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Plant Health Task Force

Online Workshop

on

TOOLS AND TECHNOLOGIES FOR MANAGING PLANT PARASITIC NEMATODES IN NORTH AMERICAN HORTICULTURAL CROPS

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ABSTRACTS

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Cultural and biological management of plant parasitic nematodes in horticultural crops

With the exception of the highly visible soybean cyst and potato cyst nematodes, the most widespread and key plant-parasitic nematodes (PPNs) of concern for horticultural crops in Canada are root-lesion nematodes, primarily *Pratylenchus penetrans*, and to a more limited extent, the northern root-knot nematode, *Meloidogyne hapla*. Due to limited recognition of the impacts of PPNs in Canada, there has been little support in recent decades for research targeting bio-cultural methods specifically for nematode control. Nonetheless, a considerable body of research addressing cultural management of PPNs has been embedded in initiatives encouraging utilization of cover crops or organic amendments for overall soil health enhancement and minimizing agricultural impacts on the environment.

Research on rotation cover crops in eastern Canada led to the discovery of Canadian forage pearl millet varieties that are non-hosts for *P. penetrans* and can be used to suppress *P. penetrans* populations prior to planting potato. Ongoing research is further demonstrating the utility of legume (cowpea) and non-legume (pearl millet) mixed cover crops for management of PPNs and promotion of soil health in vegetable cultivation in Ontario. In perennial fruit production systems in British Columbia, recent research has examined how utilization of composts and other organic waste amendments influence population dynamics of *P. penetrans* and ring nematodes (*Mesocriconema xenoplax*). Pre-plant application of compost amendments has been demonstrated to suppress *P. penetrans* over multiple years and to improve early growth of replanted raspberry, apple and sweet cherry as well as pre-plant fumigation. Additional research to elucidate mechanisms of this apparent suppression is warranted as it may reveal means of optimizing soil conditions or compost properties for nematode suppression.

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Use of natural resources for the control of nematodes in crops: Tomato, chili, and watermelon

In the Yucatan Peninsula, Mexico, where short-cycle vegetables are grown, the root problems are gill-forming nematodes. In these areas of continuous production, it is essential to maintain a sustainable management approach. In established crops, the strategy to achieve this is with non-fumigant nematicides, which results in immediate contamination of water bodies and deleterious effects on beneficial fauna, which are not targeted for control. Its prevalence in soils infested with these nematodes, allow designing non-polluting management tactics for these water bodies, such tactics should then include cultural and biological methods, mainly. The latter incorporates control agents to maintain and improve the biodiversity inherent to agricultural systems. The use of beneficial fungi, bacteria, nematodes and viruses to manage not only diseases but also other pests are well known. There are at least 750 known species of these beneficial fungi alone, such as *Beauveria*, *Metarhizium*, *Trichoderma* and mycorrhizae, which are also used as biofertilizers to improve plant growth. Among the bacteria used in agriculture are *Rhizobium*, *Azospirillum*, and *Bacillus*. Combinations of fungi and bacteria growth promoters are used in horticultural crops with sustainable results in production, together with this strategy has combined the use of grafts, where the genetic strength of native or wild cultivars is used as rootstocks, which limit the reproduction rate of nematodes.

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Developing tools to manage *Meloidogyne enterolobii* in the Southeastern United States

The guava root-knot nematode (*Meloidogyne enterolobii*) is a highly virulent species that has emerged as a significant agricultural pest in the southeastern United States. Since it was first reported in Florida in 2001, this nematode has spread to agricultural fields in Georgia, South Carolina, and North Carolina. Much of the recent spread of *M. enterolobii* can be directly attributed to the movement of infected sweetpotato 'seed' roots which are planted by growers each year to propagate their crop. These infected roots act as vectors for spreading *M. enterolobii*, and once a field is infected a growers have few management options. Dr. Rutter will provide an overview of the status and biology of *M. enterolobii* in the southeastern US as well as his ongoing efforts to help growers manage this nematode. His research focuses on identifying and mapping new sources of host resistance against *M. enterolobii* in sweetpotato, pepper, and watermelon. He will also discuss a new high throughput approach to quickly detect *M. enterolobii* in batches of sweetpotato. This work will ultimately lead to new management tools in the form of resistant crop varieties that can help manage *M. enterolobii* in infected fields and provide regulators with new methods to help detect and slow the spread of this nematode to new growing regions.

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The application of genomics and new monitoring tools for plant-parasitic nematode management in Canada

Plant-parasitic nematodes represent a major threat to crop productivity with considerable economic impact. Having co-evolved alongside their hosts, they have developed highly efficient mechanisms to evade both natural plant immunity and deployed resistance genes. Fortunately, recent advances in omics have greatly contributed to our understanding of these mechanisms. The publication of reference genomes has revealed much about the acquisition of pathogenicity genes, species evolution, and gene organization. Combined with functional analyses, the repertoire of parasitism genes has greatly expanded, and new control methods, such as RNA interference, are currently being tested. Plant-nematode interactome predictions have also revealed new susceptibility genes that are being investigated using gene editing. As in several fields, artificial intelligence promises to revolutionize the way we approach nematology. Image recognition algorithms already make it possible to predict yields or guide field scouting. These rapid advances could soon facilitate varietal selection, early and specific detection of nematodes in the field, and the development of control methods adapted to each production context. Together, these advances open the door to a new generation of monitoring, diagnostic, and management tools for plant-parasitic nematode control.

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Situation of diagnosis of phytopathogenic nematodes and its importance in phytosanitary regulation in Mexico

Plant pathogenic nematodes are considered phytosanitary problems that have gained importance in recent years, the management of which has been of great importance due to the challenge of implementation at a practical level. The detection and diagnosis of pest species plays an important role.

The detection and diagnosis of pest species plays an important role in decision making from the point of view of integrated pest management and the commercial exchange of plant products and by-products at national and international level.

The diagnosis is based on aspects of classical taxonomy, especially the use of orthotaxonomic characteristics; however, the use of DNA technologies has made it possible to discriminate species of quarantine importance and thus strengthen decision making in compliance with phytosanitary legal provisions for the commercial movement of agri-food products.

Among the applicable Mexican legal provisions are the Mexican Official Standards (NOM), Regional Standards and Bilateral Work Plans, which regulate species of quarantine importance for Mexico such as *Globodera rostochiensis*, *Meloidogyne chitwoodi*, *Ditylenchus dipsaci*, *D. destructor* and some emerging species such as *Meloidogyne enterolobii*, *M. graminis*, *M. fallax*, etc. Compliance with these regulations allows the trade of healthy agricultural products and by-products in a safe manner.

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Decision support for nematode management: What information is needed?

Rapidly evolving new technologies will result in new ways to manage plant-parasitic nematodes in the future. However, a basic understanding of nematode biology and integrated management will still be required to control these production-limiting pests. Research efforts to generate data for decision support need to advance simultaneously with new technologies to deliver stakeholders with effective systems to manage nematodes. Components of such systems should include information such as nematode identity and population densities, developmental dynamics, and distribution in soil to achieve control. This information can then be combined with information on fumigants and nematicides, plant genotype, and other inputs to support nematode management decisions by growers. The components of a decision support framework to guide nematode management will be presented with examples from wine grapes, red raspberry, and potato production systems.

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