Annual Report for NC 1197

Project/Activity Number:	NC 1197
Project/Activity Title:	Practical Management of Nematodes on Corn, Soybean, and Other Crops of Regional Importance
Period Covered:	November 2024 – September 2025
Submission Date:	November 14, 2025
Annual Meeting Date(s):	September 26, 2025
Location of Meeting:	Virtual (Zoom)

Accomplishments

Objective 1: Develop, evaluate, improve, and integrate management techniques for plant-parasitic nematodes in the north-central region (NCR) to increase grower profitability.

Surveys of Plant Parasitic Nematodes

To support continued monitoring of plant-parasitic nematode populations in crop production systems, many programs have carried out statewide surveys. The collective results from these ongoing efforts in key regional crops, such as corn and soybean, contribute to the development of regional and national maps that track nematode populations and their geographic distribution over time.

In Nebraska, a focus is being placed on emerging corn crown rot disease and potential nematode interactions, particularly with *Pratylenchus* species and a recognition of shifting grower priorities to fungal diseases like tar spot. Updated maps have been generated for the state for SCN prevalence. In Kentucky, large-scale soybean cyst nematode (SCN) surveys supported by the Kentucky Soybean Board found SCN in 75% of tested fields, with egg count distributions mapped to surveyed fields. A significant number of SCN surveyed were resistant-breaking populations. In Illinois, over 2,000 samples were tested for SCN and corroborated earlier reports that most SCN populations were HG type 2.5.7, which indicates that these populations can reproduce on the SCN-resistant soybean varieties on which most farmers rely. Similar findings were reported from North Dakota. In Ohio, the extensive SCN diagnostic service assays up to 500 samples a year and includes updated maps to maintain awareness of SCN abundance and prevalence. In Missouri, a statewide survey updated SCN prevalence citing an average of 3,000 SCN eggs per 100cc of soil. Again, a noted shift in virulence of SCN populations to HG type 1.2- was observed, which indicates that most of these populations can reproduce on the two most common SCN-resistant soybean varieties on which farmers rely. In South Dakota, more than 500 samples were tested for SCN presence, with more than 60% of those samples being positive for SCN. We also completed an extensive statewide survey which revealed 15 newly documented SCN positive counties. A HG Typing project revealed that more than 85% of populations are HG Type 2 and many of those populations have exceeded a FI of 60; rising Type 1 resistance was also documented with 40% of populations reproducing on Peking lines.

Evaluation of Cultivars and Germplasm for Nematode Resistance

Numerous states conducted cultivar and germplasm screening for nematode (largely SCN) resistance; however, many noted a high variability in resistance in lines between states and sub-regional differences. Other crops were also screened as potential winter cover crops, such as

Pennycress in Illinois which offered limited SCN infection and low hatch stimulation. This work is progressing to include SCN reproduction under field temperature conditions. In North Dakota, soybean lines with varying copy numbers of the resistance gene RHG1 were assayed for correlations to resistance. Cultivar screening in North Dakota also included potential resistance to *Pratylenchus* species. In Indiana, a new collaboration has been initiated to screen wild soybean accessions for novel sources of SCN resistance. In South Dakota greenhouse trials have identified potential alternate hosts such as dry beans and pennycress for SCN. In Missouri, small plot trials are evaluating the integration of Peking resistance into cropping systems to increase durability. In Kansas, 160 soybean breeding lines and 27 commercial varieties were screened against multiple SCN populations, finding high resistance to common HG Types but more limited resistance to a highly virulent population.

Evaluation of nematode protectant seed treatments

As new and potential nematode-protectant seed treatment products are registered and introduced to the market, it is essential to evaluate them through unbiased field trials conducted across the region. The results from these studies provide farmers, crop consultants, and other decision makers with objective data on product efficacy and the economic value of using the various available treatments. In Kentucky, trials of nematicide seed treatments are on-going, including the new *Bt*-producing lines and their efficacy against plant parasitic nematodes. In North Dakota, investigations into potential suppressive soils to reduce SCN populations and their associated microbiomes are continuing.

Development of innovative methods to detect and quantify plant parasitic nematodes

Improving the efficiency of quantifying and detecting plant-parasitic nematodes is a key goal that could help eliminate bottlenecks and accelerate critical management decisions. Of general concern was the lack of a continuous and sufficient source of indicator lines for SCN HG type testing. In North Dakota, a Recombinase Polymerase Amplification (RPA) assay was developed for rapid root lesion nematode detection; a similar assay was developed in South Dakota for SCN that demonstrated high specificity and sensitivity. In Wisconsin, efforts are continuing to develop artificial intelligence algorithms for the identification and quantification of plant parasitic nematodes from microscopic images. In Michigan, efforts to understand the belowground environment where the northern root-knot nematode's (NRKN) parasitic variability (PV) exists have revealed connections among soil groups, soil health, indicator microbiome, and NRKN PV.

Objective 2: Determine the relationships among nematode population characteristics, crop injury, and soil health.

Research that deepens our understanding of how nematodes interact with their crop hosts, associated microbiomes, and soil health can offer valuable insights into the broader biological processes shaping agricultural ecosystems. In North Dakota, research is continuing to characterize suppressive soils that reduce SCN populations and identify the causal microbial communities. In Wisconsin, research is focused on abiotic factors including high CO_2, nitrogen input and increased nighttime temperatures and their impacts on crop responses to nematode infection and pressures. In Michigan, on-going are efforts to demonstrate application of the soil food web (SFW) as a soil health diagnostic tool for identifying pre- and post-experimental soil

conditions and outcomes, and the Fertilizer Use Efficiency (FUE) and Integrated Productivity Efficiency (IPE) models for identifying if the outcomes are sustainable or not.

Objective 3: Develop and disseminate research-based information on the biology and management of plant parasitic nematodes of economically important crops in the North Central region.

Members of NC1197 share timely, research-based information on the biology and management of key plant-parasitic nematodes through diverse outreach efforts. These include presentations at extension and industry meetings, webinars, field days, podcasts, social media, online videos, newsletters, extension publications, technical reports, variety trial reports, and interviews with agricultural media such as magazines, newspapers, radio, and television. This has led to improved understanding of the cause-and-effect relationships as it relates to nematode parasitic variability and informed management decisions on application of agricultural practices and soil health management. Farmers gained appreciation of the distribution, prevalence, and impact of plant-parasitic nematodes on their operations. This knowledge led to changes in variety selection and post-planting management to improve yields. For instance, two radio spots on SCN- reaching an estimated 110,000 listeners; 7 CAT trainings reaching around 2,000 stakeholders; Various other extension talks reaching an additional 1,000 stakeholders; 10-12 clinic booths around the state that promoted SCN testing and reached around 1,500 people. In addition to their individual programs and university efforts, NC1197 members collaborate to raise awareness of plant-parasitic nematodes and deliver consistent messaging through initiatives such as **The SCN Coalition** (https://www.thescncoalition.com/) and the **Crop Protection Network** (https://cropprotectionnetwork.org/). The SCN Coalition provides resources and strategies to help stakeholders reduce the economic impact of nematodes that infect soybean through improved sampling and management practices. Other efforts include collaborations with breeders and extension agents in Kentucky to emphasize the importance of southern root knot nematode. In Ohio, collaborations with growers and the SCN Coalition are focused on education on resistant cultivar use and seed treatments as well as development of integrated management tools that address yield loss and spatial distribution of SCN. Further, there is work to increase the efforts of the SCN Coalition to include other nematodes on soybean, such as root lesion and reniform. In South Dakota, emphasis is placed on outreach to increase sample submission to support state-wide efforts in nematode prevalence. Talks and extension materials distributed across South Dakota reached over 3,500 stakeholders in a variety of fields from commercial and private applicators to new small-scale producers and those utilizing cover crops for management. In Michigan, promoting the values of the SFW, FUE and IPE models as diagnostic and decision-making tools to the scientific community has led to over 16,000 views of the models. Outreach to the agricultural community through the SCN Coalition is in the works. Further, Wisconsin researchers discovered and publicized in a peer-reviewed publication that overexpression of α-SNAPRhg1 in soybean can improve rhg1-a mediated soybean resistance to soybean cyst nematode.

Outputs

Refereed Journal Articles

Barizon J, Bissonnette K, Biggs M Haafke A, Bish M (2025) Effect of Nematode-protectant Seed Treatments on Reproduction of Heterodera glycines Virulent Phenotypes. Journal of Nematology 57 doi.org/10.2478/jofnem-2025-0032

Dhakal, R., Chowdhury, I. A., Plaisance, A., and Yan, G. P. (2025). Development of a recombinase polymerase amplification assay for rapid detection of the new root-lesion nematode Pratylenchus dakotaensis on soybean. Plant Disease 109:603-614. https://doi.org/10.1094/PDIS-05-24-1133-RE.

Dhakal, R., Plaisance, A., Markell, S. G., and Yan, G. P. (2025). Evaluation of field soils for suppressing reproduction of soybean cyst nematode, Heterodera glycines, in North Dakota, USA. Nematology 0:1-14. https://doi.org/10.1163/15685411-bja10421.

Goraya, M. and Yan, G. P. (2024). Rapid and direct detection of the stubby root nematode, Paratrichodorus allius from soil DNA extracts using recombinase polymerase amplification assay. International Journal of Molecular Sciences 25:10371. https://doi.org/10.3390/ijms251910371.

Goraya, M., Yan, G. P., Whitworth, J., and Grimm, K. S. (2024). Advancing nematode identification on potato: an isothermal recombinase polymerase amplification assay for stubby root nematode, Paratrichodorus allius. American Journal of Potato Research 101: 52–64. https://doi.org/10.1007/s12230-023-09940-4.

Haarith, D., Das, S., Nelson, E., Zapotocny, R., Bent, A.F. Overexpression of α-SNAPRhg1 Can Improve rhg1-a Mediated Soybean Resistance to Soybean Cyst Nematode. Phytopathology (2025). https://doi.org/10.1094/PHYTO-02-25-0077-R

Han J and NE Schroeder. 2025. Neuronal basis of host-finding and feeding in plant-parasitic nematodes. Annual Review of Phytopathology. 63:383-492.

Han J, Boudreaux JCT, Domier LL, McCoppin NM, Hartman GL and NE Schroeder. Discovery and analysis of a quantitative trait locus associated with resistance to Meloidogyne incognita in Glycine latifolia, a wild perennial relative of soybean. Phytopathology. Accepted.

Lartey, I., G. M. N. Benucci, T. Marsh, G. Bonito, and H. Melakeberhan (2025). The composition and function of bacterial communities associated with the northern root-knot nematode (Meloidogyne hapla) populations showing parasitic variability. Microorganisms 13, 487. https://doi.org/10.3390/microorganisms13030487.

Lawaju, B. R. and Yan, G. P. (2024). Assessment of common factors associated with droplet digital PCR (ddPCR) quantification of Paratrichodorus allius in soil. International Journal of Molecular Sciences 25:3104. doi: 10.3390/ijms25063104.

Melakeberhan, H., I. Lartey, S. Kakaire, and M.T.Z., Maung (2025). The soil food web model as a diagnostic tool for making sense out of messy data: A case of the effects of tillage, cover crop and nitrogen amendments on nematodes and soil health. Soil Systems 9, 5. https://doi.org/10.3390/soilsystems9010005.

Ojha, E., Singh, G., Plaisance, A., and Yan, G. P. (2025). Evaluation of field pea cultivars for resistance to pin nematode (Paratylenchus nanus type B) in North Dakota. Plant Disease, https://doi.org/10.1094/PDIS-02-25-0356-RE.

Pokhrel R, Krone MJ, Mullens A, Schroeder NE, Jamann T, and SX Mideros. Interaction types produce distinct microscopic phenotypes in the Exserohilum turcicum-Maize/Sorghum pathosystem. Plant Disease. Accepted.

Poudel, D., Yan, G. P., Miranda, C., Kreutz, G. F., and Chowdhury, I. A. (2024). Copy number variations at the Rhg1 locus and their relationship with resistance to soybean cyst nematode (Heterodera glycines). Frontiers in Plant Science 15:1504932. doi: 10.3389/fpls.2024.1504932.

Abstracts

Akande F, Barizon J, Haafke A, Bish M (2025) Is Peking the Answer? Evaluating Commercial Peking Soybean in the "Show Me" state. Southern Soybean Disease Workers Annual Meeting. Pensacola, Florida

Akande F, Haafke A, Barizon J, Bish M (2025) Evaluating the Effectiveness of Peking Soybean for Soybean Cyst Nematode Management in Missouri. North Central APS Annual Meeting, Brookings, South Dakota

Barizon J, Haafke A, Biggs M, Bish M (2025) A Survey of Plant-Parasitic Nematodes Associated with Soybean Production in Missouri. North Central APS Annual Meeting, Brookings, South Dakota

Dhakal, R., Chowdhury, I. A., Plaisance, A., and Yan, G. P. (2024). Development of a recombinase polymerase amplification assay for rapid detection of the new root-lesion nematode Pratylenchus dakotaensis on soybean. American Phytopathological Society Annual Meeting, Memphis, Tennessee, July 27-30, 2024.

Dhakal, R., Yan, G. P., and Kandel, S. (2024). Identification and characterization of suppressive soil microbiome against soybean cyst nematode (Heterodera glycines) in North Dakota. American Phytopathological Society Annual Meeting, Memphis, Tennessee, July 27-30, 2024.

Dhakal, R., Yan, G. P., Malick, B., and Kandel, S. (2024). Characterization of fungal and bacterial communities in suppressive soils against soybean cyst nematode in North Dakota. 4th Annual NDSU Soybean Symposium, Fargo, ND, March 27, 2024.

Karki, N., Tande, C., Shires, M. 2025. Are we losing the resistance battle against Soybean Cyst Nematodes: Distribution and virulence phenotypes of the nematode populations in South Dakota. Oral Talk, 2025 Plant Health Conference, Honolulu, HI, Aug. 2-5, 2025.

Karki, N., Tande, C., Shires, M. 2025. Developing and Evaluating Real Time Recombinase Polymerase Amplification Assay for Detecting Heterodera glycines. Poster Presentation, 2025 North Central APS, Brookings, SD, June 9-11, 2025.

Mumia, B., Yan, G. P., and Pasche, J. (2024). Exploring interactions of root-lesion nematode (Pratylenchus scribneri) and fungal pathogen (Verticillium dahliae) in the potato early die complex. American Phytopathological Society North Central Meeting, Manhattan, Kansas, June 10-12, 2024.

Mumia, B., Yan, G. P., Pasche, J., and Plaisance, A. (2024). Interactions of root-lesion nematode (Pratylenchus scribneri) and fungal pathogen (Verticillium dahliae) in the potato early die complex. NDSU All Ag Conference, November 4-7, 2024, Fargo, ND.

Paudel, S. and Yan, G. P. (2024). Validation of the real-time PCR assay for rapid detection and identification of the pin nematode, Paratylenchus nanus type B. American Phytopathological Society North Central Meeting, Manhattan, Kansas, June 10-12, 2024.

Plaisance, A., Yan, G. P., Pasche, Thompson, J. A., Peterson, D., and Benz, R. (2024). Responses of potato cultivars to plant-parasitic nematodes in North Dakota and Minnesota. NDSU All Ag Conference, November 4-7, 2024, Fargo, ND.

Poudel, D. and Yan, G. P. (2024). Development of real-time quantitative PCR assay for direct and rapid detection of Pratylenchus penetrans in potato roots. NDSU All Ag Conference, November 5-7, 2024, Fargo, ND.

Poudel, D., Yan, G. P., Miranda, C., and Kreutz, G.F. (2024). Copy number variations at the Rhg1 locus and their relationship with resistance to soybean cyst nematode (Heterodera glycines). American Phytopathological Society North Central Meeting, Manhattan, Kansas, June 10-12, 2024.

Poudyal, P., Yan, G. P., Osorno, J. M., and Kaur, H. (2024). Unraveling host resistance in dry edible beans against virulent populations of soybean cyst nematode (Heterodera glycines) in North Dakota. Journal of Nematology, e2024-1 | Vol. 56 | Page 118, DOI: 10.2478/jofnem-2024-0036.

Ranabhat, S., Plaisance, A., and Yan, G. P. (2024). Developing a real-time PCR assay for direct detection and quantification of the new root-lesion nematode, Pratylenchus dakotaensis from soybean plant roots. Journal of Nematology, e2024-1 | Vol. 56 | Page 123, DOI: 10.2478/jofnem-2024-0036.

Yan, G. P. (2024). Pratylenchus dakotaensis, a new root-lesion nematode species from soybean fields in the USA. 4th Annual Congress on Plant Science and Biosecurity, September 19-20, 2024, Barcelona, Spain (hybrid event).

Yan, G. P. and Lawaju, B. (2024). Developing a reverse transcription-quantitative polymerase chain reaction (RT-qPCR) assay for detection of Tobacco rattle virus in vector stubby root nematodes. Journal of Nematology, e2024-1 | Vol. 56 | Page 165, DOI: 10.2478/jofnem-2024-0036.

Extension Articles

Yan, G. P., Pasche, J., Secor, G., and Robinson, A. 2024. Evaluation of potato cultivars for resistance to the root-lesion nematode, Pratylenchus penetrans, Minnesota Area II Potato Research and Promotion Council and Northland Potato Growers Association, 2023 Research Reports, Pages 15-29. https://www.northlandpotatoes.com/wp-content/uploads/2024/02/2024-Complied-Research-Updated-2-19.pdf.

Yan, G. P. 2024. Resistance of soybean varieties to Pratylenchus dakotaensis, a new root-lesion nematode species that is infecting soybeans, North Dakota Soybean Council, 2024 Research Report, Teamwork in Action – Advancing Soybean Production through Research, Page 5.

Yan, G. P. 2024. Evaluation of soybean varieties and breeding lines for resistance to soybean cyst nematode and their copy number variation at Rhg1 locus, North Dakota Soybean Council, 2024 Research Report, Teamwork in Action – Advancing Soybean Production through Research, Page 8