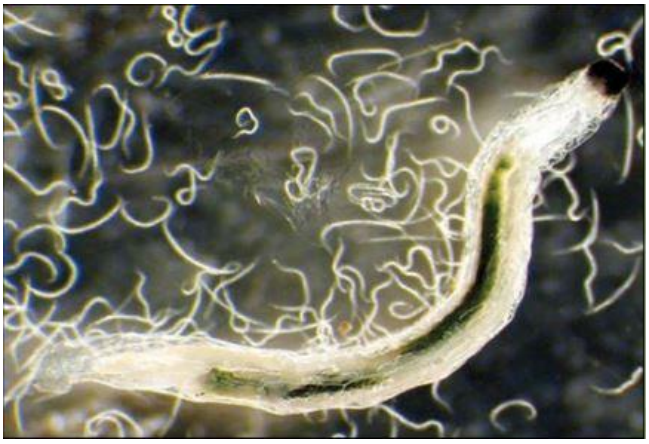
Using Nematodes to Control Root Maggots

Root maggots (*Delia radicum*) represent a major problem for growers of vegetable cole crops (cabbage, cauliflower, radish, rutabaga etc.) in Saskatchewan. Feeding by the maggot stage damages the roots. In young plants this damage may kill the seedlings – whereas in older established plants the damaged root systems are less capable of delivering the water and nutrients required for optimal growth. Affected crops are slow to mature and may not reach optimal size or quality. In crops grown for their roots (rutabaga and radish), the scars left by the feeding maggots may render the roots unmarketable. Presently, the most widely utilized approach to controlling maggots is to apply the insecticide chlorpyrifos (Lorsban) as a root drench on several occasions through the growing season. The timing of the chlorpyrifos application(s) is targeted to correspond to the development of the maggot population. Application of chlorpyrifos must cease 30 days prior to harvest. Organophosphates like chlorpyrifos have been targeted for phase out as soon as effective reduced-risk alternatives are identified.

Parasitic nematodes have shown potential to control a broad range of soil inhabiting and above ground insect pests. The nematodes can be applied as a foliar spray to reach above-ground pests or as a drench for soil-borne pests. The nematodes sense the carbon dioxide emissions of soil-borne insects and "swim" through the soil solution towards their intended host. For that reason the soil must be kept moist for the nematodes to be effective. Once the nematodes find a target pest they enter it through one of the body openings and then deposit bacteria into the pest. These bacteria kill the insect pest within a few days and then turn it into a food source for the nematode and many hundreds of its offspring. Once this food source is exhausted, the nematodes migrate in the soil in search of a new insect host. Once the pest population is eliminated, the nematodes die off. The nematodes and the bacteria they contain are considered to be safe for the environment, product applicators and consumers.



Nematodes erupting from a parasitized maggot.
http://www.omafra.gov.on.ca/english/crops/facts/14-003.htm

Greenhouse and other controlled environment research trials have shown that parasitic nematodes will attack root maggots. However field studies demonstrating efficacy of this approach for control of root maggot have been limited. In 2015 preliminary trials conducted by the UofS demonstrated some potential for the nemas to control root maggots in cabbage but the numbers of nemas applied in this trial were too high to be considered an economically viable treatment option.

The objective of this project was to assess the potential to use parasitic nematodes to control root maggots in field grown vegetable crops in Saskatchewan. A second objective was to determine the number of nemas that had to be applied to provide effective maggot control.

The experiment was conducted during the 2016 growing season at the University of Saskatchewan Horticulture Field Research Station in Saskatoon, Saskatchewan. The site has a clay loam soil with a pH of 7.3 and an E.C. of less than 1 dS/m. The trial site has been repeatedly cropped to cruciferous vegetables and is within one kilometer of commercial canola fields, resulting in a build-up of root maggots on site.

The test site was prepared in late April by rotovating the soil, at which time enough nitrogen fertilizer was incorporated to raise the total soil nitrogen level to the recommended rate for cabbage of 100 kg/ha. All other nutrients were already present in the soil in adequate quantities for cabbage production. The herbicide Treflan (480 g/L of trifluralin; Dow AgroSciences, Calgary) was applied to the soil surface at the recommended rate of 2.2 L/ha and then lightly incorporated just prior to transplanting out the test crops.

Six week old greenhouse grown transplants of cabbage (cv. Expat) and cauliflower (cv. Symphony and Terzolo) were moved into the field in early May. The seedlings were spaced 30 cm apart in rows spaced 1.25 m apart. Each treatment replicate consisted of a single row containing 10 plants. Each treatment was replicated 3 times and the treatments were arranged in a randomized complete block design with guard rows planted on the outside of the plot to minimize edge effects.

The maggot control treatments were;

Treatment 1 - Untreated control
Treatment 2 - Treated 3 times with chlorpyrifos (Lorsban) at the label recommended rate (*)
Treatment 3 - Treated 3 times with nematodes at the rate of 4,000 nematodes/plant (**)
Treatment 4 – " " " " " 20,000 " "
Treatment 5 - " " " " " 100,000 " "
Treatment 6 - " " " " " 500,000 " "

(*) The label recommended rate for Lorsban applied as a post-planting drench for root maggot control is 1.68 L of product diluted into 1000 L of water – with the resulting solution applied at the rate of 12.5 L of drench, or 21.24mL of product, per 100 m of row.

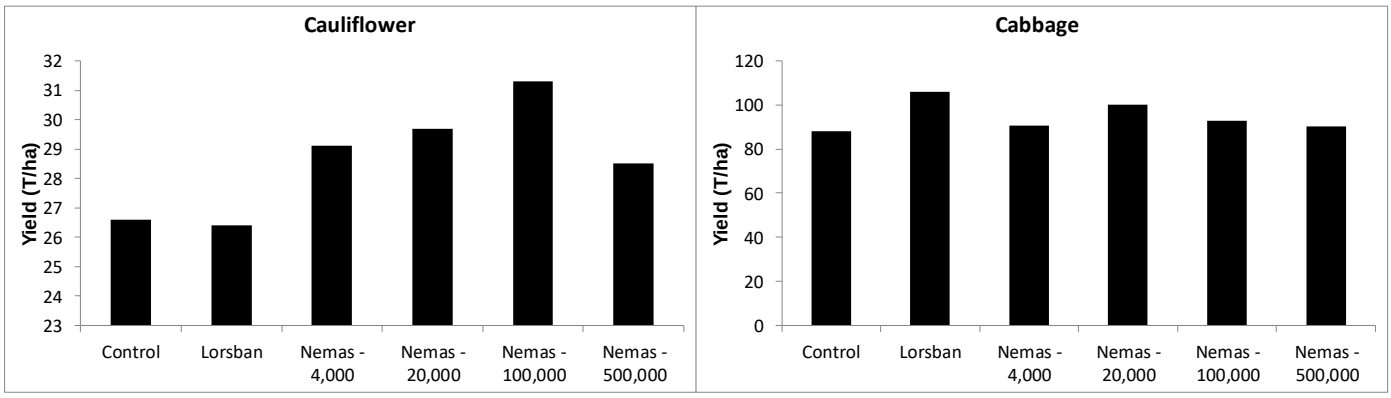
(**) The parasitic nematodes (*Steinernema feltiae)* were obtained from Biobest, Leamington, ON. While *S. feltiae* has been shown to parasitize root maggots, it may not be the most effective species. The choice of this species was instead largely driven by ease of access to an affordable commercial source of the nemas. As the number of nematodes required to control a root maggot infestation is not well known – a wide range of dosages was tested (4,000 to 500,000 nemas/plant). A solution containing the appropriate number of nemas was created by mixing a weighed quantity of nemas into a suitable volume of cold water. The solution containing the nematodes was applied as a soil drench. A watering can was used to apply approximately 0.3 L of the drench to each plant.

The Lorsban and nematode treatments were applied 3 times – at transplanting, then again at 3 and 6 weeks after transplanting. The plots were irrigated immediately after treatment to move the chemical or the nemas deeper into the root zone.

The plots were kept weed free using mechanical tillage and hand pulling. The plots were irrigated weekly using a wheel move system. A top-dress treatment of urea fertilizer (46-0-0) was applied in early July to supply an additional 20 lbs/a of nitrogen to the crop.

The crops were carefully observed following transplanting to determine if the root maggots were going to cause any loss of stand. Once the plantings were established crop vigor was assess weekly. The cauliflower and cabbage were harvested once the heads reached marketable size. The heads were counted and weighed to assess the impact of the treatments on crop yields.

Results



Influence of root maggot control treatments on yields of cauliflower and cabbage – 2016.

Growing conditions were near-ideal throughout the test period. These ideal conditions resulted in quick establishment of the transplanted seedlings, rapid subsequent growth and excellent yields. While there were some indications of root maggots slowing growth of some of the newly transplanted seedlings, there were few fatalities that could be attributed to maggot damage. In both the cabbage and cauliflower crops the plants treated with Lorsban were clearly larger/more advanced that any of the other treatments, while the non-treated control plants appeared smaller and less advanced than all the other treatments. The cauliflower plants treated with Lorsban were ready 5 days earlier than any of the other treatments – but no treatment effects on time to maturity were observed in the cabbage trial. In cauliflower, the untreated control treatments had a few less harvestable plants/plot than the other treatments which reduced overall yields. While the Lorsban treatment had very effectively protected the cauliflower plants against maggot damage, the size of the heads in the Lorsban treatment was smaller than average – this reduced the overall yield. The smaller head size might be an artifact related to the earlier harvest of the Lorsban treated plants. The nematode treated cauliflower plots, on average, produced higher yields than either the control or Lorsban treated plots. The number of nematodes applied had no impact on yields in the cauliflower trial. The vigor of all of treatments in the cabbage trials was exceptionally good – and there were no differences amongst the treatments – including the untreated control - for any of the yield parameters measured.

Conclusions – exceptionally favorable growing conditions and careful attention to inputs like fertilizer and water reduced the potential of the maggots to negatively impact growth or yields of the cabbage and cauliflower crops in this trial. While the Lorsban treatment appeared to enhance the vigor of both crops, this did not result in any enhancement of yields. Application of parasitic nematodes enhanced yields in the cauliflower trail – with the lowest dosage tested appearing to work as well as much higher application rates. The potential for relatively low dosages of nematodes to provide effective control is important – as even at the lowest application rate tested in this project, the cost of the nematodes (ca $85/a/application) is much greater than the cost of Lorsban (ca $27/a/application). However the cost of the nematode treatments might potentially be reduced if; a) lower application rates prove effective or b) if the first application of nematodes is able to establish a sustained population in the root zone – then a single application may be all that is required – whereas multiple applications will always be required for the Lorsban. Other commercially available parasitic nematodes such as *S. carpocapsae* should also be tested.