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Vascular Streak Dieback: An Emerging Problem on Woody Ornamentals in the United States

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Current Situation and Symptoms

In the past two years, nurseries in Virginia and some other states have observed wilt and severe dieback on redbud, maple, and dogwood stock (Beckerman et al. 2022). In some cases, 90-100% of stock was unsellable due to the extent of damage (fig. 1).

Figure 1. A cultivar of flowering dogwood (three rows in the foreground) with a high incidence of stunted and dying plants. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Early symptoms include leaf chlorosis, scorched leaf margins, and stunting and/or wilting of current year's growth (figs. 2 A, B, and C), eventually leading to death of individual branches and progression into the main stem.

Figure 2 A. Redbud showing leaf scorch and yellowing in the upper portion of the tree. (Photo by Nicole Kopas, Virginia Department of Agriculture and Consumer Services.)

Figure 2 B. Redbud with leaf scorch and scattered branches wilting and dying back. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Figure 2 C. Flowering dogwood with severely stunted new growth. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Wilting typically starts on the top of the plant and progresses downwards into and along the main stem (figs. 3 A and B).

Figures 3 A and 3 B. Branch on flowering dogwood showing wilt that is progressing from the branch tip downwards toward the main stem. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Streaking or discoloration within the vascular, or water-conducting, tissue occurs when symptomatic branches and/or main stems are cut (fig. 4). However, vascular symptoms may be subtle or absent on dogwood or other hosts, adding a challenge for diagnosis.

Figure 4. Vascular discoloration in redbud (A and B) and red maple (C and D). (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Commonly, opportunistic fungi such as Botryosphaeria and Phomopsis colonize the weakened branches and cause cankers, adding another challenge for detection of the primary causal agent. Branches and main stems that are cankered with secondary fungi may have sunken, split, and/or callused bark; necrosis typically shows on one side of the branch or main stem (fig. 5).

Figure 5. A. Botryosphaeria canker on maple. B. Canker progressing downwards on flowering dogwood; the bark associated with the canker is darker compared to non-cankered branch tissue. C. Cracking of a cankered location on the mainstem of redbud. D. The bark associated with the cankered area on the main stem of this redbud is darker than non-cankered stem tissue; however, cankers do not always cause apparent symptoms on the bark and cutting into the vascular tissue may be necessary to reveal the discoloration. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Vascular Streak Dieback: What We Know and Don't Know

The fungus *Ceratobasidium theobromae* (synonym: *Rhizoctonia theobromae*) has been consistently associated with vascular tissue of nursery stock showing the symptoms described above. This fungus has previously been reported as the cause of vascular streak dieback (VSD) on cacao in Southeast Asia (Samuels et al. 2012). Therefore, plant pathologists in the United States are calling the putative disease VSD. The distribution and host range of *C. theobromae* in the United States is not known; to date, it has been detected from a variety of woody ornamentals exhibiting VSD symptoms in six states (table 1). In Virginia, redbud, maple, and dogwood appear to be most commonly affected.

Table 1. List of woody ornamental plants diagnosed with vascular streak dieback in six U.S. states as of March 2023.

Genus	Species	Common Name
Acer	*griseum*	paperbark maple
Acer	*rubrum*	red maple
Acer	*x freemanii*	Freeman's maple
Amelanchier	*canadensis*	serviceberry
Calycanthus	*florida*	sweetshrub
Catalpa	*bignonioides*	Southern catalpa
Catalpa	*speciosa*	Northern catalpa
Cercis	*canadensis*	redbud
Cornus	*florida*	flowering dogwood
Cornus	*kousa*	Kousa dogwood
Crataegus	*viridis*	green hawthorn
Fothergilla	spp.	witch alder
Hamamelis	*virginiana*	witch hazel
Lindera	*benzoin*	spicebush
Liriodendron	*tulipifera*	tulip poplar
Magnolia	*tripetala*	umbrella magnolia
Myrica	*cerifera*	wax myrtle
Nyssa	*sylvatica*	black gum
Prunus	*salicina*	Chinese plum
Rhus	*aromatica*	fragrant sumac
Syringa	*reticulata*	Japanese tree lilac

The problem has been observed on field stock (fig. 6) and container stock (fig. 7), and in the landscape (fig. 8). Symptoms can be confused with those of other common nursery problems, including Verticillium wilt, Phytophthora root rot, and boring insects, as well as environmental stress such as winter injury or drought.

Figure 6. Vascular streak dieback in a nursery field of Freeman's maple. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Fig. 7. Vascular streak dieback on container redbuds. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Fig. 8. VSD-symptomatic southern wax myrtles (*Myrica cerifera*) recently planted in a landscape with leaf scorch and branch dieback. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

Proof that *C. theobromae* is the causal agent of the VSD observed in U.S. nurseries has not been established, since pathogenicity tests have not yet been possible. This is because this fungus is very difficult to maintain in culture and a pure culture is necessary to perform pathogenicity testing. However, the consistent detection of this fungus on symptomatic woody ornamentals is concerning. On cacao, *C. theobromae* produces wind-dispersed spores that develop in leaf scars and cracked mid-veins of infected leaves during periods of rain and high humidity. Such spores provide fungal inoculum to infect young, succulent leaves. After a spore infects a leaf, the fungus travels into the branch and main stem via the vascular tissue, causing dieback. These spores are thought to be short-lived during favorable conditions and are not disseminated long distances.

Avoidance and Management of Vascular Streak Dieback

Currently, robust research data to inform best management practices of VSD in the United States are lacking. For now, we can only recommend using best cultural practices to maintain plant health. This may minimize the chance of infection, since cultural and environmental stress factors often play a role in predisposing plants to attack by pathogens and opportunistic organisms.

To minimize plant stress, provide conditions that are appropriate for each plant species:

- Ensure an appropriate planting depth, proper soil pH, adequate drainage, plant spacing, and sufficient irrigation.
- Avoid nontarget herbicide injury to plants.
- Transplant containerized stock periodically to prevent roots from becoming pot-bound.

To avoid spreading VSD:

- Use only healthy plants for bud grafting or clonal propagation.
- Purchase clean plant stock, since VSD may be introduced to a nursery via infected material.
- Disinfest grafting tools and pruners with a 10% bleach solution or a commercial sanitizing product between plants.
- After pruning woody ornamentals, remove any pruned wood left lying beneath the plants.
- Regularly monitor woody plants for signs of disease and boring insects.
- Isolate any symptomatic stock that may be suspect for VSD from healthy stock.
- Keep woody plants obtained from different vendors separated. This is particularly important with plants that have been reported as hosts for VSD.
- If possible, place newly purchased plants in a separate holding area for 45 days and scout for symptom development before co-mingling with other stock.

For plants exhibiting VSD symptoms, there are currently no recommended pesticide or cultural treatments. It is unlikely that a vascular disease such as VSD can be pruned-out or eradicated from the plant.

To prevent healthy plants from infection, systemic fungicide soil drenches that are labeled for management of Rhizoctonia (table 2) may provide protection.

Table 2. Some professional-use fungicides registered in Virginia[1] as a soil drench for protection against Rhizoctonia. Follow the product label directions and minimize pesticide resistance development by limiting the number of applications as specified on the product label and by rotating products from different Fungicide Resistance Action Committee (FRAC) code groups.

FRAC Code	Brand Name	Active Ingredient
FRAC 3	Terraguard	triflumizole
	Avelyo	mefentrifluconazole
FRAC 7	Prostar	flutolanil
FRAC 7 + 11	Pageant	boscalid and pyraclostrobin
	Broadform	fluopyram and trifloxystrobin
	Mural	azoxystrobin and benzovindiflupyr
	Orkestra	fluxapyroxad and pyraclostrobin
FRAC 11	Empress	pyraclostrobin
	Heritage	azoxystrobin
FRAC 12	Medallion	fludioxonil

Soil drenches will not benefit or cure plants already infected. Plants diagnosed with VSD should be removed and incinerated to prevent possible spread to landscape plants or other nursery stock. Trees may be lopped off at the collar and incinerated, and the root ball can be culled or buried but should not be composted.

Laboratory Diagnosis of Vascular Streak Dieback

Since symptoms of VSD may be confused with other abiotic or biotic problems, a laboratory diagnosis is necessary. For VSD to be diagnosed, the putative causal agent, *C. theobromae,* must be detected.

Instructions for collecting a sample for diagnosis:

1. Take samples from a plant in an early stage of symptom development (fig. 9) rather than a late stage of decline. Colonization from secondary organisms may make accurate diagnosis from late-stage samples difficult or impossible.

Figure 9. An ideal sample for laboratory diagnosis of VSD could be taken from this southern wax myrtle (*M. cerifera*), because it is in the early stage of symptom development. Plants that are far-gone in decline, have cankers caused by opportunistic fungi, or are dead are not typically useful for VSD diagnosis. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

2. Include branches or main stems with visible vascular discoloration (figs. 4, 10, and 11), if possible. If no discoloration is found, sample living branches with wilted, stunted, or scorched leaves that are still attached to the branch. Include living tissue from different parts of the symptomatic plant, including the main stem and branches. These may be cut into 6- to 8-inch pieces, then sealed in a plastic bag so the sample does not dry out.

Figure 10. A red maple shows vascular discoloration. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

1 A recommendation for a specific pesticide product or products is not an endorsement. Users must read the product label and determine if the desired use is allowed, follow all product label directions and heed product label precautions.

Figure 11. A redbud branch with the bark removed shows vascular streaking. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

3. If parts of the plant are dead, include the transition zone between healthy (white) and dead (tan to brown) wood (fig. 12). You may need to remove bark or cut through the branch or main stem to find a transition zone. If bark is removed to locate the transition zone, do not remove all the bark from the sample. Note: Completely dead tissue is typically not useful for diagnosis.

Figure 12. The transition zone between healthy and dead wood on a cankered redbud. (Photo by Devin Bily, Virginia Department of Agriculture and Consumer Services.)

4. You may include a root sample so the diagnostic laboratory can check for soil problems or root disease caused by other pathogens. For a sufficient sample, provide a large handful of the fibrous roots in at least one pint of potting media or soil. Place the roots and media or soil in a sealed plastic bag, separate from the branch and main stem pieces.

5. It is important that the sample is sent to the lab shortly after sampling. Do not place the sample in the refrigerator before shipping or allow it to heat up (for example, in a vehicle). Try to ship the sample on the day of collection and maintain it at room temperature until shipping. Ensure that samples are sealed in a plastic bag or bags, and package the sample to avoid damage during shipment. Mail samples early in the week to arrive before Friday. Ideally, ship by two-day delivery.

References

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