Viburnum Foliar Disease Management; Downy Mildew & Cercospora Leaf Spot

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ABSTRACT

Central Florida nursery growers have reported disease management challenges since 2004 impacting the production of ornamental *Viburnum* spp. Reported symptoms included blighting and rapid defoliation that were indicative of downy mildew (DM). Growers indicated that common labeled fungicides failed to provide acceptable levels of disease management. Beginning in the spring of 2020, symptomatic plant samples were collected from local nurseries. Identification of isolated fungi, revealed the presence of multiple pathogens throughout the growing seasons (spring, summer, and fall), including *Plasmopara* sp., *Cercospora* sp., *Corynespora* sp., *Colletotrichum* sp., *Phoma* sp., *Phyllosticta* sp., and *Pestalotiopsis* sp. Several isolates were collected and preserved for subsequent pathogenicity testing. Subsequently, two trials were conducted at a commercial nursery, to evaluate the performance of a range of fungicides. Both trials utilized natural pathogen populations present on diseased plant materials, with overhead watering and fertilization per grower standards. The first trial, conducted in July thru August, evaluated thirteen fungicides available to nursery growers. The second trial, conducted in September thru October, focused on seven fungicides. Both trials included a non-treated control, with all treatments replicated (n=6) and arranged in randomized complete blocks. Disease severity, based on percent symptomatic foliage, was rated weekly and used to calculate Area Under Disease Progression Curve (AUDPC). Initial plant samples collected in May, identified DM (*Plasmopara* sp.), *Cercospora* sp. and *Colletotrichum* sp. as the primary pathogens. However, later samplings found *Colletotrichum* sp., *Corynespora* sp., and *Phylosticta* sp., that caused leaf symptoms similar to those commonly associated with downy mildew. Not surprisingly, fungicides that target oomycetes (i.e., *Plasmopara* sp.), containing ametoctradin, cyazofamid, dimethomorph, fluopicolide, mandipropamid, mefenoxam, and oxathiapiprolin, failed to statistically reduce disease severity relative to the non-treated control based on AUDPC. Fungicides containing benzovindiflupyr, difenoconazole, fluxapyroxad, and pyraclostrobin that typically target true fungi, statistically reduced disease. Copper sulfate and mancozeb, or the systemic fungicide, flutriafol, failed to reduce disease severity, while a generic phosphite gave an intermediate level of control. Results stress the importance of getting an appropriate disease diagnosis to avoid making an ineffective fungicide application.

OBJECTIVE

Determine efficacies of commercially available fungicide chemistries for the management of DM on *Viburnum* sp. to increase profitability and economic sustainability.

METHODS

Symptomatic foliage of Sandankwa viburnum (*Viburnum suspensum*) and Awabuki viburnum (*V. odoratissimum* var. awabuki) was collected from local nurseries for pathogen identification throughout the growing seasons of viburnum (spring, summer, and fall) in Hillsborough and Manatee Counties.

Two fungicide trials were conducted at a commercial nursery in Hillsborough County. The first trial was conducted in July through August using naturally infected *Viburnum suspensum* plants grown in 3-gallon containers at a commercial production plant nursery. The trial was designed in completely randomized blocks with 6 replicates including 13 fungicide treatments representing 12 Modes of Action (MOA) and water control (**Table 1**). A second trial was conducted in September through October using the same setup as the first trial but focused on 7 fungicides with a water control (**Table 2**).

All fungicide spray treatments were applied twice at a 14-day interval, except for copper sulfate, mancozeb and a phosphite that were applied weekly, using a handheld pump sprayer, calibrated to deliver fungicide treatments in 0.5L volume. In the second trial, Ryora was applied as a soil drench per manufacturer's recommendation. Plants were fertilized and overhead irrigated according to grower production standards. The percentage of symptomatic foliage was rated weekly for six weeks to calculate the Area Under the Disease Progression Curve (AUDPC).

Data analysis was conducted using a generalized mixed model analysis (PROC GLIMMIX) within SAS (version 9.4) with blocking as a random variable and fungicide treatment as a fixed effect. Means separations were performed using Fisher's protected LSD at a 95% level of confidence.

RESULTS

Identification of isolated fungi, revealed the presence of multiple pathogens throughout the growing seasons (spring, summer, and fall), including *Plasmopara* sp. (Fig. 1), *Cercospora* sp., *Corynespora* sp., *Colletotrichum* sp., and *Phyllosticta* sp. (Figs. 2 &3). Many that caused symptoms of leaf spotting, blighting and defoliation like downy mildew. Unfortunately, repeated sampling during trials failed to detect *Plasmopara sp.*, the cause of downy mildew. Additional surveys of diseased Viburnum from other nursery sites also failed to identify *Plasmopara sp.* in winter and spring of 2021. Controlled inoculations confirmed pathogenicity for *Colletotrichum* sp. and *Corynespora* sp., while *Pestalotiopsis* sp. appears to be an opportunistic saprophyte. Pathogenicity tests for *Phyllosticta* sp. and *Phoma* sp. are in progress. Each fungal genus designation was confirmed based on internal transcribed spacer region sequence. Additional sequencing is in progress for proper phylogenetic placement at the species level. These results stress the importance for growers to get an appropriate disease diagnosis to avoid making ineffective fungicide applications.

At the initiation of the first trial (**Table 1**), the initial survey of viburnum found *Plasmopara sp.* (downy mildew) (**Figure 1**), *Cercospora* sp. and *Colletotrichum* sp. as the primary pathogens present. However, subsequent sampling failed to find any sign of downy mildew. Rather, *Colletotrichum* sp., *Corynespora cassiicola*., *Phyllosticta* sp., *Phoma* sp., and a *Pestalotiopsis* sp. were recovered from symptomatic foliar tissues (**Figures. 2 and 3**). Not surprisingly, the fungicides containing ametoctradin, cyazofamid, dimethomorph, fluopicolide, mandipropamid, mefenoxam, and oxathiapiprolin that specifically target oomycetes (i.e., *Plasmopara* sp.), failed to statistically reduce disease severity relative to the non-treated control based on AUDPC. While benzovindiflupyr, difenoconazole, fluxapyroxad, and pyraclostrobin fungicides that are typically applied for the management of true fungi, statistically reduced disease severity.

In the second trial, a subset of 7 fungicides (**Table 2**) were re-evaluated on a new set of younger plants. In this trial, lower disease pressure from *Cercospora* sp., *Colletotrichum* sp., *Corynespora cassiicola*., *Phyllosticta* sp. produced more variable results. Numerically, the fungicides flutriafol and oxathiapiprolin appeared to increase disease severity relative to the non-treated control. Based on AUDPC, only benzovindiflupyr + difenoconazole (Postiva) statistically reduced disease severity relative to the non-treated control; while pyraclostrobin + fluxapyroxad (Orkestra) numerically also gave some control based on the final disease severity rating. This trial is currently being repeated.

CONCLUSIONS

Our findings align with the growers' reports of challenges with foliar disease management in viburnum while shedding a light on the components of this management puzzle. Growing season and environmental conditions play a key role in management decisions as a result of the multiple foliar diseases of *Viburnum* sp. occurring throughout the year. These results stress the importance of correct disease and pathogen diagnosis to select the appropriate fungicide treatments. Recommendations for foliar disease management of viburnum can be adjusted based on this research which includes correct disease identification, the timing of preventative broad-spectrum and pathogen-specific fungicide treatments based on environment and season, and fungicide rotations. Future research will include pathogenicity testing of isolated fungi (*Phyllosticta* and *Phoma*) and additional sequencing for phylogenetic placement to the species level; repeated testing for some of the previously tested chemistries (currently in progress), continued sampling to better understand the different diseases during propagation (**Figure 4**), and evaluating fungicide applications during plant propagation (proposal submitted).

OUTREACH EFFORTS

Elwakil, W., Steed, S.T., Vallad, L.A., and Vallad, G.E. 2021. Viburnum downy mildew – an action plan for growers. American Phytopathological Society, Plant Health 2021, Aug. 2 – 6, 2021 (Research on demand; presentation & e-poster).

Elwakil, W., Steed, S.T., Vallad, L.A., and Vallad, G.E. 2021. Viburnum downy mildew – an action plan for growers. https://www.youtube.com/watch?v=8omLE9yu6q4 (Extension video).

Steed, S.T., Elwakil, W., Vallad, L.A., and Vallad, G.E. 2021. Viburnum downy mildew – an action plan for growers. National Association County Agricultural Agents, Virtual Meeting, Aug. 2 – 6, 2021 (E-Poster).

Vallad, G.E., Vallad, L.A., Elwakil, W., and Steed, S.T. 2020. Viburnum disease management – summary of nursery trials. Hillsborough and Manatee Counties Extension, Ornamental Production & Landscape Field Day, Nov. 5, 2020 (Live virtual presentation).

UPCOMING OUTREACH: EDIS publication, 2021 FSHS Meeting, Ornamental Field Day, and Extension Blog Post.

Table 1. List of fungicide treatments applied in the first trial conducted in July thru August 2020 and area under disease progression curve (AUDPC) representing disease severity

Product	Active Ingredient	FRAC	Rate/100 gal	DS_{final}[Z]	AUDPC[Y]
Cuprofix Ultra 40D	copper sulfate	M1	1.9 lbs	74.5 ab[X]	1742 a
Ryora	flutriafol	3	14 floz	54.4 abc	1621 ab
Micora	mandipropamid	40	8 floz	63.2 abc	1611 ab
Protect	mancozeb	M3	2 lbs	74.6 ab	1467 ab
Orvego	dimethomorph + ametoctradin	40 + 45	14 floz	57.9 abc	1229 abc
Subdue Maxx	mefenoxam	4	2 floz	63.2 abc	1198 abc
Stature	dimethomorph	40	12.25 floz	50.3 abc	1105 abc
Segovis	oxathiapiprolin	49	3 floz	43.7 bc	1099 abc
Adorn	fluopicolide	43	4 floz	53.2 abc	1080 abc
Segway	cyazofamid	21	6 floz	38.7 c	935 abc
Phostrol	phosphite	33	2 qt	38.7 c	772 bcd
Orkestra	pyraclostrobin + fluxapyroxad	11+7	10 floz	17.6 d	588 cd
Postiva	benzovindiflupyr + difenoconazole	7+3	28 floz	11.9 d	437 d
Water control	-	-	- -	80.4 a	1642 a
			P-value =	*0.0001*	*0.0112*

[Z] Based on final disease rating, based on percent symptomatic foliage, collected on Aug. 6, 2021.
[X] Area Under the Disease Progression Curve (AUDPC), calculated using final four disease severity ratings.
[Y] AUDPC means followed by the same letter are not significantly different at the 95% level of confidence

Table 2. List of fungicide treatments applied in the second trial conducted in September thru October 2020 and area under disease progression curve (AUDPC) representing disease severity.

Product	Active Ingredient	FRAC	Rate/100 gal	DS_{final}[Z]	AUDPC[Y]
Protect	mancozeb	M3	2 lbs	17.0 bc[X]	139 ab
Phostrol	phosphite	33	2 qt	20.3 abc	193 ab
Cuprofix Ultra 40D	copper sulfate	M1	1.9 lbs	17.7 bc	160 ab
Orkestra	pyraclostrobin + fluxapyroxad	11 + 7	10 floz	13.5 cd	144 ab
Postiva	benzovindiflupyr + difenoconazole	7 + 3	28 floz	7.5 d	90 b
Ryora	flutriafol (drench)	3	14 floz	41.2 a	290 a
Segovis	oxathiapiprolin	49	3 floz	29.9 ab	261 a
Water control	-	-	- -	21.7 abc	172 ab
			P-value =	*0.0079*	*0.0309*

[Z] Based on final disease rating, based on percent symptomatic foliage, collected on Oct. 22, 2021.
[Y] Area under the disease progression curve (AUDPC), calculated using final four disease severity ratings.
[X] means followed by the same letter are not significantly different.

Figure 1. Viburnum leaf exhibiting symptoms of downy mildew (top) caused by (Plasmopara sp.), with sporulation showing on leaf underside (bottom left), through a hand lens (center) and through a microscope (bottom right).

Figure 2. Common foliar symptoms observed on Viburnum spp. caused by Cercospora sp., Corynespora cassiicola, Colletotrichum sp., and Phyllosticta sp. Symptom similarities highlight difficulties to accurately diagnose.

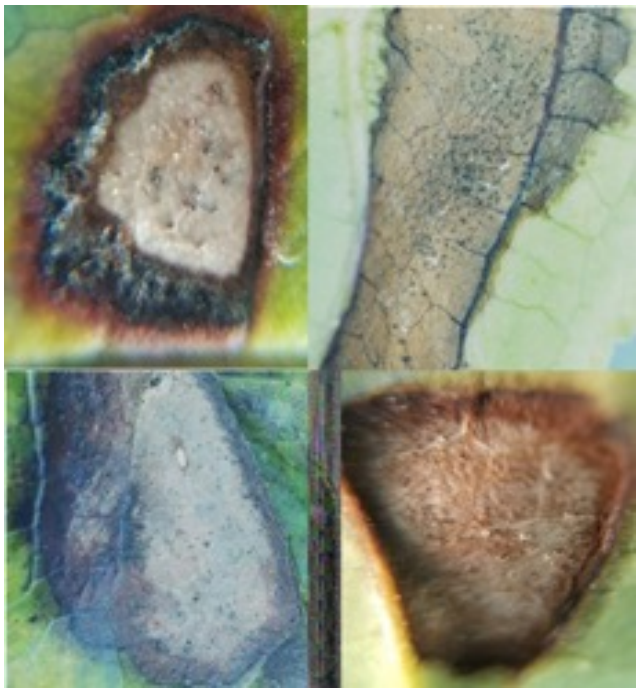

Figure 3. Hand lens view of Viburnum leaf lesions associated with Colletotrichum (top left), Cercospora (top right), Phyllosticta (bottom left) and Corynespora (bottom right).

Figure 4. Foliar disease symptoms observed during Viburnum propagation in liners (top) and recently potted plants (bottom) showing the issues of propagating from diseased plants.