Intelligent Spray Technology

SRSFC Inservice Training
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The principle behind air-blast sprayer performance is to replace all of the air within the canopy of a target plant with pesticide-laden air from the sprayer. With deciduous fruit crops, the target (plant being sprayed) changes dramatically over the years and within a given season. The size of the plant and the volume within the plant canopy will change annually in the formative years of the plant's life. Likewise, within a season as the plant progresses from dormancy to early bud break, bloom, shoot elongation, leaf development, fruiting and post-harvest the challenge of getting good pesticide coverage is constantly changing.

For effectively achieving good spray coverage and prudent use of pesticides, sprayers should be readjusted and recalibrated on a relatively frequent basis. In real-life scenarios, many air-blast sprayers may be calibrated only when new, maybe once a year or, in many cases, not at all.

Sprayers are set up to spray uniform blocks of plants. If plant size is uneven in a block, the sprayer is generally set up to do a good job delivering the spray to the larger plants. Smaller plants or missing plants within blocks result in overspraying these areas since closing certain nozzles in uneven blocks or shutting off the nozzles when a missing plant is encountered in a row is difficult to impossible and attempts to do it usually result in serious errors.

The development of "smart-spray" technology several years ago represented a vast improvement in pesticide application in that the spryer could sense the presence or absence of a target plant within a row and turn itself off or on as the situation warranted. This resulted in a significant savings in pesticide costs and a substantial reduction in misapplication of pesticides in many cases. Frequently, the savings encountered with the use of smart sprayers paid for the additional costs involved in purchasing these units.

Intelligent Spray Technology takes effective spray application to another level. Sprayers designed and operated using this technology have the ability to detect the presence of a target plant, its size, shape and foliage density and automatically apply the optimum amount of pesticide in real time. In essence, the sprayer will re-calibrate itself for every plant it encounters and for every application that the sprayer makes throughout the season.

The Intelligent Sprayer uses multiple parts and technologies that work together precisely. It uses a high-speed laser-scanning sensor in conjunction with a Doppler radar travel speed sensor, an automatic nozzle-flow-rate controller, an embedded computer, a touch screen, a manual switch box and four 5-port nozzle manifolds on each side of the sprayer. The automatic flow rate control unit is designed to process sensor signals and control individual nozzles independently with variable rate functions.

The sprayer works by using laser technology to detect the location, size, shape and density of the target plant and foliage, adjusting the spray outputs automatically as the plants need. It only works when it detects a plant, significantly reducing the amount of crop protectant needed. Additional benefits include:
 - reducing the chance of overapplying crop protectants
 - increasing the consistency of spray deposition uniformity inside plant canopies at different growth stages
 - increasing spray trajectory control
 - reducing spray loss beyond tree canopies (40% to 87% reduction)
 - reducing spray consumption by 47% to 73%
 - reducing spray loss on the ground by 68% to 93%

Efficacy and spray coverage in an ornamental nursery of an intelligent sprayer versus a conventional sprayer resulted in a 56.1 percent reduction in pesticide usage with the intelligent sprayer with no reduction in powdery mildew control. The intelligent sprayer reduced pesticide cost by 51% and spray time by approximately 50% as compared to the conventional sprayer.

In addition to building a sprayer that meets the above criteria, a second objective of the Intelligent Spray program is to develop advanced and affordable universal intelligent-decision spray control systems that can be reliably retrofitted onto conventional sprayers to more efficiently apply pesticides to reduce spray application volume, spray loss and chemical costs.

The Intelligent Spray program is headed up by Dr. Heping Zhu, and agricultural engineer based at the USDA-ARS Application Technology Research Unit in Wooster, Ohio. The project includes engineers, researcher and Extension specialists from Oregon State University, The Ohio State University and the University of Tennessee.

To date, six concept-proven intelligent sprayer prototypes have been delivered for field tests in Ohio, Oregon and the Napa Valley in California. Seven different types and sizes of sprayers being used by growers have been retrofitted with the universal spray system for field testing and demonstrations in Ohio, Oregon, South Carolina and Tennessee. These sprayers are being trialed in ornamental nurseries, peach orchards, apple orchards, citrus groves, vineyards, blueberry fields, raspberry fields, nut orchards and greenhouse crops.

Work with Intelligent Spray Technology has resulted in development of three computational fluid dynamic (CFD) models for predicting spray drift from orchards. A database of 15,000 spray drift events has been created by the CFD simulation work as has development of a computer program of Universal Orchard Spray Drift for predicting spray drift from orchards.

Research activities include:
 - spray deposition and coverage tests of intelligent sprayers and conventional sprayers in TN, OR and OH.
 - on-farm field tests to compare biological controls (efficacy) and chemical consumptions of intelligent sprayers and conventional sprayers in OH, Or, TN and CA.

- development of intelligent spray systems for greenhouse crops
- development of spray drift models and techno-economic analysis models
- pest management decision support models

Based on preliminary analysis, use of intelligent sprayers resulted in a considerable reduction in pesticide usage, number of tank refills, spraying time and resource requirements. For apple orchards ranging from 10 acres to 100 acres, cost savings of $400 to $570 per acre was recognized with the use of sprayers retrofitted with intelligent sprayer technology. The payback time for the cost of retrofitting conventional sprayers with the intelligent spray control system was four years for the 10 acre orchard and one year for the 100 acre orchard.

2017 field tests of concept-proven sprayers retrofitted with intelligent spray control system

Napa Valley vineyards in CA

Klingshirn Winery in OH

Moreland Fruit Farm in OH

Nelson Nurseries in OR

Klyn Nurseries in OH

Pleasant Cove Nursery in TN

2017 field tests of growers' sprayers retrofitted with intelligent spray control system

J. Frank Schmidt & Son Co. in OR

Willoway Nurseries in OH

Herman Losely & Son Nurseries in OH

Titan Farm in SC

George Ackerman Sprayer Company in OH

Wooden's Apple House in TN

Hale & Hines Nursery in TN