ALTERNATIVE ERADICATION STRATEGIES FOR THE PALE CYST NEMATODE, *GLOBODERA PALLIDA*, USING THE TRAP CROP *SOLANUM SISYMBRIIFOLIUM* AND TWO BIOLOGICAL CONTROL FUNGI

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The pale cyst nematode, *Globodera pallida*, first detected in the United States in 2006, can cause up to 80% yield loss in potato. The presence of *G. pallida* in Idaho, the only state where this pest has been found, has been viewed with alarm by other states and countries that import Idaho potatoes and other farm products. Consequently, *G. pallida*-infested and surrounding fields are regulated by USDA-APHIS and the Idaho State Department of Agriculture (ISDA). Eradication of *G. pallida* is a top priority for the potato industry, and millions of dollars have been spent on eradication efforts since its detection. A critical component of this work has been treatment of infested fields with methyl bromide (MeBr), which has been ongoing since the spring of 2007, with bioassays for nematode egg viability conducted at the University of Idaho in Moscow. Fumigants have been used to control cyst nematodes throughout the world; however, use of MeBr is being phased out worldwide, and MeBr may soon become unavailable for quarantine and pre-shipment (QPS) use. *G. pallida* control is also complicated by the slow hatch rate over a growing season, resulting in less susceptibility to contact nematicides compared to other cyst nematodes. The narrow host range of *Globodera* species suggests that crop rotation could be effective for their control. However, due to their obligate nature, *G. pallida* hatch only in the presence of a suitable host or closely related non-host that produces an appropriate chemical hatching factor. Consequently, population decline rates to non-detectable levels in the absence of a host can take upwards of 20 years. Thus, alternative and effective eradication approaches are needed.

Our research focuses on development of biologically-based alternative eradication measures for potato cyst nematodes, to replace currently-used methyl bromide fumigation. Strategies include (1) trap crops that stimulate nematode hatching without allowing development, (2) fungal biological control agents that are able to attack nematode cysts and eggs, and, (3) optimized combinations of the above two methods.

Solanum sisymbriifolium (litchi tomato) is a solanaceous plant that has been shown to be nearly as effective as potato at inducing *G. pallida* hatching, but does not support parasitism, and for this reason has been investigated as a trap crop for *G. pallida*. Another cyst nematode, *G. tabacum* (tobacco cyst nematode), has a life history that is similar to that of *G. pallida*, and additional parallel experiments are being conducted using this biologically and ecologically similar species as a model organism.

In one greenhouse study, we assessed effects of the trap crop *Solanum sisymbriifolium*, alone or in combination with the potential biocontrol agents *Trichoderma harzianum* or *Plectosphaerella cucumerina*, on population decline of *G. pallida*. Experiments were conducted for three simulated cropping systems: potato (*S. tuberosum*), *S. sisymbriifolium*, or fallow, each followed

by a potato crop. Soil was amended with *P. cucumerina*, *T. harzianum*, or left unamended, and then infested with nematodes at a rate of five eggs/g of soil. After 16 weeks, plants were removed and the soil containing cysts was refrigerated at 4 C for eight weeks, and then planted to potato. Cysts of *G. pallida* were counted after an additional 16-week period. Cyst numbers were significantly reduced in potato following *S. sisymbriifolium* compared to both the potato-following-fallow and the potato-following-potato treatments. Not only was a comparative reduction in cyst numbers observed, but also a decrease in nematode fecundity (numbers of eggs per cyst). Addition of *P. cucumerina* resulted in significantly lower nematode egg numbers (per gram of soil) in potato-following-fallow, whereas *T. harzianum* reduced egg numbers only in the potato-after-potato treatment. However, both biocontrol fungi resulted in lower numbers of progeny cysts in potato. In a second experiment, potato, *S. sisymbriifolium*, or barley were planted into soil infested with *G. pallida* at one of three rates: 5, 20, or 40 eggs/g soil (eggs were inside cysts). After 16 weeks, soil samples were taken to count numbers of cysts produced in each treatment, at each infestation rate. No progeny cysts were recovered from either *S. sisymbriifolium* or barley treatments, confirming that neither plant is a host for *G. pallida*. High numbers of cysts were recovered with potato and were generally proportionate to the original egg density. Soil from each treatment (containing original cysts and newly-formed cysts when present) was then planted to potato. After an additional 16 weeks, nematode reproduction was highest in the potato-followed-by-potato combination at the highest initial infestation rate. Few cysts were found in the potato-after- *S. sisymbriifolium* treatments regardless of initial infestation rate. When potato followed barley, numbers of cysts were similar to those found after a single cycle of potato, indicating that the barley crop had no effect on the survival of initial inoculum. Overall, these results suggest that *S. sisymbriifolium* has potential to significantly reduce *G. pallida* populations, and also that the cropping system (i.e., the sequence of non-host and host plants) may play a significant role in the efficacy of fungal biological control agents.

Because field trials with *G. pallida* are restricted, *G. tabacum* may be useful as a substitute model for PCN. The influence of tobacco (*Nicotiana tabacum*), and litchi tomato (*S. sisymbriifolium*) on egg hatch and subsequent development of both the tobacco cyst nematode, *Globodera tabacum*, and *G. pallida* was investigated. For *G. tabacum*, tobacco increased hatch by four times compared to water alone, whereas LT stimulated twice the hatch of that for tobacco. *G. tabacum* juveniles were observed in stained roots of both *N. tabacum* and *S. sisymbriifolium* and development to adult females occurred within four weeks in tobacco but not in *S. sisymbriifolium*. Litchi tomato stimulated tobacco cyst nematode hatch better than tobacco but unlike tobacco, does not allow significant reproduction in roots, indicating that it may be an effective trap crop for *G. tabacum*. For *G. pallida*, infection was not observed in either resistant of susceptible tobacco. Hatching assays indicate that tobacco root diffusate may stimulate hatch of *G. pallida*, but our experiments to evaluate the potential of tobacco as a trap crop are in progress.

Overall, these results suggest that trap crops and biocontrol agents have potential for control of this economically important plant parasitic nematode. Further studies to optimize these eradication strategies are ongoing.