Virginia Cooperative Extension

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Wireworm Pest Management in Potatoes

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Wireworms are the subterranean larval stage of click beetles (Coleoptera: Elateridae). They are pests of many agricultural crops including corn, sorghum, small grains, tobacco, and various vegetables, but are particularly damaging to potatoes, since the marketable portion of that crop is in the soil. Wireworms are found throughout the world, and species vary greatly across regions. In Virginia, three important pest species of agricultural crops are the corn wireworm, *Melanotus communis*, the tobacco wireworm, *Conoderus vespertinus*, and a related species, *C. lividus* (Fig. 1). A field survey of more than 60 fields in eastern Virginia from 2002 to 2004 revealed that 80% of wireworms collected were the corn wireworm, *M. communis*. This is the primary soil pest attacking potatoes in Virginia.

Fig. 1. Wireworms commonly found in Virginia soils: Corn wireworm, *Melanotus communis* (left); and *Conoderus* spp. (right); white arrows indicate actual size at full maturity.

General biology and life cycle

Wireworms often spend multiple years in the soil and a complete life cycle from egg to adult may take 2 – 5 years depending on environmental conditions. The duration of the wireworm larval stage is largely dependent on food, temperature, and soil moisture. They typically will remain in the soil for the majority of their life as larvae progressing through multiple instars. Mature wireworms are approximately ¾ to 1 inch in length.

Research has shown that wireworms move vertically through the soil on a seasonal basis. They can be found near the surface when temperatures are moderate, at least 70°F, and burrow deeper in the soil during extreme heat and cold. In late spring, fully mature and well-fed larvae will pupate in earthen cells in the upper 4 inches of the soil. Pupae (Fig. 2)

Fig. 2. Mature *Conoderus lividus* larva (bottom) and pupa (top).

are white to cream- colored, becoming darker just before adult emergence. Adults (click beetles) emerge from the soil and are active during the summer. Beetles are most active in the evening and night and typically hide in vegetation or ground litter during the day. Egg-laying females prefer weedy or grassy fields. Eggs are deposited in the soil usually in batches. A female *M. communis* can deposit between 50 and 130 eggs in her lifetime.

Damage

Wireworms are omnivores, preferentially feeding on other soil insects or roots of grasses and weeds. In agricultural crops, where weeds are killed and land is cultivated, wireworms seek out the only food available, which are the underground portions of the planted crop. Wireworms may injure potatoes by feeding on the seed piece resulting in weak stands, but the majority of their damage is caused by tunneling into tubers (Fig. 3), which reduces yield quality. Wireworm tunneling also creates an entry point for certain plant pathogens, eventually leading to tuber rot. In some years and regions of the U.S., up to 45% of the total potato tuber harvest has been down-graded or rejected outright because of wireworm injury, resulting in substantial economic loss.

Wireworms are attracted to high moisture; and densities are often higher in (low-lying) wetter portions of fields. Moreover, during extended hot, dry weather, wireworms may seek out the potato tubers for moisture in addition to food; exasperating the damage. It has been well documented that wireworm damage to potato tubers increases the longer tubers are left in the ground (Fig. 4).

Fig. 3. Tunnel injury on potato tubers from the corn wireworm, *Melanotus communis*.

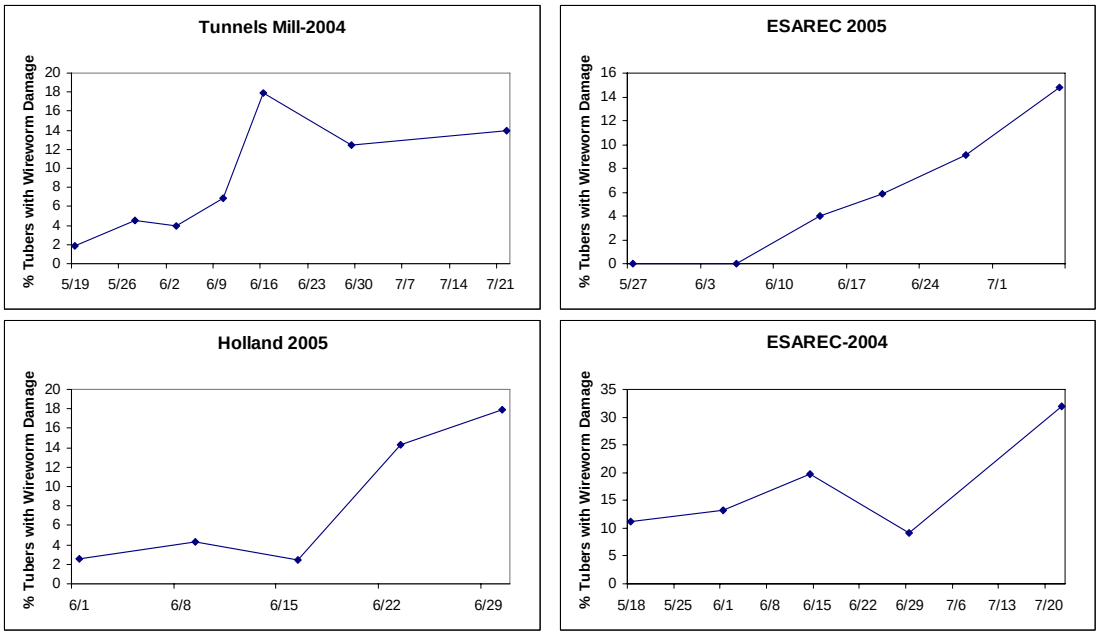

Fig. 4. The percentage of tubers damaged by wireworms over time in 4 potato fields on the Eastern Shore of Virginia.

Wireworm management in potatoes

Predicting wireworm damage

Field history. Fields with a history of high wireworm densities will tend to maintain those populations over many years. Since grasses are excellent hosts for wireworms, fields recently cleared, previously in sod or pasture, or planted with grass cover crops are more prone to high wireworm densities. Such fields should be avoided for potato production if there is a low tolerance for wireworm injury on tubers. Wireworms are also typically more abundant in low-lying areas and in fields high in organic matter.

Sampling. Wireworms are attracted to germinating seeds. Baits consisting of corn, wheat, or rolled oats buried 6 to 8 inches in the soil can be used to determine if wireworms are present in the field. Baits usually need to remain in fields for at least 1 week. Black plastic laid on the soil surface over the bait site can help warm the soil in early spring to expedite seed germination and wireworm activity. In some regions, wireworm baits have been used to predict subsequent damage to potatoes. A threshold of approximately 1 wireworm per bait indicates a need for control measures. However, in Virginia, most potatoes are planted early (late February to early April), and there is often not sufficient time or adequate soil temperature to pre-sample fields prior to planting. Fall sampling has not been shown to be effective at predicting wireworm densities in late spring. Wireworms are also highly aggregated in fields, and consequently, a large number of bait samples are usually needed to accurately estimate field densities. This can be quite laborious, and as a result, very few potato growers sample wireworms for pest management decision making.

Chemical Control

Many potato growers in the U.S. apply a preventative soil insecticide either preplant as a broadcast or at planting over the furrow for wireworm control. In the 1960s, 70s, and 80s, cyclodiene insecticides provided effective control of wireworms. However, because these chemicals were so long-lasting in the soil (a characteristic that made them so efficacious against wireworms), they were eventually banned from use in the U.S. for environmental reasons. Beginning in the 1980s until present, organophosphates or carbamates have been the tools of choice for wireworm control in potatoes. Because of variations in soil type, wireworm pressure, and climatic conditions, researchers over the past decade have obtained inconsistent, even contradictory, results with various organophosphate insecticides and application methods. In recent published paper (Kuhar et al. 2003), we summarized the performance of several organophosphates and carbamates from 45 separate insecticide efficacy trials conducted from 1983 to 2002 in 12 different states of the U.S. Percent control was standardized as a reduction in the percentage of tubers with wireworm damage relative to an untreated control. Results showed that the grower standard organophosphate chemicals, ethoprop (Mocap), phorate (Thimet), and diazinon (Diazinon) applied as a preplant broadcast or in-furrow at-planting treatment provided the best and most consistent control of wireworms (Fig. 5). In 2002, diazinon lost its federal label on potatoes in the U.S. As with most organophosphate chemicals, ethoprop and phorate are targeted for cancellation under food protection legislation in the U.S. and many other countries. Since 2002, we have tested some of the newer insecticide chemistries for wireworm control in potatoes. That work has help lead to the registrations of two new insecticides on potatoes in Virginia, the phenylpyrazole, fipronil (Regent); and the pyrethroid bifenthrin (Capture LFR). These insecticides provide similar wireworm control as the organophosphate standards, but with less environmental impact and potential human safety concerns.

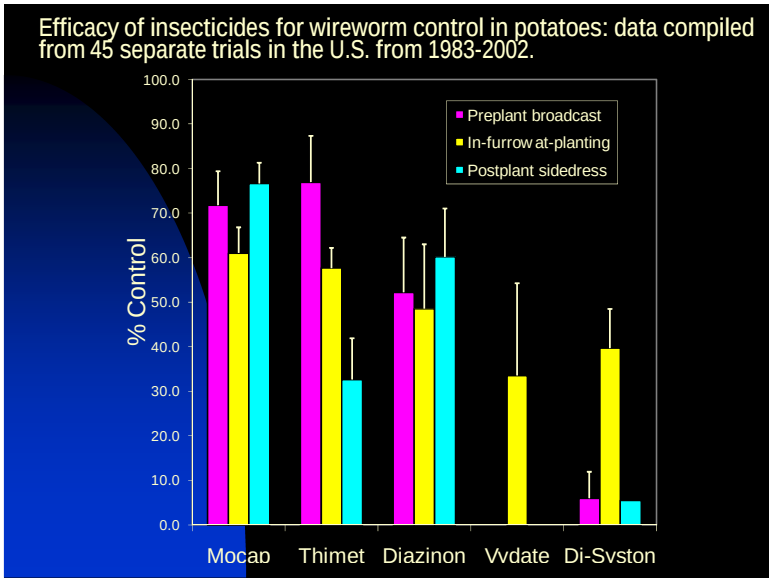

Fig. 5. Percentage control of wireworms from various insecticide efficacy trials conducted in potatoes.

Organic/Biological Control

Because they are subterranean, wireworms have relatively few predators and parasitoids. Researchers have investigated the use of entomopathogenic nematodes, but results have been variable. In one experiment conducted in Virginia in 2002, augmentative releases of the nematodes, *Heterorhabditis megidis*, *Steinernema feltiae*, or *S. riobrave* provided similar wireworm control as the insecticide standard (Fig. 6). However, attempts at repeating this experiment did not yield promising results. More research in this area is needed.

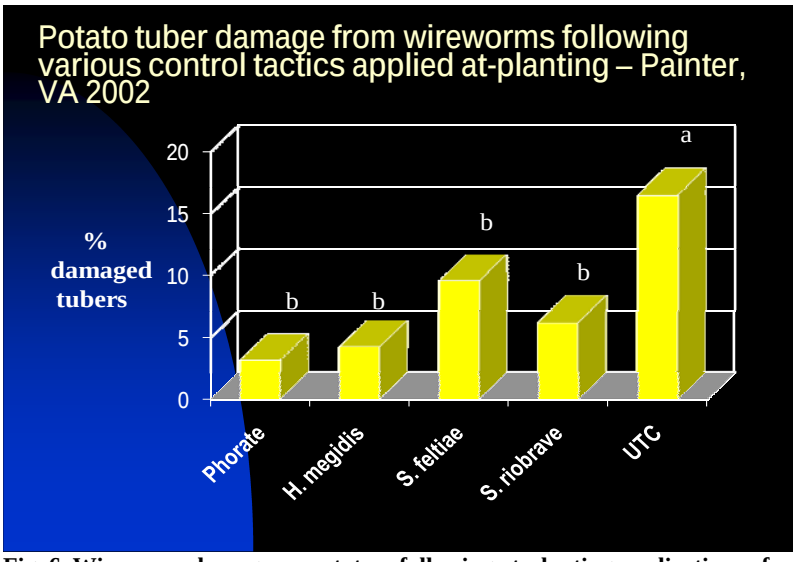

Fig. 6. Wireworm damage on potatoes following at-planting applications of either the insecticide standard, phorate (Thimet 20G), compared with three different nematode species each applied as a drench at 1 billion infected juveniles per acre. The "UTC" refers to the untreated control.

There also may be potential for using entomopathogenic fungi such as *Metarhizium anisopliae.* This organism is naturally active in the soil, and pathogenic to many different kinds of insects. Preliminary research in Virginia from 2007 to 2008 has shown very promising results with a commercially-available granular formulation of *M. anisopliae* spores applied over the furrow at planting. Averaged over four experiments, *M. anisopliae* plots had less than half as many wireworm damaged tubers as the untreated control plots. In these experiments, control was comparable to the organophosphate insecticide ethoprop (Mocap 4EC).