Weeds and Crops as Sources of Inoculum for Tomato Spotted Wilt Virus in California

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Tomato Spotted Wilt Virus (TSWV) is worldwide in distribution and has been in California since the mid 1980s, but has never been an economic threat in tomatoes until 2003 in Merced County. In 2004-05 TSWV incidence ballooned and caused serious loss in processing tomatoes grown on the Westside of Fresno County. Incidence of this virus continues to spread throughout the San Joaquin Valley and levels of incidence in 2008 processing tomatoes were variable from 1 to 25%. Tomatoes, peppers, and lettuce are major crops affected by TSWV in California, but tobacco and peanut crops are being severely affected in other parts of the country.

TSWV Symptoms: Tomato plant symptoms are characterized by initial chlorosis of leaves and terminal shoots, bronzing and necrosis. Fruit symptoms show faint to obvious concentric rings on green and/or red fruit. Oftentimes fruit is severely blotched, deformed, and unmarketable.

TSWV Vectors: The only means of field spread is via the virus vector. A number of thrips species are vectors of TSWV and responsible for the spread of the virus from plant to plant. TSWV is a plant:animal virus and also infects the thrips vector. In our studies the Western Flower Thrips (*Frankliniella occidentalis*) is the only thrips species collected from the tomato flowers and sticky cards in monitored fields. Only the first or second instar thrips larvae can acquire TSWV and then become able to transmit the virus to more plants. If an adult thrips feeds on a TSWV-infected plant, it will not be able to transmit TSWV to new plants. The virus is not passed from the adult thrips to a new egg.

TSWV Host range: TSWV has a very wide host range among plants, infecting more than 900 plant species including mostly dicots, but also some monocots. It is NOT seedborne. Many weeds and ornamental plants from many plant families are host to the virus. TSWV alternate host plants must meet specific criteria to be epidemiologically important. For a plant to be a significant source of TSWV inoculum:

1. The plant must be a host of TSWV;
2. The plant must support reproduction of the thrips;
3. The thrips must be able to acquire TSWV from the infected plant; and
4. The plant must be present within a time that would complement disease cycles and virus spread.

Most studies suggest that primary spread (spread into the crop from outside inoculum sources) is the most common type of spread seen for TSWV. Secondary spread (spread from plant to plant within the crop) would require active thrips populations multiplying within the crop, and doing so in a timeline compatible with crop development. (Thrips generation time takes approximately 20-30 days).

Thus, only plants that sustain virus infections and serve as suitable reproductive hosts for the vector can be considered important sources for spread of TSWV. Many plants susceptible to TSWV do not support thrips reproduction and are considered a "dead end" for virus spread. Two potential strategies to assist in managing TSWV is to 1) control the thrips vectors within the susceptible crop; and 2) identify and/or control the alternate host plants that support both TSWV and the thrips vector.

Transplant Monitoring in Commercial Greenhouses

Thrips and TSWV weekly monitoring was initiated in mid-February 2008 in transplant houses. In general, populations were relatively low (0-200 thrips/card), and highest numbers were identified in May. It is important to note here that thrips numbers in the field were also very high in May.

Much higher thrips populations were detected outside of the greenhouses through mid-May (~300-5800 thrips/card), with numbers decreasing by early July (data not shown). Thrips captured from all these greenhouses were identified as western flower thrips, and the numbers of females were three-fold higher than males.

In general, thrips populations associated with transplants were similar in 2007 and 2008. No obvious thrips damage was observed on transplants, nor were symptoms of TSWV observed on transplants. Consistent with this, no TSWV symptoms were observed on the fava bean indicators in greenhouses. Together, these results indicate that transplants are not an important inoculum source for thrips or TSWV in the field.

Survey of potential hosts for TSWV and thrips

To search for potential hosts for TSWV and thrips before, during and after the season, we monitored representative almond orchards; spring-planted lettuce in Fresno and spring- and fall-planted radicchio in Merced; and numerous weeds collected in the winter and spring. The radicchio planted in fall of 2007, especially direct seeded fields in Merced, had highest thrips populations and TSWV incidences (up to 95% infection), but thrips populations declined considerably into the winter. In spring-planted lettuce and radicchio very low incidences of TSWV were observed, although thrips populations were increasing in these fields. Collected thrips samples were also identified as western flower thrips.

Interestingly, an early planted pepper field in Merced, which was in close proximity to the heavily infected fall-planted radicchio field (already harvested) had extremely high thrips populations, especially in early April (30-70 thrips/flower) and an unusually high incidence of TSWV (>70%). However, as the spring-planted radicchio field in this same location had very low level of TSWV (<0.1%), it is not clear where the major source of TSWV inoculum for the pepper field came from.

Almond flowers were collected and thrips from these flowers were counted and tested for TSWV with RT-PCR. Thrips population densities were low both on yellow sticky cards and in flowers, and indicator plants placed in these orchards remained free of TSW-symptoms. To date, no TSWV has been detected in thrips from almond orchards or in almond trees. Thus, almonds do not seem to play a major role in TSWV in tomato.

In areas with recent outbreaks of TSWV, plants other than tomato were collected and tested for the virus. Plants tested include lettuce, spinach, London rocket, barnyardgrass, bindweed, bur clover, nettle, black nightshade, common sunflower, dodder, fiddleneck, lambsquarters, little mallow, pepper, pigweed, prickly lettuce, purslane, groundsel, mustard, almond, fig, Russian thistle, sowthistle, jimsonweed, cardone and tree tobacco. Most samples tested were negative for TSWV (Table 1), only lettuce, pepper, spinach, London rocket, cardone, little mallow, prickly lettuce, groundsel and sowthistle tested positive for the virus, but incidence was very low (<0.1%).

Table 1: Weed Survey Results for TSWV Incidence in Fresno and Merced Counties, 2008

Weed	Tested (+)	Weed	Tested (+)
Barnyardgrass	25 (0)	Lambsquarters	63 (0)
Black nightshade	25 (0)	Little mallow	110 (1)
Bindweed	25 (0)	Mustard (common)	60 (0)
Bur clover	25 (0)	Nettle	25 (0)
Common sunflower	25 (0)	Pigweed	25 (0)
Dodder	25 (0)	Prickly lettuce	90 (2)
Fiddleneck	25 (0)	Purslane	25 (0)
Groundcherry	25 (0)	Russian thistle	25 (0)
Groundsel (common)	40 (1)	Sowthistle	60 (1)
Jimsonweed	25 (0)	Tree tobacco	25 (0)

(+) number of plants tested positive for TSWV by immunostrips and/or PCR

Initial Research Summary (Research continues in 2009)

1. **Pepper & tomato crops** can amplify the virus and serve as an inoculum reservoir.
2. **Lettuce** is grown for a fall market and a spring market and overlaps with the summer crops of tomato and pepper. Lettuce could serve as a bridge crop for the TSWV. While some fall incidence of TSWV has been observed for several years only in 2008 was TSWV observed in the spring crop. Still incidence is low and patchy. Lettuce is not perceived to be a big threat as an inoculum reservoir or bridge crop, because most conventional lettuce is on an aggressive insecticide program for other key pests.
3. **Radicchio** is a small acreage crop that poses a big threat as a potential TSWV inoculum reservoir and bridge crop. It is capable of supporting large populations of thrips and is very susceptible to TSWV. In 2007 in Fresno County it was observed as a primary source of TSWV infected thrips that moved to nearby tomato fields spreading the virus. Growers came to recognize this and changed cultural practices. It appears that the TSWV threat can be managed with aggressive thrips management and crop sanitation as the monitored radicchio field in Fresno was TSWV free in 2008. However some radicchio fields in Merced County still had some virus incidence.
4. **Almond trees** & flowers do not appear to be an inoculum reservoir threat.
5. **Weeds** do not seem to be an important inoculum reservoir at this time although they could potentially develop into one.

References

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