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Practical Approaches to IPM in Propagation

Jeremy Webber
Koppert Biological Systems, Inc., Howell, Michigan 48843 USA

jwebber@koppert.com

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INTRODUCTION

Fungus gnats are the single greatest insect pest in propagation facilities globally-excessive moisture, conducive media temperatures, and exposed rooting media provide ample opportunity for reproduction. Pressure from this pest along with shore fly is nearly ubiquitous in any propagation facility that Koppert Biological Systems works with. Since fungus gnat larvae directly feed on actively growing roots, severe populations can consume new roots nearly as fast as young plants can produce them and economic damage is quickly an issue.

Shore fly on the other hand cause no direct damage to plants as they feed on algae that grows on a medium's surface. Their unsightly presence in the finished crop and frass deposited on the crop's foliage are the principal issue with their development.

Beyond this, pest pressures vary wildly depending on crop type, region, season, and facility. One grower's issue may not be the same at a similar facility just down the road, so custom programs utilizing both biocontrols and compatible pesticides are frequently required for the seemingly endless combinations of pest pressures and individual goals that are found from facility to facility.

FUNGUS GNAT AND SHORE FLY—THE COMMON DENOMINATOR

Likely the most adopted biocontrol in ornamental crops on the planet — *Steinernema feltiea* is relatively easy to work with and is extremely effective at controlling the larvae of fungus gnats, as well as the pupae of western flower thrips (*Frankliniella occidentalis*) when applied correctly (Figure 1).

Part of its success is its similarity to conventional products during application—there aren't any creepy crawlies here, just a paste of some sort that's diluted in a stock or spray tank and applied to the crop. The process feels like a pesticide application, so there's familiarity and ultimately this helps wary growers dip their toes in the IPM pool so to speak.

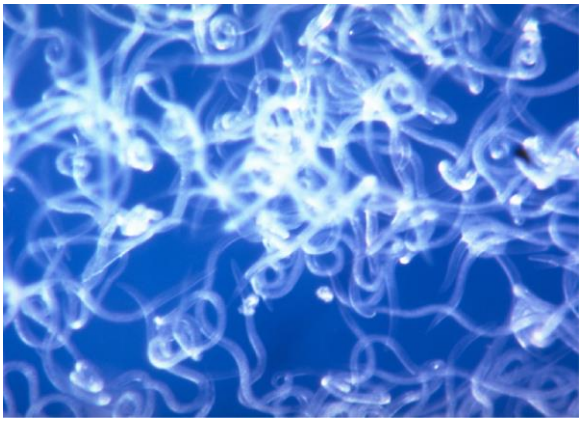

Figure 1. Nematodes.

To keep the metaphor going—what actually gets them swimming around in the deep end of the pool are the effects. When applied properly, *S. feltiae* will kill nearly every larval fungus gnat in a greenhouse, with no concern of resistance. For such a ubiquitous pest, this is the key takeaway—no resistance and consistent, predictable efficacy.

Application is relatively easy—nematodes from the two largest manufacturers in the world are both recommended for application in more or less the same manner. The product should be diluted in a few gallons of lukewarm water to activate it, then injected into your irrigation system with a portable injector and sprenched into your crop or mixed into a finished spray solution and applied over the top of the crop with a sprayer. The rate is generally accepted to be 500,000/m², usually applied weekly. At this rate, a container of 250 million will treat 500 m² or approximately 5,000 ft².

The addition of a surfactant is highly recommended for best efficacy. While the typical application frequency to fungus gnat susceptible crops is 1/week, for the most predictable results Koppert recommends tweaking the application interval versus the application rate for lower or higher pressure. For instance, poinsettia should receive intros every 5-7 days as they are highly sensitive to damage, but preventative applications in crops with no sensitivity to the pest and low pressure could receive intros every 10-14 days. Koppert recommends speaking with an IPM consultant to discuss the particulars of the application process in greater detail.

Unfortunately, this nematode has no significant effect on shore fly. While *Steinernema carpocapsae* has shown sporadic results versus this pest, the most consistent results in IPM programs has been seen from occasional usage of compatible insect growth regulators (IGRs) at times when shore fly are most prone to development (high heat, excessive moisture, algae growth). Ultimately—this pest's larvae grow in and feed on algae—any steps taken to maintain or eliminate algae where possible will ultimately go towards control. Most labeled IGRs are tank mix compatible with *Steinernema*—so control of both species is possible without adding an additional application. Koppert and most other biocontrol companies have apps and/or databases on the web to check the specific side effects of a chemical with a biocontrol agent—always check there or with an IPM consultant if you're trying a tankmix just to be safe.

Stratiolaelaps scimitus is another option for drier situations that has a similar effect to nematodes, but with a completely different mode of action so to speak. This soil-based generalist predatory mite navigates through the upper ranges of the rooting media and is highly effective at feeding on any number of pests, and perhaps even more importantly—it reliably reproduces on them too. Populations establish willingly when introduced early, and in many scenarios, can last through the length of the crop without reintroduction. Since rates and application methods vary greatly depending on crop type, media, pressure, etc.—Koppert recommends seeking the advice of an IPM consultant for the most effective introduction strategy. Since "strats" aren't fond of swimming, application early in a propagation scenario

can be a situation to avoid. Nematodes typically function best in high humidity and misting scenarios whereas "strats" tend to do much better when the media is no longer continually saturated, and the crop is hardening off.

In addition to nematodes, predatory mites (Figure 2), and IGRs, there is likely no better usage of the pest control dollar than with mass trapping (Figure 3). So far—all controls discussed attack the larval phase of development. While it's hardly the most user friendly or visually attractive option—physically removing the adult population from the crop with numerous sticky cards or tape has a significant curative and preventative effect. Fungus gnat adults are quite attracted to yellow—so it stands to reason that if 30 can be killed by a small monitoring card in a week—many, many more can be taken out in the same amount of time by simply increasing the surface area of the sticky card. Flexible yellow pest control tape is the best option here. Exact implementation depends on how your facility is designed, your workflow, and what type of pest you're going after specifically—so advice from a consultant is recommended for best implementation. Bottom line though—every adult controlled is a major number of larvae taken out of the equation as well, so the more area in yellow sticky tape, the better.

Figure 2. A predatory mite, *Stratiolaelaps miles*.

Figure 3. Sticky tape! Mass trapping is king when pressure is high.

OTHER PESTS—WESTERN FLOWER THRIPS, SPIDER MITES, AND APHIDS

While fungus gnats and shore fly are the most common pests in propagation, relatively speaking, they are also very easily dealt with. Western flower thrips and spider mites however can be much more troublesome. Their incidence overall in propagation facilities is lower than that of fungus gnat, but not by much. Because of this, no two programs for their control are exactly alike as there are numerous variables from facility to facility. Aphids also fall into this nebulous category—there are as many different approaches to their control as there are propagation businesses. Following a few of the more common approaches.

Western flower thrips

As discussed previously—*S. feltiea* is an excellent control for the pupal phase of development, so it's likely that a well-executed program for fungus gnat control will keep western flower thrips (WFT) from easily developing in a crop, and vice versa. Our clients typically use a combination of nematodes, regularly applied predatory mites, and mass-trapping in scenarios where this pest is a concern. This method targets larvae with the predatory mites, the pupa with the nematodes, and the adults with the sticky traps. All three of these controls combined make it very difficult for a WFT population to reproduce from within the crop. Blow-ins frequently occur however when outdoor weather is warm enough, this is where the mass-trapping approach really shines. Since flowers are typically rare in propagation, the cards act as beacons to the easily fooled adults and the problem can be dealt with before it even starts. When the pressure is higher however, compatible chemistry can be employed as well. There are numerous options for predatory mites as well as chemistry depending on your region, crop, and goals, so please seek out an IPM consultant for a detailed recommendation on what works best.

Spider mite

A fairly common pest, *Tetranychus*, most commonly enters propagation facilities on cuttings, either in-house or from off shore. They can be dealt with relatively easily using a combination of predatory mites (Figure 4) and/or compatible chemistry. If pressure is only occasional in hotspots or limited to specific plants, programs can be executed on an as-needed basis so long as scouting is thorough, and populations are detected early. Several different predatory mites are out there, some are specific just to spider mite, and others work for many different pests simultaneously.

For example, *Amblyseius swirskii* or *Amblydromalus limonicus* can have considerable efficacy versus spider mite even though they are primarily being used for WFT. Other mites specifically for augmenting the spider mite control of your program can be added to this cocktail for higher pressure scenarios. Getting the pieces put together effectively will require a good relationship with a trusted advisor.

Figure 4. Specialist predators like *Phytoseiulus persimilis* come into the picture when spider mite pressure increases.

Aphids

Biological control of aphids in ornamentals is still in its infancy. As opposed to other pests like WFT and spider mite, it is quite difficult to find pesticide resistant populations of aphids here in the USA. They are certainly reported on occasion—however populations generally respond well to applications of any number of pesticide categories. Many labeled products are new and relatively safe to biologicals as well as the applicators and therefore biocontrols haven't been as needed in this arena as in the ones mentioned previously. It's completely

possible to have a biocontrol program for fungus gnat, WFT, and spider mite, and to use conventional products for aphids. That said, there are numerous ornamental growers working to minimize their usage of these newer products, as well as edible growers that have a much smaller list of labeled products to work with. In these cases, Koppert tends to work with broad spectrum predators like green lacewing larvae (*Chrysoperla carnea*) (Figure 5) or the gall midge (*Aphidoletes aphidimyza*). Parasitic wasps seem to get the most press for aphid control, but they typically have narrow host ranges and are not a one-size fits all solution. Typically, when a grower is working with a more broad-spectrum predatory bio approach, if a population is discovered through weekly scouting, either a corrective small-scale pesticide app can then be made to bring the population back in line or additional predators can be applied to the hotspot. Growers vary in how they're comfortable handling this scenario, and fortunately, there are numerous options at their disposal.

Figure 5. For aphid control Koppert recommends generalist predators such as green lacewing larvae to keep it as simple as possible.