

# PARASITE CONTROL IN ALFALFA LEAFCUTTER BEE POPULATIONS

## Saskatchewan Alfalfa Seed Producers Association

The chalcid parasite, *Pteromalus venustus*, is a continuing problem in alfalfa leafcutter bee populations. *Pteromalus* is a tiny parasitic wasp which paralyzes and then lays eggs on the alfalfa leafcutter bee prepupa, leaving an intact cell containing chalcid parasite prepupae instead of a healthy leafcutter bee prepupa. *Pteromalus* is a cause for concern because it will parasitize as many alfalfa leafcutter bee prepupae as possible in a relatively short time period. Opportunities for controlling *Pteromalus* are limited and the presence of this parasite can be a drawback in marketing of alfalfa leafcutter bee cells. This article contains information on the life-cycle and control of *Pteromalus venustus*.

### CHALCID PARASITE LIFE-CYCLE

*Pteromalus venustus* is an obligate parasite, which means that it is obliged to parasitize other species in order to reproduce. Adult parasites will feed on sugar water in laboratory experiments, so they probably feed upon nectar in the field. The adult parasites do not feed on either bee prepupae or adult bees. Adult female *Pteromalus* search for completed cells containing bee prepupae which have finished feeding and have spun their cocoons. The female parasite pierces the leaf and cocoon layers of the bee cell with her ovipositor, a sting-like apparatus modified for laying eggs, and stings the prepupa, thus paralyzing it. She then lays eggs upon the surface of the paralysed prepupa. The parasite eggs hatch within 24 - 48 hours, and the young parasite larvae begin to feed upon the paralysed bee prepupa, eventually consuming it almost completely.

If some of the parasite larvae are not finished feeding, they may then turn on their siblings and consume them as well. The parasite larvae then either pupate and develop into adults, or enter a diapause stage which requires a cold period, similar to their alfalfa leafcutter bee host. Once temperatures rise sufficiently, development resumes, and the parasites pupate and emerge as adults through a small hole chewed through the alfalfa leafcutting bee cell. In the incubator, chalcid parasites usually emerge from day 8 through 13 of incubation at 30°C, although they may emerge earlier.

### POTENTIAL FOR PARASITE BUILD-UP

The male to female sex ratio for *Pteromalus venustus* is reported in the literature to be anywhere from 1:1 to 1:3. Time to development per generation depends on temperature - at an incubation temperature of 30°C, *Pteromalus* can develop from egg to adult in 12 days. Thus, a second generation can complete its development and emerge in the trays during the incubation period.

Chalcid parasite mating occurs either within the host cell prior to emergence or within minutes of emergence from the host cell, and adult female parasites can begin to lay eggs within four hours of emergence. Each female lays from 7 to 26 eggs on every parasitized alfalfa leafcutter bee prepupa.

The usual number of parasite generations which occur during the field season is not known, but is undoubtedly somewhat dependent upon date of bee release, along with temperature and duration of the field season. The unique developmental and reproductive factors involved in the chalcid parasite life-cycle result in the potential for a significant build-up of the parasite population, as noted in the hypothetical situation outlined below.

### **Hypothetical potential for chalcid parasite build-up:**

Assume that a population of alfalfa leafcutter bee cells has a level of 0.1% parasitism, or 1 parasitized cell per 1000 cells. The alfalfa leafcutter bee cells are incubated - each of the parasitized cells produces 20 parasites, which hatch between day 8 and 12, and this population has a 1:1 sex ratio, so 10 are females. Each of the 10 female *Pteromalus* lays 20 eggs in each of three cells, for a total of  $10 \times 3 = 30$  parasitized leafcutter bee pupae. The parasitism level has now risen to 3.0%, or 30 parasitized cells per 1000 cells.

If all 600 parasites in these 30 cells emerge, mate, and are taken to the field, there are now 300 female parasites per 1000 alfalfa leafcutter bees released. Assume that each female, over the course of the summer, parasitizes three cells and lays 20 eggs in each, for a total of  $300 \times 3 = 900$  parasitized cells. If none of these parasite larvae completes its development in the field and emerges from the host cell, there are now 900 parasitized cells; assuming a doubling of the bee population, this would equal 900 parasitized cells in 2000 cells, or 45% parasitism.

Of course this example assumes that parasite survival is 100% and that all re-parasitism attempts are successful, neither of which is true in the real world. However, survival may be enhanced and the number of generations in the field increased in a long hot summer. It is therefore not surprising when *Pteromalus* levels increase - for this reason it is important to have an ongoing parasite control strategy in place which will optimize parasite control during the alfalfa leafcutter bee incubation period, during the field season, and during the fall storage period.

## **PREVENTION AND CONTROL OF CHALCID PARASITISM**

### **Alfalfa leafcutter bee cell sampling**

A major step in controlling chalcid parasites in an alfalfa leafcutter bee population is to thoroughly sample the bee cells prior to spring incubation in order to determine the number of parasitized cells present. If necessary, heavily parasitized bee cell lots may then be incubated separately from parasite-free bee cell lots.

### **Parasite-proof alfalfa leafcutter bee nest material**

An important step in preventing chalcid parasitism in the field is tight nest construction. Nests must be "parasite-proof". The nest backing material should be tightly strapped to the block, with a bonded polyester fill inserted between block and backing. Nest corners can be used to stabilize the tightly-strapped nest block and various types of nest surrounds can also be utilized.

### **Chalcid parasite control measures**

Control measures are generally aimed at the *Pteromalus* adults, because parasite larvae and pupae are difficult to control while they are developing within the cells. Black lights, which emit light in the ultraviolet spectrum, attract adult *Pteromalus*. If the lights are placed over trays of water containing a small amount of surfactant, the parasites tend to be attracted into the water-traps and drown. Black lights and water-traps may be utilized in the incubator throughout the incubation period. The water should be changed periodically in order to keep the water surface free of insects.

It is generally recommended that dichlorvos resin strips be utilized for chalcid parasite control in the incubator at the rate of 0.75 strip / 1000 cubic feet of incubator space, from day 7 to 13 of incubation. Ideally, bee cells should be no deeper than one inch in incubation trays with solid bottoms ( two inches in trays with screened bottoms), so that dichlorvos vapour can penetrate into air space surrounding the bee cells. Incubation trays should be stacked a minimum of four inches apart to allow for adequate air movement. Research has indicated that under certain conditions, a significant increase in dichlorvos-related alfalfa leafcutter bee mortality during incubation may be related to dichlorvos rate, treatment time, number of bee cells treated, bee cell position in the incubator, and humidity in the incubator.

Vapour from dichlorvos resin strips readily adheres to organic surfaces, such as wooden racks, incubator trays, and leaf pieces, so after the strips are removed, the incubator must be opened up and the air circulated for at least 24 hours. Ventilation after using dichlorvos should be active - opening the door and turning on the ceiling fan may not be enough. The air in the incubation trays must be exchanged many times in order to remove all traces of dichlorvos vapour. Adequate ventilation may involve removing incubation racks from the incubator for a 24 - 48 hour period while the air is exhausted, as well as moving air through the racks and over the cells.

Chalcid parasites found on alfalfa leafcutter bee nest blocks during the fall storage period are likely the "second generation" or emergent offspring of the field parasite population. These parasites can represent a threat to the alfalfa leafcutter bee population since they will mate and attempt to parasitize developing bee larvae, causing a decrease in live count and an increase in numbers of parasitized bee cells. Use of water-traps under ultraviolet lights will help to control parasites in the fall. As well, studies on the use of dichlorvos resin strips during the fall storage period have indicated that exposure of nest blocks with backs removed to dichlorvos at a rate of 0.75 strip / 1000 cubic feet for up to seven days will not harm the alfalfa leafcutter bee prepupae within the nest blocks.

**SUMMARY** - The chalcid parasite, *Pteromalus venustus*, can re-parasitize alfalfa leafcutter bee populations during the incubation period and during the field season, causing significant bee losses. Current chalcid parasite control measures include the use of well-built, parasite-proof nest blocks in the field, the use of black lights and water-traps in the incubator, and the use of dichlorvos resin strips at a rate of 0.75 strip / 1000 cubic feet of incubator space during day 7 to 13 of the alfalfa leafcutter bee incubation period. The incubator should be actively ventilated for at least 24 hours following the parasite control period in order eliminate dichlorvos residue which may cause mortality in emerging alfalfa leafcutter bees.