Arabis Mosaic Virus

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

Arabis mosaic virus, ArMV– Genus *Nepovirus,* Family *Secoviridae,* Order *Picornavirales.*

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

ArMV has a host range that exceeds 100 species belonging to 30 families. ArMV occurs naturally in plants belonging to the genera *Rubus* spp. (blackberry and red raspberry) but can also infect *Fragaria* spp. (strawberry), and *Ribes* spp. (black currant and red currant). Some other cultivated plants that serve as hosts are *Prunus* spp. sweet cherry, plum, peach, rose, grapevine, hops, tulip, hostas, celery, horse-radish, asparagus, cucumber, carrot, and lettuce. There are sources of genetic resistance to ArMV in raspberry cultivars. Cultivars such as 'Burnetholm', 'Mailing Enterprise', 'Mailing Leo', 'Mailing Notable' and 'Mailing Orion' are considered immune, while other cultivars such as 'Lloyd George', 'Mailing Jewel' and 'Norfolk Giant' are considered susceptible to some ArMV strains (Jones & McGavin, 1998, Stace-Smith R, 1987).

ArMV infects nearly all commonly used herbaceous test plants. As diagnostic hosts *Chenopodium amaranticolor* Coste and Reyn, C*henopodium murale*, *Chenopodium quinoa* Willd, *Cucumis sativus*, *Nicotiana tabacum* L. cv. 'White Burley' and *Petunia hybrida* Vilm are commonly used. The best hosts for ArMV propagation are *Petunia hybrida* and *Nicotiana clevelandii* Gray. Some indicators used as "bait" plants for nematode transmission experiments are *C. sativus* and *P. hybrida*.

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

ArMV is often found in association with *Strawberry latent ringspot virus* (SLRSV), as they are both transmitted by the same nematode vector, *Xiphinema diversicaudatum*. Depending on the cultivar, these viruses may cause similar symptoms, such as stunting, failure to produce fruit and yellow speckling, mottling, downward curling, vein yellowing or yellow net symptoms in leaves. The symptoms on blackberry and raspberry are mostly yellowing and stunting, giving rise to the name "Raspberry yellow dwarf disease" used to describe red raspberry plants infected with these two viruses.

Strawberry plants that are infected with only ArMV are symptomless. However, in some cultivars ArMV infection can cause a chlorotic leaf mottle and mild to severe stunting or death of plants in the field. Most *Fragaria vesca* indicator clones are symptomless when infected with ArMV. In the strawberry cultivar 'Royal Sovereign', ArMV induces prominent blotching symptoms, while in the cultivar 'Cambridge Favourite' it induces diffuse mottle and necrotic spotting. Leaf symptoms start appearing in late spring before the fruit is set, and again in fall, but tend to disappear in midsummer. ArMV do not cause symptoms in naturally infected gooseberries and red currants; on black currants the virus induces chlorotic blotches of the first leaves, followed by mottle and ringspot symptoms in summer, symptoms disappear as leaves develop.

As mentioned above ArMV strains differ in ability to infect some raspberry cultivars. Susceptible cultivars such as 'Mailing Exploit' show symptoms two to three years after infection; the young canes are stunted, fruit production decreases and yellow speckling appears on the leaves; the lower leaves can present vein yellowing. ArMV induces similar symptoms in the cultivars 'Mailing Promise' and 'Mailing Admiral', but causes leaf mottling in the cultivar 'Glen Clova'. On blackberry cultivar 'Himalaya Giant', ArMV induces yellow mosaic. In cherry, rasp-leaf symptoms are observed when ArMV is present in association with viruses of the prunus necrotic ringspot type. in *Chenopodium amaranticolor* Coste and Reyn. and *C. quinoa* Willd. the symptoms (stunting, chlorotic local lesions and systemic chlorosis and necrosis, particularly in the tip leaves) are local and systemic. In *Cucumis sativa*, chlorotic local lesions and systemic yellow spots, vein-banding and stunting is induced by this virus. In a similar way the virus induces

chlorotic or necrotic local lesions in *Nicotiana tabacum* and *Petunia hybrida;* in the later one, systemic vein-clearing or chlorotic rings and line patterns also occur. In both *N. tabacum* and *P. hybrida* leaves which are produced later are symptomless but contain virus.

Isolates of this virus differ in virulence, and symptoms in most hosts are milder in summer than in winter, so during summer, subsequent leaves are symptomless but contain virus, while in winter symptoms may persist. As with other nematode-borne virus diseases, outbreaks of ArMV and SLRSV occur in patches, due to the distribution of the vector nematodes in the soil. However, if the disease results from the planting of infected stocks, the infected plants are of course distributed randomly throughout the crop.

d. Geographic distribution:

ArMV occurs naturally in the United Kingdom and Europe but has to a limited extent spread to other continents. It is present in Oceania (Australia, Tasmania, Victoria and New Zealand) (Taylor & Hewitt, 1964, Mossop et al., 1983), Asia (China, India, Iran, Israel, Japan, Honshu, Kazakhstan, Lebanon)(Fadel et al., 2005, Imura et al., 2008, Rakhshandehroo et al., 2006, Zhang et al., 2020) , South Africa, Canada (British Columbia, Nova Scotia, Ontario, Quebec) (Xiao et al., 2018), Mexico, United States (California, Connecticut, Florida, Michigan, Minnesota, Missouri, Nebraska and South Carolina) (Taylor & Hewitt, 1964, Milkus, 2001, Lockhart, 2006) and is present throughout Europe (e.g., Bulgaria, Poland, France, United Kingdom, Russia Hungary, Italy , Switzerland, Germany, Spain, Turkey and Norway) (Brown, 1986, Yardimci & Culal, 2009, Eppler, 1992, Gordejchuk et al., 1977, Komorowska et al., 2018, Abelleira et al., 2010). ArMV has also been reported in Chile (Fiore et al., 2008, Matus et al., 2008). This virus presence in South and North America is considered to have resulted from the importation of infected plans since the specific nematode vectors responsible for its transmission are not present in these continents.

e. Means of spread:

Natural transmission is by the nematode *Xiphinema diversicaudatum* and *Xiphinema coxi*. The virus particles attach to the nematode esophagus and may be retained and able to be transmitted for long periods. The virus is lost when the nematode molts and is not passed through the egg to juveniles, both larvae and adults are able to transmit ArMV. The efficiency of transmission by the vectors is highly strain-dependent. Outbreaks in the field as a result of the vector presence, have a slow expansion and oval or circular patches of affected plants can be observed. Long-distance spread of ArMV can be a direct consequence of transportation of infected plants or soil which contains viruliferous nematodes or by infected seeds. This virus can be spread through vegetatively propagated hardwood cuttings and is also seed-transmitted. There is no evidence that suggest the spread of ArMV by plant contact in the field. Pollen transmission of ArMV in *Rubus* spp. is not known to occur.

f. Recognized diagnostic tests with cited references:

Detection by reverse transcription polymerase chain reaction (RT-PCR) and through reverse transcription (RT) loop-mediated isothermal amplification (LAMP) (Zhang et al., 2020, Duarte et al., 2016, MacKenzie et al., 1997) is sensitive. Also commercial polyclonal and monoclonal antibodies are available allowing for detection by ELISA (Fiore et al., 2008, Clark & Adams, 1977, Matus et al., 2008). As noted before ArMV has broad host range and can be detected by mechanical transmission to a number of herbaceous hosts (Mossop et al., 1983).

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

Spring and early summer (May -June) is the ideal time for sampling nepoviruses. Ideally, the samples should be taken from leaves that are symptomatic and young (3/4 expanded leaves). Sampling from different sites of the same plant increases chances of detection since the virus is not evenly distributed within plants.

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

The use of certified virus-tested planting material is highly recommended, the virus may be distributed in infected planting material especially because few or no symptoms are visible in tolerant cultivars or in the early stages of infection in sensitive cultivars. Fumigating soil with nematicides prior to planting and keeping the field weed-free, is essential for removing potential virus reservoirs. Also, maintaining a cover crop between rows helps minimizing soil movement in the field. Additionally, using cultivars that support lower levels of the nematode vector populations or have resistance or tolerance to the virus is recommended. This virus spread very slowly from an infection source and can be controlled by removing infected plants plus several additional plants around the infection focus, taking care to remove as much of the root system as possible, followed by a spot treatment with a nematicide.

i. References

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