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Chilli thrips *Scirtothrips dorsalis* Hood (Insecta: Thysanoptera: Thripidae) [1]

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Introduction

The chilli thrips, *Scirtothrips dorsalis* Hood, is an important pest of various vegetable, ornamental and fruit crops in southern and eastern Asia, Africa, and Oceania (Ananthakrishnan 1993, CABI/EPPO 1997, CAB 2003).

Figure 1. Dorsal view of adult chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Lance Osborne, University of Florida

Due to its diverse vegetation and subtropical climate, Florida is extremely suitable for the establishment of invasive alien flora and fauna (Ferriter et al. 2006). In the United States, the chilli thrips, *Scirtothrips dorsalis* Hood, is a relatively new, introduced insect pest in Florida and Texas.

Synonymy

Anaphothrips andreae Karny 1925

Heliothrips minutissimus Bagnall 1919

Neophysopus fragariae Girault 1927

Scirtothrips andreae (Karny)

Scirtothrips fragariae (Girault)

Scirtothrips minutissimus (Bagnall)

Scirtothrips padmae Ramakrishna 1942

Distribution

Scientists believe that *S. dorsalis* originated either in Southeast Asia or in the Indian subcontinent, but it is now widely distributed. It is abundant on

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sacred lotus in Thailand (Mound and Palmer 1981), and on chilli peppers in India (Ramakrishna Ayyar 1932, Ramakrishna Ayyar and Subbiah 1935), where it is also a serious pest of peanuts (Amin 1979, 1980). In Japan, *S. dorsalis* is a pest of tea and citrus (Kodomari 1978). *Scirtothrips dorsalis* has been reported from South Africa and the Ivory Coast, and plant quarantine interceptions suggest that this pest is widely distributed across West Africa and is present in East Africa (Kenya).

In the United States, USDA-APHIS inspectors at various ports-of-entry have intercepted *S. dorsalis* 89 times since 1984 on imported plant materials belonging to 48 taxa (USDA 2004), and most frequently on cut flowers, fruits and vegetables. In Florida, an infestation of *S. dorsalis* was first reported from Okeechobee County on October 2, 1991, and then from Highlands County on October 10, 1994, with subsequent occurrences in 2004, 2005 and 2007 in various counties of Florida and southeastern Texas.

Figure 2. Worldwide distribution of chilli thrips, *Scirtothrips dorsalis* Hood, as of September 2009. Credits: Garima Kakkar, University of Florida

Although Venette and Davis (2004) suggested that the potential geographic distribution of *S. dorsalis* in North America might extend from southern Florida north into Canada, a study by Holt (2006) indicates that this species would be troublesome primarily in the southern and Pacific states. These studies signal that it could also become widely established in much of South America, and throughout Central America and Mexico. If this insect becomes widely distributed in the United States it could cause annual crop losses in excess of $3 billion (Holt 2006). According to the Florida Nurserymen and Growers Association, *S. dorsalis* is one of the thirteen most dangerous, exotic pest threats to the ornamental industry (FNGA 2003).

Known distribution, hosts, and initial discovery dates of *S. dorsalis* in the Greater Caribbean Region:

- Florida - landscape ornamentals and plants in retail (1991, 1994, 2005)
- Jamaica - (1995, 2007, 2008 - However, no major outbreaks as of 2008.)
- Venezuela - grapevines (2000)
- St. Vincent - pepper, amaranth, bean, eggplant, okra, pumpkin, tomato and watermelon; in 8 of 8 districts (as of 2003)
- St. Lucia - pepper, cucumber, eggplant, amaranth - found in 4 of 8 districts (as of 2004)

- Suriname - hot pepper, Momordica bitter melon, *Citrus* spp. on Cleopatra rootstock (2004).
- Trinidad - pepper, cucurbits, eggplant, okra; in 6 of 8 counties (as of 2004 - not of concern in 2008)
- Texas - roses in landscape, on roses and peppers in retail centers (2005)
- Barbados - sea island cotton, beans, carrots, peppers, eggplant (2005)
- Puerto Rico - mango (2006)

Identification

The small size (< 2 mm) of *S. dorsalis* life stages and rapid movement make it difficult to detect this insect in fresh vegetation. The very tiny eggs are inserted into soft plant tissues, and the egg stage may last one week. These characteristics increase the chance of transportation of *S. dorsalis* through international trade of fresh plant materials. *Scirtothrips dorsalis* life stages occur on all the above-ground plant parts of its hosts, and cause scarring damage due to feeding or the transmission of pathogens (Chang et al. 1995, Seal et al. 2006b).

Generally, chilli thrips are pale colored and the lengths of their first and second instar larvae and the pupae are 0.37-0.39, 0.68-0.71 and 0.78-0.80 mm, respectively. Adults are about 1.2 mm long with dark wings and dark spots forming incomplete stripes which appear dorsally on the abdomen (Seal et al. 2009a).

There are numerous microtrichia and dark transverse antecostal ridges on the abdominal tergites as well as sternites. On the lateral microtrichial fields of the abdominal tergites are three discal setae. The posteromarginal comb on segment VIII is complete. The shaded forewings are distally light in color with straight cilia. The forewings possess an incomplete second vein, or a row of setae with two or three irregular setae in the distal half and a complete first vein.

Of eight antennal segments, I-II are pale and III-VIII are dark. Antennal segments III and IV have forked sense cones. The head and legs are pale. There

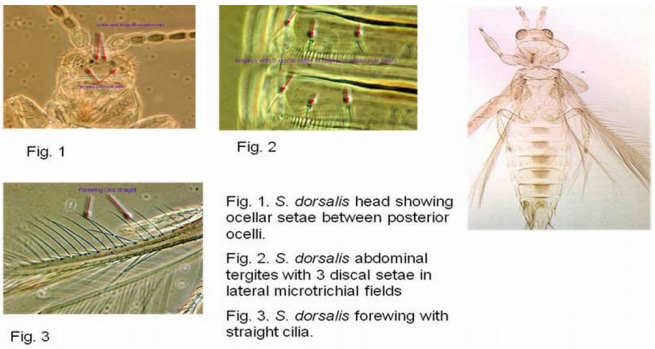

Figure 3. Some identifying characteristics of the chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Thomas Skarlinsky, USDA-APHIS

are three pairs of ocellar setae on the head. The third ocellar seta is between the posterior ocelli. The postocular setae are equal in length. The anteroangular, anteromarginal and discal setae on the pronotum are short and nearly equal in length. Posteromarginial seta II is 1.5 times longer and broader than posteromarginal setae I and III (Skarlinsky 2004).

Accurate and rapid identification of a newly introduced invasive pest is the primary requirement for an effective biological control program. More than 100 species in the genus *Scirtothrips* have been reported worldwide. Among these, approximately 10 species are serious threats to agricultural production and vegetation in the United States. Members of the genus *Scirtothrips* can be differentiated from other members of Thripidae by the following features (EPPO 2005):

- Surface of pronotum covered with numerous closely spaced transverse striae
- Abdominal tergites presents (laterally) consisting of numerous rows of parallel placed rows of tiny microtrichia (cuticular hairs on the surface of the wing membrane)
- Sternites possessing marginal setae arising at the posterior margins
- Metanotum (tergum of the metathorax) with median pair of setae emerging close to the anterior margin

Life Cycle and Biology

The life cycle stages of *S. dorsalis* include egg, first and second instar larvae, prepupa, pupa and adult. Gravid females insert the eggs inside plant tissues above the soil surface. The eggs are microscopic (0.075 mm long and 0.070 mm wide), kidney-shaped and creamy white in color (Seal et al. 2009a). The eggs hatch between two to seven days, depending upon temperature. Larvae and adults tend to gather near the mid-vein or borders of the host leaf.

Figure 4. First instar larva of the chilli thrips, *Scirtothrips dorsalis* Hood, initiating its emergence from an egg on a cotton leaf. Credits: Vivek Kumar, University of Florida

Figure 5. First instar larva of the chilli thrips, *Scirtothrips dorsalis* Hood, about to emerge from an egg on a leaf disc. Credits: Vivek Kumar, University of Florida

The two larval stages are completed in eight to ten days and the pupal stage lasts for 2.6-3.3 days. The life span of chilli thrips is influenced by the host plant species. For example, at 28°C it takes 11.0

Figure 6. Larva of the chilli thrips, *Scirtothrips dorsalis* Hood, feeding on cotton leaf. Credits: Vivek Kumar, University of Florida

days for a first instar larva to progress to the adult stage on pepper plants and 13.3 days on squash plants. The chilli thrips adult's life span lasts 15.8 days on eggplant, but only 13.6 days on tomato plants (Seal et al. 2009a).

Unlike other thrips, pupae of chilli thrips are generally found on leaves, leaf litter or on the axils of leaves, in curled leaves or under the calyces of flowers and fruits.

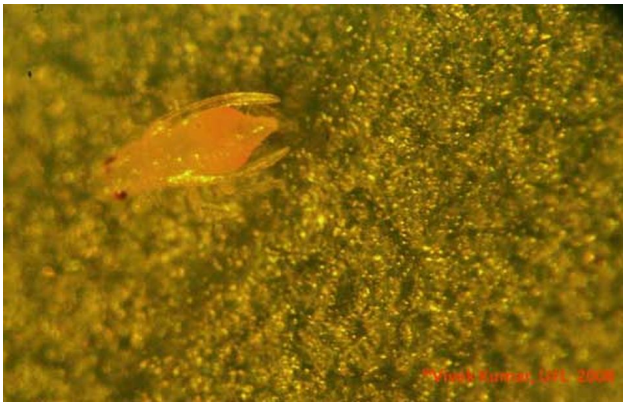

Figure 7. Pupa of chilli thrips, *Scirtothrips dorsalis* Hood, feeding on cotton leaf. Credits: Vivek Kumar, University of Florida

Hosts

Before its arrival in the Western Hemisphere, *S. dorsalis* was known to infest a wide variety of host-plants belonging to more than 100 plant taxa among 40 families (Mound and Palmer 1981). After its introduction into the Western Hemisphere, *S. dorsalis* was found to attack additional taxa of plants (Klassen et al. 2008, Osborne 2008, Venette and

Figure 8. Adult chilli thrips, *Scirtothrips dorsalis* Hood, feeding on cotton leaf. Credits: Vivek Kumar, University of Florida

Figure 9. Dorsal view of adult female chilli thrips, *Scirtothrips dorsalis* Hood, feeding on cotton leaf Credits: Vivek Kumar, University of Florida

Davis 2004). While their main wild host-plants belong to the pea family (Fabaceae), such as *Acacia, Brownea, Mimosa* and *Saraca*, the chilli thrips has also been recorded as a pest of numerous other economically important host plants in various plant families.

Figure 10. Adult chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Thomas Skarlinsky, USDA-APHIS

Among the potential economically important hosts of this pest in Western Hemisphere listed by Venette and Davis (2004) are banana, bean, cashew, castor, citrus, cocoa, corn, cotton, eggplant, grapes, litchi, longan, mango, melon, peanut, pepper, poplar, rose, strawberry, sweet potato, tea, tobacco, tomato, and wild yams (*Dioscorea* spp.). *Scirtothrips dorsalis* is a significant pest of ornamental plantings in Florida.

Plants in Florida on which *S. dorsalis* is known to reproduce are as follows:

- *Antirrhinum majus* L. - Liberty Classic white snapdragon
- *Arachis hypogaea* L. - peanut or groundnut grown in greenhouse
- *Begonia* sp. - begonia
- *Breynia nivosa* (W. Bull) Small - snow bush, snow-on-the-mountain
- *Capsicum annum* L. - pepper
- *Celosia argentea* L. - celosia, red fox
- *Coreopsis* sp. - tickseed
- *Cucumis sativus* L. - cucumber

- *Cuphea* sp.- waxweed, tarweed
- *Duranta erecta* L. - golden dewdrop, pigeonberry, skyflower
- *Euphorbia pulcherrima* Willd. - poinsettia
- *Eustoma grandiflorum* (Raf.)Shinn. - Florida blue lisianthus
- *Ficus elastica* 'Burgundy' Roxb. ex Hornem - Burgundy rubber tree
- *Fragaria* x *ananassa* - strawberry
- *Gaura lindheimeri* Engelm. & Gray - Lindheimer's beeblossom
- *Gerbera jamesonii* H. Bolus ex Hook. f. - Gerber daisy
- *Glandularia* x *hybrida* (Grönland & Rümpler) Neson & Pruski - verbena
- *Gossypium hirsutum* L. - cotton grown in greenhouse
- *Hedera helix* L. - English ivy
- *Impatiens walleriana* Hook. f. - super elfin white
- *Lagerstroemia indica* L. - crape myrtle
- *Ligustrum* spp. - ligustrum
- *Ocimum basilicum* L. - sweet basil
- *Pelargonium* x *hortorum* Bailey - geranium
- *Pentas lanceolata* (Forssk.) Deflers - graffiti white
- *Petunia* x *hybrida* - petunia easy wave red
- *Pittosporum tobira* (Thunb.) W. T. Aiton - variegated pittosporum
- *Plectranthus scutellarioides* (L.) R. - coleus
- *Plumbago auriculata* Lam. - Cape leadwort, plumbago, jamin azul
- *Ricinus communis* L. - castor bean
- *Rhaphiolepis umbellate* (Thunb.) Makino - Yeddo hawthorn
- *Richardia brasiliensis* Gomes - Brazil pusley, tropical Mexican clover, in greenhouse
- *Rhododendron* sp.
- *Rosa* sp. - rose
- *Salvia farinacea* Benth. - victoria blue
- *Shefflera arbicola* (Hayata) Merr. - umbrella tree
- *Tagetes patula* L. - marigold
- *Tradescatia zebrina* hort. ex Bosse - wandering jew
- *Vaccinium corymbosum* L. - highbush blueberry
- *Viburnum odoratissimum* var. *awabuki* (K. Koch) Zabel - sweet viburnum
- *Viburnum suspensum* Lindl. - viburnum
- *Viola* x *wittrockiana* Gams - Wittrock's violet
- *Vitis vinifera* L. - grapevine
- *Zinnia elegans* Jacq. - zinnia profusion white

(from Klassen et al. 2008, Osborne 2008)

Host list of chilli thrips, *Scirtothrips dorsalis* among different families of plants

- **Actinidiaceae**: *Actinidia deliciosa*
- **Amaranthaceae**: *Alternanthera sessilis, Amaranthus* spp.
- **Anacardiaceae**: *Anacardium occidentale, Mangifera indica*
- **Asparagaceae**: *Asparagus officinalis*
- **Asteraceae**: *Dahlia pinnata, Imorphotheca aurantiaca, Helianthus annuus*
- **Caprifoliaceae**: *Viburnum awabuki*

- **Chenopodiaceae**: *Beta vulgaris*
- **Convolvulaceae**: *Ipomoea batatas*
- **Cucurbitaceae**: *Citrullus lanatus, Cucumis melo, Cucumis sativus, Cucurbita pepo*
- **Ebenaceae**: *Diospyros kaki*
- **Euphorbiaceae**: *Hevea brasiliensis, Ricinus communis*
- **Fabaceae**: *Acacia auriculiformis, Acacia brownie, Arachis hypogaea, Brownea spp., Dolichos lablab, Glycine max, Melilotus indica, Mimosa pudica, Phaseolus vulgaris, Saraca minor, Saraca* spp., *Tamarindus indica, Vigna radiate*
- **Hydrangeaceae**: *Hydrangea* spp.
- **Liliaceae**: *Allium cepa, Allium sativum*
- **Lythraceae**: *Cuphea hyssopifolia*
- **Malvaceae**: *Gossypium hirsutum*
- **Moraceae**: *Morus* sp.
- **Myrtaceae**: *Syzygium samarangense*
- **Nelumbonaceae**: *Nelumbo lutea, Nelumbo nucifera*
- **Passifloraceae**: *Passiflora edulis*
- **Poaceae**: *Zea mays*
- **Polygonaceae**: *Fagopyrum esculentum*
- **Portulacaceae**: *Portulaca oleracea*
- **Punicaceae**: *Punica granatum*
- **Rhamnaceae**: *Zizyphus mauritiana*
- **Rosaceae**: *Fragaria chiloensis, Prunus persica, Pyrus* spp., *Rosa* spp., *Rubus* spp.
- **Rutaceae**: *Citrus aurantiifolia, Citrus sinensis*
- **Salicaceae**: *Populus deltoids*
- **Sapindaceae**: *Dimocarpus longan, Litchi chinensis, Nephelium lappaceum*
- **Solanaceae**: *Capsicum annuum, Capsicum frutescens, Lycopersicon esculentum, Nicotiana tabacum, Solanum melongena, Solanum nigrum*
- **Theaceae**: *Camellia sinensis*
- **Vitaceae**: *Vitis pteroclada, Vitis vinifera*

(from Holtz 2006)

Damage

Thrips possesses piercing and sucking mouthparts and causes damage by extracting the contents of individual epidermal cells leading to necrosis of tissue. This changes the tissue color from silvery to brown or black. Chilli thrips create damaging feeding scars, distortions of leaves, and discolorations of buds, flowers and young fruits by feeding on the meristems of the host plant's terminals and on other tender parts above the soil surface. *Scirtothrips dorsalis* has not been reported feeding on mature host tissues. According to Sanap and Nawale (1987), adult and nymphs of *S. dorsalis* suck the cell sap of leaves, causing rolling of the leaf upward and leaf size reduction. For example, a heavy infestation of *S. dorsalis* in pepper plants changes the appearance of the plant to what is called "chilli leaf curl." Appearance of discolored or disfigured plant parts suggests the presence of *S. dorsalis*.

A severe infestation of chilli thrips makes the tender leaves and buds brittle, resulting in complete defoliation and total crop loss. Infested fruits develop corky tissues (Seal et al. 2006b). Sometimes *S. dorsalis* infested plants superficially appear like broad mite infested plant. On many hosts, after a heavy infestation chilli thrips also start feeding on the upper surface of leaves.

Symptoms of Damage:

- Silvering of the leaf surface
- Linear thickenings of the leaf lamina
- Brown frass markings on the leaves and fruits
- Grey to black markings on fruits often forming a conspicuous ring of scarred tissue around the apex

Figure 11. Cotton plant heavily infested with the chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Vivek Kumar, University of Florida

Figure 12. Deformed pepper fruit (no economic value) after damage from an infestation of the chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Vivek Kumar, University of Florida

• Fruit distortion and early senescence of leaves

Disease Transmission

Scirtothrips dorsalis also possesses strong viruliferous behavior for seven recorded viruses. This species transmits chilli leaf curl (CLC) virus, and

Figure 13. Feeding scars on pepper plant leaves due to an infestation of the chilli thrips, *Scirtothrips dorsalis* Hood. Credits: Vivek Kumar, University of Florida

Figure 14. Feeding on host plant by the chilli thrips, *Scirtothrips dorsalis* Hood, also results in softening of calyx which causes premature falling of fruits. Credits: Vivek Kumar, University of Florida

peanut necrosis virus (PBNV) (Mound and Palmer 1981, Ananthakrishnan 1993). In 2003, Rao et al. found chilli thrips as vectors of tobacco streak virus (TSV) in groundnut crops in India. Recently, in Thailand its role as a vector of three tospoviruses (i.e., melon yellow spot virus (MYSV), watermelon silver mottle virus (WsMoV), and capsicum chlorosis virus (CaCV) in field crops was confirmed (Chiemsombat et al. 2008).

Management

Development of effective management practices for *S. dorsalis* is still in its infancy. Many recommendations have been suggested by the World Vegetable Center (AVRDC) which could serve as basic management practices for this pest. Management practices include crop rotation, removal of weeds (which may serve as hosts), and supporting the maximum use of natural enemies, including predators and parasites, and rotating insecticides.

Chemical control. Upon the establishment of *S. dorsalis* in the Caribbean in 2003 there was a paucity of information for effective management of this insect with modern insecticides. In order to impede the development of insecticide resistance it is always advisable to use insecticides from different classes in rotation. Pyrethroids have never been reported to provide effective control against *S. dorsalis* (Seal et al. 2006a). Various formulations of imidacloprid used as either soil drench or foliar application provide effective control of *S. dorsalis* without harming natural control agents. Imidacloprid suppresses *S. dorsalis* populations for many days (Seal et al. 2009b). Spinetoram gives the best result when used as a foliar application and imidacloprid as soil drench (Seal et al. 2008). In addition, these two insecticides when applied as above allow the continuous growth and development of natural enemies of *S. dorsalis*.

While the above provides general guidelines, for recommended controls see the University of Florida Chilli Thrips Web site.

Biological control. Various biological control agents, including minute pirate bugs, *Orius* spp. (Hemiptera: Anthocoridae) and entomopathogenic nematodes, *Thripinema* spp. (Tylenchida: Allantonematidae), have been reported to effectively control field populations of the chilli thrips. Adults of *Orius insidiosus* feed on all the life stages of thrips. Because *Orius insidiosus* also feeds on aphids, mites, moth eggs and pollen, its population does not decline strongly even if thrips populations are drastically reduced. *Thripinema* species are entomogenous nematodes which parasitize female thrips and make them incapable of laying eggs, leading to the reduction of thrips populations. In addition, they also reduce food consumption of these thrips, resulting in limited feeding damage.

Arthurs et al. (2009) evaluated two phytoseiid mites, *Neoseiulus cucumeris* and *Amblyseius swirskii*, as potential biological control agents of the chilli thrips and reported that *Amblyseius swirskii* can be a promising tool in managing chilli thrips on pepper. Other predators of chilli thrips which are being investigated, but on which adequate practical studies to assess their potential as significant natural enemies of thrips have not been done, include:

- lacewings, *Chrysoperla* spp.
- ladybird beetles
- predatory thrips, such as *Franklinothrips vespiformis* (vespiform thrips), *Scolothrips sexmaculatus* (sixspotted thrips), *Selenothrips rubrocinctus* (redbanded thrips), *Leptothrips mali* (black hunter thrips).
- predatory phytoseiid mites, such as *Amblyseius* spp., *Euseius hibisci* and *Euseius tularensis.*

When used alone, the fungal pathogen *Beauveria bassiana* is not effective in controlling chilli thrips adults or larvae, but produced better result when used in combination with Tricon (an experimental product consisting of borax, orange oil and biodegradable surfactants) (Kumar, unpublished data).

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