

## Monitoring for Pesticide Resistance in California Red Scale

*Project Leader:*

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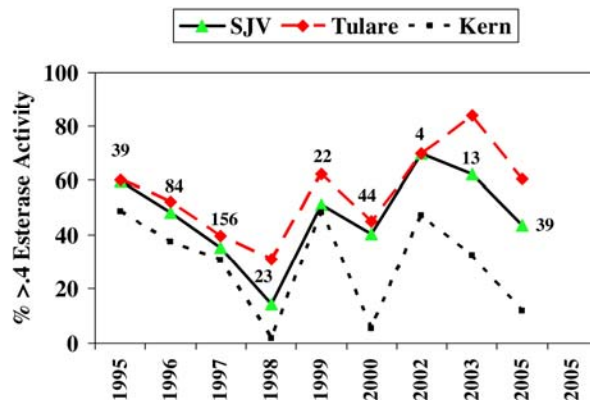
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In 1997, resistance to Lorsban, Supracide, and Sevin had reached a level that multiple applications of these insecticides did not control California red scale in a number of San Joaquin Valley orchards. In 1998, California citrus growers obtained emergency registration of Esteem and Applaud to control scale and have been relying heavily on Esteem ever since. The purpose our current project is to determine if organophosphate insecticide-resistant populations of California red scale have lost any of their resistance to organophosphates (Lorsban or Supracide) and to see if any populations have developed resistance to Esteem.

Organophosphate Resistance: Figure 1 shows the percentage of resistant red scale we find when we average all of the samples collected in a particular year. Some years it is easier to collect scale than other years (it depends on weather, grower interest, and how recently a grower treated the orchard with insecticides). The small numbers above the line are the number of scale populations tested in that year.

% of CRS individuals with > 0.4 esterase activity (OP resistance)  
Averaged over all orchards in each region

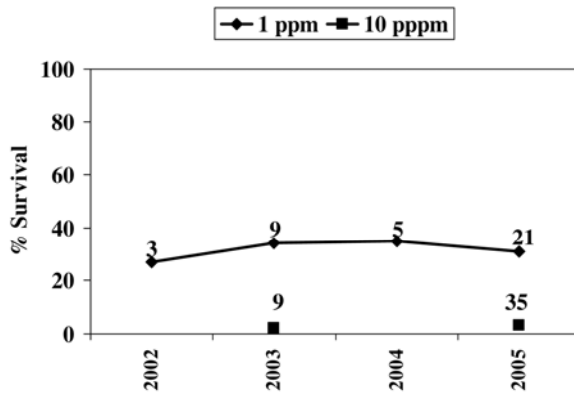


Organophosphate resistance (as measured using the esterase enzyme test) has fluctuated through the years, but it remains between 40-60% of individuals on the average. Thus, OP resistance is not declining, and growers with resistant populations should not expect control of red scale with organophosphate (Lorsban, Supracide) or carbamate (Sevin) insecticides. This figure also shows that the average resistance of Tulare County populations is higher than the Kern County populations.

There are two main reasons why organophosphate resistance is not going away. First, most of the orchards with heavy OP-resistant scale do not have a source of susceptible male scale to fly in and breed with their resistant population and reduce the resistance. Second, organophosphate use for citricola scale is on the rise and these treatments keep the resistance in red scale high.

Esteem Resistance: Figure 2 shows the percentage survival of red scale of 1 ppm and 10 ppm Esteem from 2002-2005 and the number of populations tested each year. If resistance were a problem we would expect an increase in survival through time. However, the line for 1ppm is level, and the average survival of 10 ppm in 2003 and 2005 is not very different, indicating that Esteem resistance has not developed yet.

Average % Survival of 1 ppm and 10 ppm Esteem for CRS  
(no. of populations tested)



One of the difficulties in detecting Esteem resistance in red scale is that the insecticide doesn't kill the scale immediately. Because Esteem is an insect growth regulator, it kills scale when they molt, and sometimes it takes two molts before they die. Sometimes females develop completely but don't produce eggs. We have also observed that male scales are more sensitive than female scales. We are measuring all of these differences in stages and sexes of scale in an attempt to improve the resistance monitoring test.