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Thrips as a Vector of Plant Diseases

Sanket Sahebrao Kawale, Umesh Vishal Mahajan

Sam Higginbottom University of Agriculture, Technology and Sciences,

Prayagraj (U.P.)

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Introduction- Thrips

Kingdom- Animalia

Phylum- Arthropoda

Class- Insecta

Order- Thysanoptera

Synonyms- physopoda

Etymology- Thysano- Fringe; Ptera- wings

The adult thrips are usually very small in size 1-2 mm in length and slender in shape. The head is quadrangular in shape with two prominent compound eyes and three ocelli. The filiform antennae are projected forward and bear six to nine segments with, simple or forked sensory organ. Mouth cone is formed by the labrum and labium together with basal segments of maxillae. There are three stylets derived from the two maxillae and left mandibles. The right mandible is absent, hence mouthparts are asymmetrical. Wings are either absent or long, narrow and fringed with hairs that increase the surface area. They are weak fliers and passive flight in wind is common. Tarsus is with one or two segments. The protrusible vesicle on the tarsus helps them to walk on any type of surface. Wings are membranous and fringed with long setae. The base of hind wings bears hooks that engage with an anal portion of forewings to aid in flight. They are not good fliers and usually make shorts flights, however long-distance migration occurs through the winds, atmospheric convection, and turbulence. The abdomen is 11 segmented, long, and tapering in shape. The abdomen is often pointed. An appendicular ovipositor may be present or absent. Thrips are mostly yellow, orange, black, black, or whitish-yellow. They crawl leisurely or fast when disturbed. The apex of the abdomen is flexed upward to leap from the plant surface.

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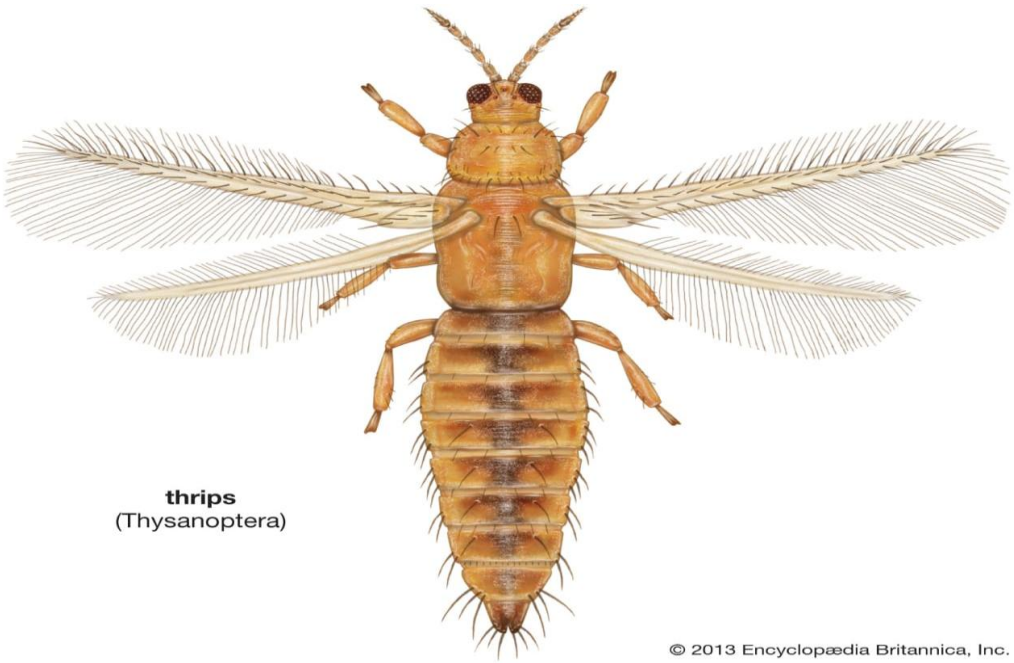
Importance-



The majority of the thrips species are considered an agricultural pest as they cause considerable loss to man's economically important crops. Some of them are predaceous and feed on other thrips species, mites, aphids, scales, and other soft-bodied insects. Many species are pests of commercially important crops. The few species serve as vectors for over 20 viruses that cause plant disease, especially the Tospoviruses. Some species of thrips are beneficial as pollinators of the flower.

Approximately, 7,700 species of thrips have been recorded out of which only less than 1% are considered as pests of crops. Most of the thrips species belong to the family Thripidae and are phytophagous. The phytophagous thrips damage leaf tissue by probing into the cell and imbibing the sap. Feeding of thrips causes damage to the leaves, flowers, or fruits and sometimes induces galls. Besides being an important insect pest the thrips acts as vectors of deadly tospoviruses of the genus Topovirus family *Bunyaviridae*. The significant losses by tospovirus in yield and quality of vegetables, fruits, and ornamentals have been recorded in different countries. Annual losses due to the tospovirus outbreak are estimated at over $1 billion worldwide. Tospovirus are not seed transmitted and thrips as vectors of tospoviruses and more than 20 tospoviruses are recorded throughout the world. The association of thrips

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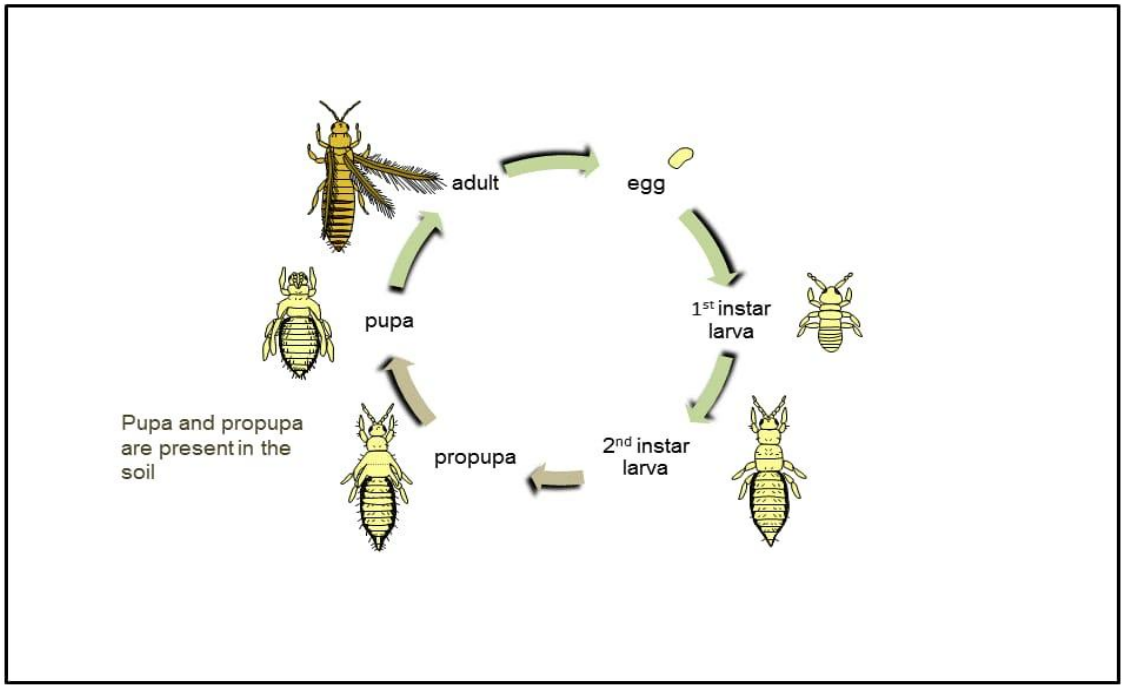
with tospoviruses and their ability to transmit specific tospoviruses are distinct. Thrips transmit the tospoviruses in a persistent and propagative manner. The thrips vectors could be considered as reservoirs for tospoviruses since these viruses replicate in their thrips vectors.

Life Cycle -

Thrips are hemimetabolous, metamorphosing gradually to the adult form. The first two instars, called larvae or nymphs, are like a small wingless adult without genitalia; these feed on plant tissue. In the Terebrantia, the third and fourth instars, and in the Tubulifera also a fifth instar, are non-feeding resting stages similar to pupae: in these stages, the body's organs are reshaped, and wing-buds and genitalia are formed. The adult stage can be reached in around 8–15 days; adults can live for around 45 days. Thrips can survive the winter as adults



or through egg or pupal diapause.

Source:www.agric.wa.gov.au

Mouthparts and Feeding Behavior-

Thrips have very characteristic mouthparts, unlike other insects the piercing-sucking type of mouthparts present. The mouthpart is asymmetrical with the right mandible of thrips reduced

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and vestigial or completely absent. The mouthparts include one elongated hypopharynx, two maxillary styles, and one mandibular stylet, supported by cibarial and salivary pumps. The left mandible is larger and modified to penetrate the cells. The maxillary stylets are held together to form the food canal. There is no separate salivary canal in thrips. The salivary duct directly opens in the front of the esophagus. During the feeding process, the head is moved towards the feeding site. The tip of the mouth cone is pressed against the plant surface in preparation for feeding. The modified mandible pierces leaf tissues and makes the initial opening for maxillary stylets. The mandible is restricted in the movement for its characteristic articulation with the head capsule and musculature. The maxillary stylets can be protracted or retracted singly or together. The labral pad supports the maxillary stylets when they are protracted into the plant tissues. The entry to the plant tissue is achieved by the vigorous forward and backward movement of the head. The maxillary stylets are interlocked to form a hollow tube for sucking the liquid food from cells. Due to their feeding, a distinctive silvery or bronze scarring on the surfaces of the stems, leaves, or fruits is often visible. The probing of thrips is differentiated into two types *viz.* shallow probing and penetration. In the case of shallow probing, the thrips make several punctures limited to epidermal tissues and few adjacent mesophyll cells. On the contrary, penetration deeper in the mesophyll cells tends to be destructive due to extreme plasmolysis or the complete disappearance of cells. The emptied space is usually filled with air, giving a silvery, scarred appearance. The brief period of shallow probes favors the transmission of the virus.

Disease Transmission-

The transmission of tospoviruses by thrips species is resultant of the complex interaction between the two biological organisms. The successful transmission of the virus by thrips involves the acquisition of the virus followed by internalization of the virus in thrips and inoculation of the virus in a susceptible host. Thrips persistently transmit tospoviruses. The tospovirus propagates within the thrips body. The first instar larvae only acquire the virus. After the multiplication in the thrips body, the tospovirus can be transmitted by late second instar larvae and adults. The adults are the only dispersing agent of tospovirus as they can fly over long distances to infect new host plants. For successful transmission, the tospovirus needs

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to cross three barriers in the thrips body *i.e.* the midgut barrier, dissemination barrier, and salivary gland barrier. A midgut infection barrier develops during the larval stage of the thrips which limits the virus uptake by the late instar larvae and adults. The virus is allowed to infect the midgut only during the early larval stage. A 55 kDa protein has been reported to regulate the barrier. The tospovirus glycoproteins are known to interact with the receptors present in midgut apical plasmalemma. The virus infects the epithelial cells of the first region of the midgut and spread to the muscle cells attached to the midgut. A 94 kDa protein of thrips is reported to assist virus circulation within thrips body. The presence of tospovirus in salivary glands, salivary ducts, and brains of viruliferous larvae and adult thrips has been reported which indicates a salivary gland barrier in non-transmitters thrips. The virus particles are injected into the host plant with the saliva during the feeding of viruliferous thrips. As there is only one canal in thrips, food ingestion and saliva egestion are usually accomplished alternately. Multiplication of the virus has been shown in the epithelial cells of the midgut, muscle cells surrounding the gut, and salivary gland cells. Once the adult thrips become viruliferous, it remains so throughout its lifespan. A transovarial infection barrier is also reported in thrips which restrict the tospovirus to be transmitted vertically. The next generation of thrips again needs to acquire the virus during their early larval stage.

Some Important Thrips Species transmitting tospvirus-

1. Onion thrips (*Thrips tabaci*)

This species most likely originated in the Mediterranean region and is common in temperate and subtropical areas where it is favored by warm, dry weather.

T. tabaci is known to transmit Iris Yellow Spot Virus (IYSV), Tomato Spotted Wilt Virus (TSWV), Tomato yellow fruit ring virus.

T. tabaci is the most serious pest in onion.

2. Scirtothrips dorsalis

S. dorsalis is a key pest of chili and one of the limiting factors in chili production in India. More than 90% yield reduction in chili was experimentally observed due to

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S. dorsalis. The qualitative yield loss may be up to 92% in sweet pepper. It also causes indirect yield losses by transmitting different tospoviruses and tobacco streak virus (TSV). In India, *S. dorsalis* was first reported to transmit TSWV causing groundnut bud Necrosis.

3. Melon thrips (*Thrips palmi*)

This species is widely distributed throughout South- East Asia, Japan, the Pacific region, and parts of northern Australia. Melon thrips have a wide range of host plants, particularly among members of the cucurbit (Cucurbitaceae) and potato (Solanaceae) families. The species is an important vector of the *Watermelon silver mottle virus* group of tospoviruses, which are common throughout Asia.

T. palmi is also responsible for indirect losses by transmitting Groundnut Bud Necrosis Virus (GBNV), Watermelon Bud Necrosis Orthotospovirus (WBNV), Capsicum Chlorosis Virus (CaCV), etc. in economically important crop plants. 70 to 90% losses in groundnut are recorded in India due to infection of GBNV. The association of *T. palmi* with tospovirus causing bud necrosis disease in groundnut crops.

4. Ceratothripoides claratris

This is one of the most destructive insect pests of tomato causing considerable yield losses in both field and glasshouse conditions. It feeds on the foliage, stems, and fruits. Due to their feeding and oviposition, scarification and malformation occur in tomatoes. This is the most prevalent thrips species of tomato in Thailand transmitting the Capsicum chlorosis virus (CaCV).

5. Tomato thrips (*Frankliniella schultzei*)

Tomato thrips originated in South America. Tomato thrips prefer to feed in flowers and have a wide range of hosts including tomato, tobacco, capsicum, lettuce, grain legumes, and many weed species. Tomato thrips can transmit most tospoviruses.

F. schultzei can cause both direct and indirect damage to the crops. Adults and nymphs of *F. schultzei* feed on the pollen and floral tissue of the plants. *F. schultzei* was found to be associated with GBNV transmission in cowpea and sun hemp.

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6. Frankliniella occidentalis

F. occidentalis is one of the most important vectors of tospoviruses.

Tomato Spotted Wilt Virus symptoms on tomato fruit

Vector: *Frankliniella occidentalis*

Distorted, unmarketable capsicum fruit from a plant infected by capsicum chlorosis virus

Vector: Melon thrips (*Thrips palmi*), Tomato thrips (*Frankliniella schultzei*)

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Conclusion-

Thrips are an important pest of various crops causing considerable economic losses. It plays a vital role in the transmission of viral diseases of plants like Tospovirus, Ilarvirus, Carmovirus, Sobemovirus, Machlomovirus genera. Management practices should be adopted to reduce infestation in the field such as the use of *Beauveria bassiana*, *Verticillium leccani* can kill thrips at all life stages. Predatory Bugs like *Orius insidiosus*, *Orius strigicollis* and *Phytoseiidae mites* also used to reduce Thrips infestation. Pesticides such as Azadirachtin, Abamectin, etc. also found effective in the management of Thrips.