

Woody Ornamentals Crop Recommendation

By Applied Bio-nomics Ltd.

OVERVIEW:

We can now talk to growers about prevention and eradication rather than balancing the pests with the biological controls. Prevention has three distinct advantages; it costs considerably less, the need for scouting is considerably reduced, and most importantly economic damage to the crop is significantly reduced, if not eliminated.

This recommendation is quite general; as location, plant mix, surrounding situations all will have a significant impact on the actual program that you will need. But having said that, when we are talking about prevention you will find that no matter where you are or what you are growing, the basic rules and release rates are quite common.

PRIOR TO PROPAGATION

The history of your site must always be considered first. If you have been dealing with spider mites in the past, you will continue to deal with them until they are eliminated. Taking propagative cuttings from plants that have a history of spider mites is a sure way to guarantee that you will carry on the spider mite tradition. It is unwise to think that dipping cuttings will stop the pests. We also believe that the whole concept of dipping every cutting into a solution is extremely dangerous in that it is an ideal way to transfer and spread viruses and other diseases. All stock plants should be treated with *Amblyseius fallacis*, at the field rate of 10,000 per acre, or 2 mites per 10 square feet. More severe infestations should be treated at 10 times the field rate. The rate is for both outdoor and indoor applications, and is only needed once for the life of the plant.

For indoor infestations, if the house has a history of spider mites, they will be hiding in the ground around the posts and the walls during the fall and winter. An introduction of *Stratiolaelaps scimitus* (formerly known as *Hypoaspis miles*) at a rate of 25 mites per square foot (or more if high levels of spider mites were present) at each post and along the walls will help kill the overwintering spider mites. This only needs to be done once, as subsequent usage of *Stratiolaelaps* for fungus gnat

control (see propagation) will maintain establishment for years to come.

In the case of the Black Vine Root Weevil (BVRW), it is important to know where they are coming from. The adult BVRW is incapable of flight, so their source is usually the perimeter of the property. BVRW love blackberry bushes or any other dense thicket, which is quite frequently the situation at many nurseries. *Stratiolaelaps* should be applied to the perimeter of the property under the shrubbery at a rate of 1 liter for every 100 feet. This rate is arbitrary and needs to be adjusted either upwards or downwards depending on the history of BVRW and the density of the thicket. Never do anything to the thicket chemically, as the benefit of the thicket (hedgerow) is considerably more significant than the negative perception. This is because it harbors a vast array of beneficial insects and mites, and is the nesting site for many birds that are extremely important to pest control.

AT PROPAGATION

Because fungus gnats can have a significant impact on the rate of growth of your plants, it is essential that they are controlled immediately. Apply *Stratiolaelaps* at a rate of 250 per 10 square feet. Skipping plants can work in clean houses, as the *Stratiolaelaps* will disperse themselves quite well. A recommended technique is to broadcast



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them over the finished crop using a “whirlybird” hand spreader. Only *Stratiolaelaps* should be used if the plant is susceptible to BVRW.

Depending on the soil mix and required moisture levels, you can also apply (within one week) nematodes at the recommended rate. This application will have two effects; first, they will kill some of the fungus gnat larvae and second, they will act as a food source for the *Stratiolaelaps*, which will help them disperse into the entire crop and establish.

If there is a very high count of fungus gnats you should consider altering the soil mix slightly, as even subtle variations in the soil mix will have significant impact on whether or not the fungus gnats will explode in population. Additives, such as rice hulls or peanut shells are especially bad for creating extremely high levels of fungus gnats. Also, the wetter the soil, the more likely the fungus gnats will be a problem. Raw potato slices should be used to monitor the relative numbers and stages of the fungus gnat larvae. Try placing a slice of potato on the soil surface for a known time (usually overnight). The fungus gnat larvae are attracted to the potato, and when lifted, will give you a relative count. Repeated monitoring for the same duration of exposure will give you an indication whether the problem is getting better or worse. Yellow sticky cards also give you relative counts but only tell you about the adults.

If the soil is loose, extremely wet, or if you are using humidity tents, the Rove Beetle *Atheta coriaria* should be applied instead of *Stratiolaelaps* at 0.1 to 1.0 per 10 square feet just once. Then apply the *Stratiolaelaps* and possibly the nematodes after the soil has dried to normal. Both *Stratiolaelaps* and nematodes will drown in extremely wet soil.

If the crop is susceptible to whitefly, apply *Encarsia formosa* at a rate of 0.25 per 10 square feet if no whitefly is detected. At one to two whitefly per yellow card per week, increase rate to 1 per 10 square feet. See below: Whitefly Strategy Overview.

Aphid prevention can be achieved by introducing *Aphidoletes aphidimyza* at a rate of 1,000 to 6,000

per 2.5 acres per week. They should be released away from any known aphid hot spots, usually in the same place each week; which will force them to disperse and seek out new infections. Any known hot spots should be dealt with directly, releasing about 100 adults from the shipping container at each hot spot.

EARLY SEASON (INDOORS)

Spider mites should be watched carefully, as the damage is permanent. Preventative releases of fallacis in the granular carrier, at a rate of 2 mites per 10 square feet should be made on all plants that are prone to spider mites, after the plants have been removed from any humidifying chamber. For houses that have a history of spider mites, bean plants should be grown around the walls and touching table legs. The beans will attract the spider mites and show damage very quickly, which will help with monitoring. Once spider mites are present, apply *Phytoseiulus persimilis* to the beans at an approximate ratio (persimilis to pest) of 1 to 100. The bush beans will become bankers, releasing persimilis up and onto the tables for as long as the spider mites survive. In most cases, this will be a long time as the spider mites come out of hibernation over a very long period of time. Bean leaves that display a ratio of 1 to 10 can be picked and used to treat remote infestations. *Feltiella acarisuga* may volunteer in a cool season crop, but their habit of pupating on the plant leaves may cause more problems. If the spider mites are under control, it is unlikely that *Feltiella* will populate the crop.

Whitefly must never be given a chance to increase. A count of over 2 whitefly per week on the yellow sticky cards should be reacted to immediately. Rates of *Encarsia* should go up to 4 per 10 square feet per week and *Delphastus catalinae* should be introduced at a minimum of 100 per 2.5 acres every two weeks, until the counts are brought back in line. If the leaves become sticky with honeydew, the parasitoid’s movements becomes impaired. *Delphastus* releases should be increased up to 5,000 per 2.5 acres if control is at stake. The use of bush bean or eggplant, strategically located along the aisles at a rate of 4 to 6 per 2.5 acres, will help draw the whitefly out of the crop. See below: Whitefly Strategy Overview.



Aphids are best managed preventatively. Begin weekly or bi-weekly introductions of Aphidoletes about 2 weeks before you traditionally begin to see aphids, at a rate of 0.3 midges per 10 square feet. If aphids are already present or the temperatures are below 59° F on average, introduce *Aphidius matricariae* at 0.05 wasps per 10 square feet, bi-weekly. See below: Aphid Strategy Overview.

Thrips can show up at any time, but catching them early is essential to prevent damage. Alternating some blue sticky cards with the standard yellow ones will make it easier for you to see them quickly, as only thrips consider the blue cards as evenly as the yellow cards. All cards should have a cotton ball stuck to them and then add vanilla extract to the cotton ball. Plant aromatics such as vanilla can increase the trapping of adult thrips on the cards by a factor of 10. You can also try other aromatics such as almond or rose oil. Card placement is critical with thrips. The cards must not be more than ½ inch above the canopy, as thrips don't soar. High mounted cards will give you a false sense of security, and only catch whitefly, aphids and fungus gnats. Work done by Margaret Skinner and Michael Brownbridge at the University of Vermont has shown that the yellow "Hero" strain of marigold is a very effective thrips trapping plant. The showy yellow flowers are much more attractive to thrips than your crop. The marigolds should have high levels of *Stratiolaelaps* in the soil and be very heavily inoculated with cucumeris (and they should also be spritzed with vanilla). If the marigolds become over-run with thrips, remove them carefully and put a new plant in its place. From what I have seen of this system, I think every grower should be planting a flat of these marigolds every few weeks throughout the year. The effect they can have in a greenhouse is nothing short of amazing.

SUMMER SEASON (INDOORS)

In crops that are susceptible to spider mites, bush beans should be interspersed throughout the crop at a rate of 1 plant for every 500 square feet. The persimilis should be placed low on the treated plants as they instinctively move upwards. A ratio of 1 persimilis to 100 spider mites will achieve control in 2 weeks. As the humidity drops in the house, any volunteering *Feltiella* will disappear. *Stethorus*

punctillum should be released at a rate of 500 per 2.5 acres every 2 weeks. The *Stethorus* are not intimidated by low humidity and high temperature. If the plants are mowed or severely pruned, fallacis should be reapplied after every mowing at a rate of 2 mites per 10 square feet. See below: Spider Mite Strategy Overview.

Whitefly should be under control based on the preventative releases. Any weekly count of over 2 whitefly per card should immediately be responded to by doubling the rate of *Encarsia*. *Delphastus* will remove very large numbers of whitefly eggs and can be used to reduce outbreaks. If *Bemisia* are present, *Delphastus* should be released every two weeks at a rate of 1,000 to 5,000 per 2.5 acres, depending on level of infestation. In extremely hot situations (over 86° F), whitefly adults will only live for a few days (instead of months) and will not lay eggs. See below: Whitefly Strategy Overview.

Aphid prevention should be maintained. If aphid hot spots begin developing, double the preventative rate and direct release extra Aphidoletes into the hot spots at a rate of 1 midge to every 100 aphids. *Aphidius* species should not be used during the summer season as the presence of hyper-parasites is inevitable. Hyper-parasites parasitize the parasites, effectively "un-zipping" any parasites that are in the crop. See below: Aphid Strategy Overview.

If you didn't start the marigolds earlier, you must start them now. There is no chemical that will manage a thrips infestation currently and any attempt to use a chemical will only screw up the other systems. Cucumeris should be applied to susceptible plants at rates varying from 50 to 500 mites per 10 square feet, every 3 weeks.

LATE SEASON (INDOORS)

This is the most important time of the year for spider mites. What you do at this time will determine how bad the next year will be. Every effort should be made to eliminate all of the spider mites before the beginning of September. Once the day-length begins to noticeably decrease and the evening temperatures drop, the spider mites begin diapausing. In a diapause state, spider mites are



more resistant to chemicals and are not as attractive to the beneficials.

If the whitefly is not in good control, it will appear to run away in the fall. This is because the normal lifespan of the adults during summer is about 2 weeks, and shorter in hot conditions. Once the temperature of the greenhouse drops, the lifespan can increase to 3 months, giving you the impression that the infestation is increasing. Luckily, they still only lay the same number of eggs. Adding parasites beyond 6 per 10 square feet will have very little effect, as there are just too many whitefly and the stickiness of the honeydew will begin to impair the movement of the parasitoids. *Delphastus* will continue to work at very high whitefly densities but their impact will not be quickly seen, as they will graze on the eggs while the adult whitefly will live on for months.

Aphids must be in good control going into the fall as the *Aphidoletes* will stop cycling due to diapause. Preventative releases will still work, as they are not being asked to cycle. The addition of supplemental lighting can have a tremendously positive effect of *Aphidoletes*. Leaving walkway lights on, or stringing some LED Christmas lights will do the job. As the temperatures drop, *Aphidius* should be substituted for the *Aphidoletes*.

PLANTING INTO THE FIELD

As soon as the plants are set out, release *Stratiolaelaps* at a rate of 10 to 20 liters per acre. It will establish permanently and will prevent BVRW as well as control fungus gnats, springtails, overwintering spider mites and soil pupating thrips among others. If the plants had *Stratiolaelaps* applied during propagation, only add it again if the plants are extremely attractive to the BVRW.

EARLY SEASON (OUTDOORS)

Spider mites can be prevented and chronic infestations can be cured by the release of *fallacis*. A general release rate of 10,000 per acre should be modified so that 5,000 are evenly dispersed, or in windy areas, placed in the upwind side; the other 5,000 used directly on infested plants or susceptible ones. This is usually a “one-time” introduction, as the *fallacis* will establish and persist in the plants for years.

Plants that haven't had *Stratiolaelaps* applied, but have BVRW should have it applied at a rate of 250 to 500 mites per container.

MID-SEASON (OUTDOORS)

Overhead watering helps prevent spider mite establishment. When many growers began switching to drip irrigation, they found the spider mite problems increased. *Persimilis* should be used for serious two-spotted spider mite problems. *Stethorus* will also work very well and will persist in the crop as long as the spider mites are there.

Aphid infestations are controlled by releasing *Aphidoletes* directly at the infestation point. An approximate ratio of 1 *Aphidoletes* to 100 aphids will bring control back within 3 weeks. The *Aphidoletes* will cycle in the field and over winter, so subsequent seasons should see fewer aphid hot spots. *Aphidoletes* should be released at dusk, after the wind has died down.

SPIDER MITE STRATEGY OVERVIEW

Spider mites in ornamentals are the most dangerous pest. The damage caused is permanent, causing economic loss almost immediately. The only realistic approach to managing spider mites is to approach the problem on a preventative basis. The use of bush beans, especially early in the season, is a good start. Spider mites love beans, tending to go to them first. The beans show spider mite damage within 24 hours, so early detection is possible. If *persimilis* is applied to the beans fast enough, a balanced culture can result; stopping the spider mites at the beans.

For plants that are susceptible to spider mites, *fallacis* has proven to be a star. Apply *fallacis* to all of these plants at a rate of 2 per 10 square feet, just after the true leaves have opened. *Fallacis* is capable of staying with clean plants for over 1 month, staying even longer if any prey or pollen is present. Mowing however, has proven to be a serious impediment to *fallacis*. We have found that *fallacis* needs to be re-inoculated after each mowing, at the field rate of 2 mites per 10 square feet. Once established, it is very effective in preventing a spider mite attack. In long term plants, we find it very easy to re-collect *fallacis* years after the original introduction, both indoors and outdoors.



Unlike persimilis, fallacis is effective against all of the commercially significant mite pests.

Persimilis is still the main beneficial, but only in the case of the two-spotted spider mite. The leaf product will work about twice as fast and with half the inoculums compared to the product in a granular carrier. During hot weather, the persimilis will avoid the exposed tops of the plants in order to prevent themselves from drying out. Stethorus will quickly move into the exposed tops of the plants and feed on a tremendous number of spider mites.

We do not recommend the use of *Amblyseius californicus*, as it is disruptive to both fallacis and persimilis.

WHITEFLY STRATEGY OVERVIEW

Whitefly is an insidious pest; low numbers can give the grower a false sense of security. The longevity and fecundity of the whitefly can lead to overwhelming situations very quickly. The only sure way to control whitefly is to start clean and prevent any significant buildup.

Weekly releases of preventative Encarsia must be considered similar to an insurance policy.

Using eggplant as a trap/banker can be very effective, although in our experience using Encarsia and starting clean will be all you need. Whitefly has a very advanced sense of smell and will move onto the eggplant in a very profound way.

If *Bemisia* have established, parasitoids are at a disadvantage because they are all reared on Greenhouse Whitefly, and parasitoids always work best on their established host. All parasitoids will adapt to *Bemisia* and will all host feed aggressively. The use of Delphastus will have a major impact on *Bemisia*, and if started early, will eliminate it before they move on to the Greenhouse Whitefly. *Bemisia* are much harder to monitor because they don't evenly distribute themselves the way Greenhouse Whitefly does.

THRIPS STRATEGY OVERVIEW

Prevention of thrips is impossible. They can penetrate any screen and will always get in. Monitoring is essential to determine when they first arrive. Yellow or blue sticky traps are preferable over waiting to see damage on the crop. Once thrips arrive, your response must be immediate and

overwhelming. Cucumeris should be applied at a rate of at least 200 mites per 10 square feet. They can be shaken out onto the crop from the bulk tube, scattered over the crop by using a hand spreader, puffed out over the crop by pouring the bulk product into a rose duster (the bran will stay behind) or blasted over the crop using a modified and governed Echo backpack leaf blower. The cucumeris, however, can only feed on the early instar thrips. The eggs of the thrips are injected into the plant tissue, making them unavailable to predators. For many thrips, pupation is away from the plant, further impairing the predators' ability to gain the upper hand. Adult thrips are rapid movers and capable of flight, therefore cucumeris needs help. Stratiolaelaps at the pupating site (in the soil) will help prevent the thrips from successfully cycling in the house.

Major inflows of thrips occur when they are disturbed from their outside habitat. Develop a communication with local farmers so that you are aware when they are about to harvest or mow their crop of alfalfa or hay. Unfortunately, they usually only mow on a sunny day, which means the wind will be up and the vents will be open. However, reducing the opening gap and duration can have a significant reduction in the number of thrips that will move into the house.

The use of blue sticky cards helps track the arrival of thrips because only they like blue to a significant level. The incorporation of vanilla to the traps will increase the trapping of the adults and can have a control effect. Use a cotton ball on the card to hold the vanilla.

Flowering marigolds are very attractive to thrips, and will pull them out of your crop. Always keep a flat of yellow Hero Marigolds in propagation so that you have a continuing supply of them throughout the season. The trapping marigolds should have lots of Stratiolaelaps in the soil and cucumeris on the foliage, as well as vanilla. If the marigold becomes overwhelmed by thrips, carefully place the plant in a plastic bag and remove it from the house.



APHID STRATEGY OVERVIEW

In recent years, the range and species of pest aphids has dramatically increased.

Regular, low releases of Aphidoletes will prevent the establishment of all species of aphids. A rate of 5,000 per 2.5 acres, per week, will protect most crops from aphids. Aphid hot spots must also be treated by direct release of Aphidoletes.

During the cooler growing season, Aphidoletes slows down to a point where the Green Peach Aphid can effectively stay ahead of them. Once the average temperature in the house goes below 59° F, Aphidoletes should be supplemented with *Aphidius matricariae*, which performs much better during this period. The addition of lights in the house can greatly improve the performance of Aphidoletes during the fall and winter. It responds to extremely low levels of light, such as walkway lights or even LED Christmas lights. If Foxglove Aphids are present during this period, double the Aphidoletes rate.

For outdoor use, release directly into the infestation. Aphidoletes will cycle and over winter.

