Monitoring insecticide resistance in Asian citrus psyllid populations in Florida

By Siddharth Tiwari, Michael E. Rogers and Lukasz L. Stelinski

For almost 15 years, insecticides have provided direct protection against Asian citrus psyllid (ACP) in Florida, and during the past five years, use of these tools has intensified to manage greening disease. There is no doubt that insecticides are an integral part of citrus pest management programs.

However, repeated and intense use of insecticides has inevitably resulted in development of resistance for many pest species, if resistance management programs were not followed. Development of insecticide resistance in insects occurs when the susceptible portions of populations are killed off, but resistant mutants persist and reproduce. Figure 1 is a diagram example of how insecticide resistance can develop.

Considering the recent discovery of ACP in Florida, the duration of their exposure to various insecticides has been relatively short compared to other insect pests that have been managed intensely. Given this relatively short period of intense insecticide use against ACP to date, management of resistance should be effective. This is because levels of resistance are still low in many cases, and we are catching the problem in its early stages.

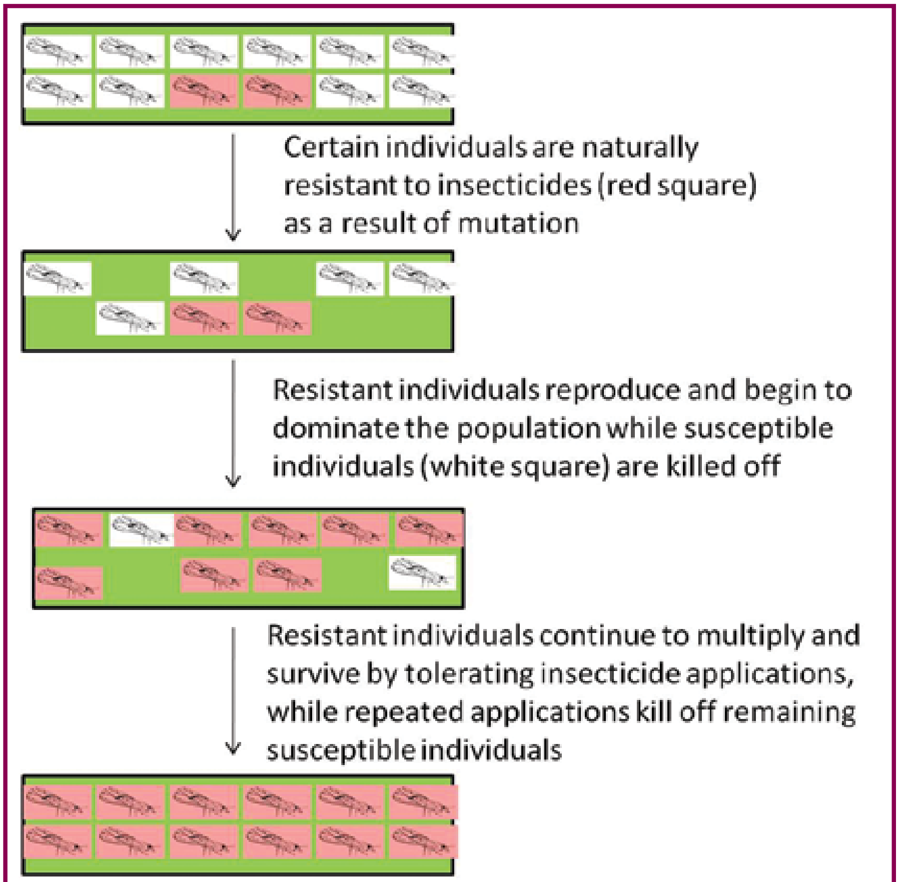

Figure 1. Schematic representation of resistance development.

Over the past two years (2009-2010), we have been monitoring insecticide resistance levels among ACP populations in Florida. In 2009, insecticide resistance was quantified by comparing the susceptibility levels of field-collected populations with a laboratory susceptible (LS) population, which has never been exposed to insecticides. This allows calculation of a so-called resistance ratio (RR), which is a measure of how much more resistant a field population is, compared with our laboratory susceptible (LS) population. We observed that resistance ratios varied among insecticides tested and locations throughout the state. One ACP population from LaBelle was 35 times more resistant to imidacloprid than the LS population. This was followed by thiamethoxam (RR = 13), malathion (RR = 5.4 and 5.0), and fenpropathrin (RR = 4.8) (Figure 2). Generally, resistance ratios below 10 are not representative of significant resistance development.

We have continued to monitor resistance development in 2010. Unfortunately, our results indicate that the presence of resistance in 2010 has become more widespread. Figure 3 illustrates that ACP collected from five field sites across Florida were less susceptible to each of the major insecticides we have been testing than the laboratory susceptible strain. Also, we found evidence of resistance in populations of ACP nymphs, in addition to adults. Among field-collected nymph populations, indications of resistance were observed with carbaryl (RR = 2.9), chlorpyriphos (RR = 3.2), imidacloprid (RR = 2.3 and 3.8), and spinetoram (RR = 3.0 and 5.9) (Figure 4). Differences in levels of resistance between various sampling locations could be due to differences in the spray schedules and intensities between those locations. Or, it could be due to genetic variability among ACP populations across Florida.

Resistance ratios for insecticides such as chlorpyriphos, imidacloprid, spinetoram and thiamethoxam that were greater than 10-fold are currently the greatest indicators of concern. Therefore, it is imperative to rotate these chemicals with insecticides from other chemical classes or modes of action. Resistance to a recently developed insecticide, spinetoram, which is considered as a replacement to organophosphate insecticides, serves as an early warning for judicious use of this product. Also, cross-resistance between imidacloprid and thiamethoxam indicates that rotation of products having the same mode of action will further hasten resistance development.

It is important to stress that our results from the past two years indicate that current levels of resistance are not yet at levels that would cause product failures. However, monitoring for resistance should continue in order to determine if further shifts occur. For future monitoring programs, we plan to increase the number of sampling sites both within and outside of Florida. In the meantime, we recommend making need-based insecticide applications, following a rotational application schedule by using insecticides with different modes of action and never applying the same chemical back to back. Appropriate rotational schedules should be coordinated among neighboring grove owners, as dispersing ACP can escape the applications from one grove and seek refuge in another. Effective rotation among newly developed Citrus Health Management Areas should help prevent further development of resistance among populations of ACP.

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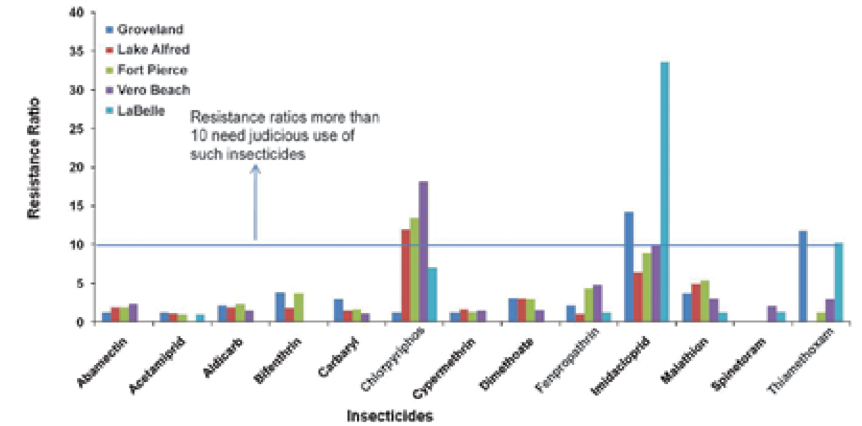

Figure 2. Resistance ratio values for various insecticides in five field populations of Asian citrus psyllid adult from Florida

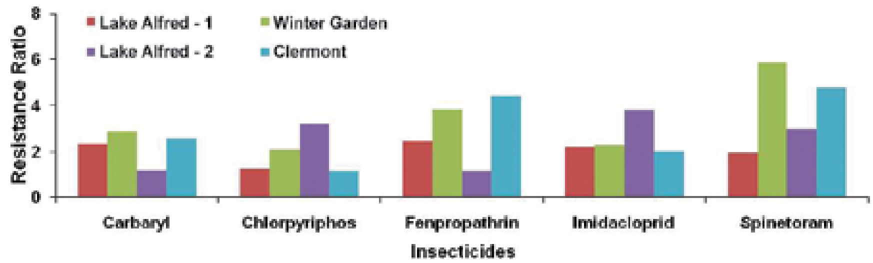

Figure 4. Resistance ratio values for various insecticides in four field populations of Asian citrus psyllid nymphs from Florida

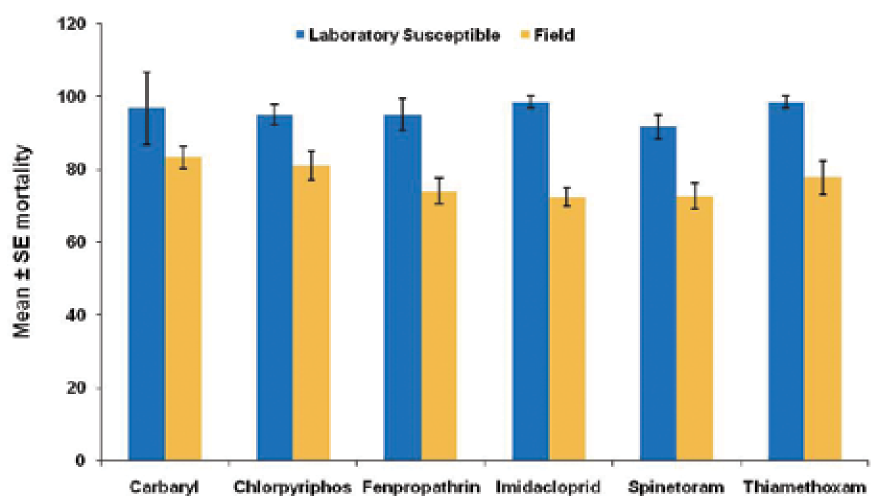

Figure 3. Mean mortality of Asian citrus psyllid adults collected from five field locations as compared to a laboratory susceptible population.