Paul C. and Edna H. Warner Endowment Fund for Sustainable Agriculture
Interdisciplinary Grant Program for On-Farm Research

Report Form

Project Title: Pesticide Stewardship using Intelligent Sprayer Technology in the Apple Orchard

Summary
Grower adoption of new technology tends to be slow, especially if there is a high price tag attached to it or the technology is perceived as complex. Intelligent sprayer technology has the potential to revolutionize the apple industry by promoting pesticide stewardship and reducing production costs while maintaining effective disease and insect pest control. The objective of the study was to validate the efficiency and effectiveness of using intelligent spray technology in controlling diseases and insect pests of apple through grower participatory trials.

What was done?
Demonstration plots were established in commercial apple orchards in Rittman and Pataskala, Ohio to validate intelligent sprayer technology as an environmental and economically sustainable strategy for managing disease and insect pests. The growers applied fungicides and insecticides (pesticides) using an airblast sprayer retrofitted with intelligent technology or using conventional airblast technology. After each spray application, the growers recorded the volume of pesticide used with the intelligent sprayer and conventional airblast sprayer. At the end of the season, the apples were harvested and sorted into three categories and counted – disease, insect injury and healthy. Video grower testimonials were taken periodically throughout the season and compiled into a video diary. An infographic explaining the technology was also developed in collaboration with Iowa State University and the USDA-ARS.

What were the results?
In both orchards, disease and insect management in plots sprayed with the intelligent sprayer was comparable to plots sprayed with the conventional airblast sprayer [Table 1 (Rittman) and Figure 1 (Pataskala)]. However, effective control was achieved using 43% less pesticide in the Rittman orchard with the intelligent sprayer and 78% less pesticides in the Pataskala orchard with the intelligent sprayer (Table 2 and 3 respectively). Both growers were excited to test the intelligent sprayer in their orchards (Video Link). The grower from Pataskala decided early on to use the intelligent sprayer across his entire farm (except in the conventional airblast test plot) and invested in the technology for the 2022 season. For the grower from Rittman, this was the second year of testing the sprayer and they also invested in the technology. The video diary will be posted on-line (www.smartapplespray.plantpath.iastate.edu/) and it will also be played for growers at the 2022 Ohio Produce Network. We are optimistic that other large commercial growers in Ohio will adopt this new technology.

How have the results contributed or will they contribute to sustainable agriculture?
By utilizing grower partnerships, intelligent technology was validated for disease and insect pest management of apples in high density orchard systems in Ohio. By reducing volume, but maintaining disease and pest control efficacy, we have shown Ohio apple growers how they can

create production systems that are more economically and environmentally sustainable than the systems that use conventional airblast technology. By decreasing the volume of pesticide applied to the trees, growers can spray more area of the orchard on a single tank, reducing the amount of time refilling spray tanks, and saving on labor costs during pesticide applications. Additionally, lowering pesticide application volume means lower pesticide costs and less pesticide entering the environment. In addition, the laser guided technology allows for targeted applications of pesticide directly to the tree canopy, reducing pesticide drift and off target application. Drift reduction reduces the potential for pesticide contamination to water sources, wildlife, and beneficial insects as well as reduced worker exposure to pesticides. Through the video diary, and other extension outreach activities including the dissemination of an infographic and presentations at state commodity events we will provide other growers with science-based knowledge to allow them to make an informed decision on adopting intelligent sprayer technology on their farm.

Table 1. Proportion Marketable, Insect damaged, and diseased 'Red Delicious' apples (percent fruit per tree) over two years at a commercial fruit farm in Rittman, OH

	Mean Percent Fruit Incidence per Tree		
Category	Intelligent[a]	Conventional Airblast	P value
Marketable	92.0 ± 8.5 A[b]	94.0 ± 7.1 A	0.3728
Insect	4.1 ± 6.2 A	2.4 ± 4.0 A	0.3296
Disease	3.5 ± 5.0 A	2.0 ± 2.6 A	0.1724

[a] The spray rate of the intelligent sprayer and conventional airblast sprayer was 0.065 L/m^3 and 655 L/Ha respectively.

[b] Mean percent fruit values were calculated from 2020 and 2021 data (n=30). Means followed by the same letter anywhere in the table are not significantly different at α=0.05 using least square means.

Table 2. Estimated total volume (L/Ha) output across the 2020 and 2021 season on 'Red Delicious' apple in Rittman, OH

	Estimated Total Volume (L/Ha)[a]	
Sprayer Technology[a]	2020	2021
Intelligent (0.065 L/m^3)	374	390
Conventional Airblast	699	699

[a] Volume (L/Ha) estimates were recorded by the grower.

[b] The spray rate of the intelligent sprayer and conventional airblast sprayer was 0.065 L/m3 655 L/Ha respectively.

Table 3. Pesticide Volume (L/Ha) output at the first eight phenological stages using two different spray technology at a commercial orchard in Pataskala, OH

	Sprayer Technology [a]	
	Intelligent	Conventional Airblast
Apple Phenological Stage	Mean Volume output (L/Ha [b])	
1cm green	179.4 F [c]	785.1 A
Pink	201.9 E	740.2 B*
50% Bloom	224.3 D	785.1 A
80% Bloom	224.3 D	785.1 A
Petal Fall	269.2 C	762.6 A
First Cover	314.0 C	807.5 A
Second Cover	224.3 D	740.2 B
Third Cover	448.6 A*	807.5 A*
P-Value		<0.0001

[a] The spray rate of the intelligent sprayer and conventional airblast sprayer was 0.065 L/m3 655 L/Ha respectively

[b] Based on 2243 trees in a one-hectare high density apple orchard.

[c] Means (mean ± standard error) followed by the same letter anywhere within the table are not significantly different with an alpha of 0.05 (n=2). Means were Log transformed for the statistical tests. Non-transformed means are reported in the table. Means with an asterisk (*) are for one reported replicate (n=1).

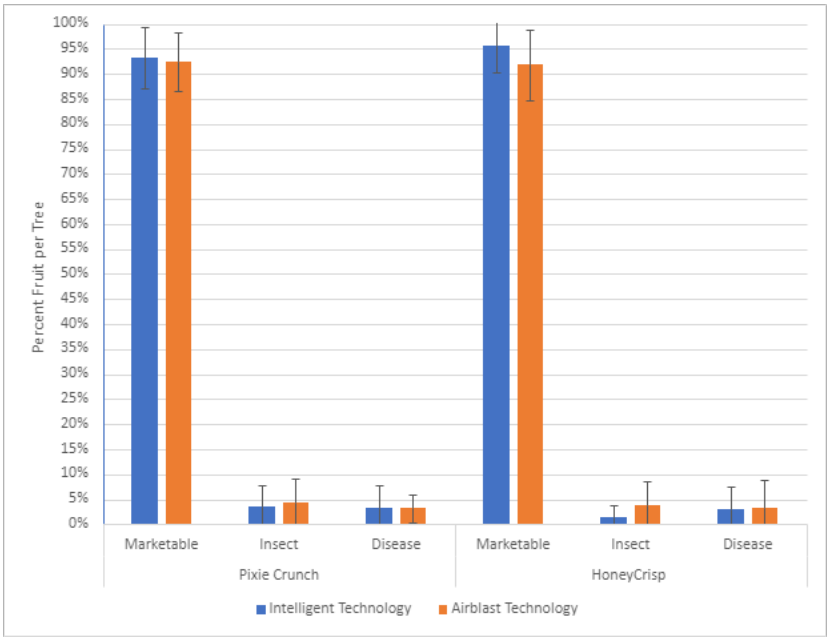

Figure 1. Percent diseased, insect injured, and marketable apples on 'Pixie Crunch' and 'HoneyCrisp' apples at a commercial orchard in Pataskala, OH in 2021. The mean (mean + standard error; alpha = 0.05) percent marketable yield ('Pixie Crunch': P=0.708,

‘HoneyCrisp’: P= 0.0701), insect injury (‘Pixie Crunch’: P=0.5559, ‘HoneyCrisp’: P= 0.0274), and diseased apple fruit (‘Pixie Crunch’: P=0.9308, ‘HoneyCrisp’: P= 0.8428) per tree (n=10) in 2021 at a fruit farm in Pataskala, OH.