# RESULTS OF 6 YEARS OF EXPERIMENTATION ON CONTROLLING PACIFIC COAST WIREWORMS IN POTATOES IN THE COLUMBIA BASIN

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In 6 experiments in commercial potato fields since 1963, we have made 107 comparisons of damage by Pacific Coast wireworms, *Limonius canus* LeConte, to potatoes in untreated plots versus plots treated with registered nonpersistent insecticides or fumigants (3 band treatments were tested in 44 plots, 3 broadcast treatments in 39 plots, and 3 fumigation treatments in 24 plots). In the band treatments, we used granular diazinon, parathion, and phorate; in the broadcast treatments, we used granular diazinon, Dyfonate® (*O*-ethyl *S*-phenyl ethylphosphonodithioate), and parathion; and in the fumigation treatments, we used ethylene dibromide, Telone® (mixed dichloropropenes) and DD® or Vidden D® (dichloropropane-dichloropropene mixture). The doses that were used and the dates of the applications were all according to the current recommendations of the Washington State University Extension Service. The combined results of all experiments should therefore provide a reliable indication of what may be expected from normal commercial use of the treatments in the Columbia Basin.

A summary of the combined data from the field tests is given in Table 1. An interpretation of these data will be reported elsewhere in detail. For this discussion, the pertinent conclusions can be summarized as follows; (1) Band treatments are less effective and much more variable than broadcast treatments. (2) Broadcast treatments are less effective and only slightly more variable than fumigation. (3) All 3 types of treatment give less protection and become more variable as the severity of the infestation increases. (4) If we assume a gross return of $600 per acre of potatoes, a band treatment will not pay for itself unless infestations average at least 0.12 wireworms/$ft^2$; infestations must average at least 0.15/$ft^2$ to justify use of a broadcast treatment, and at least 0.18/$ft^2$ to justify use of the least expensive fumigation treatment (12 lb of ethylene dibromide/acre). (5) Because treatments differ in average effectiveness, consistency of performance, and cost, the severity of the infestation determines to a large degree what method of treatment is likely to yield the greatest return per dollar invested. (6) It is obvious that infestations must be estimated in order to determine the most economical type of control measure. (7) Treatments that are likely to be the best investment at various levels of infestation are:

| Population/ft$^2$ | Type of treatment |
|---|---|
| Less than 0.12 | Treatment unnecessary |
| 0.12 - 0.15 | Band (BD) |
| .15 - .40 | Broadcast (BST)1/ or BD2/ |
| .40 - .70 | BST |
| .70 - 1.6 | BST + BD1/ (use different chemicals) or BST2/ |
| 1.6 - 2.3 | BST + BD1/ or Fumigate (F)2/ |
| More than 2.3 | BST + BD,1/ F + BD,2/ or F3/ |

1/=First choice, 2/=Second choice, 3/-Third choice

Table 1 shows that the average results after each of the treatments were encouraging but the wide variation in results is cause for concern. From these data, we expect that most treatments will achieve either satisfactory or excellent control of wireworms if they are applied as recommended; however, these same treatments will occasionally, for no obvious reason, permit serious injury even though they were used against identical infestations. We have therefore estimated the probabilities with which each type of treatment is expected to reduce injury from various infestations of wireworms to cullage of 3% or less. The reliability of treatments that were tabulated as the first choice against various populations ranged from only 67% certainty at upper limits of some of the population classes (for example, when a broadcast treatment is applied against 0.7 wireworms/ft$^2$) to 94% certainty at the lower limits of some of the population classes (for example, when a broadcast treatment is applied against 0.15 wireworms/ft$^2$).

If a producer wants to reduce the probability of high cullage, he apparently should deliberately apply treatments that will often be more expensive and more potent than necessary. Such extravagance would be justified if he could be confident that excessive damage would be prevented. The required degree of confidence in a treatment can now be economically obtained by using a sampling plan (Onsager 1969) that protects a grower against underestimating an infestation of wireworms. If that plan is used to estimate populations and if the treatments listed here are applied as recommended by the Extension Service, the probability of obtaining less than 3% cullage will be increased to 98.35-99.7% certainty compared with the 67-94% mentioned before. The plan usually requires using more potent treatments than may actually be needed; however, it becomes more efficient as the population increases (and as the cost of the suggested treatment increases) because dense populations can be estimated with greater precision than sparse populations.

At least 30 subsamples of soil, each 1/4 $ft^2$ (6-3/4 in. diameter), should be examined in fields of 10 or fewer acres. In larger fields, the number of subsamples must be increased in proportion to the relative square roots of the areas if a constant degree of representativeness is to be maintained. The subsamples should be taken from throughout a field, and not more than 5 should be taken near any one spot. The depth of the subsamples should range from at least 12 inches (during mid-May) to at least 18 inches (during July through Mid-April). One man can examine about 120 subsamples in an 8-hour day by using portable equipment that has been described (Landis and Onsager 1966).

Figures 1 and 2 are used to estimate populations of wireworms from the numbers found in sampling. First, the acreage of the sampled field and the number of subsamples that were examined are located on Figure 1. A straight line passing through those points will bisect the third scale at the appropriate Index of Representativeness and Intensity (IRI) of sampling. For example, 100 subsamples in a 40-acre field are equivalent to 50 subsamples in a 10-acre field (IRI = 50).

Then, the number of wireworms found in converted to the proportionate number that would have been found if only 10 or fewer acres had been sampled at the same level of intensity. This number is designated the Index of Relative Abundance (IRA) and may be calculated as follows: IRA = (number of wireworms found X IRI) — number of subsamples. For example, if 6 wireworms were found in 100 subsamples from 40 acres, IRA = (6) (50) ÷ 100 = 3.

Now, the IRI and IRA are located on Figure 2. A straight line passing through those points will bisect the third scale at the extimated population. For exampe, if IRI = 50 and IRA = 3, the population is estimated at 0.65 wireworms/$ft^2$.

Figures 1 and 2 may also be used to refine an estimate of an infestation or to determine whether a contemplated treatment will be effective (Onsager 1969). If an estimate is being refined, it is not efficient to continue sampling after the IRA exceeds 15. If sampling is being done to determine whether a band treatment will be effective, the IRI should be at least 30. Then, if no wireworms are found, a band treatment may safely be applied; however, if even 1 wireworm is found, it will probably be more economical to use a broadcast treatment.

It should be noted that application of a broadcast treatment plus a band treatment is more economical than fumigation with the least expensive fumigant (ethylene dibromide) because fumigation is more expensive, and because it is less likely to provide satisfactory control of severe infestations. This implies that fumigation alone is probably justified only in special circumstances; for example, if nematodes are also a problem or if a producer wishes to treat during autumn so fields can be planted very early in the spring.

It should also be emphasized that broadcast treatments will not perform as well as indicated in Table 1 if they are applied earlier than recommended. In fact, in 1968 when broadcast and band treatments were applied on March 18 and 22, respectively, the band treatments averaged more effective and less variable than the broadcast treatments. This result was expected because band treatments place a high concentration of insecticide in a small area where it persists much longer in toxic concentrations. However, neither type of treatment will provide control when application is made early if the infestation exceeds the relatively limited capacity of a band treatment.

Table 1--Percentage of injury by wireworms to potatoes in untreated plots compared with percentage of cullage after band, broadcast, or fumigation treatments with nonpersistent insecticides, 1963-1968.

| Treatment | Number of observations | % injury in untreated plots | | % cullage in untreated plots | |
|---|---|---|---|---|---|
| | | average | range | average | range |
| Band | 17 | 10 | 7-12 | 1.8 | 0.3-5 |
| Band | 8 | 16 | 14-18 | 3.3 | 1.5-6 |
| Band | 6 | 24 | 22-27 | 1.8 | 0-7 |
| Band | 7 | 36 | 34-39 | 2.2 | 0-9 |
| Band | 6 | 45 | 42-47 | 4.0 | 0-12 |
| Broadcast | 12 | 9 | 7-12 | 0.2 | 0-1 |
| Broadcast | 14 | 15 | 13-18 | 1.0 | 0-6 |
| Broadcast | 8 | 24 | 22-27 | 1.4 | 0-3 |
| Broadcast | 5 | 43 | 39-47 | 2.5 | 0-10 |
| Fumigation | 6 | 12 | 12-13 | 0 | ---- |
| Fumigation | 6 | 20 | 18-22 | 0.6 | 0-2 |
| Fumigation | 6 | 36 | 34-37 | 0.8 | 0-5 |
| Fumigation | 6 | 46 | 45-47 | 1.9 | 0-9 |

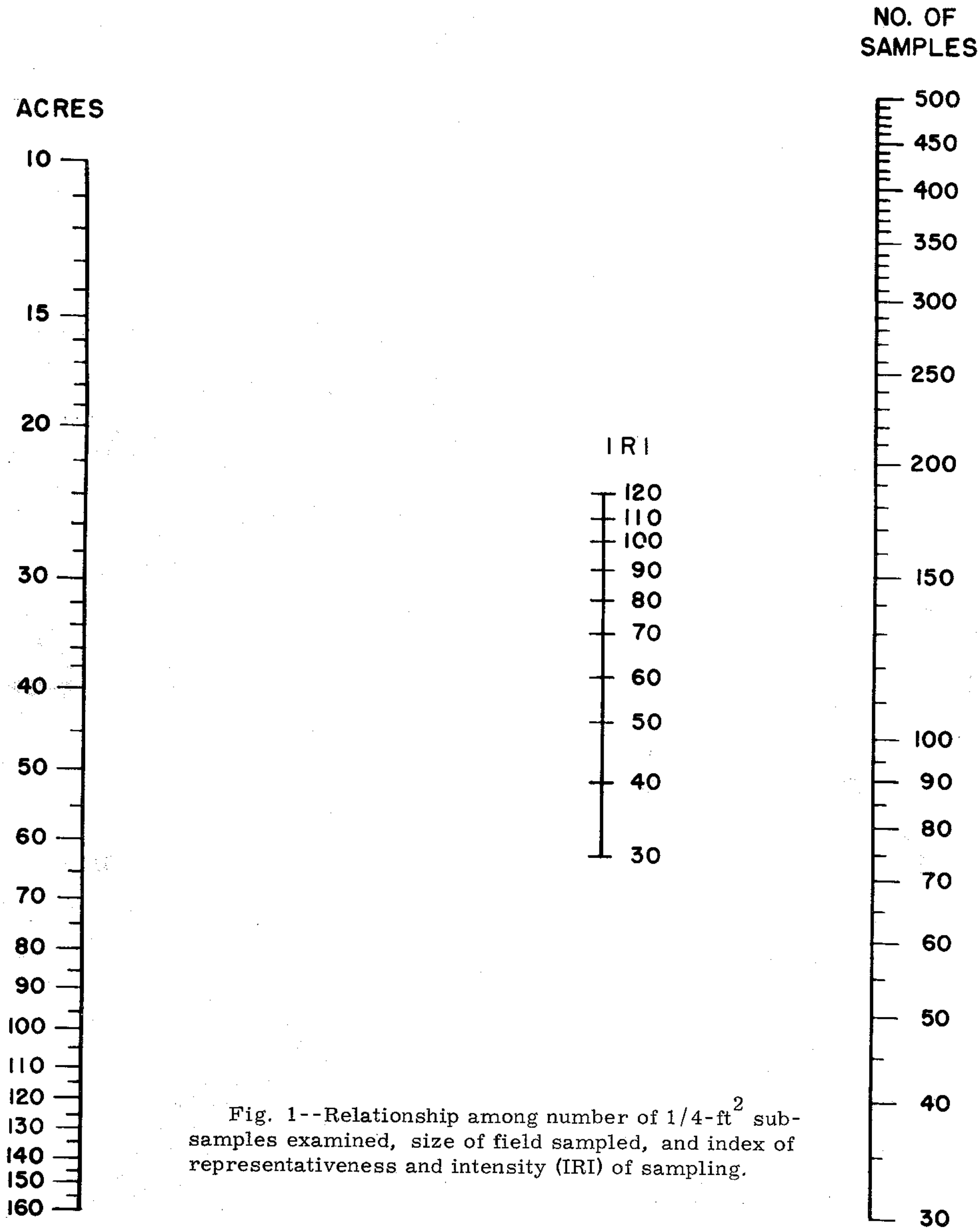


Fig. 1--Relationship among number of 1/4-ft$^2$ subsamples examined, size of field sampled, and index of representativeness and intensity (IRI) of sampling.

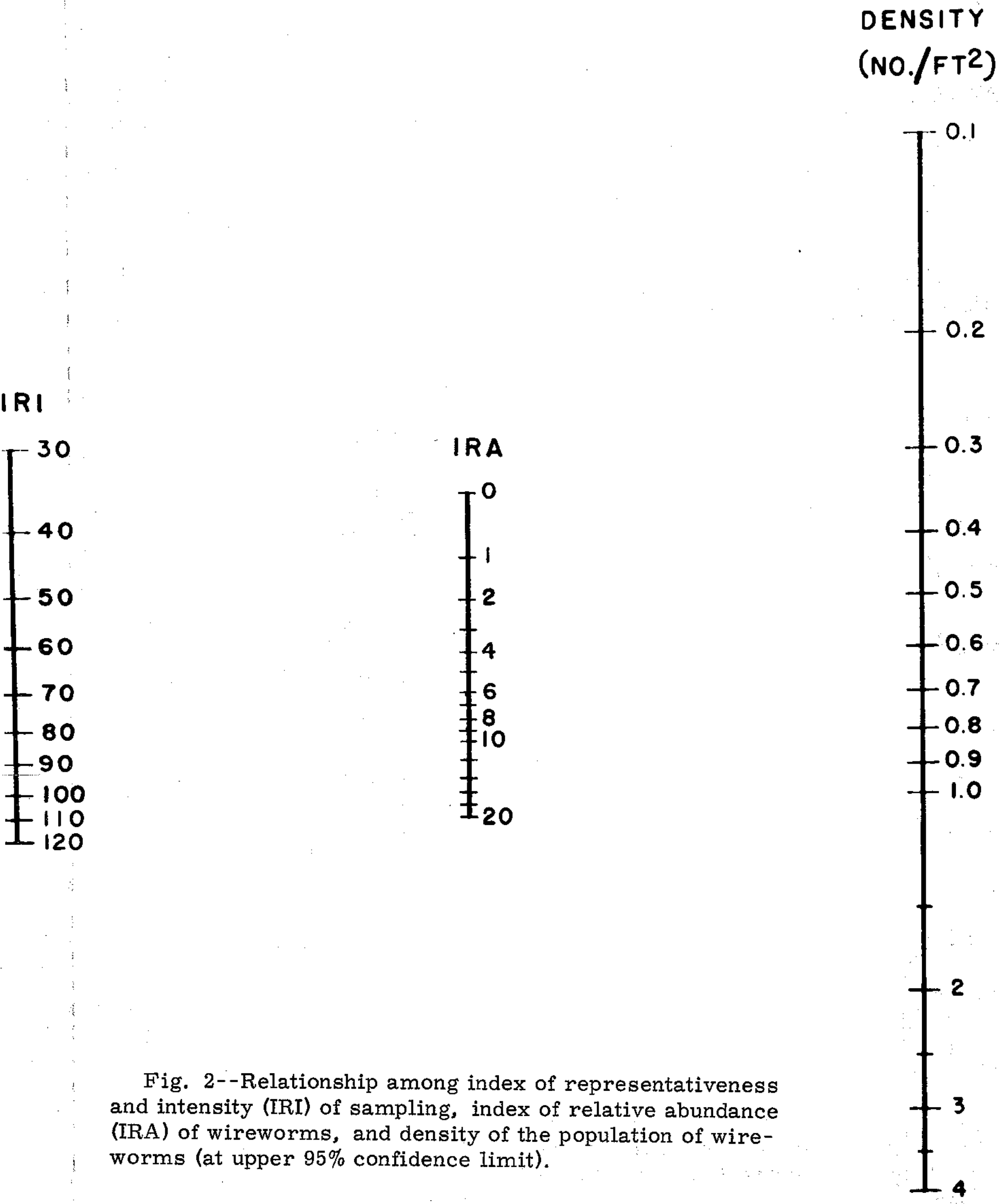


Fig. 2--Relationship among index of representativeness and intensity (IRI) of sampling, index of relative abundance (IRA) of wireworms, and density of the population of wireworms (at upper 95% confidence limit).

## REFERENCES CITED

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