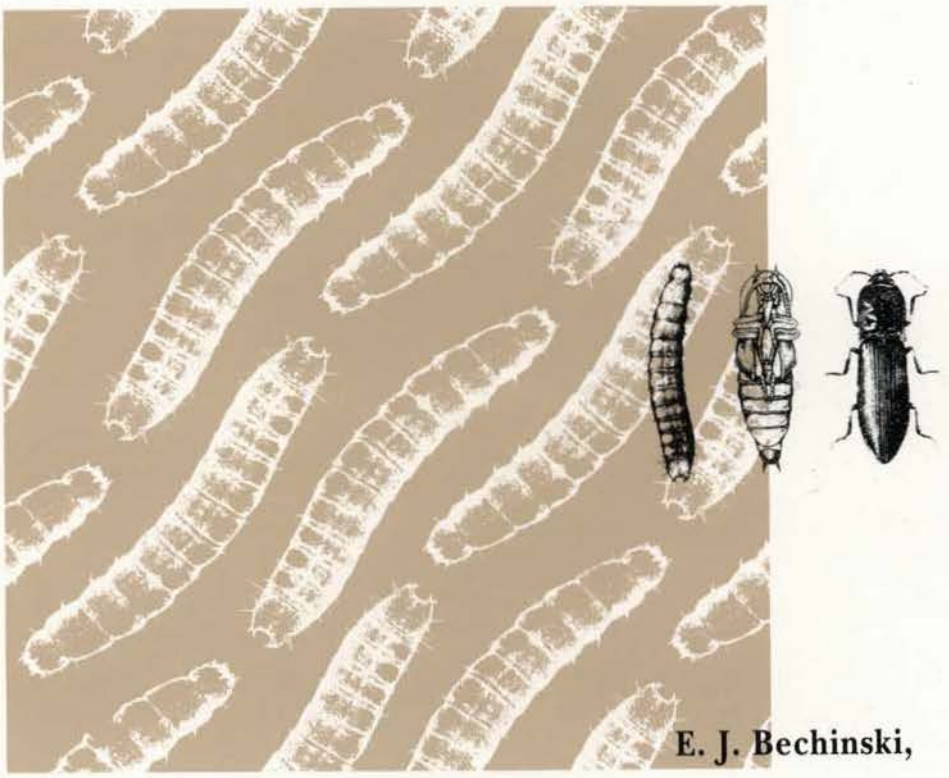
EXT 760

Integrated Pest Management Guide to

WIREWORMS IN POTATOES



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This publication describes how to use integrated pest management (IPM) to control wireworm infestations in potatoes. IPM fits together effective cultural controls with field scouting, thresholds, and judicious use of insecticides. The goal of IPM is protection: protect crop quality and yield, protect environmental quality, and protect human health.

IDENTIFICATION

More than 100 species of wireworms occur in Idaho, but only three commonly infest potatoes. The sugarbeet wireworm, *Limonius californicus*, is the most widespread, followed by the Pacific Coast wireworm, *Limonius canus*. Both are native to naturally wet soils along streams. Neither can survive dryland cropping conditions. A third species, the Great Basin wireworm (*Ctenicera pruinina*), naturally occurs in Idaho's desert sagebrush areas. It normally infests potatoes during the first few years that desert land is brought into production.

All three species are similar in appearance. Larvae are hard-bodied, slender, cylindrical, shiny yellow-to-brown "worms" about 3/4 to 1-inch long when mature (fig. 1). They have three pairs of small, thin legs behind the head. Their last body segment is forked or notched.

Two soil-dwelling insects sometimes confused with wireworms are false wireworms and ground beetle larvae (fig. 2). Both lack the notch on the last body segment characteristic of wireworms.

Fig. 1. *Wireworm larvae have shiny tan bodies with three pairs of thin legs behind the head. The insert shows the characteristic notch on the last body segment.*

False wireworms are dryland insects that only occur in irrigated crops when desert land first is cultivated. They closely resemble wireworms but do not feed on potatoes. False wireworms wriggle and crawl rapidly if held in your hand. This is in contrast to true wireworms, which move very little. Ground beetle larvae are beneficial predators that feed on many soil-borne insects. Unlike wireworms, ground beetle larvae have a soft underbody. They vary in color from yellow to brown to black and they also crawl rapidly when disturbed.

Adult wireworms are slender, tan to black, bullet-shaped beetles about 1/2-inch long (fig. 3). They are called click beetles because they flip themselves into the air with an audible click when placed on their back.

Fig. 2. *Ground beetle larvae are beneficial predators sometimes found in the soil with wireworms.*

Fig. 3. *Adult wireworm beetle.*

LIFE CYCLE

Wireworms usually take 3 to 4 years to develop from an egg to an adult beetle (fig. 4). Virtually all of this time is spent in the larval stage. Egg and pupal stages each last about 1 month. Adults live about 9 months, spending most of this time hibernating in the soil. They are the only stage that occurs above ground. Larvae of all ages may be present in the soil at the same time.

Wireworms overwinter 9- to 24-inches deep in the soil either as larvae or adults. When soil temperatures reach 50 to 55°F during the spring, beetles move to the surface. Females give off a pheromone scent that attracts males. After mating, females burrow back into the soil and lay eggs. Females often re-emerge, fly to other parts of the field, and lay more eggs. This pattern of egg laying produces spotty infestations. The field may have patches with severe wireworm damage and other parts that escape damage.

The Pacific Coast wireworm usually lays eggs in bare soil. The sugarbeet wireworm prefers soils shaded by vegetation. It often lays its eggs in grassy swales or along rock piles and ditchbanks with grassy weeds. Both species lay about 350 eggs over a 3-week period. Eggs hatch within a month.

Larvae move up or down the soil in response to temperature and moisture. During the growing season, they feed within 6 inches of the surface, unless soil

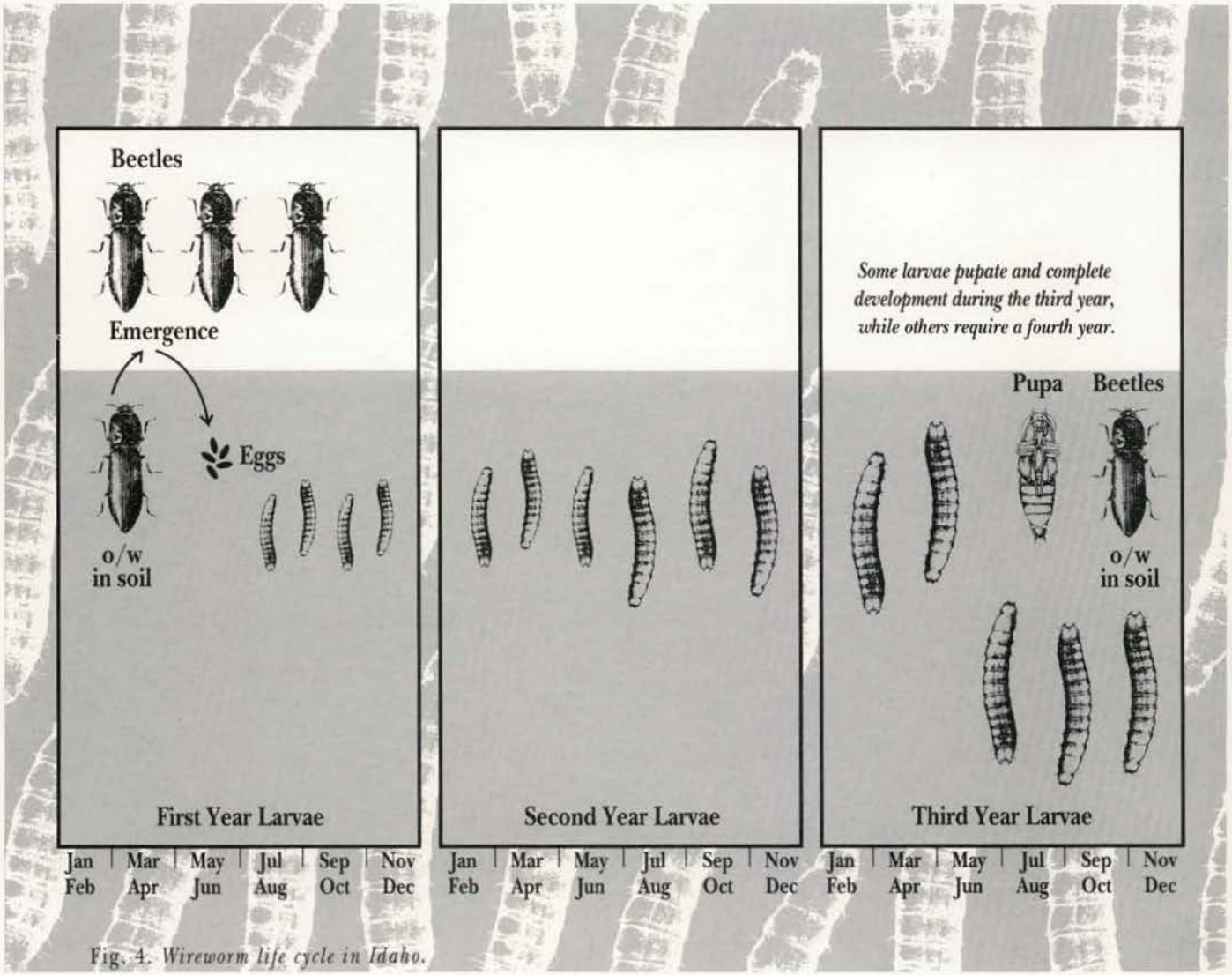


Fig. 4. *Wireworm life cycle in Idaho.*

temperatures become too hot (more than 80°F) or dry.

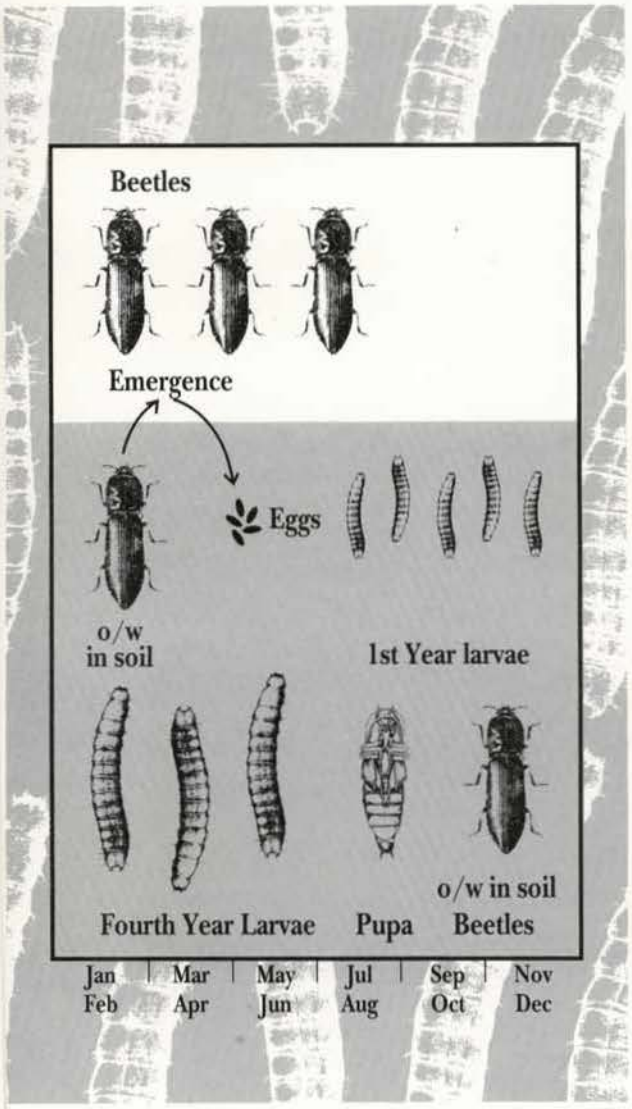
After feeding for three or four seasons, larvae pupate within an earthen cell during late summer. They complete development to adults within 3 or 4 weeks but remain in the soil until the next spring.

DAMAGE

Larvae feed on all underground parts of the potato plant and on the seed piece. Year-old larvae feed on roots, not tubers, and cause little damage. Older, larger larvae are the only ones that damage tubers. They can cause severe damage during their last 2 years. One wireworm can attack several tubers. Adult beetles feed on roots of cull sugarbeets and some weeds and therefore pose no economic threat.

The major damage wireworms cause is reduced tuber quality, rather than decreased yield. Larvae eat holes up to an 1/8-inch diameter that extend an inch or so into the tuber (fig. 5). Damage symptoms depend on the age of the tuber when attacked. Wireworms feeding on young, growing tubers produce deep, funnel-shaped pits (fig. 6). Feeding on more mature tubers creates round, clean-cut holes lined with potato skin (periderm). These holes look as if the tuber was stabbed with a nail.

Wireworm feeding can open seed pieces and tubers to bacterial and fungal rot infections. Seed piece decay sometimes is severe enough to reduce the stand.



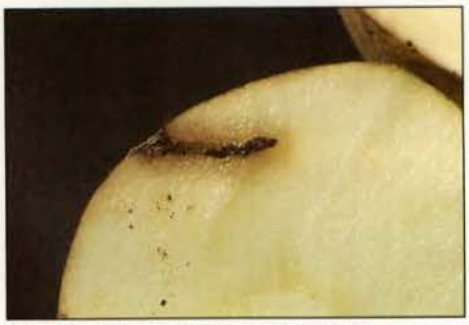


Fig. 5. *Internal injury to tuber from wireworm feeding.*

Fig. 6. *External pitting and scarring from wireworm feeding.*

INTEGRATED PEST MANAGEMENT PLANS

Field Scouting and Thresholds

Always check your fields for wireworm infestations before planting potatoes, even if the previous crop showed no signs of wireworm damage. You can use two sampling methods to scout for wireworms: baiting and soil sampling. Baiting is the easiest way to determine if wireworms are present and sometimes can signal if control is necessary. Soil sampling gives a more accurate measure of infestation levels but also requires more work.

Baiting involves placing food lures in the soil. The carbon dioxide gas that sprouting or fermenting baits give off attracts wireworms from the surrounding soil. One effective bait is a 1:1 mixture of whole wheat and corn. Coarse chopped carrots, potatoes, oatmeal, or wheat flour also work well. Presoaking whole grain baits in water for one day increases their attractiveness. Wrap bran and flour baits in a nylon stocking so you can inspect them more easily later.

Bury a fist-size portion of bait 4- to 6-inches deep and cover it with soil. Mound soil 4- to 5-inches high over the top in a dome shape so rainwater runs off (fig. 7); this keeps the bait from rotting and makes it easier to examine. Bait either during the fall before planting or in the spring. Regardless, soils must be moist and temperature at 6 inches must be at least 45°F.

Baits do not work well when soil is cool or dry because wireworms stop moving under those conditions. When baiting during cool springs, cover each bait with a 3-foot^2 piece of clear plastic. This "solar heater" warms the soil and increases wireworm activity, especially early during the season.

Place 25 or more baits for each 30 acres of field size. The more bait stations you use, the better your chances of detecting wireworm infestations. Flag the location of each bait station. Randomly spread out baits across the entire field. Consider how previous field history might affect wireworm levels. For example (fig. 8), if part of the field had been a pasture or if grassy weeds previously were a problem, bait those areas separately from the rest of the field. Wireworms may be a problem only in those areas.

Dig up baits and the surrounding soil after 5 to 10 days and examine for wireworm larvae. Tear the baits apart on a tarp or sieve them through 1/4-inch hardware cloth. Calculate the average number of wireworms per bait station.

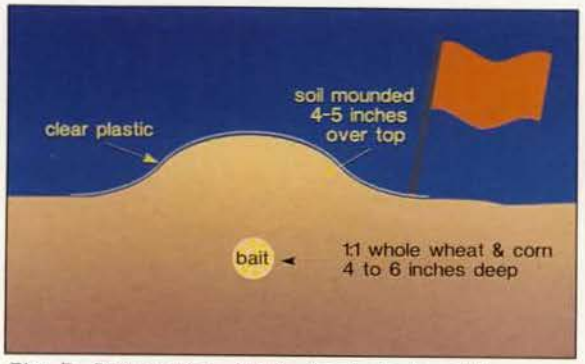


Fig. 7. *Bait station with "solar heater" used to detect wireworms.*

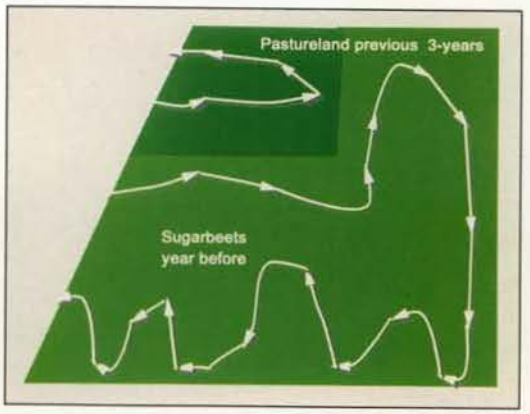


Fig. 8. *Sampling pattern for nonuniform fields. Here the old pastureland is sampled as if it was a different field because wireworms can increase to damaging levels in grassy pastures. The old pasture might be the only part of the field that requires treatment.*

Table 1 shows how to interpret wireworm counts from bait stations. If baits do not detect wireworms, you probably do not need to apply an insecticide. At the other extreme, four or more wireworms per bait station indicate a high chance of extreme damage. If the average count falls between these limits, you have a moderate to fair chance of wireworm damage unless you apply an insecticide. Sample the soil to determine population levels more precisely. If most bait stations are empty but a few have several wireworms each, consider treating only those areas where you detected infestations.

Table 1 recommends control if expected tuber damage is 3 percent or more at harvest. This is an arbitrary level. When planning wireworm control, consider tolerances for defects set in your contract or by the intended end use. Allow for additional types of external defects, such as mechanical damage, growth cracks, or *Rhizoctonia.*

There are limitations to using bait stations. Cool soil, dry soil, wet soil, and soils high in organic matter all reduce bait effectiveness. For example, if you bait two fields and detect wireworms in one field but not in the other, you cannot know for sure if wireworm infestations really differ between fields. Infestations might have been the same in both fields, but cool temperatures in one field or dry soil in the other could have prevented larvae from moving through the soil to the bait. The only way to be sure about actual infestation levels is to take soil samples.

Soil sampling involves digging 1/4 foot^2 cores (6 x 6 inches square by shovel, or 6 3/4-inch diameter post-hole digger) 12 inches or more deep. Separate wireworms by screening through a pair of sieves (fig. 9). Use 1/4-inch hardware cloth stapled to a wooden frame for the upper sieve and 8 to 16 mesh window screen for the lower sieve.

Fig. 9. *Use a pair of homemade sieves on a spring steel stand to recover wireworm larvae from soil samples.*

Table 1. How to interpret wireworm counts from bait stations.

Average no. wireworms per bait station	Risk of economic damage	IPM recommendation
0 wireworms	Low (less than 1 chance in 10)	Control not needed or verify infestation level via soil sampling
up to 0.5	Moderate (1 chance in 3)	Sample soil and use decision card
up to 1.0	Less than 50:50	
up to 2.0	Probable (more than 50:50)	
up to 4.0	High (75 to 90% chance)	Apply insecticide at planting
more than 4.0	Extreme	Do not plant potatoes

Fig. 10. WIREWORM DECISION CARD

Field/unit ID: _____ Date: _____

Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total number wireworms	TREAT if total exceeds	Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total number wireworms	TREAT if total exceeds
1	_____	_____	1	26	_____	_____	2
2	_____	_____	1	27	_____	_____	2
3	_____	_____	1	28	_____	_____	2
4	_____	_____	1	29	1	_____	2
5	_____	_____	1	30	1	_____	2
6	_____	_____	1	31	1	_____	2
7	_____	_____	1	32	1	_____	2
8	_____	_____	1	33	1	_____	2
9	_____	_____	1	34	1	_____	2
10	_____	_____	1	35	1	_____	2
11	_____	_____	1	36	1	_____	2
12	_____	_____	1	37	1	_____	2
13	_____	_____	1	38	1	_____	2
14	_____	_____	1	39	1	_____	2
15	_____	_____	1	40	1	_____	2
16	_____	_____	1	41	1	_____	2
17	_____	_____	1	42	1	_____	2
18	_____	_____	1	43	1	_____	3
19	_____	_____	2	44	1	_____	3
20	_____	_____	2	45	1	_____	3
21	_____	_____	2	46	1	_____	3
22	_____	_____	2	47	1	_____	3
23	_____	_____	2	48	1	_____	3
24	_____	_____	2	49	1	_____	3
25	_____	_____	2	50	1	_____	3

Designates that a decision is not possible

The decision card (fig. 10) can help you make accurate control decisions for the fewest number of soil samples, or cores. When wireworm populations are high, you need only a few samples to make a control decision. We designed the card to give conservative recommendations. The card is more likely to signal control when wireworm levels are low than fail to recommend control when infestations are high.

To use the decision card, dig 1/4-foot^2 soil samples from across the entire field. Use one decision card for fields up to 30 or 40 acres. Divide larger fields into uniform 30- to 40-acre blocks and use a different decision card in each. As for baiting, if you know that previous cropping conditions favored wireworm buildup in certain parts of the field, you may want to sample those areas separately with a different card.

Each time you dig and sieve a 1/4-foot^2 sample, write on the card the number of wireworms recovered. Record your results as a running total, the total number of wireworms recovered from all soil cores. Compare your running total with the values in columns labelled DO NOT TREAT and TREAT. Then make one of these three decisions:

1. No insecticide needed

If your running total is less than the value in the column labelled DO NOT TREAT, the wireworm infestation probably is below the economic threshold. No wireworm control is needed in the field. You do not need to dig and screen more soil samples. Note that the card does not list values for the first 28 samples. This is a safeguard to prevent you from making the wrong control decision. You need 29 consecutive soil cores without any wireworms before you safely can conclude that no insecticide is needed.

2. Apply insecticide

If your running total is greater than the value in the TREAT column, the wireworm infestation probably is greater than the economic threshold. Unless you apply an insecticide, wireworm damage probably will be greater than 3 percent damaged tubers. You do not need to dig and screen more cores. *The card recommends insecticide application if average infestations exceed 0.08 wireworms per foot^2. This economic threshold has been chosen from research studies to keep wireworm injury less than 3 percent damaged tubers at harvest.*

3. Continue sampling

If your running total is equal to or between the values in the two columns labelled DO NOT TREAT and TREAT, you cannot make a control decision. Continue to dig and screen soil samples until either (1) the card gives a treat/don't treat recommendation, or (2) you have inspected a total of 50 cores. If your running total remains between the DO NOT TREAT and TREAT columns after 50 samples, the infestation is too close to the threshold to accurately classify as either control/don't control. The field most likely needs control.

Figure 11 shows how to use the decision card. In this example, a single wireworm larva was found in the very first soil sample. This result was recorded on the card by writing a 1 in the RUNNING TOTAL column for soil sample number one.

This running total is not bigger than the card value in the TREAT column, and there is no card value in the DO NOT TREAT column, so we cannot decide whether insecticide is needed. The correct decision is to dig another soil sample. No wireworms are found in the next soil sample; the running total remains at one and the correct decision again is to continue digging and sieving soil. Samples three through six likewise are not infested, so sampling continues. The seventh sample detected one wireworm; now the running total increases from one to two. Because our running total of two is bigger than one, the value in the TREAT column, we can stop sampling and conclude that control is needed. There is no need to dig and sieve more soil.

soil core (sample)	number of wireworms recovered	running total
#1	1	1
#2	0	1
#3	0	1
#4	0	1
#5	0	1
#6	0	1
#7	1	2

Fig. 10.

WIREWORM DECISION CARD

Field/unit ID: _____ Date: _____

Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total number wireworms	TREAT if total exceeds	Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total number wireworms	TREAT if total exceeds
1		1	1	26			2
2		1	1	27			2
3		1	1	28			2
4		1	1	29	1		2
5		1	1	30	1		2
6		1	1	31	1		2
7		2	1	32	1		2
8			1	33	1		2
9			1	34	1		2
10			1	35	1		2
11			1	36	1		2
12			1	37	1		2
13			1	38	1		2
14			1	39	1		2
15			1	40	1		2
16			1	41	1		2
17			1	42	1		2
18			1	43	1		3
19			1	44	1		3
20		2		45	1		3
21		2		46	1		3
22		2		47	1		3
23		2		48	1		3
24		2		49	1		3
25		2		50	1		3

Designates that a decision is not possible

Stop After 4th Sample: TREAT

Fig. 11. *How to use the decision card.*

Biological Control

Predatory ground beetles and a fungus disease are two naturally occurring biocontrols that kill all stages of wireworms. We do not yet know enough about these beneficials to recommend practical ways of increasing their effectiveness. Gulls, horned larks, and other birds eat beetles and larvae. Take any steps you can to protect and increase bird populations. University of Idaho faculty have tested predatory nematodes for larval control; results have been erratic and use is too expensive at this time.

Cultural Control

You can reduce wireworm infestations by knowing how crop rotations and other production practices affect population levels. The following factors increase the chance of wireworm damage in potatoes:

- Wireworm damage in any five or six prior crops,
- Wheat and barley grown up to 4 years before potatoes, even if you did not see any crop damage in these crops,
- Fields previously farmed dryland or the 6 years after sagebrush lands first are farmed,
- Fields heavily infested with grassy weeds the year before planting potatoes,
- Fields following grassy sods and pastures,
- Red clover included in the rotation.

Even though these factors favor wireworm buildup, this does not mean that wireworms always reach damaging levels under those situations. You must use bait stations or take soil samples to determine actual infestation levels.

Including alfalfa in the rotation can reduce wireworm levels by creating dry and compact soil unfavorable to wireworms. Include 3 or 4 years of alfalfa, followed by potatoes, then another row crop. Do not allow alfalfa to become weedy with grasses because larvae feed on the crowns and roots of grassy weeds. Corn and sugarbeets are moderately favorable hosts for wireworms. Small grains:potato is the rotation most likely to develop damaging wireworm levels. Again, this does not mean that wireworms always reach damaging levels under small grain:potato rotations, only that conditions are favorable for their increase. Use bait stations or soil samples to determine actual infestation levels. Keep written records of field cropping history so you can plan rotations that prevent or reduce problems.

Deep plowing (9 to 10 inches) kills the pupae but has little direct effect on larvae or adult beetles. Once mechanical injury destroys their soil cells, pupae cannot make new ones and they die if exposed. To be effective, you would have to plow during early August because the pupal stage is complete by late August. Birds following the plow feed on any exposed wireworms.

Insecticides and Fumigants

Consult your local Extension agricultural agent for current recommendations about using insecticides and fumigants for wireworms. Try to control wireworms in your rotational crops. Once you reduce wireworm numbers, they usually remain low for some time because the life cycle is so long.

When selecting pesticides for wireworm control, consider these factors:

- **Fumigants** produce gases that move through the soil and kill nematodes, symphylans, and some diseases as well as wireworms. Only use fumigants if the

benefits of controlling these other soil-borne pests are enough to offset the added cost of fumigants. Apply fumigants at least 3 weeks before planting to avoid plant damage. Soil temperature at treatment depth must be at least 50°F and soil must be moist, otherwise wireworms will not be active and fumigants will be ineffective.

- **Granular and liquid insecticides** for wireworms do not fume. Wireworms must move through the soil and contact the chemical in order to be killed.
- **Length of residual activity** varies among pesticides. Most remain toxic in the soil for 6 to 8 weeks.
- **Insecticide timing and placement** depends on the level of the wireworm infestation. Control is best when insecticide surrounds the new tuber, especially the underside, because most wireworms move up toward the tuber from below. When wireworm populations are low, you can apply band or sidedress treatments during planting. Some insecticides move with irrigation water; proper placement is necessary to insure these insecticides move and surround the new tubers.

  When wireworm infestations are high, broadcast treatments either before or during planting give better control than sidedress or band applications. Make postemergence rescue applications only if wireworms infest seed pieces. These treatments are not as effective as preplant or at-plant applications. To decide if sidedress applications are needed, dig and inspect seed pieces from 100 random locations across the field. Sidedress only if wireworms infest three or more seed pieces out of 100.
- **Always read label instructions** before applying pesticides to guarantee correct timing, placement, and preharvest interval.

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