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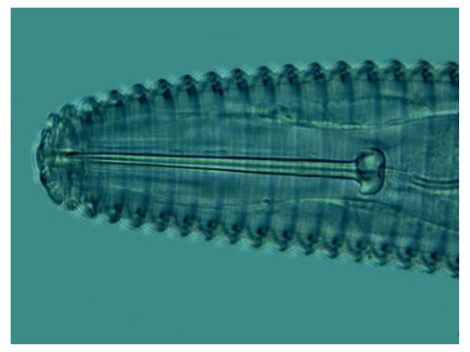
Population dynamics of *Mesocriconema xenoplax* parasitizing sweet cherry trees in British Columbia, Canada

Thomas Forge & Paige Munro
Agriculture and Agri-Food Canada, Summerland Research and Development Centre, Summerland, British Columbia



Introduction

- Sweet cherry (*Prunus avium*) production is increasing worldwide, particularly in the semi-arid Okanagan Valley region of British Columbia (BC), which is at the northern limit of cherry production in North America.
- The ring nematode, *Mesocriconema xenoplax*, has recently become recognized as a pest of cherry trees in BC (Forge et al. 2021). *M. xenoplax* is well known as a pest of grapevine and peach and plum in lower latitude regions of the world, but little is known of its population ecology and impacts in northern-temperate cherry orchards.
- Basic knowledge of the temporal dynamics of *M. xenoplax* populations is needed to: 1) understand cumulative impacts of *M. xenoplax* on cherry tree health and develop damage thresholds, 2) identify appropriate sampling times for diagnostic and monitoring purposes, and 3) predict the impacts of climate change on *M. xenoplax* population densities in the region.
- Perennial fruit production in western North America is dependent on regular irrigation which maintains relatively constant soil moisture contents. Therefore, we hypothesized that population growth during each growing season would be monotonic and driven primarily soil temperatures, and that year-to-year variation in multiplication during the growing season would be correlated with year-to-year variation in soil degree-day heat accumulation.
- **Objective:** In order to test these hypotheses and improve general knowledge of *M. xenoplax* population dynamics in cherry orchards, we measured *M. xenoplax* population densities on a monthly basis over four years in relation to soil temperature and moisture regimes in a mature, irrigated sweet cherry orchard.

Materials and Methods

The sample orchard:

- The orchard was located on the grounds of the Agriculture and Agri-Food Canada, Summerland Research and Development Centre.
- The soil was classified as a Skaha gravelly sandy loam, which is an Orthic Brown soil on glaciofluvial deposits, and is typical for orchards in the region.
- The trees were 14 year old varieties 'Staccato' and 'Sentennial' grafted onto Mazzard rootstock, planted in a 5 m between-tree x 6 m between-row spacing. This combination of variety, rootstock and spacing is typical for sweet cherry orchards in the region.
- An approximately 2 m wide strip under the trees was kept free of competing vegetation via annual herbicide application. The trees were irrigated with understory microsprinklers on a weekly basis between May and mid-September of each year to maintain a relatively constant soil moisture regime.
- Five 10 m long rows of 20 trees were designated to be the five plots for sampling.
- A Decagon EM50 datalogger was installed in the middle of the third row-rep, and 5TE and 5TM probes were installed at depths of 15, 30 and 60 cm to record soil moisture and temperatures at hourly intervals. Growing season degree-days were calculated for each year using base of 5 C.

Sampling and analyses:

- Commencing April 3 of 2018, a composite soil sample was taken from each plot during the first week of each month. Each sample was comprised of five 30 cm deep cores were taken from a 50 cm radius around trunks of five trees in the row, with the position oscillating between 0, 45 and 90 degrees out from the axis of the tree row, to ensure that each composite sample equally represented the tree root zone. The sampling strategy ensured that a different set of five trees was sampled at each date. Nematodes were extracted using a modified wet sieving-sucrose flotation method, and ring nematodes were counted using an inverted microscope.

Results

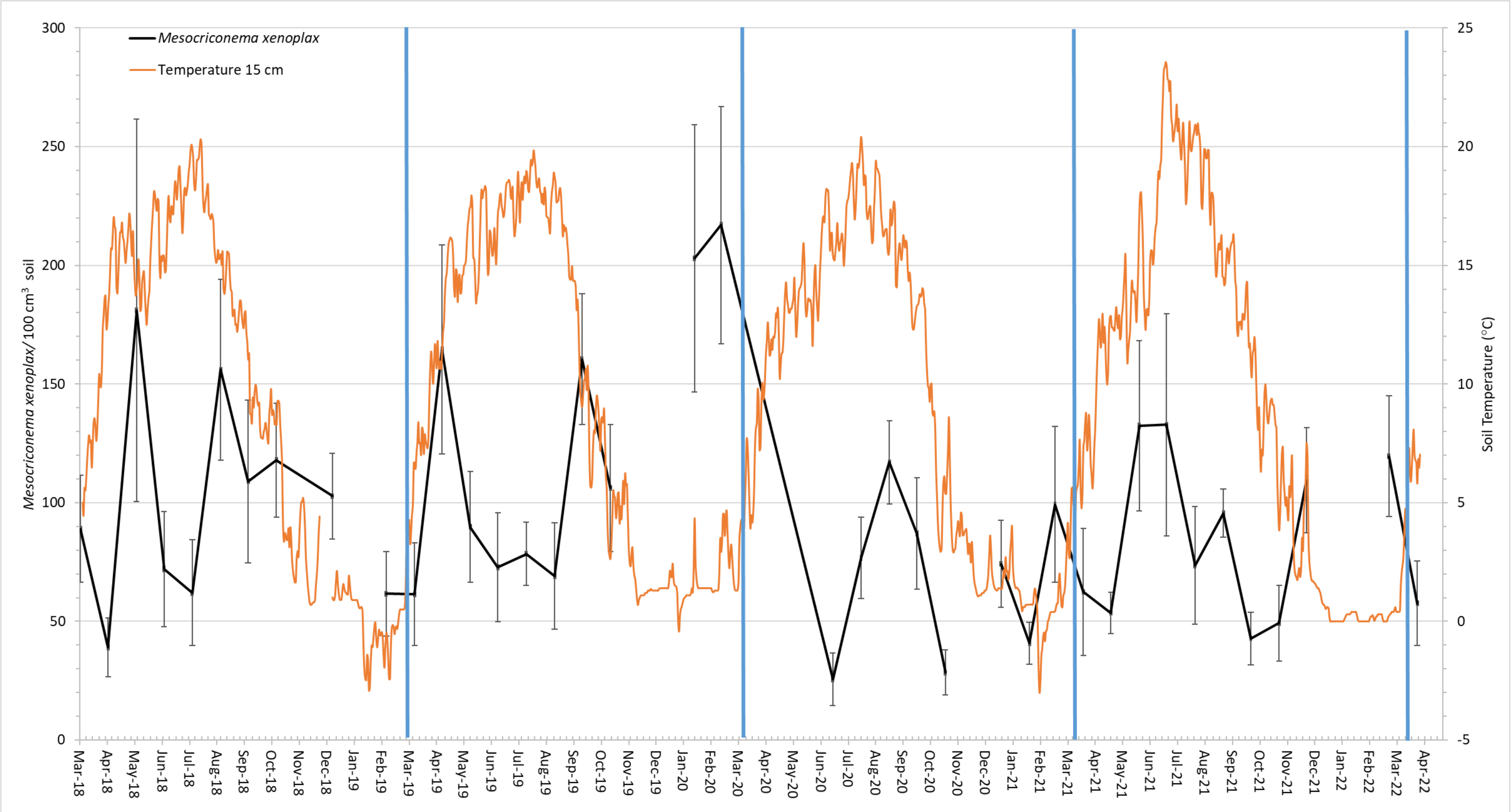


Figure 1. Seasonal trends in *Mesocriconema xenoplax* population densities (black line, left axis) and average daily soil temperatures at 30 cm depth (orange line, right axis) through four years in a cherry orchard in Summerland, British Columbia. Vertical blue lines mark March 31'st and is defined as the beginning of the growing season for this study.

- There was evidence of bimodal population dynamics in all four years, but with "spring peak", "summer depression" and "fall peak" occurring at different times each year.
- 2018 and 2019 had similar population dynamics, with spring peaks in May (2019) or June (2018) as soil temperatures increased above 10 C but before any significant GDD accumulation. Population densities declined through July and August when soil temperatures were between 15 and 20 C, and then secondary periods of population growth resulted in fall peaks observed in September (2018) or October (2019), as temperatures dropped below 15 C and GDD accumulation approached 1500 degree-days.
- The 2020 growing season followed a winter in which soil did not freeze substantially, and spring peak population densities were observed in February and March when soil temperatures were still below 5 C. The summer minimum and fall peak were observed in June and September, respectively, consistent with 2018 and 2019.
- In 2021, the overall hottest year, appeared to be anomalous. The spring peak extended into July when soil temperatures approached 25 C, and with population densities declining through October.

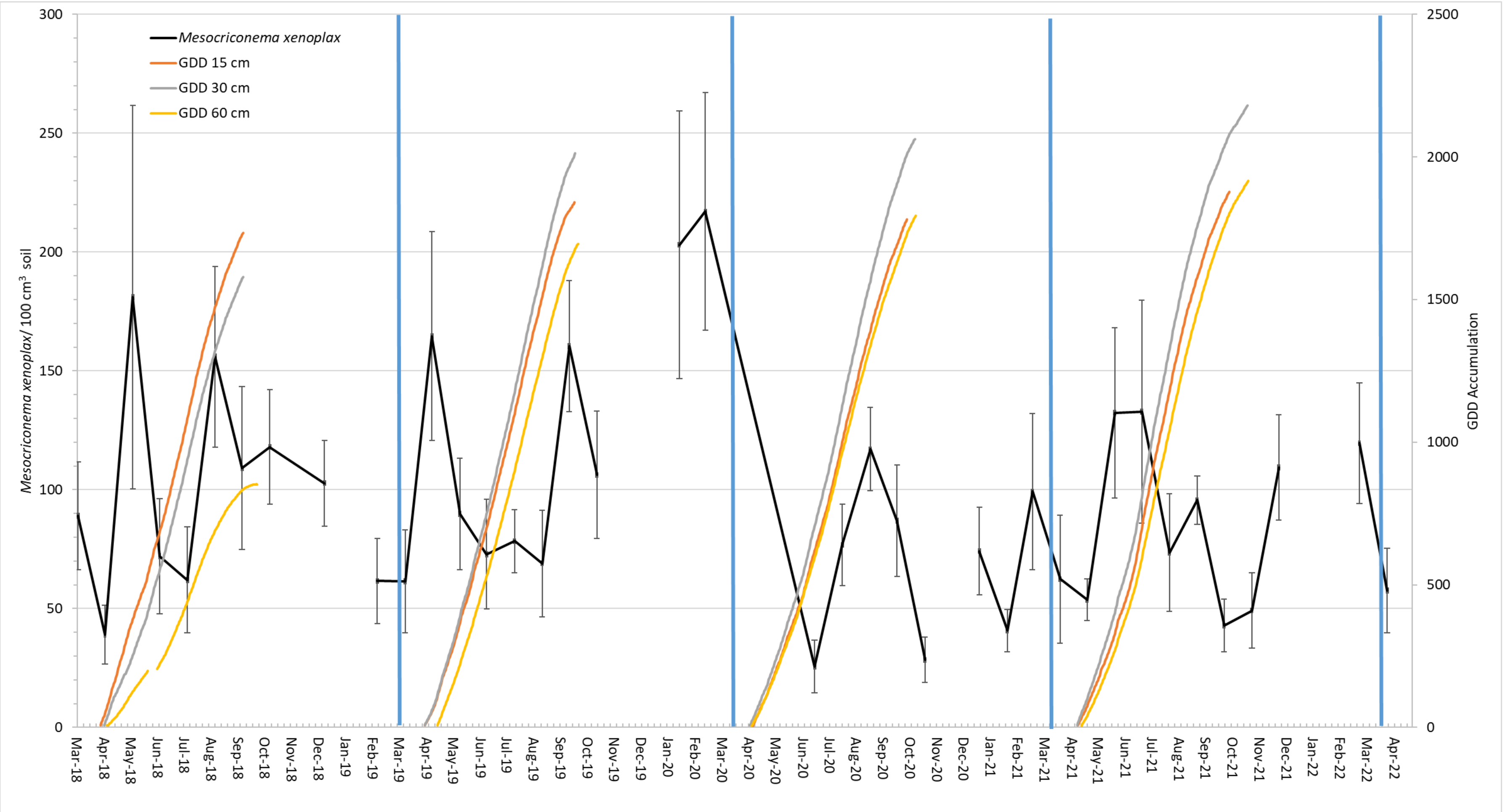
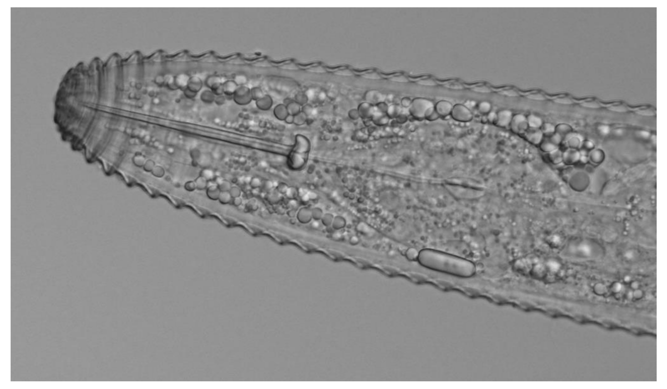


Figure 2. Seasonal trends in *Mesocriconema xenoplax* population densities (black line, left axis) in relation to Growing Degree Day (GDD) accumulation at 15, 30 and 60 cm depths (right axis) through four years in a cherry orchard in Summerland, British Columbia. Vertical blue lines mark March 31'st and is defined as the beginning of the growing season for this study.

Discussion

- Counter to our working hypotheses, we found that population growth of *M. xenoplax* is not monotonic during the growing season, and year-to-year variation in annual population growth is not correlated with year-to-year variation in soil growing degree day accumulation.
- Although population dynamics were bimodal, there were substantial year-to-year differences in the timing of spring and fall peak population densities that were not clearly related to soil temperatures. For example, in 2020 the spring peak was observed in March when soil temperatures were still below 5 C. Similarly, population densities generally declined in summer after soil temperatures rose above 15 C, but in 2021, the hottest year, this decline did not begin until after soil temperatures were approaching 25 C, and extended through October and November when the second population peak had occurred in other years.
- As this production system is uniformly irrigated throughout the growing season, and soil moisture regimes did not vary substantially by year (data not shown), we have ruled out soil moisture fluctuations as a driver of changes in population densities.
- The lack of predictable seasonal trends in population dynamics of plant parasitic nematodes under a temperate perennial crop has been noted before (Forge et al. 1998; Vrain et al. 1996). Such results suggest that density-dependent processes, such as availability of fine roots relative to nematode population densities, may also be important drivers of annual *M. xenoplax* population dynamics. Density-dependent factors complicate attempts to model *M. xenoplax* population dynamics on the basis of soil temperatures alone.
- We suggest that future research should assess temporal dynamics of relationships between *M. xenoplax* populations and fine root densities. An additional limitation of the current study is that sampling was limited to 30 cm depth. Future research should attempt to determine if apparent declines in population densities in the 0 to 30 cm depth interval are related to downward migration.
- Our data suggest that spring (May-June) and fall (September-October) sampling periods would be equally representative of *M. xenoplax* population densities in irrigated orchards in BC.



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Acknowledgements

We would especially like to thank co-op student Alene Wong for initiating data collection. We would also like to thank the Minor Use Pesticide Program and the Services Staff at the Summerland Research and Development Centre for their maintenance of the orchard and willingness to host the study.

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