

An emerging threat to the redbud nursery production in the southeastern United States

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FACTS AT A GLANCE

MAJOR HOST

Eastern redbud (*Cercis canadensis* L.)

CAUSAL AGENT

Unknown

ASSOCIATED MICROBES

- Ceratobasidium* sp.(Csp)
- Botryosphaeria* spp.
- Didymella* spp.
- Diaporthe* spp.
- Phytophthora* spp.
- Phytophthium* spp.
- Fusarium* spp.
- Pythium* spp.

CURRENT DISTRIBUTION

TN, VA, NC, IN, FL, and OK

VSD symptomatic plants exhibit brown- to-gray vascular streaking in the xylem tissue within small stems, branches and the main trunk, stunted growth, decline with water sprouts/ epicormic shoots below the dead branches, chlorosis, necrosis, leaf scorch and poor root development, and/or tip dieback that may continue into the main stem or stems of the tree and ultimately cause tree death.

PRECEDING EVENTS

A redbud sample that showed wilting and dieback was first received by the Tennessee Department of Agriculture (TDA) in 2019; since then, multiple laboratories throughout the country have received numerous plant samples with symptoms similar to VSD. Redbud plants that exhibit VSD symptoms have been reported from nurseries in Virginia, North Carolina, and Tennessee, while individual detections have occurred in nurseries in Indiana, Florida, and Oklahoma. VSD has also been found in newly planted landscape plants, in a botanic garden and natural landscapes.

HOST NUMBER IS KEEP INCREASING

So far, VSD symptoms have been recorded from not only redbud but also 25+ popular ornamental and woody plant genera including more than one species of *Acer*, *Catalpa*, and *Cornus*, as well as on species of *Amelanchier*, *Calycanthus*, *Craetaegus*, *Fothergilla*, *Hamamelis*, *Lindera*, *Liriodendron*, *Magnolia*, *Myrica*, *Nyssa*, *Prunus*, *Rhus* and *Syringa*.

ARE THERE ANY REDBUD CULTIVARS THAT ARE RESISTANT TO VSD?

According to research conducted by the Tennessee State University (TSU) team in 2022, none of the tested cultivars exhibited 100% resistance to VSD-associated symptoms during the growing season.

WHAT'S CAUSING THIS ISSUE?

Initial attempts to isolate the causal agent of VSD ended up identifying some major pathogens such as *Botryosphaeria* spp., *Didymella* spp. and *Diaporthe* spp. that are known for their ability to cause canker and dieback in redbud. Additionally, *Phytophthora* spp., *Phytophthora* spp., *Fusarium* spp. and *Pythium* spp. were frequently isolated from the roots. The symptomatic plants did not exhibit Verticillium wilt, bacterial leaf scorch, or other vascular diseases.

Our insight regarding the causal agent of VSD had a breakthrough when *Rhizoctonia*-like organisms, which current molecular analyses identify as *Ceratobasidium* sp. (*Csp*), were consistently isolated and detected association with the redbud trees exhibiting vascular discoloration. When the infected tissue was incubated in humidity chambers, *Csp* growth was observed as a yellow mycelial mat. A *Rhizoctonia*-like mycelium with thick hyphae at right angles was also observed with a microscope. *Ceratobasidium theobromae* [synonym, *Rhizoctonia theobromae*] (*Ct*) was originally described in association with vascular streak dieback (VSD) of cacao trees in Asia and once listed as a priority pest. However, it is no longer considered as such today, and the identity and origin of this fungus are in question, with insufficient information available for clear characterization of this pathogen.

To determine if *Csp* is causing the dieback on redbud and other hosts, Koch's postulates must be fulfilled, reproducing the characteristic symptoms after inoculating plants with *Csp* and reisolating the organism. Thus far, efforts to complete the Koch's postulates have been unsuccessful. The fastidious nature of this fungus, making it hard to isolate, grow, and maintain in culture, poses challenges in obtaining sufficient material for DNA analysis and inoculation work. Future research need to ascertain whether VSD is caused by *Csp* alone or by multiple factors simultaneously, perhaps including canker-causing pathogens, root rot pathogens or abiotic stresses that might render host plants more susceptible to *Csp*.

WHAT IS THE ECONOMIC IMPACT OF VSD ON THE NURSERY INDUSTRY?

Tennessee, being the #1 redbud producer in the U.S., is experiencing a major economic impact from VSD. However, Tennessee growers are not the only ones facing this issue. Redbud producers in other states in the southern states, including North Carolina and Virginia, are also reporting economic losses due to the rejection of plant shipments, cancellation of redbud orders, and having to destroy symptomatic plant material in the nursery. To identify the extent of economic losses that have occurred due to VSD in the U.S., Tennessee State University (TSU) recently conducted a multi-state survey. The findings of this survey will be pivotal in understanding the dimensions of the issue.

IS THERE LIGHT AT THE END OF THE TUNNEL?

Multiple laboratories throughout the country are conducting collaborative research to address the knowledge gaps on VSD. Recently, our team at TSU developed a molecular tool for the accurate detection of *Csp* from potentially infected host plant material. Our real-time polymerase chain reaction (PCR) primers are currently undergoing further testing by several other institutions. With demonstrated success, these primers may soon be released for use as a diagnostic tool, enabling efficient and accurate detection of *Csp* from symptomatic plant materials.



The TSU team is also conducting cultivar screening trials to identify the tolerance of redbud species and cultivars to VSD, as this information is crucial for initiating breeding programs to obtain hybrids with promising horticultural characteristics and increased resistance to VSD. According to research findings, redbud cultivars with yellow-colored foliage and papery leaf texture were more susceptible to VSD than other tested cultivars, showing leaf-scorch symptoms starting in late May. In contrast, VSD-tolerant cultivars with dark green and purple foliage and thick leathery leaves exhibited VSD-associated leaf-scorch symptoms in late August. The TSU team is continuing with the cultivar screening, including more redbud species, cultivars, and hybrids received from different regions, to identify VSD resistance.

Best Management Practices to Combat VSD



Scouting and early diagnosis

Sanitation

Crop rotation

Avoid unnecessary pruning

Use only healthy plants for propagation

Proper irrigation

Use appropriate depth for planting

Avoid herbicide injury

Proper fertilization

Chemical control

- **As a specific pathogen has not been identified at this time, there are no chemical treatment recommendations for VSD management.** However, since the nursery producers are in fundamental need of management recommendations, the TSU team with the collaboration of industry partners conducted fungicide efficacy trials in 2022 using redbud plants that were naturally exhibiting VSD-related symptoms. Results indicate that foliar applications of Postiva (FRAC 3 + 7) at 20 fl oz/100 gal and Mural (FRAC 7 + 11) at 7 oz/100 gal at 14-day application intervals were the most effective treatments in reducing leaf scorch associated with VSD on eastern redbud seedlings, on 3-year-old plants, and on several 2-year-old budded cultivars growing in field and container settings. These treatments also reduced the population levels of canker-causing pathogens such as *Botryosphaeria* spp. and *Didymella* spp. Although some treatments were identified as effective in reducing the VSD-associated symptoms, they did not cure already- infected plants. TSU is continuing with research to identify more effective chemical treatments to manage VSD.
- Since soilborne pathogens have been frequently isolated from the VSD symptomatic plants, proper management of soilborne pathogens such as *Phytophthora*, *Pythium*, *Rhizoctonia*, and *Fusarium* spp. might be beneficial for reducing the damage caused by VSD. If using preventive fungicide drenches to protect roots against *Rhizoctonia* and other soilborne pathogens, fungicides with different modes of action should be applied in rotation. Some recommended rotations include:
 - Empress or Heritage (FRAC 11), rotated with Medallion (FRAC 12) or Terraguard (FRAC 3).
OR
 - Mural or Orkestra (both FRAC 7+11) rotated with Terraguard (FRAC 3) or Medallion (FRAC 12).

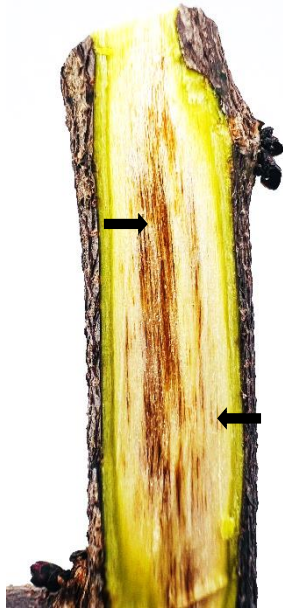
If you encounter redbud plants in nurseries or managed landscapes with VSD symptoms, contact Dr. Fulya Baysal-Gurel at fbaysalg@tnstate.edu.

Pictorial guide for VSD identification

Leaf scorch and interveinal chlorosis associated with VSD symptomatic redbud plants



VSD-associated vascular streaking on redbud-
vertical cross section view



Dieback associated with VSD

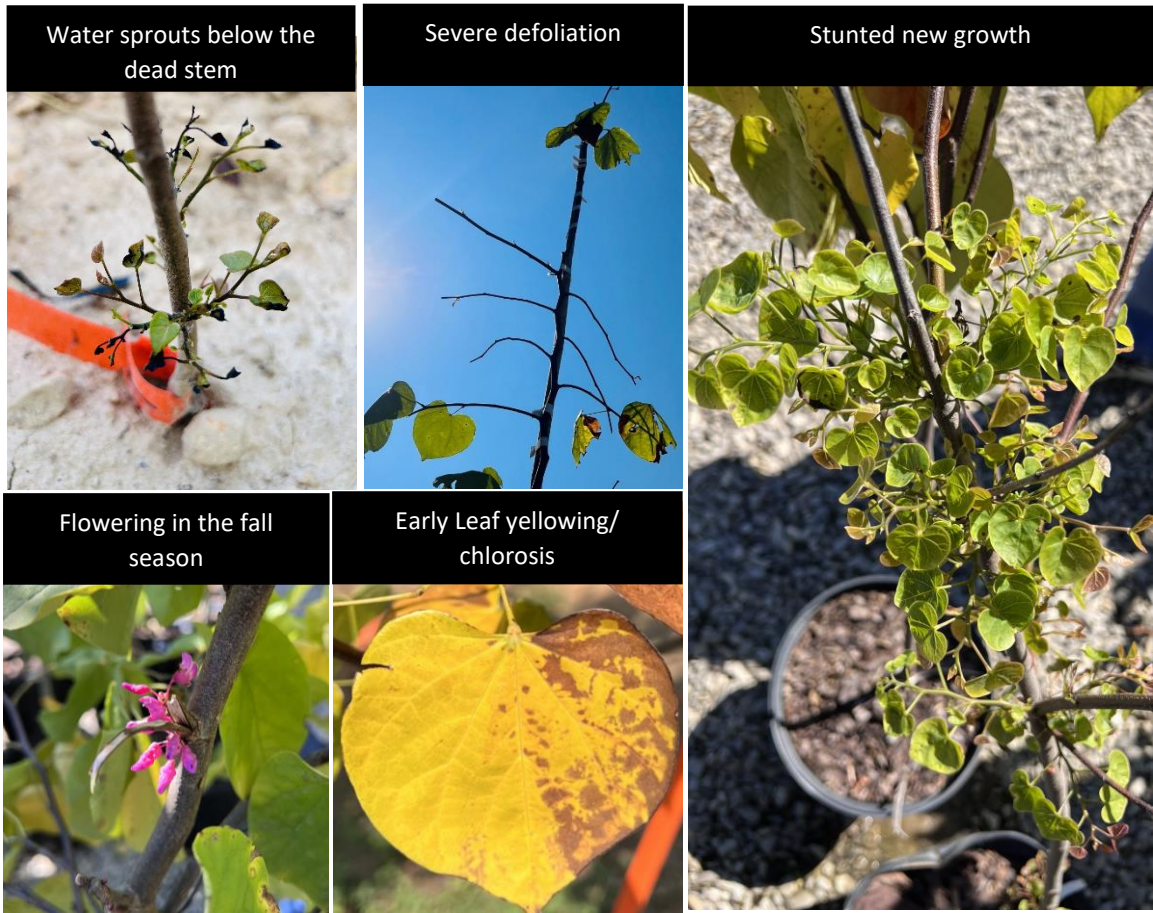


VSD-associated vascular streaking
on redbud-horizontal cross
section view



Stunted growth observed with VSD-symptomatic redbuds

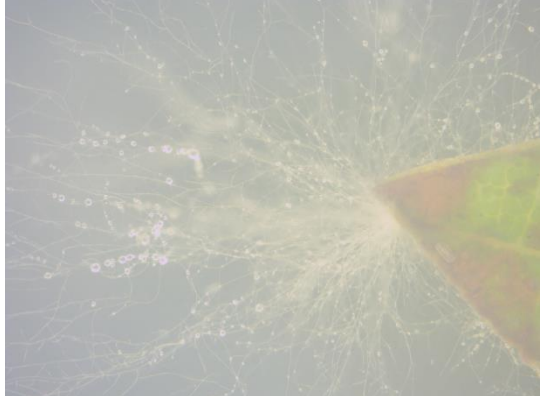




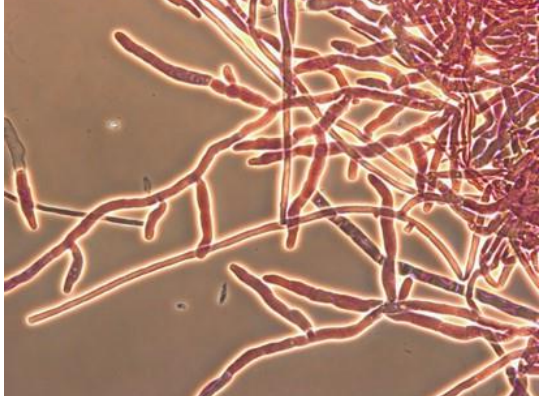
Csp growing from the incubated VSD symptomatic redbud leaf, stem and roots



Csp growth from the leaf of VSD symptomatic redbud plant as seen under a dissecting microscope (50X)



Csp growth as seen under a light microscope (600X)



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Disclaimer

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