



CANADIAN FOREST SERVICE

Insect Production Services

Western Spruce Budworm

(*Choristoneura occidentalis*)

Biology

Introduction

The western spruce budworm (*Choristoneura occidentalis*) is a major defoliator of coniferous forests across western North America. Although western spruce budworm prefer Douglas-fir, they also readily attack white fir, blue spruce, Engelmann spruce, western larch and western hemlock. Trees become weakened after four to five years of successive defoliation and may attract other insects and disease. Tree mortality occurs if trees undergo severe defoliation for six to eight years. The first recorded outbreak in Canada occurred on Vancouver Island, British Columbia, in 1909. Epidemics of this species do not occur on a cyclic basis. Some outbreaks last only a few years and end naturally, while others have persisted in the Rocky Mountains for up to 30 years in spite of all control tactics.

Life Cycle

Western spruce budworm produce one generation a year (univoltine) and have four stages in their life cycle: egg, larva, pupa and moth. In July and early August, females lay overlapping eggs in elongate rows on fir and spruce needles. These rows are two to three eggs wide and can contain up to 150 eggs per mass. The eggs are light green, oval and about 1 mm long by 0.2 mm wide. They hatch 7 to 14 days after oviposition. There are six larval stages (instars) before pupation. First-instar larvae are very small and light green in colour. Often, the larvae will spin a thread of silk and get carried to other trees by the wind. This process of dispersal is termed "ballooning." These larvae do not feed; instead, they immediately seek suitable shelter in which to overwinter, such as old flower bracts and cracks in bark. The tiny first-instar larvae spin silk shelters to wrap themselves in. Within this shelter, called a hibernacula, the larvae shed their skins and moult into yellow-orange-coloured second instars. They remain dormant in this overwintering stage, called diapause, until spring. In early May to June, before tree buds begin to expand, the second-instar larvae emerge from their hibernacula and move toward the tips of the tree branches. Early feeding occurs on staminate flower buds or old needles. Larvae will mine old needles until vegetative buds begin to expand. Once these buds swell, the larvae bore into them and begin feeding within the protection of the bud cap. Here, they moult into the third instar and continue to feed until the buds expand. Fourth and fifth instars create feeding shelters and stay hidden by tying newly flushed needles together with silk until they have consumed the entire bud. Second-



Care Instructions

Western spruce budworm is shipped as diapausing second-instar larvae in a parafilm-gauze sheet. Artificial diet is not normally included. Unless you have requested otherwise, these insects will have fulfilled their diapause requirement and are ready for use. We recommend that you rear these insects immediately upon receipt, although they may be stored at 2–4°C for up to 1 month and still provide adequate results.

1. Cut the parafilm-gauze sheet into patches containing the number of larvae suitable for the size of rearing container that you will use (e.g., 30–40 larvae when using our ¾ oz. [22 ml] cups of prepared artificial diet). Where possible, cut along the pressed lines on the parafilm to minimize larval injury or mortality. Place the patches on artificial diet for emergence, ensuring that the gauze side is closest to the food source. Turn the rearing containers upside down so that the diet is at the top, because the tiny larvae move up towards the light and will be able to find the food. Maintain the larvae at 23°C, 60% relative humidity and a 16h:8h light:dark cycle.
2. When the artificial diet becomes dry or discoloured (after 10–12 days), transfer the larvae to fresh diet and remove the parafilm-gauze patch. Reduce the larval rearing density to 6 per cup when using ¾ oz. (22 ml) cups of artificial diet.
3. Natural foliage may also be used for feeding, although this is not recommended because natural foliage is a potential source of microbial pathogens that may infect the insects. Washing the foliage will reduce this risk. Fill large containers with branches (e.g., fir, hemlock, larch or spruce) containing numerous buds that have just begun to flush with new year's growth. Clean or change rearing containers regularly to avoid frass build-up and add fresh foliage when required. As larvae become larger, fully expanded new year's buds may be used and the rearing density must be reduced, as the larvae become cannibalistic.
4. Larvae will start to pupate approximately 3 weeks after the initiation of the rearing process. Pupae should be removed from rearing containers to avoid predation and to provide adequate space for adult eclosion.
5. Adults will emerge 6–8 days after pupation and require only a daily misting of water for survival.

third- and fourth-instar larvae are orange to cinnamon-brown in colour with black heads and black thoracic shields. Fifth-instar larvae are olive-brown in colour with two pairs of white spots on each body segment. They begin to have reddish-brown heads but their thoracic shields remain black. Sixth-instar larvae have both red heads and red thoracic shields. They are 25 to 32 mm in length and their white spots are much more distinctive. Once a bud is ingested, older instars will move to new shoots and then to other trees in search of food. It is at this stage that they are eating voraciously and are the most destructive. By late June and July, larvae cease feeding and metamorphose into pupae, usually within old-year foliage. Around 10 days later, from late June to mid-July, adult moths emerge. They are small, with characteristic "bell-shaped" wings that are reddish-brown to grey in colour, with banded forewings and a white dot on each wing margin. Moths will mate and deposit their eggs, preferably on a healthy tree. They are able to travel very long distances, especially if they are transported by wind or storms.

Damage and Nuisance

The first sign of an infestation is silk webbing on branch tips. Also, bud caps will remain on infested shoots long after all others have been shed. In addition to foliage, larvae feed heavily on staminate flowers and developing cones. When an epidemic begins, most defoliation occurs in the top portion of the forest crown. Infested stands turn a reddish colour because partially eaten needles on the tree start to die. Over time, these dead needles fall, tree-tops turn grey and, when heavy defoliation persists over four or five successive years, entire stands are eventually decimated. Defoliation weakens trees and makes them more susceptible to other types of insect damage, diseases and harsh conditions such as drought. Commercially, spruce budworm outbreaks have the potential to seriously affect timber and non-timber boreal forest resources, reducing annual growth and timber volumes. Young trees in the understorey often die after only three years of defoliation, greatly reducing future timber prospects and natural regeneration. In urban areas, large populations of western spruce budworm can greatly reduce the aesthetic value of homes and recreational areas because they also attack ornamental firs and spruces.

Natural Control

Natural factors such as disease, predators, parasites and adverse weather all play very important roles in controlling budworm.

Natural predators include spiders, beetle larvae, snakeflies and more than 40 species of insect parasites. Many bird species also feed on budworm, including warblers, thrushes, sparrows, waxwings and flycatchers. Less than half of the larvae survive to adulthood; however, this amount can still lead to epidemics. Forest land owners have the option of integrating control tactics, such as biological insecticides, silvicultural practices and chemicals. At the present time, at least four natural viruses are endemic to North America, including the granulosis, entomopox, nucleopolyhedrosis and cytoplasmic polyhedrosis viruses. Use of these viruses as biological insecticides is considerably more expensive than chemicals and not always effective. However, the bacterial pathogen *Bacillus thuringiensis* (Bt) is more cost-effective and the most common biological insecticide used on Crown land for budworm control today. Unfortunately, Bt degrades in sunlight and washes away in rain easily, so it offers a very narrow window for control. Climate conditions also greatly affect western spruce budworm survival. Cool summers reduce feeding and development, making larvae more vulnerable to parasites, predation and disease. Late freezing conditions in the spring will kill developing larvae and early freezes in the fall damage eggs before they have hatched.

What Can I Do?

For private landowners, controlling budworm may prove difficult. The greatest problem is getting to the larvae because they stay hidden so well within needles, buds and feeding shelters. If there are small trees, few in number, manual removal is a possibility. If spraying is necessary, Bt is available at most gardening centres and is much safer to use than chemicals. Spraying chemical insecticides might also greatly affect natural budworm predators and non-target species, so read the label carefully before using these products and follow instructions strictly.

Contact

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