Washington Grain Commission
Wheat and Barley Research Annual Progress Reports and Final Reports

Project #: 13C-3019-3687

Progress Report Year: *2 of 3 (maximum of 3 year funding cycle)*

Title: A Genetic Arsenal for Drought Tolerance, Getting to the Root of the Problem

Cooperators: *Karen A. Sanguinet (CSS) , Kim Garland-Campbell (USDA/ARS; CSS), Xiao Zhang (WSU, Tri-cities, CEB), Timothy Paulitz (USDA/ARS; Plant Pathology)*

Executive summary: Lignin content and accumulation in stems, leaves and roots has been linked with different stress tolerances in crop plants. Lignin confers rigidity to plant cell walls, and increases in response to drought, heavy metals, salinity, and pathogen attack. Therefore, managing overall lignin content, as well as its proportion in the roots versus shoots of crop plants is important for improved stress tolerance. Few studies have investigated the role of lignin in grass root systems at present. Reports on maize and wheat showed that lignin content in the root was higher than in the shoot, and that these levels varied depending on genotype. In wheat, lignin concentration was shown to decrease in seedlings and roots when exposed to mineral deficiencies and increase in response to toxic minerals. Given these findings, our preliminary results, there is a need to further investigate the role of lignin in roots. The overall goal of the project is to determine the role of lignin in wheat roots for drought tolerance and disease resistance and to develop a high-throughput method for lignin analysis is wheat roots and straw. We have worked on processing stem and root tissues for overall lignin content using two independent assays as well as sending pulverized stem and root tissues for analysis of monomers to the Zhang lab at WSU-TC. We had good success with lignin extraction in stems, but are still working on lignin extraction from root tissues. As such, we are outsourcing the lignin chemistry to a collaborator who works with grasses and lignin in roots and has already developed protocols. We have also begun to implement drought studies using the Phenospex drought spotter in the wheat greenhouse. In the coming year, we will refine the methodology and complete the analyses on the Lou/Au backcross populations in terms of lignin content, drought performance, and disease resistance for soil-borne pathogens.

Impact: In addition to stress tolerance, lignin has important implications for the rhizosphere and agricultural soils, particularly since it is a stable component of soil organic matter (SOM). There is evidence that lignin slows down the mineralization of nutrients from crop residues. For example, the ratio of lignin to nitrogen is used as an indicator for litter degradation. Studies have shown that lignin negatively affects short-term nitrogen release from different types of green manures that differ in lignin content and that time is a key factor in the lignin/nitrogen equation. Since SOM contains roughly two-thirds of global terrestrial carbon storage and lignin is an important component of SOM, lignified biomass represents a promising source of sustainable fertilizer, which is a concern for Washington state farmers and globally. Our research has shown the lignin monomer content and not total lignin content in winter wheat stems is important for residue breakdown and thus management. Long-term our data will shed light on the role of lignin in rhizosphere processes as well—such as soil-borne pathogen management and improving overall plant responses to abiotic stresses like drought, salinity, changes in pH, and cold.

WGC project number: 13C-3019-3687
WGC project title: A Genetic Arsenal for Drought Tolerance, Getting to the Root of the Problem
Project PI(s): Karen A. Sanguinet, Kim Garland-Campbell, Xiao Zhang, Timothy Paulitz
Project initiation date: 7/1/18
Project year (X of 3-yr cy year 2 of 3

Objective	Deliverable	Progress	Timeline	Communication
1. Quantification of lignin content in roots and stems	A robust and reliable method to accurately determine lignin content in root samples in a high-throughput manner is the main deliverable of this objective.	The first rounds of lignin extractions were performed with the parental lines: AUS28451 and Louise in 2018 both for total lignin and for lignin monomers. Following optimization of the protocols for root extractions, the Lou/Au BC1F6 populaitons were analylzed in 2019, but another repetition is needed. We have also identified some additional backcross lines of interest, There were technical issues with quantification of the full aromatic	The quantification of lignin and optimization of the extraction methods was performed for total lignin. Three independent methods have been used for lignin quantification. We are now going to perform an entire aromatic profile for Aus28451 and Louise.	We developed a robust and high-throughput method for lignin quantification, and are planning a methods protocol for publication in addition to another peer-reviewed publication with the aromatic profiles.
2. Assessment of the role of lignin in drought	If lignin in roots is associated with drought, this can then be a desirable trait and selected/screened for in breeding populations.	The parental lines have been assessed and protocols established for the greenhouse trial in years 1 and 2 so the selected BC can be assessed in year 3.	Assessment of the parental lines was completed in 2018 and is being followed by two rounds of greenhouse trials with the backcross lines in year 3.	The findings and protocols will be reported at field days and in peer-reviewed publications.
3. Root lignin and soil-borne disease	If lignin in roots is associated with disease reisistance as hyprothesized, this can then be selected/screened for in breeding populations.	The parental lines have been assessed and protocols established for the greenhouse trial in years 1 and 2 so the selected BC can be assessed in year 3.	Assessment of disease resistance was assayed in spring 2019, but needs to be repeated in 2020.	The findings and protocols will be reported at field days and in peer-reviewed publications.