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Management of Organophosphate-Resistant Codling Moth in the Field

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SUMMARY

- **Guthion resistance is low to moderate in most Washington codling moth**
- **Cross-resistance to Assail (and likely Calypso) is likely**
- **Cross-resistance in the neonicotinyls does not appear to reduce field efficacy at this point**

Codling moth, *Cydia pomonella*, is the key pest of apple and pear. It has become more difficult to control using insecticides in some areas of Washington, particularly when using azinphosmethyl (Guthion). Guthion resistance in codling moth has been problematic in other fruit-growing states, such as California, Michigan, and Missouri. In California, Guthion resistance conferred cross-resistance to many other insecticides (Figure 1), including old ones (DDT) and ones that had never been used before (fenpropathrin and esfenvalerate).

Several new insecticides provide alternatives to Guthion for codling moth control, including the neonicotinyls Assail and Calypso. While these materials could provide effective tactics, cross-resistance is a concern. If this were to occur, codling moth populations that were Guthion-resistant would be resistant to the neonicotinyls, even before the neonicotinyls were used in the field.

In 2003 we conducted a survey of codling moth resistance to Guthion in Washington (Figure 2). In this study, most areas had low to moderate levels of Guthion resistance. We also identified an apple orchard with high levels of organophosphate resistance (Manson-1).

At some locations, we also examined potential cross-resistance to several insecticides. We found no cross-resistance to Lorsban or Asana (Table 1); however, there was evidence for potential cross-resistance to Assail, which had not been used before in the test locations (Table 2).

In 2004, using the Manson-1 site, we conducted two experiments. First, we examined levels of cross-resistance to several insecticides (Table 3). Second, and perhaps more importantly, we conducted a field efficacy trial of several new materials to determine if potential cross-resistance would reduce the efficacy of these materials when used for codling moth control (Table 4). Applications in this trial were made by airblast sprayer, and plot sizes were greater than one acre per treatment.

We again found evidence for cross-resistance to Assail (Table 3). Guthion resistance had decreased slightly from 2003 to 2004, yet the Assail cross-resistance was still significantly high. This indicates that Guthion-resistant codling moth may have a higher tolerance to Assail.

However, codling moth control was maintained despite the Guthion resistance (Table 4). Lorsban and Asana provided control, although these are not materials recommended for use in IPM programs (Lorsban is illegal at those timings). Success also provided control in the second generation, when three applications were used; two applications for the first generation did not provide comparable control. The Diamond / Assail combination also provided control (see the posters on Codling Moth Control by Granger et al. for further information).

For Guthion, high rates and well-timed applications still provided excellent control. For Assail and the related neonicotinyl Calypso, control was also very good. This indicates that while resistance may be present, control can still be maintained using label rates and good application timing.

Guthion resistance will be a problem as long as it remains an important component of tree fruit pest management. Effective alternatives now exist, including mating disruption, and the use of alternative tactics should be encouraged. Cross-resistance is a great concern with the neonicotinyls, and these materials should be used wisely to preserve their efficacy for the future.

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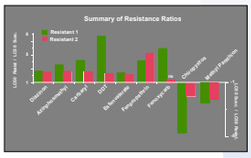

Figure 1. Summary of cross-resistance to various insecticides in two Guthion-resistant codling moth populations in CA. These are from laboratory bioassays of lab-reared colonies. A higher bar indicates a higher level of cross-resistance; levels close to 1 indicate susceptibility. Significant cross-resistance was found to diazinon, Sevin, DDT, Asana, Danitol, and Comply. Alternatively, negative cross-resistance was found to Lorsban and Penncap; here, the Guthion-resistant populations were more susceptible to those insecticides.

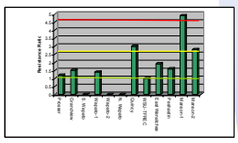

Figure 2. Summary of Guthion resistance in Washington in 2003. These are from codling moth populations collected around the state. A higher bar indicates a higher level of Guthion resistance, and a ratio of 1 indicates susceptibility (green line). Moderate resistance occurs at about 2.5 (yellow line), while high resistance occurs about 4.5 (red line). Most populations have low to moderate resistance.

Asana-2003	LC50 (µg ai / moth)	Resistance Ratio
Prosser	0.06	1.2
Grandview	0.03	0.6
WSU-TFREC	0.05	--

Table 1. Bioassay results for Asana, 2003. Asana resistance was not found in the two apple orchards sampled in 2003.

Assail-2003	LC50 (µg ai / moth)	Resistance Ratio
Prosser	0.32	na
Grandview	0.11	1.0
WSU-TFREC	0.11	--
Manson-1	0.76	6.9
Manson-2	0.27	2.5

Table 2. Bioassay results for Assail, 2003. Assail cross-resistance with Guthion was indicated in the two apple orchards sampled in 2003 that had Guthion resistance present (Manson-1 and -2). However, these data were not conclusive as there was too much variation to determine statistical significance.

Manson-1 2004	LC50 (µg ai / moth)	Resistance Ratio
Guthion	0.39	3.6
Assail	0.80	6.1
Asana	0.10	2.0
Lorsban	0.03	-1.7

Table 3. Bioassay results for Manson-1, 2004. Assail cross-resistance with Guthion was indicated in this apple orchard sampled again in 2004. Guthion resistance had decreased from 4.7-fold in 2003. There also appeared to be low levels of Asana cross-resistance, and potential negative cross-resistance with Lorsban.

Treatment	1st gen % inf.	2nd gen % inf.
Calypso 6 oz (2 covers / gen)	0.0	0.3
Assail 3.4 oz (2 covers / gen)	0.2	0.0
Guthion 3 lb (2 covers / gen)	0.1	0.0
Diamond 40 oz, Assail 3.4 oz (1 combination cover / gen)	0.6	0.1
Success 6 oz (2 apps 1st gen, 3 apps 2nd)	1.2	0.2
Lorsban 2 lb (2 covers / gen)	0.0	0.1
Asana 14.5 oz (2 covers / gen)	0.0	0.0

Table 4. Field trial results for codling moth control, Manson-1, 2004. In this field trial, the neonicotinyls Assail and Calypso provided good control, as did Asana and Lorsban (Lorsban is not legal for this use, however). Guthion also provided good control, despite the levels of resistance shown in Table 3. Success was successful using 3 applications for the second generation; 2 applications appeared weaker. The combination program of Diamond and Assail also appears to be a potential codling moth management program.