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Biology of Pacific Coast and Sugarbeet Wireworm in the Columbia Basin

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The two most important soil-dwelling insect pests of irrigated row crops, including potatoes, in the Columbia Basin are the sugarbeet wireworm (*Limonius californicus*) and the Pacific Coast wireworm (*Limonius canus*). Both species are native to wet soils along streams and waterways. Wireworms are the larval stages of a group of beetles called "click beetles" (Family Elateridae), so-called because of their habit of snapping their bodies - - which produces an audible clicking noise - - to catapult themselves into the air, apparently as an escape mechanism. The click beetle stage emerges from the soil in early spring, mates, and lays eggs (see Figure 1 for life cycle of wireworms). The adult lives only a month or two. Eggs are laid in bare soil or in soils that are shaded to some extent by vegetation, such as along the perimeter of fields near grassy borders. The click beetle stage has been reported to damage certain crops, including grapes and perhaps other fruit crops, by feeding on developing buds. The adults are not directly damaging to potatoes.

Eggs hatch in spring and early summer (Figure 1), and the newly hatched wireworms feed on roots, rootlets, and root hairs of the developing potato plants. The wireworm stage requires 2 to 4 years in the soil to complete development, thus the same insects can damage crops on one piece of ground during consecutive growing seasons. The wireworm is elongate, approaching ¾ to 1 inch in length in mature larvae, hard-bodied, and a shiny, yellow or orange color. It is often assumed that most of the damage to potato tubers is caused by the older larvae, although this remains to be confirmed. Mature wireworms pupate beneath the soil surface in late summer and molt to the adult stage in autumn. The adult emerges the following spring.

Because wireworms have multiyear life cycles, potato growers who rotate crops may find that wireworm pressure in their fields depends substantially upon what was grown in those fields in previous years. Growers who follow a highly favored wireworm host, such as wheat or other grains, clover, or irrigated pasture, may experience higher pressure in their potato fields than if the potato crop had followed a less favorable type of crop, especially if no efforts were made to control wireworms in those favored crops. Fields with a history of having high densities of grassy weeds may also experience pressure. Crops such as corn, sugarbeets, peas, and beans are also suitable to wireworms, but may not be quite as favorable as grain crops. Potatoes grown in newly cultivated soil that previously was rangeland may also suffer extensive damage because of wireworms, although the damage would tend to be done by species other than the Pacific coast or sugarbeet wireworm. If the field is kept in cultivation and is irrigated, the range-associated wireworms tend to be replaced by the *Limonius* species being discussed here. Weed-free fields of alfalfa appear to be fairly unsuitable for wireworms. Wireworm populations also tend to decline in non-irrigated fields kept fallow and weed-free for a growing season.

Depth of wireworms in the soil changes seasonally (Figure 2). Upward migration begins in early spring - - as early as March in warmer areas - - once soil temperatures begin to warm. The upward movement tends to slow in early summer. In mid-summer, wireworms may avoid the top several inches of soil particularly if the soils are very warm or very dry. Shading of the soil surface, for example by extensive potato canopy, may reduce this mid-summer tendency to move downwards, particularly in irrigated soils. Mid-summer irrigation cycles can affect movements upwards and downwards in soils as the soil surface dries and then is re-wetted. In autumn, wireworms move downward in the soil for overwintering (Figure 2).

A major difficulty associated with managing wireworms in potatoes is caused by the lack of an efficient monitoring tool to tell growers when wireworm densities are sufficiently high to warrant control measures. One method used to sample wireworms is taking a number of soil cores in spring, and examining the soil for wireworms. This procedure is extremely time-consuming, and may miss low densities of wireworms that nonetheless will cause damage to tubers. A less time-consuming means for determining presence or absence of wireworms in a field is with the use of baits, which can be buried in fields, collected after several days, and then examined for the presence of wireworms. Baits are often composed of germinating seed of grains (especially wheat or barley), but carrots, bran, and uncooked rolled oats also work well. Seed baits can be inefficient because the retrieved bait, after a period of several days in the soil, often is composed of a mat of rapidly growing root material, which is difficult to examine for the presence of wireworms. I have found that baits composed of a 1:1 or 2:1 mix of soil and uncooked rolled oats (e.g., Quaker oats), wrapped in bridal veil mesh, and thoroughly wetted just before being buried, work extremely well at attracting wireworms; the baits are also easy to process. The baits are buried 6-10 inches deep in spring as soon as the soil begins to warm, and are left in the soil for 3 to 4 days before they are retrieved. I use a 2 foot long section of brightly colored twine tied to the mesh material, which allows me to find the buried baits in the field and to rapidly pop the baits out of the soil for examination. The baits are useful for determining presence of wireworms in a field. However, as yet we do not know the specific relationship between numbers caught in baits and potential for tuber damage, although there are studies underway to address this question. We also do not yet know what density of baits is appropriate; this also is being addressed.

A second major difficulty associated with managing wireworms is that we do not understand what factors affect their distributions within fields and between fields. We know that wireworms are extremely clumped in fields, showing areas of high density and areas of low density. Figure 3 shows the result of a baiting experiment done in fallow ground on either side of a plot of potatoes. Forty-eight baits were allocated among 4 rows. Size of each circle in the figure is proportional to catch in that bait, with the largest circle corresponding to 36 wireworms in a single bait. As the figure shows, bait catch was highly variable, with some baits not collecting even a single wireworm and other baits collecting very large numbers. This sort of patchiness is very typical for wireworms, and leads to complications in monitoring. It also may explain why effectiveness of an insecticide treatment appears sometimes to be irregular, even within a single field. We do not know why the insects are distributed so patchily, but it could reflect variability in soil type, soil moisture, or distribution of grassy weeds in previous years.

Chemical controls for wireworms include pre-plant broadcast applications of Mocap or Thimet. Pre-plant soil fumigation using Telone II can be very effective, but is expensive. Granular insecticides such as phorate can be used as side-dress or band treatments. Late-season "rescue" treatments are not available, and because early season controls are not always completely effective, the lack of late-season options is a real problem.

There are several research topics that would assist us in managing wireworms. Some of these topics are being addressed at the Wapato laboratory or in entomology laboratories located in other states:

1. Develop an efficient monitoring tool that is labor efficient but also allows growers to predict wireworm damage.

2. Determine why wireworms are so patchily distributed, both field-to-field but also within fields. What factors (such as soil type, soil moisture, soil organic content, a field's pesticide history, a field's crop history, a field's weediness) might affect wireworm patchiness and density?
3. Determine what distances wireworms in the soil can move over the course of a season.
4. Determine what cues the adult female uses in deciding where to deposit her eggs. Do females move field-to-field, or are they relatively sedentary? Can the adult beetle be managed?
5. Can we develop "rescue" treatments in potatoes, for those instances in which early season controls failed or were not applied?
6. Do potato varieties differ in susceptibility to wireworms, and is plant resistance an option for wireworm management?

Figure 1. Life cycle of Pacific coast wireworm in Columbia Basin

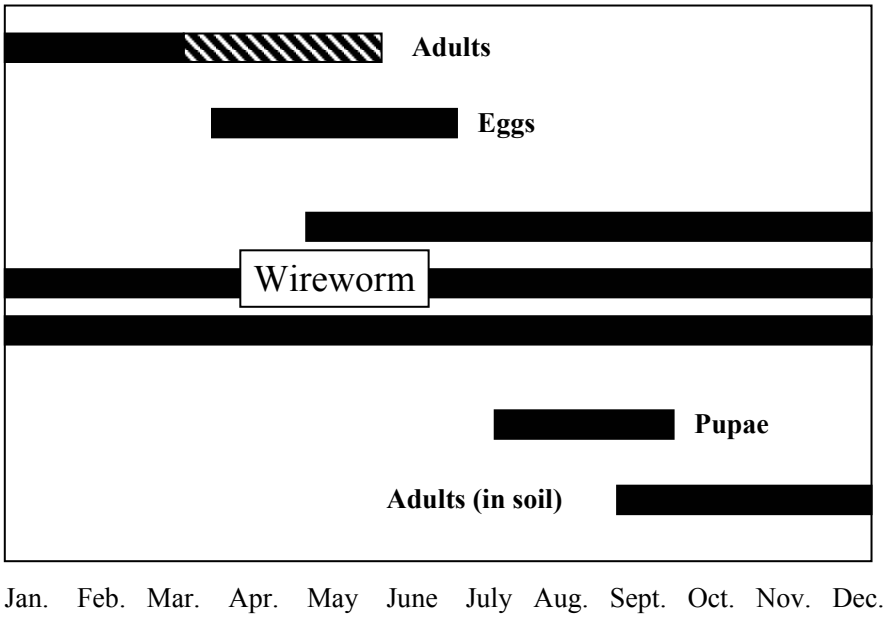


Figure 2. Vertical distribution (inches below soil surface) of wireworms in potato field: Walla Walla, WA (after Jones and Shirck 1942)

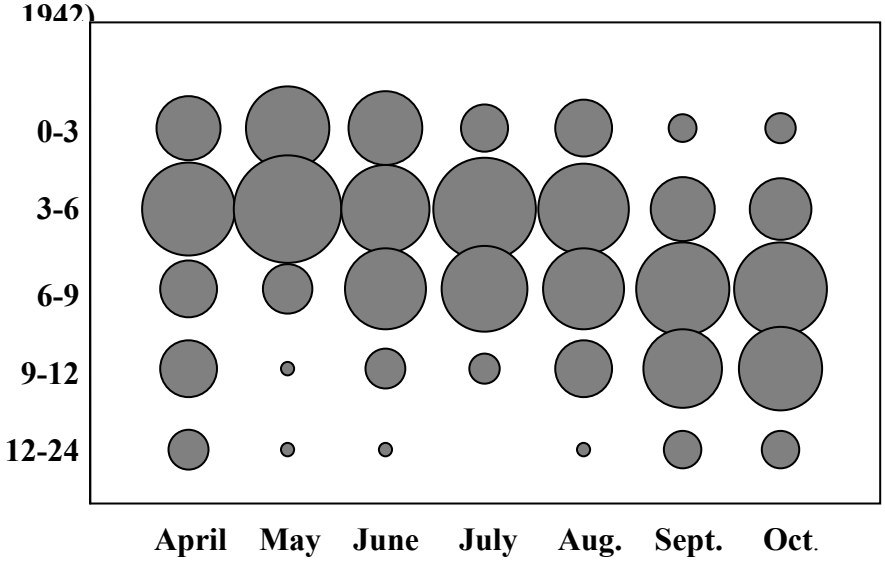
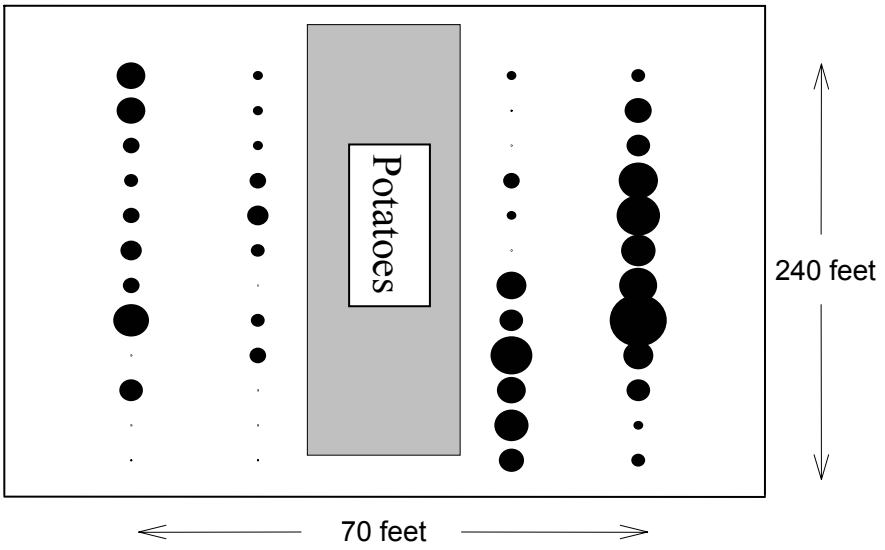


Figure 3. Numbers of wireworms per oatmeal bait (each filled circle depicts single bait) in fallow areas adjacent to potato field.



Planning to Plant Mustard, Consider Direct Seeding

Andy McGuire, WSU Extension, Grant-Adams Area

Mustard green manures should be planted in August, with mid-August being optimal. Broadcast and planting into a clean seedbed can both produce good stands, but there are advantages to direct seeding through the previous crop's residues:

- It saves on tillage costs as the residue will be tilled under with the mustard anyway.
- It saves on fertilizer costs as the incorporated crop residue will tie up some nitrogen requiring more fertilizer for the same mustard production
- It incorporates fewer wheat seeds left over from harvest resulting in less volunteer wheat to compete with the mustard.
- After the mustard canopy closes, the residue on the ground will begin to break down. Mushrooms, the fruiting bodies of basidiomycetes are often seen under the mustard on direct seeded fields. These beneficial fungi are known to improve soil quality.
- When the residues are left aboveground to be incorporated with the mustard, they may buffer the N release from mustard decomposition and reduce the potential for leaching of nitrate.

For direct seeding to be a success, the chaff from the previous crop must be spread uniformly. Normal planters may be used as long as they place the mustard seed in contact with the soil. Then the soil must be kept moist until the mustard germinates, after 2-5 days in most conditions. See our website (http://grant-adams.wsu.edu/) for more information on mustard green manures.