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TECHNICAL NOTE

Forest Pest Management Institute

No. 2 Biological Control Methods

LECONTVIRUS: A VIRAL INSECTICIDE FOR CONTROL OF REDHEADED PINE SAWFLY, *NEODIPRION LECONTEI*

Introduction

The redheaded pine sawfly, *Neodiprion lecontei*, (Fig. 1), can be a serious insect pest of young hard pine plantations. Red pine is the preferred host in Ontario and Quebec, but jack, Scots and other pines can also be attacked. Complete defoliation frequently kills small trees and less extensive feeding results in reduced growth, branch mortality and tree deformity.

Fig. 1. A colony of healthy redheaded pine sawfly.

This sawfly feeds in colonies of about 20 to 150 larvae. It is seldom distributed evenly throughout a plantation and, in Canada, it shows site preferences for open-growing trees, trees on knolls and trees along the edges of plantations bordered by hardwoods. These areas of high population density are called "hot spots" (Fig. 2). Cocoons overwinter in the litter layer of the soil, adults emerge in June and July and eggs are laid in previous year's needles. Colonies of larvae are found from July to September. They prefer to eat old foliage, but in heavy infestations all the needles are consumed.

Fig. 2. A "hot spot" where the sawfly population density has been high for several years.

Until recently, the only method of controlling this pest was the use of chemical insecticides and results were inconsistent. Often some colonies were missed, the infestation persisted and retreatment was required the following year. Lecontvirus is a highly effective biological insecticide for control of

redheaded pine sawfly that has several advantages over chemical insecticides.

What Is Lecontvirus?

Lecontvirus is a biological insecticide, the active ingredient of which is a naturally occurring nuclear polyhedrosis virus (NPV) specific for the redheaded pine sawfly. Lecontvirus is prepared from virus-infected redheaded pine sawfly larvae that are freeze-dried and ground to a fine powder. This powder, which can be stored dry for several years, contains about 0.05% NPV in the form of polyhedral inclusion bodies (PIBs) and the remaining 99.95% is insect debris. To facilitate easy handling and measurement of required dosages, this powder is suspended in an emulsifiable oil prior to distribution to clients. Once suspended in oil, Lecontvirus should be used before the expiry date because the virus loses its activity in oil.

NPVs have been found only in invertebrates and have a very limited host range. Redheaded pine sawfly NPV infects only this species of sawfly and does not even infect other species of sawflies in the same genus. From an environmental standpoint, its use is very attractive because it does not harm beneficial non-target insects such as pollinators, parasites and predators.

Lecontvirus has undergone extensive safety testing in mammals, birds and fish before being registered in Canada and no ill-effects were recorded. However, because the virus contains protein and the insect debris also contains protein, repeated exposure may lead to allergic reactions. Also, the emulsifiable oil carrier is a skin and eye irritant. Hence, the label carries precautionary statements about washing spills from the skin and eyes and wearing a mask or respirator during preparation and application. As with all pesticides, it is essential that applicators read the label carefully before use.

Lecontvirus was registered under the Pest Control Products Act (Canada) in 1983 and it carries a restricted label. Currently, it can only be used by Federal or Provincial forestry personnel. The sole source of supply is the Forest Pest Management Institute. Between 1976 and 1983, Forest Pest Management Institute, Quebec Department of Energy and Resources and Ontario Ministry of Natural Resources staff successfully treated 354 plantations with a combined area in excess of 3,000 ha.

How Lecontvirus Works

Polyhedral inclusion bodies, which contain rod-shaped virus particles (Fig. 3),

Fig. 3. An electron micrograph of a thin section of polyhedral inclusion bodies showing the rod-shaped virus particles. Magnification 64,000X

must be ingested by larvae in order to cause infection. The infection process begins when the insect consumes foliage contaminated with PIBs. The inclusion body protein dissolves in the alkaline gut juices of the larva and the virus particles are released. They penetrate

the midgut cells and a cycle of virus replication commences. During virus replication, masses of PIBs are formed, the gut is destroyed and death results from a combination of starvation and bacterial invasion of the body cavity. The entire process from infection to death in an individual larva takes 10 to 14 days under field conditions when the virus is applied at the right time. Virus-infected living larvae have a whitish appearance because there is no food in their guts and because of the presence of PIBs. Virus-killed larvae typically adhere to the foliage until dislodged (Fig. 4).

Fig. 4. Virus-killed redheaded pine sawfly larvae.

A particularly attractive feature in using Lecontvirus as a control agent compared to chemical insecticides is that the virus not only kills the infected larvae but can also be transmitted both within a colony of larvae and between colonies. When one larva in a colony becomes infected with virus, it excretes some PIBs from both its mouth and anus, recontaminates the foliage and infects the rest of the colony. The virus is also transmitted from diseased to healthy colonies by rain and probably by predacious and scavenging insects such as ants and hoverflies which are often seen walking on redheaded pine sawfly colonies. Infection between colonies takes some time to occur and it may be up to 40 days postspray until colonies that were missed during the application finally succumb to the disease. When treatments with Lecontvirus have been correctly timed, retreatment of a plantation has never been required.

How To Use Lecontvirus

For effective control of redheaded pine sawfly and a high level of foliage protection, the virus must be applied on early larval instars; detection of the infestation at this time is essential. Different larval instars are shown in Fig. 5. It is recommended that the virus be applied on first-, second- or third-instar larvae. Fourth-instar larvae can be recognized by black spots, which do not occur on first-, second- or third-instar larvae. Applications can still be made if a few fourth-instar are present, but if all larvae have black spots either a chemical pesticide should be applied or the virus treatment delayed until next year.

Some practice is required in detecting infestations when larvae are small, but there are a few useful indicators. Obviously, if a plantation was infested the previous year, it should be carefully checked. Adult sawflies can be seen mating and ovipositing in late June and early July and eggs can be seen in rows in the needles (Fig. 6). Search for eggs on severely damaged trees around "hot spots", which seem to be preferred oviposition sites. Newly hatched larvae are difficult to see, but "flagging" (Fig. 7) advertises their presence. Small larvae skeletonize the surface of needles, which then turn brown, curl and droop. Close examination of nearby needles will reveal the presence of a sawfly colony.

The recommended dosage is 5×10^9 PIB/ha on first- and second-instar larvae and 10^{10} PIB/ha on third- and fourth-instar larvae. The appropriate volume of emulsifiable oil concentrate, shaken well, is added to the correct vol-

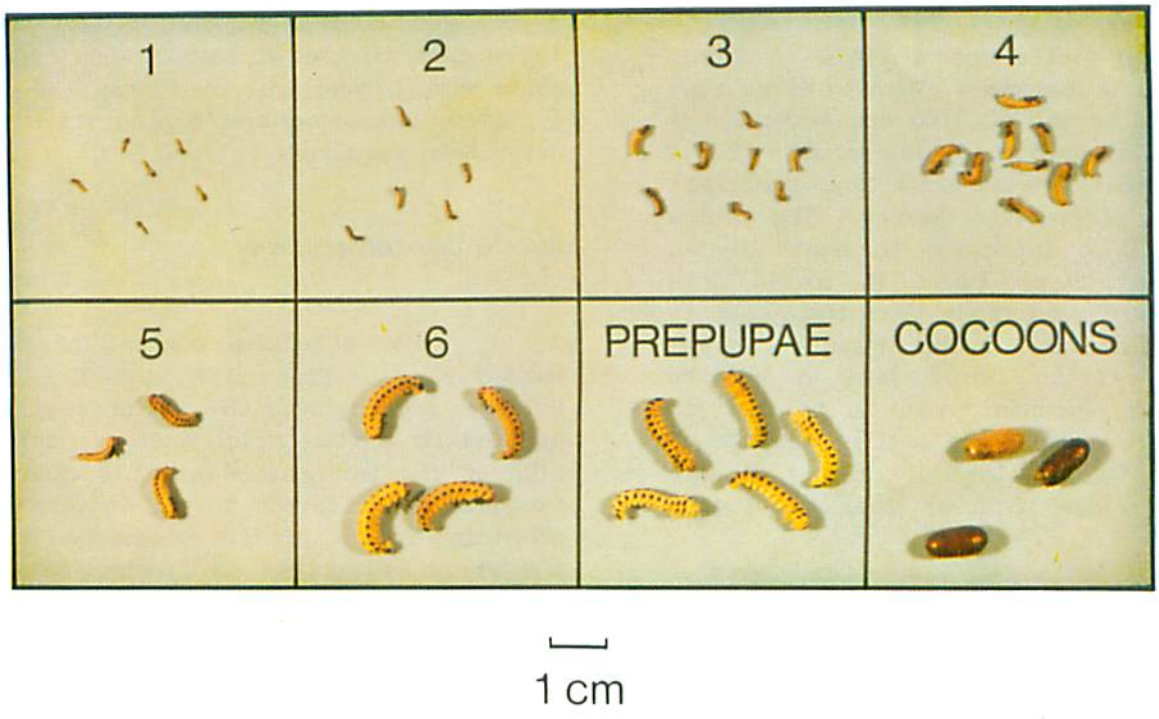

Fig. 5. Different larval instars and cocoons of redheaded pine sawfly: first-, second- and third-instar larvae do not have black spots.

Fig. 6. Redheaded pine sawfly eggs are laid in rows in the needles.

Fig. 7. "Flagging" of needles caused by small larvae feeding.

ume of water. Heavily chlorinated or highly alkaline water should not be used.

Once the decision has been made to use Lecontvirus, the next step is to determine how to apply it. To do this, the situation in individual plantations must be assessed depending on the severity of the infestation, the size of trees and the previous history of damage. Blanket spray coverage is required on small, heavily infested trees, whereas virus introductions or treatment of "hot spots" may be adequate for larger trees with lower populations. Both aerial and ground spray treatments have been used successfully.

When a large number of infested plantations has to be sprayed in a short period of time and at the correct stage of insect development, an aerial application is recommended. However, there may be constraints to aerial treatments if only small areas are involved or if local management policy is to use only ground spray applications. Lecontvirus can be applied with conventional boom and nozzle or Micronair® rotary atomizers on fixed-wing aircraft or Beecomist® spinning nozzles (with drilled sleeves) on helicopters. Aircraft should be calibrated to deliver 9.4 L/ha (1 U.S. gal./acre). Droplet diameters should be in the 100 to 250 micron range. To ensure a good deposit, Lecontvirus should be applied under conditions of high relative humidity and low wind velocity. Such conditions usually prevail in the early morning at daybreak and sometimes in the early evening if it has been a cool, overcast day. Entire plantations are usually sprayed, but if the infestation is light and the area large, the virus can be "seeded" into the sawfly population by spraying widely spaced swaths.

The same dosages are recommended for ground spray application, but in a higher volume, 20 L/ha, than is used for aerial sprays. Almost any spray apparatus that does not heat the tank mix can be used for Lecontvirus. The most commonly used equipment is back pack mistblowers and hydraulic pressure sprayers. Different strategies can be used depending on the severity of the infestation; either the entire plantation or "hot spots" only can be treated. Every third or fourth row in a plantation can be sprayed with a mistblower taking advantage of any wind to carry the spray cloud across rows. Individual colonies can be sprayed with hand-held, pressurized hydraulic sprayers. Here, particular care should be taken to treat colonies at the tops of trees as the virus will eventually spread to colonies located on lower branches.

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