

Grant Codes: AP7054

Title: Population characterization of plant parasitic nematodes associated with cereal production in Southeastern Idaho

Personnel: Dr. Juliet Marshall, EXT. Crop Mgmt. Specialist (SC and E Idaho)
Dr. Pooria Ensafi, Postdoctoral Fellow, Nematologist
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Justification for Project Extension:

Background: Idaho is a key agricultural state, with major cereal production in its south and southeast regions. Effective management of nematode diseases typically involves using resistance genes and planting tolerant varieties. However, current knowledge of plant parasitic nematode species is largely based on outdated reports, primarily identifying economically important nematodes at the genus. Given that plant parasitic nematodes can cause substantial damage to cereals, and display diverse pathotypes and races, species identification and pathotype study are crucial for selecting appropriate breeding lines and assessing resistance gene efficacy.

Recent Development (July 2023- present): Shortly after the harvesting season, we initiated soil sampling in several counties of southeastern Idaho, including Fermont (Ashton, St. Anthony, Parker), Teton, Madison (Sugar City, Rexburg), Jefferson (Rigby), and Bonneville (Ririe). Soil samples were transferred to Aberdeen R&E Center, processed, and nematodes were extracted. Initial morphological identification is underway, with molecular identification expected to begin soon. Our focus has been on fields rotating cereal with other major crops (e.g., potatoes, sugar beets). We have observed a variation in the types of plant parasitic nematode, including Stunt and Root-knot nematodes, which necessitates expanding the project to include more fields in the area. Additionally, the limited window for soil sampling requires project continuation into 2025.

Preliminary results indicate discrepancies between the morphological and morphometric characteristics of extracted nematodes, particularly in stunt and root-nematodes. As species transition for stunt nematodes is observed, and morphological characteristics do not align with referenced taxa, we plan to incorporate scanning electron microscopy to examine the key characteristics for classification including lip region and lateral striations. This approach will entail an increase in the project budget.

Objectives: We hypothesized significant variability in parasitic nematode species. Our initial findings support this hypothesis, particularly the morphological variability of the species present. To achieve our objectives and gather comprehensive data to substantiate our findings, we propose extending the project by an additional year.

Methods/Plan of Work for 2025: We are planning to extend the study area to include more cereal fields in the current counties with specific approach to wheat vs. barley and to incorporate central and southern counties. Our methodology will include a new protocol for molecular DNA

✓ extraction using the sonar technique. Additionally, we will prepare description for the new species and in-transition taxa using scanning electron microscope.

Extending Duration: One year

Anticipated Benefits/ Expected Outcomes and Impacts, and Transfer of Information:

Wheat and barley producers in Idaho will gain access to the most recent information regarding the status of their fields. This includes details on the species present the effectiveness of current management strategies, including potential resistant sources. Results from in-depth identification will assist in explaining the variability in crop response to parasitic nematode and other pathogenic organisms. These organisms are likely to cause significant damage, especially when interacting with nematodes in complex disease. This knowledge will be pivotal for developing more effective management plans and mitigating the impact of plant parasitic nematodes on crop yields.

References:

- Ensafi, P., Smiley, R. W., Moll, M. T., Rashed, A., Jackson, C. A., & Marshall, J. M. (2023). Resistance and Tolerance Screening of Spring Wheat Cultivars to Cereal Cyst Nematode (*Heterodera avenae*) in Southeastern Idaho. *Plant Disease*, 107(9), 2729-2735.
- Hafez, S. L., Sundararaj, P., Handoo, Z. A., & Siddiqi, M. R. (2010). Occurrence and distribution of nematodes in Idaho crops. *International journal of nematology*, 20(1), 91-98.
- Smiley, R. W., & Nicol, J. M. (2009). Nematodes which challenge global wheat production. In B. F. Carver (Ed.), *Wheat: Science and Trade* (pp. 171-187). Wiley-Blackwell.
- Smiley, R. W., & Yan, G. (2015). Discovery of *Heterodera filipjevi* in Washington and comparative virulence with *H. avenae* on wheat. *Plant Disease*, 99(3), 376-386.
<https://doi.org/10.1094/pdis-08-14-0789-re>
- Zasada, I. A., Kitner, M., Wram, C., Wade, N., Ingham, R. E., Hafez, S., ... & Hammack, N. (2019). Trends in occurrence, distribution, and population densities of plant-parasitic nematodes in the Pacific Northwest of the United States from 2012 to 2016. *Plant Health Progress*, 20(1), 20-28.

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**FY2025
COMMODITY COMMISSION BUDGET
Principal Investigator: Juliet Marshall**

Allocated by <u>Idaho</u> Wheat Commission (Commission/Organization)	during FY2023	\$	-
Allocated by <u>Idaho</u> Wheat Commission (Commission/Organization)	during FY2024	\$	25,316

REQUESTED SUPPORT: Budget Categories	<i>Awarded for FY2024</i>	<i>Requested for FY2025</i>
(10) Salary (staff, post-docs, et NOTE: Faculty salary/fringe NOT allowed)	\$ 7,820	\$ 10,827
(12) Temporary Help/IH	\$ 6,450	\$ 6,750
(11) Fringe Benefits	\$ 3,846	\$ 5,032
(20) Travel	\$ 950	\$ 950
(30) Other Expenses	\$ 6,250	\$ 6,250
(40) Capital Outlay >\$5k	\$ -	\$ -
(45) Capital Outlay <\$5k	\$ -	\$ -
(70) Graduate Student Tuition/Fees	\$ -	\$ -
TOTALS	\$ 25,316	\$ 29,809

TOTAL BUDGET REQUESTED FOR FY2025:	\$ 29,809
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BREAKDOWN FOR MULTIPLE INDEXES:					
Budget Categories	(Insert Co-PI Name)	(Insert Co-PI Name)	(Insert Co-PI Name)	(Insert Co-PI Name)	(Insert Co-PI Name)
(10) Salary (staff, post-docs, et	\$ -	\$ -	\$ -	\$ -	\$ -
(12) Temporary Help	\$ -	\$ -	\$ -	\$ -	\$ -
(11) Fringe Benefits	\$ -	\$ -	\$ -	\$ -	\$ -
(20) Travel	\$ -	\$ -	\$ -	\$ -	\$ -
(30) Other Expenses	\$ -	\$ -	\$ -	\$ -	\$ -
(40) Capital Outlay >\$5k	\$ -	\$ -	\$ -	\$ -	\$ -
(45) Capital Outlay <\$5k	\$ -	\$ -	\$ -	\$ -	\$ -
(70) Graduate Student Tuition/Fees	\$ -	\$ -	\$ -	\$ -	\$ -
TOTALS	\$ -	\$ -	\$ -	\$ -	\$ -
Total Sub-budgets					\$ -

ANNUAL REPORT

Grant Code: AP7054 (227054) & AP7211 (227011)

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Overview

Cereals are the most important source of food in the world, and it is estimated that plant parasitic nematodes cause over 80 billion US dollars in damage to agricultural crops annually. The impact on cereals, particularly wheat and barley, is significant. For instance, cereal cyst nematode alone has been responsible for damages amounting to over 3 million pounds in the UK, 72 million dollars in Australia, and 3.4 million dollars in the Pacific Northwest. Our understanding of parasitic nematodes in Idaho has been limited to a general approach applied to all crops. This approach was studied by Dr. Saad Hafez in 1992 (updated in 2010), with identification made only up to genus level. We conducted this study to improve our knowledge on PPN at species level, and population density of different PPNs in soil. The results will provide a better assessment of resistance in our breeding programs, that are pathotype sensitive, and will contribute to future development of wheat and barley integrated disease management.

Project Status & Accomplishments:

We conducted soil sampling in southeast Idaho after harvesting in 2023. The project is currently focused on nematode extraction and morphological identification, preliminary in cereal fields, and where cereals are rotated with other major crops, such as potatoes. To date, we have sampled soil from several counties: Fermont (including Ashton, St. Anthony, Parker), Teton, Madison (Sugar City, Rexburg), Jefferson (Rigby), and Bonneville (Ririe). Fields were selected based on accessibility, geographic distance from other sampling sites, diversity of the ownership/management, inclusion of fields known to be infested from our previous CCN resistance trials. The soil samples have been processed, nematodes are extracted, and morphological identification is underway. Molecular identification will be performed on the extracted nematodes, with sequencing results combined with morphological characteristics for comprehensive analysis.

Plant root and residual sampling will occur 3-4 weeks after 2024 planting for the extraction and identification of migratory, endo-, and semi-endoparasites. Further soil sampling to detect nematodes in other will be coordinated with plant sampling or conducted during the post flowering stage of cereals in fields.

Preliminary results from the morphological identification of extracted nematodes at genus level:

Important plant-parasitic nematode (PPN) was found in in all sites: Cereal cyst nematode *Heterodera*. Commonly present nematodes identified as Root lesion nematode *Pratylenchus*,

²⁰ Stubby root nematode *Trichodorus*, Stunt Nematode (full identification pending molecular analysis), Spiral nematode *Helicotylenchus*, Stem nematode *Ditylenchus*, Root-knot nematode *Meloidogyne*. Other nematodes identification is in progress. The final species identification will be confirmed and reported after the molecular analysis.

Personnel contributions:

Dr. Pooria Ensafi (University of Idaho, postdoc) is a nematologist responsible for the nematode identification to the species level, root sampling and processing, molecular DNA extraction and purification, phylogenetic analysis, and preparation of experiment outcome for publication.

Projection:

The project that the sequencing results for ribosomal and mitochondrial DNA, along with the D2-D3 expansions of large subunits, will be integrated with morphological data. The identification of potentially new species is currently underway. Preliminary results from morphological identification, combined with the insights from other ongoing projects suggest the presence of species not previously reported.

The study area, including cereal-associated fields, is extensive. Due to the brief window between the harvesting and the winter season, we anticipate extending the project into 2025.

This extension will allow us to include regions in South and Central Idaho, as well as additional fields from currently sampled counties, thereby increasing the chances of detection.

Publication

The results of this project, along with the necessary Scanning Electron Microscopy images will be published in peer-reviewed journal.