Spruce Budworm

Choristoneura fumiferana (Clemens)
Lepidoptera: Tortricidae

Régnière, J.; Lysyk, T. J.; Auger, M. 1989. Population density estimation of spruce budworm, *Choristoneura fumiferana* (Clem.) (Lepidoptera: Tortricidae) on balsam fir and white spruce from 45-cm mid-crown branch tips. Canadian Entomologist 121: 267-281.

Objectives: To relate density of *C. fumiferana* on balsam fir to density on white spruce; to examine *C. fumiferana* density within host canopy; and to improve the accuracy of estimation through error corrections.

Abstract: Spruce budworm, *Choristoneura fumiferana* (Clemens), is the most destructive defoliator of balsam fir, *Abies balsamea* (L.) Mill., and white spruce, *Picea glauca* (Moench) Voss, in eastern North America. The last three larval instars cause most of the defoliation. Periodic outbreaks occur every 30 years, while epidemics can last 5–10 years.

Densities of *C. fumiferana* are often estimated from 45-cm branch tip samples taken from the mid-crown of host trees. This sampling method is used on both balsam fir and white spruce, but the appropriateness of comparing densities estimated by this technique between host species has not been evaluated previously. Foliage density in these branch samples is determined by branch architecture, which differs between white spruce and balsam fir. Research conducted in eastern Canada indicated that white spruce had foliage nearly 40% denser than balsam fir. Pest density should be expressed in a consistent manner to allow comparisons between host trees and among studies. Densities of *C. fumiferana* expressed as per sample, per m^2 surface area, per kg fresh weight, and per foliage bud were compared but none of the expressions presented a clear advantage over the others in regards to reduction in variability. Fresh weight is generally easier to calculate than surface area, so the authors recommend expressing density of *C. fumiferana* per kg fresh foliage weight.

The distribution of *C. fumiferana* within the host canopy differs with life stages. While changes in the vertical distribution of *C. fumiferana* did not appear to affect density estimates, changes in the horizontal distribution along branches are more important. Overwintering larvae prefer the base of branches over the apical tips where branch samples are taken. In contrast, the authors found more first through fourth instars (60%) and more egg masses (67%) within 45-cm of the branch tips. Density estimates of different life stages of *C. fumiferana* on 45-cm mid-crown branch samples can be compared using a correction factor for each host species.

Sampling Procedure: Sample 45-cm branch tips from the mid-crown of host trees using pole pruners. Use collection baskets attached to the head of the pole pruners when large instars are present as they tend to drop off branches when disturbed. Return samples to the laboratory and tally the number of *C. fumiferana* present in each life stage. Have samples randomly checked by experienced personnel for accuracy in detecting *C. fumiferana*. Weigh the fresh foliage present in the samples. Express the density of *C. fumiferana* in terms of mean kg fresh weight. If of interest, measure branch sample surface area so foliage density, an index of tree health, can be expressed as kg/m^2. Use the method of Miller et al. (1971) to extract small overwintering larvae from the foliage using a caustic solution of sodium hydroxide (NaOH).

Corrections for changes in horizontal distribution along mid-branch samples and examination error by personnel processing the branch samples can be made simultaneously for each host species. Use the following equations to estimate *C. fumiferana* density on whole branches (d) from the density of *C. fumiferana* per kg fresh foliage weight estimated from 45-cm branch tip samples (d_1):

$$d = d_1 (u + [(1 - u)/-5.31 + 4.14a - 0.45 a^2])(1 - \exp[1.94 - 1.14a])^{-1} \text{ and}$$

$$d = d_1 (u + [(1 - u)/-1.80 + 1.88a - 0.21 a^2])(1 - \exp[1.94 - 1.14a])^{-1}$$

for balsam fir and white spruce, respectively. In both equations, a = the average instar of *C. fumiferana* present. The variable u represents the proportion of foliage by weight present in the 45-cm branch tip samples taken from the mid-crown. Use the approximate values of $u = 0.47$ and $u = 0.30$ for balsam fir and white spruce, respectively. However, u varies for both host species among stands, so consider estimating u in each sampled stand of balsam fir and white spruce for the most accurate value.

If sampling egg masses or overwintering larvae, use the average value of $a = 2$ and set the examination error term of $[1- \exp(1.94 - 1.14a)]^{-1}$ to 1 as the authors did not determine the examination error for these life stages.

When branch samples are examined for accuracy by a second experienced observer, the correction factor for the examination term, which is $[1- \exp(1.94 - 1.14a)]^{-1}$, can be eliminated from the equations.

Notes: The simultaneous correction factor should not exceed 1.5 as values larger than this were not examined in this study.

Reference:

Miller, C. A.; Kettela, E. G.; McDougall, G. A. 1972. A sampling technique for overwintering spruce budworm and its applicability to population surveys. Inf. Rep. M-X-25. Fredericton, N.B.: Canadian Forest Service; 11 p.