

There are few pests that can do a better job of harassing growers throughout the world than thrips. Their numbers of confirmed pest species continues to grow, largely due to the global economy, with plants for planting, finished plants, and cut flowers being the main vectors.

About 25 years ago, thrips in North American and European production houses were limited to fairly innocuous species that were easily treated with Biological controls or, more frequently, with chemicals. The arrival of the Western Flower thrips was the harbinger of our current situation. In general, thrips are small, soft bodied arthropods that can fly (somewhat). They cause damage by scraping the plant tissue and by destroying the structure of the flowers' ovum, which leads to damaged fruit or misshapen flowers. They cause considerable economic damage, especially in cut Orchids and cucumbers, but damage of devastating magnitude can occur over a vast range of plants.

Their physical characteristics help them considerably in their quest to destroy your crop. Being both small and soft bodied allows them to penetrate easily any commercially produced screen (including "no-thrips" screens). Being able to fly, albeit in a limited fashion, allows them to be wind dispersed. For the most part, their eggs are pushed into the plant material, keeping them safe from predators. The larval stages, when they are vulnerable, are relatively short term and mobile. They usually pupate off the plant, in the substrate, once again removing them from harm's way and the adults are quick and adaptive. They are truly challenging pests.

Our approach to managing thrips is a combination of Biological controls, physical traps, alternate "guardian" plants, and procedural changes in the protected environments. I say protected environments because the impact of thrips in moderate climates outdoors is considerably lower. In Florida, and the more humid areas of Southern California, outdoor thrips cause serious damage, but once the climate moderates, so does the commercial damage.

The first thing to know is that I do not believe that a single thrip has died from an insecticide registered against thrips for the past 3 years. Yes, after an application, you can find a few dead thrips, but I will bet you that they died from the soap effect of the spreaders and the stickers rather than the active ingredients. So, don't even think about using chemicals against thrips. The miticide Avid sometimes is used against thrips as a repellent and, once again, the adjuncts do the killing, but control is seldom seen. Another even more important reason not to use chemicals is because there is now considerable research that shows that sub-lethal chemical attacks actually induce the thrips to lay more eggs. But, of course, the most important reason not to use chemicals is because that will prevent us to come and help you. Our predatory mites cannot survive your sprays and the sub-lethal residues prevent our products from working effectively.

When we come into a new customer's operation our first strategy is to discuss the characteristics of thrips. Here are a few points that we cover;

- Thrips can fly, but not well. Studies have shown that thrips entry points are usually the doorways, rather than the scoop roof vents. Doors should be closed.
- Yellow or white flowers are very attractive to thrips. Put yellow marigolds, that you grew yourself, in pots at every entry door.
- Plant's aromatics are also very attractive to thrips. Use vanilla or almond extract to attract thrips to the marigolds. Put a cotton ball on your yellow sticky cards to trap up to 10 times the number of thrips.
- Thrips just barely fly, so a trap higher than the flowers or foliage is too high. They are like attack helicopters, just at the tree tops.
- More thrips can often be found under your bench than above it. Hang some traps below your bench, and certainly below your crop.
- While screens won't work, deflection certainly does. Outdoor growers know all about "thrip fences" which deflect the airflow up. For every foot in height, these fences give you 10 feet of exclusion. So, if you are in an area, like Oxnard, where a prevailing wind will blow thrips from harvested strawberries, or mowed hay, or harvested beans, or whatever, and you have a greenhouse that is 100 feet wide, you need a "fence" 10 feet higher than your roof height. This fence, in large scale, can be a row of trees on your windward side.
- Most thrips pupate in the soil or the dirt under the benches. Make sure that you have Ss or Gg in the soil at all times. Ss or Gg under the benches will persist for many years.

By understanding the above points and acting on them, a lot of thrip management is already achieved.

There is a lot of interest in "foliar nematode sprays". I like nematodes and they are effective against thrips, but I don't believe that a "foliar" application is appropriate. Nematodes are very susceptible to light and should be directly applied to the soil. For those who say that the "foliar" technique works, I suggest that you do your own experiment. Spray the foliar nematodes on one side of your crop. On the other side, make up the same mixture with the spreaders and stickers, but leave out the nematodes, spray this half, then apply the nematodes directly onto the soil.

The spray idea does two important things however. First, it satisfies growers who are new to Biological control and just can't stand not to spray. Second, overhead irrigation simulates outdoor conditions. Thrips came into your protected crop to get away from the rain; they hate getting wet.

The next step is applying Biological controls. We recommend and produce the predatory mite *Amblyseius cucumeris*. This predator has been commercialized for about 30 years. It was the replacement for the previous mite *A. barkerii*, which was actually a better thrip predator, but was dropped because it interfered with *P. persimilis*, the key spider mite predator. We have not produced *swirskii* because we believe that *cucumeris* is more cost effective and we are concerned about *swirskii's* interference with other Biological controls, such as *Aphidoletes* and *persimilis*. In the assessment trials, a few years ago at Bleiswijk, *limonicus* was the best thrip predator, *swirskii* second best, *barkerii* third, then *cucumeris*, then the other *Amblyseius* species. But, *limonicus* was rejected over 20 years ago because it interfered with others as well as itself. *Swirskii* has known interference and requires both whitefly and thrips to be present at the same time to work at its enhanced rate and is negatively

affected by temperatures below 24 C, making them ineffective in crops such as Poinsettia and other shoulder season crops.

So, we just apply twice as much cucumeris and get even better results. The cost of cucumeris, even at double the rate, is still considerably less than any of the other Biological controls and *cucumeris* doesn't interfere with any other product.

Rates of release vary from crop to crop and from season to season, but the usual application is anywhere from 50 to 500 per square meter every 2 to 4 weeks. Because cucumeris is a generalist, it can establish in crops where pollen is being produced and is quite effective as a spider mite preventer. It also eats sucking insect's eggs as an added bonus.

*Orius* is the other traditional Biological control used against thrips, but we have never sold it. We tried, for quite a few years to rear *O. tristicolor*, but we were never able to get it going to a point where it could be commercialized. *O. insidiosus* is the commercial species sold in North America. *Orius* is a true bug, closely related to the Lygus bug. They are both generalist predators, going after thrips, aphids, loopers; almost everything. But, the Lygus bug generates a plant damaging compound in its saliva and *Orius* doesn't. Lygus is a pest, and *Orius* isn't. We seldom recommend purchasing *Orius* for the following reasons:

- They are too expensive. Putting the same money into more cucumeris and vanilla has worked better for us, every time.
- They readily volunteer. We frequently see the same density of *Orius* in the houses that weren't inoculated as the houses that were.
- They have an "obligatory diapause", meaning that if they are used before the Spring Equinox they may drop into a diapause that will last for at least 3 months.
- Their lifecycle is very slow, especially in the cooler Spring.
- The method of rearing is feeding them in a bucket of frozen moth eggs. This is not selecting for either flight ability or active searching behaviour.

Our recommendation is to plant nectar producing plants in the surrounding environs which will attract the native *Orius* into your facility.

The other predators that are needed in a thrip control program are either of the two soil mites (*Stratiolaelaps scimitus* or *Gaeolaelaps gillespiei*). Both actively feed on pupating thrips in the soil and are effective to a level of 80% in their predation. They are also key predators for fungus gnat control, as well as weevil control and spider mite management.

In most Northern climates, thrips tend to be a summer pest. They also tend to inundate crops, usually because of harvesting or disturbing windward crops and fields. Therefore, using Biological controls preventatively is not usually recommended. Vanilla infused traps and flowering yellow or white plants, and even the bush beans that you are using to manage your spider mites, are all attractive to thrips. They can tell you when it is time to apply the cucumeris.

Many people used blue sticky traps instead of, or with, the yellow sticky cards. The idea of the blue card is that it is equally attractive to thrips but not attractive to other common pests, so counting the blue cards is easier. From my experience, our customers just don't have the pest loads that sometimes inundate the yellow cards so it is easy to count all of the pests on the yellow cards. Card placement, however, is critical if you want to see a "representative" sample of thrips. Cards placed above the crop will give you representative sampling for most aphids, fungus gnats, greenhouse whitefly, leaf miner flies, and their predators and parasites, but they will not tell you accurately about thrips or Bemisia. For thrips, the cards must never be more than ¼" over the plant material. In fact, we have found that we frequently get better trapping of thrips under the benches. Try placing a yellow bin of soapy water with vanilla extract added under your benches. You will be amazed at how many adult thrips you will trap.

Thrips, unlike any other pest, can actually be trapped to control. In cucumber houses that suddenly become inundated with thrips, we have been able to reduce the thrip adult count from 40 thrips per flower to less than 1 thrip per flower, overnight, by hanging 1 foot wide yellow sticky tape down each row, below the flower level, and placing vanilla soaked cotton balls every 10 feet.

In some crops, vanilla soaked marigolds are the only place you will find thrips. Apply cucumeris to the marigolds and they will become killing plants. Never, ever, spray these plants. The spray will disperse the thrips and induce them to lay an extra dose of eggs into your crop. If the plants are swarming with thrips, carefully bag them, then tie the bag shut and leave it in the sun for a week before throwing them into the trash.

We have been experimenting with other plant aromatics. Vanilla is still the best that we have seen, but it must be fresh and volatile. Almond extract works amazingly, sometimes. This year we are going to be trying rose oil, peppermint, avocado oil, etc. You can play with different aromas, and should, as regional preferences may be occurring.

*Cucumeris* are an amazing thrip predator. Their favoured method of predation is to sense the 1<sup>st</sup> instar larvae emerging from the plant tissue, take up position, and bite the head off as it emerges. If you have enough cucumeris present to balance the thrip load, complete control can be achieved in one generation. The biggest mistake people make with thrips management is under applying these extremely inexpensive predators.

We have had excellent results protecting crops such as Gerbera by using these techniques. If thrip counts suddenly increase, just put more cucumeris on the crop and swap out the overwhelmed, vanilla soaked marigolds and sticky cards. Doorways must never be left open and vanilla traps must be present at every doorway or air intake location, even if you have "thrip screen" over them.

Some thrips don't pupate in the soil, like Echinothrips. They can be a serious pest, but just like the Western Flower thrip, they can be managed by smell. For Echinothrips we double the release rate of *cucumeris* and increase the number of vanilla soaked traps.

Onion thrips and other less serious thrip pests are also easily managed the same way as WFT. We have found that our annual invasion of Onion Thrips in our persimilis system can be managed by just using the UV "Bug Zappers" for just a few nights. The zapper should be low, below the crop. Adding vanilla helps. Most zappers are hung high so they don't electrocute the employees, but if you can drop them down, and put them on timers, you shouldn't cause any human suffering. Remember to hang a bucket of soapy water under the zappers, to kill the stunned ones and see the results.