PARASITE CONTROL IN ALFALFA LEAFCUTTER BEE POPULATIONS - 2011

D.W. Goerzen

Saskatchewan Alfalfa Seed Producers Association, 127 E - 116 Research Drive, Saskatoon, SK S7N 3R3

The chalcid parasite, *Pteromalus venustus*, is a persistent problem in alfalfa leafcutter bee populations. This chalcid parasite first paralyzes the alfalfa leafcutter bee prepupa and then lays eggs on the surface of the bee prepupa, leaving an intact cell containing chalcid parasite prepupae instead of a healthy leafcutter bee prepupa. The chalcid parasite is a cause for concern because it has the potential to parasitize a large number of alfalfa leafcutter bee prepupae in a relatively short period of time. Opportunities for controlling chalcid parasites are limited, and the presence of the parasite can be a drawback in the marketing of alfalfa leafcutter bee cells. This article contains information on the biology and control of the chalcid parasite, *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 parasites 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 paralysing it. The female parasite then lays eggs on 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 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^{o}C, although they may emerge earlier.

POTENTIAL FOR PARASITE BUILD-UP

The male : female sex ratio for *Pteromalus venustus* is reported in the literature to be anywhere from 1:1 to 1:3. The time required to development one generation depends on temperature - at 30^{o}C, chalcid parasites can develop from egg to adult stage in 12 days. A second generation of chalcid parasites can thus complete development and emerge during the alfalfa leafcutter bee incubation period. Chalcid parasite mating occurs either within the parasitized cell prior to emergence or within minutes of emergence from the cell. Adult female parasites can begin to lay eggs within four hours of emergence, and will lay from 7 - 26 eggs on every parasitized alfalfa leafcutter bee prepupa.

The usual number of parasite generations occurring during the field season is unknown, but is likely dependent upon the 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 0.1% level of parasitism, or 1 parasitized cell per 1000 bee 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 parasites lays 20 eggs in each of three cells, for a total of 10 x 3 = 30 parasitized leafcutter bee prepupae. The parasitism level has now risen to 3.0%, or 30 parasitized cells per 1000 bee 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 parasite, over the course of the summer, parasitizes three cells and lays 20 eggs in each, for a total of 300 x 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% level of parasitism.

This hypothetical 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 chalcid parasite 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

Sampling of alfalfa leafcutter bee cells

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 lots of bee cells may then be incubated separately fromlots which are parasite-free.

Parasite-proof alfalfa leafcutter bee nest material

An important step in preventing re-parasitism in the field is tight leafcutter bee 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 adult parasites, since parasite larvae and pupae are difficult to control while they are developing within the bee cells. Black lights which emit light in the ultraviolet spectrum attract adult chalcid parasites. If these 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. Ultraviolet lights and water-traps may be utilized in the incubator throughout the incubation period. The water should be changed frequently in order to keep the surface free of insects.

It is 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 increased dichlorvos rate, increased treatment time, number of bee cells treated per unit area, bee cell position in the incubator, and relative humidity in the incubator.

Vapour from dichlorvos resin strips readily adheres to organic surfaces, such as wooden racks, incubator trays, and leaf pieces. For this reason, 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 use of well-built, parasite-proof nest material in the field, use of ultraviolet lights and water-traps in the incubator, and 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.