Forest Insect & Disease Leaflet 21

U.S. Department of Agriculture Forest Service

White Pine Weevil

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The white pine weevil (figure 1) - *Pissodes strobi* (Peck) (Coleoptera: Curculionidae) - is a native insect attacking eastern white pine (*Pinus strobus* L.). The latest cytogenetic and breeding studies indicate that two other North American pine weevil species - the Sitka spruce weevil and the Engelmann spruce weevil-also should be classified as *Pissodes strobi*. The present distribution of *P. strobi* is thus transcontinental, coinciding with the natural distribution of eastern white pine, Sitka spruce, and Engelmann spruce. This leaflet discusses the biology, ecology, and management of *P. strobi* attacking eastern white pine only. However, some of the management issues also may address problems associated with attacks on other tree species.

Figure 1 - *Adult white pine weevil.*

In the eastern United States, the white pine weevil may attack at least 20 different tree species, including ornamentals. However, eastern white pine is the most suitable host for brood development. The tree species attacked can be grouped as follows:

Severely attacked

eastern white pine, *Pinus strobus* L.
jack pine, *Pinus banksiana* Lamb.
Norway spruce, *Picea abies* (L.)

Commonly attacked

foxtail pine, *Pinus balfouriana* Grev. & Balf.
Japanese pine, *Pinus densiflora* Sieb. and Zucc.
limber pine, *Pinus flexilis* James
western white pine, *Pinus monticola* Dougl. ex D. Don
Scots pine, *Pinus sylvestris* L.

Occasionally attacked

mugho pine, *Pinus mugo* Turra
Jeffrey pine, *Pinus jeffreyi* Grev. & Balf.
blue spruce, *Picea pungens* Engelm.
Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco
red spruce, *Picea rubens* Sarg.
white spruce, *Picea glauca* Voss

Rarely attacked

Austrian pine, *Pinus nigra* Arnold
table mountain pine, *Pinus pugens* Lamb.
red pine, *Pinus resinosa* Ait.
pitch pine, *Pinus rigida* Mill. Himalayan blue pine, *Pinus wallichiana* A.B.
Jacks black spruce, *Picea mariana* (Mill.)

Life History and Developmental Stages

Pissodes strobi has one generation each year. The adults hibernate in the duff underneath host trees. In early spring the adults emerge and crawl up the trunks of host trees. They are strong fliers and are known to fly on warm, sunny days at canopy level. After reaching the terminal shoot of the host, males and females begin feeding just below the terminal bud cluster. Although most females mate in the fall and retain viable sperm through the winter, remating continues throughout the spring feeding and egg-laying period.

Eggs are laid in small urn-shaped feeding cavities made in the bark by the female. Egg cavities can be distinguished from feeding holes by the dark brown excrement cap the female deposits to seal off and protect the eggs. Egg laying begins just below the terminal bud cluster and can extend down the upper half of the terminal shoot. Eggs may be laid singly or in clusters of two or more eggs per cavity. On average, each female may lay 100 eggs, although as many as 200 have been reported. Often, two or three mating pairs may occupy a leader. When this occurs, many eggs are laid. While most of these eggs hatch, survival to adult generally is determined by larval competition for food. When only a few eggs are laid, the larvae usually are drowned in pitch. When this occurs, the terminal shoot may be deformed but not killed.

The egg, 10 mm (.04-inch) in length, hatches in 6 to 14 days, depending on weather conditions. As eggs hatch, groups of larvae form a "feeding ring," burrowing down the leader first in the inner bark and then between the wood and the bark. As more eggs hatch, less food is available, so that larvae from eggs laid late and well below the terminal bud cluster may not survive. During the following 5 to 6 weeks, the larvae molt four times. The larvae are white, legless, grublike, and 9 to 10 mm (.36 to .4 inch) long when fully grown. At the end of their feeding period, the larvae construct pupal cells in the pith and wood of the stem (figure 2). Pupal cells are characterized by the small strands of wood lining, creating a chip cocoon. There they remain inactive for 5 to 6 weeks, first as pupae and later as callow adults.

Figure 2 - *White pine weevil larva in chip cocoon.*

Beginning in late July and during August and early September, increasing numbers of adults chew small round emergence holes through the chip cocoon and bark (figure 3). The adults (figure 1) are brown, 6 to 7 mm (.24 to .28 inch) long, and covered with white and tan scales, arranged in large and small spots. A number of other similarly marked *Pissodes* species may be confused with *P. strobi*. In the Northeast, the deodar weevil, *P. nemorensis* Germar (= *P. approximatus*) may be mistaken for *P. strobi*, especially in the fall when both may feed together on the lateral branches. In the fall, the young adults feed on buds and bark tissue of the stem and branches. Although mating often occurs, egg production is inhibited by a reproductive diapause (rest period). As average daily temperatures continue to decline, adults seek shelter in the litter beneath the host trees. They may continue to feed at the base of the tree during the day, but eventually hibernate. Most overwinter within 20 cm (8 inches) of the boles of the host trees. Generally, adult white pine weevils live only 1 year, although some have been reported to live 2 or 3 years. Details of the life cycle of *P. strobi* (figure 4) have been studied by many researchers.

Figure 3 - *Adult white pine weevil recently emerged from chip cocoon.*

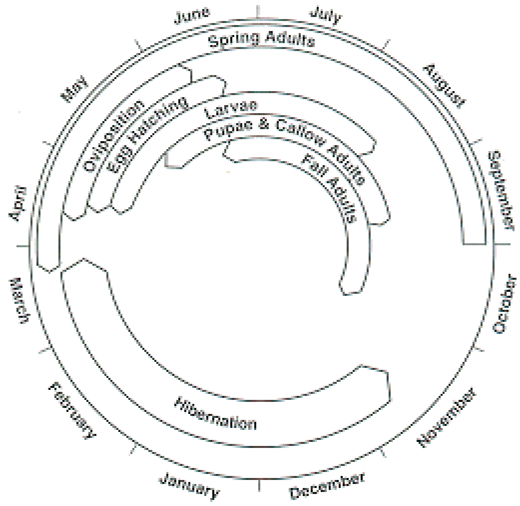

Figure 4 - *Life cycle of the white pine weevil in the eastern United States.*

Evidence of Infestation

The first evidence of attack in spring is the tiny glistening droplets of resin exuding from the feeding punctures made by the adults on the previous year's growth, just below the terminal buds. Two to three weeks later, eggs are laid in new punctures that do not produce resin droplets. Feeding by larvae effectively girdles the stem, causing the new shoot to wilt and the needles to turn reddish brown (figure 5). The wilting is noticeable in June in the southern part of the range and progressively later in the North and West. By the end of the season, larval feeding may extend below one or more whorls of branches. In such cases, all whorls above the larval feeding collar die. A successful attack always kills the previous year's growth (figure 6), although 3 or even 4 years' growth often is affected. Circular holes, 2 to 3 mm (.10 to .12 inch) in diameter, on an infested stem indicate that adults have emerged.

Figure 5 - *Early evidence of attack by white pine weevil. Symptoms include crystallization (white) of pitch from feeding, reduced growth and wilting of new shoots, and browning of needles.*

Figure 6 - *White pine showing death of leader and top lateral growth from weevil attack.*

Damage Caused

Weevil attacks cause four types of damage to occur: growth reduction, stem deformation, increased susceptibility to wood decay organisms, and tree mortality. Tree mortality is rare and only occurs in small trees (less than 1.3 m or 4 ft tall) growing very vigorously in full sunlight.

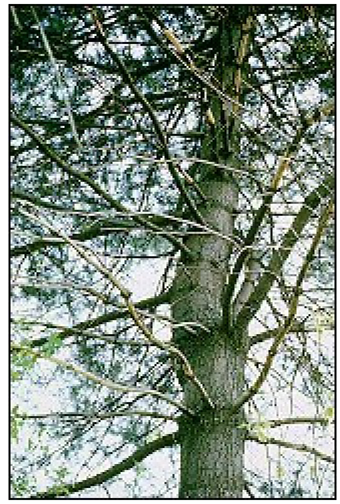

Figure 8 - *White pine deformed by the white pine weevil. The remaining dead leader provides a pathway for disease organisms.*

Each weevil attack reduces tree height growth by 40 to 60% in that year. Stem deformation is common because one or more laterals takes over terminal dominance of the attacked tree. If two or more laterals take over, a forked and often very bushy tree results (figure 7). If only one lateral gains dominance, the stem often maintains a crook for many years. Stem deformities may result in wood defects such as compression wood and bark-encased knots that reduce the value of sawn lumber. This reduction in wood quality is considered the major impact of white pine weevil. Finally, part of the dead leader usually persists for many years (figure 8) and may act as a point of entry for heart rot organisms such as *Phellinus pini* Ames, the major heart rot disease of older eastern white pines.

Figure 7 - *A "bushy" open-grown white pine, showing the effect of numerous attacks by the white pine weevil.*

Natural Mortality Factors

Mortality factors affecting larvae, pupae, and overwintering adults appear to have the most influence on white pine weevil populations. These include competition of larvae for food, natural enemies, drowning of larvae in pitch, and environmental factors acting against overwintering adults.

Natural enemies include a dipteran predator, *Lonchaea corticis* (Taylor), and two hymenopteran parasites, *Eurytoma pissodis* Gir., and *Dolichotomitus terabrans nubilipennis* (Viereck). Birds, such as the white-breasted nuthatch, downy woodpecker, chickadees, grosbeaks, and warblers, also may feed on larvae and pupae; however, the importance of these has not been determined. Small rodents such as voles, field mice, and shrews also destroy adults hibernating in the litter.

Weevil-Tree Interactions

The white pine weevil prefers vigorous leaders, 4 to 9 mm (.16 to .36 inch) in diameter. They also appear to prefer thicker bark, which increases the survival of immature stages. Weevils utilize a range of bark thickness from 1 to 3 mm (0.3 to .10 inch), but prefer the 1.5- to 2.5-mm (.06- to .09-inch) range. Other characteristics of white pine provide some resistance to attack. Planting trees grown from various geographic seed sources indicates that variation in susceptibility to weevil attacks could be used to reduce the probability of planting highly susceptible trees. The presence or absence of certain chemicals such as monoterpenes may determine the success of attack by weevils. Trees with both high concentrations of the monoterpene alpha-pinene and low concentrations of limonene were much less likely to be heavily weeviled than other trees. Laboratory experiments indicate that the water content of the terminal shoot affects the number of eggs laid, with relatively low water content significantly reducing the number of eggs laid. Field observations suggest that rainfall, soils, and other factors that affect stem water content during the egg-laying period may affect the extent of weeviling and whether or not the leader is killed.

Silvicultural Practices To Reduce Weevil Damage

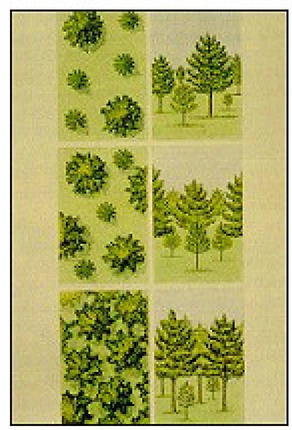

Figure 9 - *Crown closure: A, 25%; B, 50%; and C, 75%. Young white pine should be grown under an overstory of approximately 40 to 50% crown closure. This will provide enough shade to discourage weevils but allow in enough light for adequate growth. Most unmanaged natural stands have 70 to 80% crown closure.*

The weevils prefer open-growing trees and fully sunlit terminals with diameters of 5 mm (.2 in) or more. Growing pine under a hardwood overstory reduces weevil attack by slowing the growth of the leader, and by reducing sunlight and temperature below that preferred by female weevils. The hardwood canopy also affects the dispersal of the adults in fall by intercepting most of the ultraviolet light that strongly stimulates the weevils. Under such conditions, fewer pines are attacked, the number of eggs laid is small, and larval survival is considerably reduced. However, heavy shade can be detrimental to the growth of white pines. Thus, there must be a balance between sufficient shade to reduce weevil injury and enough light to maintain adequate tree growth. As a goal, approximately 40 to 50% crown closure of the overstory trees should be maintained (figure 9). Most unmanaged stands have a natural crown closure of 70 to 80%.

A second important silvicultural practice is to maintain high densities of young white pine until the trees reach about 6 m (20 ft) in height. This is especially important in open-grown plantations or stands. It is possible to culture young white pine in an open-grown situation if the density of the regeneration is kept high. A minimum of 800 trees per .4 ha (1 acre), that is, 2- by 2.4-m (7- by 8-foot) spacing, should be grown, although 1,200 per acre, or 1.8- by 1.8-m (6- by 6-foot) spacing, would be preferable. Not all trees need to be white pine. Density creates competition, which forces rapid height growth with minimal terminal diameter growth. Competition also forces laterals on weevil-attacked trees to "straighten" quickly. In addition, it causes natural lower branch mortality, which augments pruning for control of white pine blister rust. This practice may require pre-commercial thinning of plantations when trees reach 6.1 to 7.6 m (20 to 25 ft) in height.

Silvicultural techniques that reduce stem (leader) moisture content during the weevil's egg laying period (see figure 5) also are likely to reduce the incidence of weeviling. Growing pine under a hardwood canopy, dense stocking in open-grown stands, and planting on well-drained soils are management strategies that could reduce stem water content at the time of day and year weevils are laying eggs. The practical problems of using these techniques need further evaluation.

Mechanical Control

In ornamental plantations of small trees and in stands of saplings, pruning the infested terminals and branches before adults emerge can reduce the weevil population. Subsequent or simultaneous pruning of laterals and forks can aid the trees in forming a nearly straight main stem. Pruning should be done as close to the topmost unaffected whorl of branches as possible and should be done as soon as possible after the first indication of weevil attack. Usually this means the first sign of wilting. This will prevent the loss of more than one season of growth and reduce the overwintering weevil population. Infested terminals should be destroyed or removed from the site.

Banding of trees and bases of leaders with sticky substances may retard dispersal of adults and reduce attack on selected trees. Sticky substances should be applied on tape or other material, not directly on the bark. However, because adults can fly to leaders, banding by itself may not prevent weeviling.

Chemical Control

Chemical control should be considered when 2 to 5% of the trees are weeviled in a single season. Before making the decision to reduce the weevil population, a biological and economic evaluation is highly desirable. Information such as stand stocking, non-weeviled tree height, growth rate, and stand location relative to sensitive habitats should be used in the process of decision making. The interval between treatments depends on the level of infestation. In low or moderate weevil hazard areas, a second treatment will usually not be needed for 4 to 6 years. In high weevil hazard areas, the interval between treatments may need to be shorter. Timing of the application and optimal coverage of the terminal buds and leaders with insecticide are critical to the success of a chemical control program.

Chemical insecticides are effective only against adult weevils, because all the immature stages are spent inside the leader. Because of the short residue properties of most insecticides, it is important that applications be well synchronized with periods of peak adult activity. Chemical control measures can be undertaken either in spring (when the adults emerge from hibernation and start feeding and oviposition) or in fall (after the new adults emerge). Applications in spring can be concentrated to cover the leader and upper branches. Weevils are especially susceptible to control measures during fall when they are feeding on new growth in the upper crown. Using backpack mist-blowers or other ground equipment has been more successful than aerial application. Chemical application in conjunction with pruning of infested leaders gives the best results.

Pesticide Precautions

Most insecticides are listed for restricted use, and must be applied by or under the direct supervision of a licensed applicator. Pesticides improperly used can be injurious to humans, animals, and plants. Directions for use on the container label should be carefully read, fully understood, and strictly followed to avoid unintentional misuse. Avoid prolonged inhalation of insecticide concentrate fumes or spray drift. Wear protective clothing and equipment as specified on the label.

Because use of pesticides is regulated by the Federal Government and by each respective State, before purchasing a pesticide check with local authorities, county agents, a University Cooperative Extension Service, or an Agricultural Experiment Station for current local use status.

Ecosystem Management Implications

Eastern white pine occurs on a very wide range of sites and was historically a component of most forest cover types within its botanical range. Across this range it has played many ecological roles, occurring in relatively pure stands or in mixture with other pines or hardwoods. Not only is it a very valuable timber species, but it has high wildlife and esthetic values. Unfortunately, over most of its range it has never regained its previous dominant status following the extensive logging of the original "pinery."

White pine weevil is not a tree killer and, therefore, does not play an obvious role in the abundance or survival of white pine. Nevertheless, it has had an important influence on how slowly white pine has regained a significant role in many forest stands. In many areas, regeneration following logging was open-grown, and young stands often were poorly stocked, creating ideal conditions for weevil survival. Trees were attacked numerous times, slowing growth and creating trees of very poor wood quality. This, along with the introduction of white pine blister rust, *Cronartium ribicola* Fisch, in the early 1900's, gave eastern white pine a reputation as a difficult species to culture in forest stands. Management of the species, therefore, was reduced and the amount of white pine regenerated by forestry activities was limited.

White pine weevil should not be viewed as an impediment to growing eastern white pine. Management guidelines exist that can limit the impact of weevil damage. Even trees being grown for nontimber uses, such as future super-canopy trees, could benefit from management practices that reduce weevil attacks and thereby increase overall height growth.

Acknowledgments

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Pesticides used improperly can be injurious to humans, animals, and plants. Follow directions and read all precautions on the labels. Consult your local forest pathologist, county agricultural agent, or State extension agent about restrictions and registered uses of particular pesticides.

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