**Effects of Sublethal Doses of Bt and Intrepid™ in the Lab and in the Field**

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### Introduction

*Bacillus thuringiensis (Bt)* and Intrepid™ (methoxyfenozide) are often used for controlling leafrollers in Washington apples.

It has been shown that if sublethal doses of Bt or Intrepid™ are encountered by leafrollers that they can complete their life cycle; however, a delay in development occurs.

This developmental delay could potentially affect the timing of subsequent model-based activities including control measures and monitoring, as well as affecting leafroller parasitoids and other natural predators.

We examined the effects of sublethal doses of DiPel® (Bt) and Intrepid™ on oblique-banded leafrollers (OBLR) in the lab and in the field.

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### Methods

#### LAB EXPERIMENTS

- DiPel® DF (Bt) and Intrepid™ 2F spiked artificial diets were made at various sublethal rates.

- OBLR larvae from colony were fed Bt or Intrepid™ spiked diet in the 3rd and 4th instars for one or two days then transferred to control diet.

- Larvae were monitored daily; all molts were recorded through to moth emergence or death.

#### FIELD EXPERIMENTS

- Orchards under various control strategies were monitored throughout the field season, focusing on PLR and OBLR phenology.

- Analyses were performed to determine differences in flight times and larval phenology between orchards that received Bt or Intrepid™ and those that did not.

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### Results

#### LAB EXPERIMENTS

**Bt**

The Bt treated larvae required ~70-100% longer to complete the instar immediately after the one fed Bt; however, the following molts occurred quicker than in the control larva and overall, the time between treatment and adult emergence was only delayed by about 10-20% compared to the untreated controls (Table 1).

**Intrepid™**

When Intrepid™ was ingested larva molted quicker than untreated larvae, however, the time required to complete development to the pupal and adult stages was about 10-20% longer than control larvae (Table 2). Examination of the data showed that larvae fed Intrepid™ virtually always completed supernumerary molts (Table 3), whereas only 41-40% of the control larvae had more than five molts. About 85% of third instar larvae treated with Intrepid™ went through six or more molts and about 65% of the larvae treated as fourth instars went through 6 or more molts.

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### Conclusions

We have documented developmental delays in OBLR and PLR caused by Bt and Intrepid™ in both the lab and the field.

Lab data shows that the prediction of OBLR flight could be off by as much as 5-15% after an application of Bt or Intrepid™ to 3rd and 4th instar larvae.

Field data is supportive of the lab data; orchards treated with Bt or Intrepid™ had noticeably delayed flight when compared to untreated orchards and phenology of the larva in the Bt and Intrepid™ treated orchards generally lagged behind larvae in untreated orchards.

One effect of this developmental delay is to cause uncertainty in predicting the flight of the spring generation, and to a higher degree, predicting the summer generation flight, particularly if two or more sprays of Bt are used during the spring generation.

Implications for IPM are both positive and negative. Negatively, subsequent control measures such as additional sprays that are based on model predictions could be applied at incorrect times. In addition, model-based monitoring could be impacted. One possible positive impact is that the delay may increase parasitism because the larvae are in susceptible stages longer; however, probably only a small portion of the total population in the field is exposed to sublethal doses causing a delay in development and parasitoids may deposit eggs or attack an already dying larva, which may not support parasitoid development.

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