PROGRESS REPORT (FINAL REPORT)

PROJECT NO.: ARS

TITLE: Leafroller Biology and Potential for Control with Insect Growth Regulators

PERSONNEL: David Horton and Alan Knight, USDA-ARS, Wapato

REPORTING PERIOD: 1997/98 - 1999/00

ACCOMPLISHMENTS:

This project had two major objectives: (1) to determine whether contact by adult leafroller with insect growth regulators affects moth fecundity and egg fertility (KNIGHT); (2) to describe more fully the effects of growth regulators on larval biology, including effects on survival and diapause (HORTON).

1997-1998

Adults: Showed that exposure of male and female moths of oblique-banded leafroller (OBLR) to residues of CONFIRM in petri dishes caused reduced fecundity and egg fertility.

Larvae: (1) Showed that photoperiod and temperature control diapause decisions in larval OBLR (cooler temperatures and shorter days prompt diapause); (2) showed that exposure of larval OBLR to residues of CONFIRM and INTREPID prompted higher levels of mortality under long-day (16:8) conditions than short-day (14:10) conditions; (3) confirmed that INTREPID (at low rates) has more activity against OBLR larvae than low rates of CONFIRM.

1998-1999

Adults: Showed that exposure of male and female moths of OBLR to residues of INTREPID in petri dishes resulted in reduced fecundity and egg fertility (similar to results for CONFIRM).

Larvae: (1) Showed that low-temperature prompted diapause in OBLR larvae but failed to confer increased resistance to residues of CONFIRM and INTREPID (unlike short-day results); (2) because of unexpected results in temperature trials, repeated photoperiod study and re-confirmed that short-day conditions confer some resistance to residues of CONFIRM

and INTREPID (relative to 16:8 conditions); (3) showed that short-day caterpillars had tendency to become less susceptible to CONFIRM and INTREPID as they aged, presumably due to lack of feeding in preparation for diapause.

1999-2000 (details reported below in RESULTS)
Adults: Experiments were conducted to determine whether reductions in egg-laying and fertility occurred for natural populations of OBLR exposed within an orchard. Light-traps were used to collect moths from treated and untreated orchards. No females were captured in traps, and the experiment was terminated (see RESULTS).
Larvae: (1) Repeated photoperiod study using *Pandemis* instead of OBLR. (a) Showed that *Pandemis* has a critical photoperiod prompting diapause longer than that for OBLR, although this needs to be confirmed using stock recently out of the field; (b) showed (unlike for OBLR) that short-day conditions did not confer increased resistance to effects of growth regulators (this study conducted twice to confirm these results); (c) showed that rearing OBLR or *Pandemis* larvae under crowded conditions prompts substantial increases in mortality of larvae that have contacted residues of CONFIRM or INTREPID. (2) Began assays to test whether feeding stimulants might usefully be used to increase activity of growth regulators against larval OBLR and *Pandemis* (these studies ongoing).

RESULTS (1999-2000):

Adults: CONFIRM was not registered in time to conduct these studies in a commercial orchard, so the experiment was done at the Moxee farm. Larval OBLR were seeded into treated and untreated blocks of apple by placing ca. 5000 larvae (per block) on shoot terminals. One block was sprayed with CONFIRM using a small air-blast sprayer; a second block acted as a control. Light traps were set up in each block and equipped with mesh bags to allow capture of living moths. Following the spray, traps were checked at regular intervals and moths taken to the laboratory to allow egg-laying (for fecundity and fertility estimates). However, only male moths were captured in the traps, and the study was terminated. A commercial orchard naturally infested with *Pandemis* has been identified, and these studies will be conducted next year with (now registered) CONFIRM (see new proposal by Horton and Knight). Comment: This study was also conducted with codling moth in two experimental orchards using INTREPID. In that study, Knight found that number of eggs

deposited and fertility of eggs were reduced for moths collected from the sprayed orchard compared to those from the unsprayed orchard.
Larvae: (1) Previous trials indicated that rearing larvae under short-day conditions conferred some decrease in susceptibility to CONFIRM and INTREPID for early instar OBLR larvae (see above). We tested whether similar effects occur for *Pandemis* larvae. Two separate experiments were conducted, providing identical results, and showed that survival of *Pandemis* following exposure to residues of CONFIRM and INTREPID is not higher at short-days than at long-days (Figure 1). It remains to be determined why OBLR and *Pandemis* differ in this response; the species' differences have been consistent in two separate experiments, involving several hundred larvae per species. (2) Crowding of larvae produced strongly enhanced activity of CONFIRM and INTREPID (residues) for

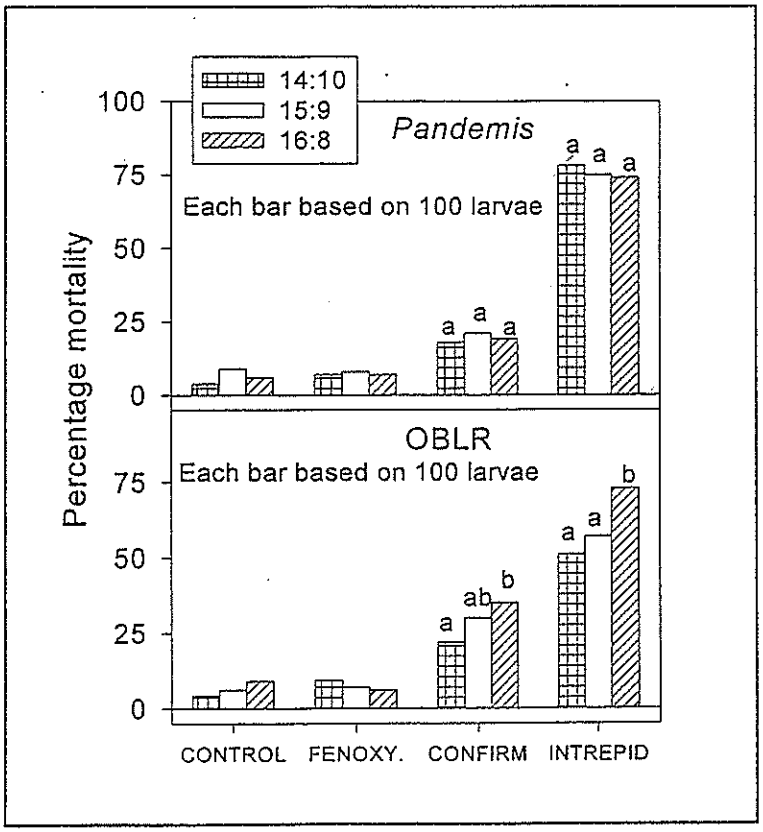

Figure 1. Percent mortality in newly hatched leafroller larvae exposed for 2 hrs. to residues of growth regulators, and effects of photoperiod.

both OBLR and *Pandemis* (Figure 2; percentages in figure have been adjusted for control mortality using Abbott's formula). It is unknown why crowding produced this effect, but it may reflect increased levels of activity by larvae under crowded conditions. (3) Studies conducted in

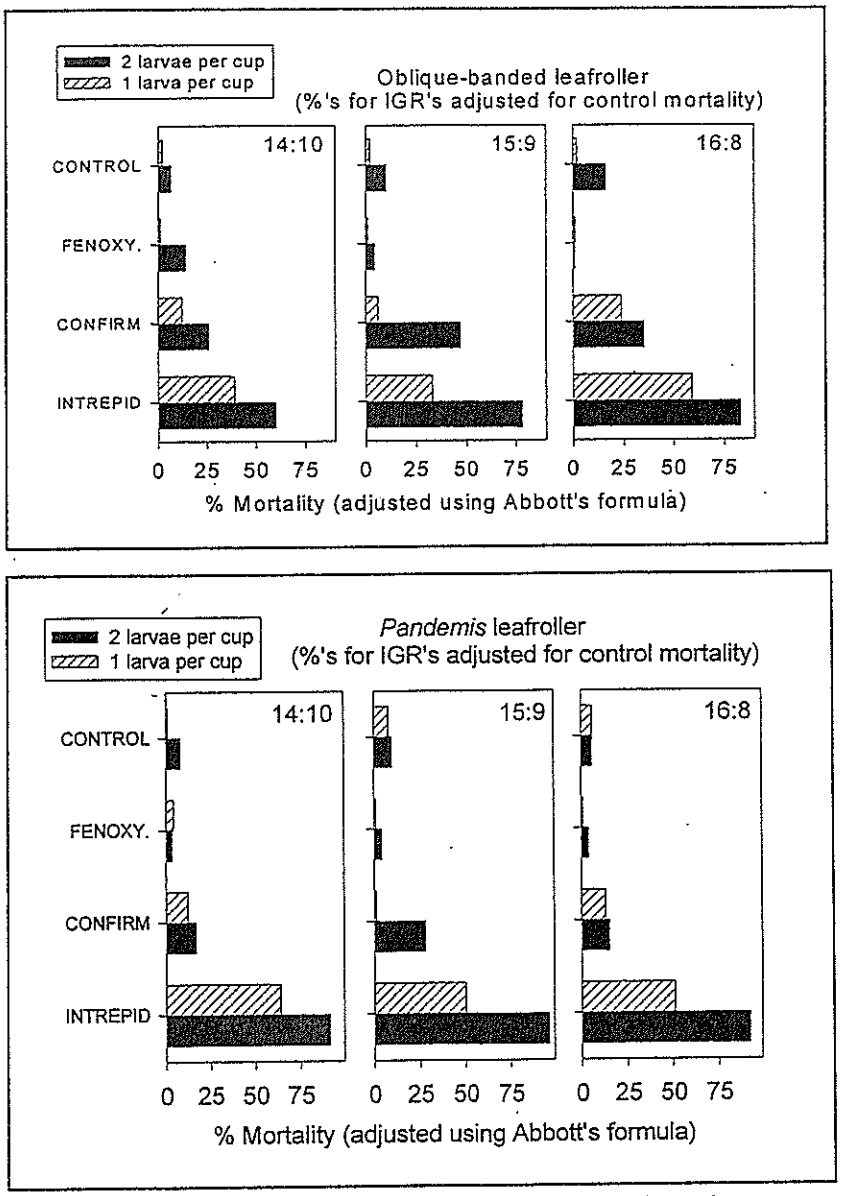

Figure 2. Effects of crowding on susceptibility of newly hatched OBLR and *Pandemis* leafroller to residues of growth regulators.

Canada with OBLR feeding on raspberries showed that certain commercially available feeding stimulants (especially PHEAST) prompted increased consumption rates by larvae and increased susceptibility to *B.t.* when the pathogen was applied in a mixture with the feeding stimulant. We have just begun studies aimed at determining whether these stimulants may be mixed with growth regulators to prompt increased consumption rates and consequent increases in ingestion of growth regulators. Preliminary feeding trials with mid-sized larvae of *Pandemis* and OBLR (on apple seedlings) have been completed, with objectives being to develop appropriate assay techniques for this type of study. This preliminary trial provided no evidence that either PHEAST or COAX affected 48-hour weight gain in OBLR larvae, whereas both products were shown to prompt increased weight gains in *Pandemis* larvae (Table 1). These assays will be repeated with larger sample sizes, and will be modified to allow consumption rates to be estimated.

Table 1. 48-hour weight gains of mid-sized larvae fed treated and untreated apple seedlings. Gains adjusted for initial weight using analysis of covariance ($N = 11$ or 16 larvae per treatment for *Pandemis* and OBLR, respectively).

	Oblique-banded		*Pandemis*	
	Fresh weight (mg)	Dry weight (mg)	Fresh weight (mg)	Dry weight (mg)
Control (water)	6.19	1.17	1.91	0.16
PHEAST (1.0 g per 100ml water)	6.34	1.01	1.31	0.06
PHEAST (2.5 g per 100ml water)	6.55	1.03	5.71	0.80
COAX (5% in water)	7.07	1.22	4.58	0.64
Significance	NS	NS	0.048	0.013