# Appearance of Damage Symptoms and Reinfestation Rates for Christmas Trees Attacked by the Zimmerman Pine Moth, *Dioryctria Zimmermani* (Lepidoptera: Pyralidae)

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# APPEARANCE OF DAMAGE SYMPTOMS AND REINFESTATION RATES FOR CHRISTMAS TREES ATTACKED BY THE ZIMMERMAN PINE MOTH, *DIORYCTRIA ZIMMERMANI* (LEPIDOPTERA: PYRALIDAE)[1]

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## ABSTRACT

Two blocks of Scotch pine Christmas trees were inspected to determine an appropriate time to evaluate Zimmerman pine moth damage, and to determine reinfestation rates for trees previously attacked by this insect. Results showed that damage evaluation should be delayed until mid-August and possibly later, in early fall. Evaluation done before this time could result in underestimation of total damage. In the reinfestation study, previously attacked trees were shown to sustain both a higher rate of reattack and more attacks per tree the following year than control trees. However, at most, only 61% of the new attacks the following year were on trees with a previous attack. Also, 47% or more of the infested trees observed the second year were newly infested. These results indicate little practical benefit of using attacked trees solely as a trap crop for ovipositing moths. Attacked trees with severe damage should therefore be removed.

The Zimmerman pine moth (ZPM), *Dioryctria zimmermani* (Grote), is a primary pest of Christmas trees grown in the Midwest (Rennels 1960, Schuder 1960, Butcher and Carlson 1962). Its preferred host is Scotch pine, *Pinus sylvestris* (L.), but it does attack all *Pinus* spp. grown in the Great Lakes region (Schuder 1960; Yonker 1982). The damage it causes can be aesthetic and monetary, as broken terminals, dead laterals, and altered tree-form can all result from attack.

Carlson (1965) developed regression relationships for infested whorls and terminals to predict the extent of an infestation on a plantation-wide basis. However, an attempt to correlate the number of damaged lateral branches with the total number of infested trees in a field was not successful. Also, timing of tree inspections with respect to appearance of damage was not established. In the current study, individual trees were inspected to determine when initial damage appears, and when maximum damage is sustained. Results of this study should help growers evaluate the full extent of damage in their fields, and aid them in making control decisions.

Several authors have outlined chemical control programs (Butcher and Carlson 1962, Appleby and Randell 1980, Schuder 1983), including recommendations for removing heavily infested, damaged trees (Rennels 1960, Schuder 1960). These latter authors stated that once a tree is attacked, it is often reattacked in following years and serves as a source of infestation for other trees. This relationship was further studied, with emphasis on the feasibility of using attacked trees as a natural trap crop for ovipositing females.

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Table 1. Infestation characteristics of blocks A and B.

| Block (Year) | No. Trees | No. (%) Attacked | No. (%) Damaged | % Attacked Showing Damage |
|---|---|---|---|---|
| A (1978) | 839 | 18 (2.1) | — | — |
| A (1979) | 839 | 63 (7.5) | 31 (3.7) | 49.2 |
| A (1980) | 839 | 138 (16.4) | 63 (7.5) | 45.7 |
| A (1981) | 839 | 179 (21.3) | — | — |
| B (1978) | 870 | 109 (12.5) | — | — |
| B (1979) | 870 | 152 (17.5) | 84 (9.7) | 55.3 |
| B (1980) | 371 | 53 (14.3) | 17 (4.6) | 32.1[a] |

[a]Due to harvest, damage estimate was based upon an August, not November evaluation.

## MATERIALS AND METHODS

Two blocks of Scotch pine Christmas trees located in Rochester, Indiana, were chosen for study. The presence of ZPM in 1978 and the minimal use of insecticides prior to this study were two criteria for block selection. In 1979, trees in block A were 4 years old, with heights ranging from 0.9 to 1.2 m. Trees in block B were 6 years old, with heights from 1.8 to 2.4 m. Both blocks were surrounded by other blocks of trees in this 8.1-ha field.

Each tree was initially examined for ZPM attacks in late June. Both the number and location of all attacks was carefully noted, as well as the appearance of all visible damage. Damage included broken or dead terminal and lateral leaders, and dead lateral branches. Trees with attacks were reinspected in mid-July, August, and November to document later occurring damage. The November inspection was chosen to ascertain final (recognizable) damage before the occurrence of fall needle yellowing and drop that could disguise damage. From the inspections, initial and maximum damage were determined, as well as infestation rates for previously attacked and unattacked trees.

## RESULTS

Table 1 describes the infestation rates and damage characteristics of blocks A and B. During the study, an average of 11.8 and 14.8% of the trees sustained at least one ZPM attack in blocks A and B, respectively. Approximately 48% of the attacked trees from both blocks showed some degree of damage. One or more dead lateral branches extending from an infested whorl area was the most common damage observed. Dead terminal or secondary leaders resulting from attack(s) in the top whorl were less common. ZPM tunneled leaders were rarely observed.

Figure 1 shows the chronological appearance of all ZPM damage observed. For both blocks, the percentage of trees ultimately damaged that showed damage in June was less than 15%. Through July and early August, damage increased substantially, but began to level-off by mid-August. Damage occurred earlier in block A and may be related to the smaller tree's inability to tolerate ZPM attacks. Only 6–14% of the total damage observed occurred after mid August.

Data collected from trees with old and current attacks were used to determine reinfestation rates for trees in both blocks. Reinfestation rates were compared to rates of attack for trees not attacked the first year, but attacked the second year (control trees). Table 2 shows that for each study year, trees with an attack were much more prone to attack the following year than the control trees ($P < 0.05$, $\chi^2$ analysis in $2 \times 2$ contingency table). Also, these trees sustained significantly ($P < 0.05$) more attacks per

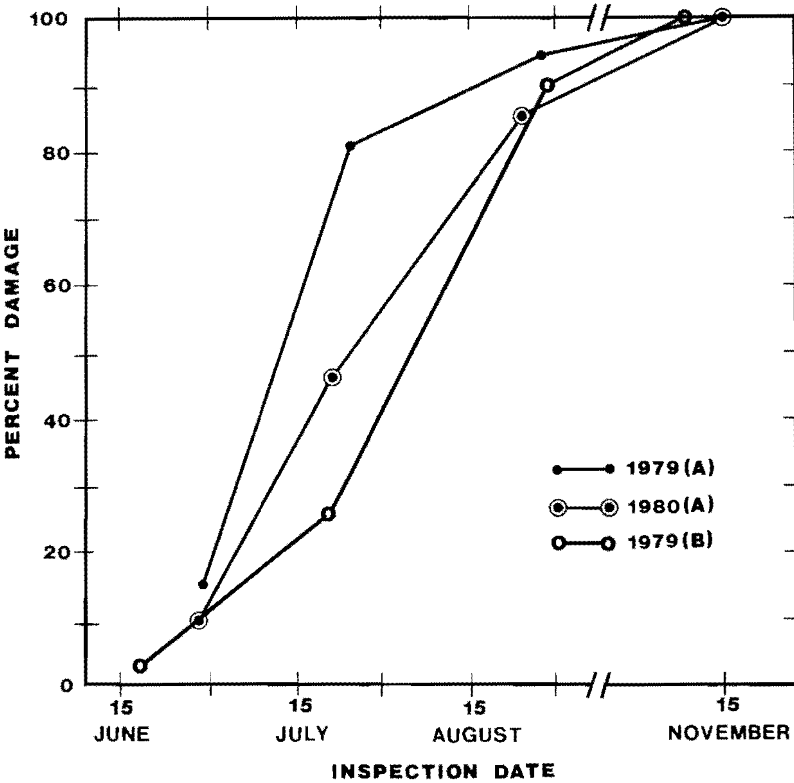


Fig 1. Chronological appearance of damage caused by Zimmerman pine moth in blocks A and B.

Table 2. A comparison of the following years' rates of ZPM attack and the mean number of attacks per tree for previously attacked and control trees.

| Block (Year) | % Trees Attacked Following Year | | $\bar{x}$ Attacks/Tree Following Year | |
|---|---|---|---|---|
| | Attacked Trees | Control Trees | Attacked Trees | Control Trees |
| A (1978) | 63 | 6 | 1.4 | 1.2 |
| A (1979) | 52 | 14 | 1.9[a] | 1.3 |
| A (1980) | 59 | 13 | 2.3[a] | 1.4 |
| B (1978) | 72 | 10 | 2.1[a] | 1.5 |

[a]Mean significantly different from control mean ($P < 0.05$; $\chi^2$ test).

Table 3. Efficiency of ZPM-infested trees as a trap crop for ovipositing ZPM moths.

| Block (Year) | No. Trap Crop Trees | % New Attacks on Trap Crop[a] | No. Newly Infested Trees | % Infested Trees Newly Infested |
|---|---|---|---|---|
| A (1978) | 16 | 18 (0) | 53 | 84 |
| A (1979) | 63 | 31 (8) | 105 | 76 |
| A (1980) | 138 | 56 (27) | 93 | 53 |
| B (1978) | 109 | 61 (34) | 71 | 47 |

[a]Number in parentheses is the percentage of attacks on trap crop trees with two or more current attacks.

tree the following year than the control trees. These results imply either a moth attraction for previously attacked trees, some degree of restriction of ovipositing moths to trees from which they emerged, or a higher larval survival rate on the attacked trees.

Table 3 shows the potential of using ZPM infested trees as a natural trap crop for ovipositing females. In the best years, infested trees "caught" only 61 and 56% of the following years' attacks. Even then, 47–53% of all trees attacked the second year were newly infested. Table 3 also shows the protection afforded by those trap crop trees with at least two active attacks. These trees caught, at most, 34 and 27% of the attacks observed the following year.

## DISCUSSION

The damage evaluation study showed that a time lag of at least three months exists between ZPM attack (mid-April) and the appearance of substantial damage (late July). These results suggest that the most accurate time to assess damage is after mid-August. Growers who evaluate damage earlier, for instance at shearing (June), may severely underestimate total damage. Evaluation done at moth emergence (early to mid-August) provides a better estimate, and also allows for the application of an insecticide at a time when ZPM is susceptible.

Although most damage, even that appearing in June, was still evident in November, its cause (ZPM, other insect, or mechanical) was sometimes not discernible in November. This suggests that growers should still make evaluations in late summer or early fall to help distinguish all ZPM damage. Damage evaluation at this time is also practical for growers who prefer a spring (April) insecticide application (Appleby and Randell 1980).

The reinfestation results showed that although the infested trees sustained a higher rate of reattack than the control trees, many newly infested trees were observed the following year. Attacked trees, particularly those most heavily infested, did not provide adequate protection for the previously uninfested trees. Since a trap crop does not seem feasible, the recommendation to remove the heavily infested, unsellable trees seems justified (Rennels 1960, Schuder 1960). Also, chemical protection should still be considered for all trees to prevent the current infestation from spreading away from the attacked trees left in the plantation.

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