Additional Criterion for Evaluating Insecticide Treatments for Control of Sugarbeet Root Maggot Larvae

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Introduction

The sugarbeet root maggot, *Tetanops myopaeformis* (Röder), is one of the most serious insect pests affecting sugarbeets in the Western United States and Canada. Damage is done to small roots by the larvae, and a heavy infestation often results in reduction of stand and yield.

The three most commonly used criteria for evaluating the performance of insecticides in controlling the larvae are 1) stand loss, 2) larval counts, and 3) yield data. These criteria are, however, often poorly correlated with one another, especially when infestations are light to moderate, and they show no consistent pattern regarding the performance of the insecticides. Consequently, there has been considerable confusion concerning the rating of test chemicals under such circumstances.

Some workers rated insecticide treatments based on larval counts, others relied on yield data, and still others depended on stand loss. Therefore, there is an obvious need for improvement in sampling techniques in order to facilitate communication among workers who are engaged in sugarbeet root maggot control studies. A *root damage rating* has been used by the author, and this method was found to be simpler, more accurate and more consistent than previously used techniques.

Analysis and Critera

Stand loss: The uniformity of crop stand immediately after thinning, the pattern of stand loss, and the size of beets at the time of egg hatching can all affect stand counts as well as final yield. A plot with a higher plant population after thinning has a tendency to lose more beets than a plot containing fewer plants, but the effect on yields may be less in the former. A 10 to 20% reduction in stand may not show up in the final yield if the initial stand was more than 100%; that is, more than 100 beets per 100 row feet. On the other hand, the same amount of stand loss would be readily reflected in the final yield if the initial stand was 50% or less. Yield losses would be greater when stand reductions are patchy than when plant losses are more or less uniformly distributed throughout the field. If the beets are large at the time maggot eggs hatch, stand loss will be minimal; although, larval feeding on the roots may be heavy.

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The technique suggested for determining root maggot injury based on stand loss is to count the number of beets in a given distance, preferably 100 feet of row with a minimum of 50 feet of row in each plot, immediately after thinning. Mark the distance measured and recount the beets immediately before or at harvest time. Each treatment can be replicated four or more times, and stand loss is expressed as percent based on the initial stand.

Larval counts: Although this is laborious and time consuming, there is no assurance that all of the larvae present around each beet have been recovered. As in the case of stand loss, larval counts and yield data are not always highly correlated, especially when larval counts are made late in the season.

The number of larvae per beet varies with sampling time and the volume of soil taken around each beet. Larvae become full grown by mid-summer in Northern Colorado and tend to move away from the beets. The recovery of larvae, therefore, becomes harder as the season progresses.

Sampling time and volume of soil for each sample differ considerably with the investigators. Allen et al. (1)[2], for example, took 10 beet-soil samples from each plot in mid-September, with each sample measuring 8 inches by 8 inches and 12 inches deep. Plots were arranged in randomized blocks replicated eight times—each plot consisted of four 60 foot rows. Peay et al. (2), on the other hand, made larval counts by digging 10 beets and the adjacent soil from each plot to a depth of 11 inches in late June and early July. The plots, four rows wide and 40 to 50 feet long, were arranged in randomized blocks with four to eight replications.

Based on the author's experience, the best time to take beet-soil samples for larval counts is when dead beets are readily seen in the field. At this time, larvae are concentrated around the roots and the volume of soil taken with each sample is not very important. A minimum of 10 beets per plot seem to be required for an accurate measurement. Hand pulling of beets is not recommended because it tends to break the root tip and leave most of the larvae behind in the soil. Instead, beets and the soil around them should be carefully removed, using a shovel or soil core sampler.

Yield data (root and sugar): Two important factors that influence yields besides plant stand and number of larvae are a) post-feeding weather conditions and b) plot size.

[2] Numbers in parentheses refer to literature cited.

It has been observed frequently that some treated plots which had various degrees of larval control actually showed lower root yields than untreated check plots. This phenomenon was more pronounced when infestations were light to moderate and the post-feeding weather conditions were favorable for recovery of injured beets.

To obtain accurate yield data, each plot must have at least one border row on each side, and these border rows should receive the same treatment as other rows in the plot. The primary purpose of having border rows is to obviate any positive or negative compensating effects. In a small plot test, 50 feet or more from the center two rows of either four or six row plots seem to produce satisfactory yield data.

The number of rows per plot and the length of row harvested, however, depend largely on the nature of tests and individual workers' past experience. Two-row plots of 50 ft long, for instance, are quite satisfactory in initial screening tests and early advanced performance tests.

Root damage rating: This method has been used in evaluating the efficiency of insecticides on many root crop insects. The author has been testing the method on the sugarbeet root maggot since 1969 and found it the most useful of all criteria mentioned. Some of the advantages are a) accuracy and consistency, b) sensitivity that provides accurate information even under light to moderate infestations and c) simplicity and rapidity.

Time of sampling is critical because the best time to rate damage is when maximum injury has occurred and wounds are still fresh. When samples are taken at a later date, at harvest time for example, damage becomes inconspicuous and makes rating more difficult. In addition, roots sampled at harvest time have escaped heavy damage and thus severely damaged beets are eliminated from the sampling scheme. The correct time for sampling is when dead beets are readily seen in a field. This is the same time as mentioned above for larval counts. Both the larval counts and root damage rating can be made at the same time, using the same beets.

Table 1 shows the proper sample size in root damage system under various conditions. The computation was based on the 1971 data using a method described by Snedecor et al, (3)[2].

Table 1.- Proper sample size in root damage rating system.

	No. beets/plot/replication	
No. replication	0.1*	0.2*
4	15	5
6	11	3
8	8	3

*Maximum allowable standard error of a mean root damage rating.

The suggested root damage rating scale is from one to five. General descriptions for individual categories are given below.

1. Healthy roots with no feeding scars.
2. Slightly damaged. Less than three small scars on the root surface.
3. Moderately damaged. More than three feeding scars, but damaged area does not exceed one-half of total root surface.
4. Heavily damaged. Most of the lower half of the tap root is damaged, and a small portion of root tip may be cut off.
5. Severely damaged. Beets are dead or nearly dead and more than one-third of the root tip is cut off.

Summary and Conclusions

Stand losses, larval counts, and yield data frequently provide insufficient information regarding the relative effectiveness of insecticide treatments. In order to overcome such difficulties, an additional evaluation criterion, a root damage rating, is proposed. The root damage rating seems to be the most accurate, consistent and dependable method of all four criteria described, and rating of insecticide performance can be made fairly accurately using this criterion alone. Stand losses, larval counts and yield data can, however, provide useful supporting data.

Addition of "root damage rating" to the existing evaluation criteria would aid investigators in their analyses of the performances of various insecticides. A standard evaluation system is highly desirable. The "root damage rating" described is easy, accurate and consistent, and it is proposed as a means of promoting greater uniformity and understanding among sugarbeet root maggot investigators.

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