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WIREWORM MONITORING AND CONTROL

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Wireworms are the larvae of click beetles. Several different species of wireworm can be found in Nova Scotia, and it is the larval stage that is becoming increasingly problematic in numerous crops. Due to the lifecycle of the beetle, a field with a high level of wireworms will likely continue to have high levels of the pest for 3 to 6 years.

DESCRIPTION

There are several different larval stages of click beetles, and as the larvae become older and larger, they tend to inflict more damage. Wireworms begin very small and white in color, this growth stage typically lasts between 1 and 2 years. White larvae then develop a hard shell that is yellow or goldish in colour **(Figure 1)**; this mature larval stage can last between 2 and 6 years depending on food resources. The older larvae can be 0.5-1.0 inches long and are very visible. In the spring they will attack transplants and seeds, and in the fall they cause damage to root crops such as potatoes, carrots, sweet potatoes, etc. (Institute of Agriculture and Natural Resources, n.d.)

Figure 1. *Wireworm larvae. (Courtesy R. Gillis-Madden)*

KEY CONCEPTS

- Wireworms are particularly problematic in newly broken ground or in rotations that include a perennial forage plowdown
- In an infested field, wireworm can continue to be problematic for 2 to 6 years
- Wireworms move in the soil profile throughout the season.
  - » They come to the surface in the spring as the soils warm, in early- to mid-May.
  - » They go deeper in the soil profile in the hot and dry months, starting in mid- to late-June.
  - » In mid-September they come back to the soil surface to cause more problems.
- Wireworm damage is typically aggregated and patchy in a field
- Chemical control options are limited, and do not necessarily provide effective, long term control.
- Cover crops such as buckwheat or brown mustard have been shown to provide control

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LIFE CYCLE

All stages of the wireworm (adult, larva and pupa) overwinter in the soil. In an infested field, it is typical to find all growth stages present. Adult click beetles **(Figure 2)** are particularly attracted to sod and grain crops for laying their eggs – freshly broken ground, high levels of grassy weeds, or rotations that include a perennial forage plowdown are particularly prone to wireworm problems. (Chaput, 2000). Wireworms shift their position in the soil column depending on the soil temperature: in the spring as the soils start to warm, wireworms come up through the soil profile and can cause problems by predating on seed or new transplants **(Figure 3)**. In Nova Scotia, especially under black plastic, this can be as early as the first or second week of May. By mid- to late-June, wireworms will typically descend deeper into the soil profile where it is moister and cooler, and usually crop damage in July and August is minimal. In mid-September, as the soils start to cool, wireworms again start to travel up through the soil profile and cause damage to root crops such as potatoes, carrots, etc. By mid-October they once again descend deeper into the soil profile for winter hibernation.

Figure 2. *Adult click beetles (Courtesy of ©entomart)*

Figure 3. *Wireworm larvae attacking a lettuce transplant. (Courtesy of R. Gillis-Madden)*

DAMAGE

Wireworms feed on the roots and seeds of several crops. Once the eggs hatch, wireworms will exist in a single field until they become adults, at which point they may again lay their eggs in the same field, or fly to another field. Wireworms will predate newly seeded or transplanted crops. If a transplant or a new seedling does not have a robust enough root system, it will die. If the root damage itself is not significant enough to kill the young plant, the damage left by the wireworm is an open door for secondary infection by bacteria and fungi. Wireworm damage in a newly seeded or transplanted crop will often be aggregated **(Figure 4)** – the damage will appear in one or several defined areas and will not typically be evenly distributed across the entire field. In the fall the damage caused by wireworms is to marketability – wireworms will leave holes or scars on root vegetables **(Figure 5, Figure 6)**. These blemishes are unappealing to consumers, and can also become infected with secondary pathogens, resulting in rots and reduced storage life.

Figure 4. *Lettuce transplants decimated by wireworm predation in early spring. (Courtesy R. Gillis-Madden)*

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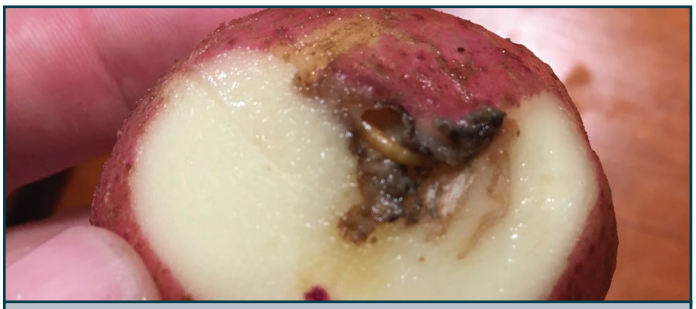

Figure 5. *Wireworm damage in potato. (Courtesy R. Gillis-Madden)*

Figure 6. *Wireworm damage in garlic. (Courtesy R. Gillis-Madden)*

HOW TO SET UP A BAIT TRAP

- Dig bait holes 6 inches deep, scattered throughout the field.
- Bury a few chunks of sliced up carrot or potato (half a cup to a cup).
- Cover the bait with soil and mark each trap with a stake or field flag for easy identification. If doing several traps, it is recommended to number the traps for simple recording of findings.
- In 5-7 days, dig up the trap and inspect vegetable pieces and surrounding soil for wireworm larvae.
- Count the number of wireworms in each trap and record the number found.
- If one or more wireworms are found per bait trap, averaged across the field, then crop damage is likely.

TRACKING THE INFESTATION

If you suspect that wireworms are present in your field, you might want to set baits to help evaluate the degree of infestation. Baiting is especially recommended if you are planting into ground that has previously had problems. Baiting the fall prior to planting a high-value crop will allow you to make appropriate crop rotation decisions. Target setting out baits between mid-September and mid-October. Baiting can also be done in the spring when soil temperatures reach 5-10˚C. It is important to remember that wireworms are not evenly distributed across a field, it is best to set 20+ baits per field to get an accurate picture of wireworm levels. These traps should be checked every 4-5 days to track accurate population numbers (Hughes, 2014).

Baiting can give you an approximation of the wireworm population in a field, but will not necessarily be an accurate predictor of damage. Research conducted on Prince Edward Island by Dr. Christine Noronha found that wireworms will travel approximately 3.6 meters in 24 hours to reach bait traps. They will then move along to the next trap, without depleting all of the food that was in the initial trap. This can make it challenging to obtain an accurate picture of the true population. (Isaacs, 2019)

WIREWORM MANAGEMENT: CHEMICAL CONTROL OPTIONS

Wireworms, like most soil-borne pests, are difficult to control. Several factors make managing this pest challenging, the first being their long lifecycle. Secondly, because wireworms move up and down the soil profile readily, it can be hard to target them with chemical or biochemical control options. As of spring 2020, there are a handful of chemical options that are available for wireworm management **(Table 1)**, none of which provide long-term control. It is important to note that these pesticides will help manage a wireworm population but typically they do not solve the problem. There are very few crops that have a registered product for wireworm management. Part of a good wireworm strategy would be to use these crop-seed treatment pairs as a trap crop, an intercrop, or part of your crop rotation, ideally paired with the cultural practices outlined below.

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Table 1. *Insecticides registered for wireworms as of April 2020. Always read and follow the label carefully. For the most up-to-date labels, please visit the Health Canada Pesticide Label Search:* **https://pr-rp.hc-sc.gc.ca/ls-re/index-eng.php**

Active ingredient	FRAC Group	Trade name(s)	Labelled Crops
Acephate	1B	Orthene	Tomato, tobacco
Chlorpyrifos	1B	Pyrinex	Potatoes
		Pyrifos	
Phorate	1B	Thimet	Potato
Tefluthrin	3A	Force	Field, sweet, pop, and seed corn
Bifenthrin and its trans isomer	3A	Capture	Potato
Thiamethoxam	4A	Cruiser *(various formulations also include fungicides, etc.)*	Corn, various types of bean (both dry and succulent), cereals, sunflowers, sugar beets, etc. *See label for complete crop listing.*
Clothianidin	4A	Titan	Potatoes
		Poncho	Canola, rapeseed, corn
		NipsIt	Potatoes, corn, wheat
		Emesto Quantum	Potatoes
Imidacloprid	4A	Alias	Durum wheat, winter wheat, spring wheat, barley, oats, soybeans
		Stress Shield	Wheat, barley, oats
		Sombrero	Corn, cereals, soybeans
		Acceleron	Soybeans
		Gaucho	Corn

Pesticides in FRAC Group 1B, like the ones listed in Table 1, are organophosphates. Organophosphates have been on the chopping block with the Pest Management Regulatory Agency (PMRA) for years because of the risks associated with human exposure.

Pesticides in FRAC Group 3A, like the ones listed in Table 1, are synthetic pyrethroids. They deter wireworms from feeding on the seed/seedling, but **they do not kill the wireworms**. Do not expect Group 3A pesticides alone to provide any measure of long-term control (van Herk & Vernon, 2018).

Pesticides in FRAC Group 4A, like the ones listed in Table 1, are neonicotinoids. Neonicotinoids are on the chopping block with PMRA as well and are being phased out in the coming years because of environmental concerns. While they intoxicate wireworms, **they do not kill the wireworms**. Do not expect Group 4A pesticides alone to provide any measure of long-term control (van Herk & Vernon, 2018).

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WIREWORM MANAGEMENT: CULTURAL CONTROL OPTIONS

Cultural practices are an effective method for preventing and controlling wireworm populations. During the growing season, it is important to keep the field clean of grassy weeds or volunteer cereals, as these are prime hosts. Avoid rotation with grass, pastures, and highly susceptible crops as much as possible. Brown mustard and buckwheat have been proven to reduce populations of wireworm when used in a crop rotation (Hughes, 2014).

Brown mustard (*Brassica juncea*) has high levels of glucosinolates, which have biofumigant properties that are effective at managing wireworms (Government of New Brunswick, 2015). Glucosinolate content in brown mustard peaks at flowering **(Figure 7)**. Timing incorporation for this window will maximize the effectiveness of the biofumigant. It is best to terminate the brown mustard before it sets seed, as it can easily become a weed. Note that the lower branches of a mustard plant will be forming pods, even while still in full-flower, so this crop should be monitored closely to avoid it becoming a weed issue.

Figure 7. *Brown mustard in Full Flower. (Courtesy Heirloom & Perennial*

For maximum biofumigation properties, the brown mustard should be flail mowed and immediately (within a half hour) incorporated. If you have the capabilities, the field should then be rolled to seal in the biofumigant gasses. Targeting when the wireworms are active in the upper soil profile (i.e. mid-September to mid-October) will improve effectiveness. Recent research out of PEI has suggested that just having brown mustard growing in the field when the wireworms come up for a fall feeding can provide a measure of control, without incorporation (Noronha C. , 2017). Brown mustard should be seeded at 10 lbs/acre (11.2 kg/ha). It is important to have good establishment and a good stand for the brown mustard to provide adequate control. This means that you need to provide some measure of fertility to the brown mustard. Assuming a soil test report of "Medium" for phosphorus and potassium, fertilizing with 50lbs actual N/ acre, 50 lbs P2O5/acre, and 50 lbs K2O/acre should provide a good stand (Noronha C. , 2016). It is recommended to adjust your soil pH to as close to 7.0 as possible, as biofumigation will not be as successful in soils with a pH lower than 5.5 (Government of New Brunswick, 2015). Research has shown that Centennial mustard has 0.9 mg/g greater flucosinolate content, compared to common brown mustard (Rakow, Raney, & Relf-Eckstein, 2008). As of spring 2020, the average price for Centennial mustard is $226 for 50 lbs ($45.20/acre), whereas common brown mustard is $109 for 50 lbs ($21.80/ acre). Local reports from growers in Nova Scotia suggest that using common seed can still provide effect control at significant savings.

Buckwheat (*Fagopyrum esculentum*) is another cover crop that can be used to manage wireworm populations **(Figure 7)**. Buckwheat has phytochemicals that serve as deterrents, anti-feedants and toxins; these can cause the wireworm to die either from starvation or direct toxicity from consumption (Bohorquez Ruiz, Scott, & McNeil, 2018). Buckwheat should be seeded at 40 lbs/acre (44.8 kg/ ha). Similar to brown mustard, a good stand of buckwheat is necessary for the buckwheat to have any wireworm management activity. Assuming a soil test report of "Medium" for phosphorus and potassium, fertilizing with 50lbs actual N/ acre, 50 lbs P2O5/acre, and 50 lbs K2O/acre should provide a good stand (Noronha C. , 2016). Research has shown that the variety, Mancan can provide good control, and is typically readily available from local seed supply outlets. A 50lb bag of Mancan buckwheat seed , as well as general common seed retails for around $70 in spring 2020, or $56/acre. Note that buckwheat will very quickly go to seed, even while in full-flower **(Figure 8)**, so be sure to monitor the crop regularly and terminate it before it can become a weed problem.

Figure 8. *Healthy buckwheat stand. (Courtesy R. Gillis-Madden)*

Figure 9. *Buckwheat in full flower already setting seed. (Courtesy R. Gillis-Madden)*

It has also been found that repeated soil cultivation, prior to planting the cash crop can reduce wireworm populations (Hughes, 2014). This method is not recommended for fields that are susceptible to erosion, or those that already have diminished organic matter levels, as cultivation will disrupt the upper layer of soil and break down aggregates.

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