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Western Flower Thrips (*Frankliniella occidentalis* [Pergande])[1]

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Introduction

Many species of thrips can be found in Florida. These include adventive species like *Frankliniella occidentalis*, *Frankliniella schultzei*, *Thrips palmi*, and *Scirtothrips dorsalis*. Native species include *Frankliniella tritici* and *Frankliniella bispinosa*. *Frankliniella occidentalis* is a pest of several crops throughout Florida and the world and is capable of causing economic loss (Fig. 1).

Figure 1. Western flower thrips adult.
Credits: Lyle Buss

Taxonomy

The order Thysanoptera consists of more than 5,000 species in two suborders, Tubulifera and Terebrantia. The suborder Tubulifera has over 3,000 species in one family, Phlaeothripidae. The suborder Terebrantia consists of over 2,000 species in seven families. Thripidae is the largest of these families, with about 1,700 species. It includes genera such as *Scirtothrips*, *Thrips*, and *Frankliniella* (Mound and Teulon 1995; Mound et al. 2009).

Synonyms

The original name for *Frankliniella occidentalis* was *Euthrips occidentalis* Pergande 1895 (Hoddle et al. 2012; GBIF 2014). This species has a high number of synonymies as a result of the variability that *Frankliniella occidentalis* has in structure and color in its native range.

Some other synonyms are (CABI 2014):

Euthrips helianthi Moulton 1911

Euthrips tritici var. *californicus* Moulton 1911

Frankliniella californica Moulton

Frankliniella tritici var. *moultoni* Hood 1914

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Frankliniella canadensis Morgan 1925

Frankliniella nubila Treherne 1924

Frankliniella chrysanthemi Kurosawa 1941

Frankliniella claripennis Morgan 1925

Frankliniella conspicua Moulton 1936

Frankliniella treherni Morgan

Frankliniella dahliae Moulton 1948

Frankliniella tritici maculata Priesner 1925

Frankliniella dianthi Moulton 1948

Frankliniella occidentalis f. *brunnescens* Priesner 1932

Frankliniella moultoni Hood

Frankliniella occidentalis f. *dubia* Priesner 1932

Frankliniella syringae Moulton 1948

Frankliniella venusta Moulton 1936

Frankliniella umbrosa Moulton 1948

The Entomological Society of America (ESA)-approved common name for this species is western flower thrips. Other common names around the world include alfalfa thrips, trips occidental de las flores, trips de California, thrips californien, thrips des petits fruits, trips del maiz, and kalifornischer blütenthrips.

Distribution

Western flower thrips is a native of western North America. It remained confined to western North America (west of 100°W longitude) until the 1960s. In the following decades it has spread with the horticultural trade throughout North America and the world (Kirk and Terry 2003; CABI 2014). According to CABI (2014), its current distribution includes:

Asia: China, Iran, Japan, Republic of Korea, Kuwait, Malaysia, and Sri Lanka

Africa: Algeria, Kenya, Morocco, Reunion, Swaziland, Tunisia, Uganda, and Zimbabwe

North America: Canada, Mexico, and the United States of America

Central America: Costa Rica and Guatemala

South America and the Caribbean: Dominican Republic, Martinique, Puerto Rico, Argentina, Brazil, Ecuador, Chile, Colombia, Guyana, Peru, Uruguay, and Venezuela

Europe and the Mediterranean: Albania, Austria, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Guernsey, Hungary, Ireland, Israel, Italy, Latvia, Malta, Montenegro, the Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Turkey, the United Kingdom, and Ukraine

Oceania: Australia and New Zealand

In cooler areas western flower thrips may not overwinter or may be restricted to greenhouses. In Florida it is found throughout the state but it is more predominant in the north (Salguero-Navas et al. 1991; Childers and Beshear 1992; Kirk and Terry 2003).

Description

Eggs: The eggs are small (550 µm X 250 µm) and oval-shaped (Lewis 1973 as cited by Mau and Martin; CABI 2014). The eggs of thrips in the suborder Terebrantia are inserted into any non-lignified tissue of a plant (Reitz et al. 2011; CABI 2014).

Larva I and II: Larvae are small and wingless and may be found in flowers (Fig. 2), buds, or places where leaves are touching. These are actively feeding stages. (Reitz 2009; CABI 2014).

Figure 2. Western flower thrips larva.
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Prepupa and pupa: The prepupa is characterized by short wing buds and antennae that are not pulled back over the head (Fig. 3). The pupae have longer wing buds, and the antennae are pulled backward over the head. These non-feeding life stages usually are passed in soil, although they can occur in complex flowers like chrysanthemum. (CABI 2014)

Figure 3. Western flower thrips prepupa.
Credits: Lyle Buss

Adults: Adults have fully developed wings with long fringes of cilia typical of most Thysanoptera. The adult of this species is less than 2 mm in length. It has three color morphs. These color morphs are termed dark-brown, light, and intermediate (yellow with a dark longitudinal band along the dorsum of the thorax and the abdomen). The intermediate morph is the most common in Florida. Males usually make up a much smaller proportion of the population and are smaller and paler than females. Adults and larvae may be found in similar locations (Reitz 2009). The cryptic behavior of western flower thrips limits exposure to insecticides (Brodsgaard 1994).

This species may be differentiated from its congers by key diagnostic features. These include a smooth antennal pedicel (Fig. 4), spines arising from the second antennal segment that are not exceptionally heavy (Fig. 5), a pair of ocular setae that are separated by at least one and a half times the diameter of a single ocellus (Fig. 6), four small setae arising on the anterior margin of the prothorax between the major antemarginal setae (Fig. 7), and a microtrichial comb on abdominal segment VIII that is complete and well-developed (Fig. 8).

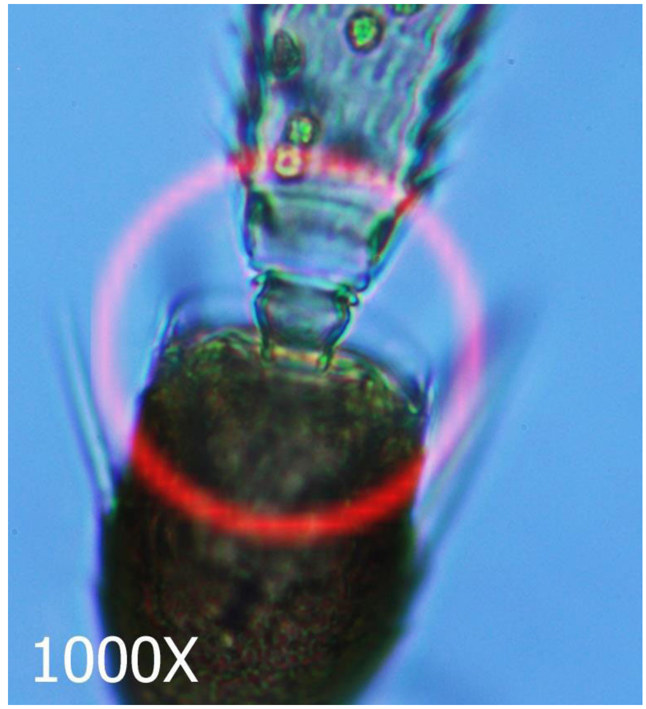

Figure 4. Western flower thrips antennal pedicel.
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Figure 5. Western flower thrips—spines on second antennal segment.
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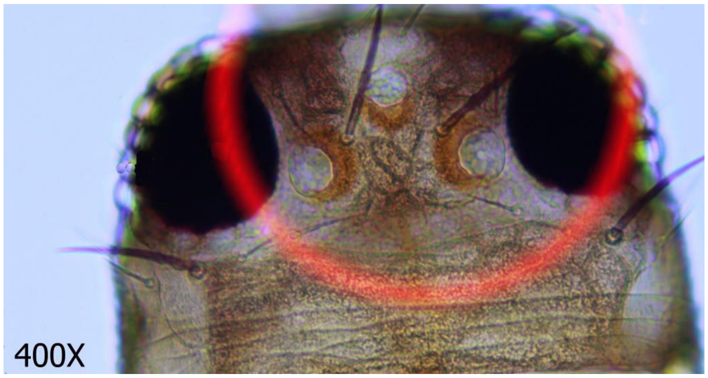

Figure 6. Western flower thrips ocular setae.
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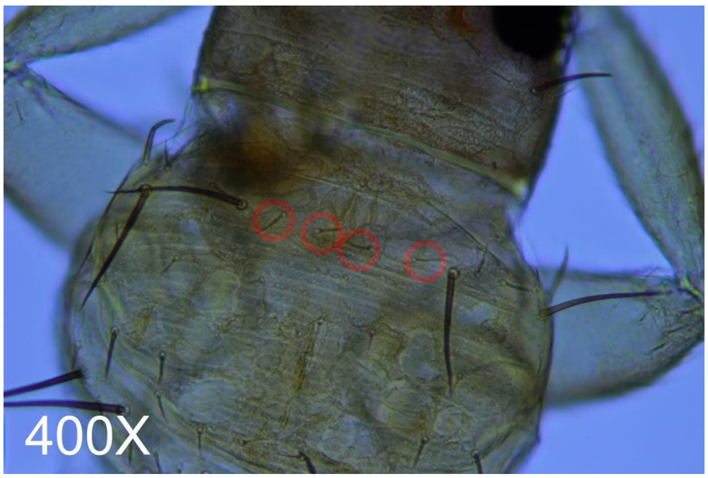

Figure 7. Western flower thrips—antemarginal setae.
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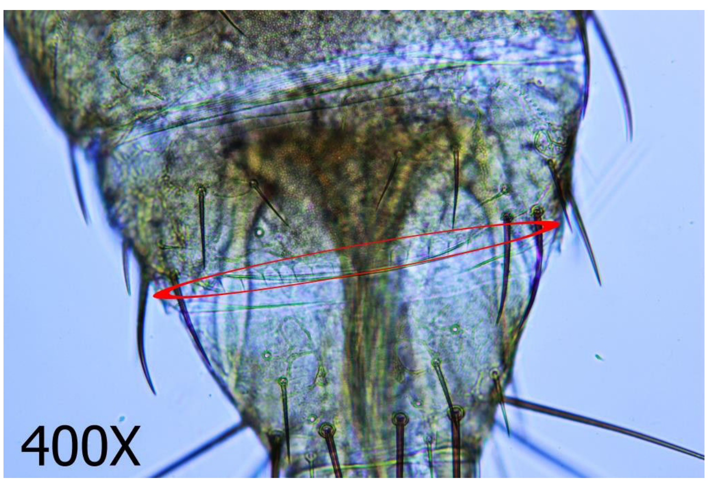

Figure 8. Western flower thrips—microtrichial comb on abdominal segment VIII.
Credits: Jeff Cluever

Biology and Behavior

Western flower thrips has a punching-sucking feeding habit, using the mandible to punch a hole into the host and then inserting the maxillae into the opening. The maxillae then ingest the fluids from the cells, but not directly from the vascular tissue. Western flower thrips will also ingest the contents of pollen grains. There is evidence of predatory behavior in this species. In cotton this species was found to be a predator of spider mite eggs (Gonzalez and Wilson 1982, Hunter and Ullman 1989, Kindt et al. 2003).

Western flower thrips males are produced from unfertilized eggs and females are produced from fertilized eggs. The adult female uses her saw-like ovipositor to oviposit (lay eggs) into foliage of a plant. Even though this species does not exhibit sociality, males will form mating swarms (Terry and Gardener 1990, Lewis 1991a).

Western flower thrips individuals are not strong fliers, but the adults are capable of dispersal over long distances (Ramachandran et al. 2001). The fringed posterior surface of the wings, typical of most thrips species, enhances their ability to fly. There is a record of the thrips species *Frankliniella tritici* and *Haplothrips graminis* being caught on aircraft-mounted sticky traps at 10,000 feet (Glick 1939 as cited by Lewis 1991b, Lewis 1991b).

Life history

On cabbage leaves at 27°C, western flower thrips develops from egg to adult in 10.2 days. It takes western flower thrips 3.07, 1.78, 2.38, 1.00 and 2.04 days to complete the egg, larva I, larva II, prepupal, and pupal stages respectively. At this temperature, an adult female produces an average of 76.6 eggs in her lifetime (Zhang et al. 2011).

Hosts

Western flower thrips is a polyphagous species with hosts in 65 families (CABI 2014). Some examples of host plants are alfalfa, apricots, artichoke, carnations, chrysanthemum, corn, cotton, cucumber, eggplant, gerbera, gladiolus, grapefruit, grapes, impatiens, melons, nectarines, peaches, peanut, peas, pepper, plums, Spanish needle, strawberry, tomato, watermelon, and wild radish. Note that a species classified as a host still may not be able to support reproduction of western flower thrips (Frantz and Mellinger 1990, Chau et al. 2005, CABI 2014)

Economic Importance

Thrips cause both direct and indirect injury to crops. Direct damage occurs when the thrips cause injury by feeding or oviposition (Fig. 9). Examples of direct injury caused by this species are scarring of pepper due to feeding (Funderburk et al. 2014a), and oviposition wounds in tomatoes (Funderburk et al. 2014b). Indirect damage refers primarily to the transmission of viruses by thrips. Examples of plant viruses transmitted by *Frankliniella occidentalis* include *Tomato spotted wilt virus* (TSWV) (Fig. 10), *Tomato*

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chlorotic spot virus (TSCV) (Fig. 11), *Impatiens necrotic spot virus* (INSV), and *Groundnut ringspot virus* (GRSV) (Fig. 12) (Fung et al. 2002, Frantz and Mellinger 2009, Hoddle et al. 2012, Frantz and Fasulo 2013, Webster et al. 2015).

Figure 9. Western flower thrips feeding damage to tomato leaf. Dark specks are frass (excrement).
Credits: Hugh Smith

Figure 11. Symptoms of *Tomato chlorotic spot virus*.
Credits: Hugh Smith

Figure 10. Symptoms of *Tomato spotted wilt virus*.
Credits: Gary Vallad

Figure 12. Symptoms of *Groundnut ringspot virus*.
Credits: Gary Vallad

Management

To sample for *Frankliniella* thrips or other flower-inhabiting thrips, select a set number of flowers, then either strike these flowers against a light-colored board and count the thrips while still in the field or place the flowers in a vial of ethanol and count the thrips later in the lab (Funderburk et al. 2014a, b). Blue sticky traps may also be used to sample thrips from the field. Blue traps were found to catch more *Frankliniella occidentalis* compared to yellow sticky traps, but yellow sticky traps have the advantage that they may also be used to monitor for leafminers, aphids, and white-flies (Natwick et al. 2007, Frantz and Fasulo 2013, Muvea et al. 2014). It is possible to estimate of the population of

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thrips in the field with sticky traps, but trap catches have rarely been shown to reflect population size accurately or to be accurate predicators of damage. In addition, thrips caught on sticky cards may be difficult to identify to species.

In most circumstances only adults are identified, although keys exist to identify second instar larvae. Specimens are usually identified at 40X magnification. Specimens are slide-mounted using CMC-10 (temporary) or Canada balsam (permanent) mounting media. Museum-grade specimens are usually cleared with a solution of potassium hydroxide (Hoddle et al. 2012).

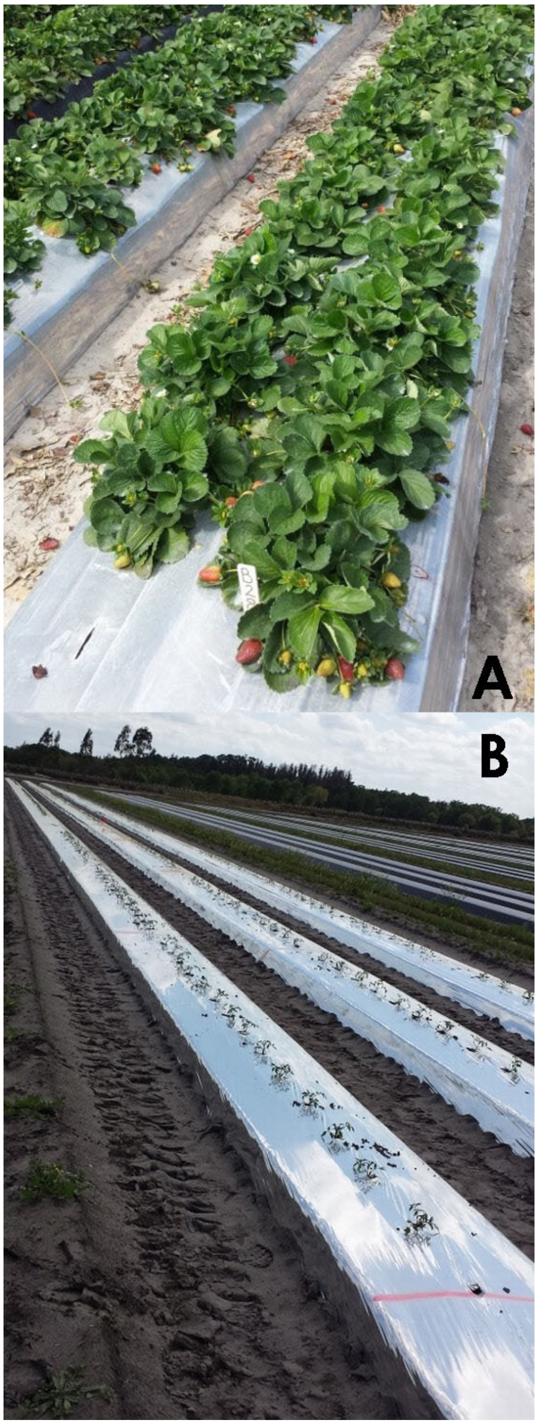

Figure 13a and 13b. Silver reflective mulch used to repel thrips from strawberry (a) and tomato (b).
Credits: Hugh Smith

Cultural control techniques may be used to manage *Frankliniella occidentalis*. In northern Florida, UV-reflective mulch is used to reduce the number of thrips in tomato. UV-reflective mulch interferes with the host-finding behavior of thrips. (Stavisky et al. 2002, Demirozer 2014) (Fig. 13a and 13b). A reduction in nitrogen fertilization may result in a decrease in the number of *Frankliniella occidentalis* (Stavisky et al. 2002). Care must be taken when selecting an insecticide because thrips may build up resistance to an insecticide if it is applied too frequently. Resistance by western flower thrips to many groups of insecticides has been documented (IRAC 2014). Current information on insecticides available for thrips management in Florida can be found in the Vegetable Production Handbook for Florida.

Natural Enemies

Among the most important natural enemies of this species are minute pirate bugs, *Orius* spp. (Fig. 14). In pepper, suppression occurs at a ratio of approximately one *Orius insidiosus* to 180 thrips, and control occurs at a ratio of approximately one *Orius insidiosus* to 50 thrips (Funderburk 2009). Other thrips predators include the predatory mites *Amblyseius swirskii* and *Neoseiulus cucumeris* (Arthurs et al. 2009; Dogramaci et al. 2011).

Demirozer et al. (2012) reviewed effective, economical, and ecologically sound integrated pest management programs (IPM) for thrips in fruiting vegetables. The components included the following: define pest status (economic thresholds), increase biotic resistance (natural enemies and

Figure 14. Minute pirate bug, a predator of thrips.
Credits: Hugh Smith

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competition); integrate preventative and therapeutic tactics (scouting, ultraviolet [UV]-reflective mulch technologies, biological control, compatible insecticides, companion plants, and fertility); and vertically integrate the programs with other pests. These programs have been widely implemented in Florida, and they have significantly improved management of *Frankliniella* thrips and thrips-transmitted tospoviruses.

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