



CANADIAN FOREST SERVICE

Insect Production Services

Spruce Budworm

(*Choristoneura fumiferana*)

Biology

Introduction

The spruce budworm (*Choristoneura fumiferana*) is a major defoliator of coniferous forests across North America. Although spruce budworm prefer balsam fir, they also readily attack white, red and black spruce and may even be found feeding on tamarack and 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. In Canada, recorded outbreaks of spruce budworm date back as far as 1704. These outbreaks occur on average every 20–30 years and can remain within an area for 10 years. The last major epidemic in Canada occurred from the 1970s to the mid-1980s.

Life Cycle

Spruce budworm produce one generation a year (univoltine) and have four stages in their life cycle: egg, larva, pupa and moth. In July to 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, 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 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-coloured second instars. During this overwintering stage, called diapause, they remain dormant until spring. In late April and early May, before tree buds begin to expand, the second instars 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. From the second to the fifth instar, larvae remain similar



Care instructions—Spruce budworm (diapause)

The diapause strain of spruce budworm is shipped as diapausing second-instar larvae in parafilm-gauze sheets. Artificial diet is not normally included. Unless you have requested otherwise, these insects will have fulfilled their diapause requirement and are ready for use. Insect Production Services 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 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. Invert the rearing containers 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. 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., balsam fir or any type of 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.
3. Transfer the larvae to fresh diet when it becomes dry or discoloured (i.e., after about 10–12 days) and remove the parafilm-gauze patch at this time. Reduce the larval rearing density to 6 per cup when using ¾ oz. (22 ml) cups of artificial diet.
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.

in appearance, changing from a grey to yellow colour with each moult. When they moult into their sixth instar, they are brown-black with a cream-coloured longitudinal stripe down each side and distinctive white spots on each body segment. 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 the most destructive. By mid- to late June, larvae cease feeding and metamorphose into pupae, usually within old foliage. Male pupae have four rings around the abdomen, whereas females have three rings. Around 10 days later, from late June through to mid-July, adult moths emerge. They are small, with characteristic “bell-shaped” wings, and are reddish-brown to grey in colour. 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 the occurrence of silk webbing on branch tips. Also, bud caps will remain on infested shoots long after all others have been shed. 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, treetops 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. In urban areas, large populations of 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. 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 is 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.

What Can I Do?

For private landowners, controlling budworm may prove difficult. The greatest problem is getting to the larvae because they are still 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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