Section III. Root-feeding maggots, soil arthropods and other problems

HOW TO INTERPRET WIREWORM COUNTS FROM BAIT STATIONS IN POTATOES

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Development of recommendations:

I derived guidelines for using bait stations to determine if insecticides are needed for wireworm control in potatoes. I began by using the data of Gibson (1939) to compute statistical models that predict wireworm damage as a function of larval density. Gibson monitored damage to potatoes at Yakima caused by the sugarbeet wireworm, *Limonius californicus*, and the Pacific Coast wireworm, *Limonius canus*. These also are the most important species in Idaho potato fields. My best-fit model was

equa. 1 $$p = 1 - \exp(-1.65784 \times^{1.54933})$$

$$n = 6,\ P = 0.0001,\ r^2 = 0.992$$

where p is the predicted proportion of wireworm-damaged tubers at harvest and x is the mean number of wireworm larvae per 1-ft^2 X 18-inch deep soil sample prior to planting. In Idaho, 3% damaged tubers is a commonly accepted upper limit for wireworm injury. Equation 1 predicts that tuber damage will exceed 3% if wireworm density at the beginning of the season is greater than 0.076 larvae per 1-ft^2 (1 larva per 13.2-ft^2). Onsager (1969) earlier had derived a linear model from Gibson's data, but his model is not as biologically realistic because it predicts wireworm damage even when no larvae are present. Damage predictions from Equation 1 are most accurate for wireworm densities ≤ 0.5 larvae per 1-ft^2 soil sample. Beyond that range, the model is extremely conservative; it overestimates tuber damage. The practical consequences of that limitation are nil because 0.5 larvae per 1-ft^2 is well in excess of the economic threshold.

I converted economic thresholds from larvae per 1-ft^2 soil sample to number of larvae from bait stations by analyzing the data of Williams (1993). He worked with a third species, *Limonius infuscatus*, within a dryland pea and wheat cropping system during 1985 - 1989 at Walla Walla County, Washington, and Umatilla County, Oregon. His data set consisted of wireworm densities from paired soil core and bait samples. Baits were 1:1 wheat and corn seed. These were buried 6-inches deep during early March and were covered with a black polyethylene sheet. Wireworms were recovered by screening 3 to 5 weeks later.

Correlation analyses generally failed to detect statistically significant relationships between numbers of wireworms from soil core samples and bait stations. However, by reorganizing the data into frequency classes (percentage of bait stations with 0, 1, 2, 3, and 4 or more wireworms) and then plotting these values against absolute density from soil cores, it was possible to assign a risk of economic damage to each infestation class. The result is Table 1, HOW TO INTERPRET WIREWORM COUNTS FROM BAIT STATIONS. As previously, Table 1 defines economic damage as 3% wireworm-damaged tubers at harvest.

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	extreme	do not plant potatoes

If baits do not detect wireworms, Table 1 suggests that insecticide application probably is not needed. At the other extreme, more than 2 wireworms per bait station indicates a high chance that damage will exceed 3%. If the average count falls between these limits, ¼-ft^2 soil samples should be taken to more precisely determine population levels. Because soil sampling is tedious and time-consuming, I also developed a sequential decision card (Figure 1) that minimizes the number of cores required to make a control decision.

Practical recommendations for baiting (excerpted from University of Idaho Current Information Series "IPM Guide to Wireworms in Potatoes" [in press, due March 1994]):

Baiting involves placing food lures in the soil. The carbon dioxide gas given off by sprouting or fermenting baits 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. Pre-soaking whole grain baits in water for one day increases their attractiveness. Wrap bran and flour baits in a nylon stocking so you more easily can inspect them later.

Bury a fist-size portion of bait 4 to 6 inches deep and cover it with soil. Mound soil 4 to 5-inches over the top in the shape of a dome so rain water runs off; 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 under cool or dry soil conditions because wireworms stop moving under those

conditions. When baiting during cool springs, cover each bait with a 3-foot square piece of clear plastic. This "solar heater" warms the soil and increases wireworm activity, especially early during the season.

Put out 25 or more baits for each 30 acres of field size. The more bait stations used, the better the 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, 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 them apart on a tarp or sieve them through 1/4-inch hardware cloth. Calculate the average number of wireworms per bait station.

TABLE 1 recommends control if expected tuber damage at harvest is 3% or more. This is an arbitrary level. When planning wireworm control, consider tolerances for defects set in your contract or by the planned 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 or natural foods all reduce the effectiveness of baits. 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 take soil samples.

Literature Cited

Gibson, K.E. 1939. Wireworm damage to potatoes in the Yakima Valley of Washington. J. Econ. Entomol. 32: 121-124.

Onsager, J.A. 1969. Sampling to detect economic infestations of *Limonius* spp. J. Econ. Entomol. 62: 183-189.

Williams, L.H. 1993. Unpublished data from Ph.D. dissertation. Division of Entomology, University of Idaho, Moscow.

Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total no. wireworms	TREAT if total exceeds	Number of cores examined	DO NOT TREAT if total is less than	RUNNING TOTAL: total no. 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

FIGURE 1. Sequential decision card for wireworm control in potatoes.

Dig 1/4 -ft^2 cores (6 X 6 inches square by shovel or 6 3/4 -inch diameter post-hole digger) to a depth of 12 inches or more. Separate wireworms by screening soil through a pair of sieves. 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. Take 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. If you know that previous cropping conditions favored buildup of wireworms 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-ft^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. You do not need to dig and screen more soil samples. Note that the card does not list values listed for the first 28 samples. This is a safeguard to prevent you from making the wrong control decision. It takes 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 infestations probably is greater than the economic threshold. Unless you apply an insecticide, there is a good chance that wireworm damage will be greater than 3% 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 below 3% 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. Control most likely is needed.