

## PROPOSAL TO THE TRI-STATE WHEAT COMMISSIONS (FY 2010)

**Title:** Nematicides as a Component of Nematode Management and Research on Wheat

**Investigator:** Richard Smiley, OSU-Pendleton; [richard.smiley@oregonstate.edu](mailto:richard.smiley@oregonstate.edu); 541-278-4397

**Cooperators:** Juliet Windes (UI-Idaho Falls) and Tim Paulitz (USDA-ARS-Pullman) will assist in coordinating experiments and in disseminating results to growers in Idaho and Washington. Dan Ball (OSU-Pendleton) will assist by loaning the spray equipment required for this project.

**Funding History:** \$28,899 is requested for FY2010 (= \$9,633/commission)

FY 2007 & 2008: \$24,920 per year - 'Tolerance to lesion nematodes'. FY 2009: \$17,075 - 'Resistance to cereal cyst nematodes'. Each commission contributed one third of the total.

### Abstract:

Root-lesion nematodes and cereal cyst nematodes reduce annual profitability of wheat farms in Idaho, Oregon and Washington by a region-wide estimate of \$51 million and \$3.4 million, respectively. Measures to reduce losses from these nematodes continue to be difficult. Nematicides are not currently a component of integrated management strategies. Research proposed here will evaluate new and novel chemical and biological nematicides to potential uses in commercial agriculture and, as importantly, in research to improve the efficiency of commercial agriculture. Tests with lesion nematodes will be at the OSU experiment station at Pendleton. Tests with cereal cyst nematodes will be on commercial wheat fields in Idaho, Oregon and Washington.

### Objective:

1. Evaluate the ability of new chemical and biological nematicides to reduce root damage by lesion nematodes and cereal cyst nematodes, and to reduce nematode populations

### Procedures:

1. **Root-lesion nematodes on winter wheat:** The experiment will be conducted simultaneously on two separate fields infested by *Pratylenchus thornei* at the Columbia Basin Agricultural Research Center, near Pendleton. Treatments will include two rates of Movento<sup>®</sup> (spirotetramat) nematicide applied on three occasions, once in fall (November) and twice in the spring (March and April). Multiple timings are proposed because lesion nematodes can invade roots at any stage of root maturity. Application rates will follow the manufacturer's suggestion but multiple timings are proposed to evaluate a 'maximum potential effect' rather than a treatment with potential for immediate commercial use. Refinement of rates and timings can be made later if Movento improves grain yield and grain quality in these first tests. Spray equipment required for this experiment will be borrowed from the OSU weed science program. Movento treatments will be compared with a bacterial seed treatment (Vovito<sup>®</sup>; *Bacillus firmus*) with purportedly longer activity than chemical nematicide seed treatments and nematicides applied at planting. Also, our existing standard, Temik 15G<sup>®</sup>, will be banded under the seed at the time of planting as a positive control treatment. An untreated control will be included as the fifth treatment. If

any of the tested products are effective on winter wheat in these tests, an immediate benefit will be that the full treatment could be used to replace the Temik test which differentiated tolerance levels among spring but not winter wheat varieties.

Seven replicates of treatments will be used in each of two fields. Plots will be 6 × 30 feet in a randomized complete block design. Data will include yield and test weight.

2. **Root-lesion nematodes on spring wheat:** Two spring wheat experiments will also be conducted simultaneously on fields infested by *P. thornei*. Treatments, design, fields, and data collection will be as described for winter wheat. Movento will be applied to foliage three times in each field; March, April and May. As many as six additional seed treatments will also be examined, for a total of 11 treatments. One of the latter seed treatments (Dividend Extreme + Cruiser + Avicta) improved grain yield by 18% during 2009. Spring wheat is generally more responsive than winter wheat to seed treatment.
3. **Cereal cyst nematodes on wheat:** Movento will be applied to foliage of spring or winter wheat already planted in fields infested with cereal cyst nematodes. Experiments will be performed at St. Anthony, ID, Imbler, OR, and Palouse, WA. Candidate fields in Idaho and Washington will be identified in collaboration with Juliet Windes and Tim Paulitz, with preference given to fields from which soils were collected for the Tri-State Wheat Commission greenhouse research conducted last year (FY2009).

Application of Movento will be made once in Idaho and twice in Oregon and Washington fields. The application time will be coordinated with the grower and/or state collaborator. Cyst nematodes only attack embryonic tissues at the tip of new roots. Females become immobile and must be fertilized before they can produce eggs. The goal is to treat plants after females are immobile and before significant root damage and egg production occurs, thereby reducing the nematode population in treated areas. The best timing should be prior to stem elongation (Feekes growth stage 5), probably from March to May depending on different growth stages at the test locations. Treated and untreated plots will be replicated seven times in plots measuring 5 × 30 feet. Root and soil samples will be collected at the time of harvest. Treatments will be evaluated for effects on root symptoms, nematode populations, grain yields and test weights. Assays of roots will be done in the Pendleton lab and assays of nematodes will be at Western Labs in Parma ID.

### **Timeline: 2009-2010**

#### Activities prior to the grant period which starts on July 1, 2010:

Oct-Nov 2009	Establish winter wheat experiments for lesion nematodes at Pendleton
March-June	Establish spring wheat experiments for lesion nematodes at Pendleton
March-June	Establish wheat experiments for cyst nematodes in ID, OR & WA

#### Activities during the grant period:

July-Sept	Harvest all experiments, evaluate nematode populations and root damage, and report initial results at the Society of Nematology meeting in Boise.
Oct-Nov	Finalize and refine the summary of results and, if justified, establish 2 <sup>nd</sup> -generation nematicide treatment experiments with winter wheat.
Dec-Feb	Prepare terminal report for wheat commissions and publications for technical journals. Begin communicating results to growers and scientists.

## Justification:

Lesion nematodes and cereal cyst nematodes reduce annual profitability of wheat farms in Idaho, Oregon and Washington by a region-wide estimate of \$51 million and \$3.4 million, respectively (4,5). These parasites reduce yield in some Oregon fields by up to 50 percent (4,5,7,9). Much information is still lacking regarding the distribution and damage caused by these root parasites across the PNW but current knowledge is in harmony with that in other countries (1,2,8). The PI is preparing extension bulletins to summarize available information regarding management of nematode-infested wheat fields. Dr. Guiping Yan, at Pendleton, is developing diagnostic tests to improve the speed and accuracy for identifying these nematodes in soil (10,11,12).

Crop rotation is generally not economically feasible for managing nematodes without irrigation in regions of low to intermediate rainfall (8). However, it is in these dryland fields that plants often become short on water late in the growing season and also suffer the greatest economic damage from these nematodes. Compared to plants with healthy root systems, plants with roots damaged by nematodes have a reduced ability for collecting water and nutrients (7,8). Management options other than crop rotation are needed in regions of lower rainfall.

Progress is being made in developing genetic resistance and tolerance. Optimal nematode control is achieved when tolerance and resistance are both present (8). Resistance describes the ability of plants to eliminate or greatly reduce the rate of nematode multiplication. Resistance mechanisms are activated only after the nematodes have entered the root tissue and are already damaging root cells. Resistance therefore reduces the nematode population that affects future crops but does not adequately protect the current crop. Several projects are studying resistance. Alison Thompson, formerly of the OSU program at Pendleton, is currently a Ph.D. student at WSU. She is characterizing resistance to lesion nematodes by an Afghani landrace (AUS28451) that has already been crossed with PNW-adapted wheat varieties. AUS28451 prevents reproduction by both of the *Pratylenchus* species found in PNW wheat fields (8). Thompson is also developing a molecular marker so wheat breeders can track the inheritance of this resistance without using lengthy and problematic greenhouse bioassays. Likewise, the PI's team at Pendleton is testing crosses between PNW wheat varieties and a donor of the *Cre1* gene for resistance to cereal cyst nematodes (5). The latter finding resulted from research funded by the Tri-State Commissions during FY2009.

Tolerance measures the ability of plants to yield well even when roots are heavily parasitized by a nematode. Tolerance protects the current crop and important differences have been demonstrated for varieties of spring wheat but not of winter wheat (4). The procedure used to make those determinations apparently failed to differentiate fall-planted wheat varieties because the growing season is simply too long in comparison to the activity of the nematicide (Temik) used for this research. Improved screening procedures are required to identify tolerance differences that are likely to occur among genotypes of winter wheat.

An effective screening technique is therefore still lacking for differentiating lesion nematode tolerance levels in winter wheat (4). This project proposes to examine new chemical and biological nematicides that have the potential for being used for this purpose and also for use in commercial agriculture. Work toward that goal began at Pendleton during 2009. Preliminary tests with a new Syngenta seed treatment gave a promising result in spring wheat. Yield of 'Hank' was improved 18% over the untreated control in stands growing from seed treated by a combination of Dividend Extreme, Cruiser and Avicta (6). That test will be repeated in this project. However,

that treatment isn't likely to be equally effective for winter wheat due to the longer period of protection required for winter than spring wheat.

Bayer CropScience recently registered the first insecticide that is translocated downward as well as upward (3). All other systemic products move only upward from the point of absorption. Since the product has no residual activity in soil, it is applied to foliage and not to the seed to protect stems and roots from in-season insect damage. Movento<sup>®</sup> insecticide was registered in 2008 for use on fruit and vegetable crops in the USA. Section 18 exemptions were also established for use against onion thrips in Idaho, Oregon and Washington. In Brazil, the product is registered to protect wheat and soybeans against bugs that damage the base of stems. In California, application of Movento to walnut trees reduced lesion nematode damage on roots and improved crop yield. Bayer is not currently funding research on wheat in the USA but has already supplied the product to the PI and recommended that it be applied at rates up to 5 fl oz/acre. Bayer wants the testing of Movento to be compared with a biological seed treatment (Vovito<sup>®</sup>) that they consider to have longer-lasting effects against nematodes than any currently available chemical seed treatment. Vovito is registered on other crops in the USA and will be evaluated on wheat in this project.

No other wheat researcher appears to be testing these new products. If successful, one of these 1<sup>st</sup>-generation 'maximum-potential-effect' treatments could be used immediately to screen winter wheat for tolerance to lesion nematodes. Demonstrations could also be established to provide convincing visual evidence that these nematodes are in fact significantly reducing wheat production and that "hope is on the way". Refinement of application rates and/or timings could then be examined for commercial use as part of an integration of control practices that include varieties with tolerance plus resistance and crop rotation wherever that might be possible.

**Budget: (expense per Commission would be \$9,633)**

Technical salary for OSU Res. Asst. (\$3,000/month x 3 months)	9,000
Student labor: 240 hours x \$12/hour	2,880
Employee benefits (60.3% for Res. Asst. + 10% for student)	5,715
Total labor	17,595
Goods and services:	
Materials & supplies (equipment fuel, plot stakes, flags, herbicide, office, etc.)	600
Nematode assays at Western Labs (\$25/sample x 74 samples)	1,850
OSU land fee (\$850/acre or \$850 minimum/experiment)	3,400
OSU combine fee (\$25/hour x 12 hour)	300
OSU vehicle fee & fuel (pickup at \$0.51/mile; truck + trailer at \$0.98/mile)	2,336
Travel:	
Servicing off-station experiments (food for 6 trips + lodging for 2 trips to Idaho)	360
Tri-State Commissioner's meeting in Portland (transportation)	205
National nematology conf. at Boise (registration, transportation, lodging & food)	573
Publication charges for extension & technical reports (expense was >\$9,000 in 2009)	1,680
Equipment (a suitable sprayer will be borrowed in 2010)	0
<b>Total expense</b>	<b>\$28,899</b>
<b>Expense if divided equally into thirds</b>	<b>\$9,633</b>

An OSU research assistant will assist with all aspects of this research. A student will assist with field work and grain processing. Benefits are paid at rates shown in the budget. In 2009, OSU reduced the amount of state funding for the salary & benefits of the OSU research assistant by \$23,088 and began charging fees for use of land, vehicles and equipment. Travel from Pendleton (for treatments, sampling and harvest) was calculated as 543 miles for ID, 65 miles for OR, and 141 miles for WA. Nematode analysis at Western Labs is at a discounted rate lower than is possible using in-house labor. Reporting and meetings are important components of outreach and future planning. For example, in 2009 the PI paid \$9,156 as 'page charges' to publish seven technical manuscripts.

**Relation to Other Research:** Smiley receives base-level funding from the USDA-ARS Root Disease Research Unit at Pullman. Smiley is a co-advisor with Drs. Paulitz, Campbell, Murray, Elling and Steber for two Ph.D. dissertations at WSU; resistances to *Fusarium* crown rot (Grant Poole) and lesion nematode (RLN) (Alison Thompson). This proposal complements studies of 1) crop rotation for RLN (Smiley & Machado), 2) tolerance to RLN (Smiley), 3) resistance and molecular markers for RLN (Campbell & Yan; focus is on different genes and donors, with no overlap), 4) resistance and molecular markers for cyst nematodes (Smiley & Yan), and 5) diagnostic tests to improve diagnostic services at commercial nematode labs (Yan & Okubara).

#### References:

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2. Riley, I.T., J.M. Nicol, and A.A. Dababat (eds.). 2009. Cereal Cyst Nematodes: Status, Research and Outlook. CIMMYT, Ankara, Turkey. (244 pages)
3. Safferling, M. (ed.). 2008. Spirotetramat: the first phloem-mobile and fully systemic insecticide. Bayer CropScience Journal Vol. 61. (454 pages)
4. Smiley, R.W. 2009a. Root-lesion nematodes reduce yield of intolerant wheat and barley. *Agronomy Journal* 101:1322-1335.
5. Smiley, R.W. 2009b. Occurrence, distribution and control of *Heterodera avenae* and *H. filipjevi* in the western USA. p. 35-40 in *Cereal Cyst Nematodes: Status, Research and Outlook*. I.T. Riley, J.M. Nicol, and A.A. Dababat (eds.). CIMMYT, Ankara, Turkey.
6. Smiley, R.W., J.A. Gourlie, K.E.L. Rhinhart, and H. Yan. 2010. Evaluation of seed treatments to control lesion nematodes in spring wheat. *Plant Disease Management Reports* 4: (submitted)
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8. Smiley, R.W., and J.M. Nicol. 2009. Nematodes which challenge global wheat production. p. 171-187 in *Wheat Science and Trade*. B.F. Carver (ed.). Wiley-Blackwell, Ames, IA. (569 pages)
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11. Yan, G.P., and R.W. Smiley. 2010. Distinguishing *Heterodera filipjevi* and *H. avenae* using PCR-RFLP and cyst morphology. *Phytopathology* 100: (in press).
12. Yan, G.P., R.W. Smiley, P.A. Okubara, A. Skantar, S.A. Easley, J.G. Sheedy, and A.L. Thompson. 2008. Detection and discrimination of *Pratylenchus neglectus* and *P. thornei* in DNA extracts from soil. *Plant Disease* 92:1480-1487.

SIGNATURES

PROPOSAL TITLE: **Nematicides as a Component of Nematode Management and Research on Wheat**

SUBMITTED TO: OSU Agricultural Research Foundation, for the Idaho Wheat Commission, Oregon Wheat Commission, and Washington Grain Commission

SUBMITTED BY: Richard Smiley

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(Principal Investigator)

Date:

APPROVED BY:

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Dr. Sonny Ramaswamy, Director  
Oregon Agricultural Experiment Station

Date:

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Ms. Dorothy Beaton, Executive Director  
Agricultural Research Foundation

Date:

**CURRENT AND PENDING SUPPORT**

NAME	SUPPORTING AGENCY	TOTAL \$ AMOUNT	EFFECTIVE AND EXPIRATION DATES	% OF TIME COMMITTED	TITLE OF PROJECT
Current: R. Smiley R. Smiley	USDA-ARS Tri-State Comm.	\$109,669 \$ 17,075	7/7/09-7/6/10 7/1/09-6/30/10	40% 15%	Root diseases of wheat and barley Resistance to cereal cyst nematode
Pending: NA					