

**Washington Grain Commission**  
**Wheat and Barley Research Annual Progress Reports and Final Reports**  
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**Project #:** 3061-4949

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

**Title: Management of Nematode Diseases with Genetic Resistance**

**Investigators: S. Hulbert, K. Garland-Campbell, and T. Paulitz**

**Cooperators: R. Smiley**

**Executive summary:**

- We have screened 112 adapted lines from the Western Spring Regional Nursery in 2014, in a field infested with cereal cyst nematode (*H. filipjevi*) near Colton, WA. SY Steelhead and AUS28451 (an Iranian landrace) showed resistance. Glee (WA 8074), Glee 0W and SY605 CL showed moderate resistance. A newly tested line, Svevo, showed resistance. Ouyen, a resistant check to *H. avenae*, was susceptible, while Chara, another resistant check to *H. avenae*, showed moderate resistance to *H. filipjevi*.
- In Spring, 2014, *Heterodera filipjevi* was discovered in Washington, near Colton. We have extended our survey to cover all of Whitman County in Fall, 2014, with a more intensive sampling to determine the extent of this infestation. We sampled 75 sites, and are currently extracting DNA to use molecular methods to determine species identity.
- We were successful in conducting a greenhouse screen of 112 varieties using infested soil collected in the spring 2014. SY Steelhead and AUS28451 were resistant. The resistant check for *H. avenae* Ouyen was moderately resistant to *H. filipjevi*, while another resistant check Chara showed resistance. In addition, we discovered two additional resistant lines, Svevo and Soft Svevo.
- For root lesion nematode (*Pratylenchus thorneii* and *P. neglectus*), we have screened a collection of Iranian landraces and identified several with dual resistance to both species. We have conducted QTL analysis of resistance in a specific landrace, AUS28451. We are confirming these QTL in backcross populations of AUS28451 cross to Alpowa and to Louise. We have identified promising segregants from these backcross populations that perform well in infested field sites in Pendleton.
- AUS28451 has more root lignin than the adapted PNW cultivar, Louise. We have assayed total root lignin in the mapping population. Total lignin is correlated with nematode resistance in this population. We are currently measuring the expression of genes in the lignin pathway with the goal of identifying possible methods of selection for this trait using gene expression or QTL rather than conducting full scale resistance assays.
- A survey of plots at Spillman in 2014 revealed significant populations of lesion nematodes in several fields. We are establishing a disease screening nursery at Spillman. This nursery, which will be easily accessible, will enable us to evaluate more germplasm in the field.

**Impact:**

- We have now identified 6 locally-adapted spring wheat varieties with resistance to cereal cyst nematode. These varieties may be available to growers in the next 1-2 years, allowing them to reduce the inoculum levels in their fields.
- The resistance to cereal cyst nematode that is present in these varieties is being used in crossing and breeding additional varieties in the ARS and WSU breeding program.
- The use of molecular markers will facilitate pyramiding resistance genes for cereal cyst nematode.
- The selected backcross lines with AUS28451 as the resistant parent and either Alpowa or Louise as the adapted parent, are being further topcrossed to the best current spring and winter breeding lines.

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WGC project number: 3061-5745  
WGC project title: Management of nematode diseases with genetic resistance  
Project PI(s): S. Hulbert, T. Paulitz, K. Campbell  
Project initiation date: 7/1/2013  
Project year: 2014-2015

Objective	Deliverable	Progress	Timeline	Communication
Obj. 1. Conduct surveys for CCN	Maps of CCN around all of Eastern and Central Washington	Completed a survey of 52 locations in July, 2013. Found white females in 27% of locations. With the discovery of <i>H. filipjevi</i> in Washington announced in Aug. 2014, we initiated a more intensive survey of Whitman County, collecting 75 locations in Sept.-Oct. 2014. Cysts are being extracted, and we will optimize molecular methods to do species identifications, which was not done on previous surveys.	Because of new species findings, survey will extend to the end of year 3, 2015.	Paulitz, T. C. 2014. "Root Disease Research at ARS Pullman-What's New?" Spokane Farm Forum, Ag Expo, Feb. 4, 2014. (presentation). Smiley, R. et al. Information on <i>Heterodera filipjevi</i> presented to APHIS in Fall, 2014. Paulitz, T. C. 2014. Updates in Wheat Disease Research, Garfield Grange, Colfax, Washington, January 25, 2014 (presentation)
Obj. 2) Screen adapted PNW and US varieties in infested grower fields for resistance to CCN, identify the Cre genes involved, and use markers to incorporate this resistance into breeding programs	List of resistant US and PNW varieties and lines, knowledge of what Cre genes we have in our backgrounds	Conducted initial trials showing feasibility of testing in grower fields, in summer, 2012. Evaluated spring wheat using visual rating system in infested grower field in 2013 and 2014.	Testing in field will be done in summer, 2015. Cross CCN resistant lines to other sources of resistance in 2014. Screen these populations in 2015.	Manning, Thompson. Y., Pumphrey, M., Garland-Campbell, K., and Paulitz, T. 2014. Screening locally adapted spring wheat lines for resistance to cereal cyst nematode. ASA, CSA, and SSSA Annual Meeting, Long Beach, CA. Nov. 2014. (presentation)
	Germplasm rated for resistance to CCN	Field trial was conducted in summer, 2014 in Colton. This is the field where <i>H. filipjevi</i> was discovered. SY SY Steelhead continued to show resistance. Glee (WA 8074), Glee OW and SY605 CL showed moderate resistance, with some reps showing very few cysts. These should be retested to verify. Ouyen, which is resistant to <i>H. avenae</i> , was susceptible in this field, while Chara showed moderate resistance. AUS28451, used in root lesion resistance work, showed resistance to <i>H. filipjevi</i> . We also identified Svevo with a high level of resistance. For the first time, we have identified locally adapted varieties with resistance.	Testing in field will continue in summer 2015.	Manning, Thompson. Y., Pumphrey, M., Garland-Campbell, K., and Paulitz, T. 2014. Screening locally adapted spring wheat lines for resistance to cereal cyst nematode. 2014 Dryland Field Day Abstracts. Dept. of Crop and Soil Sciences Technical Report 14-1. Pg. 68.
	Greenhouse method of screening was successfully tested	In Spring, 2014, we were successful in greenhouse screening using soil infested with <i>H. filipjevi</i> collected from the field in April. These results confirmed field results. SY Steelhead continued to show a resistant reaction. AUS28451, used in root lesion resistance work, also showed resistance. The resistant check for <i>H. avenae</i> Ouyen was moderately resistant to <i>H. filipjevi</i> , while another resistant check Chara showed resistance. In addition, we discovered two additional resistant lines, Svevo and Soft Svevo.	Continue greenhouse testing of lines in Winter and Spring, 2015	
Obj. 3. Complete the identification of and verify QTLs associated with resistance to root-lesion nematodes in AUS28451 and select resistant breeding lines in PNW adapted backcross populations with AUS28451 as a source of resistance.		A major QTL for resistance to both species of lesion nematode was identified on chromosome 5A from AUS 28451. Validation of this QTL is being done using field trials in infested fields, and in the greenhouse. Additional markers are being placed on the linkage map.	7/2013-12/2015	Thompson, A., Garland, Campbell, K. Paulitz, T. and Smiley, R. 2014. Rooting out defense mechanisms in wheat against plant parasitic nematodes. American Society of Plant Biologists Conference. July 12-16, Portland, Oregon (presentation)
		Backcross populations with AUS28451 as a resistance source are being selected. New crosses are being made with other sources of resistance. The selected best backcross lines were grown in nematode infested and drought stress locations at Pendleton and Lind in 2014.	7/2013-12/2015	