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

Project #: 13C-3019-3687

Progress Report Year: *__1__ 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 Path)*

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. We have also begun to implement drought studies using the Phenospex drought spotter in the wheat greenhouse. In the next two years, 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.

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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
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Project year (X of 3-yr cycle): year 1 of 3

Objective	Deliverable	Progress	Timeline	Communication
1. Quantification of lignin content in roots	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 will be analylzed in 2019-2020.	The quantification of lignin and optimization of the extraction metnods will be performed in the first part of year 1 so that by the end of year 1 all of the BC1F6 populations will be analyzed	An article was published in the Aug/Sept 2018 issue of Wheat Life on drought and roots. If a robust and high-throughput method proves successful, a methods protocol will be published.
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 year 1 so the selected BC lines with low, intermediate and high lignin content can be assessed in years 2 and 3.	Assessment of the parental lines were completed in 2018 and will be followed by two rounds of greenhouse trials with the backcross lines in years 2 and 3.	The findings and protocols will be reported at field days and in peer-reviewed publications. We published two abstracts in the Lind Field Day Abstract book in 2018 and Sanguinet also presented on roots at the Wheat Academy in Dec. 2018
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.	Previous work has indicated that the landrace AUS28451 is resistant to soil-borne nematodes and Rhizoctonia. Both parental and BC lines with varing degrees of root lignin content have been assessed for disease resistance in a greenhouse screen with conetainers.	Assessment of disease resistance will be repeated in 2019-20.	The findings and protocols will be reported at field days and in peer-reviewed publications.