The relationship between insects & plant viruses

2018 Pest Control Supplement - Virus-carrying Insects

Learn how insect pests in greenhouse-grown crops vector plant viruses.

SUBSCRIBE

December 22, 2017

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Impatiens displaying symptoms (necrotic ring spotting) of necrotic spot virus
Photo: Raymond Cloyd

Insect pests of greenhouse-grown horticultural crops (ornamentals and vegetables) cause direct damage to plants; however, a number of insect pests can also cause indirect damage. Indirect damage is primarily associated with the ability of certain insect pests to serve as vectors of plant viruses that are transmitted to crops. Insect pests that serve as vectors (organisms capable of transmitting a virus from one plant to another) and consequently can transmit plant viruses include: aphids, thrips (western flower thrips), whiteflies, mealybugs, and leafhoppers.

Insects obtain a virus or viral particles when feeding on infected plants. They transmit plant viruses during the feeding process. The virus is secreted, along with saliva, into a new host plant and transmission occurs. Sucking insects such as aphids can carry plant viruses in their mouthparts or stylets (referred to as non-persistent transmission) or virus particles can accumulate inside their body, and be introduced into a plant during feeding (referred to as persistent or circulative transmission). The primary insect vectors affiliated with greenhouse production systems are aphids, whiteflies, and western flower thrips (*Frankliniella occidentalis*).

Virus vectors

Aphids can transmit more than 300 plant viruses to many greenhouse-grown plants. For example, the green peach aphid, *Myzus persicae*, which is a common aphid species that feeds on many greenhouse-grown crops, can transmit over 100 plant viruses including bean yellow mosaic virus, carnation mottle virus, and cucumber mosaic virus. The green peach aphid transmits these viruses in a non-persistent manner, in which the viruses are stylet-borne and do not enter the hemolymph (fluid

similar to blood that circulates inside the body of insects). In general, for most viruses associated with greenhouse-grown crops, aphids can transmit plant viruses almost immediately after feeding on infected plants. However, these aphids with non-persistent transmission lose the ability to vector a virus after a few minutes or hours after acquisition. As such, aphids associated with non-persistent transmission must reacquire viral particles in order to continue transmitting a virus.

Whiteflies can acquire a virus as nymphs or adults in about an hour after feeding on an infected plant. Once a virus is acquired, whiteflies remain vectors for the remainder of their life (for adults, up to 45 days). The sweet potato whitefly (*Bemisia tabaci*) is known to transmit more than 100 plant viruses including ageratum yellow vein virus and tomato yellow leaf curl virus. Whiteflies can transmit viruses in a persistent or circulative manner.

Adult western flower thrips can transmit viruses such as the tospoviruses, impatiens necrotic spot virus and tomato spotted wilt virus, during their lifespan (up to 35 days) with the virus replicating within the body of the western flower thrips. Western flower thrips acquire viruses as first or second instar larvae, although first instar larvae are more efficient in acquiring a virus. The virus is then transmitted by either second instar larvae or adults during feeding. Western flower thrips acquire a virus through their mouthparts when feeding on infected plants. The virus initially infects the gut where the virus replicates (makes copies of itself). Then, the virus accumulates in the gut tissue and spreads internally within the thrips' body. The virus must reach the salivary glands in the mouthparts for transmission to occur. During the feeding process, the virus, along with saliva, enters the new host plant, resulting in transmission. To transmit a virus, western flower thrips larvae must feed on infected plants or weeds for 15 to 30 minutes. Then, the virus incubates inside the thrips' body for four to 10 days before transmission to plants can occur.

Adults are unable to acquire and transmit a virus because the salivary glands of adults do not become infected with the virus. Although the virus may replicate or multiply inside the body of an adult western flower thrips, transovarial transmission does not occur, which means that the virus is not passed on to the offspring. Therefore, each new generation of thrips needs to feed on a new infected plant.

Aphids feed on a plant. Aphids can transmit more than 300 plant viruses.
Photo: Raymond Cloyd

> *The primary insect vectors affiliated with greenhouse production systems are aphids, whiteflies and western flower thrips (Frankliniella occidentalis).*

Management of virus vectors

Because aphids, western flower thrips, and whitefly females have a high reproductive capacity, management strategies need to be implemented early in the production cycle to maintain populations below damaging levels and to avoid transmission of viruses. Preventing infective vectors from

transmitting viruses to susceptible plants involves sanitation, exclusion, and applying insecticides. Sanitation primarily entails weed removal, which is important in alleviating problems with insects that vector viruses. Remove weeds from inside and outside the greenhouse, as many broadleaf weeds can serve as a refuge or reservoir for the viruses transmitted by aphids, western flower thrips, and whiteflies. For instance, weeds that are known to harbor impatiens necrotic spot virus include: wood sorrel (*Oxalis* sp.), chickweed (*Stellaria media*), bittercress (*Barbarea vulgaris*), prostrate spurge (*Euphorbia supina*), and jewelweed (*Impatiens capensis*). Furthermore, old stock plants or “pet plants” maintained in greenhouses may serve as reservoirs for viruses.

Physical exclusion by means of installing insect screening, with a mesh or pore size of 150 µm, over greenhouse openings (vents or side-walls) will restrict the movement of flying insects such as adult aphids, western flower thrips and whiteflies into the greenhouse. Due to the low tolerance level for insects that transmit viruses, extensive applications of insecticides are conducted. Moreover, mortality must be high because any insect vectors that survive can continually spread viruses. However, this can lead to insecticide resistance — and this is important, as aphids, western flower thrips, and whiteflies are three major insect pests that are widely known to develop resistance to insecticides. When using insecticides to suppress populations of these insect pests, always rotate insecticides with different modes of action within a generation (two to three weeks, although this varies depending on temperature) before switching to another mode of action. This will mitigate the possibility of developing resistance.

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The author acknowledges Dr. Ann Chase and Margery Daughtrey (plant pathologists) for providing feedback and ensuring that the information associated with viruses is accurate.