

White Grubs

Phyllophaga spp.

Coleoptera: Scarabaeidae

Fowler, R. F.; Wilson, L. F. 1971. White grub populations, *Phyllophaga* spp., in relation to damaged red pine seedlings in Michigan and Wisconsin plantations (Coleoptera: Scarabaeidae). Michigan Entomologist 4: 23-28.

Objective: To predict seedling mortality of red pine, *Pinus resinosa* Soland., based on larval density of white grubs, predominantly comprised of *Phyllophaga* spp.

Abstract: White grubs (*Phyllophaga* spp.) are a widespread pest of the roots of many species of vascular plants. Larvae chew and girdle roots, impairing growth rates and easily killing young plants.

White grub populations were studied in red pine, *Pinus resinosa* Soland., plantations in national forests in the Great Lakes region. Root damage was assessed on seedlings and related to larval density using linear regression. Damage levels were positively related to larval density, particularly when separated by instar ($r^2 = 0.78$). This relationship is expressed in the following formula:

$$y = 0.94 + 2.30(1 - e^{-0.03x})$$

where x = the feeding index and y = the damage index (modified from Johnston & Eaton 1939). The feeding index (FI) used in the above equation is $FI = [N_1 + 2N_2 + 4N_3 + 8N_4]/n$ where N_1, N_2 , etc. represent the number of larvae in instar 1, 2, 3, or 4, and n = the mean number of larvae sampled at the study site. The FI assumes that each instar eats twice as much as the previous instar. The damage index is defined as:

Damage Score	Extent of injury to roots
1	No grub injury
2	≤33% of fibrous roots damaged
3	34-66% of fibrous roots damaged
4	67-99% of fibrous roots damaged; some seedlings stripped of fibrous roots but some regrown root tips
5	100% of fibrous roots destroyed or tap root severed above the fibrous roots

The percentage of red pine seedlings damaged at the study site can also be predicted from the feeding index using the equation $y = 5.34 + 65.41(1 - e^{-0.04x})$, where x = the feeding index and y = the percentage of seedlings damaged. Finally, the damage

index was positively related ($r^2 = 0.89$) to the percentage of damaged red pine seedlings and can be predicted using the equation $y = 1.08 + 0.03x$, where y = the damage index and x = the percentage of seedlings with damaged roots. This formula provides a reasonable damage estimate for *Phyllophaga* spp. larvae when >10% but <90% of the seedlings are damaged, without the need to actually score root damage on dug seedlings.

A threshold of 0.5 larvae per 0.09 m² or 0.03 m³ soil has been suggested as a damage threshold for *Phyllophaga* spp. larvae, but the authors suggest this should be lowered. Based on their study, a density of 0.5 larvae per 0.03 m³ would result in 16-34% seedling mortality in the subsequent growing season, including approximately 4% loss due to other mortality factors. A threshold of ≥ 0.25 larvae per 0.09 m² is suggested if seedling mortality should be $\leq 20\%$.

Sampling Procedure: Ideally damage estimates should be made before seedlings are planted or soon afterwards. Establish 4-5 parallel transects across the plantation. In the summer, sample larval densities by digging a 0.03 m³ soil sample enclosed by a 30.5 x 30.5 cm metal quadrant. Take 4-6 soil samples evenly spaced along each transect. Sift each soil sample through a 0.64 cm mesh screen. Identify larvae to *Phyllophaga* spp. larvae and tally the number of each instar present. Calculate the mean density of larvae per 0.03 m³ soil.

Calculate the Feeding Index (FI) using the equation $FI = [N_1 + 2N_2 + 4N_3 + 8N_4]/n$ where N_1, N_2 , etc. represent the number of larvae in instar 1, 2, 3, or 4, and n = the mean number of larvae sampled at the study site. Predict the percentage of damaged red pine seedlings using the equation $y = 5.34 + 65.41(1 - e^{-0.04x})$, where x = the feeding index and y = the percentage of seedlings damaged. Predict the extent of larval damage using the equation $y = 0.96 + 2.07(1 - e^{-2.92x})$, where x = the damage index and y = the mean density of *Phyllophaga* spp. larvae per 0.03 m³ soil. Consult Table 1 to relate the calculated damage index to the predicted extent of injury to seedling roots.

If seedlings are dug and examined for feeding injury, the damage index can be predicted using the equation $y = 1.08 + 0.03x$, where y = the damage index and x = the percentage of seedlings with damaged roots. Sample 20-90 seedlings near each location where the soil was sampled for *Phyllophaga* spp. larvae.

Reference:

Johnston, H. R.; Eaton, C. B. 1939. White grubs in forest nurseries of the Carolinas. Rep. E-486. U.S. Department of Agriculture, Bureau of Entomology and Plant Quarantine; 9 p.