BLUEBERRY (*Vaccinium corymbosum* 'Blue Ribbon')
Mummy Berry; *Monilinia vaccinii-corymbosi*
Botrytis Blight; *Botrytis cinerea*
Alternaria Fruit Rot; *Alternaria tenuissima*

J. W. Pscheidt[1], B. W. Warneke[1], L. Nackley[2]
K. Stellmach[3], and TJ Hafner[3]
[1]Dept. of Botany and Plant Pathology
Corvallis, OR 97333
[2]NWREC
15210 NE Miley Rd, Aurora, OR 97002
[3]Agricare
35711 Helms Dr., PO Box 717
Jefferson, OR 97352

Efficacy of various electrostatic and intelligent sprayer rates when using an organic fungicide program on mummy berry, 2023.

An organically managed blueberry block in Marion County, OR with a history of high mummy berry disease pressure was selected to compare the use of two different sprayers and five spray volume rates for mummy berry management. In the past, use of an organic fungicide program resulted in high disease pressure and a loss of 10-20% of the total yield. In order to reduce disease pressure, organic growers must use a combination of cultural tactics to reduce inoculum, most of which are labor intensive and expensive. Organic fungicide programs revolve around use of inorganic and biological fungicides which have been observed to have mixed efficacy in western Oregon.

Spray applications on this farm are typically applied using an electrostatic sprayer at 12.5 gal/Acre, which is a low volume for ground based spraying in the Willamette Valley (Table 1). As a general rule, the lower the spray volume applied generally results in lower spray coverage on the plant. It was hypothesized that increasing the application volume could result in improved disease control compared to the standard low volume practice. The fungicide program used was the same across all sprayers and volumes tested, including the quantity applied in the field (Table 2).

Table 1. Setting and spray volumes applied to Blue Ribbon blueberries.

Setting^{w}	Spray volume (GPA)
Electrostatic low^{x}	12.5
Electrostatic high	25
Standard Airblast	90
Intelligent-low^{y}	64^{z}
Intelligent-high^{y}	79^{z}

^{w}Treatments applied at approx. 3.5 mph.
^{x}Electrostatic low is the farm's typical practice.
^{y}Intelligent high and low treatments applied at 0.12fl oz/ft^3 and 0.06fl oz/ft^3 of canopy, respectively.
^{z}Spray volumes (gallons per acre) were estimated a single time at bud break.

The block consisted of 'Blue Ribbon' blueberry bushes, which are highly susceptible to the mummy berry pathogen. Plots were arranged as a randomized complete block design with two rows of bushes between experimental rows. Within the experimental area, rows of bushes were approximately 450 ft long, with experimental plots being approximately 40 ft long each resulting in about 300 ft of experimental plot area with 150 ft of row outside the experimental area.

Within each plot a vigorous bush near the center of the 40 ft section of bushes was selected to serve as the reference bush for data taking. Vegetative shoots on three bushes (the center bush and one on either side of the center) were examined 9 to 10 May (early bloom) for mummy berry shoot blight on each side of the row. Green berries (~350) were harvested from the center bush in each plot on 26 Jun (late green fruit), and placed in a resealable plastic bag and subsequently in a cooler for transport back to the lab. Berries from each bag were randomized and a subset of 200 were chopped latitudinally and visually assessed for the presence of mummy berry mycelia in the carpels of the berry. Ripe berries were harvested on 20 Jul from the same center bush, then transferred to crisper boxes. Berries were placed evenly on a wire mesh shelf with damp paper towels below and incubated at 70^{o}F. Berries were assessed daily for post-harvest frut rots for 14 days.

Shoot blight data was analyzed with a linear model and treatment comparisons were conducted with a Tukey honest significant difference test. Green berry and ripe berry data were analyzed with a generalized linear model with a binomial distribution and treatment contrasts were conducted using the emmeans package and adjusted for multiple comparisons using the Tukey method with 95% confidence intervals included. A 95% confidence interval in statistical reporting represents a range of values within which we are 95% confident that the mean lies, based on our sample data, indicating the degree of uncertainty in our estimate. All data was analyzed in R version 4.0.3.

Table 2. Setting and spray volumes applied to Blue Ribbon blueberries.

App. Date	Product(s)	Application rate[z]
30 Mar	Regalia + Serenade Opti	1pt , 16oz
7 April	Regalia + Serenade Opti	1pt, 16oz
14 April	Regalia + Serenade Opti	1pt , 16oz
19 April	OSO 5% SC	13oz
3 May	Serenade Opti	16oz
12 May	Botector + Organic Triggrr + Tri-Fol	8oz, 0.1gal, 0.03gal

[z]Application rate in quantity/acre.

There were no significant differences in the number of blighted shoots among all treatments in the study (Table 3). The highest number of berries with mummy berry was observed from bushes in the intelligent-high treated plots while the lowest number of berries with mummy berry was observed in the electrostatic high treated plots. There was only a 3.6% difference between these two treatments where all other treatments, including the non-treated bushes, were not significantly different from them. In general there was much less disease observed than was expected given plentiful apothecia and past infection levels observed in this block.

For postharvest rots, when *Botrytis* was assessed after 14 days the non-treated bushes had significantly lower rot than bushes with the intelligent low treatment, with all other treatments between those, and not significantly different from either (Table 4). For *Alternaria*, there were no significant differences among all treatments. For total rot, electrostatic low resulted in the lowest total rot, which was significantly lower than electrostatic high, intelligent low, and intelligent high. The non-treated and standard airblast treatments were between all other treatments and not significantly different than any of them (Table 4).

Spray coverage is closely linked with sprayer parameters, with the two largest being spray volume (gallons per acre) and air velocity/volume. There are numerous studies linking improved spray coverage to an increase in spray volume. Spray coverage is particulaly important when applying contact fungicides that form a protective layer across plant surfaces with minimal systemic action. The typical practice at the farm in this study involed application volume of 12.5gal/A using an electrostatic sprayer. Application volumes of conventional applications using airblast sprayers typically range from approximately 50gal/A up to 100gal/A and sometimes higher. While spray coverage was not directly assessed in this study, the difference in spray volume between the electrostatic and airblast treatments likely also led to differences in spray coverage.

Table 3. Mean number of blighted shoots and infected berries.

Setting	Average number of blighted shoots[z]	Percent infected green berries[z]
Non-treated	35.5 (14.5-56.5) A	3.8 (2.6-5.3) AB
Electrostatic low	35.5 (14.5-56.5) A	5.1 (3.8-6.9) AB
Electrostatic high	37.1 (16.1-58.1) A	3.3 (2.2-4.7) B
Standard Airblast	53.0 (32.0-74.0) A	3.5 (2.4-5.0) B
Intelligent-low	41.8 (20.8-62.7) A	5.8 (4.3-7.6) AB
Intelligent-high	47.5 (26.5-68.5) A	6.9 (5.3-8.8) A

[z]Means followed by 95% confidence intervals in parentheses. Values followed by different letters are significantly different.

The main premise of this study was that higher spray volume applied by the intelligent spray would lead to improved plant coverage and better disease control than the low volumes applied by the electrostatic sprayer. However for both shoot blight, and post harvest infections there were no significant differences in disease levels among the different sprayer settings tested, including against the non-treated control. There were significant differences in green berry infection among sprayer treatments, however the minimal spread between treatments and low infection in the non-treated control were not enough to characterize as biologically relevant. This was an unexpected result, as there were numerous apothecia and thus primary inoculum present when blocks were scouted at budbreak to tight cluster (early –mid april).

Table 4. Mean number of berries out of 100 examined with *Botrytis*, *Alternaria*, or total rot after 14 days in a moist chamber.

Setting	*Botrytis*	*Alternaria*	Total rot[z]
Non-treated	2.0 (1.0-4.0) A	2.3 (1.2-4.3) A	5.5 (3.7-8.2) AB
Electrostatic low	3.5 (2.1-5.8) AB	1.0 (0.4-2.6) A	4.5 (2.9-7.0) A
Electrostatic high	5.5 (3.7-8.2) AB	1.5 (0.7-3.3) A	10.5 (7.9-13.9) B
Standard Airblast	5.3 (3.5-7.9) AB	0.8 (0.2-2.3) A	7.0 (4.9-10.0) AB
Intelligent-low	7.0 (4.9-10.0) B	1.3 (0.5-3.0) A	10.2 (7.6-13.6) B
Intelligent-high	4.3 (2.7-6.7) AB	2.3 (1.2-4.3) A	10.0 (7.4-13.4) B

[z]Encompasses *Botrytis* and *Alternaria*, as well as other unidentified fruit rots.

There could be several reasons why mummy berry infection levels were observed to be below average in this study. Weather is a large contributor to mummy berry disease dynamics, with warm, wet weather being ideal to disperse ascospores that initiate primary infections. There were numerous apothecia present at budbreak and weather was warm and wet, however, the weather changed rapidly from warm and wet to hot and dry in early May when plants were at early bloom. This could have decreased the amount of primary inoculum and thus mummy berry infection levels. Another reason could be application of an effective fungicide outside the experiemental area. The block that the experiment was conducted in was managed organically historically, however outside the experiemental area the block was being tranisitioned to be managed with conventional fungicides. Conventional fungicides are much more effective than organic fungicides at managing mummy berry infections. This could mean that within the block as a whole there was less inoculum than in years past, and thus lower infection levels resulted.

This experiment was the first time the grower cooperators had used the intelligent sprayer. This came with a learning curve and the farm research coordinator had various takeaways about the sprayer mostly centered around spray volume considerations and the intelligent sprayer application interface. The main question about spray volume, and a common question among many parties interested in variable rate spraying, is determining the correct amount of spray to mix for a given application due to a variable volume being applied throughout the season. The intelligent sprayer applied a higher volume than expected for the first three applications and a lower volume than expected for the last two applications. This led to higher volumes being mixed for subsequent applications than originally predicted. Product quantities per application area were attempted to be standardized across application equipment and spray volumes, which was difficult given a lack of background using the system on the blueberry farm. Additionally, the intelligent sprayer user controls are displayed on a 10in touchscreen tablet in english only. The spray coordinator at the grower's operation primarily speaks Spanish, so there was some difficulty navigating the small text on some of the menus and selecting the appropriate settings. One feature that the spray coordinator particularly liked was the nozzle on/off animation on the left and right edge of the screen that displayed which nozzles were active in real time.

Future trials could pair spray coverage analysis with evaluation of mummy berry infection to more comprehensively evaluate spray efficiency and efficacy. Additionally, recordings of the spray volume used for each treatment could more fully elucidate the spray savings of using the intelligent sprayer compared to a standard airblast sprayer.