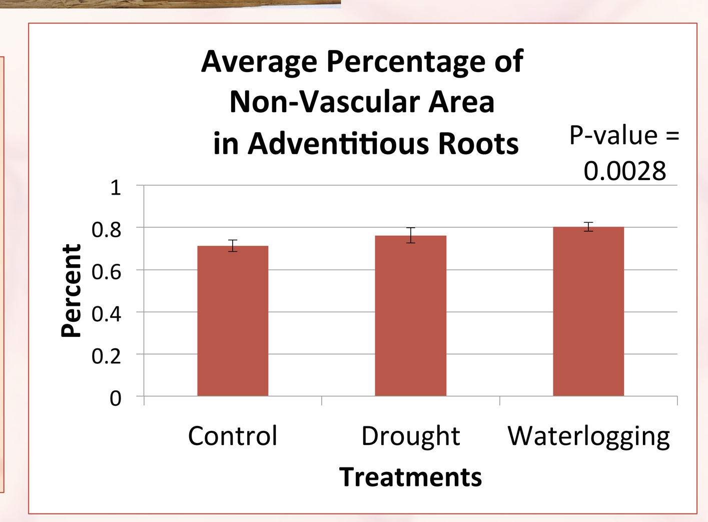
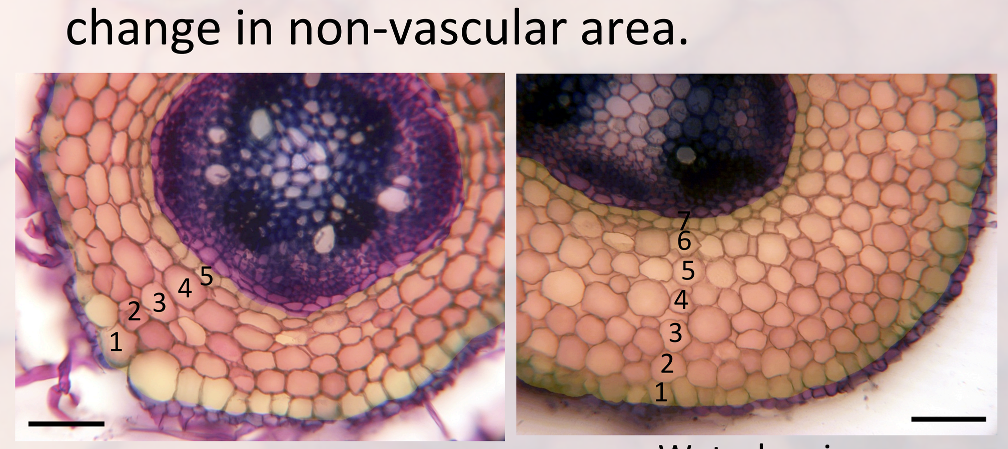


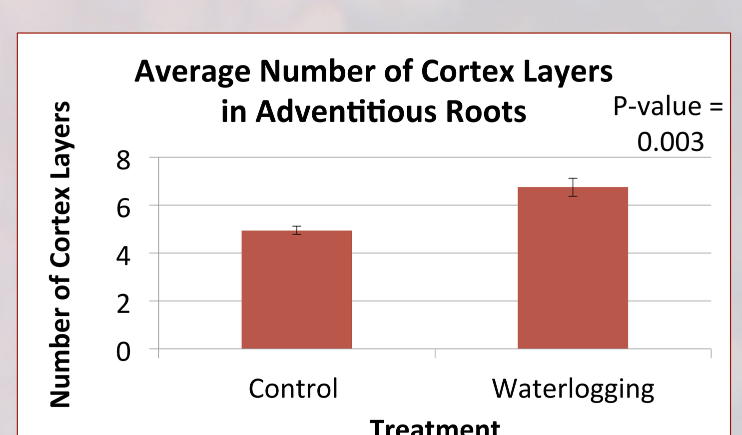
Figure 1: Compared to the control (71%), the percentage of non-vascular area of the adventitious roots was higher in both drought-treated (76%) and waterlogged roots (80%).

- Under waterlogging treatment, the percentage of non-vascular tissue area in adventitious roots was significantly higher in waterlogged roots compared to the control (p=0.0028).
- Under drought soil treatment, we saw no significant change in non-vascular area.



These 2 adventitious root sections depict the on average higher number of cortex layers of the waterlogged roots compared to the control.

Figure 2: Under waterlogging treatment, there are on average 7 cortex layers compared to the control's on average 5 cortex layers.



- This increase in non-vascular tissue area in the waterlogging treatment is due to an increase in the number of cortex layers in the adventitious roots (p=0.003).

4. Similar, but statistically insignificant, trends were found for the main roots

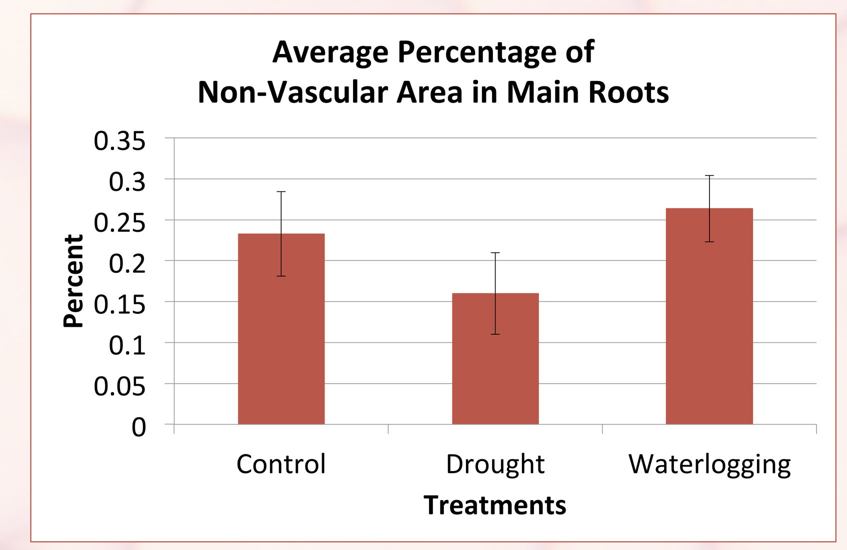
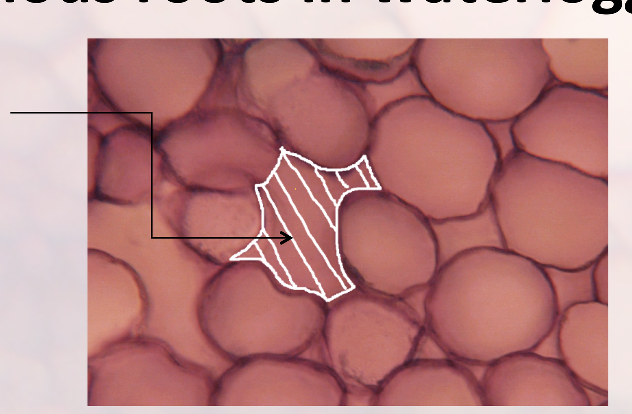


Figure 3: Compared to the control (23.27%), drought treatment contained 15.97% and waterlogging treatment contained 26.38% of non-vascular area in the main roots.

- Under waterlogging treatment, the percentage of non-vascular tissue area in the main roots appeared higher in waterlogged roots compared to the control; however, this was not statistically significant.
- Under drought treatment, similar to the adventitious roots, we saw no significant change in the non-vascular area.

5. The intercellular space is larger in adventitious roots in waterlogging

Intercellular space



- Adventitious roots of waterlogged plants have a larger percentage of intercellular space between the cortex layers compared to control.

Figure 4: Given the data, the waterlogged treatment contained a larger percentage of intercellular space of total cortex area compared to the control.

6. Conclusions

- The adventitious roots of tomatoes acclimate to flooding.
- The percentage of non-vascular area in adventitious roots proved to be notably higher in waterlogged roots compared to the control. I hypothesize that this leads to the increase in the exchange of gases, especially oxygen, between the plant and its environment.
- This increase in non-vascular tissue area proved to be the result of an increase in number of cortex layers and intercellular space in the adventitious roots.
- Despite statistically insignificant data, the main roots of tomatoes also showed evidence of an increase in non-vascular tissue area.

6. Future Work

- Further work could be done to compare the acclimated anatomical characteristics to another set of treatments with a longer term of exposure to the control, drought, and waterlogging treatments. This would tell us if the main roots also show significant change in their non-vascular tissue area and number of cortex layers.
- Further work could also be done to test if the increased porosity of waterlogged adventitious roots allows increased gas flow into the root.

7. Acknowledgements

I would like to thank everyone from the Brady Lab for giving me the opportunity to become a part of the team. I would also like to thank my incredible mentor, Kaisa Kajala, for guiding and also teaching me along the way. Finally, I would like to thank my family and friends for their never-ending love and support.