Blueberry Leaf Mottle and Blueberry Shoestring Virus

a. Virus/pathogen name, including accepted acronyms and synonyms

Blueberry leaf mottle virus is a *Nepovirus* in the *Secoviridae* family
BLMoV is the ICTV accepted acronym, however BBLMV, BLMV have also been used.

Weak cross-reactivity between *Grapevine Bulgarian latent virus* (GBLV) and BLMoV caused confusion on the relationship of these viruses. However, in 2011 the full genome of GBLV was determined which confirmed that GBLV is a closely related, but distinct species to BLMoV (Elbeaino et al., 2011).

b. Host range, including resistance or tolerance within the crop hosts, alternate hosts

BLMoV infects both wild and cultivated blueberry; highbush blueberry - *Vaccinium corymbosum*, *V. myrtilloides, V. angustifolium* and hybrids *V. corymbosum x V. angustifolium.*

A small field trial in Canada identified five clones Mn61, Mn84, Mn135, Mn354, NBBC1 which were not infected by BLMoV, however other viruses were detected in Mn61 (Jaswal, 1990)

BLMoV is readily transmitted to *Chenopodium quinoa* and is used as an indicator plant, symptoms include death of terminal growth, chlorotic local lesions and systemic mottling (Ramsdell and Stace-Smith, 1980). Other herbaceous hosts include *C. album*, *C. amaranticolor*, *C. capitatum*, *C. foetidum*, *C. murale*, *Cucumis sativa* 'straight eight', *Cyamopsis tetragonaloba*, *Gomphrena globose*, *Lycopersicon esculentum* 'subarctic', *Nicotiana benthamiana*, *N. clevelandii*, *N debnyii*, *N. glutinosa*, *N. haranova*, *N. rustica*, *N. sylvestris*, *N. tabacum* 'Havana 425' 'White Burley' 'Xanthi', *Phaseolus vulgaris* 'bountiful', with a number of these being asymptomatic (Ramsdell and Stace-Smith, 1980).

BLMoV has been found in a number of grapevines in Korea. The sampled grapevines showed yellowing and mottling or were asymptomatic (Kwak et al., 2015).

c. Symptoms on crop host including varietal differences with images of symptoms when available.

Highbush 'Rubel' shows strong symptoms including leaf mottling, older stem dieback with deformed, stunted new growth and leaves sometimes have chlorotic circular windows present. Highbush cultivar 'Jersey' shows milder symptoms including, smaller leaves, slight leaf mottling of lower leaves, stunting and growth reduction, and stem dieback is not prevalent. 'Rubel' have nil productivity, whereas 'Jersey' have greatly reduced productivity (Ramsdell, D. C, 1987).

Korean grapevines infected with BLMoV had yellow and mottled leaves, or were asymptomatic (No pictures present) (Kwak et al., 2015).

a. Geographic distribution:

BLMoV was first identitifed in 1977 in highbush blueberries in Michigan, USA (Ramsdell and Stace-Smith, 1980) and then in a number of halfhigh clones in a cultivar susceptibility trial in Canada (Jaswal, 1990). More recently BLMoV has been found in the Midwest and Northeast in the USA (Martin and Tzanetakis, 2018). There is only one report of BLMoV outside of North America, in grapevine in Korea (Kwak et al., 2015).

Once GLBV was determined to be a separate species, the reports of European GBLV samples are no longer relevant to the distribution of BLMoV.

b. Means of spread:

BLMoV is spread by seed and pollen, with honeybees known to be involved in the movement of infected pollen (Boylan-Pett et al., 1991; Childress and Ramsdell, 1987, 1986). Seed transmission of BLMoV is low and plants are rarely grown from seed in a commercial setting (Childress and Ramsdell, 1987). While many nepoviruses are transmitted by nematodes, there is no evidence that nematodes spread BLMoV (Childress and Ramsdell, 1985).

c. Recognized diagnostic tests with cited references:

Commercial ELISA kits are available for detection of BLMoV. It should be noted that GBLV, a closely related nepovirus shows weak cross-reactivity to BLMoV ELISA, and vice versa. RT-PCR has become readily available and routinely been used for detection (Villamor et al.,2022)

d. Sampling recommendations for each pathogen including timing and tissue to be sampled

As with other blueberry viruses, the youngest fully expanded leaves should be sampled. Buds have also been used for BLMoV ELISA with less background reported than with leaves (Jaswal, 1990)

e. Management strategies for the pathogen and the vector(s) of the pathogen

Both wild blueberry and volunteer blueberry plants close to fields have tested positive for BLMoV (Sandoval et al., 1995), so these should be removed, along with any infected plants within the field. As bees are known to spread BLMoV infected pollen, the movement of hives from infected regions to non-infected should be avoided.

Blueberry Shoestring

f. Virus/pathogen name, including accepted acronyms and synonyms

Blueberry shoestring virus is a positive sense RNA virus in the *Sobemovirus* genus of the Solemoviridae family. The ICTV accepted acronym is BSV, however BSSV, BlSSV and BBSSV are commonly used in the literature.

g. Host range, including resistance or tolerance within the crop hosts, alternate hosts

BSSV has been found in *Vaccinium corymbosum* L., *V. angustifolium* Ait, *V. myrtilloides, V. ashei* and hybrids *V. corymbosum* x *V. angustifolium*, *V. corymbosum* x *V. darrowi.*

While multiple early reports state 'Bluecrop' shows resistance, more recently BSSV has been found in 'Bluecrop' plants in Poland (Paduch-Cichal et al., 2011).

Mechanical and aphid inoculation of nine cultivars found different BSSV susceptibility of the cultivars, however only one 'Brightwell' (Rabbiteye) was negative for both inoculation methods, suggesting resistance (Acquaah et al., 1995). A field trial of 11 clones identified field resistance in Mn84, Mn135, Mn332 –Northsky, MN350 –Northcountry, Mn354, Me-1 NBBC1. However, other viruses were detected in all except Mn84, Mn135, Mn354, NBBC1 (Jaswal, 1990).

Innoculation of a number of herbaceaous species have been unsuccessful, however innoculations of young 'Jersey' results in symptoms after 5-6 months (Lesney et al., 1978)

h. Symptoms on crop host including varietal differences with images of symptoms when available

Leaf symptoms vary from pointy distorted leaves, narrow leaves and a red oak leaf pattern across fully developed leaves. Red vein discoloration is normally seen, which may cover the majority of the leaf, or just one of more sections. Not all leaves of an infected plant show symptoms, and different environments may result in different intensities (Martin et al., 2012).

Highbush blueberry shows reddish streaks on stems (current and 1yr stems) Some petals will also show red streaks. Berries may show premature red or purple coloration. Leaves are straplike, crescent or curled, some may show red midrib streaking, red vein banding or red oak leaf patterns. Not all leaves show symptoms, some bushes show many leaf symptoms whereas others may only be present on a few shoots near the crown. Increasing disease progression can be seen along a row. Visual symptoms of disease may take many years to become apparent, with healthy bushes planted alongside diseased bushes showing symptoms only after four years

(Ramsdell, 1987). Symptomless plants have tested positive for BSSV and are likely reservoirs of the virus.

i. Geographic distribution:

Shoestring as a graft transmissible disease was first described in 1957 in New Jersey (Varney, 1957). BSSV has also been found in the Northeast and Midwest in the USA (Hancock et al., 1993a; Martin and Tzanetakis, 2018). A single sample has tested positive in Maine (Hancock et al., 1993a), and there are unpublished reports of the disease in North Carolina, and Washington (as mentioned in (Ramsdell, 1987)). BSSV is also present in Canada (Hancock et al., 1993a; Jaswal, 1990; Lockhart and Hall, 1962). Outside of North America, BSSV has been identified in Poland (Paduch-Cichal et al., 2011).

j. Means of spread:

BSSV is spread by the blueberry aphid *Illinoia pepperi* MacG (Morimoto et al., 1985; Morimoto and Ramsdell, 1985).

k. Recognized diagnostic tests with cited references:

Commercial ELISA kits are available for the detection of BSSV yet PCR is the preferred method today.

l. Sampling recommendations for each pathogen including timing and tissue to be sampled

As with other blueberry viruses sampling of the youngest, fully expanded leaves is recommended. Unequal distribution of the virus means multiple samples should be taken from different locations. BSSV is also able to be detected from flower buds, where BSSV titre is high (Ramsdell, 1987).

m. Management strategies for the pathogen and the vector(s) of the pathogen

Roguing of infected plants in combination with insecticide targeted to the blueberry aphid is needed to manage BSSV. Both wild and cultivated blueberry are known to be susceptible, with a number of wild asymptomatic blueberry testing positive for BSSV (Hancock et al., 1993b) therefore the removal of wild blueberry near fields is also recommended.

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Date of last update: July 2026