Insecticide cross resistance in the western flower thrips: physiological mechanisms and IPM strategies.

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Summary of Research Progress To Date. This was the first year of funding for our project and here we report data collected from July 1, 2011 to December 31, 2011. In order to test the hypothesis that one mechanism of insecticide resistance in the western flower thrips (WFT) is via the efflux transporter pathway, we first established a bioassay protocol for testing commonly used insecticides and determining the LD_{50} for each. We have successfully bioassayed the following insecticides: Assail, Capture, Danitol, Pylon, Warrior II, Movento, and Dimethoate (Figures 1 & 2) along with three control treatments (Figure 3). We specifically tested the inhibition of the efflux transporter pathway with the chemical Verapamil in combination with Assail (Figure 2).

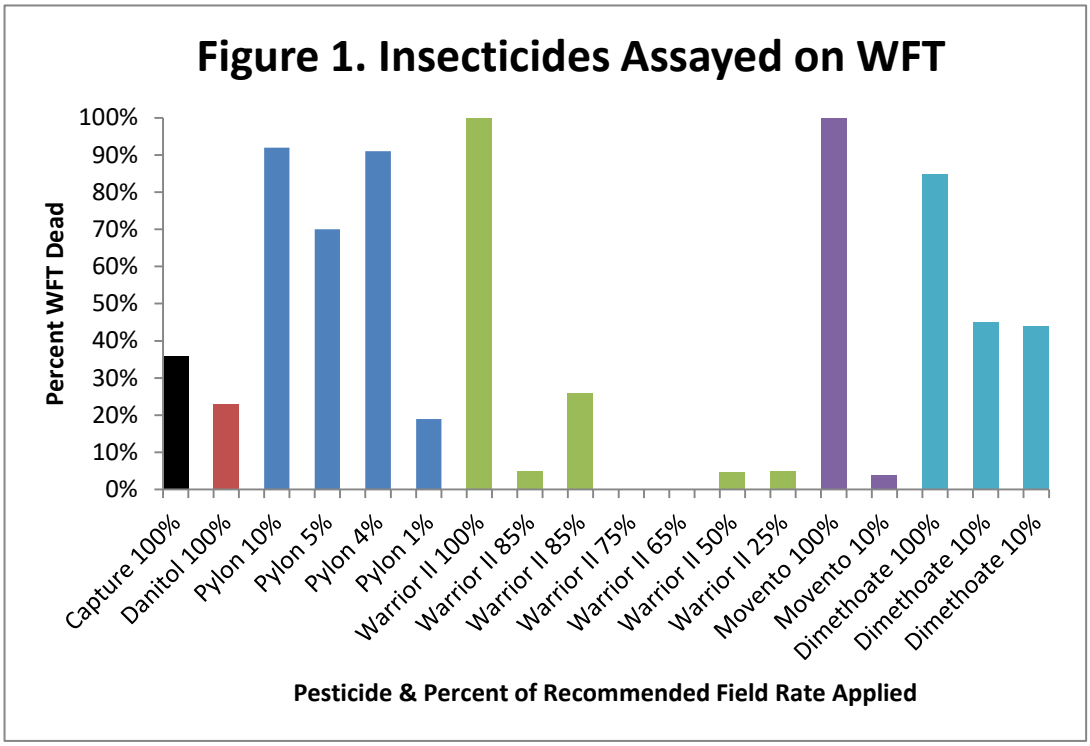

Figure 1. Insecticides assayed on WFT. The recommended "field rate" was used full strength (100%) or was diluted to determine the dose that killed at least 50% of WFT.

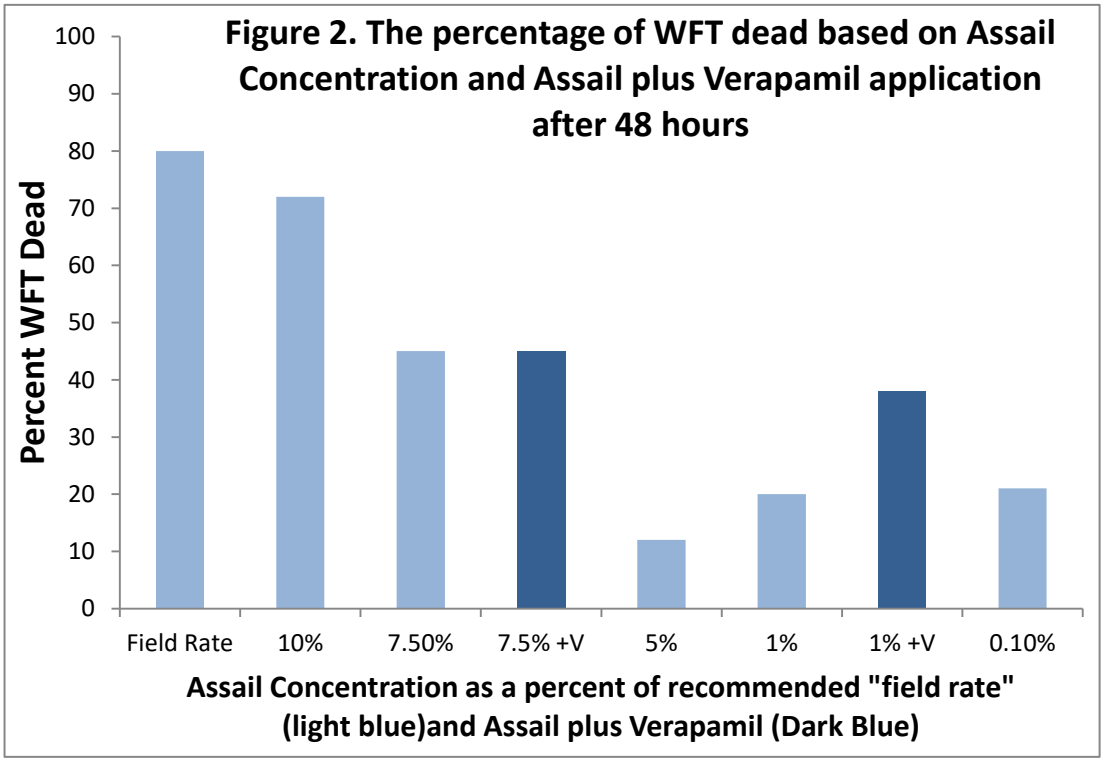

Figure 2 shows the percentage of WFT that were killed with varying concentrations of Assail by itself and in combination with the efflux transporter inhibitor, Verapamil (+V). When Verapamil was present with 7.5% Assail, there was no difference in the total number of WFT killed than with 7.5% Assail alone. However, there was an 18% increase in WFT mortality when Assail was applied at 1% plus Verapamil compared to 1% Assail alone. This is a somewhat ambiguous yet intriguing result, but because Assail is not commonly used to control WFT, this experiment was primarily used to determine a baseline for comparison with other insecticides plus Verapamil.

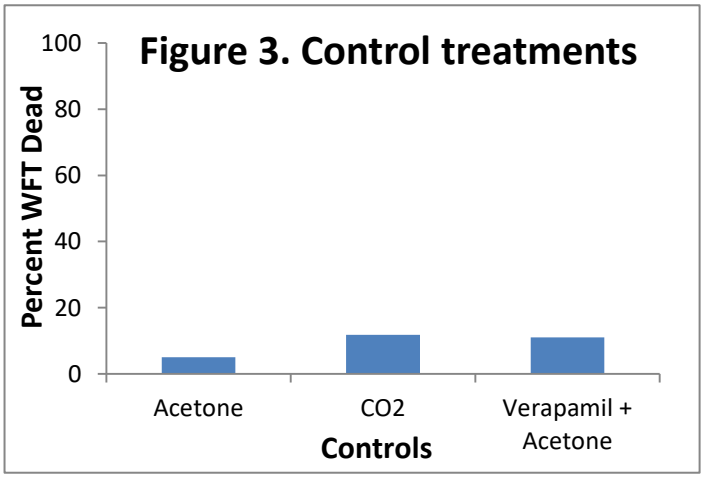

Figure 3 shows the control chemicals that were assayed on WFT to be certain that the chemicals that the insecticides were diluted in and the gas (carbon dioxide) that was used to anaesthetize the insects were not also killing the insects. As is clear in this graph, there was very little mortality (close to zero) for all controls.

In summary, we have found limited evidence that the efflux transporter inhibitor Verapamil does have a synergistic effect with the insecticide Assail, but at a very low dose (only 1% of the recommended field application rate). We are continuing these experiments such that at the end of the funding period we expect to have data showing the interaction between Verapamil and the following insecticides: Capture, Danitol, Pylon, Warrior II, Movento, and Dimethoate.

Table 1. The data showing sample sizes for each control and insecticide treatment. Only adult thrips were used. All thrips were collected from the WSU Wheat Greenhouse, Pullman WA.

Treatment	Percent Dead	Sample Size
Acetone	5%	20
CO2	11.8%	31
Verapamil + Acetone	11%	19
Assail Field Rate	80%	11
10% Assail	72%	18
7.5% Assail	**45%**	**22**
7.5% Assail + Verapamil	**45%**	**51**
5% Assail	12%	17
1% Assail	**20%**	**20**
1% Assail + Verapamil	**38%**	**26**
0.1% Assail	21%	14
100% Capture	36%	25
100% Danitol	23%	22
10% Pylon	92%	25
5% Pylon	70%	23
4% Pylon	91%	23
1% Pylon	19%	26
100% Warrior II	100%	26
85% Warrior II	26%	19
75% Warrior II	0	9
65% Warrior II	0	6
50% Warrior II	5%	21
25% Warrior II	5%	21
100% Movento	100%	26
10% Movento	4%	26
100 Dimethoate	85%	27
10% Dimethoate	45%	56