An agricultural heavyweight

Strategies for beating European wireworms

by Joanna MacKenzie

It spends most of its life hidden in the soil beneath your feet. At first glance, measuring in at only two centimeters in length and a mere millimeter wide, it looks like a lightweight in the agricultural boxing ring. Seemingly innocent, although ubiquitous, it is a worm-like creature with a hardened yellow surface. Yet it is a crop damaging heavyweight, responsible for countless crop losses across Canada: the wireworm. Two eyespots on its hind end betray its true identity; it is one of the European wireworms, most ravenous of its species.

While the Atlantic provinces harbor native wireworm species, these three European species – also known as the Dusky wireworm, the Lined wireworm, and the Potato wireworm – cause the lion's share of crop damage. These species were first introduced to Canada in soil ballast once used to steady empty ships as they returned from the Old to the New World to load up on lumber. Unfortunately, these small creatures can have a profound effect on agricultural systems.

Wireworm larvae persist in soil for up to five years, feeding on roots of plants and causing significant reductions in the yield and quality of many economically important crops. Wireworms prefer stable soil environments where food is plentiful, and are thus prevalent in pastures and uncultivated land. When such lands are brought into crop production, crop damage and losses are sure to follow.

After many destructive years in the soil, the wireworm pupates, emerging the following spring as a click beetle. In contrast to its larval stage, the adult click beetle is short-lived, inconspicuous, and docile. Named for their ability to right themselves by flipping into the air with an audible snap, click beetles survive only long enough to mate and lay their eggs that hatch to release wireworms.

Wireworms are notoriously indiscriminate in their food choices, being attracted to carbon dioxide emitted by any growing or decaying vegetation in the soil. Countless crops are vulnerable to attack. There are many reports of wireworms feeding on an

Summer research interns prepare to install bait traps to monitor the impact of rotational crops on wireworm population levels. (Photos courtesy of Joanna MacKenzie)

abundance of crops, ranging from grains to root crops, strawberries to pumpkins. Combine this voracious appetite with a lengthy lifecycle spent dwelling in the soil and you have a very destructive creature.

Preferring warm, damp soil conditions that prevail in spring and autumn, the wireworm migrates to the soil surface, only to retreat to the depths when it becomes too dry or cold. This movement renders crops such as grains susceptible to wireworm

A larval European wireworm prepares to feast on a carrot in laboratory trials.

attack in the early stages of growth, and also puts late harvested root crops at risk in the fall feeding period. Thus, wireworm damage is often documented as stand loss in grain crops, while root crops suffer cosmetic damage just before harvest. Such damage also provides an access point for many diseases that can, in turn, result in further crop losses, especially in storage. It has been suggested that up to a quarter of potato crop losses in North America can be attributed to wireworm feeding, which renders a crop unmarketable by riddling the surface and flesh of tubers with holes.

RESEARCH

Potent and environmentally persistent insecticides that last for many years in the soil were once used to suppress wireworms, but removal of many organophosphate-based pesticides from the Canadian market has left crops vulnerable to attack. High levels of protection once offered by these chemicals stunted further research into alternate strategies in the post-WW II years. So, we now must turn back to the research of our forefathers and search for non-chemical methods to alleviate the colossal damage caused by this minute pest.

Looking to both past and newly emerging research, alternative management strategies have been attempted with varying degrees of success. Investigators have explored the feasibility of altering the timing of crop planting or harvest in an attempt to avoid peak feeding periods, a strategy that can be successful but has limited potential in the short growing season of the Atlantic provinces. Others have encouraged timing tillage operations to target eggs and newly hatched larvae that constitute the most susceptible periods in the wireworm life history; however, this strategy requires mid-summer tillage when most crops are actively growing. A more extreme version of this strategy suggests that fields should be left in bare fallow, including complete removal of any potential food sources (i.e., weeds), for an entire growing season to starve out wireworms – at the expense of a season's profit and depleted soil quality.

Biological control agents, namely fungal pathogens and nematodes that target soil insects, are currently under intense scrutiny on Canada's East and West coasts. The use of attractive trap crops and rotational crops has also been explored, with much success using wheat as a trap crop to reduce wireworm damage in strawberries. This was further pursued by researchers at the Organic Agriculture Centre of Canada (OACC) in Nova Scotia. Many farmers' crops, as well as OACC research plots, have been seriously challenged by wireworm feeding. Therefore, OACC staff rallied to develop alternative cultural management strategies to tame the wireworm and mitigate damage, exploring strategies that can be employed by organic and conventional producers alike.

Research, supported by the Nova Scotia and Prince Edward Island Departments of Agriculture, Agriculture and Agri-Food Canada, and Dominion Produce, began in 2007 to examine the potential for incorporation of unattractive or damaging crops in a cash crop rotation to reduce wireworm levels in infested fields. The experiment started with a typical potato rotation: potatoes, followed by a grain crop underseeded with clover, followed by a final year of clover before potatoes are planted once again. With this rotation in mind, alternative crops were planted in the grain and clover years. Crops under evaluation included Brown mustard that contains glucosinolate compounds harmful to the wireworm; flax that may be nutritionally inadequate to support wireworm larvae; alfalfa that may create an inhospitable soil environment with its water wicking root system; and buckwheat with a rapid growth rate that may be amenable to tillage at those times at which wireworms are most susceptible.

Wireworm damage to grain stands generally occurs soon after planting, as the wireworms are attracted to the rich source of carbon dioxide generated by young seedlings.

Wireworm population levels were monitored throughout the experiment to detect any immediate effects of the crops. In 2009, carrots were planted following the experimental crop growth to determine the carryover effect of the various crops on the yield and wireworm damage levels in a root cash crop. Brown mustard suppressed wireworm population levels in the years it was actively growing and also successfully reduced the proportion of carrots deemed unmarketable due to wireworm damage, yet this came with a cost of reduced carrot yield. While these findings hold promise, the economics of using Brown mustard in root crop production remains to be evaluated to determine if saving carrots from wireworm damage using this crop rotation strategy compensates for possible yield losses.

STRATEGIES

Research has also targeted the development of what has been termed a "push-pull-immobilize" strategy, in which wireworms are "pulled" away from a root cash crop through the use of an attractive bait crop, "pushed" away through the use of compounds that may invoke plant defenses against herbivory or otherwise limit wireworm feeding, or "immobilized" through the disruption of the wireworm lifecycle. Work on this strategy began in 2007 in laboratories at the Nova Scotia Agricultural College and has since expanded into larger scale field trials. Initial explorations for the push aspect of the strategy focused on evaluating carrot varieties for wireworm feeding preferences in an effort to identify varieties less susceptible to wireworm feeding. Likewise, compounds that may limit wireworm feeding were assessed. While wireworms did not show a preference or aversion to any of the carrot varieties evaluated, neem oil, derived from the tropical neem tree, did emerge as a promising feeding deterrent, and has since moved into larger scale field testing.

Meanwhile, a number of crops were evaluated for the pull strategy, where the goal was to identify crops more attractive to wireworms than the carrot cash crop. Wireworms were given a choice between feeding on carrots or a range of potential bait crops that included wheat and corn kernels, potatoes, and dandelion roots. Wheat emerged as a promising potential pull agent and was also evaluated on a larger scale in field trials. Immobilization agents were also evaluated, but no promising leads were revealed. While crop management recommendations cannot yet be made, promising findings are lighting the way to a new production strategy that may employ wheat, nearly irresistible to wireworm species, as a trap crop in carrot production. When combined with a prospective, though yet unregistered, neem oil feeding deterrent and other mindful management strategies, wireworm damage to our prevalent root crops could be reduced.

The stealthy wireworm has been revealed as a worthy foe in both conventional and organic agriculture. But do not despair! Armed with a watchful eye and a battery of emerging management tools, European wireworms are enemies not beyond defeat.

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