Stubby Root Nematode Control Using Mustard Biofumigation

On-Farm Demonstration Research Manual

Prepared for:

Neger Farms & Silver Valley Farms

Prepared by:

Shannon Venturini, A.Ag., Marjolaine Dessureault, P.Ag., Jen McFarlane, A.Ag., M.P.M., and Amy Blakeman, A.Ag.,

E.S. Cropconsult Ltd.

Drew Bondar, P.Ag. and Conley Keyes, P.Ag.,

British Columbia Ministry of Agriculture and Food

March 10, 2023

(Updated fall 2024)

Disclaimer:

Opinions expressed in this document are those of the author and not necessarily those of Agriculture and Agri-Food Canada or the BC Ministry of Agriculture and Food. The Government of Canada, the BC Ministry of Agriculture and Food and their director agents, employees or contractors will not be liable for any claims, damages or losses of any kind whatsoever arising out of the use of, or reliance upon, this information. The research principles shared in this manual are for demonstration purposes only.

Acknowledgement:

Funding is provided by the Canadian Agricultural Partnership a five-year, $3 billion investment to strengthen the agriculture, agri-food and agri-based products sector, ensuring continued innovation, growth and prosperity.

CANADIAN AGRICULTURAL PARTNERSHIP

es cropconsult

BRITISH COLUMBIA

Canada

Contents

Background	3
Objective & Research Question	3
Trial Design	4
Methodology	4
Materials and Equipment	4
Data Collection and Evaluation	5
Trial Schedule	6
Budget	6
Labour	6
Potential Funding Opportunities	6
Datasheet Template	7
References	8

Background

Stubby root nematodes (*Paratrichodorus* sp.) have been shown to cause decreases in yield, canopy volume, and top dry weights in blueberry crops over time (Forge *et al*. 2012). Control of these pests can be challenging, however, biofumigation using mustard can be an effective suppression tool (Chen *et al*. 2022).

Glucosinolate compounds are produced by mustards and other plants in the Brassica family (GNB 2015; Prasad *et al*. 2015; Chen *et al*. 2022). When mustard plants are cut and incorporated into the soil, glucosinolate is broken down by myrosinase, an enzyme within plant cells, which creates isothiocyanate (GNB 2015; Prasad *et al*. 2015). Isothiocyanate has been shown to suppress various fungi, pests, nematodes, and bacteria; therefore, mustard varieties with higher glucosinolate content are best for use as biofumigants (GNB 2015; Prasad *et al*. 2015). A study done in 2015 by Prasad *et al*. compared the glucosinolate concentrations of six different mustard species and found that *Brassica juncea* (commonly called brown or Indian mustard) contained the highest glucosinolate concentrations, followed by *B. nigra*. In 2022, Chen *et al*. found *B. juncea* to be an effective biofumigant, reducing root lesion nematodes in potatoes by 48%. However, even within *B. juncea* there is some variability in efficacy, depending on the variety. Some varieties have been bred specifically to have increased glucosinolate levels for the purpose of use as biofumigants and are able to be planted at different points during the growing season under various conditions (GNB 2015; Chen *et al*. 2022).

There are many parameters that can affect the effectiveness of biofumigation. On-farm demonstration research is a valuable approach that producers can use to objectively evaluate what works best for their operation. Demonstration research can be replicated over a few years to gain confidence in the results.

Objective & Research Question

The objective of this on-farm demonstration research is to evaluate biofumigation using a mustard cover crop.

The research question this project will address is:

1) Does biofumigation with mustard suppress stubby root nematode populations?

Trial Design

In order to determine biofumigant efficacy, a mustard cover crop will be planted in an approximately 4.5-acre field with historical stubby root nematode issues (Fig. 1). The field was previously planted with Elliot blueberries, which were removed in 2022. Soil samples will be taken before and after biofumigation to determine impact on stubby root nematode populations.

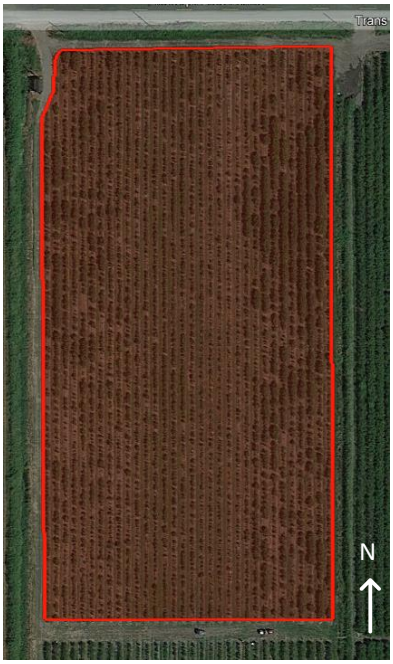

Figure 1. Trial area; mustard will be planted in field outlined in red.

Materials List

- 70 lbs mustard seed
- Cultivator
- Equipment for planting and irrigating mustard
- Flail mower
- Equipment for sealing/rolling mustard
- Soil probe
- Bucket
- Large ziplock freezer bags for soil samples
- Cooler and ice packs
- Permanent marker
- Datasheet

Methodology

1) **Plant**: Fertilize and work the field prior to seeding. To maximize biomass, apply nitrogen (N) at a minimum rate of 50 lbs/ac and maintain N and sulfur at a 6:1 ratio. Broadcast seeds at a rate of 15 lbs/ac, then lightly till to about 1 inch depth. Emergence will begin in 4 to 5 days. Irrigate as necessary throughout growth.
2) **Mow:** Cut plants as finely as possible within two weeks of flowering (about 35-40 days after planting), which is when glucosinolate levels are highest.
3) **Incorporate**: Till mowed mustard into the soil **as soon as possible**. Best practice is to have a cultivator following behind the mower to ensure quick incorporation. Up to 80% of the fumigation gas can be lost within 20 minutes if not incorporated immediately (McGrath n.d.). Best if done on a cool, cloudy morning with high chance of rain in the afternoon. If no rain is forecasted, irrigate soon after incorporation until top six inches of soil are wet. Moisture is necessary for the breakdown of glucosinolate into isothiocyanate.
4) **Seal**: Roll the soil surface to seal in isothiocyanate. Sealing should be done as soon as possible to avoid loss of isothiocyanate, preferably on the same day as incorporation.

Data Collection and Evaluation

Soil sampling:

- When to sample:
  - 1st sample: early spring
  - 2nd sample: 1-3 days prior to mowing
  - 3rd sample: two to four weeks after mowing
  - 4th sample: at the same time of year as 1st sample next season (2024) to determine long-term efficacy
- Walking in a W transect, take 15 random samples with a 1-inch diameter soil probe to a depth of 15 cm and mix all samples together in a clean bucket to create a composite sample (Fig. 2-3).
  - Ensure there is no plant material in the sample by brushing aside surface debris.
- Pour the soil into a large ziplock bag and label with farm and field name, date of sample, and depth sampled.
- Keep samples in a cool place and out of direct sunlight until they can be taken to the lab. An insulated container is ideal (Abawi and Gugino 2007; OMAFRA 2022)
- Submit sample to a lab or local nematode expert for counting and identification.

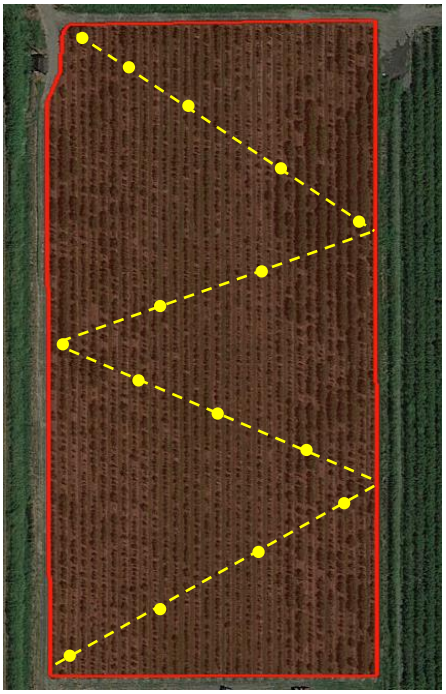

Figure 2. Example sampling pattern showing a W transect; dashed yellow lines show the walking pattern of the sampler, yellow dots are where samples were taken.

Mustard stand rating:

- Prior to mowing, rate the mustard stand on a scale from 1 to 5, with 1 = poor and 5 = excellent. The rating will be subjective, but factors that should be considered are: plant height, bloom percentage, patchiness, etc. If stand health varies greatly in certain parts of the field, you may wish to divide the field into sections and give different ratings.

Evaluate:

- Compare pre-fumigation and post-fumigation nematode counts – did the mustard have an impact on populations?

Figure 3. Soil sampling equipment; clean bucket, soil probe, ziplock bags, and permanent marker.

Record-keeping:

- The following information should be recorded (see attached datasheet): planting date, mowing date, incorporation date, soil sampling dates, and a rating of the mustard stand.
- Data collected: composite soil sample, nematode types and counts, mustard rating
- Photos and videos: Steps 1 to 4 of the methodology documented via short videos. Mustard stand pictures prior to mowing.

Trial Schedule	
Date	**Description of Activities**
April 2023	Initial nematode sampling
June 2023	Planting mustard cover crop
July 2023	Pre-fumigation nematode sampling
July 2023	Mow, incorporate, and roll mustard to begin biofumigation
August 2023	Post-fumigation nematode sampling
October 2023	Analyze data and prepare a project summary report
2024	Nematode sampling to evaluate long-term effect

Budget for Supplies (new)		
Item	**Description**	**Cost ($)**
Seeds	70 lbs brown mustard seeds (*B. juncea*) - ensure variety is bred for fumigation (e.g., Mighty Mustard™ "Kodiak" or "Pacific Gold")	300
Lab fees	Nematode extraction x 4, AAFC	NA

Labour (outside of normal farm practices)		
Item	**Description**	**Hours**
Preparing soil and planting	Planting mustard seeds, including working soil and applying fertilizer	8
Soil sampling	Four sampling periods, time to sample field and drop off lab samples	8
Mowing	Cutting down mustard	4
Incorporating	Working mustard into the soil	4
Sealing	Rolling field to seal in biofumigant	4
Record-keeping	Documentation of project, including taking photos and videos	2
Summary	Analyse data and prepare a trial summary	8

Potential Funding Options

1. BC Climate Agri-Solutions Fund (BCCAF) – Cover Cropping.
2. Environmental Farm Plan/Best Management Practices (EFP/BMP) funding- Cover Cropping (Practice Code 1304).

Datasheet Template

Record-Keeping

Activity	Date	Weather Observations
Mustard planted		
Mustard mowed		
Mustard incorporated		
Irrigation activities		
1st soil sampling (early spring)		
2nd soil sampling (pre-mow)		
3rd soil sampling (post-mow)		
4th soil sampling (spring 2024)		

Results

Activity	Data
Mustard establishment Rating 1-5 (1 = poor, 5 = excellent)	
Early spring nematode levels (from lab)	
Pre-mow nematode levels (from lab)	
Post-mow nematode levels (from lab)	
2024 nematode levels (from lab)	

References

Abawi, G., and Gugino, B. 2007. Soil Sampling for Plant-Parasitic Nematode Assessment. Retrieved from: https://bpb-us e1.wpmucdn.com/blogs.cornell.edu/dist/0/7265/files/2017/01/Soil-Sampling-for-Nematode-Assessment-Factsheet-2ei1p6k.pdf

Chen, D., Zebarth, B. J., Comeau, L. P., Nahar, K., and Dixon, T. 2022. Effect of biofumigation on population densities of Pratylenchus spp. and Verticillium spp. and potato yield in Eastern Canada. American Journal of Potato Research. 99: 229-242.

Forge, T., Zasada, I., Pinkerton, J., and Koch, C. 2012. Host status and damage potential of Paratrichodorus renifer and Pratylenchus penetrans (Nematoda) to blueberry (Vaccinium spp.). Canadian Journal of Plant Pathology. 34(2): 277-282.

(GNB) Government of New Brunswick. 2015. Revised 2015 Agriculture, Aquaculture and Fisheries Growing Mustard for Biofumigation. https://www2.gnb.ca/content/dam/gnb/Departments/10/pdf/Agriculture/GrowingMustardBiofumigation.pdf

McGrath, M. (n.d.). Biofumigation for Managing Phytophthora Blight and Other Soil-Borne Pathogens. Retrieved from: https://www.vegetables.cornell.edu/pest-management/disease-factsheets/biofumigation-for-managing-phytophthora-blight-and-other-soil-borne-pathogens/

(OMAFRA) Ontario Ministry of Agriculture, Food, and Rural Affairs. 2022 .Sampling soil and roots for plant parasitic nematodes | ontario.ca. Retrieved from: https://www.ontario.ca/page/sampling-soil-and-roots-plant-parasitic-nematodes#:~:text=Collect%20soil%20cores%20in%20a

Prasad, P., Pandey, S., and Kumar, J. 2015. High performance liquid chromatography for glucosinolate Brassica L. species. Indian Journal of Natural Products and Resources. 6(3): 221-226.