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

(Begin 1 page limit)
Project #: 3061-7667
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

Executive summary:

- In 2017, we concentrated our survey around the infested fields in Colton and near Colfax, to locate additional "hot" locations for testing purposes. We identified an additional field with *H. filipjevi* that would be suitable, if monocropped to wheat or barley. We identified a field for *H. avenae* that was in wheat last year.
- We established greenhouse pot cultures of *H. avenae* and *H. filipjevi.* These cultures will be grown in the greenhouse to increase nematode populations and then used for screening
- In spring and summer 2017, we developed a high throughput greenhouse technique and screened 786 advanced lines from 4 WSU breeding programs for resistance to *H. filipjevi* and *H. avenae.* This was the largest number screened to date. This method assesses roots of young plants grown in cone-tainers containing soil collected from highly infested fields in fall and vernalized at 4 C prior to planting.
- From this screening, we identified resistance in 10 to 21% of the advanced winter wheat lines, but less than 2% of spring wheat lines. Named and advanced lines resistant to *filipjevi* in one or more trials include ARS Crescent and Selbu, Cara, Otto, Masami, Madsen, Foote, ORCF-102, Prichett, SY605CL and Steelhead; WA 8235, 8206, 8163, 8194; Svevo and Soft Svevo.
- Preliminary resistance to *H. avenae* was found in Norwest 553, Jasper, and WA 8227. Chara and WA 8235 showed resistance to both *H. filipjevi* and H. *avenae.* In addition, three HRW and 12 SWW showed resistance.
- We developed KASP markers for QTLs for resistance to *H. filipjevi* that were identified in a CIMMYT study and assayed the breeding lines that we evaluated above. We were not able to identify the same QTLs in our material, except in the durum Svevo and Soft Svevo. These sources of resistance may be specific to CIMMYT derived material.

Impact:

- Using the high throughput greenhouse screening system, we can now screen material at an earlier stage and report results to breeders. We identified many good sources of resistance to cereal cyst nematode *H. filipjevi* and *avenae* in the adapted winter wheat and a few in spring wheat breeding lines and varieties. Planting these varieties will reduce the inoculum levels in infested fields.
- We collected all the data needed to identify markers associated with specific *Cre* genes, which should speed up selection and possibly identify new sources of resistance
- **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: 2017-2018

Objective	Deliverable	Progress	Timeline	Communication
Obj. 1. Screen adapted PNW and US varieties and advanced material in WA breeding programs for resistance to *Heterodera* in infested soil in the greenhousem, 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 fifth year of resistance testing, all in the greenhouse, using vernalized field soil infested with *H. filipjevi* and *avenae* against both winter and spring wheat. Screened 786 lines from the programs of Carter, Pumphrey, Campbell, and Morris, regional nurseries, and a Campbell mapping population (NEMAMAX). Identified 135 resistant lines. Named and advanced lines with resistance to *H. filipjevi* include ARS Crescent and Selbu; Cara, Otto, Masami, Madsen, Foote, ORCF-102 Prichett, SY605CL and Steelhead; WA 8235, 8206, 8163, 8194; Svevo and Soft Svevo. • Preliminary resistance to *H. avenae* was found in Norwest 553, Jasper, and WA 8227. Chara and WA 8235 showed resistance to both *H. filipjevi* and *H. avenae* . In addition, 3 HRW and 12 SWW showed resistance.	Will continue greenhouse testing next year using vernalized, infested soil in the greenhouse.	T. C. Paulitz, Y. Manning-Thompson, Nuan Wen, Dan Schlatter, James Borneman, and Kimberly Garland-Campbell. 2017. Research on Cereal Cyst Nematode in Eastern Washington. 6th International Cereal Nematode Symposium, Agadir, Morocco Sept. 11-15, 2017.
	Greenhouse pot cultures of *H. filipjevi* and *H. avenae*	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 2017. The soil has been vernalized and will be tested to look at hatchability and make sure the cultures do not have mixed species. The populations will aslo be increased with one more cycle in the greenhouse	
Objective 2. Use markers to identify the *Cre* genes in our lines, and use markers to incorporate this resistance into breeding programs	Usable markers that can be incorporated in the breeding programs.	Markers for QTLs showing resistance to *H. filipjevi* in CIMMYT lines were converted to KASP markers, and large set of our resistant material was run to see if we have any of these QTLs. Unfortunately, these markers were only found in resistant durum lines. This indicates that our material may have different background resistance that the CIMMYT lines, although we are using this germplasm in our program. SSR markers linked to *Cre1* , *Cre3* , *Cre5* , *Cre8* , *CreX* , and *CreY* genes are currently being tested. These markers may facilitate the understanding of the resistance background of our material.	Continue to develop and test markers for other identified *Cre* genes	
	Greenhouse pot cultures of *H. filipjevi* and *H. avenae*	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 Washton 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. *H. filipjevi* was only found in southern Whitman County, and *H. avenae* in eastern Whitman county. No cysts were found in other locations. In 2017, we concentrated our survey efforts to identify other fields with high levels of *filipjevi* and *avenae* that could be used for greenhouse testing. We identified a field near Colfax for *H . avenae,* and a field near Colton that may have to be increased for *H. filipjevi.*	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. 2017. "Root Disease Research at ARS Pullman-What's New?" Spokane Farm Forum, Ag Expo, Feb. 2, 2017. (presentation).
Obj. 4. Identify pathotypes of *H. filipjevi*	Knowledge of pathogen diversity in relation to other world populations, to aid in selecting resistance *Cre* genes	Differential lines were imported from Turkey and seed was increased in the greehouse. Initial screens were started in Fall, 2017.	Pathotype testing will continue in the greenhouse in 2018-2019.	