Taking aim at pests

Initial studies show that intelligent sprayers can reduce chemical use without sacrificing control

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Figure 1. A modified hydraulic, high ground clearance sprayer equipped with a retrofitted intelligent variable-rate spraying system (three sections on right side) and a conventional constant-rate spraying system (three sections on left side) for paired comparison trials in the field.

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What if a sprayer could "sense" when a plant was present and deliver a protective spray at that time, but turn off when a plant was not present?

If this "intelligent" sprayer can reduce the spray normally applied to empty spaces between plants, less pesticide would be applied to control pest problems in nursery rows without sacrificing control.

If less pesticide is needed to spray each row, each spray tank-load would cover more rows, therefore saving on tank refills, labor, soil compaction, fuel,

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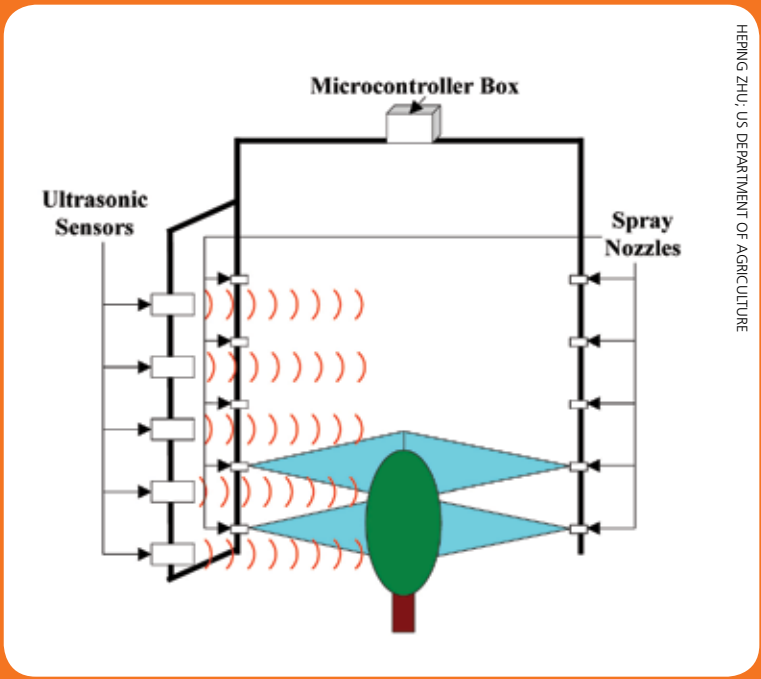

Figure 2. Shown is a variable-rate hydraulic boom "intelligent" spray system. The ultrasonic sensors signal the presence, absence, and size of plants, as well as travel speed. This information is relayed to a microcontroller, which then activates the spray nozzles only where spray is needed.

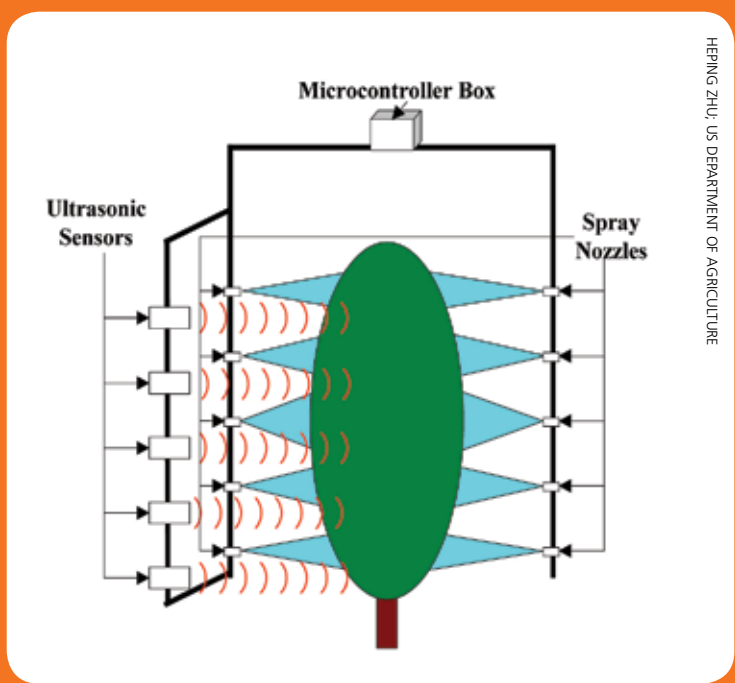

Figure 3. The top diagram shows a shrub at the height of two nozzles. As a result of that, only the bottom two sets of nozzles have activated. In the bottom diagram, the shrub is taller and all five sets of nozzles have activated.

and pesticide costs. And if nozzles turn off when there is no target to spray, there should be less pesticide deposited on soils or as drift.

Target-sensing "intelligent" sprayers have been developed for horticultural systems, such as orchard crops. Now, they are being developed for ornamental production. Research on two intelligent, or precision, sprayers is being conducted in nurseries by a multi-state team from the USDA/ARS Application Technology Research Unit in Ohio, Ohio State University, Oregon State University, and the University of Tennessee.

The goal of this research is to develop efficient and affordable sprayers that use technology to respond to crop size and presence. The sprayer then uses that information to vary the flow of pesticides from nozzles during applications.

Variable-rate hydraulic 'intelligent' sprayer

Here in Oregon, we've had the opportunity to evaluate one of the intelligent sprayers, a variable-rate hydraulic sprayer, for field efficacy. A hydraulic, high ground clearance sprayer (TR-4 Tracker; GK Machine, Inc., Donald, Ore.) was used for field testing in Oregon.

Equipment on the sprayer included a sprayer controller, a flow meter, two 200-gallon spray tanks, and two centrifugal pumps. From a 30-foot-long horizontal frame hang vertical booms with six sections. Each section has two booms with nozzles on opposite sides of the booms so that both sides of the plants are sprayed as the boom passes over a row.

One side of the sprayer (three sections) was retrofitted with an intelligent spray system, and the other side (three sections) remained as a conventional spray system (Figure 1). The intelligent spray system retrofit consisted of several elements which work together (Figures 2 and 3). It has ultrasonic sensors to detect the presence of a plant, its size and volume and a travel speed sensor.

Next there is a sensor-signal analyzer/variable-rate controller that sig-

nals solenoid valves in real time to automatically provide variable flows to nozzles based on what the sensor detects. In addition, a semi-automatic control system was added for more operator control. The above modifications of the sprayer allowed paired comparisons between intelligent and conventional treatments simultaneously for the field trials.

During 2011 in Oregon, we compared the intelligent and conventional spray system applications against two common pests: powdery mildew and aphids. We evaluated plots before and after applications of pesticides for powdery mildew and aphids during the growing season. While the rate of each pesticide remained the same between the two systems, the total volume of pesticide mix applied per acre varied between the two spray systems.

For the fungicide applications (3 applications), 75 gallons/acre were applied with the conventional system and compared to 30 gallons/acre with the intelligent sprayer. The rating system used a visual assessment of the percent of both sides of the leaves covered by powdery mildew.

Only one insecticide application was made. Forty gallons/acre were applied with the conventional system and compared to 20 gallons/acre with the intelligent sprayer.

The average number of aphids per leaf was determined from field samples. There was no statistical difference in the control of the powdery mildew or aphids between the conventional and the intelligent spray systems.

Similar trials were conducted in 2012. Only data from two fungicide applications for powdery mildew were available for analysis. However, the results again showed no statistical difference between powdery mildew ratings of the intelligent sprayer and the conventional sprayer treatments.

The intelligent sprayer trials in Oregon show that this technology can

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Heping Zhu of USDA and Sam Doan of J. Frank Schmidt & Son Co. enjoy a light moment during a demo of the intelligent sprayer. In view is the sensor driven nozzle system. It shows the white sensors on one side and the nozzles on the other side of the retrofitted boom.

significantly reduce the volume of pesticide application while achieving comparable control.

What about spray deposition, coverage and drift? In Ohio, laboratory tests were conducted to verify deposition uniformity inside canopies with various sizes of trees at different travel speeds using a prototype sprayer. The trees ranged in size from 2.8 to 8.1 feet tall.

The variable flow intelligent sprayer's deposits on the leaves and coverage of the leaves were relatively uniform, regardless of changes in the canopy size of the trees or travel speed of the sprayer.

Variable-rate, air-assisted 'intelligent' sprayer

Another design of an intelligent spray system, a variable-rate air-assisted intelligent sprayer, is being field tested in Ohio.

Like the variable-rate hydraulic sprayer, the air-assisted sprayer has sensors (a laser scanning system), a sensor analyzer/variable-rate controller, and solenoid valves. However, it uses different microprocessors and algorithms, including an onboard touch screen and embedded PC.

There has been field and lab assessment of coverage, spray loss between trees, and spray drift at different stages of trees (April, May, and June). The coverage and deposition inside canopies of the air-assisted intelligent sprayer were more stable than a conventional sprayer over different growth stages with approximately 40 percent coverage.

Compared to a constant application rate of 50 gallons/acre from a conventional sprayer, the intelligent sprayer reduced the application rate by 70, 66, and 52 percent in April, May, and June, respectively.

This research, funded by a Specialty Crops Research Initiative (SCRI) grant, will continue to field test the deposition, efficacy and reliability of both of these sprayers; to integrate an "expert" system into a greenhouse sprayer; and to complete an economic analysis of the use of these sprayers.

While it is still early in the investigation of intelligent sprayers in nursery systems, initial data shows strong promise in reducing the amount of pesticides used while providing comparable control of the pests. Factor in a decrease in spray lost on the soil or by drift and the potential for a reduction in operating costs, and the intelligent sprayer may be a smart idea whose time has come.

Acknowledgements

We'd like to thank Robert Nelson, and Gordy Webster at J. Frank Schmidt & Sons for their generous assistance and support with this research and Hans Nelson and Sons, Bailey Nursery, Jacto Inc., and the Specialty Crops Research Initiative for support for this project.

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