What's new in variable rate technology?

By Arnold Schumann, Kevin Hostler and Siza Tumbo

In a series of three *Citrus Industry* articles published during 2008 and 2009, we described variable rate technology (VRT) used for site-specific management of pesticide sprays and granular fertilizers in citrus groves. Florida citrus production is increasingly dependent on agrochemicals, including fertilizers, while the prices of these products have remained relatively high, thus eroding citrus profit margins.

Many growers have adopted a more aggressive foliar nutrient-spraying program to maintain tree health and productivity in the presence of greening and canker diseases. Meanwhile tree removal due to citrus greening and canker disease management is causing significantly more gaps in tree canopies, which should therefore no longer be sprayed or fertilized uniformly. This article discusses new, more efficient VRT agrochemical application methods which have become necessary in order for citrus production to remain profitable.

Ultra-low-volume (ULV) pesticide sprayers can reduce the amount of active ingredient required per acre and drastically reduce application times, but ULV methods are not well-suited for spraying nutrients. The high concentrations of nutrients required in the sprayer tank at such low volumes can exacerbate chemical incompatibilities, precipitation, nozzle clogging and foliage "burn" from concentrated fertilizers.

ULV applicators are also not easily adapted for VRT. Traditional high-volume airblast sprayers are well suited for the simultaneous application of pesticides and nutrients; they provide good spray penetration and coverage of tree canopies, and higher application efficiencies can be achieved with VRT.

With VRT, pesticide sprayers use sensors, computers, and GPS technology to continuously measure citrus trees along the row and make adjustments to the amount of spray delivered to each tree. Most importantly, spaces with missing trees are not sprayed, which saves significant money by reducing chemical wastage, spray drift and off-target environmental pollution. Growers using VRT are consistently reporting 15 percent to 50 percent savings of agrochemicals in mature groves and >50 percent in young replant blocks.

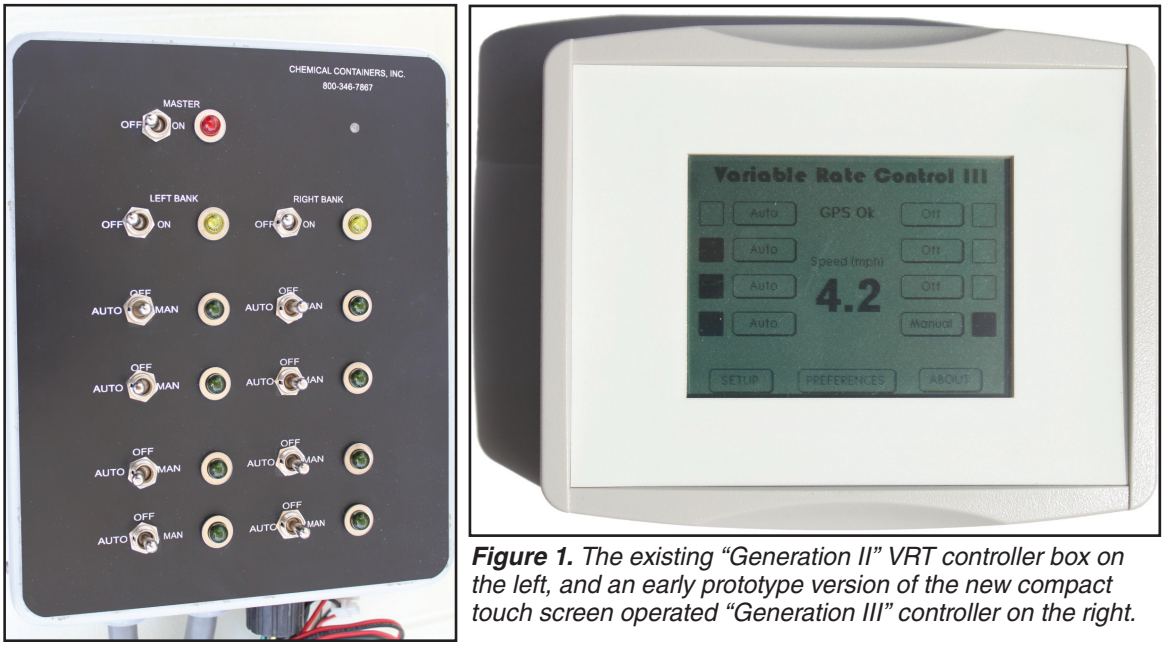

Figure 1. *The existing "Generation II" VRT controller box on the left, and an early prototype version of the new compact touch screen operated "Generation III" controller on the right.*

UF/IFAS RESEARCH IN VRT

In 2008-2009, several new refinements in citrus VRT fertilization and pesticide spraying systems were tested and made available to growers by licensing the technology to Chemical Containers Inc. (CCI) in 2009. The technology-transfer partnership between UF/IFAS and CCI has proved mutually beneficial because UF/IFAS was able to rapidly test and improve prototypes in a real grove operating environment while CCI was able to rapidly deliver the benefits of the new technology to growers by upgrading their existing controller and deploying it through their sales and support network.

The operation of the existing CCI control box, the "look-ahead" feature, and the canopy sensors were changed so that a single VRT system on a given tractor can serve a variety of different attached applicators such as airblast sprayers, hoop sprayers, granular fertilizer spreaders and Temik® applicators. Other enhancements include GPS-guided, look-ahead synchronization, customizable spray buffers around trees and selective agrochemical application for different tree size classes. In this "Generation II" controller (Figure 1), the familiar toggle switches, indicator lamps and large enclosure were retained but made fully compatible with the existing "Generation I" valves and sensors already installed on grove equipment. A wireless hand-held Pocket PC® computer (not shown) is used to configure the operating parameters of the controller.

This year we plan to further streamline the design to provide more features and improve efficiency and reliability in a new "Generation III" design (Figure 1). The new touch-screen VRT controller will be more compact and weather-proof while retaining full plug-in compatibility with existing sensors and valves. A full software- and touch-screen-based controller will be much easier to upgrade with new features and will permit menu choices in other languages.

Other features in the pipeline for the new controller include the ability to collect and store tree canopy characteristics data measured by the sensors for later downloading, viewing, analyzing and mapping in a GIS program. Growers will benefit from up-to-date information on tree sizes, and the locations of gaps and resets in their groves. Automatic spray buffers based on prevailing wind direction and speed could improve spray deposition on canopies while avoiding off-target drift.

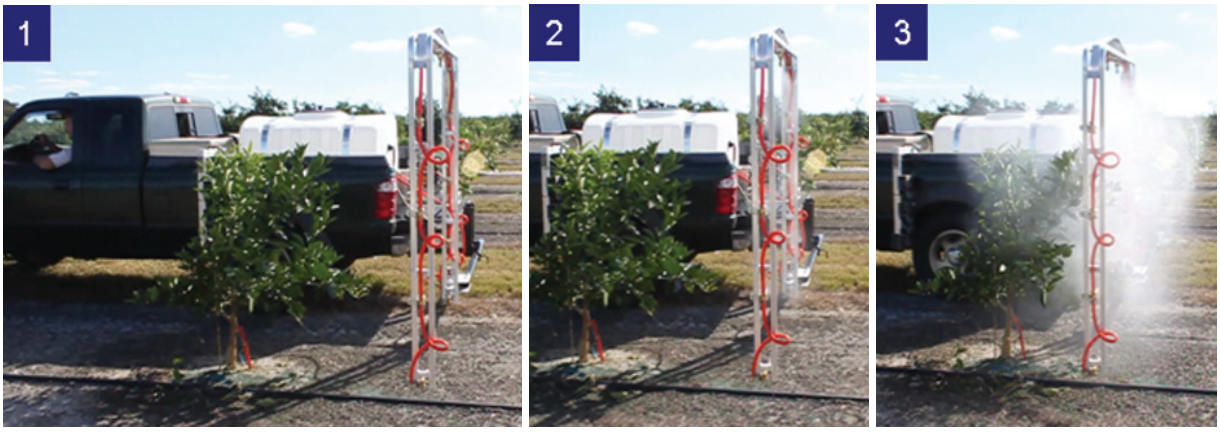

Figure 2. *Automatic VRT spraying sequence of a young citrus tree at 3.4 mph. The duration of the whole video sequence was about 1.25 seconds*

The accuracy and reliability of the VRT controller is our top design priority. The new controller is being designed to work with a range of different approved sensors because certain sensor technologies may work better than others in a given situation. For example, the currently implemented optical sensors work well in detecting mature trees, but occasionally miss a small reset tree target. The latest sealed, weather-proof ultrasonic sensors could be more efficient than optical sensors in detecting small reset tree targets or partially defoliated canopies. The precision spray application achievable with the VRT controller is illustrated in the freeze-frame video sequence of images 1-6 (above), taken while spraying a young citrus block. The hoop sprayer was traveling at a speed of 3.4 mph and 12-inch buffers were activated in front and behind the tree canopies by the automatic look-ahead sensors. Spray liquid savings were estimated to exceed 50 percent.

Image 1 shows the sprayer before activation of the spray, image 2 shows spray activation at 12 inches in front of the canopy and image 5 shows spray deactivation at 12 inches past the canopy. The look-ahead sensors are visible in front of the rear wheels. There was a gentle breeze from right to left.

UF/IFAS COLLABORATIVE RESEARCH ON AUTONOMOUS SPRAYERS WITH CARNEGIE MELLON UNIVERSITY AND CORNELL UNIVERSITY

This research project focuses on the retrofitting of a VRT airblast grove sprayer for use with a fully autonomous driverless tractor. Much of the research involves development of computer hardware and software to automatically operate the VRT sprayer while reporting any errors to the autonomous tractor system.

The first phase of the project was completed in November 2009, and the sprayer was demonstrated at a field day at Southern Gardens. Future upgrades to the VRT sprayer are likely to further improve precision and efficiency of spray deposition and reduce off-target spray drift by dynamically regulating the flow of spray liquid through each of the 20 nozzles and by changing the air flow from the fan on each side of the sprayer. The liquid or air flows will be determined by the canopy size and density characteristics measured with a scanning laser sensor mounted at the front of the tractor.

The upgrade to the liquid flow control system is nearly complete and will be tested in the next few months. In order to avoid undesirable pressure changes due to liquid flow regulation which would affect droplet size, we chose the Capstan®-Wilger® valve design which keeps the pressure the same, but interrupts the ejected liquid stream at 10 times per second according to different duty cycles.

Variable rate application technology in Florida citrus continues to evolve in order to offer the best possible permanent savings in agrochemicals, including fertilizers, by increasing application efficiency without adversely affecting product efficacy. The combined savings of comprehensive VRT precision agriculture can offset much of the increasing costs of citrus production and fits well into integrated pest management programs.

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