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Tobacco streak virus in cranberry

Four viruses have been detected in cranberry to date: *Tobacco streak virus* (TSV), *Blueberry shock virus* (BIShV), *Blueberry scorch virus*, and *Blueberry red ringspot virus*. TSV was first discovered in association with berry scarring (figure 1) in Wisconsin in 2012, and has since emerged as a potential threat for growers in the major production regions of the United States, including Wisconsin, Massachusetts, and New Jersey. The association of TSV with berry scarring in cranberry is strong, and TSV has been detected in all cultivars tested, including both newer hybrid cultivars (e.g., 'Crimson Queen,' 'Demoranville,' 'Grygleski Hybrid 1,' 'HyRed,' and 'Mullica Queen') as well as older cultivars (e.g., 'Norman LeMunyon,' 'Pilgrim,' and 'Stevens').

Symptoms

Scars appear on berries as necrotic, irregularly shaped, indented lesions ranging in length from <2 mm to >10 mm (figure 1). Some affected berries abort, while others mature but are small in size and are distorted with lesions causing deep indentations, cracks, or both. All leaves, stems, runners, and roots appear normal on plants bearing affected fruit. In almost all cases where symptoms occur, every berry on an upright is symptomatic, and every upright on an affected runner produces symptomatic fruit, suggesting a systemic infection. Although not as common as berry scarring, flower and tip blighting are also observed on TSV-infected uprights (figure 2).



FIGURE 1. Irregularly shaped, indented lesions on cranberry fruit infected with TSV



FIGURE 2. Blossom blight symptoms on uprights infected with TSV

TOBACCO STREAK VIRUS IN CRANBERRY

However, other pathogens, such as *Phyllosticta vaccinii* and *Monilinia oxycocci*, as well as feeding from insects such as the blackheaded fireworm, can cause similar blossom blight symptoms, so this symptom is less diagnostic than berry scarring. Affected berries turn red in color prematurely, during the early fruit set stage of development (figure 3). That is why this is an opportune time to scout for berry scarring on a marsh, as virus-infected berries become more difficult to find later in the season when healthy berries also turn red. Feeding from insects such as cranberry fruit worm can also cause premature reddening in berries, and care should be taken to accurately identify the cause of reddening during the early fruit set stage of development.

Berry scarring symptoms associated with TSV can easily be mistaken for symptoms associated with another cranberry virus, *Blueberry shock virus* (BIShV). BIShV has also been detected in several growing regions, and berry scarring symptoms associated with TSV or BIShV are identical and cannot be used to distinguish the viruses (figure 4).

“Recovery” of cranberry plants from TSV

TSV overwinters in cranberry plants in the field. Plants “recover” from the virus in the year following scarring symptoms. That is, plants which produce scarred TSV-positive fruit in one year produce nonscarred TSV-positive fruit in following years. TSV-positive cranberry uprights exhibit berry scarring symptoms for only one year, and remain asymptomatic in subsequent years. Once plants have recovered from TSV, the infected recovered uprights are visually indistinguishable from uninfected, healthy uprights. However, despite

the absence of symptoms, recovered plants and the pollen they produce remain TSV-positive and continue to serve as a source of inoculum that may spread the virus to healthy plants.

Average berry weight and percent fruit set are significantly decreased in TSV-positive uprights with scarred fruit. This is because most berries affected by scarring become shriveled by the time of harvest, and any berries that do not shrivel are stunted and severely deformed. Recovered TSV-positive uprights, however, do not differ from healthy uprights in average berry weight, number of flowers produced, or percent fruit set, suggesting that there are no negative impacts of TSV on yield. Impacts of TSV on return bloom in recovered uprights in the years following berry scarring symptoms are variable, but research suggests that return bloom is not negatively impacted in the first year following scarring symptoms. Impact in subsequent years is less clear since data is not available on fluctuations in return bloom in healthy cranberry uprights over multiple years. All research was performed on cultivar ‘Mullica Queen’ but similar results are expected for other cultivars.



FIGURE 3. Scarring and premature reddening on cranberry fruit at the early fruit set stage of development



FIGURE 4. Berry scarring symptoms on uprights infected with *Blueberry shock virus* (left) and *Tobacco streak virus* (right)

Sources and spread of TSV

The origins of TSV in cranberry beds are not known. TSV can infect plants in many different families; however, it has not been detected in weeds in or surrounding symptomatic cranberry beds. Viruses in many woody plants are carried in planting stock, and it is possible that TSV enters cranberry beds on cranberry plugs or vine cuttings.

Viruses tend to move toward metabolically active organs, or “sinks” in plants. As these “sinks” change with cranberry development, the distribution of a virus within a cranberry upright changes throughout the growing season as well. For cranberry uprights with scarred fruit, virus distribution is uneven and changes throughout the growing season, while little change in virus distribution is observed in recovered uprights bearing unscarred fruit.

How TSV spreads within and among cranberry beds is currently unknown. In other crops, thrips are often involved in the transmission of TSV. Thrips are routinely detected in cranberry beds, but their involvement in the transmission of TSV in cranberry has not been studied. TSV is detectable both in and on cranberry pollen, making it possible that pollinators spread the virus from plant to plant. TSV is seed-borne in several crops, but research suggests that TSV is not transmitted by seed in cranberry. The role of people spreading TSV by walking in beds has not been studied, but it is probably minor since TSV is often detected in parts of beds not previously subjected to foot traffic.

Recommendations

Once a cranberry plant becomes infected with TSV, it cannot be cured. Because we cannot visually distinguish a recovered, infected plant from a healthy, uninfected plant, it is impossible to eliminate all potential sources of inoculum within an infected cranberry bed by attempting to remove infected plants. Nevertheless, the following recommendations will help minimize the impact of TSV on cranberry marshes.

- Prevent the introduction of TSV into cranberry beds and marshes by using virus-free planting stock when establishing new beds. At the very least, do not establish a new bed with cuttings from a bed known to harbor TSV.
- The best time to scout for TSV visually is during early stages of fruit development, in mid- to late July. Scarred berries turn red prematurely and stand out from the background of green leaves and healthy, immature berries (figure 3).
- To collect samples for TSV testing, follow these guidelines.

If you see scarred fruit:

- Collect about 10 uprights with scarred fruit from an affected bed.
- 1 upright = 1 sample.
- Place each sample (1 upright) into a single plastic bag.
- Refrigerate (do not freeze!) samples until shipping.
- Request to have berries and leaves tested from each upright if collection is during early fruit set. Request that leaves be tested if collection is during late fruit set or harvest.

If you do not see scarred fruit:

- More samples and more uprights per sample are required when looking for TSV in the absence of berry scarring.
- Collect about 10 uprights from 10 locations representative of a bed.
- 10 uprights = 1 sample.
- Place each sample (10 uprights) into a single plastic bag.
- Repeat until you have at least 8 samples, each sample in its own bag. The more samples you test, the better for getting an accurate answer.
- Refrigerate (do not freeze!) samples until shipping.
- Request to have leaves tested from each sample.
- Since the role of insects in spreading TSV in cranberry is not known, do not spray insecticides with the goal of curtailing virus spread. The risk of harming pollinators outweighs the benefits of killing possible insect vectors of TSV.
- Although research and observations to date suggest little or no long-term impact of TSV on cranberry yield or vine health, be aware that combinations of viruses in woody plants can sometimes cause problems. Therefore, monitor infected beds closely for a reduction in yield or a decline in plant appearance.



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