WILLIAM B. RUTTER
Research Plant Pathologist-Nematologist
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EDUCATION

Iowa State University Ames, IA Genetics Ph.D. 2013
- Thesis: "Identification and characterization of effectors secreted from sedentary endoparasitic phytonematodes"

Knox College Galesburg, IL Biology and Biochemistry B.A. 2008

APPOINTMENTS

USDA-ARS Charleston, SC Research Plant Pathologist-Nematologist GS14 2024-present
USDA-ARS Charleston, SC Research Plant Pathologist-Nematologist GS13 2020-2024
USDA-ARS Charleston, SC Research Plant Pathologist-Nematologist GS12 2017-2020
Kansas State University Manhattan, KS Postdoctoral Research Associate 2014-2017
Iowa State University Ames, IA Postdoctoral Laboratory Coordinator 2013-2014
Iowa State University Ames, IA Graduate Research Assistant 2009-2013

GRANT FUNDING: PI or Co-PI on 18 funded proposals totaling $14.5 Million ($1,744,532 awarded directly to ARS) since 2018

◊ 2018-2019 PI on grant from the Sweetpotato Crop Germplasm Committee entitled "Evaluating Sweetpotato Germplasm for Resistance to the Invasive Root-Knot Nematode *Meloidogyne enterolobii*" funded at $20,000. Conceived project, wrote proposal, managed project, analyzed data, and wrote report.

◊ 2018-2019 PI on grant from the National Plant Disease Recovery System entitled "Developing Resources to Manage the Exotic Root-Knot Nematode *Meloidogyne enterolobii*" funded at $39,406 for one year. Conceived project, wrote proposal, managed project, analyzed data, and wrote report.

◊ 2018-2019 Co-PI on SC Department of Agriculture Block Grant entitled "Detecting and Managing the Hypervirulent Nematode *Meloidogyne enterolobii* on Sweetpotato and Pepper in South Carolina" funded at $30,000 (ARS subaward $19,703). Helped write proposal, managed ARS subaward, analyzed data, helped write report.

◊ 2019-2020 PI on grant from the Pepper Crop Germplasm Committee entitled "Evaluation and GWAS Analysis of a Pepper Diversity Panel for Resistance to the Invasive Root-Knot Nematode *Meloidogyne enterolobii*" funded at $25,000. Conceived project, wrote proposal, managed project, analyzed data.

◊ 2019-2020 PI on grant from the National Plant Disease Recovery System entitled "Developing Resources to Manage the Exotic Root-Knot nematode *Meloidogyne enterolobii*" funded at $39,000 for 1 year. Conceived project, wrote proposal, managed project, analyzed data

GRANT FUNDING (continued)

- ◊ 2019-2020 Co-PI on grant from the SC Department of Agriculture Block Grant program entitled "Detecting and Managing the Hypervirulent Nematode *Meloidogyne enterolobii* on Sweetpotato and Pepper in South Carolina" funded at $45,000 (ARS subaward $25,000). Helped write proposal, managing ARS subaward, analyzed data.
- ◊ 2019-2023 Co-PI on grant from the NIFA-Methyl Bromide Transition program entitled "Developing Sustainable and Profitable Tools for Management of Tomato Fields Infested with Soilborn Pathogens, Nematodes, and Weeds" funded at $500,000 (ARS subaward $39,351). helped write grant, provided preliminary data, conducting research, and currently managing ARS subaward.
- ◊ 2019-2024 Co-PI on grant from the Specialty Crops Research Initiative-Coordinated Agricultural Project (USDA-NIFA-SCRI-CAPs) program entitled "A Multi-state Effort to Contain and Manage the Invasive Guava Root Knot Nematode (GRKN) in vegetable Crops" funded at $3,418,578.00 (ARS subaward $468,571). Helped conceive and write, provided preliminary data, currently managing ARS subaward.
- ◊ 2020-2021 PI on grant from the National Plant Disease Recovery System entitled "Developing Resources to Manage the Exotic Root-Knot nematode *Meloidogyne enterolobii*" funded at $43,324. Conceived project, wrote proposal, managed project, analyzed data.
- ◊ 2020-2021 Co-PI on North Carolina Agricultural Foundation award entitled "Evaluate the durability of GRKN resistance found in Sweetpotato and Other Crops" funded at $53,000. Provided preliminary data, helped conceive and write project.
- ◊ 2020-2024 Sponsoring Scientist for an NSF-NPGI Post-Doctoral Research Fellowship entitled "Elucidating Root-Knot Nematode Genetic Resistance Through de novo Genome Assembly of Cultivated and Wild Chili Peppers" funded at $207,000 for a 3-year post-doctoral position for Dr. Emily Delorean. Provided all preliminary data, helped conceive and write the proposal, providing scientific mentorship to awardee.
- ◊ 2021-2022 PI on grant from the National Plant Disease Recovery System entitled "Developing Resources to Manage the Exotic Root-Knot nematode *Meloidogyne enterolobii*" funded at $42,552. Conceived project, wrote proposal, managed project, mentored Master's student.
- ◊ 2021-2025 Co-PI on grant from the USDA-NIFA-SCRI program entitled "Rapid Development of Marketable Root-Knot Nematode-resistant Sweetpotato Varieties: translation of genomics and advanced phenomics into on-farm crop management solutions" funded at $5,040,975 (ARS sub-award $498,480). Provided preliminary data, helped conceive and write proposal, helped hire and mentor biological science technician.
- ◊ 2022-2023 Co-PI Sweetpotato Crop Germplasm Committee entitled "Evaluating Sweetpotato Germplasm for Resistance to Reniform Nematode" Funded at $22,000. Conceived project, wrote proposal, helped manage project, and served on PhD student's committee.
- ◊ 2022-2026 Co-PI on grant from the USDA-NIFA-SCRI program entitled "CleanSEED: a project to ensure the sustainability of U.S. sweetpotato seed programs" Funded at $5,000,000 (ARS sub-award $500,000). Provided preliminary data, helped conceive and write proposal, helped hire and mentor post-doc.

GRANT FUNDING (continued)

◊ 2023-2024 PI ARSX pilot initiative award "Nematode Early Warning System (NEWS) facilitates real-time remote monitoring of soil pathogens in agricultural fields" Funded at $25,000. Conceived of project, wrote proposal, and managed project.

◊ 2023-Present Co-PI Cucurbit Crop Germplasm Committee entitled "Evaluating Watermelon Germplasm for Resistance to Reniform Nematode" Funded at $19,000 Conceived project, wrote proposal, helped manage project.

◊ 2024-present Co-PI Phase I USDA-NIFA SBIR with Belenova LLC entitled "Next-Gen Biocontrol for Efficient Meloidogyne enterolobii Management" Funded at $175,000

SCIENTIFIC CONFERENCES AND MEETINGS

◊ American Phytopathological Society annual meetings (2017-2019). Attended and presented research at two meetings.

◊ Society of Nematologists annual meeting (2018-2024). Attended and presented research at four meetings.

◊ Southeast area Nematology working group for Hatch project S-1066(2017-2019). Attended and presented research at three meetings.

◊ National Sweetpotato Collaborators meeting (2020-2021). Attended and presented research.

◊ International Conference on Molecular Plant-Microbe Interactions (2009). Attended and presented research.

◊ International Conference on Evolution of *Caenorhabditis* and Other Nematodes (2013). Attended and presented research.

◊ Donald Danforth Plant Science Center 16th Annual Fall Symposium "Macroinfluence of Microorganisms: Host-Microbe Interactions and Inspired Techologies" (2014). Attendee

◊ National and International meetings of the Secretions Produced in Tylechida (SPIT) working group (2008-2013). Attended and presented research at five meetings

INVITED PRESENTATIONS

◊ Seminar at Clemson University Department of Plant and Environmental Science entitled "Turning a Pathogen's Weapons Against Itself: Using Effector Biology to Aid Development of Pathogen Resistance in Plants" (9-2017)

◊ Seminar University of Florida Department of Nematology entitled "Turning a Pathogen's Weapons Against Itself: Using Effector Biology to Aid Development of Pathogen Resistance in Plants" (10-2018)

◊ Seminar at University of Georgia entitled "Developing Tools to Monitor and Manage Root-Knot Nematode (Meloidogyne sp.) in Vegetable Crops" (3-2020)

◊ Invited to present research entitled "Evaluation of Sweetpotato Germplasm for Resistance to the Guava Root Knot Nematode" at the Annual sweetpotato collaborators meeting (1-2019)

◊ Seminar at Louisiana State University entitled "Developing tools to Manage Guava Root-Knot Nematode on Sweetpotato and other Vegetables" (10-2020)

◊ Invited by Dr. Churamani Khanal at Clemson University to present a graduate level lecture entitled "Molecular plant-nematode interactions and nematode genomics" (2-2021)

◊ Invited to present at sweetpotato stakeholders symposium organized by USDA-ARS (2021)

◊ Invited by Dr. Lei Zhang to give a department seminar at Purdue University entitled "Developing Tools to Manage Root-Knot Nematodes in Vegetables" (2021)
◊ Graduate level lectures at Clemson University on the molecular biology of plant-nematode interactions as well as the molecular mechanisms of host resistance to nematodes (Spring 2022&2023)
◊ Invited lecture for graduate students at Appalachian State University entitled "Developing host plant resistance against plant-parasitic nematodes" (6-2023)
◊ Departmental seminar at Clemson University entitled "Developing new Genetic and Phenotyping Tools to Breed for Resistance to Root-Knot Nematodes in Vegetable Crops" (2-2024)
◊ Invited by the National Program Leader, Dr. Joseph Munyaneza, to represent USDA-ARS at the international Procinorte Plant Heath Task Force working group meeting (8-2024)

PROFESSIONAL SERVICE

◊ Executive Board Member, Society of Nematologists (2023-present)
◊ Chair, Institutional Biosafety Committee, US Vegetable Laboratory (2023-present)
◊ Chair Southeast Nematology Working group (Hatch project S1092) (2023-present)
◊ Vice Chair Southeast Nematology Working group (Hatch project S1092) (2022-2023)
◊ Chair, Nematode resistance committee, Society of Nematologists (2022-2024)
◊ Grant panel member, USDA-NIFA AFRI Pests and Beneficial Species in Agricultural Production Systems program (2022)
◊ Associate Editor, Vegetable Research (2020-present)
◊ Chair, Nematology Committee, American Phytopathological Society (2019-2021)
◊ Grant panel member, USDA-NIFA Crop Protection and Pest Management program, (2019)
◊ Awards committee member, Society of Nematologists (2019)
◊ Associate Editor, Phytopathology (2018-2020)
◊ Subject Matter Expert on Guava Root-Knot Nematode for USDA-APHIS Technical Working Group, 2019
◊ Peer reviewer for multiple journals including: *Phytopathology*, *Plant Disease*, *Journal of Nematology*, *Plant Health Progress*, *PLOS ONE*, *Functional & Integrative Genomics, Frontiers in Plant Science, Molecular Plant Microbe Interactions, G3*

MENTORSHIP

◊ Mentored and supervised four post-doctoral research associates, three of whom have now secured permanent nematology research positions at USDA-ARS; Dr. Leslie Schumacher (USDA-ARS, Tifton), Dr. Benjamin Waldo (USDA-ARS, Beltsville), Dr. Catherine Wram (USDA-ARS, Beltsville)
◊ Mentored and supervised a Master's student at Clemson University, who is now in a permanent Biological Science Technician position at USDA-ARS Charleston
◊ Mentored and supervised eight seasonal student workers.

PEER-REVIEWED PUBLICATIONS
(†=corresponding authorship, *=co-first authorship, *italics*=mentorship)

1. Singh S, **Rutter W.B.**, Wadl PA, Campbell HT, Khanal C, Cutulle M. Effectiveness of Anaerobic Soil Disinfestation for Weed and Nematode Management in Organic Sweetpotato Production. *Agronomy* 14(9):1935. 2024. Doi: https://doi.org/10.3390/agronomy14091935

2. Cham AK, Adams AK, Wadl PA, Zacarías MO, **Rutter W.B.**, Jackson M, Shoemaker D, Bernard EC, Yencho C, and Olukolu B A. Metagenome-enabled models improve genomic predictive ability and identification of herbivory-limiting genes in sweetpotato. *Horticultur Research*. 2024; 11: uhae135. Doi: 10.1093/hr/uhae135

3. George J, Reddy GV, Wadl PA, **Rutter W.B.**, *Culbreath J*, Lau PW, Rashid T, Allan MC, Johaningsmeier SD, Nelson AM, Wang ML, Gubba A., Ling K., Meng Y., Collins D. J., Ponniah S. K., Gowda P. H. Sustainable sweetpotato production in the United States: Current status, challenges, and opportunities. *Agronomy Journal*. 2024;116(2): 630-660 doi: 10.1002/agj2.21539

4. Alam MS, Khanal C, Roberts J., **Rutter W.B.**, Wadl P. Enhancing reniform nematode management in sweetpotato by complementing host-plant resistance with non-fumigant nematicides. *Plant Disease.* Published online 2024. doi: 10.1094/PDIS-07-23-1412-RE

5. *Culbreath J.*, *Wram C.*, Khanal C., *Bechtel T.*, Wadl PA, Mueller J, †**Rutter W.B.** A community-level sampling method for detection of Meloidogyne enterolobii and other root-knot nematodes in sweetpotato storage roots. *Crop Protection*. 2023 Dec 1;174:106401. doi: 10.1016/j.cropro.2023.106401

6. Wadl P.A., Campbell H.T., **Rutter W.B.**, Williams L.H., Murphey V., *Culbreath J.*, Cutulle M.A. sustainable approach for weed and insect management in sweetpotato: breeding for weed and insect tolerant/resistant clones. *Weed Technology*. 2023 Feb;37(1):60-6. Doi: 10.1017/wet.2022.99

7. Alam M.S., Khanal C., Roberts J., **Rutter W.B.** Impact of non-fumigant nematicides on reproduction and pathogenicity of Meloidogyne enterolobii and disease severity in tobacco. *Journal of Nematology*. 2023 Feb;55(1): 20230025 doi: 10.2478/jofnem-2023-0025

8. He F., Wang W., **Rutter W.B.**, Jordan K.W., Ren J., Taagen E., DeWitt N., Sehgal D., Sukumaran S., Dreisigacker S., Reynolds M. Halder J., Sehgal S. K., Liu S., Chen J., Fritz A., Cook J., Brown-Guedira G., Pumphrey M., Carter A., Sorrells M., Dubcovsky J., Hayden M. J., Akhunova A., Morrell P. L., Szabo L., Rouse M., Akhunov E. Genomic variants affecting homoeologous gene expression dosage contribute to agronomic trait variation in allopolyploid wheat. *Nature communications*. 2022 Feb 11;13(1):826. Doi: 10.1038/s41467-022-28453-y

PEER-REVIEWED PUBLICATIONS (continued)
(†=corresponding authorship, *=co-first authorship, *italics*=mentorship)

9. Slonecki T.J., **Rutter W.B.**, Olukolu B.A., Yencho GC, Jackson DM, Wadl PA. Genetic diversity, population structure, and selection of breeder germplasm subsets from the USDA sweetpotato (Ipomoea batatas) collection. *Frontiers in Plant Science*. 2023 Feb 2;13:1022555. doi: 10.3389/fpls.2022.1022555

10. *Waldo B.D.*, Branham S.E., Levi A., Wechter W.P., **†Rutter W.B.**. Distinct Genomic Loci Underlie Quantitative Resistance to Meloidogyne enterolobii Galling and Reproduction in Citrullus amarus. *Plant Disease*. 107(7):2126-32, 2023. doi: 10.1094/PDIS-09-22-2228-RE

11. *Delorean, E.E.*, Youngblood R.C., Simpson S.A., Schoonmaker A.N., Scheffler B. E., **Rutter W.B.,** and Hulse-Kemp A. M. Representing true plant genomes: haplotype-resolved hybrid pepper genome with trio-binning. *Frontiers in Plant Science* 2023;14. doi: 10.3389/fpls.2023.1184112

12. **Rutter W.B.**, Franco J, Gleason C. Rooting Out the Mechanisms of Root-Knot Nematode–Plant Interactions. *Annual Review of Phytopathology*. 2022 Aug 26;60:43-76. doi: 10.1146/annurev-phyto-021621-120943

13. **Rutter, W.B.**, Wadl, P.A. Mueller, J.D., Agudelo, P.A. Identification of Sweetpotato Germplasm Resistant to Pathotypically Distinct Isolates of *Meloidogyne enterolobii* from the Carolinas. *Plant Disease* 105(10):3147-53, 2021. doi: 10.1094/PDIS-02-20-0379-RE

14. Hajihassani, A. **Rutter, W.B.**, Schwarz, T., Woldemariam, M. W., Ali, M. E., Hamidi, N. 2020. Characterization of Resistance to Root-Knot Nematodes (*Meloidogyne spp.*) in *Solanum sisymbriifolium*. *Phytopathology*. *10*(3), 666-673.2020. doi: 10.1094/PHYTO-10-19-0393-R

15. Pogorelko, G.V., Juvale, P.S., **Rutter, W.B.**, Hütten, M., Maier, T.R., Hewezi, T., Paulus, J., Van der Hoorn, R.A.L., Grundler, F.M.W., Siddique, S., Lionetti, V., Zabotina, O.A., Baum, T.J. Re-targeting of a plant defense protease by a cyst nematode effector. *The Plant Journal*. 98(6), 1000-1014. 2019. doi: 10.1111/tpj.14295

16. Keinath, A.P., Wechter, W.P., **Rutter, W.B.**, Agudelo, P.A. Cucurbit Rootstocks Resistant to *Fusarium oxysporum* f. sp. *niveum* Remain Resistant When Coinfected by Meloidogyne incognita in the Field. *Plant disease*. 103(6), 1383-1390. 2019. Doi: 10.1094/PDIS-10-18-1869-RE

17. Hajihassani, A. **Rutter, W.B.**, Luo, X. Resistant Pepper Carrying N, Me1, and Me3 have Different Effects on Penetration and Reproduction of Four Major *Meloidogyne* species. *Journal of Nematology*. 51, 1-9. 2019. Doi: 10.21307/jofnem-2019-020

PEER-REVIEWED PUBLICATIONS (continued)
(†=corresponding authorship, *=co-first authorship, *italics*=mentorship)

18. **Rutter, W.B.**, Skantar, A.M., Handoo, Z.A., Mueller, J.D., Aultman, S.P., Agudelo, P.A. *Meloidogyne enterolobii* found infecting root-knot nematode resistant sweet potato in South Carolina, United States. *Plant Disease*. 103(4), 775-775. 2019. Doi:10.1094/PDIS-08-18-1388-PDN

19. **Rutter, W. B.**, Kousik, C. S., Thies, J. A., Farnham, M. W., & Fery, R. L. PA-593: A Root-knot Nematode-resistant Sweet Cherry-type Pepper, *HortScience*, *53*(12), 1922-1923. 2018. Doi: 10.21273/HORTSCI13544-18

20. Salcedo, A.*, **Rutter, W.B.***, Wang, S., Akhunova, A., Bolus, S., Chao, S., Anderson, N., De Soto, M.F., Rouse, M., Szabo, L., Bowden, R.L., Dubcovsky, J., Akhunov, E. Variation in the AvrSr35 gene determines Sr35 resistance against wheat stem rust race Ug99. *Science*. 358(6370):1604-1606. 2017. Doi: 10.1126/science.aao7294

21. **Rutter, W.B.**, Salcedo, A., Akhunova, A., He, F., Wang, S., Liang, H., Bowden, R.L., Akhunov, E. Divergent and convergent modes of interaction between wheat and *Puccinia graminis f. sp. tritici* isolates revealed by the comparative gene co-expression network and genome analyses. *BMC Genomics*. 18(1):291. 2017. Doi: 10.1186/s12864-017-3678-6

22. Pogorelko, G., Juvale, P.S., **Rutter, W.B.**, Hewezi, T., Maier, T.R., Mitchum, M.G., Davis, E.L., Hussey, R.S., and Baum, T.J. A cyst nematode effector binds to diverse plant proteins, increases nematode susceptibility and affects root morphology. *Molecular Plant Pathology*. 17(6):832-844. 2015. Doi:10.1111/mpp.12330

23. **Rutter, W.B.**, Hewezi, T., Maier, T.R., Mitchum, M.G., Davis, E.L., Hussey, R.S., and Baum, T.J. Members of The *Meloidogyne* Avirulence Protein Family Contain Multiple CLE-Like Motifs. *Phytopathology.* 104(8):879-85. 2014. Doi: 10.1094/PHYTO-11-13-0326-R

24. **Rutter, W.B.**, Hewezi, T., Abubucker, S., Maier, T.R., Huang, G., Mitreva, M., Hussey, R.S., and Baum, T.J. Mining Novel Effector Proteins from the Esophageal Gland Cells of Meloidogyne incognita. *Molecular Plant-Microbe Interactions*. 27(9) 965-974. 2013. Doi: 10.1094/MPMI-03-14-0076-R

MANUSCRIPTS SUBMITTED FOR PEER REVIEW
(†=corresponding authorship, *=co-first authorship, *italics*=mentorship)

25. Khanal C*, **Rutter W.B.***, Alam MS, Alarcon-Mendoza I. *Meloidogyne floridensis* has a unique virulence profile against root-knot nematode resistant and susceptible pepper (*Capsicum annuum*) lines. *In Review*. 2024

26. *Wram C.*, Baker H., Wadl P. A., **†Rutter W.B.** Resistance to *Meloidogyne enterolobii and M. incognita* in the USDA sweetpotato germplasm collection originating from Caribbean Islands, South America, and Central America. *In Review*. 2024

27. **Rutter W.B.**, Hajihassani A., Wang Y., Wang Y. Phenotypic characterization and molecular mapping of recessive resistance to *Meloidogyne Javanica* in cucumber, *Cucumis sativus*. *BioRxiv*. 2021

POPULAR PRESS ARTICLES AND INTERVIEWS

◊ The Society of Nematologists quarterly newsletter featured a profile of Dr. Rutter and his on-going research at the USDA-ARS (Dec-2018) https://nematologists.org/nematology-newsletter-archive/

◊ Dr. Rutter's research on Guava Root Knot Nematode was highlighted on USDA-ARS Tellus, highlighting his research on sweetpotato (https://youtu.be/4fZlXIfsXbo) (Feb-2021)

◊ The South Carolina Public Television show "Making It Grow" (over 40K subscribers) featured a segment on Dr. Rutter and his research that was viewed by growers and home gardeners across and beyond the state on their seven affiliate channels and has continued to be featured in re-runs (https://youtu.be/iJ721lSOY8E) (Nov-2022)

◊ Dr. Rutter's research on detecting *M. enterolobii* in sweetpotato was highlighted on the Mississippi State Extension podcast (Guava Root-knot Nematode in Sweet Potato | Mississippi State University Extension Service (msstate.edu)) (April-2023)

◊ The Charleston news station WSFA featured a news segment on Dr. Rutter's sweetpotato research (https://www.wsfa.com/video/2023/11/24/video-charleston-based-research-behind-thanksgiving-meal/) (Nov-2023)

◊ Dr. Rutter's release of the first *M. enterolobii* resistant sweetpotato breeding line USVL10-185 was highlighted in a video released by USDA-ARS Tellus. Link: https://tellus.ars.usda.gov/stories/articles/developing-sweetpotatoes-are-fit-fight-pests?utm_medium=email&utm_source=govdelivery (Aug-2024)

◊ Dr. Rutter was invited to be interviewed about his research on the "I See Dead Plants" podcast. Sponsored by the Crop Protection network and USDA-NIFA. Spotify Link: (https://open.spotify.com/show/6f2rN3BWYwOKNLPmEhzP0F) (Aug-2024)

REFERENCES

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