

RESEARCH/ INVESTIGACIÓN

FURTHER ELUCIDATION OF THE HOST RANGE OF *GLOBODERA ELLINGTONAE*

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ABSTRACT

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Globodera ellingtonae was first discovered in Oregon and Idaho in 2008 and described as a new species in 2012. Knowledge of the host range of this nematode is limited, with only tomato (*Solanum lycopersicum*) and potato (*Solanum tuberosum*) reported as hosts. This study was conducted to expand the information available on the host range of *G. ellingtonae*. In greenhouse studies, a range of agricultural Solanaceous and non-solanaceous crop plants and Solanaceous weeds were inoculated with *G. ellingtonae* and nematode reproduction was determined after four months. Crops historically grown in rotation with potato at the site where *G. ellingtonae* was discovered in Oregon, alfalfa (*Medicago sativa*), wheat (*Triticum aestivum*), and oat (*Avena sativa*) were all non-hosts for the nematodes. None of the Solanaceous crop plants evaluated, *Capsicum annuum* (bell and jalepeno pepper), *Nicotiana tabacum* (tobacco varieties), *Physalis philadelphica* (tomatillo), or *Solanum melagena* (eggplant) were hosts for *G. ellingtonae*; leaving tomato and potato as the only Solanaceous crops demonstrated to be hosts for *G. ellingtonae*. All of the Solanaceous weed species evaluated, *Solanum nigrum*, *Solanum dulcamara*, and *Solanum rostratum* were hosts for *G. ellingtonae* with final population density/initial population density (P_f/P_i) values ranging from 1.5 to 27.0. The trap crop *Solanum sisymbriifolium* was a non-host for the nematode.

Key words: *Globodera*, host, potato cyst nematode, reproduction

RESUMEN

Peetz, A.B., H. V. Baker, and I. A. Zasada. 2019. Elucidación adicional de la gama de hospedantes de *Globodera ellingtonae*. *Nematropica* 49:12-17.

Globodera ellingtonae se descubrió por primera vez en Oregón e Idaho en 2008, y se describió como una nueva especie en 2012. El conocimiento del rango de hospedadores de este nematodo es limitado, con solo tomate (*Solanum lycopersicum*) y papa (*Solanum tuberosum*) informados como hospedadores. Este estudio se realizó para ampliar la información disponible en el rango de hospedadores de *G. ellingtonae*. En estudios de invernadero, se inoculó una variedad de cultivos agrícolas de Solanáceas y no Solanáceas y malezas Solanáceas con *G. ellingtonae* y se determinó la reproducción del nematodo después de cuatro meses. Los cultivos que históricamente se cultivaron en rotación con papa en el sitio donde se descubrió *G. ellingtonae* en Oregón, la alfalfa (*Medicago sativa*), el trigo (*Triticum aestivum*) y la avena (*Avena sativa*) no fueron hospedadores de los nematodos. Ninguna de las plantas de cultivo Solanáceas evaluadas, *Capsicum annuum* (pimiento y jalepeno), *Nicotiana tabacum* (variedades de tabaco), *Physalis philadelphica*

(tomatillo) o *Solanum melagena* (berenjena) fueron anfitriones de *G. ellingtonae*; dejar el tomate y la papa como los únicos cultivos Solanáceos demostraron ser anfitriones de *G. ellingtonae*. Todas las especies de malezas Solanáceas evaluadas, *Solanum nigrum*, *Solanum dulcamara* y *Solanum rostratum* fueron hospedantes de *G. ellingtonae* con valores de densidad de población final / densidad de población inicial (Pf/Pi) que oscilaron entre 1.5 y 27.0. El cultivo de trampa *Solanum sisymbriifolium* no fue hospedante para el nematodo.

Palabras clave: *Globodera*, huésped, nematodo del quiste de la patata, reproducción

INTRODUCTION

A *Globodera* species morphologically and molecularly distinct from the quarantine potato cyst nematodes (PCN; *Globodera rostochiensis* and *G. pallida*) was first discovered in potato production fields in Oregon and Idaho in 2008 (Skantar *et al.*, 2011). As part of this initial find, nematodes were inoculated onto potato (*Solanum tuberosum*) and potato was identified as a host for this nematode. In 2012, this nematode was described as *Globodera ellingtonae* (Handoo *et al.*, 2012). Data from studies including hatching assays, developmental biology, and phylogenetic analysis indicate that *G. ellingtonae* is more closely related to *G. rostochiensis* than *G. pallida* (Handoo *et al.*, 2012; Phillips *et al.*, 2015; Zasada *et al.*, 2015). Studies on the development of *G. ellingtonae* in a field environment also indicate that *G. ellingtonae* can likely survive in the Andes Mountains of South America where its close relatives *G. pallida* and *G. rostochiensis* originated (Plantard *et al.*, 2008; Boucher *et al.*, 2013; Phillips *et al.*, 2015, 2017). Beyond tomato and potato being identified as hosts for *G. ellingtonae* (Zasada *et al.*, 2013; Lax *et al.*, 2014), and tobacco as a non-host (Lax *et al.*, 2014), little information exists on the host range of *G. ellingtonae*.

The established host range for PCN is narrow and restricted to plant species belonging to the family Solanaceae (Sullivan *et al.*, 2007). *Globodera pallida* and *G. rostochiensis* have highly specialized survival strategies and host-specific hatching cues are usually required for the nematodes to hatch (Perry and Gaur, 1996). Additionally, these nematodes establish a complex relationship with their host to enable successful reproduction (von Mende *et al.*, 1998). Recently, the host range of each PCN was expanded to include Solanaceous weeds commonly found in or near agricultural fields. New reported hosts for *G.*

pallida included *Solanum physalifolium* while *Solanum dulcamara*, *Solanum nigrum*, and *Solanum villosum* were reported as hosts for *G. rostochiensis* (Boydston *et al.*, 2010; Rott *et al.*, 2011; Mimeo *et al.*, 2014).

Knowledge of the host range of plant-parasitic nematodes is critical information when making informed management decisions such as which crops to rotate to as well as which cover crops to use. From a policy perspective, weeds and cover crops alike can act as alternate hosts of plant-parasitic nematodes, keeping populations alive amidst eradication efforts and thus rendering these efforts unsuccessful (Forge *et al.*, 2000; Boydston *et al.*, 2004; Boydston *et al.*, 2010). As such, our objective was to expand the known host range of *G. ellingtonae* with particular focus on potential Solanaceous host plant species and other crop species grown in rotation with potato.

MATERIALS AND METHODS

Cysts of *G. ellingtonae* were reared on ‘Russet Burbank’ potato (*Solanum tuberosum*) in a field at Powell Butte, OR, USA. Soil was collected from the site and air-dried prior to extraction of cysts for inoculum. Cysts were extracted from soil using a USDA cyst extractor (Ayoub, 1980). Extracted cysts were handpicked, enumerated, and then crushed with a rubber stopper on a 250- over a 25- μ m sieve, with eggs being retained on the 25- μ m sieve. Eggs were washed from the sieve into a 50-ml tube and then enumerated using an inverted microscope.

Several *Solanum* weed species were tested for host status for *G. ellingtonae* including *S. dulcamara* (accession PI 643457), *S. nigrum* (accessions PI 304600 and PI 381290), *S. rostratum* (accession PI 420997), and *S. sisymbriifolium* (accession unknown). Seeds were obtained from the United States Department of

Agriculture Germplasm Resources Information Network (USDA GRIN; <https://www.ars-grin.gov/> in Beltsville, MD) and Chuck Brown (USDA-ARS Prosser, WA). Seeds were notched using a micro scalpel, placed on an 85-mm Grade 1 filter paper (Whatman; Buckinghamshire, UK), moistened with deionized water, and subsequently incubated in sealed 100 x 15 mm petri plates (VWR; Radnor, PA) in complete darkness at 18°C for 3-5 days. Germinated seeds were then placed in 6-pack containers containing soilless media to continue to root. Crop plants were also evaluated including oats (*Avena sativa*), bell and jalapeño pepper (*Capsicum annuum*), alfalfa (*Medicago sativa*), 'K326' tobacco (*Nicotiana tabacum*), 'TM900 Mexican Strain' tomatillo (*Physalis philadelphica*), 'Wheeler' wheat (*Triticum aestivum*), 'Rutgers' tomato (*Solanum lycopersicum*), and 'Black Beauty' eggplant (*Solanum melongena*). These were all direct seeded into 6-pack containers containing soilless media. An unknown variety of tobacco was also included in the experiment. Tobacco plants were received as seedlings from Karen Keller (USDA-ARS, Corvallis, OR). ' Désirée' potato (*S. tuberosum*) was included as a positive control in each experiment and seedlings were produced by placing tubers in a 25- x 25-cm bin containing soilless media to germinate. When weed and crop seedlings were approximately 5 to 7 cm tall, they were transplanted into 10-cm round clay pots containing approximately 500 g of a 1:1 steam-pasteurized sand and Willamette loam mix. *Globodera ellingtonae* was inoculated onto plant roots either by pipetting ~2,500 eggs directly onto roots in 2 to 3 ml water or by placing 10 cysts containing eggs onto the root system prior to covering roots with soil to achieve an initial density (P_i) of approximately 5 eggs/g soil.

Pots containing plants were placed in 99 x 51 x 16.5 cm plastic bins with 25 pots per bin (Sterilite; Townsend, MA). Holes were drilled in the bottom of the bins and screens were secured to the 10 drilled holes. Experiments were arranged in a randomized complete block design with 4 to 6 replications per treatment for the Solanaceous weeds and Solanaceous crop species experiments, respectively; each experiment was conducted twice. Plants were watered with 9-45-15 (N-P-K) fertilizer (Scotts, Marysville, OH) immediately after transplanting. Plants were grown in a greenhouse under long-day conditions, 16-hr

photoperiod, with 23/18°C day/night temperatures and were fertilized twice each week with 20-20-20 (N-P-K) fertilizer (Scotts). The plants were grown in the greenhouse for four months or until the plants naturally senesced. At harvest, the aboveground portion of the plant was removed and discarded. The soil from the pots, along with any tubers or roots were spread on trays to dry. Tubers and roots were removed and discarded from dry soil. The total amount of dry soil was weighed and 200-g subsamples were collected from each sample. Cysts were extracted, collected, counted, crushed, and the egg density determined as described above.

For each plant, final egg density (P_f) was divided by P_i to obtain P_f/P_i . The relative susceptibility (RS) of the plants was calculated by dividing the P_f of the test plant by the average P_f for ' Désirée' potato (EPPO, 2006), a measure that has been used in previous studies evaluating Solanaceous weeds as host for *G. rostochiensis* (Rott *et al.*, 2011; Mimee *et al.*, 2014). Each host was given a RS score with 1 indicating the highest level of susceptibility and a score of 9 being the highest level of resistance.

RESULTS AND DISCUSSION

This is the first report of the host status of several Solanaceous plants for *G. ellingtonae*. Prior to this report, the host status of only three plant species had been considered, with tomato and potato as hosts (Zasada *et al.*, 2013; Lax *et al.*, 2014) and tobacco as a non-host (Lax *et al.*, 2014) for *G. ellingtonae*. Similar to *G. rostochiensis* and *G. pallida*, *G. ellingtonae* has a very narrow agricultural crop host range; only tomato and potato are hosts of the plants evaluated (Table 1). Similar to our previous findings (Zasada *et al.*, 2013), potato, in general, is a better host for *G. ellingtonae* than tomato. In this study the average P_f/P_i was 4.3 times greater on potato than tomato, similar to the 5.3 times difference in reproduction between potato and tomato in a previous study (Zasada *et al.*, 2013). However, root diffusates of potato and tomato elicited similar hatch of *G. ellingtonae* in *in vitro* assays (Zasada *et al.*, 2013). To date, the following potato varieties have been demonstrated to be hosts for *G. ellingtonae*: Désirée, Russet Burbank, Yukon Gold, Modoc, Norland, Umatilla, and Colorado (Zasada *et al.*, 2013; Lax *et al.*, 2014). The only other

Table 1. Host status of Solanaceous crop species and crop species grown in rotation with potato (*Solanum tuberosum*) in Oregon for *Globodera ellingtonae*.

Crop species	Cultivar	Common name	Pf/Pi^x	RS score ^y
<i>Avena sativa</i>	NA ^z	Oat	0 ^c	9
<i>Capsicum annuum</i>	NA	Green bell	0	9
<i>C. annuum</i>	NA	Jalepeño	0	9
<i>Medicago sativa</i>	NA	Alfalfa	0	9
<i>Nicotiana tabacum</i>	NA	Tobacco	0	9
<i>N. tabacum</i>	K326	Tobacco	0	9
<i>Physalis philadelphica</i>	TM900 Mexican Strain	Tomatillo	0	9
<i>Solanum lycopersicum</i>	Rutgers	Tomato	5.4 (±1.1)	1
<i>S. melongena</i>	Black Beauty	Eggplant	0	9
<i>S. tuberosum</i>	Désirée	Potato	33.1 (±2.7)	1
<i>Triticum aestivum</i>	Wheeler	Wheat	0	9

^x Pf/Pi is the multiplication rate expressed as a ratio between final egg population (Pf) divided by the initial egg population (Pi). Values are the mean (± standard error) of 12 observations from repeated experiments.

^yRS = Relative susceptibility, which is calculated as Pf of test plant/ Pf of ‘Désirée’ potato (EPPO, 2006).

^zNA=Not Available

Solanaceous crop reported to be a host for a *Globodera* species is eggplant (Ambrogioni et al., 2000). There was no reproduction of *G. ellingtonae* on bell pepper, eggplant, and on the two cultivars of tobacco evaluated (Table 1). Lax et al. (2014) reported no reproduction on ‘K326’ tobacco as was observed in this study. The inclusion of the non-solanaceous crop plants, alfalfa, oat, and wheat (Table 1) was to demonstrate that only potato was a host in the crop rotation scheme employed at the farm where *G. ellingtonae* was found in Oregon.

All of the Solanaceous weed species included in the study were hosts for *G. ellingtonae*, except for *S. sisymbriifolium* (Table 2). Sullivan et al. (2007) reported *S. nigrum* as a non-host for *G. rostochiensis* with an RS score of 9. However, later research indicated that *S. nigrum* has a range of susceptibility against *G. rostochiensis*. Interestingly, this range seems to be dependent on the origin of the *Globodera* population, as well as where the plant was collected. This varying host status was significant for *S. villosum* and *G. rostochiensis* (Rott et al., 2011; Mimee et al., 2013). Additional examples of this complex relationship were also observed between *S. dulcamara* and *G. rostochiensis* (Mimee et al., 2013). Several Solanaceous weed species were tested but not included in our results due to difficulty in obtaining enough viable seed to repeat experiments. Among those, *S. ptycanthum* (accession 64750068), *S. sarrachoides* (accession 954750073), *S. triflorum*, and *S. villosum* (accessions 804750186 and 884750018) were

assessed during a single experiment (data not shown). All of these species would be considered hosts for *G. ellingtonae* with *S. sarrachoides*, *S. triflorum*, and *S. villosum* being excellent hosts (RS = 1) and *S. ptycanthum* a good host (RS = 5). For comparison with other PCN host ranges, *S. ptycanthum* and *S. triflorum* were reported to be a poor hosts for *G. rostochiensis* (Rott et al., 2011). Of particular interest is the likely host status of *S. sarrachoides*. It has been reported as a non-host for *G. rostochiensis* but a suitable host for *G. pallida* (Boydston et al., 2010; Rott et al., 2011). Additionally, we have observed replication of *G. ellingtonae* on *S. sarrachoides* in the field (Zasada, unpublished data).

Solanum sisymbriifolium has been identified as a trap crop for PCN (Scholte, 2000). While *S. sisymbriifolium* does induce egg hatch of *G. pallida* and *G. rostochiensis*, it does not allow the nematodes to complete their life cycle; *S. sisymbriifolium* is also not a host for *G. ellingtonae* (Table 2). From a management perspective, there may be temporal limitations of crop growth period (207-227 days to reach 90-95% hatch) of *S. sisymbriifolium*, which may be an impediment to utilizing it as a trap crop in the field (Timmermans et al., 2006). However, a recent study evaluated the impact of *S. sisymbriifolium* on the ability of *G. pallida* to parasitize potato after exposure to a *S. sisymbriifolium* trap crop (Dandurand and Knudson, 2016). In this study, the progeny were as low as 1/1,000 of the initial population, indicating *S. sisymbriifolium* root diffusate may impact *G.*

Table 2. Host status of Solanaceous weed species for *Globodera ellingtonae* (*Ge*) and comparison of host status to reports for *Globodera pallida* (*Gp*) and *Globodera rostochiensis* (*Gr*) from the literature.

<i>Solanum</i> species	Accession	Pf/Pi^v	<i>Ge</i> RS ^w	<i>Gp</i> RS ^x	<i>Gr</i> RS ^y
<i>S. dulcamara</i>	PI 643457	3.6 (±6.2)	2	7	4-9
<i>S. nigrum</i>	PI 304600	27.0 (±7.1)	1	7	3-9
<i>S. nigrum</i>	PI 381290	14.3 (±11.3)	1		8-9
<i>S. rostratum</i>	PI 420997	1.4 (±0.9)	5		9
<i>S. sisymbriifolium</i>	NA ^z		9		9
<i>S. sisymbriifolium</i> II	NA		9		
<i>S. tuberosum</i> 'Désirée'		9.7 (±3.1)	1		

^v Pf/Pi is the multiplication rate expressed as a ration between final egg population (Pf) divided by the initial egg population (Pi). Values are the mean (± standard error) of 8 to 12 observations from repeated experiments.

^wRS = Relative susceptibility which is calculated as Pf of test plant/ Pf of 'Désirée' potato.

^xBoydston *et al.*, 2010

^yRott *et al.*, 2011 and Mimee *et al.*, 2014

^zNA = not available.

pallida reproduction following its removal and subsequent crop rotation to a known host. *Solanum sisymbriifolium* may contain glycoalkaloids with unknown nematicidal activity, and the fruit is toxic to some mollusks (Bagalwa *et al.*, 2010; Dias *et al.*, 2012). The potential biocidal activities of this species against *Globodera* species warrants further investigation.

Knowledge of the potential for Solanaceous weed species to support nematode reproduction is critical when trying to manage or exclude a nematode from an area. For example, if *G. ellingtonae* is introduced to a different region where an alternate host is growing, its population density may potentially increase even in the absence of potato production. Depending upon the density of the host Solanaceous weeds in a field, the potential increase in population density of *G. ellingtonae* could be more rapid and greater than if potato was planted on a rotational basis because a host would be present every year on which *G. ellingtonae* could reproduce. Future recommendations regarding control of *G. ellingtonae* include cultural controls such as fallow and a strict weed control program, as well as further research into the full potential of *S. sisymbriifolium* as a trap crop in a field setting.

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LITERATURE CITED

- Ambrogioni L, T. Irdani, and S. Caroppo. 2000. Basal threshold temperature and life cycle of *Globodera tabacum* on eggplant in relation to accumulated day degrees. *Nematologia Mediterranean* 28:73-76.
- Ayoub, S. M. 1980. Plant nematology, an agricultural training aid. NemaAid Publications.
- Bagalwa, J. J., L. Voutquenne-Nazabadioko, C. Sayagh, and A. S. Bashwira. 2010. Evaluation of the biological activity of the molluscicidal fraction of *Solanum sisymbriifolium* against no target organisms. *Fitoterapia* 81:767-771.
- Boucher, A. C., B. Mimee, J. Montarry, S. Bardou-Valette, G. Bélair, P. Moffett, and E. Grenier. 2013. Genetic diversity of the golden potato cyst nematode *Globodera rostochiensis* and determination of the origin of populations in Quebec, Canada. *Molecular Phylogenetics and Evolution* 69:75-82.
- Boydston, R. A., H. Motjahedi, J. M. Crosslin, P. E. Thomas, T. Anderson, and E. Riga. 2004. Evidence for the influence of weeds on corky ringspot persistence in alfalfa and scotch spearmint rotations. *American Journal of Potato Research* 81:215-225.
- Boydston, R. A., R. Zemetra, and C. R. Brown. 2010. Weed hosts of *Globodera pallida* from Idaho. *Plant Disease* 94:918-918.
- Dandurand, L. M., and G. R. Knudsen. 2016. Effect of the trap crop *Solanum sisymbriifolium* and two biocontrol fungi on reproduction of the

- potato cyst nematode, *Globodera pallida*. *Annals of Applied Biology* 169:180-189.
- Dias M. C., L. Conceição, I. Abrantes, and M. J. Cunha. 2012. *Solanum sisymbriifolium* - a new approach for the management of plant-parasitic nematodes. *European Journal of Plant Pathology* 133:171-179.
- Forge, T. A., R. E. Ingham, D. Kaufman, and J. N. Pinkerton. 2000. Population growth of *Pratylenchus penetrans* on winter cover crops grown in the Pacific Northwest. *Journal of Nematology* 32:42-51.
- Handoo, Z. A., L. K. Carta, A. M. Skantar, and D. J. Chitwood. 2012. Description of *Globodera ellingtonae* n. sp (Nematoda: Heteroderidae) from Oregon. *Journal of Nematology* 44:40-57.
- Lax, P., J. Duenas, J. Franco-Ponce, C. Gardenal, and M. Doucet. 2014. Morphology and DNA sequence data reveal the presence of *Globodera ellingtonae* in the Andean Region. *Contributions to Zoology* 83:227-243.
- von Mende, N., M. J. Gravato Nobre, and R. N. Perry. 1998. Host finding, invasion and feeding. Pp 215-238 in Sharma, S. B. (ed.) *The cyst nematodes*. Norwell, MA: Kluwer Academic Publishers.
- Mimee, B., R. Andersen, G. Belair, A. Vanasse, and M. Rott. 2014. Impact of quarantine procedures on weed biodiversity and abundance: Implications for the management of the golden potato cyst nematode, *Globodera rostochiensis*. *Crop Protection* 55:21-27.
- Perry, R. N., and H. S. Gaur. 1996. Host plant influences on the hatching of cyst nematodes. *Fundamental and Applied Nematology* 19:505-510.
- Phillips, W. S., S. R. Kieren, and I. A. Zasada. 2015. The relationship between temperature and development in *Globodera ellingtonae*. *Journal of Nematology* 47:283-289.
- Phillips, W. S., M. Kitner, and I. A. Zasada. 2017. Developmental dynamics of *Globodera ellingtonae* in field-grown potato. *Plant Disease* 101:1182-1187.
- Plantard, O., D. Picard, S. Valette, M. Scurrah, E. Grenier, and D. Mugniery. 2008. Origin and genetic diversity of western European populations of the potato cyst nematode (*Globodera pallida*) inferred from mitochondrial sequences and microsatellite loci. *Molecular Ecology* 17:2208-2218.
- Rott, M., T. Lawrence, and M. Belton. 2011. Nightshade hosts for Canadian isolates to *Globodera rostochiensis* pathotype Ro1. *Canadian Journal of Plant Pathology* 33:410-415.
- Timmermans, B. G. H., J. Vos, T. J. Stomph, J. Van Nieuwburg, and P. E. L. Van der Putten. 2006. Growth duration and root length density of *Solanum sisymbriifolium* (Lam.) as determinants of hatching of *Globodera pallida* (Stone). *Annals of Applied Biology* 148:213-222.
- Scholte, K., 2000. Growth and development of plants with potential for use as trap crops for potato cyst nematodes and their effects on the number of juveniles in cysts. *Annals of Applied Biology* 137:31-42.
- Skantar, A. M., Z. A. Handoo, I. A. Zasada, R. E. Ingham, L. K. Carta, and D. J. Chitwood. 2011. Morphological and molecular characterization of *Globodera* populations from Oregon and Idaho. *Phytopathology* 101:480-491.
- Sullivan, M. J., R. N. Inserra, J. Franco, I. Moreno-Leheude, and N. Greco. 2007. Potato cyst nematodes: Plant host status and their regulatory impact. *Nematropica* 37:193-201.
- Zasada, I. A., A. B. Peetz, N. Wade, R. A. Navarre, and R. E. Ingham. 2013. Host status of different potato (*Solanum tuberosum*) varieties and hatching in root diffusates of *Globodera ellingtonae*. *Journal of Nematology* 45:195-201.
- Zasada, I. A., R. E. Ingham, and W. S. Phillips. 2015. Biological insights into *Globodera ellingtonae*. 4th Symposium of Potato Cyst Nematode Management (including other nematode parasites of potatoes).

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