Technology to assist citrus growers: Variable rate pesticide technology

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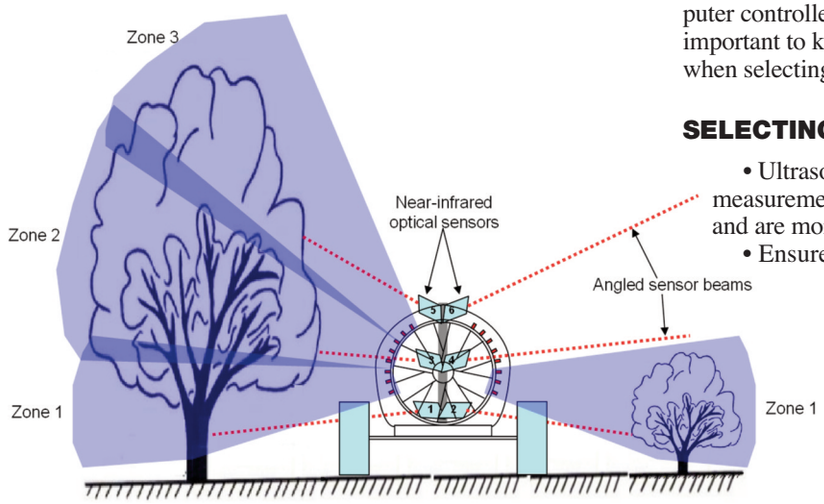

Figure 1. *Variable rates of pesticide spray delivered to a mature tree (left) and reset (right)*

(EDITOR'S NOTE: This is the third article discussing variable rate technology (VRT) for Florida citrus; articles in January and March 2008 discussed fertilization).

Variable rate technology (VRT) and site-specific management of all agrochemicals, including fertilizers, is rapidly becoming a necessity rather than an option to remain profitable. Higher prices of agrochemicals and the increasing need for insecticide sprays and tree removal due to citrus greening and canker disease management have underscored the need for more efficient application methods such as 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 environmental pollution.

Currently, most commercial VRT air blast sprayers make adjustments to the spray output by varying the number of spray nozzles activated at a given time. Groups of nozzles actuated by different automatic valves are aimed at different height zones of the tree canopy. The corresponding sensor controlling each valve and zone is aimed at the canopy covered by the lower extent of each zone as shown in Figure 1. Thus, tree canopies of different sizes are only sprayed as needed. As with fertilizer spreaders, the actual electronic sensor, computer controller, and valve components may vary, but it is important to know some of their advantages or disadvantages when selecting a VRT system.

SELECTING VRT SPRAYER HARDWARE

- Ultrasonic and optical sensors are available for canopy measurement. Optical sensors respond rapidly (1/1000 sec) and are more compact and durable than ultrasonic sensors.
- Ensure that the VRT computer controller uses automatic "look-ahead" compensation to properly synchronize the spray output with the measured variability in the tree canopy. A controller with this important feature will also acquire ground speed from a GPS receiver, Doppler radar device, or a wheel rotation encoder. The GPS receiver is by far the simplest speed measurement device since it requires no calibration and newer models are both inexpensive and highly sensitive so that satellite signals are well received in tree canopies.
- Automatic valves may be electrically, hydraulically or pneumatically actuated. The electrical solenoid or servo valves are the simplest to operate, being directly driven by the controller. Ensure that the valve response time is fast enough (0.5 sec or less) to keep up with the commands from the controller.

Solid-set young tree blocks are most efficiently sprayed with a VRT "hoop sprayer" shown in Figure 2, where spray nozzles on specially modified booms are arranged in an inverted "U" situated above and hanging down along the sides of the trees. The same VRT sprayer system of sensors, controller and valves can be used for this specialized spray application, although only the components for the lowest canopy zone are actually used.

Figure 2*. Young solid-set trees being sprayed with an automatic VRT hoop spray boom.*

Figure 3. *Enhanced VRT system, from left: optical canopy sensors mounted to the front of a tractor, VRT control box in the tractor cab, and the handheld setup computer*

UF/IFAS RESEARCH

In 2008, several new refinements on citrus VRT fertilization and pesticide spraying systems were made available to growers. The operation of the 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. For example, a single VRT system can now be plugged into a fertilizer spreader, air blast sprayer, hoop sprayer or Temik® applicator. This avoids the need for separate sensor or control systems on each applicator.

Sensor sharing was achieved by mounting the optical sensors to the front of the tractor (Figure 3), where they remain cleaner (less spray and dust) and allow faster ground speeds due to the additional GPS-guided look-ahead distance (sensor-to-discharge separation). The new VRT controller is normally used independently, but to facilitate easy configuration of operating parameters and to select the desired applicator, a wireless handheld PocketPC® computer application was developed (Figure 3). Enhanced operating parameters include customizable spray buffers around trees to ensure proper spray coverage in difficult weather conditions and selective agrochemical application for different tree size classes.

Other VRT research projects include the development of a laser scanning system for characterizing tree canopy structure, an electro-mechanical control system for on-the-go changing of sprayer air volume, and a sensing system for differentiating young flush from mature leaves. The laser scanner, coupled with a GPS receiver, can provide more detailed, real-time information on tree height, canopy volume, and foliage density or condition for various variable rate applications.

In one project, we have used the foliage density information from the laser scanner to actuate a movable air deflector plate inside the air outlet of an air blast sprayer. This system could regulate the horizontal discharge of sprayer air based on the foliage density, thereby reducing the off-target movement of spray droplets beyond the sprayed row. Recently, we have been working on the development of a spot-spraying system for spraying only young flush on mature citrus trees. Such a system is intended to minimize pesticide usage and impact on beneficial insects from frequent psyllid control sprays applied for greening disease management. These VRT devices are not commercialized yet.

VRT SPRAYER PERFORMANCE

Feedback from several citrus growers using VRT sprayers, including the new multi-purpose controllers, has been very positive. The cost of spraying pesticides has increased by about 130 percent in groves requiring a full greening and canker disease management program. Additionally, from 2006-07 to 2007-08, the price of spray chemicals increased by about 8 percent, fertilizer by 80 percent, and equipment application costs by 11 percent.

Savings in chemical consumption by growers using VRT sprayers in mature blocks (~40 years old) with resets has consistently averaged 25 percent to 30 percent, which is similar to VRT fertilizer application savings. More savings come from the reduction in tank refills (time, labor, fuel). As with VRT fertilization, the percentage savings are greatest in the most variable groves with the widest tree spacing. This is important because variability in Florida groves is increasing due to removal of greening or canker infected trees. Variations in tree size also come from past freezes, tristeza virus and blight. In young solid-set blocks, the savings are directly proportional to the sizes of gaps remaining between tree canopies. Typical large grower operations can justify the expense of the VRT equipment conversion in one season, and in some cases, one application.

VRT pesticide application in Florida citrus offers the same savings in agrochemicals as VRT fertilization, and with the new multi-purpose controllers available now, the combined savings of comprehensive VRT precision agriculture can offset much of the increasing costs of production.

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