Potato Progress

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How do Wireworms Find Their Host Plants?

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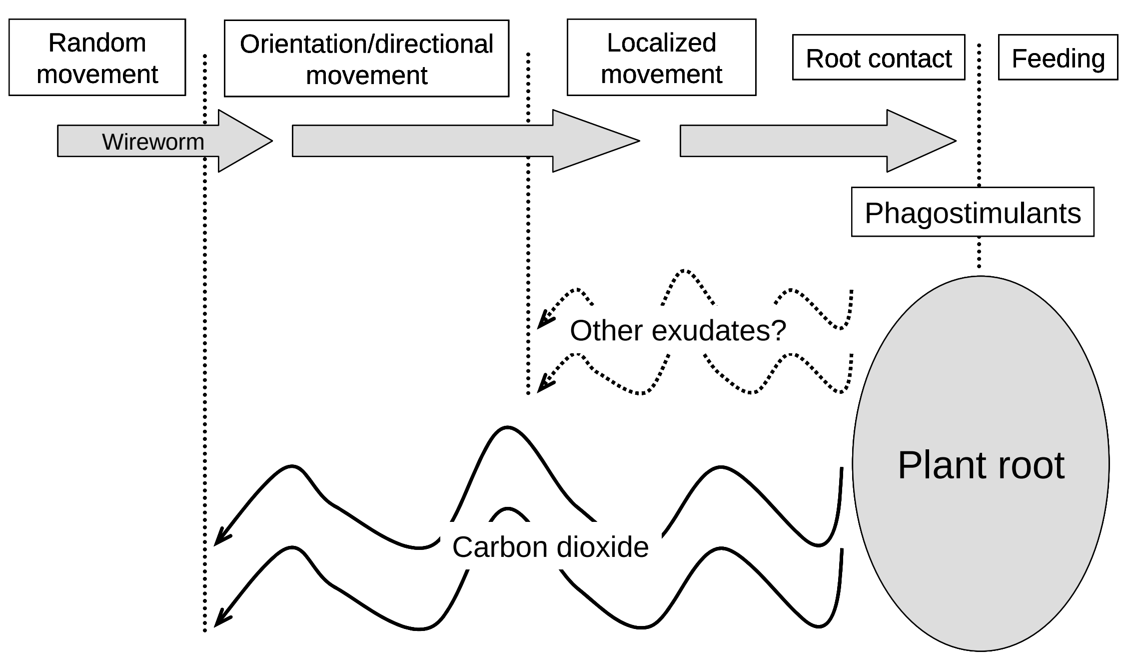
Root- and tuber-feeding insects such as wireworms face challenges in locating host plants that are not faced by above-ground, plant-feeding insects. Insects that feed above ground on plants may use a combination of visual, chemical, and physical cues to locate host plants and to discriminate between suitable or non-suitable plant species. In contrast, subterranean insects must rely on chemical and physical cues alone (Johnson and Gregory 2006). Chemicals that are released from the roots of plants or other subterranean plant organs are thought to be the major cues used by wireworms and other soil-dwelling plant-feeders in locating food sources. These cues are likely to include plant products that attract wireworms from a distance, combined with chemicals that then lead to feeding (or deter feeding) once the plant has been located.

Figure 1. Schematic showing probable roles of chemical cues affecting host finding behavior in wireworms



A generalized scheme of host-finding. Figure 1 is a modification of a diagram in Johnson and Gregory (2006) that summarizes how wireworms or other subterranean insects use plant cues to locate feeding sources, in this case the root of a suitable host plant. Long-range orientation to the food source, followed by movement toward the host plant, is likely done in response to carbon dioxide (CO_2) emitted by roots. Carbon dioxide is the most abundant volatile emitted by plant roots, and is known to diffuse through the soil over relatively great distances (Johnson and Gregory 2006). Laboratory assays have shown that wireworms are attracted even to artificial sources of carbon dioxide. Studies which have tested carbonated water, sugar/yeast solutions, CO_2-emitting mosquito baits, effervescing tablets of "Fizzies" candy (Bernklau et al. 2004), or tank CO_2 (Doane et al. 1975) have all demonstrated that wireworms and other soil-dwelling insects accumulate at the carbon dioxide source.

Less well understood is the role that other root exudates may have in affecting wireworm host finding. Plant roots emit a variety of chemicals into the neighboring soil matrix, and these products have been shown to affect the behavior of soil-dwelling organisms in the vicinity of the roots. Chemicals known to affect wireworm behavior include various amino acids, alcohols, and esters (Thorpe et al. 1946). These products presumably act at shorter ranges than the more highly volatile CO_2. The assumption is that these or related chemicals, in combination with changes in CO_2 concentration as the host plant is approached, act to prompt increasingly localized movement by the wireworm as the root is neared. Localized movement in response to CO_2 and other plant-emitted products will then lead eventually to the wireworm coming into physical contact with the root, at which time a decision must be made by the wireworm either to feed on or to reject the root. This decision is governed by contact chemosensory cues in the roots. Assays done in the laboratory have shown that a variety of chemicals associated with plant roots or root exudates prompt feeding in wireworms. These chemicals are known as phagostimulants, and may include various sugars, fats and oils, and proteins (Thorpe et al. 1946). Plant-associated products that might deter feeding in wireworms are less well known, but in potatoes may include chemicals such as glycoalkaloids, as discussed in the following section.

Feeding on tubers. The specific cues used by wireworms to find and feed on potato tubers are not known. Orientation to potato plants is likely to be in response to CO_2 (and possibly other exudates) from roots or the growing tuber. It is less clear what cues associated with the tuber prompt feeding. Field studies have shown that potato cultivars have different levels of susceptibility to feeding by wireworms, presumably due to chemical differences between cultivars. However, it is rarely clear whether the reduction in feeding on less susceptible cultivars is due specifically to properties of the tuber, or is due more generally to properties of the potato plant. That is, reduced feeding on tubers in the field could be due to chemical properties of the tuber, or to a failure by wireworms to be attracted to the growing potato plant (possibly due to lack of appropriate long-distance volatile cues or to presence of chemical deterrents emitted by roots).

Laboratory trials to assess feeding susceptibility have been done with tuber slices obtained from susceptible and resistant cultivars. These assays have shown that levels of susceptibility may indeed be correlated with presence or absence of various chemicals. Wireworms are less likely to feed on tubers that have higher levels of glycoalkaloids in the tuber skin, whereas tubers having high sugar concentrations and low levels of glycoalkaloids in the skin may be particularly susceptible (Jonasson and Olsson 1994). In sum, decisions to feed on tubers by wireworms appear to be driven at least in part by chemical composition of the tuber skin. Other characteristics of the tuber (e.g., skin thickness, tuber age) possibly affecting tuber susceptibility to wireworms are largely unexplored.

What about baits? Can we use the sort of information summarized in this report to develop insecticide-treated baits for use in managing wireworms? Ideally, the bait should attract wireworms from a distance, and induce feeding upon contact even in the presence of the insecticide. Pellets composed of a nutrient substrate such as wheat or corn starch, in combination with CO_2-producing microorganisms (such as yeast), might be used as long-distance attractants. Encapsulation methods that have been developed to provide improved storage of microorganisms or pesticides might then lead to formulations having desirable storage and handling properties. By adding to this product a feeding stimulant (such as sugar) and minute quantities of an insecticide, it may then be possible to produce a bait that has the desired characteristics: i.e., a bait that attracts wireworms from a distance and that is readily fed upon, leading eventually to death of the pest.

Ongoing studies at the Wapato laboratory. Studies are ongoing at the USDA-ARS Fruit and Vegetable Insect Laboratory in Wapato to develop a synthetic bait for wireworms. Assays using a soil-filled olfactometer are being done to test whether different CO_2-generating formulations attract wireworms from a distance. Other trials are being done to test whether biting response of wireworms on filter paper disks is enhanced if the disks are treated with a sugar solution or extract from host plant material, with objectives to identify chemical feeding stimulants. Aims are to develop a product that will attract wireworms from a distance, and prompt feeding once the wireworm comes into contact with it.

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Multifaceted Bio-Control Methods against the Columbia Root Knot Nematode and Colorado Potato Beetle

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Meloidogyne chitwoodi commonly called the Columbia root knot nematode (RKN) is the most important plant parasitic nematode of potatoes in Washington. This nematode damages the tuber causing warting on the tuber skin, and necrotic spots within the tuber. These symptoms decrease the marketability of the tubers, as the potato processors have a tolerance of less than 10 percent infection (culls) caused by RKN. RKN infestations are most commonly controlled through the use of Telone II and metam sodium. Another pest of potatoes is the Colorado potato beetle (CPB) *Leptinotarsa decemlineata.* Once established, the larval stages as well as the adults are able to cause significant foliar damage, affecting potato yield.

Current research is underway to determine if combinations of control methods will offer significant management of the two pests at the same time. The first method is the use of mustard meals amended into the soil. Mustard meals are an attractive alternative if the potato producer can afford a 15 day pre-plant window for application of the meal. Mustard meals are the by-products of defatting the mustard seed for extraction of cooking oil. Glucosinolates are the compounds found in mustard meal believed to have pesticide qualities, and in addition may repel the Colorado potato beetle from laying eggs on potato plants grown in the seed meal amended soil.

The other method currently being investigated is the use of entomopathogenic nematodes (EPN). Entomopathogenic (entomo= insect, pathogenic= infecting), implies this nematode infects insects. EPN have been found to suppress populations of RKN, and at the same time infect larval stages of CPB that drop down into the soil to pupate. However, in addition to infecting the larval stages of the beetle in the soil, EPN have also been found to suppress RKN. Both of these pests have life cycles affected by temperature, and their life stages during the growing season can be determined using the growing degree day model. Ideally, stages of both the RKN (egg-laying) and the CPB (larval stages) can be targeted to a specific timeline, and EPN can be applied at those susceptible stages in the lifecycles.

Advantages to using mustard meals are reduction of pesticide costs, increased soil health, and incorporation of organic matter. Disadvantages include the 15 day waiting period before planting as mustard meals are also herbicidal. The advantage of using EPN is they have not been registered as pesticides, and are therefore not under stringent regulations for use in crops. EPN's can be applied in the sprinkler system, and are tolerant of pesticide residues. However, these EPN's are light and heat sensitive, requiring night application followed by 1-2 inches of irrigation.

These multifaceted approaches can be used both by conventional and organic potato grower and will provide potato growers with sustainable means to control both the nematode and insect pest.

Integrated Pest Management Program for Insects and Mites in Idaho, Oregon and Washington Potatoes

Guidelines for managing insects in potatoes in the Pacific Northwest have been updated for 2007 and posted on the potato commission website: http://www.potatoes.com/Research-IPM.cfm. These guidelines are an update of the version from last year. Changes include such things as: deletion of some products that are no longer registered on potatoes (such as Di-Syston and Guthion). There are several new products (such as Acramite and Beleaf) registered on potatoes. There are some changes in use patterns (such as Penncap M is no longer recommended for use on aphids, Assail is recommended for use on beet leafhopper). We have two significant new additions to the guidelines. First, with the help of Juan Alvarez (U of Idaho), we are including Idaho. Second, because of the surge in generic products, what is in what package is increasingly difficult to track. We have included an attachment that lists every insecticide (398) that is registered for use on potatoes in Washington and Oregon. With the exception of a very small number of 24c registrations, this list should apply equally to Idaho. The products are sorted by active ingredient, and the list includes the product name, manufacturer and whether it is available as a 24c registration.

This document started out a few years ago as about 10 pages and has grown to 53 pages. Each year it is longer, more complex and takes more work, but the document serves a valuable purpose. All the authors and contributors would be interested in your feedback to help improve future editions.

Tuberworm is Still Out There!

The potato commission-supported tuberworm trapping network is up and running again this year. So far it has shown that tuberworm successfully overwintered again, but is in very small populations. To date we have not trapped any tuberworm moths north of Basin City, and only a very small number in a few traps south of Basin City to the Oregon border. Even in the hotspots of recent years in Oregon, trap catch has been low this year. All this said, remember that **tuberworm does very well in hot weather**, and it may not take a lot of gravid females in a vine-killed field at the end of the season to cause to difficulty in the marketplace. No matter where you are in the Columbia Basin, keep an eye out for tuberworm until your crop is safely harvested. For the latest trap catch data in map format see (updated mostly on Wednesday mornings):

http://www.potatoes.com/research.cfm