# WIREWORM CONTROL - THEN AND NOW [1]

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In the Pacific Northwest, wireworms are the most important soil insect pests of potatoes. There are at least 270 known species, but only a few are of economic importance. The species most likely encountered are the Pacific Coast wireworm, Limonius canus LeConte, the sugarbeet wireworm, Limonius californicus (Mannerheim), and the Great Basin wireworm, Ctenicera pruinina (Horn). The two Limonius species are referred to as the irrigated type because they persist in irrigated land, often in great numbers. The Great Basin wireworm, a dryland type, inhabits unirrigated land where annual rainfall is less than 15 inches. However, regardless of species, they all damage potatoes equally, and the extent of damage depends on the population density.

## Life cycle of wireworms

The adults, known as click beetles, emerge from the soil in spring (April and May) and mate, and the female returns to the soil to lay eggs. Adults normally live only about two months. The eggs hatch in about a month, and the larvae feed mainly on rootlets and root hairs the first year. Damage to tubers is done by larvae in the second and subsequent years. They overwinter 12 to 18 inches deep in soil, only to return to the surface to feed each spring. Mature larvae pupate in the soil during late July through early September, transforming to adults about a month later but remaining in the soil until the following spring. Wireworms require 3 to 6 years to mature. Thus, except for the first year, the same larvae can damage tubers for several years if no control measures are taken. On the other hand, it could take a long time for wireworms to build up to an economic level even if a previously uninfested field became infested because they have such a long life cycle.

## Damage to potatoes

No crop is immune to attack by wireworms, but potato is one of the most susceptible crops because a low larval population can cause appreciable damage.

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[1] Mention of a pesticide or commercial product does not constitute a recommendation for use by the USDA.

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It is difficult to estimate the damage done by wireworms in dollars, but Lane (1941) reported that the average annual loss from damage to the marketable potato crop alone amounted to approximately $4,000,000 in the four states of Washington, Oregon, Idaho, and Montana. Wireworms rarely reduce potato plant stand or yield, but they can render tubers unmarketable by their feeding tunnels. Because wireworms inhabit the soil, they can go undetected until after potatoes are planted, and often after tuber development. Unlike treatments for controlling foliage feeders, which can be made at any time during the growing season as damaging populations are detected, treatments for wireworm control should be made before or at planting time because they cannot be made after the rows close. Also, this is when wireworms are actively feeding, and developing tubers need protection.

The economic threshold of wireworms on potatoes is difficult to assess because it depends on the extent of damage a grower is willing to tolerate and how much he is willing to spend for control of wireworms. Inasmuch as the U.S. Standards for Grades of Potatoes allows 5% damage for all external tuber defects, including wireworm damage, for U.S. No. 1 Grade, the wise grower should minimize damage by wireworms to make allowances for other defects, such as bruises, cracks, and scab, which are more difficult to control. It would also be prudent to treat for wireworms when in doubt because potato is a high value crop.

## THE PAST

Prior to 1940, chemicals for controlling wireworms were few and very expensive (Thomas, 1940). Arsenicals and mercuric compounds, known as stomach poisons, were tried against wireworms with little success. Lead, zinc, sodium, and calcium arsenate mixed in the soil were found to be very deleterious to plants, while mercurous chloride (calomel) was required in high concentrations. The only contact insecticides available were pyrethrum and rotenone, but they were relatively ineffective against wireworms. Best results were obtained with fumigants, such as carbon disulfide, chloropicrin, cyanides, dichloroethyl ether, and paradichlorobenzene. However, these fumigants were either only partially effective or too costly.

Due to the lack of effective or economical chemicals, other methods were employed to control wireworms (Lange et al. 1958). One of the oldest methods was the use of baits. Wireworms found at buried baits were destroyed, but this method was both inefficient and impractical on large areas. Later, chemicals were added to baits to act as poisoned baits, but with questionable results. Fertilizers were recommended for wireworm control based on the belief that they acted directly against the larvae by contact or by gases which were given off. However, the value of fertilizers was perhaps primarily the result of stimulation of plant growth and not toxicity to wireworms. Flooding in hot summer weather was demonstrated to eliminate wireworms, but it could be done only on level ground and the water leached out alkali salts which adversely affected subsequent crops. Wireworms in the pupal stage (July and August) are soft and easily damaged and unable to survive if exposed to the elements, but this required plowing in summer.

Crop rotation was recommended based on studies that certain crops reduced wireworm populations; however, it did not reduce populations to subeconomic levels for a potato crop.

It is apparent that in the early years, grower were at the mercy of these menacing insect pests. Any and all methods had to be employed to reduce the wireworm population, and even then the crop sustained damage. One wonders how they managed to get a marketable crop.

Chlorinated hydrocarbon insecticides

The development of chlorinated hydrocarbon insecticides in the 1940's heralded a new era in chemical control of insects. They effectively controlled wireworms, were relatively inexpensive, and had low mammalian toxicity, and did not affect plant growth. However, they were highly persistent, which contributed to their demise. Residues of aldrin and dieldrin in crops were often found to exceed established tolerance. Furthermore, wireworms were becoming resistant to these insecticides. Thus, registered uses of aldrin and dieldrin were cancelled in the late 1960's followed by DDT in 1972, and finally chlordane in 1978.

## THE PRESENT

Organophosphorous insecticides

Due to problems associated with the use of chlorinated hydrocarbon insecticides, we saw the development of new classes of compounds beginning in the 1950's. One such class is the organophosphorous insecticides of which parathion is one of the oldest. Some organophosphates are effective against wireworms, but unlike chlorinated hydrocarbons, they are short lived in soil; therefore, they should be applied in spring when wireworms are most active.

Other important considerations for effective control are insecticide toxicity and longevity, and timing of application. For example, Dasanit and diasinon are less toxic than the other organophosphates. Also, Dyfonate has the greatest longevity, while phorate has the least. Thus, although phorate is highly toxic, it should not be used in early planted potatoes (before April 15). Phorate also acts systemically to control several foliage-feeding insects, while the other insecticides act only on specific soil insect pests when applied to the soil.

The organophosphorous insecticides presently registered for use against wireworms on potatoes are as follows:

| | lb.AI/A for | | |
|---|---|---|---|
| Insecticide | Preplant broadcast | At-plant sidedress | Seedpiece furrow |
| diazinon | 3-6 | 1-3 | |
| ethoprop (Mocap) | 4-6 | 2 | 2 |
| fensulfothion (Dasanit) | 5 | | 3* |
| fonofos (Dyfonate) | 4 | 2 | 2 |
| parathion | 4-6 | | |
| phorate (Thimet) | | 2-3 | 2-3 |

* As 4-6 inch band ahead of planter shoe.

## Carbamate insecticides

Insecticides belonging to the class known as carbamates are generally ineffective against wireworms. Carbofuran (Furadan), the only carbamate registered for wireworm control on potatoes, is not very effective. However, it will aid in controlling them when applied in the seedpiece furrow at 3 lb. AI/A to systemically control other insects. Carbamates such as aldicarb (Temik) and carbaryl (Sevin) will not control wireworms.

## Fumigants

Soil fumigants are very effective in controlling wireworms when applied as a broadcast (overall) treatment before planting potatoes. At one time, they included dichloropropane-dichloropropene mixtures, ethylene dibromide, and Telone (1,3-Dichloropropene). However, only Telone is presently registered for use. While the primary use of Telone for wireworm control is prohibitive due to the high cost, it may be justified when used to control a variety of pests, including wireworms. Metham-sodium (Metam, Nemasol, Soil Prep and Vapam) is also used for potatoes, but it is not registered for controlling wireworms.

Deciding on which treatment to use

Wireworm density is the most important factor to consider when deciding on which treatment to use. Soil sampling can be used to estimate the density of wireworms in a field, and a posthole digger is a convenient tool for taking such samples. Take soil core samples randomly throughout the field to a depth of at least 18 inches, sift the soil, and record the number of wireworms found. Five such samples equal one square foot, so the estimated population density (number of wireworms/ft $^2$) is calculated by dividing the number of wireworms found by the number of square feet sampled. Increasing the number of samples increases the precision of the estimate. However, a minimum number of samples should be taken in a given acreage; e.g. 30 samples in a 10-acre field, 60 in 40 acres, 90 in 90 acres, and 120 in 160 acres. Shown below is the relationship of wireworm density (as determined by soil sampling) to percentage of injured and damaged tubers in untreated potatoes:

| Wireworms/ft$^2$ | % Injured | % Damaged* |
|---|---|---|
| 0.08 | 7 | 1 |
| 0.43 | 26 | 5 |
| 1.1 | 42 | 10 |
| 2.1 | 55 | 15 |

*** In accordance with the U.S. Standards for Grades of Potatoes, Sec. 51.1560 and 51.1564, September 1, 1971, as amended.**

The higher the density, the more effective a treatment should be. In general, the most effective treatment is fumigation, followed in order by insecticide treatments of broadcast, furrow, and sidedress applications. Treatments to use for the estimated wireworm densities (as determined by soil sampling) are as follows (Onsager and Foiles 1969):

| Treatment* | Wireworms/ft$^2$ |
|---|---|
| **Furrow; or at-plant sidedress** | **0.04 - 0.2** |
| **Preplant broadcast** | **0.2 - 1.0** |
| **Broadcast + furrow or sidedress; or broadcast** | **1.0 - 1.7** |
| **Fumigation; or broadcast + furrow or sidedress** | **1.7 or more** |

*** First-named treatment is the first choice.**

Wireworm control after plant emergence

In spring, wireworms first attack the seed pieces, which act as baits. Therefore, seed pieces can be examined in untreated fields to determine if a damaging populations is present. Soon after plant emergence, randomly dig at least 100 hills with a shovel, examine the seed pieces and soil, and count the number of wireworms found. An average of 0.05 wireworms/hill is capable of causing 0.9% damage to tubers, and 0.3 wireworms/hill can cause 5.2% damage (Toba and Turner 1981). The only treatment registered for use at postemergence is a sidedress application of phorate shanked 3-4 inches to each side and level with the seed piece. This should be done when the plants are still small to prevent root pruning.

If a treatment was applied for wireworms before or at planting time and seed piece examination revealed the presence of live wireworms, it is difficult to say whether or not the wireworms will be killed before they have a chance to feed on the tubers. This is why it is important to know the population density before planting so that the proper treatment can be applied for adequate control.

## THE FUTURE

It is common knowledge that registering the use of a new chemical is becoming ever so difficult, and it does not appear that there will be any for wireworm control in the near future. However, barring any loss of presently registered chemicals or wireworms becoming resistant, there should be effective and safe insecticides available for years to come. The important things to remember to ensure adequate control are population density and proper choice of treatment.

## REFERENCES CITED

1. Lane, M. C. 1941. Wireworms and their control on irrigated lands. USDA Farmers' Bul. No. 1866, 21 pp.

2. Lange, W. H., Jr., M. C. Lane, and M. W. Stone. 1958. A comparative appraisal of wireworm and seed-corn maggot control in the western United States. Proc. 10th Int. Congr. Entomol. 3:131-145.

3. Onsager, J. A., and L. L. Foiles. 1969. Results of 6 years of experimentation on controlling Pacific Coast wireworms in potatoes in the Columbia Basin. Proc. 8th Annu. Wash. St. Potato Conf. P.13-19.

4. Thomas, C. A. 1940. The biology and control of wireworms. Penn. St. Coll. Sch. Agric. Exp. Sta. Bul. 392, 90 pp.

5. Toba, H. H., and J. E. Turner. 1981. Seed piece examination: A method for sampling wireworm on potatoes. J. Econ. Entomol. 74:718-720.