SASKATCHEWAN ALFALFA SEED PRODUCERS ASSOCIATION

ALFALFA LEAFCUTTING BEE PARASITE CONTROL WITH PYRETHRIN AEROSOLS

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Research undertaken to identify new compounds for control of chalcid parasites has led to the identification of pyrethrin aerosol as a promising parasite control agent. Pyrethrins are a group of natural insecticides extracted from the flowers of a *Chrysanthemum* species. Pyrethrins act by contact, penetrating the insect integument, paralyzing the insect nervous system, and also interfering with oxygen transport within insect cells. Pyrethrin synergists or activators are combined with the pyrethrins to make them more effective insecticidal agents. Pyrethrin aerosol formulations are comprised of pyrethrins and one or more pyrethrin synergists (piperonyl butoxide, n-octyl bicycloheptene dicarboximide).

Pyrethrins are released into the incubator environment as an aerosol carrying small pyrethrin particles. Since the most critical factor associated with use of pyrethrin aerosol for parasite control involves adequate circulation of the pyrethrin particles within the incubator, parasite control research described in this publication was undertaken in prototype leafcutting bee incubators incorporating a specially designed air circulation system which was highly effective in maintaining uniform incubation temperature, delivering pyrethrin aerosol, and dissipating pyrethrin residue.

1998 field-scale parasite control research

Research in 1998 to determine the efficacy of the pyrethrin aerosol (KN-409) for parasite control involved 5 million leafcutting bee cells with a parasite level of 7.0% incubated at 30°C / 50% RH. A total of 10 pyrethrin aerosol dispensers (1 dispenser / 217 ft^3) were installed on the wall of the incubation chamber, facing the leafcutting bee incubation trays. The pyrethrin aerosol dispensers were factory-calibrated to deliver 27.5 mg active ingredient / dispenser at 7.5 minute intervals. The positioning of the dispensers was undertaken in such a way that the pyrethrin aerosol plume was gently dispersed over the surface of the bee cells in the incubation trays by utilizing the "pull system" mode of air circulation within the incubation chamber. Pyrethrin aerosol treatment continued from day 00 through day 12 of incubation.

On day 13, the air circulation was changed to the "push system" mode, whereby air was moved vigorously over the trays and captured on the opposite wall of the incubator. This airing effect, in conjunction with operation of the incubator fresh air intake system, was designed to break down the pyrethrin residue. Extensive sampling of bee cells was undertaken at intervals to determine re-parasitism of bee cells and mortality due to parasite stinging. Data collected during day 12-19 of incubation is given in Table 1. These data indicate that parasitism level of bee cells in the incubator was reduced from 7.0% to 1.6%.

Table 1. 1998 parasite control experiment leafcutting bee re-parasitism (%)

Category / Cell contents	KN-409
Healthy LCB cells	97.4
Re-parasitized cells	**1.6**
Dead pupae stung	1.0

1999 field-scale parasite control research

Research in 1999 involved an evaluation of pyrethrin aerosol (KN-409) for parasite control in incubator 01 and an evaluation of dichlorvos for parasite control in incubator 02. In each of the prototype leafcutting bee incubators, 3.4 million bee cells with a parasite level of 2.6% were incubated at 30°C / 50% RH. Both solid bottom and screen bottom incubation trays were utilized in each of these experiments.

In incubator 01, 14 pyrethrin aerosol dispensers (1 dispenser / 155 ft^3) were installed on the wall of the incubation chamber and parasite control treatment was undertaken as previously described. In incubator 02, 1.6 dichlorvos resin strips (0.75 resin strip / 1000 ft^3) were suspended from the ceiling of the incubation chamber in such a way that the dichlorvos would be dispersed over the surface of the bee cells from day 07 through day 14 of incubation by utilizing the "pull system" mode of air circulation; air circulation was then changed over to the "push system".

Data collected during day 12-19 of incubation is given in Table 2. In the pyrethrin aerosol experiment, re-parasitism of bee cells occurred at levels of 1.5% (solid bottom trays) and 0.3% (screen bottom trays). In the dichlorvos experiment, re-parasitism of bee cells occurred at levels of 4.0% (solid bottom trays) and 1.8% (screen bottom trays). Clearly, in both pyrethrin aerosol and dichlorvos parasite experiments, use of screen bottom incubation trays resulted in lower re-parasitism of leafcutting bee cells, indicating that additional air movement through the screen bottom trays resulted in enhanced delivery of both pyrethrins and dichlorvos to leafcutting bee cells.

Table 2. 1999 parasite control experiments leafcutting bee re-parasitism (%)

Cell contents	KN-409		Dichlorvos	
	solid	screen	solid	screen
Healthy LCB cells	97.8	98.5	88.0	91.0
Re-parasitized cells	**1.5**	**0.3**	**4.0**	**1.8**
Dead pupae stung	0.7	1.2	8.0	7.2

As noted previously in 1998 parasite control data, it was observed that in some cases, developing bee pupae were being stung and killed by parasites, but not successfully re-parasitized. In 1999, mortality due to stinging was found to occur at levels of 0.7% (solid bottom trays) and 1.2% (screen bottom trays) in the pyrethrin aerosol test, and at levels of 8.0% (solid bottom trays) and 7.2% (screen bottom trays) in the dichlorvos test.

2000 field-scale parasite control research

Research in 2000 involved evaluation of pyrethrin aerosol (KN-409) in incubator 01and evaluation of pyrethrin aerosol (KN-418) in incubator 02.

In each incubator, 5.1 million bee cells with a parasite level of 1.7% were incubated at 30°C / 50% RH. Screen bottom incubation trays were utilized in both of these experiments.

In incubator 01, 14 pyrethrin aerosol dispensers (1 dispenser / 155 ft^3) were utilized. In incubator 02, 5 pyrethrin aerosol dispensers (1 dispenser / 434 ft^3) were utilized; in both incubators, parasite control treatment was undertaken as previously described. Pyrethrin aerosol KN-409 contains 0.975% pyrethrins, 1.950% piperonyl butoxide, and 3.210% n-octyl bicycloheptene dicarboximide, while pyrethrin aerosol KN-418 contains 1.80% pyrethrins and 10.00% piperonyl butoxide.

Data collected during day 12-19 of incubation is given in Table 3. In the KN-409 experiment, re-parasitism of bee cells occurred at a level of 1.0%. In the KN-418 experiment, re-parasitism of bee cells occurred at a level of 1.9%. Additional in-field sampling of bee cells indicated levels of adult bee emergence, re-parasitism, and mortality due to parasite stinging that were not significantly different from data collected in the incubator.

Table 3. 2000 parasite control experiments leafcutting bee re-parasitism (%)

Cell contents	KN-409	KN-418
Healthy LCB cells	98.9	97.3
Re-parasitized cells	**1.0**	**1.9**
Dead pupae stung	0.1	0.8

Parasite control research in the prototype leafcutting bee incubators has demonstrated the efficacy of pyrethrin aerosols for chalcid parasite control, the efficacy of utilizing screen bottom trays in conjunction with pyrethrin aerosol treatment, and the potential for use of pyrethrin aerosol formulations containing higher levels of pyrethrins and pyrethrin synergists in order to control chalcid parasites.

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