BOXWOOD (*Buxus sempervirens* ‘Suffruticosa’)

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Spray coverage and penetration into Boxwood canopies at a commercial nursery using an air blast sprayer and an over-the-row boom sprayer

Boxwood blight (*Calonectria pseudonaviculata*) has been present in Oregon nurseries since 2011. Cultivars resistant to *C. pseudonaviculata* are available, however susceptible types are still widely grown due to commercial demand. *C. peseudonaviculata* can infect all aboveground parts of a boxwood plant and causes defoliation in susceptible cultivars. When chemical controls are used to manage boxwood blight, thorough coverage of the foliage and penetration into the canopy is essential for good disease management. Growers use a wide variety of spray equipment and settings to apply fungicides for Boxwood blight control. There is little available information on sprayer types and spray volumes that most effectively cover and penetrate boxwood canopies.

To investigate the effectiveness of different sprayer types and spray volumes a spray coverage trial was conducted on 10 September 2020 at a commercial nursery in Washington County, Oregon. The boxwood planting consisted of three parallel rows of 6 ½ year old *Buxus sempervirens* ‘Suffruticosa’ with rows spaced 2.2 ft from each other and plants spaced approximately 1.5 ft from each other within the row. Rows were approximately 335 ft long. Rows were oriented east-west and plants were approximately 20-24 inches tall and sheared into a roughly ovoid shape. The sprayer typically used by the nursery for spraying boxwoods was a high clearance over-the-row boom sprayer capable of a 40 ft spray width, similar to a Hagie DTS10 (Hagie Mfg., Clarion, IA). To compare with the nursery’s sprayer, a standard Pak-blast airblast sprayer (Rears Mfg., Coburg, OR) retrofitted with the Intelligent Spray System (ISS) was used. The ISS uses a Lidar sensor, Doppler ground speed sensor, embedded computer, and individual pulse width modulation valves at each nozzle to release spray only when a target is sensed. In addition the ISS modulates spray volume based on the canopy density sensed by the Lidar sensor. Using the spray controller installed in the tractor, the sprayer could be switched between using the ISS and standard mode where the sprayer would be fully on or off.

Table 1. Sprayer settings used in the on-nursery boxwood coverage trial, and volumes per acre from the trial.

Sprayer used^{xy}	Tractor speed (mph)	Nozzle set	Spray rate (GPA)^{z}
Nursery Standard Over-the-row	1.7	Teejet Fulljet fl-10VS	100^{y}
	1.1		200^{y}
			400^{y}
Pak-Blast Standard	1.9	Teejet D10 DC46	272^{z}
Pak-Blast Intelligent^{x}			49^{z}

^{x}Intelligent mode treatment applied at a spray rate of 0.12fl oz/ft^{3} of canopy.
^{y}Calibrated volume, spray volume not recorded during the trial.
^{z}Rates calculated from an assumed spray area of 176 ft^{2} per replicate, actual sprayed areas varied in size.

Plots consisted of approximately 27 ft long sections of the three boxwood rows. In center row of each plot, water sensitive cards were placed inside and on boxwood bushes where symptoms of boxwood blight are known to occur. Two water sensitive cards were placed opposite each other on the outside of a boxwood bush approximately 5 to 8 in off the ground, both facing perpendicular to the direction of the row (i.e. facing north and south). Another two cards were clipped together back-to-back then inserted about 4 to 6 in into the center of the boxwood bush from above so that the face of both of the cards were facing perpendicular to the direction of the row (i.e. facing north and south). The spray pattern of the over-the-row boom sprayer used by the nursery was such that the nozzles released droplets in a thick rain-like pattern from above the plants. Plants were sprayed twice at the 200 GPA setting with this sprayer to achieve the 400 GPA rate. The spray from the Pak-blast airblast sprayer was projected at the boxwood bushes from the side, as the tractor with sprayer travelled alongside the rows. The Pak-blast sprayer treatments were applied from both sides of the rows to ensure coverage of both sides of the boxwood bushes. After spraying was completed, cards were allowed to dry for 30min before being placed in zip top plastic bags. Water sensitive cards were then scanned and analyzed for percent coverage and deposit density (deposits/cm^2) using DepositScan image analysis software. Percent coverage was analyzed using a generalized linear model and deposit density data was analyzed using a linear model. Contrasts were conducted using marginal means with comparisons conducted between all treatments. All data was analyzed in R version 3.5.1.

Table 2. Percent coverage and deposit density on 'Suffruticosa' boxwood bushes from the on-nursery coverage trial.

Sampling location	Spray treatment	Percent coverage[z]	Deposit density[z]
Outside Canopy	100GPA Over-the-row	1.2 (0.2-6.0) A	14.0 (1.4-26.5) AB
	200GPA Over-the-row	0.3 (0.01-7.1) AB	9.5 (-3.1-22.0) A
	400GPA Over-the-row	17.3 (11.5-25.3) B	16.8 (4.2-29.3) AB
	300GPA Airblast	70.3 (61.5-77.9) C	36.8 (24.2-49.3) B
	300GPA Airblast Intelligent[y]	60.0 (50.9-68.4) C	36.7 (24.1-49.3) B
Inside Canopy	100GPA Over-the-row	0.8 (0.1-5.8) A	11.7 (-0.9-24.3) A
	200GPA Over-the-row	1.3 (0.3-6.1) A	25.08 (12.5-37.7) A
	400GPA Over-the-row	3.2 (1.2-8.4) A	4.6 (-8.0-17.2) A
	300GPA Airblast	0.5 (0.04-6.1) A	9.4 (-3.2-22.0) A
	300GPA Airblast Intelligent[y]	0.2 (0.002-12.3) A	4.7 (-7.9-17.3) A

[y]Treatments in intelligent mode applied at a spray rate of 0.12fl oz/ft^3 of canopy.
[z]Means followed by 95% confidence intervals in parentheses, means within boxes followed by different letters are significantly different at $p<0.05$.

On the outside of the canopy, coverage among both the standard and intelligent airblast sprayer treatments was significantly higher than all rates using the over-the-row boom sprayer. While coverage on the outside of the canopy using the 200 GPA rate of the over-the-row sprayer was not significantly different than when 100 GPA was used, the 400 GPA rate resulted in significantly higher coverage than the 100 GPA treatment. The deposit density on the outside cards from both air blast sprayer treatments was significantly higher than the 200 GPA over-the-row treatment, but not either the 100 or 400 GPA over-the-row treatments (Table 2). Inside the canopy coverage was low, and not significantly different among all treatments, with a maximum of 3.2% observed with the 400 GPA over-the-row (Table 2). Additionally, there were no significant differences in deposit density observed on the inner canopy cards (Table 2).

Coverage on the outside of the canopy was much higher using the airblast sprayer than the over the row sprayer, likely due to both the position of the cards and the nozzle/spray pattern from each sprayer. Water sensitive cards on the outside of the canopy were placed so that they were oriented vertically and perpendicular to the direction of the boxwood rows. This resulted in cards directly facing the airblast sprayer but facing away from the over the row sprayer. Coverage with the over the row sprayer would have been much better if water sensitive cards were placed on the tops of the bushes facing vertically. Similarly, coverage with the air blast sprayer would have likely been less if cards were placed on the sides of bushes facing the direction of the row.

The boxwood blight pathogen can infect all aboveground portions of the plant, so penetrating the boxwood canopy with fungicides is important to provide full protection of the boxwood plant. Suffruticosa boxwood bushes have a dense growth habit and very little spray penetrated into the boxwood canopy where the water sensitive cards were placed using both of the sprayers in this study.

A different sprayer type would likely be the most effective way to adequately cover and penetrate 'Suffruticosa' boxwood bushes. Even when different settings were tried using the two sprayers in the study, coverage on the outside of the canopy and penetration inside the canopy was likely not enough to achieve acceptable disease control. The grower standard practice at the nursery in this study was 100 GPA using the over the row sprayer, and it was found that at that volume inadequate coverage on the sides and inside of the canopy was achieved. Even when the water volume was increased to 200 GPA or 400 GPA using the over-the-row sprayer, only modest increases in coverage were observed in these card positions. For the airblast sprayer, coverage on the outside of the canopy was good on the sides that faced the sprayer, but it did not penetrate inside the canopy. Further modifying spray settings on the two sprayers used in this study through changes in nozzles or travel speed would likely have minimal effect on improving spray coverage and penetration into the boxwood canopies, as both sprayers were already operating at near their maximum spray volume output. A sprayer that could spray the bush from multiple angles (such as a tunnel sprayer) at high air and/or spray volume would likely be the most effective self-propelled sprayer type, or a high pressure/volume hand gun sprayer.

Further investigation of other application equipment such as tunnel or hydraulic sprayers may elucidate spray volume and other equipment considerations that result in effective spray coverage on boxwood bushes. From a practical standpoint, we advise boxwood growers to use high volumes when spraying fungicides for boxwood blight management. In addition, locally systemic fungicides should be used when conditions are critical for chemical management such as during wet weather on juvenile growth in the spring.

Acknowledgements: Although we are unable to specifically name the nursery involved we greatly appreciate their cooperation with this research.