

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

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Project #: 3061-7667

Progress Report Year: 1 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

Executive summary:

- In 2016, we surveyed 50 locations in Walla Walla, Garfield, Columbia and western Whitman counties. Cysts were identified to species level with DNA techniques developed in previous. *H. filipjevi* was only found in southern Whitman County, and *H. avenae* in eastern Whitman County. No cysts were found in other locations.
- In Spring 2016, we used a high throughput greenhouse technique to screen 216 advanced lines from 4 breeding programs at WSU for resistance to *H. filipjevi*. This method uses soil collected from highly infested fields in spring. In the past 6 years, screening has been done in an infested field in Colton, which limits the number of varieties that could be screened, and was mainly used for screening the regional nurseries. For the first time, we also initiated screening for *H. avenae* in the greenhouse.
- We also developed a method for collecting soil in the fall, vernalizing in the cold room at 4 C, and starting screening in Feb. We found that cysts remained viable and hatched for at least a year, and were successful in getting infection in Aug. 2016 from soil collected in Oct. 2015. This will allow us to do additional screening in the winter and summer.
- From this screening, ARS Crescent and ARS Selbu continue to show resistance to *H. filipjevi* and 8 advanced breeding lines with resistance were identified from the Campbell program. From the Carter program, 2 soft white and 2 hard red breeding lines were identified with resistance, in addition to Jasper, Azumut and WA 8206. From the Morris soft durum program, Svevo, Soft Strongfield and two selections of Soft Alzada were resistant. No resistant lines were identified in 2016 from the Spring Wheat Program of Pumphrey.
- Because of lower inoculum densities of *H. avenae*, resistance assessments were not as conclusive as with *H. filipjevi*, but a number of potentially resistant lines were identified in all programs.

Impact:

- Because of the higher throughput of the greenhouse screening system, we can now screen material at an earlier stage so breeders can use this information in deciding what crosses to advance. We have identified many good sources of resistance in the winter material, less with the spring material. We have also identified released winter and spring wheat varieties with resistance to cereal cyst nematode *H. filipjevi*. These varieties may be available to growers in the next 1-2 years, allowing them to reduce the inoculum levels in their fields.
- **What measurable impact(s) has your project had in the most recent funding cycle? Because of the greenhouse techniques that we developed, breeders can now screen more material and are incorporating *Heterodera* resistance into their selections.**

WGC project number: 3061-7667
WGC project title: Management of nematode diseases with genetic resistance
Project PI(s): S. Hulbert, T. Paulitz, K. Campbell
Project initiation date: 7/1/2016
Project year: 2016-2017

Objective	Deliverable	Progress	Timeline	Communication
Obj. 1 and 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	Completed a fourth year of resistance testing in a field site in Colton, infested with <i>H. filipjevi</i> . Screened over 100 lines from the Regional Spring Wheat Nursery. Evaluated lines based on number of white females on the root. Each line was paired with the susceptible "Alpowa" in each 4-row head row. Unfortunately, the field test was not successful because of low levels of infection. We hypothesize that we planted too late, because of the very warm spring conditions, the nematodes had already hatched out. This is the same time we have planted in past years, and we know there was good inoculum in the soil, because soil collected in early April gave good results in the greenhouse.	Have completed field testing of adapted varieties against <i>H. filipjevi</i> . This field will be cropped in bluegrass next year, so field testing will not be possible. We will put all our effort into greenhouse screening in the future	Manning-Thompson, Y, Thompson, A., Smiley, R., Paulitz, T., Garland-Campbell, K., 2016. Cereal Cyst Nematode Screening in Locally Adapted Spring Wheat (<i>Triticum aestivum</i> L.) Germplasm of the Pacific Northwest, 2015. Plant Dis Manag. Rep. 10:N003
	Germplasm rated for resistance to CCN	We developed a method for collecting soil in the fall, vernalizing in the cold room for 4 C, so we can start screening in Feb. We found that cysts remained viable and hatched for at least a year, and were successful in getting infection in Aug. 2016 from soil collected in Oct. 2015. This will allow us to do additional screening in the winter and summer months. Using this method, the following crosses were identified with resistance to <i>H. filipjevi</i> : HRSWQ033-0-0-1, SWW10111-DH-32, SWW10111-DH-54-s, SWW12120-DH-1-2, SWW12160-DH-1-10, and SWW12336-DH-1-4	Testing in field will be discontinued in 2017, but greenhouse testing will be used to test crosses and populations made with CCN resistant parents and locally adapted varieties.	
	High throughput greenhouse screening of both advanced and early crossing material from double haploid program.	216 advanced lines from 4 breeding programs at WSU for resistance to <i>H. filipjevi</i> in spring 2016. ARS Crescent and ARS Selbu continue to show resistance to <i>H. filipjevi</i> and 8 advanced soft elite advanced lines with resistance were identified from the Campbell program (DH08X028-106-0, DH08X028-111-0, DH08X028-193-0, DH08X028-26-0, X010730-6L, X20060123-0-31C, and X20060126-0-35C). From the Carter program, 2 soft white (SWW10106-DH-1-s and SWW10111-DH-54-s) and 2 hard red (HRW11132-1-DH-14-4 and HRSW0026-0-0-2) lines were identified with resistance, in addition to Jasper, Azumut and WA 8206. From the Morris soft durum program, Svevo, Soft Strongfield and two selections of Soft Alzada were resistant. No resistant lines were identified from the Spring Wheat Program of Pumphrey.	Continue greenhouse testing of varieties in Winter and Spring, 2017. Goal is to test all WSU winter and spring varieties that are in variety testing trials.	
	Greenhouse pot cultures of <i>H. filipjevi</i> and <i>H. avenae</i>	Ideally, instead of relying on naturally infested soil collected in the field, we should produce inoculum in the greenhouse. Because the nematode can only reproduce on living plants, this involves infecting plants in large pots, harvesting the soil after two months, and vernalizing it to induce the nematodes to hatch.	We were successful in creating pot cultures from infested field soil in summer, 2016. The soil has been vernalized and will be tested to look at hatchability and make sure the cultures do not have mixed species.	
Obj. 3. Conduct surveys for CCN	Maps of CCN around all of Eastern and Central Washington	From 2013-2015, we surveyed 210 fields in eastern Washington and the Palouse. In 2016, we surveyed 50 locations in Walla Walla, Garfield, Columbia and western Whitman counties. Cysts were identified to species level with DNA techniques developed in previous. <i>H. filipjevi</i> was only found in southern Whitman County, and <i>H. avenae</i> in eastern Whitman county. No cysts were found in other locations.	The species-specific survey for the Palouse has been completed. However, other areas of eastern Washington and possibly northern Idaho should be surveyed. In addition, we should use methods that have the ability to pick up mixed populations of the two species.	Paulitz, T. C. 2016. "Root Disease Research at ARS Pullman-What's New?" Spokane Farm Forum, Ag Expo, Feb. 3, 2016. (presentation).
Obj. 4. 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.	Germplasm with resistance/tolerance to root lesion nematode.	Backcross populations with AUS28451 as a resistance source are being selected. A mapping population has been created, and seed was increased in the field this year.	Lines will be tested in the field at Spillman in 2017.	Thompson, AL, Mahoney, AK, Smiley, RW, Paulitz, TC, Hulbert, S, Garland-Campbell, K, 2017, Resistance to multiple soil-borne pathogens of the Pacific Northwest is co-located in a wheat recombinant inbred line population. Submitted to G3.