

For Airblast Spray Application and Modeling Conference. May 16-18, 2022.

Automatic Spray Volume Decision with Intelligent Airblast Sprayers

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Foliar Spray Application – most common method of delivery in modern crop production



Current spray practices have very low efficiency and require a complicated calibration process to determine the amount of chemicals to be used.



Calibration for conventional sprayers

$$\text{GPA} = \frac{43,560 Q}{88 D V}$$

If nozzles are same:

$$Q = N \times q$$

If nozzles are different:

$$Q = q_1 + q_2 + \dots + q_N$$

GPA – gallons/acre

Q –total flow rate (gallon/min)

D – spray width by each run (ft)

V – travel speed (mph)

N – number of nozzles

Flowrate



Travel speed

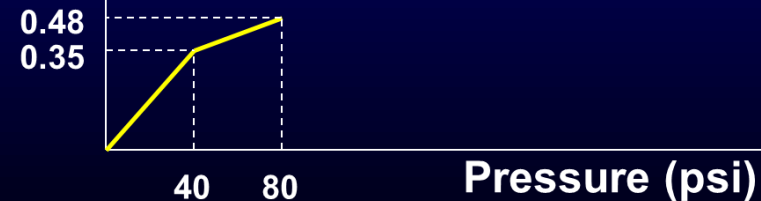


Pressure vs Flowrate

Flowrate
(GPM)

$$q = C d^2 \sqrt{P}$$

A hollow cone nozzle D5-DC25 output is 0.35 GPM at 40 psi and will be 0.48 GPM at 80 psi.



Laser-guided intelligent sprayer technology

An advanced and affordable spray system that avoids the orchard sprayer calibration and minimizes human involvements in spray volume decisions



Use individual **tree foliage volume** to control **spray outputs** of each nozzle instead of traditional gallons per acre

270° radial,
90-ft range



Convert point-to-point distances to surface structures

43,200 points/s

Each nozzle **output** is controlled by individual canopy **foliage volume** with 10Hz PWM valve:

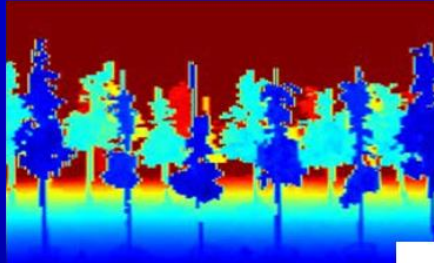


$$Q_i = \frac{E_{vol}}{t} = \frac{h \cdot W \cdot v \cdot t \cdot \rho \cdot \nabla}{t}$$
$$= h \cdot W \cdot v \cdot \rho \cdot \nabla$$

Universal control system as a retrofit on sprayers

Commercial intelligent spray controller

Existing sprayers



Algorithms



Laser sensor



Air Filtration



PWM flow control valve



GPS



Flow controller



Android Tablet Display

Retrofit





Original nozzle disc

Attach a PWM solenoid valve to the nozzle body

Spray trials in an apple orchard



Conventional mode (45 gpa)



Automatic mode

Total spray volume used for the test row

Conventional application: 3.3 gallon

Automatic application: 2.1 gallon

36% reduction

Smart Guided Systems commercialized the intelligent spray control system (<https://www.smartguided.com/>)

Smart-Apply® Intelligent Spray Control System™

The screenshot shows the homepage of Smart Guided Systems. At the top left is the logo "Smart Guided SYSTEMS" with a play button icon. To its right is a language selector showing "EN" with a US flag and a dropdown arrow. Further right is a "SUBSCRIBE" button. Below the logo is a navigation menu with links: HOME, DEMO EVENTS, GOLF COURSE SYSTEMS, INTELLIGENT SPRAYER, VIDEOS, SHOP, and DEALER LOCATOR. The main content area features a large dark grey banner with the text "INTELLIGENT SPRAY CONTROL SYSTEM™". Below this banner is a light blue box containing the text: "For the most accurate, updated, and comprehensive information on the Smart-Apply Intelligent Spray Control System™, visit [SmartApply.com](https://www.smartapply.com)". At the bottom of the page, there are three elements: the "Smart Apply Precision-Controlled Application" logo, the ASABE 2020 AE50 Outstanding Innovation Award logo, and the text "ASABE 2020 AE50 Innovation Winner".

John Deere sells the product through dealer network.

Specialty crop growers have upgraded their standard sprayers with the commercial spray system since 2019.

Crops:

Apples

Grapes

Citrus

Berries

Cherries

Hazel nuts

Hops

Pistachios

Almonds

Walnuts

Pecans

Nurseries (trees and shrubs)

Countries:

USA

Australia

Canada

Chile

Denmark

India

Mexico

New Zealand

South Africa

Switzerland

Compared to conventional sprayers with comparable controls of insects and diseases, the intelligent sprayers:

- 1. increased spray deposition uniformity**
- 2. minimized off-target losses (up to 87% reduction in airborne spray drift, up to 93% reduction in spray loss on the ground),**
- 3. reduced pesticide use by up to 70%,**
- 4. annual chemical savings by \$50-\$980 per acre.**

Dr. Mark Gleason leads investigations of intelligent sprayers to apply pesticides in apple orchards for IPM programs

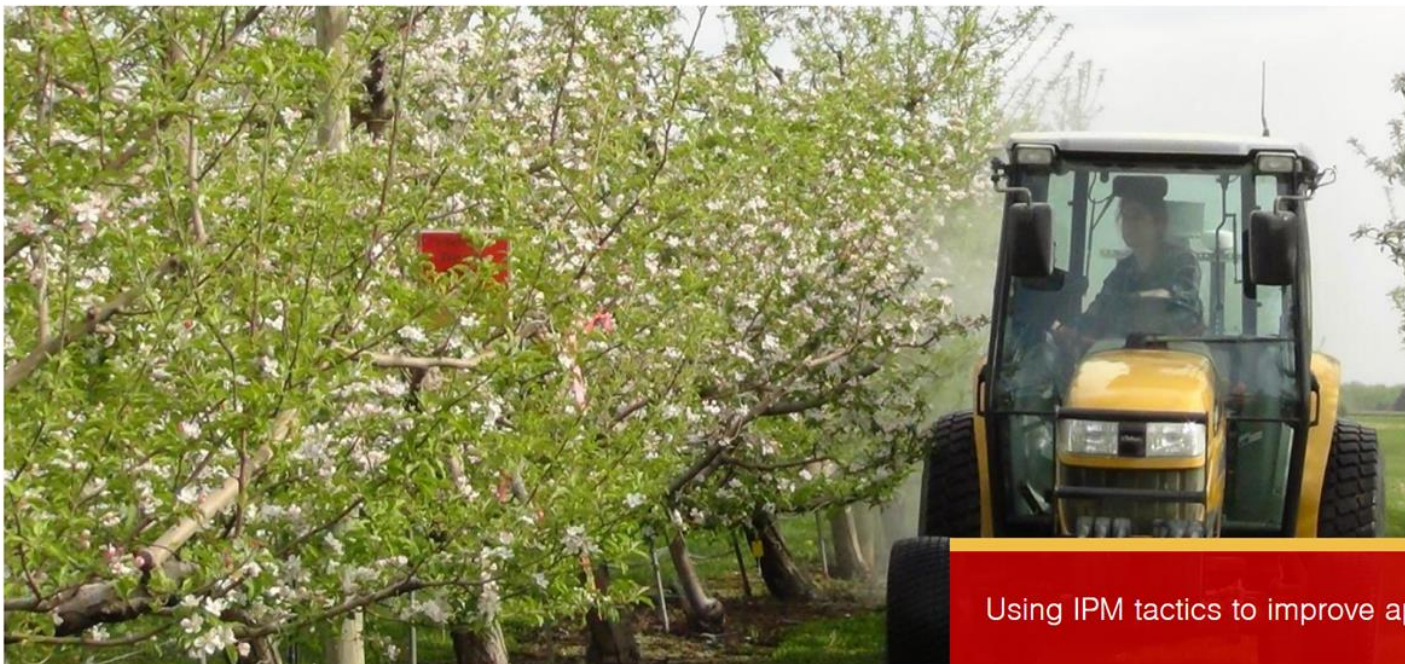
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Smarter Spraying for Apples

Smart(er) Apple Spraying podcast Home About People Blog Project videos Resources Useful websites



Using IPM tactics to improve apple production.

Project's objectives are:

- Assess combining Intelligent Sprayer technology with warning systems for fire blight and summer diseases to achieve season-long pest and disease management of apples.
- Compare economic profitability and cost effectiveness of using the Intelligent Sprayer with disease-warning systems to current practices for control of apple diseases and arthropod pests.
- Share the projects' advances with apple growers in the eastern half of the U.S. through diverse outreach approaches and an IPM Information Portal.

Welcome to SmarterAppleSpraying!

This 3-year (2020-2022) project, involving Iowa State University, The Ohio State University, and USDA-ARS, is funded by USDA's Crop Protection and Pest Management (CPPM) Program.

Recent Blog Posts

[Pesticide spray coverage: searching for the Goldilocks zone](#)

<https://www.smartapplespray.plantpath.iastate.edu/>

Label Rate Discussion

FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT (FIFRA)

[As Amended Through P.L. 112–177, Effective Sept. 28, 2012]

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FIFRA

Sec. 2

(ee) TO USE ANY REGISTERED PESTICIDE IN A MANNER INCONSISTENT WITH ITS LABELING.—The term “to use any registered pesticide in a manner inconsistent with its labeling” means to use any registered pesticide in a manner not permitted by the labeling, except that the term shall not include (1) applying a pesticide at any dosage, concentration, or frequency less than that specified on the labeling unless the labeling specifically prohibits deviation from the specified dosage, concentration, or frequency, (2) applying a pesticide against any target pest not specified on the labeling if the application is to the crop, animal, or site specified on the labeling, unless the Administrator has required that the labeling specifically state that the pesticide may be used only for the pests specified on the labeling after the Administrator has determined that the use of the pesticide against other pests would cause an unreasonable adverse effect on the environment, (3) employing any method of ap-

FIFRA 2(ee) Recommendations

By New York State:

Certain limited variations from the use directions specified on pesticide labels are authorized under FIFRA Section 2(ee).

These "2(ee) recommendations" allow:

1. Use at any dosage, concentration, or frequency less than specified on the labeling.
2. Use against any target pest not specified on the labeling.
3. Methods of application not prohibited on the labeling.
4. Mixtures with fertilizer, unless prohibited on the labeling.

By Washington State:

Section 2(ee) of FIFRA and General Pesticide Rule WAC 16-228-1225 allow that a pesticide may be:

- Applied at any dosage, concentration, or frequency less than that specified on the label (unless the label specifically prohibits such an application).
- Applied against any target pest not specified on the label (unless EPA has required that the pesticide may be used only for the specified pests).
- Applied by any method not prohibited by the label (unless the label specifically states the pesticide may be applied only by the methods specified on the label). Examples of methods include aerial, ground and airblast.
- Mixed with another pesticide or a fertilizer (if not prohibited by the label).

Thank You!

Questions?



and travel speeds

on both sides

For additional information, please contact Dr. Heping Zhu at HEPING.ZHU@USDA.GOV.