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Wireworm

Wireworms are destructive insect pests of grain crops in western Canada. The pest prefers cereal crops, but also feeds on potatoes, pulses and canola. The wireworm larva feed below ground on seeds and shoots.

Background

Approximately 30 pest species of wireworm exist in Canada, and several are found in Alberta. These species include the following:

- *Selatosomus destructor* (previously *Ctenicera/ aeripennis destructor*)
- *Ctenicera lobata*
- *Ctenicera morula*
- *Athous spp*
- *Limonius canus*
- *Limonius californicus*
- *Hypnoides spp.*

In surveys, *Hypnoides* and *Selatosomus* species were found in many areas in Alberta, preferring non-irrigated land. *Limonius* species were found to prefer irrigated land.

Hypnoides bicolor was the dominant species on dryland in Alberta, found in 74 per cent of survey samples in 2010 compared to *Selatosomus destructor* at 11 per cent and *Limonius californicus* at 10 per cent.

Life cycle

Four to 11 generations of wireworm can be found in a field, but the number of years a population can survive varies with the quality and availability of food. Wireworms in all growth stages are likely to infest a field in long-term grass or pasture, and populations in the soil can be more than three million per hectare.

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Larvae

Wireworm larvae are slender, jointed and hard-bodied. They have three pairs of legs behind the head, and the last abdominal segment is flattened with a keyhole-shaped notch. Fully grown larvae vary in length, depending on species, and range from 1 to 4 cm.

Selatosomus destructor larvae grow up to 2.5 cm in length, and *Hypnoides bicolor* grow up to 1.0 cm in length. Larger species can cause more crop damage.

The larval stage of wireworms can live 4 to 11 years in the soil and are quite resistant to adverse conditions, although most live 3 to 5 years. These overwintering larvae are called resident larvae.

Larvae that survive their first winter can survive for at least two years without any food other than humus. They hibernate in the soil from 5 to 25 cm below ground level. Older larvae commonly feed to a depth of 15 cm in the topsoil.

Pupae

When fully grown, the larvae pupate about 5 to 10 cm below the soil surface, usually in July. Pupation lasts for less than a month. The adult overwinters in the soil and does not emerge above the soil surface until the following spring.

Adults

Wireworm adults, called click beetles, emerge from the soil in April and early May. They are slender, black beetles about 8 to 12 mm long. Click beetles make a clicking noise when placed on their backs and do somersaults to right themselves.

The adult click beetles become active when the air temperature is above 10 C. They mate and then seek egg-laying sites. From late May through June, individual females deposit 200 to 400 eggs in loose soil or under lumps of soil.

Eggs

Depending on the moisture, temperature and firmness of the soil, the tiny eggs are laid anywhere from just below the soil surface to 15 cm deep. After three to seven weeks, the wireworms hatch, and the larvae begin to feed on live roots or seeds of cereals or grasses.

The most vulnerable period for wireworms is from the egg to early larval stage. Only two to eight per cent of eggs and young wireworm larvae survive. These larvae, called neonate larvae, join the resident populations of larvae. If no food is found within one to four weeks of hatching, the neonate larvae die.

Host plants and damage

Wireworms prefer annual and perennial grasses. They also attack potatoes, sugar beets, corn, lettuce, sunflower, canola and onions. The longer a field is in cereals or pasture, the higher the pest population and potential for greater crop damage. In Alberta, damage to wheat crops ranges from 1 to 50 per cent annually. Damage to other non-cereal crops varies from farm to farm.

Wireworm larvae are attracted to carbon dioxide given off by germinating seeds. The resident larvae move up in the soil profile and feed on germinating seeds or young seedlings. One larva can easily consume two or more seeds. The larvae shred the stems but seldom cut them off. The central leaves die, but outer leaves often remain green for some time. Damaged plants soon wilt and die, resulting in thin stands.

Poor seed and dry conditions can also cause thin stands; consequently, many wireworm infestations are passed off as poor germination. Wireworm damage can be distinguished from cutworm damage by pulling up seedlings. Cutworms usually cut off the entire plant below the surface while wireworms seldom cut off plants.

Wireworms do the most damage in early spring when they are near the soil surface. During summer months, larvae move deeper into the soil where it is cool and moist. Wireworms do not ingest solid plant material, but chew tissues, then regurgitate fluids containing enzymes and then imbibe the juices and plant products made soluble by the enzymes.

Potato seed pieces are seldom damaged to a point where poor stands result. However, new tubers can be severely damaged. Tunnels made by the wireworm allow disease organisms to enter, and the damaged tubers are less marketable.

Damage is generally higher in silty, medium textured, well-drained soils and in soils cultivated for at least 12 years. Damage is less likely in heavy or very light soils. Crops grown on newly broken sod can suffer great losses for one to two years; then the damage decreases rapidly, only to gradually increase in succeeding years if no wireworm control measures are applied.

Monitoring

Accurate identification of poor plant stands is critical in determining if wireworms are responsible for the damage. Several methods are available to determine the presence of wireworms in a field.

Fields should be monitored yearly if wireworms are an ongoing concern. Wireworms generally move up and down in the soil profile and do not move very far laterally, so infestations can vary greatly within a field.

As a point of caution, no monitoring or sampling procedure is accurate enough to provide a full understanding of the number, location and economic risk that wireworms might pose to a crop. Because of the extreme variability in monitoring results that can occur due to wireworms being in a non-responsive state at various times of the year, it is not possible to get conclusive results at any one time.

Baiting the insect pest at low soil temperatures or during inclement weather will reduce the effectiveness of most baits. Also, in fields with high levels of organic matter, such as recently plowed sod fields, wireworms might not leave the green manure to move to baited traps or bait balls. In other words, a low wireworm catch in various baits can still mean that high wireworm populations are present.

1) Potato sampling

Whole potatoes buried in marked locations in a field in the spring or from early to mid- August will indicate whether wireworms are present. Bury the potatoes 10 to 15 cm deep, and then dig them up after a couple of weeks and examine them for wireworm tunnels. Monitor fields each year.

2) Soil sampling

To sample for larvae, sieve the soil through a screen. Mark out areas 50 cm by 50 cm and sieve the soil to a depth of 15 cm. Repeat in different areas of the field to determine an average number of larvae per square metre. Sampling during germination will increase the likelihood of finding larvae feeding on seedlings.

3) Bait balls

Bait balls can help in the assessment for the presence of wireworms, but they do not necessarily indicate the density of larvae and are not always foolproof. Larvae may not be attracted to the bait if they have sufficient feed

already. Recently tilled soil may also be giving off carbon dioxide, so the larvae may not be attracted to the bait.

Bait balls are typically made with wheat flour or oatmeal, and they attract larvae with the release of carbon dioxide. For 1 bait ball, mix 1 to 1.5 cups of oatmeal or wheat flour with 2 tablespoons of honey and up to ½ cup of water until a ball can be made with the mixture. Tie up the ball in a mesh bag, like an onion bag, or cheesecloth so that it can retrieved more easily from the soil.

Bury the bait balls in 4 to 6-inch deep holes and mark the locations with flags. About 20 evenly spaced bait balls per acre are needed to get a reasonable assessment of wireworm presence. Check the baits every four to five days to see if they have attracted any wireworms.

Economic thresholds

An action threshold of approximately 32 wireworms per square metre has been recommended in the past. If wireworms are found at this density or higher through soil sampling, then seed treatment or other management would be required in the following years.

However, the poor and variable accuracy of sampling methods in general calls into question the reliability of action thresholds at present. The current thinking by some entomologists is that the presence of wireworms when sampling, even at low levels, is potential cause for concern.

Control

Environmental control

Larval activity is governed by temperature and moisture conditions. Cool, wet weather forces wireworms closer to the surface while dry, hot weather forces them deeper into the soil. Cool weather restricts adult activity and lengthens the egg-laying period.

Eggs laid near the soil surface or in compacted soil are subject to high mortality when moisture levels and temperatures fluctuate rapidly. Mortality is from 92 to 98 per cent in eggs and young larvae. Most wireworm mortality occurs during the first two weeks of larval life.

Biological control

Parasites: A few nematode parasites control wireworms that pupate below ground. At present, these nematodes are not available for commercial use.

Pathogens: Wireworms are susceptible to bacterial and fungal diseases, and mortality is higher in moist soils.

Predators: Click beetles and their larvae are prey to both birds and small rodents. The adults are preyed upon when they lay eggs. The larvae are eaten in spring when they are near the surface or when exposed by cultivation. Birds pull them from the soil, and moles and shrews dig for them.

Chemical control

Seed treatments provide the best method of protecting against wireworm damage. Several seed treatment insecticides previously registered and very effective on wireworm have been removed from the marketplace due to environmental and toxicological concerns. Lindane (Vitavax) was phased out in 2004. Lindane was very effective on both resident and neonate larvae, controlling 65 to 70 per cent of resident larvae and 85 per cent of neonate larvae.

Other effective insecticides, used primarily in potato, that are no longer available include Temik, Dyfonate, Furadan and Counter (corn).

Currently registered seed treatments that replaced lindane are in the neonicotinoid insecticide family. Research has shown that these insecticides are generally effective at protecting seeds and seedlings from resident larvae, but mortality is low. Instead, the resident larvae become moribund and lethargic throughout the seedling establishment stage. Neonicotinoids are also completely ineffective on neonate larvae. As a result, wireworm infestations appear to be on the rise in western Canada.

Check Alberta Agriculture and Rural Development's *Crop Protection* guide (Blue Book), Agdex 606-1, for updates and complete labels on registered insecticides. See Alberta Agriculture's website at: http://www1.agric.gov.ab.ca/$Department/deptdocs.nsf/All/agdex32

No post-emergent insecticide option is available for wireworm control.

Cultural control

Crop rotation and other cultural practices can help prevent wireworms from becoming a major problem. While these practices can be useful, they may not be adequate in controlling resident infestations.

Crop rotation: A crop rotation with resistant varieties and legumes is useful. Wireworms do not usually damage buckwheat and flax.

Do not plant susceptible crops such as cereals on the same land in two successive years. Fall rye and winter wheat are more resistant than spring cereals because the former crops grow vigorously in the early spring. However, a dry summer followed by a wet autumn has resulted in damage to fall-seeded rye.

Take special precautions after breaking sod. If a crop on newly broken land is destroyed by wireworms, re-seed immediately with a resistant crop. This approach is preferable to leaving the land fallow, since a recurrence of the wireworm problem would then be likely.

Wireworms can seriously damage seedlings of sweetclover and alfalfa. Producers should plant legumes with a light nurse crop or in a mixture with a grass as the seedlings usually escape damage in a mixture. Mature plants are not damaged by wireworms.

Crop rotations usually prevent wireworms from becoming a major problem in sugar beet fields. Because sugar beets are normally grown in a four-year rotation in Alberta, crops less susceptible to wireworm attack can be grown on infested fields so that populations will not build up. Root and row crops such as potatoes, corn, onions or beans should not be grown in a rotation where wireworms have been a problem.

Wireworms can also be present when sugar beets are grown on land previously uncultivated or planted to grass or pasture. Deep plowing in the fall and frequent cultivation in early summer are suggested when wireworms are known to be present in these fallow fields.

Seeding practices: Use methods that speed germination and early growth of the crop to help reduce the effect of wireworm damage. Avoid very early or very late seeding.

Seed into a warm, moist soil at a depth of 2 to 5 cm to encourage rapid germination and emergence. If the soil is dry, delay seeding until it rains. As much as 90 to 95 per cent of a crop has been destroyed when seeded into a dry soil compared with 5 to 10 per cent loss when seeded into moist soil. Moisture also helps young seedlings recover from wireworm damage.

Increase the seeding rate in fields infested with wireworms, especially for wheat. Use as much as an extra bushel per acre, or for a patchy infestation, double seed the area. Use healthy seed.

Use on-row packing to promote germination. Wireworms are very poor travellers. Some remain in the larval stage for 9 or 10 years, during which time they travel only a few metres. Firming the soil further makes wireworm movement so difficult that most of the worms will seek their food in the looser soil between the seed rows.

If the packers do not follow the seed rows, they will tend to leave the rows loose while firming the intervening strips. This practice may encourage the worms to follow the seed rows and cause heavy damage.

Tillage: Tillage, as part of a normal crop production practice, can help reduce the effect of wireworm, but will not control infestations. Shallow cultivation in early spring can expose eggs and injure larvae.

Summerfallow for wireworm control is not recommended because the practice has almost no effect on mature larvae, which can survive for two years on soil humus alone. In fact, wireworm damage is more severe after fallow.

Cultivation of summerfallow during the latter half of July can destroy pupae as well as larvae. Destroying all green growth during June and July may starve neonate larvae.

Any tillage operations should be restricted to the upper 5 to 8 cm of the soil to maintain a compact soil layer beneath the tilled layer. Adult click beetles are affected by a compact sub-layer because they are forced to lay their eggs close to the surface where the eggs can easily dry out or be discovered by predators.

Soil fertility: A light topping of rotted manure or an application of phosphate fertilizers will help reduce wireworm damage. The phosphorous encourages root development and early maturity. Manure can be applied late in the fallow year or early the next spring and should be incorporated into the soil.

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