Thrips Identification Workshop

Collecting and identifying common thrips species found in Canadian greenhouse crops

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vineland RESEARCH & INNOVATION CENTRE

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Preface

This workshop and guidebook were prepared by:

Ashley Summerfield & Rose Buitenhuis
Vineland Research and Innovation Centre

Sarah Jandricic & Cara McCreary
Ontario Ministry of Agriculture, Food and Rural Affairs

Roselyne Labbé
Agriculture and Agri-Food Canada

All photos were taken by Ashley Summerfield unless otherwise specified

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Preface

This identification guide was designed for use by growers and IPM practitioners in greenhouse floriculture, vegetable, and fruit crops in Canada.

It was created so that greenhouse growers and IPM practitioners can easily and properly identify species of thrips infesting their crops without necessitating the use of outside identification services.

Proper thrips identification is important because A) the presence of some thrips species can threaten exportation of plant material (*e.g.* chilli thrips, *Scirtothrips dorsalis*), and B) effective control measures can vary considerably by species. For example, *Thrips tabaci* (onion thrips) and *Thrips nigropilosus* (chrysanthemum thrips) are both usually susceptible to Success (spinosad), while *Frankliniella occidentalis* (western flower thrips) is not. On-site identification means that appropriate control measures can be implemented more quickly.

NOTE: The key in this guide is NOT comprehensive for all thrips species that may occur in Canada, nor those that may be found on imported plant material. The species included are those *most likely* to be encountered in floriculture, vegetable and/or fruit greenhouses. The species featured in this guide were chosen based on recent surveys conducted in southern Ontario, and therefore this key is most relevant to growers in the Great Lakes region of North America. Other regions may have different "most common" species. There are also many other thrips species present in the Great Lakes region that are not common pests of greenhouse crops and were therefore not included in this key.

If accurate species identification is in doubt, please contact an OMAFRA IPM extension specialist, the National Identification Service (NIS) at the Canadian National Collection of Insects, Arachnids and Nematodes (CNC) or the greenhouse entomology team at AAFC in Harrow, Ontario.

A note about species names

Throughout this guide we use the latin names for thrips species (e.g. *Frankliniella occidentalis*) rather than common names (e.g. western flower thrips). The reason for this is that common names are not all that common and often lead to confusion.

Firstly, the common names can differ between regions and commodities. For example, the common name used in Europe for the invasive *Thrips parvispinus* is "tobacco thrips", however in North America we already use "tobacco thrips" to refer to a native species, *Frankliniella fusca*.

Many common names for pests are based on a host plant they were originally found on, but this may not be the host plant they are most often associated with. Take, for instance, *Chaetanaphothrips orchidii*, whose common name is "orchid thrips". Despite its name, in the greenhouse industry we most often find this species on tropical foliage plants such as monstera and fiddle-leaf fig. However, "vanda thrips" (*Dichromothrips corbetti*) is found exclusively as a pest on orchids.

In some instances, the common name used most often for a species is actually part of the latin name. In Ontario, *Echinothrips americanus* is most often called "Echinothrips" in conversation, although its official common name is "poinsettia thrips".

In a written reference guide, we think it is important to be consistent with what terms we use. In light of all of the complications described above, we have chosen to use latin names, as these are not ambiguous nor do they change between regions.

For those of you who do not read latin names regularly, the standard practice is to use the entire latin name upon first introduction (e.g. *Echinothrips americanus*), and then in subsequent mentions, the first half of the name (the genus name) is abbreviated to the first letter (e.g. *E. americanus*). We have included the common names in the species profiles, and you can use the table of contents as a quick reference guide until you remember who is who.

Contents

1. Tools and Equipment

These are the tools we like to use when identifying thrips. A buying guide with examples and where you can find supplies mentioned in this guide has been included at the back of this guidebook (Appendix B).

To identify thrips you will need the following materials:

- an aspirator
- 70% alcohol (ethanol or isopropyl)
- a shallow dish (e.g. petri dish) for examining specimens under the microscope
- a mid-quality stereo microscope

The following tools are helpful for handling thrips while you are identifying them (Fig. 1):

- A transfer pipette
- a dissection needle/probe (such as you would find in a student's dissection kit)
- an extra fine tip paint brush (size 00 or 000) for positioning specimens

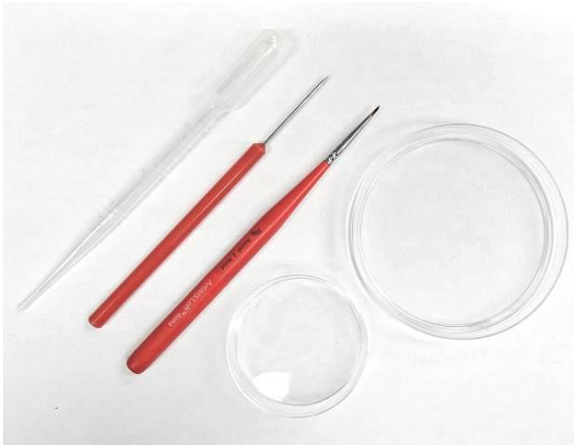


Figure 1. Left to right: transfer pipette, dissection needle, paint brush, and petri dishes

Aspirator

An aspirator is a vacuum device that will help you collect thrips. Typically, aspirators are made from tubes and vials and use either your mouth or a bulb to generate suction, although battery operated aspirators also exist. Aspirators are available for purchase from Bugdorm.com (Fig. 2) or Amazon. A more economical option is to make your own aspirator using supplies you can find online.

Figure 2. Ready-made aspirator from Bugdorm.com

One of the most important considerations when purchasing or building an aspirator is the mesh size of the fabric filter that will contain the insects. Thrips are incredibly small! You will need a very fine mesh of 100 microns or less, or US 150-mesh or higher.

About mesh sizes:

When mesh size is listed in microns, the number describes the size of each hole. Therefore a smaller number equals a finer mesh.

When mesh size is listed using US mesh units (e.g. 150-mesh), the number describes the number of openings per inch. With these units, a higher number equals a finer mesh.

1. Tools and Equipment

DIY Aspirator

You can build your own aspirators very easily with a few inexpensive supplies. This kind of aspirator can be used to collect very small insects and can be hung around your neck when you are not using it.

Materials needed:

- 0.5-1.0 m Silicon or PVC tubing
- 3 x 1 ml / 1000 µl pipette tips
- A piece of fine mesh fabric the size of a postage stamp
- Tape
- Scissors

Look for tubing with an interior diameter (ID) of 3/16 to 1/4 inch. You can find it at pet stores with the aquarium supplies, or hardware stores.

Fine mesh fabrics that might be suitable include: screen printing fabric, nylon home brewing filters, or bags for making nut milk.

You can use any type of long-lasting tape e.g. electrical tape, hockey tape, or duct tape.

Figure 3. Materials needed to build your own aspirator

Instructions:

1. Trim approximately 2 cm off the first pipette tip.
2. Place the square of mesh over the cut end of the pipette tip.
3. Assemble the aspirator tip: Insert the cut pipette tip & mesh into a second pipette tip (Figure 4A & 4B). Secure with tape if the fit is not snug and the pipette tips come apart easily.
4. Trim approximately 3-5 mm off the end of the second pipette tip to create a wide enough opening for insects to pass through easily (2-3 mm is a good size for thrips).
5. Cut a length of tubing. A length of 0.75-1.0 m is a good length if you want to be able to wear it around your neck.
6. Insert one end of tubing into the bottom of the aspirator tip (Figure 4C). Secure with tape.
7. Assemble the mouthpiece: Trim 1 cm off the end of a third pipette tip. Insert the cut end of the third pipette tip into the open end of the tubing (Figure 4D). Secure with tape.

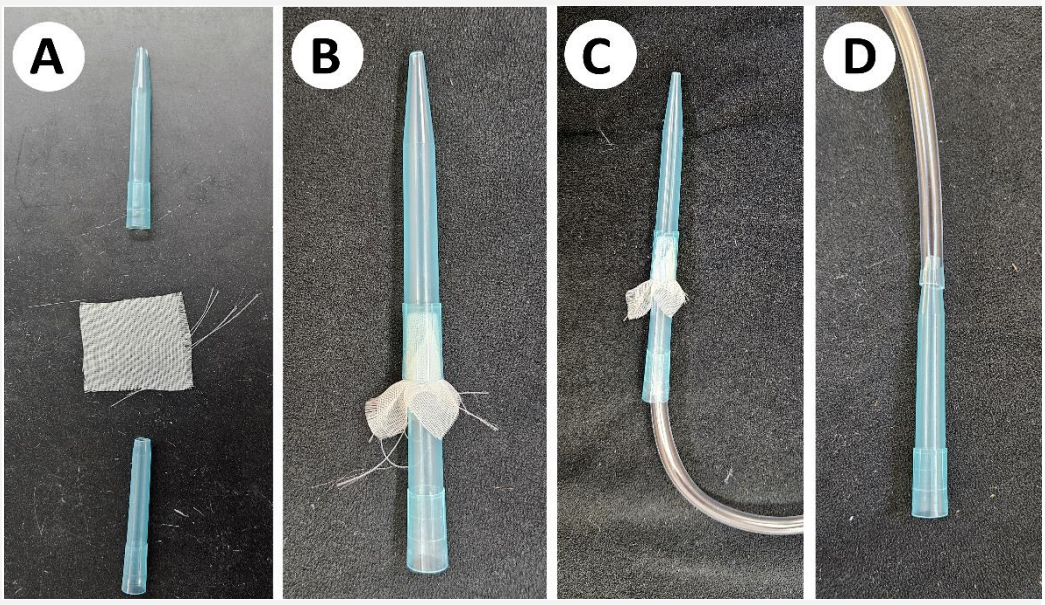


Figure 4. Assembling the aspirator tip and mouthpiece

Figure 5. Assembled aspirator

1. Tools and Equipment

Microscopes

All features referred to in this key can typically be seen using a mid-quality stereo microscope (also known as a dissection microscope). Your microscope will need to have a minimum 40X magnification.

There are many kinds of stereo microscopes available that range in price from a few hundred to over a thousand. As with most things, you often get what you pay for with microscopes.

Digital microscopes vary considerably in both quality and price. Depending on the model, these may be sufficient for large species, but may lack the image quality needed for all species we encounter. They also tend to be challenging to work with since the lens needs to be very close to the specimen (the distance from the microscope lens to the specimen is called "working distance").

Compact stereo microscopes with a static zoom dial (e.g. 1X, 2X, 4X) can offer a good balance of portability, affordability, and quality. They have a longer working distance than digital microscopes but may still feel crowded depending on the user. Their size and weight make them a good option if you wish to bring your microscope to different locations regularly.

Continuous zoom microscopes are the most expensive but are also the highest quality and offer the best user experience. They have the longest working distance, making it easy to position and locate your specimens. They tend to be larger and heavier, so this is a better option if you plan to leave your microscope in one place most of the time. Professional stereo microscopes, like the one we use in our lab, costs over $3,000, but retail stereo microscopes, like the AmScope SM-1 pictured below (Fig. 6), can cost as little as $500 and provide comparable quality.

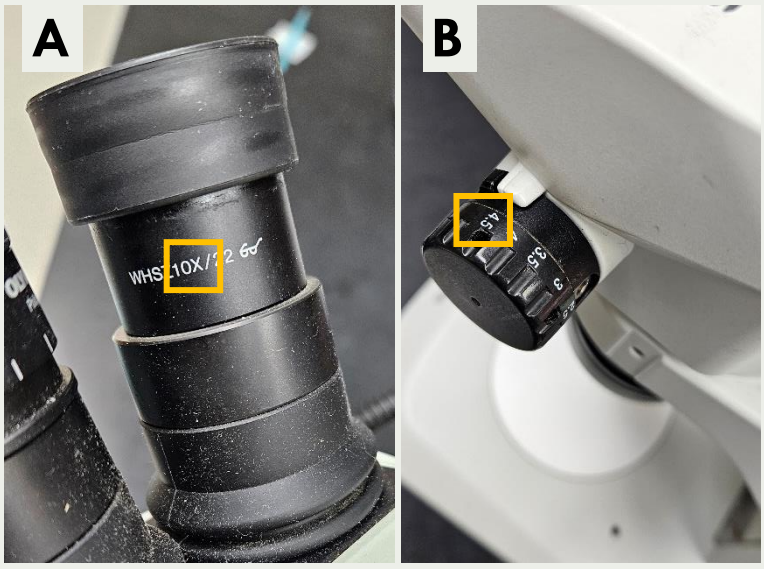
Figure 6. From left to right: compact microscope (AmScope SE306R), retail continuous zoom microscope (AmScope SM-1), and professional continuous zoom microscope (Olympus SZ61).

Things to consider when shopping for a microscope:

- You want a "stereo" or "dissecting" microscope, not a "compound" microscope.
- Magnification:
    - You need at least 40x to ID thrips.
    - Having a zoom range that also includes lower magnifications (e.g. 10x, 20x) will make it easier to locate specimens.
- Oculars (i.e. eye pieces) – look for these features that will make your microscope more comfortable to use:
    - The oculars face forward in the same direction as the platform where you place the specimens (this platform is called the "stage").
    - Has 2 oculars rather than only 1 ("binocular").
    - The oculars are adjustable and allow you to move them to suit how wide your eyes are set apart.
    - Has a 45 degree inclined head (as opposed to those where you are looking straight down).
- Lighting:
    - Good lighting is essential!
    - Make sure you have a light source that is coming from above, bottom lighting is not necessary.
    - Some microscopes have built in lights, but others require an external light source that may need to be purchased separately.

How to determine the magnification level of a microscope

What if you already have a microscope but aren't sure what its maximum magnification is? To determine the magnification level of a microscope, you multiply the magnification of (A) the eyepiece and (B) the highest number on the magnification dial. In this image the eyepiece magnification is 10x, and the dial magnification goes up to 4.5, for a maximum magnification of 45x.



2. Collecting thrips

Plant taps

Plant taps, or collecting thrips directly from foliage and flowers, is the best way to collect thrips samples for identification in your greenhouse. This will ensure you are getting a representative sample of which species are established in your crop or causing an outbreak.

Be sure to collect from all plant parts (foliage and flowers, upper and lower leaves) as different thrips species have different preferences of what parts of the plants they inhabit.

Collect thrips using plant taps from multiple areas of the crop (randomly selected) to get a representative picture of the entire thrips population in your greenhouse, or from specific areas of concern. Thrips can be tapped onto a tray or white piece of paper and collected with an aspirator. Plastic trays can easily be obtained from a dollar store and can be cleaned and reused. Transfer the thrips from the aspirator to a vial or other small container with 70% alcohol (either ethanol or isopropyl) to kill and store thrips.

For potted plants, the whole plant can be lifted or tilted over the tray to be tapped. For larger plants, such as cut flowers, vegetable crops, or fruit crops, you can hold the tray under the part of the plant you are tapping, or aspirate thrips directly from leaves and flowers.

If you do not have an aspirator, thrips can be tapped directly into a shallow container of soapy water to kill them. Alternatively, thrips can be tapped into a container with a lid, which can be placed in the freezer for at least 30 min to kill the thrips.

Thrips are easiest to examine under the microscope when dead, but not dried out. Therefore, samples should be identified within the next 48 h after collection so the samples do not desiccate.

Figure 7. Hold smaller potted plants over a white tray and tap the foliage briskly to dislodge thrips.

Figure 8. For larger plants or crops in troughs, hold the tapping tray underneath the foliage you are want to collect thrips from. Photo: © Kings Printer for Ontario, 2024.

Sticky cards

Sticky cards only catch flying thrips and may not give you an accurate picture of the species composition within your crop if there are more sedentary or wingless species present. However, sticky cards can sometimes be used for identification under the right conditions.

Light-coloured thrips can often be identified to species on yellow or white sticky cards, although some of the features may be more challenging to see. Blue cards may make features more difficult to see depending on the shade of the card.

Regardless of the card colour, dark-coloured thrips are very difficult to identify on sticky cards, so it is best to only identify them using specimens collected from plant taps.

Figure 9. *Frankliniella occidentalis* (western flower thrips) (left) and *Thrips tabaci* (onion thrips) (right) on a yellow sticky card

In addition to colour, glue-type can also affect your ability to ID thrips. Wet-glue cards are better for identification as the glue prevents the specimens from drying out. On dry-glue cards, thrips tend to dry and shrivel very quickly, making it difficult to see identification features. On wet-glue cards, the specimens will start to decompose over time, so it is best to only attempt to identify thrips on cards that have been up for 2 weeks or less.

Pro tip:

Before identifying thrips on sticky cards, wrap them in clear plastic to keep your hands and microscope clean.

Materials that can be used to wrap cards include clear plastic food bags, cling wrap, and clear page protectors.

You can store wrapped cards in the fridge or freezer to preserve the specimens if you are unable to examine them right away.

3. Identification Basics

Thrips anatomy

Like all adult insects, thrips bodies are divided into three main parts – the head, thorax, and abdomen. The thorax of thrips is further divided into the pronotum, mesonotum, and metanotum. The pronotum is the segment that is closest to the head, and is one of the main features we use for thrips identification. The meso- and metanotum, which form the lower half of the thorax is not used in this identification key.

On the head, the main characteristics used in thrips identification are the ocelli. These are a trio of spots located between the larger compound eyes. Ocelli are primitive eyespots that detect light and dark. They can be different colours depending on the thrips species.

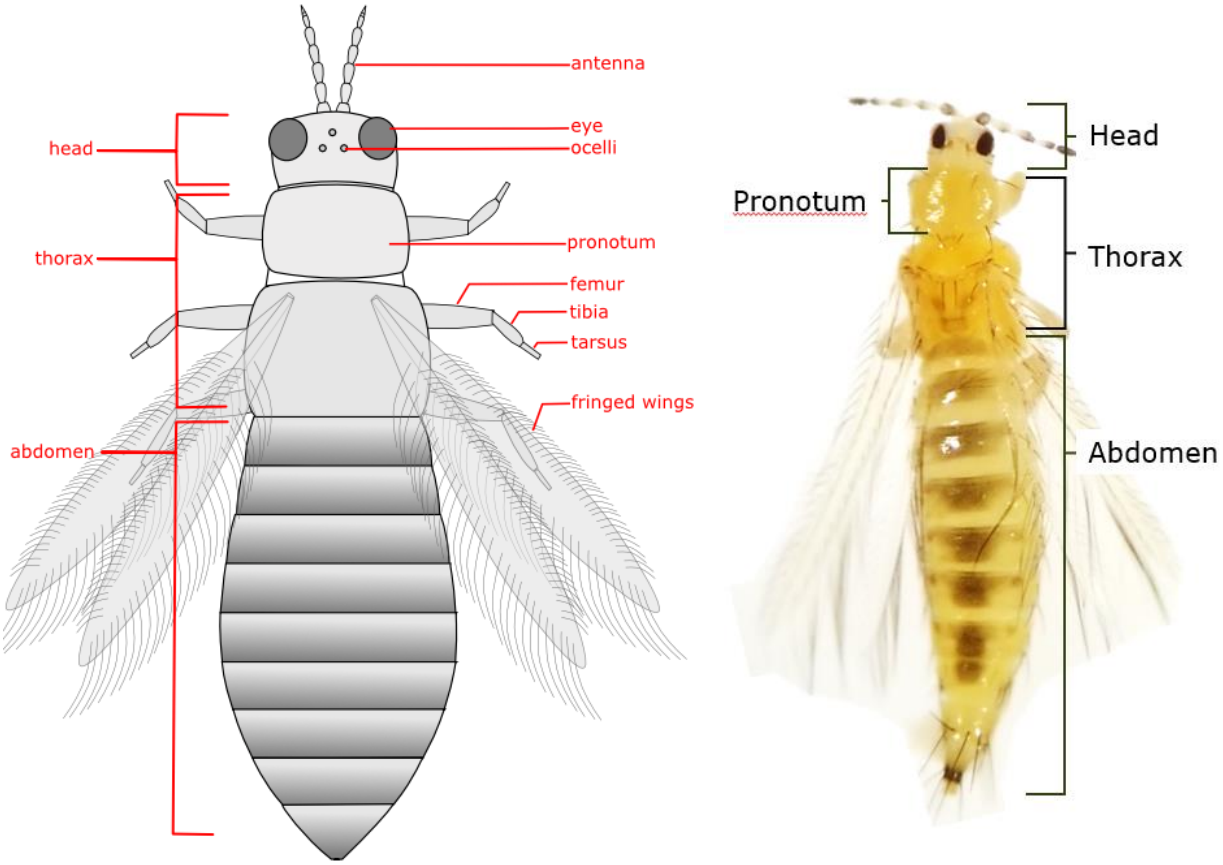


Figure 10. Important anatomical features of adult thrips.

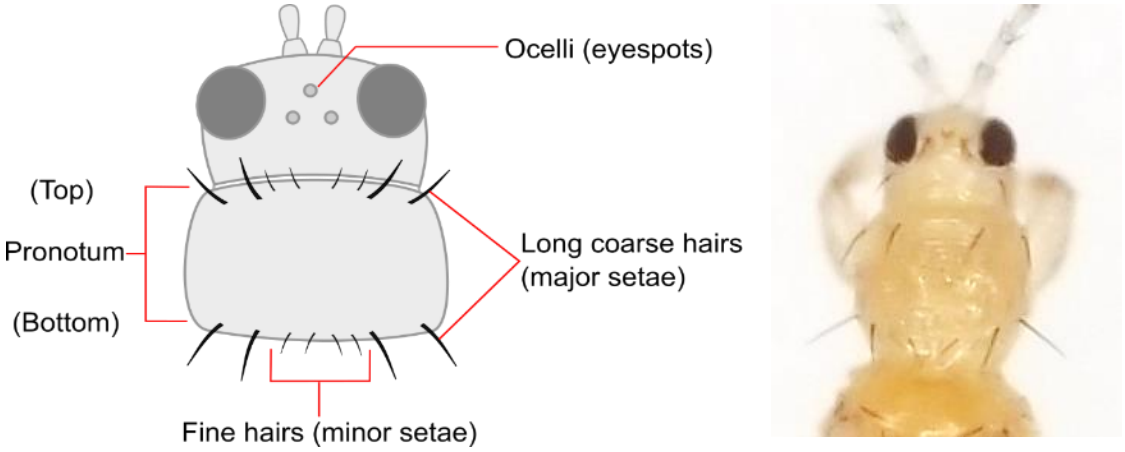


Figure 11. Important species identification features found on the head and pronotum.

Specimen life stage and positioning

For proper identification, ADULT thrips (usually winged) must be used. If none of the thrips in the sample have wings, they may be a wingless species. In this case, choose the largest thrips in the sample which have large eyes, a distinct head, thorax and abdomen (see Fig. 12). Larval thrips will appear more "tube like" without distinctive body parts and have small eyes.

Position the thrips stomach side down so that the wings and eyes are facing up, with the head facing away from you. This is often easier to do with a small probe or fine paintbrush with the thrips floating in water (or 70% alcohol) in a Petri dish or other small clear container. If you are having difficulty getting them in the right position, try reducing the amount of liquid in the dish using a transfer pipette, or try positioning them in clear hand-sanitizer gel.

Look at multiple specimens (minimum of 20) to confirm your identification(s) for an infestation on a specific crop. To get a wider picture of the species composition in your greenhouse, at least 100 thrips should be identified. Remember, it is common to have several different kinds of thrips in a single crop. Generally, it is species proportions that are most important (e.g. 60% western flower thrips and 40% onion thrips). This can help you determine which species are causing the most damage, and help you determine the most appropriate management strategy.

For instance, if you have a mixed population of onion and western flower thrips, pesticide sprays are more likely to be effective when onion thrips is the dominant species. However, if western flower thrips is the dominant species, these sprays are less likely to be effective and may be detrimental as they could disrupt biocontrol programs targeting this and other crop pests.

Thrips larva | Thrips adult, legs facing up | Thrips adult, wings facing up

Figure 12. Thrips larva vs. adult thrips. Adult thrips must be positioned with their wings facing up to see identification features.

Females vs. Male thrips

Female thrips are typically larger and more robust than their male counterparts. In some species, males and females can be completely different colours (this is called "sexual dimorphism").

The abdomen of female thrips are broader in the middle and taper to a point. In light-coloured species, a double fishhook shaped ovipositor (the body part that allows thrips to poke a hole in the leaf tissue and lay their eggs inside) is often visible when looking at the underside of the thrips.

The abdomens of male thrips are narrower, the same width throughout, and rounded at the end (shaped like a hot dog). In light-coloured specimens, their reproductive organs are visible and look like orange jelly-like blobs.

A. Female (left) and male (right) western flower thrips

B. Fishhook-shaped ovipositor of female thrips

C. Orange reproductive organs of male thrips

Figure 13. Appearance and identifying features of female and male thrips.

Why is it important to be able to tell the difference between males and females?

Since the males can look very different than the females, they can easily be mistaken for a different species.

For example, male pepper thrips (*T. parvispinus*) are pale yellow, whereas the females are dark brown. The males could be mistaken for chrysanthemum or chilli thrips based on body colour and size.

4. Thrips Key

Simple key to important thrips pests of Canadian greenhouses

Fourth Edition (2024)

We periodically update the key as we encounter new species. When new versions of the key are made, you will find them at: ONfloriculture.com/simple-thrips-ID-key/

How to use a dichotomous key

Always start at step one for each specimen. For each numbered step (1-15), pick one of the two possible choices that most resembles your specimen. This will indicate the species OR the next step you should jump to. When working through this key, look at several specimens as identification features may be more visible on some specimens than others, and the colour of some species may vary considerably.

If you reach a dead end and your specimen does not match with the steps, you may have one of the many other thrips species that are not covered in this key. Seek help from someone with advanced thrips identification experience, such as an OMAFRA IPM Specialist.

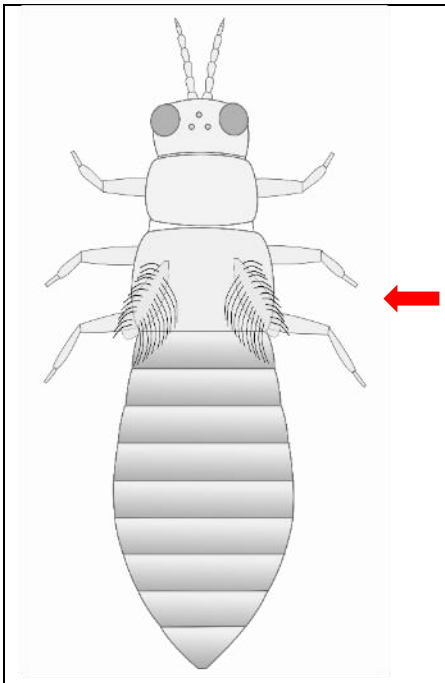
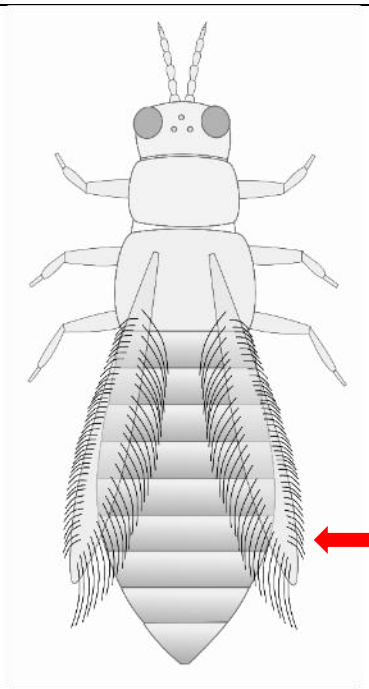
Identification key

STEP 1.

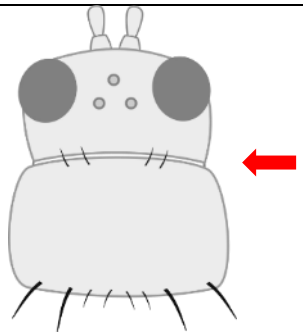
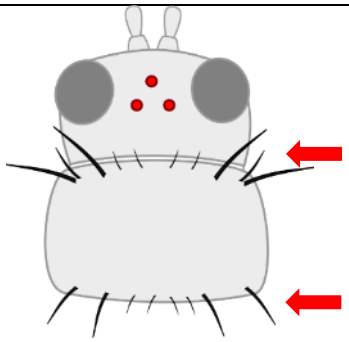
	
a. Head and pronotum light tan or yellow; abdomen tan, yellow or light to medium brown: (GO TO STEP 2)	b. Head, pronotum, and abdomen all brown to black in colour; head and pronotum may be lighter brown than the abdomen, but not yellow: (GO TO STEP 7)

LIGHT COLOURED THRIPS

STEP 2.

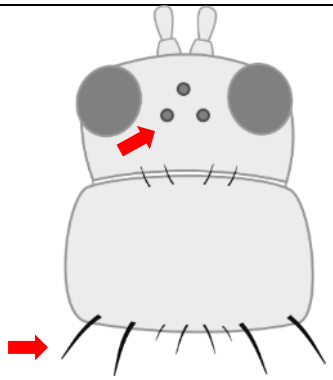
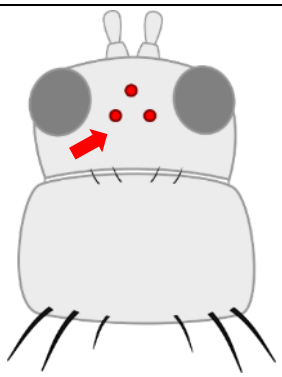
	
a. Very short wings, shorter than the width of the body: *Thrips nigropilosus* (chrysanthemum thrips), wingless form. Both winged and wingless forms may be present in the same population.	b. Long fringed wings extending nearly the full length of the body: (GO TO STEP 3)

STEP 3.

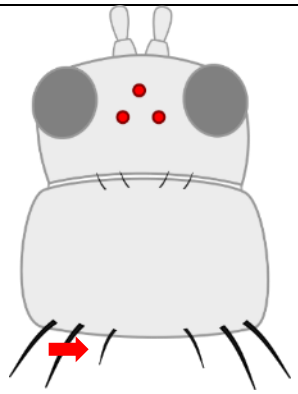
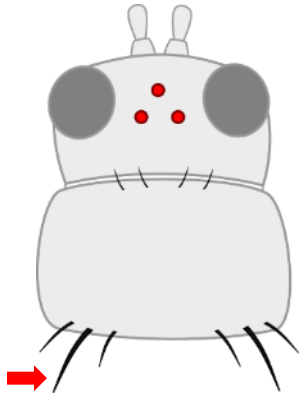
	
a. No long coarse hairs on the top of pronotum; bottom of pronotum may or may not have long coarse hairs; ocelli may or may not be red: (GO TO STEP 4)	b. Top of pronotum has 2 pairs of long coarse hairs that are roughly equal in length; ocelli are red: Most likely *Frankliniella occidentalis* (western flower thrips)[1]

[1] In Ontario greenhouses, the majority of thrips you are likely to encounter will be *F. occidentalis*. However, specimens with these features may also be other *Frankliniella* species such as *F. tritici, F. bispinosa,* or *F. schultzei* (pale forms). Differentiating between *Frankliniella* species requires a compound microscope and advanced identification skills.

STEP 4.

	
a. Ocelli grey; 2 pairs of long coarse hairs on the bottom of the pronotum: *Thrips tabaci* (onion thrips)	b. Ocelli red; bottom of pronotum may or may not have long coarse hairs: (GO TO STEP 5)

STEP 5.

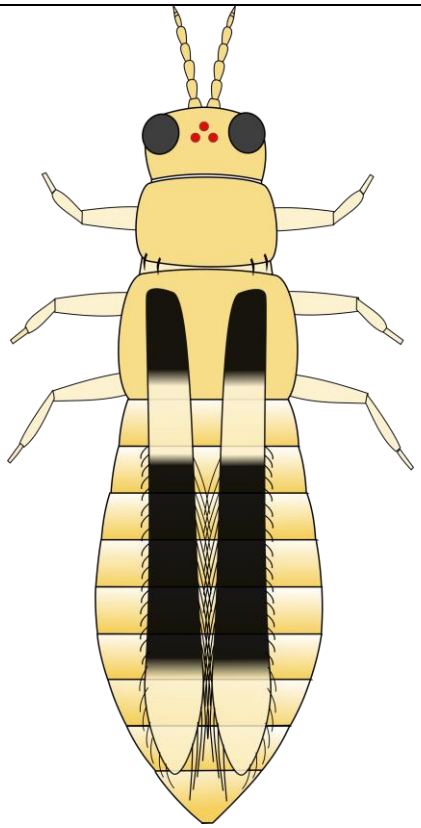
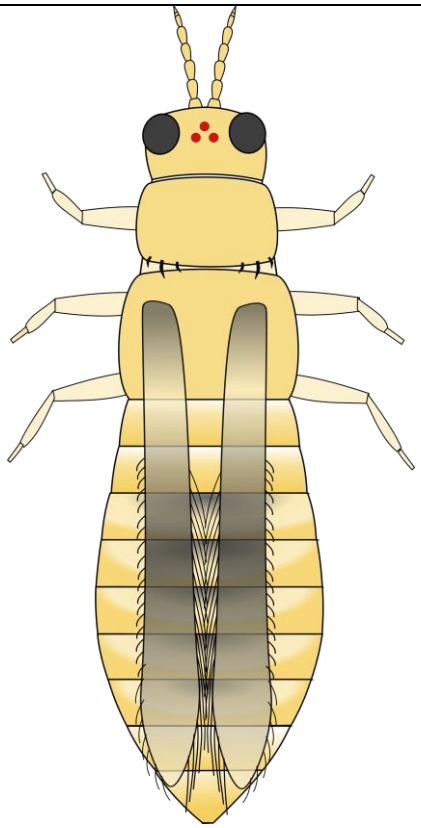
	
a. Three pairs of long coarse hairs on the bottom of the pronotum, outer two pairs distinctively longer than those in the middle; wings are pale or absent; foliar feeding damage typically on lower leaves: Most likely *Thrips nigropilosus* (chrysanthemum thrips)[2], winged form: not common, present throughout North America.	b. Coarse dark hairs on the bottom of the pronotum are short and may be difficult to see. Small body size compared to other thrips species. Wings are grey or black; usually found on tropicals: (GO TO STEP 6)

[2] Could also be male *Thrips parvispinus* or *T. setosus* - see Step 11 for identification of females if dark coloured thrips are found in the same population.

If found on crops other than chrysanthemum and gloxinia may be *T. palmi***, which is not present in Canada but may be intercepted on plant material imported from tropical regions including Florida, Mexico, and Central America. Differentiating between *T. nigropilosus* and *T. palmi* requires advanced identification skills and compound microscope.

**If you think you may have found a species not usually present in Canada you should consult an OMAFRA IPM specialist to verify the identification and discuss management options.

STEP 6.

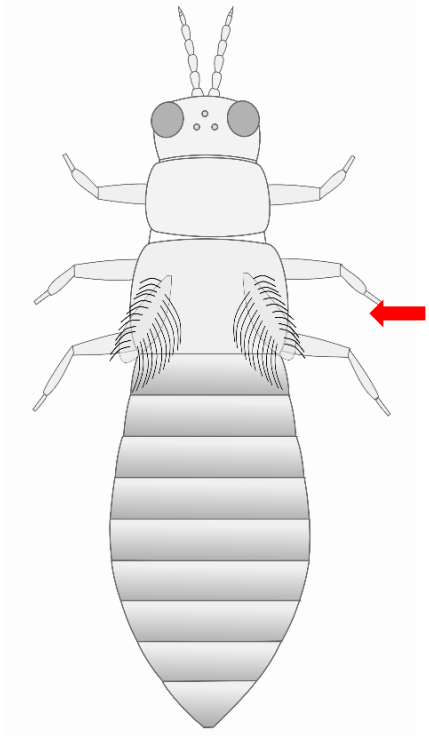
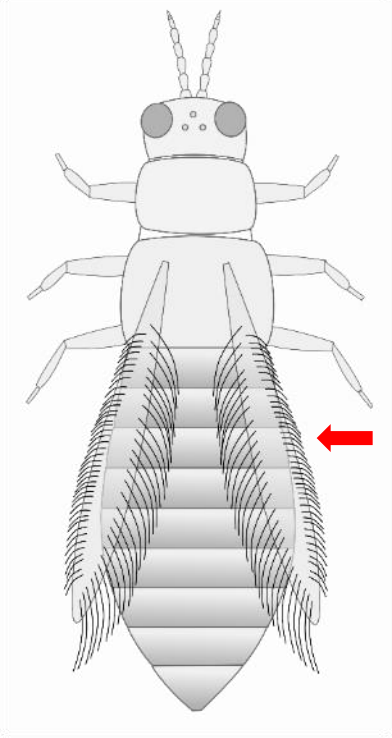
	
a. Head and body yellow; wings black with distinct clear band in the middle; hairs on the bottom of the pronotum are fine and may not be visible with a dissection microscope. Usually found on tropicals: ***Chaetanaphothrips ochidii,* (orchid thrips). This species is not present in Canada but widespread in tropical and sub-tropical regions, including California and Florida; may be inter-cepted on imported plant material.	b. Coarse dark hairs on the bottom of the pronotum are short and may be difficult to see, middle pair distinctly longer than the others. Wings are grey with some pale sections but not distinct bands. Usually found on tropicals; distinctive feeding damage that resembles broadmite damage: ** Scirtothrips dorsalis (*chilli thrips*). This species is not present in Canada, but present in Florida, Texas, Mexico, and the Caribbean; may be intercepted on imported plant material.

** If you think you have found a species not usually present in Canada, such as *C. orchidii* or *S. dorsalis*, you should consult an OMAFRA IPM specialist to verify the identification and discuss management options.

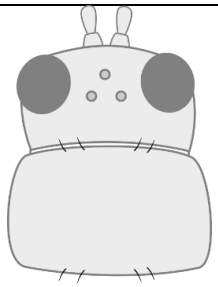
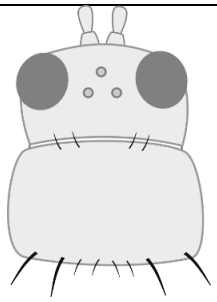
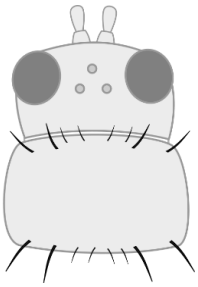
Dark-coloured thrips:

Dark-coloured thrips are very difficult to identify on sticky cards because the dark pigmentation makes the hairs on the pronotum nearly impossible to see. Therefore, this key should not be used to identify dark-coloured species stuck to cards. If you are finding thrips that are very dark brown to black on your sticky cards, it is advisable to collect specimens from the crop before proceeding with this key (if you can't find any in your crop, you probably don't need to worry about them!)

STEP 7.

	
a. Very short wings, shorter than the width of the body; body dark brown to black: *Frankliniella fusca* (tobacco thrips), wingless form. Both winged and wingless forms may be present in the same population.	b. Long fringed wings extending nearly the full length of the body: (GO TO STEP 8)

STEP 8.

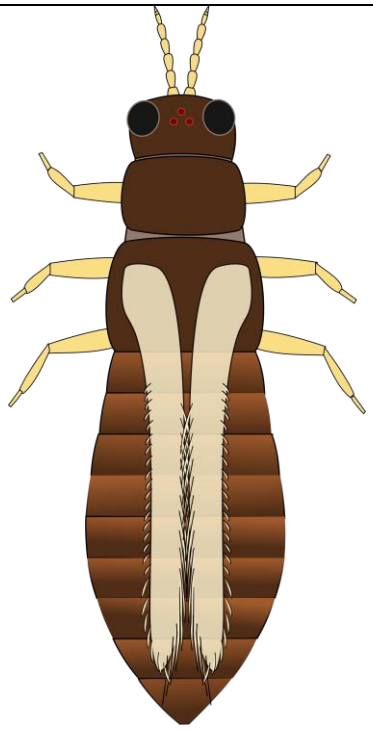
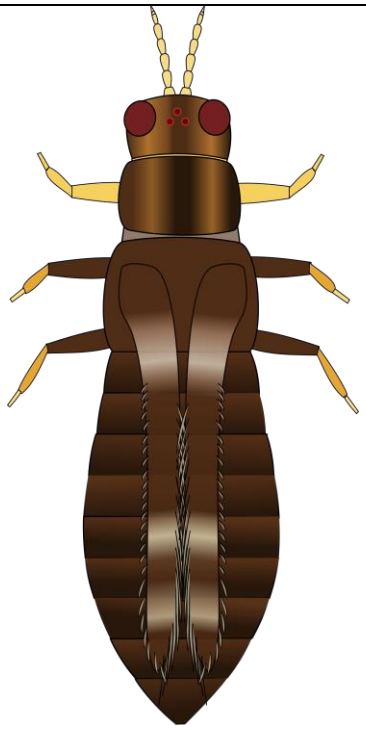
	 OR 
a. No long coarse hairs on the pronotum; front legs entirely yellow: (GO TO STEP 9)	b. Pronotum has long coarse hairs. (hairs may be difficult to see on very dark thrips – may be easier to see in side view: (GO TO STEP 10)

Pro tip:

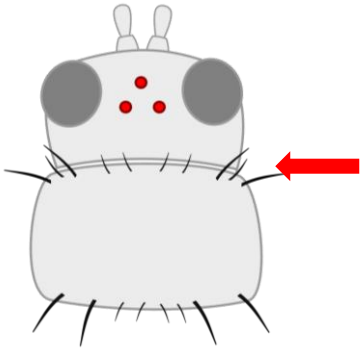
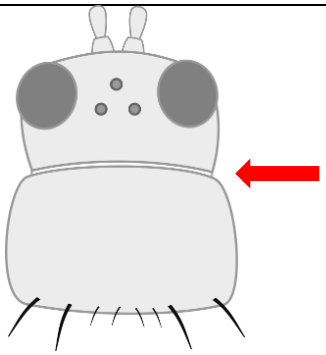
Hairs on the pronotum may be difficult to see on very dark specimens.

The hairs may be easier to see if you turn the specimen on its side.

STEP 9.

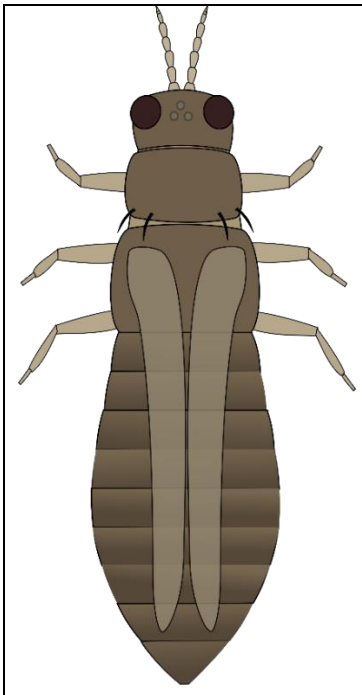
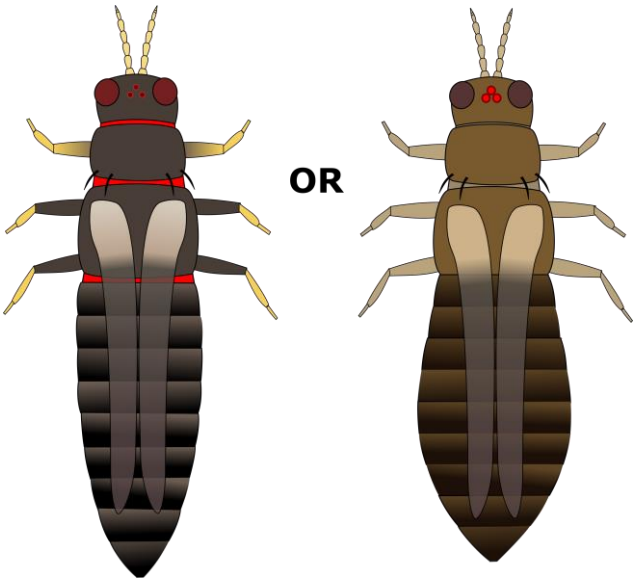
	
a. All legs entirely yellow; head and pronotum as dark as or darker than the rest of the body; wings uniform in colour and paler than the body (visible on dry specimens): *Heliothrips haemorrhoidalis* (greenhouse thrips); very uncommon in Ontario	b. Front legs yellow, back legs yellow with brown femurs; head and pronotum often lighter in colour than the rest of the body; light patches at the top and tips of the wings (visible on dry specimens): *Hercinothrips femoralis* (banded greenhouse thrips) uncommon in Ontario

STEP 10.

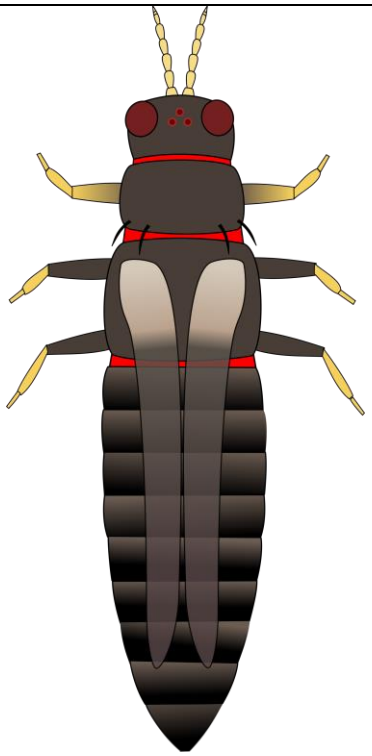
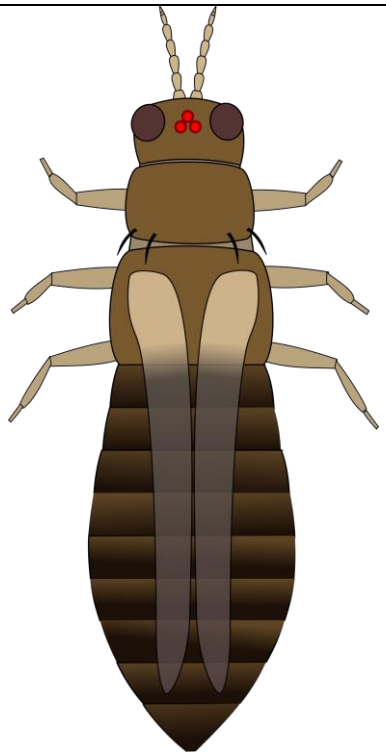
	
a. Pronotum has long coarse hairs on BOTH top and bottom of pronotum; no red pigment visible between the segments: Most likely *Franklinella fusca*, (tobacco thrips) [3], winged form.	b. NO long coarse hairs or fine hairs on the top of pronotum; bottom has 2 pairs of long coarse hairs; red pigment may or may not be visible between segments: (GO TO STEP 11)

[3] May also be *F. occidentalis*, dark morph (usually seen in fall and winter), *F. intonsa* (not known from Ontario, but present in British Columbia), or *F. schultzei* (not present in Canada but present in Florida, Central America & the Caribbean, may be intercepted on imported plant materials.

STEP 11.

	
a. Head and body light to medium brown, never black, uniform in colour. Grey ocelli/no ocelli visible; wings uniform in colour and pale in colour: *Thrips tabaci* (Onion Thrips), dark morph	b. Abdomen dark brown to black; head and pronotum either medium brown or black; red ocelli; light patches at the top of the wings (visible on dry specimens): (GO TO STEP 12)

STEP 12.

	
a. Head and body black; red ocelli (may be difficult to see); red pigmentation often visible between the segments; back legs yellow with black femurs, femurs of front legs dusky at base but not distinctly black; abdomen widest at the top and narrowing towards the tip: *Echinothrips americanus*, (poinsettia thrips) On orchid crops this may also be *Dichromothrips corbetti*.	b. Head and pronotum medium to dark brown, abdomen often darker than head; ocelli bright red and easily visible; no red pigmentation visible between segments; legs pale and uniform in colour; abdomen widest in the middle: *Thrips parvispinus* (pepper thrips) or *Thrips setosus* (Japanese flower thrips)**, females The males of both species are pale yellow. Neither species is established in Canada but are present in some US states; may be intercepted on imported plant material. In northern latitudes, *T. parvispinus* is typically intercepted on tropicals, and *T. setosus* has been found on Hydrangea.

**If you think you have found a species not usually present in Canada, such as *Thrips parvispinus* or *T. setosus*, you should consult an OMAFRA IPM specialist to verify the identification and discuss management options.

5. Species profiles

These species profiles are designed to give you a little more insight into the appearance, biology, and habits of the species that we have encountered (or may encounter) in greenhouse crops in the Great Lakes region. This is not a comprehensive review of everything that is known about each species. For many species, there has been very little published. Therefore, these profiles contain a mix of published information as well as our first-hand experiences.

The photos in these profiles should not be used as an identification tool! As many thrips species can vary in colour and appearance, using photos to ID thrips can lead to misidentification. You should first identify your specimens using the key, then, you can consult the species profiles to verify that the features, host plants, and other traits align with your specimens.

If, after consulting these profiles, the traits described don't align with the answer that the key lead you to, it is possible that:

- You have another thrips species not included in the key,
- You missed a feature while working through the key and were led to the wrong answer, or
- The species ID is correct but the traits you are observing (e.g. host plants) have not been previously published or observed by us.

If you think you may have taken a wrong turn in the key, try it again with a few more specimens. If they all lead you to the same answer, it would be best to consult an expert to verify the ID.

Species statuses and related terms:

- Native: a species that originates in eastern North America.
- Exotic: a species that does not originate in Eastern North America and is not naturalized.
- Established: an ongoing breeding population of an exotic species.
- Naturalized: a non-native species that has been established in eastern North America for a sufficiently long time to be considered part of the landscape (e.g. dandelions and starlings).
- Local: a species that is present (native, naturalized, or established) in the Great Lakes region.
- Not local: a species that is present in other parts of North America, but not in the Great Lakes region.
- Common: is likely to be found in surveys, even if only at low numbers.

Frankliniella occidentalis - Western flower thrips

Other common names: California thrips

Status in Great Lakes region: Naturalized – although originally from the southwestern USA, this species has been established throughout North America for at least 40 years.

Appearance:

- Large body size
- Body colour highly variable; base colour pale to dark yellow with variable amounts of brown markings
- Hairs on head and pronotum are long, coarse, and very noticeable
- Ocelli are dull red and appear as three distinctly separate circles

May be confused with: Other *Frankliniella* species, including:

- *F. tritici* (eastern flower thrips) – common in Ontario
- *F. bispinosa* (Florida flower thrips) – not local
- *F. schultzei* (common blossom thrips) – not local

Differentiating *Frankliniella* species requires a compound microscope and advanced identification skills.

Host plants: Extremely wide host range that includes many ornamental, vegetable, and fruit crops. They are a particular problem for:

- Vegetables: peppers, tomatoes, eggplants, cucumbers, and long beans
- Fruit: strawberries, raspberries, and melons
- Floriculture: Chrysanthemum (potted and cut), gerbera (potted and cut), ivy geranium, cut snapdragons, certain spring bedding crops such as verbena, dracaena, new guinea impatiens, and dahlia

Other notable traits:

- Extremely pesticide resistant
- Flower feeders, often damage petals
- Adults attracted yellow sticky cards and blue to a lesser extent
- Pupate in the soil
- Fast life cycle (approx. 2 weeks) at temperatures between 20-30°C
- Fly-ins are common in summer months
- Local populations are cold tolerant (i.e. are able to survive our winters)

Female *F. occidentalis* (left) is larger and darker than the male (right) and has coarser hairs on the head and pronotum.

Colour variation in female *F. occidentalis*. Darker forms are more common in fall and winter, though a range of colours may be present at any time, even within the same population.

Thrips tabaci - Onion thrips

Status in Great Lakes region: Naturalized – although originally from the Mediterranean, this species has been established throughout North America for over 100 years.

Appearance:

- Small to medium body size.
- Pale beige/tan to dark brown in colour; relatively uniform in colour; head and pronotum may be slightly paler than abdomen.
- Darker colour morphs are more common in fall & winter.
- Hairs only on bottom of the pronotum; hairs are relatively fine; no large hairs visible on head.
- Grey ocelli may be either not visible or appear as a slightly shaded area between the eyes.

May be confused with:

- Male *F. occidentalis*
- Darker forms may be mistaken for *T. parvispinus, T. setosus*, or *F. fusca*

Host plants: Extremely wide host range that includes many ornamental and greenhouse vegetable crops. They are often a problem for:

- Floriculture: Chrysanthemum (potted and cut), gerbera (potted and cut), cyclamen, osteospermum
- Vegetables: tomato, pepper, cucumber
- Cannabis: this species makes up most of the thrips found in indoor cannabis production

Other notable traits:

- Asexual reproduction - there are no males in local populations (or they are at least *extremely* rare)
- Pupate in soil
- Cause primarily foliar damage; they will also eat pollen but typically do not damage flowers
- Adults attracted yellow sticky cards and blue to a lesser extent
- Fly-ins common in summer months
- Local populations are cold tolerant

Frankliniella fusca - Tobacco thrips

Status in Great Lakes region: Native

Appearance:

- Large body size
- Body dark brown; head and pronotum usually as dark as abdomen or slightly lighter
- Dull red ocelli (may be difficult to see)
- Long coarse hairs on both the top and bottom of the pronotum; hairs on the top of the pronotum are usually shorter than those on the bottom and less pronounced compared to *F. occidentalis*
- Wings either uniformly light brown without clear bands, or wings absent
- The only wingless dark-coloured thrips that is common in the greenhouse

May be confused with: *Frankliniella intonsa* (European flower thrips) looks nearly identical to *F. fusca*. *F. intonsa* has not been found in Ontario, however it has become established in other regions including British Columbia. *F. intonsa* does not have a wingless form.

May also be confused with:

- *Thrips tabaci,* dark morph
- *Thrips trehernei* - local, not common in greenhouse crops
- *Frankliniella schultzei*, dark morph - not local
- *Thrips fuscipennis* - not local, can be found in BC

Host plants: Wide host range that includes many ornamental and vegetable crops. This species is very common but rarely causes major outbreaks.

Other notable traits:

- Cold tolerant
- Flower feeding species
- Confirmed vector of TSWV
- Pupates in the soil
- Wingless form is induced by short days and therefore more common in fall & winter

Echinothrips americanus - Poinsettia thrips

Other common names: Impatiens thrips

Status in Great Lakes region: Native

Appearance:

- Large body size
- Head, pronotum, and abdomen black; head is as dark as abdomen
- Wings have clear patch at top which appear white on live or dry specimens
- Reddish pigmentation visible between segments
- Hairs on the bottom of the pronotum
- Red ocelli
- Femurs of middle and back legs black, femurs of front legs dusky

May be confused with:

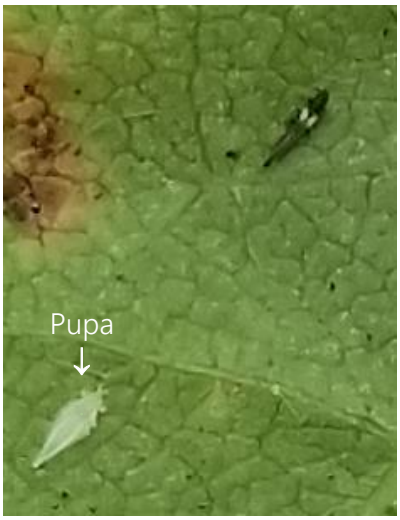
- *Thrips setosus* (Japanese flower thrips) – exotic
- *Dichromothrips corbetti* (Vanda thrips) – exotic, only found on orchids

Host plants: Wide host range. Until recently they were primarily a pest of ornamental crops. They are becoming increasingly common in greenhouse vegetables, and may also attack some fruit crops such as raspberries. Common pest of:

- Gerbera
- Poinsettia
- Some tropical foliage plants
- Peppers

Other notable traits:

- Foliar feeders, usually preferring older, lower leaves
- Pupates on leaves
- Slow-moving and disinclined to fly
- More attracted to blue sticky cards, however, are rarely caught on sticky traps unless the trap is touching the foliage



Thrips nigropilosus – Chrysanthemum thrips

Status in Great Lakes region: Naturalized – originated in Europe but is now widespread globally.

Appearance:

- Small body size
- Pale yellow in colour often with some light brown markings on abdomen
- Pronotum may have some light brown blotchy shading
- Long coarse hairs only on the bottom of the pronotum only; small coarse hairs may be visible in the middle or top of the pronotum
- Bright red ocelli that appear to bleed together
- Wings may be absent
- The only wingless pale thrips species that is common in greenhouses

May be confused with:

- Male *T. parvispinus* or *T. setosus*
- *Thrips palmi* (Melon thrips) – not local
- *Scirtothrips dorsalis* (Chili thrips) – not local
- *Chaetanaphothrips orchidii* (Orchid thrips) – exotic

Host plants: Primarily a pest of ornamentals in the Asteraceae family including chrysanthemum, pyrethrum, and marigolds. May also be a pest of greenhouse lettuce and greenhouse strawberries. Has been found attacking mullein banker plants.

Other notable traits:

- Foliar feeder, often strongly preferring lower leaves
- Wingless morph is triggered by short day length and therefore more common in fall & winter as well as short-day crops
- Rarely show up on monitoring cards
- Outbreaks are often concentrated in discrete patches within the crop

Thrips parvispinus - Pepper thrips

Other common names: Tobacco thrips (Europe)

Status in Great Lakes region: Exotic

Appearance:

- Small body size
- Abdomen dark brown, head and pronotum paler than abdomen, usually amber to medium brown
- Wings have clear patch at top. Patches appear paler than body when live/dry, but do not appear white as with *Echinothrips americanus* or *Thrips setosus*
- Bright red ocelli that appear to blur together
- Long coarse hairs on the bottom of the pronotum only
- No reddish pigmentation between segments
- Males are yellow

May be confused with:

- *Thrips setosus*
- *Frankliniella fusca*
- *Thrips tabaci*, dark morph

Host plants: Wide host range. Found primarily on ornamental crops, and occasionally greenhouse peppers. In Canada, it is typically intercepted on imported tropicals, including mandevilla, schefflera, anthurium, and hoya.

Other notable traits:

- Tropical species
- Not cold tolerant and not expected to be able to establish outside the greenhouse in Canada
- Pupates in the soil
- Often causes deformed leaves and growing points that resembles broad mite damage
- Very active thrips – look for fast movement if inspecting plants or monitoring using plant taps
- Larvae small compared to other thrips species and may be difficult to see; counts often underestimate actual numbers

Thrips setosus - Japanese flower thrips

Status in Great Lakes region: Exotic

Appearance:

- Small body size
- Abdomen very dark brown, head and pronotum either as dark as abdomen or slightly lighter
- Wings have clear patch at top which appear white on live or dry specimens
- Bright red ocelli that appear to blur together
- Long coarse hairs on the bottom of the pronotum only
- No reddish pigmentation between segments
- Males are yellow

May be confused with:

- *Thrips parvispinus*
- *Echinothrips americanus*

Host plants: Wide host range that includes many vegetable and ornamental crops. In Canada, it has only been intercepted on hydrangea, and in Michigan it has also been found on hostas.

Other notable traits:

- Primarily damages foliage, but may also be found in flowers
- Feeding causes typical silver feeding spots
- Confirmed vector of TSWV and INSV
- Comes from a temperate region, is cold tolerant, and capable of surviving outdoors in Canada
- Pupates in soil

A note of caution:

It is often not possible to differentiate *Thrips parvispinus* and *T. setosus* conclusively without a compound microscope and advanced identification skills. However, so far in Canada *T. setosus* has not been found on tropical plants, and *T. parvispinus* has not been found on hydrangea.

Hercinothrips femoralis - Banded greenhouse thrips

Status in Great Lakes region: Exotic

Appearance:

- Large bodied and stocky, abdomen is often noticeably wider than pronotum
- Abdomen dark brown, head and pronotoum are medium to dark brown
- Vertical bands of dark brown shading may be visible on head and pronotum
- Wings are dark brown with multiple clear bands that appear white on dry or live specimens

May be confused with:

- *Echinothrips americanus*

Host plants: Wide host range. In Canada they are most frequently found on tropical foliage plants such as Ficus, Peperomia, and occasionally on greenhouse vegetables.

Other notable traits:

- Leaves large oily black droplets of excrement on leaves; the droplets are larger than those left by other thrips species
- Pupates on leaves
- Relatively slow life cycle (around 1 month at 25°C)

Chaetanaphothrips orchidii – Orchid thrips

Other common names: Anthurium thrips

Status in Great Lakes region: Exotic

Appearance:

- Small body size
- Pale yellow head and body
- Bright red ocelli that appear to bleed together
- Wings are black with distinct clear band in the upper-middle
- There are 2 pairs of coarse hairs on the bottom of the pronotum, but these are relatively short and fine compared to other species in this key; under most dissection microscopes it may appear that there are no hairs on the bottom of the pronotum

May be confused with:

- *Scirtothrips dorsalis* (chilli thrips)

Host plants: This species has a wide host range, but in North America they are typically found on tropical plants, they are a particular pest of Anthurium in some parts of the world. In Canada they have been found on Monstera, Ficus, Philodendron, Bougainvillia, Calathea, and spider plants.

Other notable traits:

- Relatively slow life cycle, may take a month or more depending on temperature.
- No males recorded in this species
- Adults often lay eggs on unfurled leaves
- Pupation site not confirmed – either in soil or hidden in leaf crevices

Scirtothrips dorsalis - Chilli thrips

Status in Great Lakes region: Exotic

Appearance:

- Small body size
- Head and abdomen yellow in colour
- Bright red ocelli
- Wings are light to dark grey with some fading near the top of the wings, but not a distinct band
- Short coarse hairs on the bottom of the pronotoum; these may be difficult to see depending on the quality of your microscope.

May be confused with:

- *Chaetanaphothrips orchidii* (orchid thrips)
- *Thrips nigropilosus* (chrysanthemum thrips)

Host plants: Wide host range that includes many ornamental and vegetable crops. In Florida, they are a significant pest of strawberry and a wide variety of ornamentals, especially roses. Other common host plants in Florida include peppers, eggplant, and cucurbits.

Other notable traits:

- Feeding damage causes stunting and deformity of leaves and growing points, which can resemble broad mite damage, as well as leaf curling
- Also cause bronzing of strawberry fruit

Photo: J.D. Montemayor, UF/IFAS

6. IPM strategies

Which thrips species you have in your crop can impact many parts of an integrated pest management (IPM) program. Unfortunately, for species other than *Frankliniella occidentalis* (western flower thrips), greenhouse IPM research is limited. For example, even though *Thrips tabaci* (onion thrips) is a well-studied species, much of the research has focused on outdoor crops. Until more research is conducted, we need to rely on our understanding of the biology and behaviour of these other thrips species, and, when available, observations by growers and IPM professionals.

This section outlines our current knowledge of best management practices for various thrips species found in greenhouse crops in Ontario. Information is likely to change as we learn more about these species or as they adapt to our growing environment.

Biology & Behaviour

All the thrips species we cover have an egg stage, 2 larval instars, a pupal stage, and an adult stage (Fig. 14). However, different species can complete their life cycle more quickly at certain temperatures than others. For example, the optimal temperature for *F. occidentalis* is around 25°C, then at higher temperatures its development slows down. *Thrips parvispinus* (pepper thrips), on the other hand, develops fastest at 30°C. This means you are more likely to have an outbreak of *T. parvispinus* when greenhouses are at their hottest, while *F. occidentalis* population growth would be highest at more moderate temperatures.

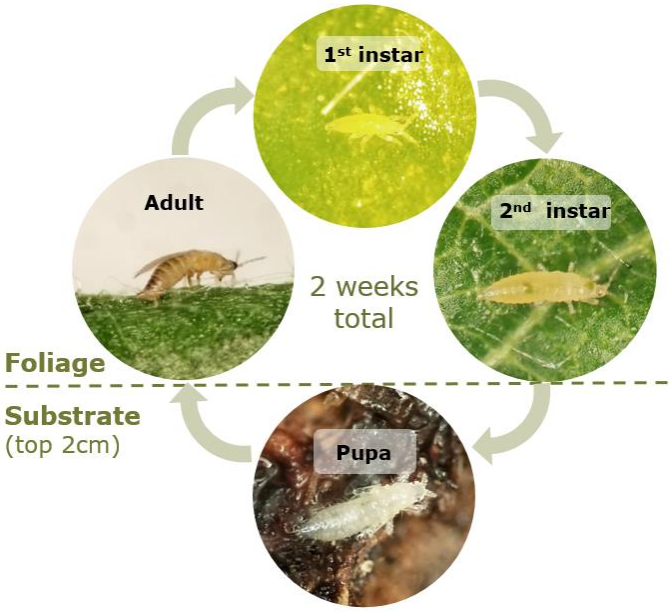


Figure 14. Life cycle of *Frankliniella occidentalis*. Total life cycle from egg to adult takes 2 weeks at 25°C.

Most thrips pests (including all the species described in our key), lay their eggs inside the leaf tissue, protecting them from predators, sprays, and human detection. However, there are a few thrips pest species who lay their eggs on the leaf surface. *Gynaikothrips uzeli* (weeping fig thrips), and *Gynaikothrips ficorum* (Cuban laurel thrips) are two such species.

Where thrips larvae and adults are found on plants can also vary between species. Some thrips species prefer flowers, such as *F. occidentalis*, *T. parvispinus*, *F. fusca* (tobacco thrips), and *T. setosus*

(Japanese flower thrips). Other species are primarily foliage feeders, including *Echinothrips americanus* (poinsettia thrips), *T. nigropilosus* (chrysanthemum thrips), and *Hercinothrips femoralis* (banded greenhouse thrips).

Most species found in the greenhouse pupate primarily in the soil/substrate. For these species, you can use soil-dwelling predators, nematodes, or drenches of entomopathogenic fungi to target pupal states. However, *E americanus* and *H. femoralis* are the exceptions. These two species pupate on the leaves, and soil-targeted measures will not contribute to control. *Scirtothrips dorsalis* (chilli thrips) pupate in multiple sites, including the leaf litter, curled leaves, and under the calyx of flowers, which also make them poor targets for soil-applied management strategies.

Understanding their biology and behaviour can help you more effectively monitor and manage each thrips species and also aid in identification. For example, using their location on the plants, coupled with the type of feeding damage, can help confirm thrips species identifications made using the Simple Identification Key we provide in this guide. Knowing where most life stages are found can also help target spray and biocontrol applications.

Monitoring

Figure 15. Inspecting a pepper flower for thrips. [Photo: © Kings Printer for Ontario, 2020]

How you monitor can differ between species. Thrips species that tend to prefer flowers (see above) are best monitored using flower taps or flower inspections (Fig. 15). However, this monitoring method will not be effective for foliage-feeding species. Whole plant taps, or taps of both flowers and foliage, are a more reliable monitoring method that will work for most thrips species.

In all cases, visual inspections of the crop and looking for petal, leaf, and fruit damage is key to both early detection and evaluating pest pressure. Often, unusual plant damage is the first sign that you have a different thrips species. Crop inspections and damage assessments may be your best bet for early detection of species such as *T. parvispinus* that can cause plant deformities even at low numbers. Some thrips species, such as *H. femoralis*, leave large fecal droppings which can also signal infestation.

The accuracy of sticky cards for monitoring will be dependent on whether a thrips species is an active flier, as well as where they are more likely to be within the crop canopy. In ornamental crops, *Echinothrips americanus* and *H. femoralis* are generally more sedentary species that often prefer

the lower leaves of the plant, which means that they are less likely to be caught on cards placed just above the crop canopy, as is typical when monitoring for *F. occidentalis*. However, in greenhouse vegetables, *E. americanus* has been observed throughout the canopy of pepper crops, and green cards placed directly above the canopy have caught high numbers of adults. For species with wingless morphs, such as *F. fusca* and *T. nigropilosus*, the wingless adults will never be caught on sticky cards. However, some growers use small pieces of sticky cards (e.g. ¼ of a small monitoring card, often blue) placed on foliage to monitor less active or non-flying species. In all cases, if you are noticing low thrips numbers on monitoring cards, but high damage on the crop, it is time to switch to plant taps or flower inspections, which are more informative.

Physical Control

As with monitoring cards, the activity level and location within the crop will dictate whether mass trapping with sticky cards or tape will be effective. Source of infestation is an important consideration, as is time of year.

In the warmer months, locally established species, such as *F. occidentalis* and *T. tabaci*, are more likely to enter the greenhouse from the surrounding landscape through vents and doors. Concentrating mass trapping near these entry points will help reduce the number of thrips that make it to the crop (Fig. 16). In contrast, exotic thrips species, such as *T. parvispinus*, come in on imported plant material, so mass trapping will be most effective within the crop and should be used early in production (even in propagation).

Figure 16. Sticky tape mounted above the crop can intercept thrips entering through roof vents and spreading between rows. [Photo: © Kings Printer for Ontario, 2023]

Both local and exotic species can also invade from established populations in other parts of the greenhouse, so increasing mass trapping in heavily infested areas and along walkways can help slow the spread.

Lures may be used as an attractant to increase the number of thrips captured on mass trapping cards or tape. There are two kinds of lures currently available in Canada for thrips – aggregation pheromones and kairomones. The pheromone lures (e.g. Thripline from Bioline) are species specific and will only work for *F. occidentalis*. The kairomone lures (e.g. Lurem-TR from Koppert) are based on plant compounds and are therefore attractive to multiple species of thrips, though only a few species have been formally tested.

Installing screens over vents can create a physical barrier to reduce the entry of locally established species. The most important consideration in screening a greenhouse is the type of pest being targeted for exclusion. Because thrips are so small, a very fine mesh is required to achieve total exclusion. For *F. occidentalis*, the minimum mesh size is 215 microns. For smaller thrips species, such as *T. tabaci*, it may be necessary to use an even finer mesh size. However, screens that use a very fine mesh can impact venting capacity, which should be taken into consideration when deciding to install screens.

If exotic species are your primary pest issue, vent screening is not likely to help, however physical barriers can prevent thrips outbreaks from spreading to clean varieties or crops. For example, floating row cover or landscape cloth erected vertically between greenhouse bays from the floor to hip or shoulder height has been found to reduce the spread of *T. parvispinus* in anthuriums.

Cultural Control

One of the biggest factors than can influence the management of any thrips species is variety/cultivar selection within susceptible crops. Specific varieties can a) be more attractive to thrips, b) promote higher thrips populations, or c) are more likely to show thrips damage. Choosing less susceptible varieties can reduce overall populations on your farm. Recording shrink (i.e. crop losses) by variety due to damage each year can provide important information regarding which varieties to grow in the future. This is especially true of highly damaging species such as *T. parvispinus*, where other management measures (e.g. biological control, chemical management) are less available or unreliable.

Figure 17. Yellow flowering mums can be used as trap plants for *F. occidentalis* among vegetative and budding plants.

Additionally, more susceptible varieties can also be used as trap plants to intercept thrips populations as they move through the crop, by placing them at the ends of rows or benches (Fig. 17). This has previously been done with chrysanthemum varieties such as "Saskia" and "Vryon" which, when flowering, can be more attractive than vegetative mum to *F. occidentalis.* Using trap plants of a different plant species entirely can also be effective (e.g. sweet alyssum to protect mandevilla crops from *T. parvispinus*), but may require extra labour and growing space. In addition to diverting thrips away from the crop, trap plants can be used to reduce thrips populations by releasing extra biocontrol agents on them, bagging and removing them every few weeks, or spraying them with pesticides. Spot-spraying the trap plants alone has the added benefit of

reducing the chance of pesticide resistance occurring, and minimizing the impact that pesticides have on biocontrol agents (see "Pesticides" section, below).

Among the many diverse cultural management techniques, biosecurity, cleaning and sanitation deserve careful consideration when it comes to thrips management, although they are often overlooked as part of a diligent IPM strategy.

Biosecurity is especially critical for preventing introductions of exotic thrips pests, such as *T. parvispinus* and *S. dorsalis*. Identifying and resolving pathways of introduction is the primary strategy to prevent introduction and spread of pests. Pathways of introduction into a greenhouse may be different for each pest species. Exotic thrips species are often first introduced on infested plant material. This includes plant propagation material as well as mature ornamental plants brought in to complete larger orders. An important part of managing the spread of invasive thrips pests is managing workflow. By reducing the movement of plant material (including waste), equipment, and employees from areas of high risk (e.g. infested areas, propagation area, loading dock) into uninfested areas, enables you to catch and treat invasive pests before they spread throughout the crop.

When any thrips or pest outbreak occurs, sanitation is a necessary part of any IPM program that has a direct impact on pest levels. Generally, sanitation involves the removal of infested materials and potential sources of infestation (e.g. weeds, leaf litter) (Fig. 18), followed by cleaning with a detergent, and then disinfection of surfaces. During crop production, basic sanitation is used to suppress development of pests. Ideally, at the end of each crop cycle, a major sanitation is needed (often referred to as 'crop clean out') before replanting (Fig. 19).

Figure 18. Weeds and organic debris can harbor thrips and other pests and pathogens.

Figure 19. Removing organic debris is the first step in a thorough clean out between crop cycles that will help prevent infestation of the next crop.
[Photo: © Kings Printer for Ontario, 2006]

Biological control

Biocontrol research is limited for species other than *F. occidentalis*, and more research is needed to determine what works best for each thrips species. What we are learning is that the strategies that have been effective for *F. occidentalis* are not a one-size-fits-all strategy for other thrips species. Phytoseiid mites, such as *Neoseiulus cucumeris* and *Amblyseius swirskii*, have been the cornerstone of thrips IPM programs in many greenhouse crops. However, they do not provide adequate control for *E. americanus*, and on-farm trials in Canada indicate that they are also not effective for *T. parvispinus* in ornamentals. They were effective against *T. tabaci* in greenhouse research trials, however this does not match the experience of growers who struggle to control this species with biocontrol.

Larger generalist predators, such as *Orius insidiosus, Anystis baccarum,* and *Dicyphus hesperus*, have been shown to be more effective *E. americanus, T. parvispinus*, and *T. setosus* compared to phytoseiid mites. They are better able to handle larger and more active thrips species, and can kill all stages of larvae as well as adults (Fig. 20).

Figure 20. *Anystis baccarum* eating an adult *Thrips parvispinus* on a mandevilla flower.

Various species and strains of biopesticides and nematodes may also have variable efficacy depending on the target thrips species, even when they are effective in lab trials. Careful monitoring of your thrips populations before and after application will help you determine if the products you are applying are having the desired effect. Microbial insecticides may take several days for full effect, so wait at least 5-7 days before monitoring following a foliar application. Soil applications may take longer for the full effect to be observed.

In all cases, combining several strategies for thrips is your best pathway to successful thrips management. Biocontrol programs tend to be more successful if foliar and substrate-level (where appropriate) strategies are combined to target multiple thrips life stages (i.e. larvae/adults versus pupae). Also combining management techniques (e.g. predatory mites and microbial pesticides) can also help manage multiple life stages at once, as Phytoseiid mites consume larval thrips only while microbial pesticides work best on adult thrips.

You can refer to Table 1 at the bottom of this section for biocontrol agents and microbial biopesticides (as well as conventional pesticides) known be effective for the management of thrips

species found in Ontario greenhouses. Note that biocontrol is unlikely to work alone, without utilizing the physical, cultural and monitoring strategies described above.

Pesticides

Different pesticides work to manage pests in different ways. They can be categorized based on their modes of action (how the pesticide works) and sites of action (where the pesticide works). The Insecticide Resistance Action Committee (IRAC) working groups classify pesticide groups into families/groups according to their mode of action. They may be further classified into subgroups for those with similar modes of action. Information on IRAC classifications can be found on their website.

Certain thrips species are known to be able to develop high levels of resistance to a wide variety of active ingredients. Pesticide resistance means there is a change in the sensitivity of a pest population to a specific active ingredient that can be passed from one generation to the next. This is obvious when products repeatedly fail to achieve expected levels of control. Repeated applications of insecticides with the same mode of action will select for the few individuals in a population that carry a heritable resistant trait. In closed environments, there is reduced genetic diversity, and pests with short life cycles, such as thrips, have a greater propensity to develop resistance.

Some thrips species are more likely to develop pesticide resistance than others, although they all have this potential. Several of the species found in the greenhouse have documented resistance (*F. occidentalis*, *F. tritici*, *T. tabaci*, *F. fusca*, *C. orchidii*, and *S. dorsalis*). Still more may have developed resistance that has not been formally documented. Such is the case with *T. parvispinus*, as we have already observed cases of resistance to both Success (spinosad) and Ference (cyantraniliprole) on farms in Canada.

It is essential to use Insecticide Resistance Management (IRM) strategies to prevent or delay resistance. This could be particularly important for exotic species if you have an established in-house population where interbreeding with susceptible populations from outside is unlikely. Due to the fast life cycle and general propensity for resistance among thrips as a group, pesticides should be used as the last tool in the toolbox. Where possible, use spot sprays to target outbreaks. Spot sprays may be particularly useful for thrips species that tend to have a patchy distribution within the crop, such as wingless or sedentary species, or species that exhibit strong preferences for certain plant varieties (e.g. *T. parvispinus*).

An additional and extremely important consideration when choosing pesticides as a management tool for thrips are the non-target effects. Many registered pesticides have negative impacts on biocontrol agents or residual effects. Before choosing a pesticide, it is important to note the pesticide persistence, and compatibility with biocontrol agents that are already established on the crop or that may be applied in the near future (even those that are used for non-thrips pests!). Refer to supplier databases or the ministry's Ontario Crop Protection Hub for details.

Table 1. Main biological and pesticide management tools for various thrips species in Ontario. Efficacy based on data collected as of February 2024. Subject to change with further efficacy trials.

Pest management tool	Western flower thrips (*Frankliniella occidentalis*)	Onion thrips (*Thrips tabaci*)	Poinsettia thrips (*Echinothrips americanus*)	Pepper thrips (*Thrips parvispinus*)	Banded GH thrips (*Hercinothrips femoralis*)	Chili thrips (*Scirtothrips dorsalis*)
Phytoseiid mites (foliage-dwelling)	√	√ *A.limonicus*, *A. swirskii*	X	X	X	√ *A.limonicus*, *A. swirskii*
Orius	√	√	√	√	√	√
Lacewings	?	X	√ (at high rate)	√ (at high rate)	X	?
Dicyphus	√	?	Some suppression	?	X	?
Anystis	?	√	?	√ (some evidence)	X	?
Soil-dwelling mites	√	Some control	X	?	X	?
Dalotia coriaria	√	Some control	X	?	X	?
Nematodes	√	X (*S. feltiae* – other species need further testing)	X	?	X	X
Biopesticides & Biorationals	BotaniGard WP, LalGuard M52 OD; others generally untested	BotaniGard WP (soil applied only); others untested	EC formulations or mixed with oils	Bioceres EC, LalGuard M52 OD; (WP formulations generally not effective)	BotaniGard WP, LalGuard M52 OD, Suffoil-X	BotaniGard WP, LalGuard M52 OD
Conventional Pesticides	Highly depends on the thrips population and spray history. Success, Avid, Pylon, and drenches of Beleaf can be effective under some circumstances.	Success, Avid, Pylon, Kontos	Success, Avid, Pylon, Kontos	Success, Avid, Kontos (drench), Pylon, Rimon, Rycar	Success, Avid, Pylon, Kontos (Usually controlled with 1 application)	Success, Avid, Pylon, Kontos

Appendix A: Resources

More resources from this workshop

You can find the links listed below, as well as more resources at:

https://onfloriculture.com/thrips-id-workshop-resources/

We will continue to add more resources to this page as this project continues, including how-to videos, a clickable buying guide, and printable information sheets.

You can stay up to date on news an information about greenhouse crops in Ontario by following:

- ONfloriculture.com
- ONGreenhouseVegetables.ca

Thrips Identification Keys

If you are looking for more detailed keys or those that cover more species, there are several resources available online. Here are a few that feature species relevant to greenhouse crops:

- Cluever, J.D., Smith, H.A. 2017. A photo-based key of thrips (Thysanoptera) associated with horticultural crops in Florida, Florida Entomologist, 100(2): 454-467.
    - https://journals.flvc.org/flaent/article/view/87973
- Key to eleven species of thrips found on flowers and foliage, NC State Extension
    - https://content.ces.ncsu.edu/insect-and-related-pests-of-flowers-and-foliage-plants/thrips-found-on-flowers-and-foliage
- Hoddle MS, Mound LA, Paris DL. 2012. Thrips of California. CBIT Publishing, Queensland.
    - https://keys.lucidcentral.org/keys/v3/thrips_of_california/Thrips_of_California.html

Further reading on IPM concepts

We only scratched the surface on thrips IPM in this guide. Here are more resources you can consult to dig deeper on some of these concepts:

Greenhouse IPM:

- Crop Protection Guide for Greenhouse Vegetables 2020-2021 (OMAFRA publication 835)
    - https://www.publications.gov.on.ca/store/20170501121/Free_Download_Files/300239.pdf

Biosecurity:

- Greenhouse Vegetable Sector Biosecurity Guide (CFIA)
    - https://inspection.canada.ca/plant-health/invasive-species/biosecurity/greenhouse-vegetable-sector-biosecurity-guide/eng/1484722296145/1484722331070

- Floriculture Sector Biosecurity Guide (CFIA)
    - https://inspection.canada.ca/plant-health/invasive-species/biosecurity/floriculture-sector-biosecurity-guide/eng/1489427460069/1489427556596?chap=0

Sanitation:

- Cleaning & sanitizing a greenhouse between crop cycles (video)
    - https://ongreenhousevegetables.ca/2023/06/08/cleaning-sanitizing-a-greenhouse-between-crop-cycles/

Insect screening:

- Screening of greenhouses for insect exclusion
    - https://www.ontario.ca/page/screening-greenhouses-insect-exclusion

Insecticide Resistance Management (IRM):

- IRAC Training Centre
    - https://irac-online.org/training-centre/

Pesticide compatibility with biocontrol:

- Ontario Crop Protection Hub
    - https://cropprotectionhub.omafra.gov.on.ca/
- Koppert Side Effects Database:
    - https://www.koppert.com/news-information/side-effects-database/
- Biobest Side Effects app:
    - https://www.biobestgroup.com/side-effects-data

Appendix B: Buying Guide

Microscopes

There are many different microscopes available to purchase, but the variety of options can be a little overwhelming. Though there are certainly other microscopes of equal or better quality available, these are the models we used in our workshops and we can verify are sufficient quality for identifying thrips.

AmScope SE306 Series compact forward-mounted binocular stereo microscope, 20x-40x

- We specifically recommend model SE306R-P-LED
- Note that the SE306 Series has models with forward mount and reverse angled oculars – make sure the oculars are facing in the same direction as the viewing platform
- Buy from AmScope website (prices in USD):
    - AmScope often runs really good sales, including black Friday, boxing day, presidents day, and open box deals.
    - https://amscope.com/products/c-se306r-p-led-se-parent?variant=41315072966831%3Fvariant%3D41315072966831%3Fvariant%3D41315072966831%3Fvariant%3D41315072966831
- Buy from Amazon:
    - https://www.amazon.ca/AmScope-SE306R-P-LED-Forward-Mounted-Magnification-Battery-Powered/dp/B005ANZHVE?ref_=ast_sto_dp
    - https://www.amazon.ca/AmScope-SE306R-PY-LED-Forward-Mounted-Microscope-Magnification/dp/B005AQE9EM?ref_=ast_sto_dp

AmScope SM-1 Series continuous zoom binocular stereo microscope, 7-45x

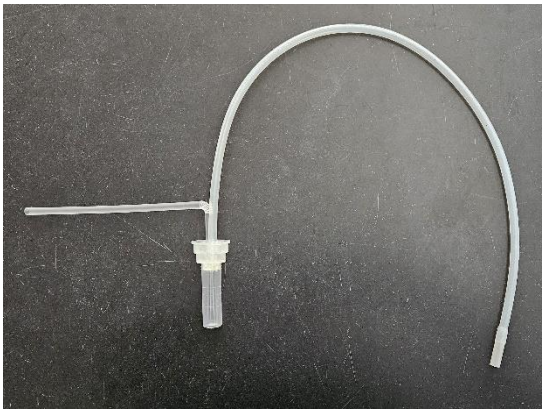
- There are many variants in this series; we recommend the model SM-1BS.
- Buy from AmScope (prices in USD):
    - https://amscope.com/products/sm-1bsl-64s-v331
- Buy from Amazon:
    - https://www.amazon.ca/7X-45X-Stereo-Binocular-Microscope-Pillar/dp/B00X4LJD4Q?ref_=ast_sto_dp

Parco Scientific PA-1EX continuous zoom binocular stereo microscope, 7-45x

- This microscope is indistinguishable from the AmScope SM-1BS, but is sold at a lower price
- Buy from Amazon:
    - https://www.amazon.ca/Scientific-PA-1FX-IFR09W-Trinocular-Microscope-Magnification/dp/B08XMXFPF3/ref=sr_1_5?dib=eyJ2IjoiMSJ9.9HN-oEWSu9yzPhG25uaxJKrzqUGQEg9yaCJAlidxd8jqAbldK1v9qGoWdhpqNV_nIbV8JB9kttwUytcUqsxU3z2m3AV7dbq1FmUryExjKBabYYcS4Ve4jcDp8rRk3puMYz0EpwGP12ss4LuGyCyaTJC6uQ7vmwCbjBqAWteJHs7yTUidQAyxOJcm1nmCA3ey5ekLQcSHEbTgsCIoVFyE0f_NyO5mVawnnRWJix064vbkMIGp9tXi_7ja5f14JQn0YWGIraynQKC89Q5pAHgZ9rzY1EUq_7Jjy_HPSj2Oomc.pY7PvFVLfsgZ0J-gpHwkJb1uEzKcuDouLkbxNvzktQ4&dib_tag=se&keywords=PARCO&qid=1708912262&sr=8-5&th=1

Insect aspirators

If you don't want to build your own aspirator, there are a few available to purchase that would be suitable for collecting thrips:



- Bugdorm B6 Insect aspirator (pictured above):
    - https://shop.bugdorm.com/product_info.php?cPath=2_28&sort=1a&products_id=195
- Bugdorm T6 insect aspirator:
    - https://shop.bugdorm.com/product_info.php?cPath=2_28&sort=1a&products_id=192
- Bartovation insect aspirator (Amazon):
    - https://www.amazon.ca/Bartovation-ENS05-Insect-Collection-Aspirator/dp/B0934TYV2W
    - Note that we have not tested the Bartovation aspirator and therefore cannot confirm its quality.

Other tools used when identifying thrips

All of these helpful little accessories can be found in online stores such as Amazon. If you want to shop in-person, most of these supplies can be found at craft stores such as Michael's.

- Fine tip paint brush
    - Used to pick up thrips specimens.
    - Can be found in craft stores in the painting section.
    - Look for size 0, 00, or 2/0. The brush tip should be about the size of a pencil lead.
- Dissection probe, aka "teasing needle"
    - A pointed, thin, metal tool that you can use to get your specimen into position.
    - Dissection probes usually come included in a student's dissection kit, or they can be purchased on their own in online stores.
    - Other tools will serve the same purpose include long sturdy sewing needles (such as those used for upholstery, embroidery, or leatherwork) or a fine point awl (such as tailors, beading, needle-point, or light-duty awls). These can be found at craft stores and sewing supply stores.
- Transfer pipette or droppers
    - Used to suck up thrips in ethanol without needing to pour out the whole vial, or remove ethanol from your dish.
    - Can be found at craft stores, often among painting accessories or soap making supplies.
- Petri dishes
    - Used to hold your specimen and ethanol while you're examining them under the microscope.
    - Petri dishes are not typically found in regular stores, so if you want the real deal, you'll need to shop online.
    - Any small shallow dish will serve the purpose. The dish can be plastic or glass, but you ideally want something with a completely flat bottom that doesn't have any grooves or ridges. You should use a clear or white dish to ensure the greatest contrast to be able to see the hairs on the pronotum.