Passing the intelligence test

Research shows intelligent spray systems deliver healthy plants with fewer pesticides

By Robin Rosetta, Randy Zondag and Heping Zhu

Nurseries are under more pressure than ever to reduce the use of pesticides while still producing pest-free plants. This dilemma raises a couple of questions:

- Is it possible to maintain — or improve — pest management while lowering the volume of pesticides applied?
- If we make spray systems "smarter" by adding technology like sensors, can we minimize spraying the gaps between plants, improve spray deposition on plants, and reduce spray losses to the air and ground?

A team of research and Extension scientists at USDA-ARS Application Technology Research Unit, Oregon State University, The Ohio State University, and University of Tennessee answered those questions.

An air-assisted precision sprayer was designed to detect plant presence, size, shape and foliage density, to assess sprayer travel speed in real time, and to match the outputs to the plant canopy structures in the field.

The sprayer uses a high-speed laser scanning sensor, which can detect objects out to a distance of 30 meters and in a 270-degree radius. Additionally, there is a Doppler radar travel speed sensor, an automatic nozzle flow rate controller, an embedded computer with a touch screen in the cab, and 40 individually operated nozzles that spray variable flows independently to designated areas of the canopy.

Can intelligent spray systems control pests effectively and reduce the volume of pesticides?

Researchers evaluated the variable-rate air-assisted sprayer for control of insect pests and plant diseases in six commercial nursery fields in three states in 2013 and 2014. They compared two conventional air-assisted tower sprayers and three radial air-blast sprayers with the new "intelligent" sprayer for pest management efficiency. ▶

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Target insects included aphids, potato leafhoppers, honey locust pod gall midges, and pear sawflies; diseases included Pacific Coast pear rust, apple scab and powdery mildew on various host plants.

The field tests showed that the laser-guided variable-rate sprayer controlled insects comparably to the conventional air-assisted sprayers and had comparable or lower disease infection rates (Figures 2, 3 and 4).

The survival rates of aphids on crabapples (Figure 2a) and potato leafhoppers on red maples (Figure 2b) were nearly zero when insecticides were applied with either the intelligent sprayer or conventional tower air-assisted sprayer treatments.

There were no significant differences in total number of pear sawflies on cherry trees after each spray when comparing applications from the intelligent spray system, the non-intelligent sprayer (intelligent system disabled), and an air-blast sprayer using best management practices (nozzles not targeting plants turned off and sprayer switched off at the ends of rows) (Figure 3).

There was no significant difference in the presence of rusts on three-year-old flowering pears between the intelligent sprayer and the conventional air-blast sprayer treatments (Figure 4a). Powdery mildew infections on Norway maple trees were lower with the laser-guided sprayer treatment than with the conventional radial air-blast sprayer treatment (Figure 4b).

In Oregon, the intelligent sprayer reduced spray volume by 54–80 percent in two trials during 2013, and by 34–60 percent in two trials in 2014, compared to the air-blast sprayer using best management practices.

Overall, in trials in five nurseries in Oregon and Ohio, the average application rates during two growing seasons with the intelligent sprayer were 39 gallons per acre in field #1, 22 gallons per acre in field #2, 46 gallons per acre in field #3, 33 gallons per acre in field #4, and 22 gallons per acre in field #5. The average application rates from the conventional, constant-rate sprayers in these five fields were 79, 55, 78, 52 and 51 gallons per acre. Moreover, the intelligent sprayer reduced pesticide use by 43–80 percent, with comparable insect control efficiency and equal or better disease control.

Can intelligent spray systems save money?

A cost analysis of chemical expenses during the growing season comparing sprayer treatments showed a cost of $220 per

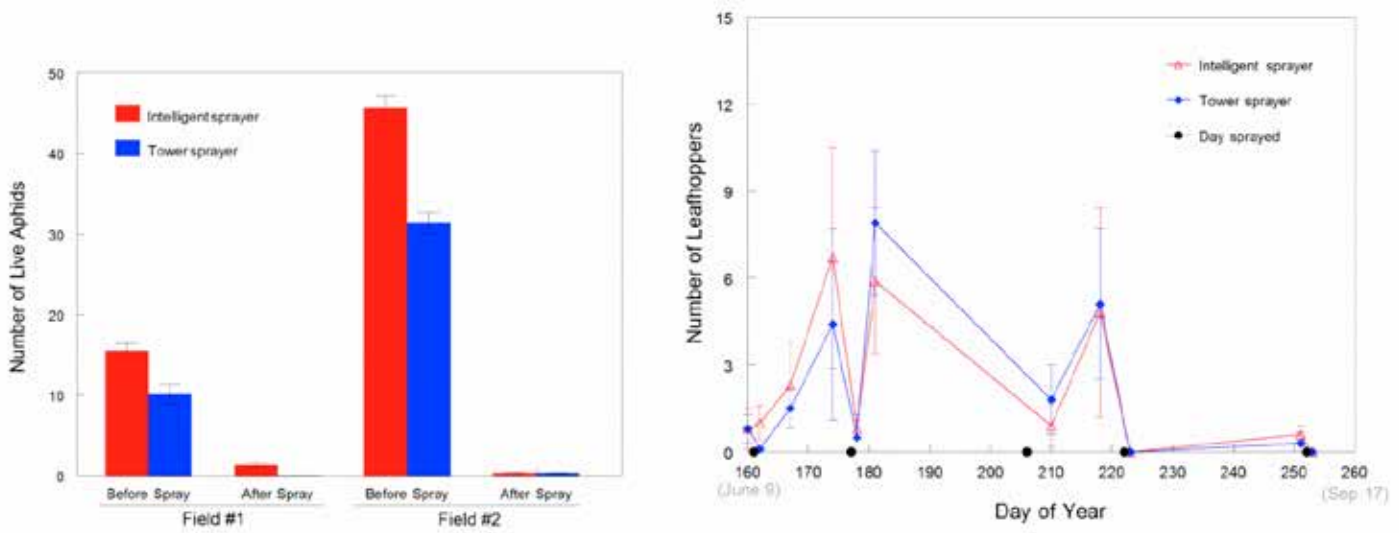

Figure 2. Comparisons of (a) aphid infestations on a crabapple and (b) potato leafhopper infestation on a red maple between the laser-guided intelligent sprayer and conventional tower air-blast sprayer treatments.

acre to control pear rust with the intelligent sprayer and $532 per acre with the conventional air-blast sprayer (Figure 5a).

The use of the intelligent sprayer to control pear rust resulted in a 59 percent reduction in chemical costs. To control pear sawfly on cherry trees, the use of the intelligent sprayer resulted in 32 percent reduction in chemical costs compared with the air-blast sprayer, and a 53 percent reduction compared with the non-intelligent sprayer (Figure 5a).

Chemical costs for scab control on crabapple for the intelligent sprayer were 62 percent lower than for the tower sprayer, and 67 percent lower than the non-intelligent sprayer (Figure 5b).

Costs for powdery mildew control were lower by 70 percent for the intelligent sprayer and 73 percent for the non-intelligent sprayer compared to the tower sprayer (Figure 5b).

The cost savings with the intelligent sprayer to control pear rust, powdery mildew, apple scab and pear sawflies are significant. There would be added fuel and labor savings — one filled spray tank covers more acreage — to the chemical savings.

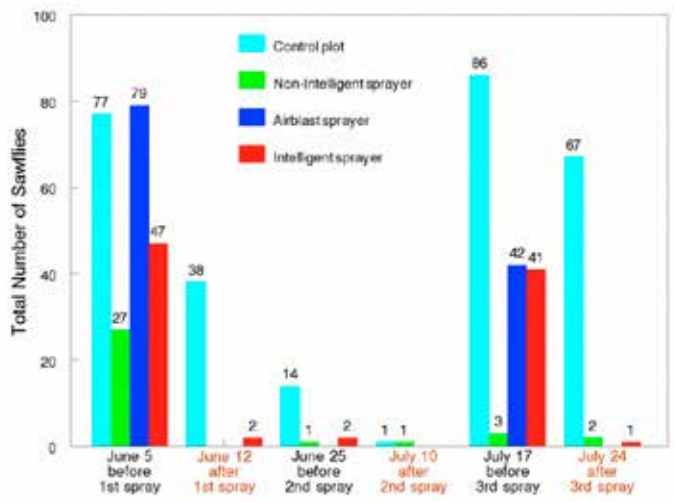

Figure 3. Comparisons of sawfly infestations on cherry trees between the untreated control, intelligent sprayer, non-intelligent sprayer and conventional air-blast sprayer treatments.

Do intelligent spray systems efficiently cover the plant targets while reducing spray losses to the ground and air?

Concerns about the potential of pesticides to contaminate the ground, air and water have motivated researchers to focus on optimizing application efficiency for sprayers. There has been relatively little research on spray application science in nurseries until recent years. There is much room for optimization.

Studies have shown that only 30 percent of spray volume in conventional nursery applications is deposited on target trees, and 34 percent of total spray volume is lost on the ground (Zhu et al., 2008). Even at the reduced volume (75 gallons per acre, or 25 percent less than conventional rates), researchers found 4–14.5 times as much spray deposit as actually needed (Zhu et al., 2006).

Field experiments in Ohio demonstrated that the intelligent sprayer, compared to conventional sprayers, reduced variations in spray deposition due to changes in tree structure. This research has shown no significant difference in spray coverage or spray deposition comparing the laser-guided intelligent sprayer to conventional sprayers.

With the intelligent sprayer there was increased spray deposition uniformity on plants at different growth stages. Furthermore, the new sprayer reduced spray loss beyond tree canopies by 40–87 percent, airborne spray drift by up to 87 percent, and spray loss on the ground by 68–93 percent.

For controlling pests, decreasing pesticide use, and reducing production costs and worker exposure to pesticide risks, ▶

this new generation of intelligent sprayer delivers precisely what it was designed to do.

Robin Rosetta is associate professor and entomologist at Oregon State University's North Willamette Research and Extension Center. She can be reached at robin.rosetta@oregonstate.edu.

Heping Zhu is adjunct assistant professor in the Department of Food, Agricultural and Biological Engineering at The Ohio State University. He can be reached at zhu.16@osu.edu.

Commercial horticulturist Randy Zondag serves as Extension educator and director at the Environmental Sciences Network at Ohio State, He can be reached at zondag.1@osu.edu.

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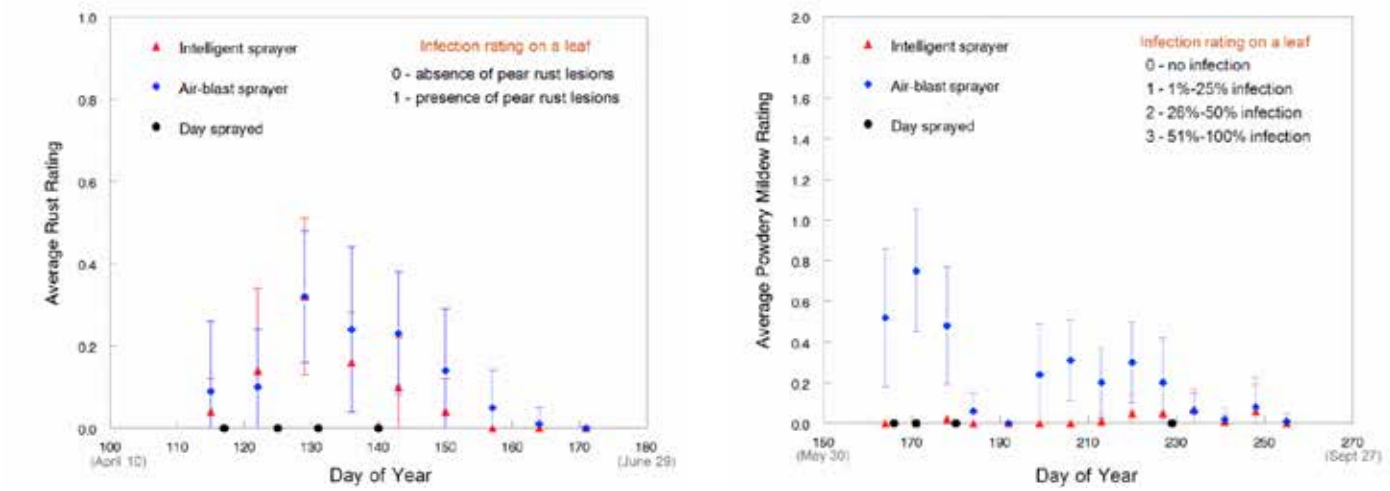

Figure 4: Comparisons of (a) rust infections on flowering pears and (b) powdery mildew infections on Norway maple trees between the laser-guided intelligent sprayer and conventional radial air-blast sprayer treatments.

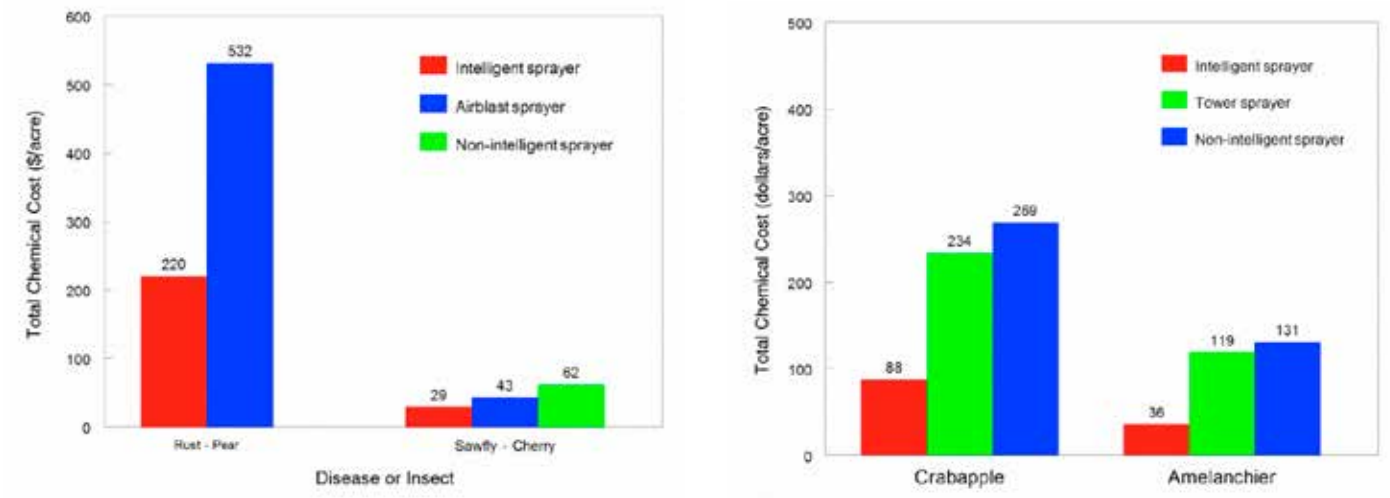

Figure 5. Comparisons of total chemical costs in treating (a) rust infections on flowering pears and sawfly infestations on Norway maple trees, and (b) apple scab infections on crabapple and powdery mildew infections on Amelanchier trees between the sprayer treatments.