VIRUSES AND APPLE PROPAGATION: WHY SHOULD I WORRY?

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Several viruses can cause devastating diseases in domestic apple (*Malus x domestica* Brokh.). Major viruses affecting apple production in New York are apple chlorotic leaf spot virus (ACLSV), apple stem pitting virus (ASPV), apple stem grooving virus (ASGV). These viruses are common and generally latent; in other words, they do not cause acute symptoms on most commercial cultivars. However, when present is susceptible cultivars or in mixed infections, their effect can be economical. Apple mosaic virus (ApMV) and tomato ringspot virus (ToRSV) can also affect apple production in New York. Cherry rasp leaf virus (CLRV) and tobacco ringspot virus (TRSV) are potential threats to apple production in New York.

Effect of Viruses on Apple Crop Performance. Viruses can reduce tree growth and budding success, thus causing substantial losses in nurseries and orchards. They also can reduce the productive tree lifespan in orchards. The impact of viruses is usually more severe when the trees are infected at an early development stage. Most viruses are predominantly latent; they survive in their host without causing symptoms. Latent viruses are transmitted when a virus-infected scion is grafted onto, for example, a susceptible rootstock. Infected trees can sometimes manifest symptoms. However, diagnostic symptoms can be deceiving because they can be confused with herbicide damage, chemical thinners, mineral deficiencies, and other diseases. In addition, they vary with the susceptibility of the cultivar and rootstock, cultivar and rootstock combination, virus strains and environmental conditions. Only laboratory tests can reliably identify viruses in apple.

ACLSV is one of the most widely distributed viruses of fruit trees. It is present in cultivated, ornamental and wild species of the Rosaceae. ACLSV virus causes no observable symptoms in most commercial apple cultivars. This virus is believed to be the major contributing factor to apple top working disease. It can cause a decline of grafted trees generally 1-2 years after trees are top grafted with virus infected scion budwood. Although trees on most rootstocks show no obvious disease symptoms, the performance of infected trees can be reduced. A reduction in yield of 10-30% has been reported for ACLSV in combination with other latent viruses. In susceptible apple cultivars, foliar symptoms can include chlorotic leaf spots and line patterns, premature leaf drop, stunting, terminal dieback, inner bark necrosis and local bark necrosis surrounding the inoculum buds.

ASGV is common in apple trees. On ‘Virginia crab’, this virus causes depressions in the wood cylinder. In other scion/rootstock combination, the graft union can be swollen and exhibits a necrotic line. As symptoms of ASGV progress over time, the necrosis of the graft union terminal makes the scion exhibits poor growth, and leaves can become pale and drop prematurely.

ASPV is frequently found in apple. No symptom is associated with infection on most scion/rootstock combinations although infection can result in the development of pits in the wood cylinder. In susceptible cultivars, extensive pitting can impair functions of the vascular tissue. Production can be reduced, particularly when ASPV is co-infecting with other latent viruses.

ApMV is one of the oldest known apple viruses. Infected trees develop pale to bright cream spots on spring leaves as they expand. These spots may become necrotic as the season progresses, coalescing into shot holes. Severely affected leaves drop prematurely. Most commercial cultivars are affected, but the severity of symptoms varies; 'Golden Delicious' and 'Jonathan' are severely affected whereas 'Mclntosh' is only mildly affected. Except in severe cases, infected trees can still produce a crop, with yield reductions varying from no reduction to 50% reduction. The occurrence of ApMV is very scarce in apple in New York.

ToRSV causes apple union necrosis. The disease can be prevalent in ‘Delicious’ on MM106 rootstock. The first symptom is pitting at the graft union. Removal of the bark at the union exhibits a brown line of necrotic tissue. In more advanced stages of the disease, trees may break off at the union. Infected trees generally have thinner canopies and the leaves become pale green. Fruit productivity progressively declines and trees may die 4-5 years after the initial symptoms are observed. The disease is especially severe in trees that become infected in the first two years after planting. Trees that become infected with ToRSV after they are well established in a planting site may remain productive for many years, although vigor is reduced.

CLRV causes flat apple disease. Infected trees exhibit a general reduction in productivity that can be associated with smaller upward-rolled leaves and smaller fruit. Symptoms are more pronounced on the fruit of ‘Delicious’ and related cultivars. CLRV is present in western North America, from Utah to British Columbia. Thus far, tis virus has not been reported in apple in New York. Therefore, vigilance is recommended when trees, liners or scion buds are sourced from a non-reputable operation in western States to avoid the introduction of CLRV to New York.

TRSV is the causal agent of union incompatibility in apple trees in Canada. This virus has yet to be reported in apple in the United States; however, it is present in other fruit crops in New York. Therefore, vigilance is recommended for the selection of planting sites where TRSV is known to occur.

Transmission of Viruses in Apple. All viruses of apple are transmitted through vegetative propagation and grafting. ACLSV, ASGV, ASPV and ApMV have no known insect vectors and are not seed transmitted. Therefore, their widespread dissemination exclusively results from either the careless use of scion buds from infected trees for propagation or for top working, or from infected rootstock liners. The absence of obvious symptoms of the latent viruses (ACLSV, ASGV and ASPV) on most trees increases the risk of their unintentional distribution through top working.

ToRSV has a broad host range, including fruit, vegetable, and ornamental crops, as well as weeds such as dandelion and chickweed, in addition to apple. This virus is transmitted by the

dagger nematodes *Xiphinema americanum* and *Xiphinema rivesi*. Spread of the virus is relatively slow in apple orchards; however, the movement of soil can accelerate its dissemination because nematodes that carry the virus can be transferred throughout the orchard or from orchard to orchard. A careful selection of the planting site and its management are critical to manage ToRSV in New York orchards.

CLRV infects sweet cherry, peach and several broadleaf weeds such as dandelion and broadleaf plantain, in addition to apple. CLRV is transmitted by the dagger nematode *Xiphinema americanum*. Spread of CLRV is slow and trees grown on sites previously planted to CLRV-infected trees can become infected.

TRSV can infect other fruit, field, and ornamental crops, as well as weeds such as broadleaf plantain, in addition to apple. This virus is transmitted by the dagger nematode *Xiphinema americanum*. A careful selection of the planting site is critical to avoid dealing with of TRSV in New York orchards.

Management Recommendations of Viruses in Apple. There is no cure for a virus-infected apple tree in the orchard and there is no direct way to combat a virus besides removing infected trees. Therefore, it is paramount to consider preventive measures such as:

- Plant trees for which buds and rootstock liners are only derived from clean, virus-tested mother stocks to ensure a healthy and high quality crop.
- Source propagation material only from clean, virus-tested trees to prevent the dissemination of viruses, particularly latent viruses.
- Rogue infected trees if growth and/or productivity are unsatisfactory, and replant only clean trees.
- For nematode-transmitted viruses, perform a soil test to determine the presence of vectors prior to replanting, limit the movement of soil, if viruliferous vectors are present, control weeds, and select tolerant/resistant cultivars and rootstocks.
- Get familiar with apple tree certification and strategically integrate this knowledge into your orchard establishment plans and production business model.

In summary, viruses can have a devastating effect of apple growth and productivity. Since no cure is available in an orchard, *a careful selection of clean rootstock liners and clean scion buds is paramount to mitigate the impact of viruses in apple.*