Herbicide resistance in Florida citrus

By Stephen H. Futch, Analiza H.M. Ramirez and Megh Singh

Citrus is a major agricultural commodity in Florida and its value is estimated at nearly $1.14 billion annually. Within the Florida citrus industry, weed and grove floor vegetation management account for an estimated 12.9 to 14.1 percent of the total production budget as estimated by Ron Muraro, farm economist with the University of Florida's Citrus Research and Education Center in Lake Alfred. This estimate indicates weed and vegetation management cost the average Florida citrus grower $234.91 per acre; that's a total industry cost of $129.2 million each year to control weeds within the tree rows and row middles. Nearly 40 percent of the total weed management cost consists of the use of pre- and postemergence herbicides to control various broadleaf and grass weeds. The remainder of the costs is for application, mowing and limited hand labor to control escape (uncontrolled) weeds and vines.

With the reliance on herbicides to control weeds, growers in Florida and other citrus-producing countries are concerned about development of herbicide resistance of one or more weed species, especially due to frequent use of postemergence herbicides like glyphosate. Historically, glyphosate has been included in the majority of herbicide applications, thereby increasing the likelihood of herbicide resistance development. It is well documented that the repeated use of the same herbicide or several herbicides from the same mode of action increases the likelihood of developing herbicide-resistance in weeds. Herbicide resistance is well documented in other agricultural crops, not only in Florida, but in many agricultural crops grown within the United States. Currently there are 142 herbicide resistance cases involving nine herbicide groups in the United States.

In Florida, some noted herbicide-resistant weeds in agronomic crops include pigweed (*Amarantha* spp.), nightshade, lambsquarters and goosegrass.

It has been well documented that plant susceptibility to applied herbicide is greatly impacted by the stage of growth of the targeted species. Seedling and young plants are more susceptible than older plants to most herbicides. In addition, susceptibility to herbicides is also influenced by:

- Herbicide concentration
- Toxicity of applied herbicide
- Environmental factors (light, moisture, temperature)
- Coverage

Plants that are under moisture stress are less susceptible to foliar-applied herbicides due to leaves being curled as a result of moisture stress which results in a less permeable leaf cuticle and exposed leaf surface to be contacted by the herbicide. Extreme temperatures (too high or too low for optimal growth) will also impact plant susceptibility to herbicides.

Herbicide resistance is defined as the inherited ability of a weed to survive and reproduce following exposure to a dose of herbicide normally lethal to the weed.

Resistance can be divided into three broad categories. Herbicide resistance is usually used to refer to a weed biotype that is resistant to a single specified herbicide. Cross resistance is when the weed biotype is resistant to two or more chemically similar herbicides that are in the same herbicide family and mode of action. Multiple resistances are when the weed biotype is resistant to two or more chemically unrelated herbicides with different modes of actions.

In a plant, resistance may be

naturally occurring or induced by such techniques as genetic engineering, selection of variants produced by tissue culture, and/or other techniques that cause/induce mutation (eg. herbicide-resistant crops like Roundup Ready corn, soybean and others).

Herbicide resistance is different from herbicide tolerance. Herbicide tolerance is defined as the inherent ability of plants to withstand a certain dose of herbicide. In some cases, weeds may withstand a given herbicide rate. However, tolerance may be overcome by increasing the herbicide rate. In certain situations, herbicide tolerance may be related to plant age; for example, older mature plants are more tolerant than young plants to a given rate of herbicide. In other cases, some plant species are naturally tolerant to herbicides regardless of location or cropping situations.

Some citrus growers have indicated weed species that they believe may be resistant and/or tolerant to glyphosate include Spanish needles, ragweed parthenium, phaseybean, goatweed, Florida and Brazil pusley, spreading dayflower, dayflower and nightshade. Many of these growers have indicated failure of herbicides applied at the recommended rates to control these weeds. Oftentimes, this happens when herbicide applications are made on older/mature weeds, and complete coverage of the entire plant with the postemergent herbicide is insufficient to provide desired control.

Preventing herbicide resistance can be achieved by rotating herbicides from different herbicide families. Additional weed control tactics such as cultivation and spot spraying can also be effective by removing weed escapes that were not controlled by an earlier applied herbicide. Such rotation should include a different herbicide group that will provide weed control of the targeted weed.

Growers in Florida control weeds in citrus groves with the application of different types and combinations of herbicides, which may help prevent or delay development of herbicide resistance in weed populations. While true resistance has not been fully documented within the Florida citrus industry, many weeds do show herbicide tolerance to selected herbicides. When tolerance is expressed, it is suspected that coverage and/or the plant age are major factors allowing these weeds to survive the herbicide treatment.

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Field Research of Interest to Citrus Growers: How Do We Know These Practices Work?

By Harold Browning

The 2012-13 citrus harvest season has focused attention on the health status of existing citrus trees throughout the state, and the uncertainty that this population of producing trees will survive and remain productive to adequately supply the industry's fruit needs. At present, tree attrition due to all causes exceeds replanting rates, and thus, there is more pressure on maintaining the potential for fruit production.

We all can envision that the ultimate solution to HLB for the industry is to reach a point where tools are available to replant with HLB-tolerant or resistant plant material, and to maintain tree health for a period long enough to ensure production and positive return. Some of these tools are available now, but work continues to provide the long-term solutions.

Meanwhile, the citrus industry is demonstrating its resolve through replanting efforts around the state, and the recent announcement of plans to enable significant new plantings provides optimism for maintenance of yield potential in the industry.

A number of practices have been discussed, tested by growers in the grove, and promoted for their potential to retain or restore health to infected groves. CRDF Research and Commercial Product Delivery Programs were established with the flexibility to respond to opportunities, and often are asked to provide support for these practices or materials. This is accomplished through evaluation of the particular technology or material, what is known of its effects, and what can be done to further understand if and how it can affect HLB health. In most cases, these practices or materials have been tested in other crop systems or in other countries, or are new enough that there are not adequate field tests to determine their value. CRDF has been most often asked to assist in "proving" that the approach is worthwhile and should be broadly adapted. While grower trials are relatively easy to set up, they often are not conclusive, and thus, controlled field experiments must accompany these demonstrations to understand cause and effect.

CRDF is planning for the new budget year and the opportunities that are provided with the pending support from the Florida Legislature. Among the topics being evaluated for enhanced attention and support are:

- Larger scale grower field trials of candidate HLB-tolerant rootstocks
- Effects of plant growth regulators on citrus vascular (phloem) health and fruit drop
- Identification and characterization of field survivors of HLB in declining groves
- The complex interaction of nutrients, soil characteristics and other variables on HLB infection and root health
- Screening of anti-microbial materials to reduce HLB bacterial titer in infected trees
- Utility of solar thermal therapy to reduce infection in diseased trees
- Continued improvement in Asian citrus psyllid management in mature and young trees
- Fine-tuning of general cultural practices to promote health in infected trees
- Reducing tree stress factors that magnify or are magnified by HLB (e.g., Phytophthora)

CRDF currently is sponsoring research projects on all of these topics, and provides updates to the industry through the posting of quarterly progress reports on all projects and quarterly reports from the Commercial Product Delivery Program. However, with the potential for one or more of these practices or materials to have more immediate impacts on HLB management, we are looking for ways to accelerate efforts to better understand their value when the new funds are available.

Harold Browning is Chief Operations Officer of CRDF. The foundation is charged with funding citrus research and getting the results of that research to use in the grove.

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