
2010 Crop Recommendations

Cucumber

Overview:

Few crops are as attractive to pests as Cucumber. Fortunately, most of the beneficials are also fond of Cucumber.

The major issues, from a biological control point of view are; continuous cropping (possibly carrying over pests), High-wire (hard to monitor and close to high energy lights), high frequency of traffic (increases likelihood of pest movement), high susceptibility to thrip attack, lack of pollen and high frequency of fungicide application.

As always, the movement of people in the greenhouse is a major form of dispersal of the crawling pests, such as spider mites. Whenever possible, restrict the movement of people in known hot spots. Enter the hot spots last and then directly leave. Coveralls should be frozen overnight or washed each day, especially for the people that worked in a known infested area.

Prior to Planting Out:

The house should be thoroughly cleaned. Walls, floors, posts, wires etc should be washed with soap or another suitable cleaning product. Whitefly and Aphids will persist in cool greenhouses for well over 1 week without any plant material available, but they will be killed with a thorough cleanup.

If the house has a history of spider mites, they will be hiding in the ground around the posts and the walls. An introduction of *Hypoaspis miles* (250 mites per square meter) at each post and along the walls will help kill the over-wintering spider mites.

Discuss with the propagator the presence of pests. Ensure that your plants are clean because of good pest management practices and not because of a chemical insecticide. If an insecticide is used, get all of the details such as rate and date, as well as method of application.

At Planting Out:

Apply *Hypoaspis miles* at a rate of 50 to 100 per square meter. Lower rates can be used on new rockwool or other substrates, but care must be taken to ensure that the *Hypoaspis* is thoroughly mixed. *Hypoaspis* can be diluted with sawdust or vermiculite but it is difficult to maintain an even distribution immediately after the mixing. Skipping plants can work in clean houses, as the *Hypoaspis* will disperse themselves quite well.

Apply *Encarsia Max* at a rate of 0.5 per square meter if no whitefly is detected. At one to two whitefly per yellow card per week increase rate to 1 per square meter. If using regular *Encarsia*, the rate should be doubled. See below; Whitefly Strategy Overview.

At First Flower (week 2 to 8):

Apply “20 to 1” *P. persimilis* at a rate of 1 leaf per plant. This should be done over a number of weeks. The “20 to 1” *P. persimilis* is harvested from our rearing system at an earlier date so that the ratio of spider mites to *P. persimilis* is 20 to 1. We have found that this ratio is ideal for establishing a stable balance of predators and prey. On applications in Holland, we have had numerous years where this single application has been effective for the entire year. See below; Spider Mite Strategy Overview.

Apply *Aphidoletes aphidimyza* at a rate of 2000 per hectare per week. The release points must be neutral, away from any known aphids. Any aphid hot spots should be treated with a direct application of *Aphidoletes* or *Aphidius matricariae* (if green peach aphid) at a rate of 1 *Aphidoletes* to 10 aphids. Small hot spots should be treated by releasing some adults from a tray

or with *Aphidoletes Max*, a hanging vial that slowly releases *Aphidoletes* over a 1 week period. See below; Aphid Strategy Overview.

If whitefly are present at any level, apply *Delphastus catalinae* at a rate of 1 per square meter. Any count over 2 whitefly per week is a serious infestation and should be countered by increasing the rates to 4 per square meter for *Encarsia Max* or 6 per square meter for *Encarsia*. See below; Whitefly Strategy Overview.

Early Season:

Watch for the return of the spider mites. Returning mites are frequently still “red phased” so are easy to scout unless *Phytoseiulus persimilis* are present. The horizontal spacing of the plant helps the spider mite evade the predators. *P. persimilis* tend to move in an upward pattern once they have cleaned up the leaf they were placed on. As a result, care should be taken when placing out the predators. Predatory mites should be placed directly at the major point of infestation and above and surrounding the site. Spider mites below your application site have a high likelihood of escape unless you spread out your attack. Always treat the surrounding plants that don’t have any apparent damage, at least 2 deep, because these plants usually already have some spider mites on them. Failure to contain the site will have you chasing spider mites for the entire season and spending a lot of money. See below; Spider Mite Strategy Overview.

Prevention of Thrip attack is multi-pronged. *A. cucumeris* should be applied to each plant over a period of 5 weeks. This can be accomplished by either applying a slow-release packet on every 5th plant each week or by creating a small pile of bulk product near the base of the Cucumber plant. Because there is no pollen on a Cucumber plant, the predatory mites need to be applied with some type of alternate food source. The bran mites will continue to reproduce in the slow-release packets and in the mounds placed on the growing media for the 5 week cycle period. The presence of *Hypoaspis* miles in the root zone will help prevent soil-pupating thrips such as WFT from cycling in the house. Once Thrips are detected, *Orius* should be released (after March 1) at the recommended rate. Blue or yellow sticky cards are effective at stripping the adults out of the house if they are laced with vanilla extract. Thrips love the smell of vanilla and can be persuaded to leave the crop for it. Introducing support plants, such as fennel can provide the *Orius* with a pollen and nectar source and may even help the *cucumeris* establishment. 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 Max* should go up to 6 per square meter per week (regular *Encarsia* up to 8 per meter) and *Delphastus catalinae* should be introduced at a minimum of 0.1 per square meter every two weeks, until the counts are brought back in line. Once the leaves become sticky with honeydew, the parasitoids movement becomes impaired. *Delphastus* releases should be increased up to .5 per square meter if control is at stake. The use of Eggplant, strategically located along the aisles at a rate of 4 to 6 per hectare, will help draw the whitefly out of the crop. The Eggplant is preferred by the whitefly and can be used to trap and can be a very effective banker system. High levels of whitefly on the Eggplant should be vacuumed off, taking care to freeze the vacuum bag to kill the whitefly. A daily vacuuming of the Eggplant can strip a significant number of whitefly adults out of the crop. *Orius*, *Delphastus* and *Encarsia* should be introduced to the Eggplant, as it will become a nursery for the beneficials. The presence of the thrip predators in the crop will also help with whitefly control, as they will feed on whitefly eggs and larvae. *Aphidoletes* also feeds on whitefly larvae when they are starving for aphids. See below; Whitefly Strategy Overview.

Watch for Aphids entering the house. Rates of the preventative release should increase to 3000 per hectare per week, as the crop is now much larger. Hot spots should be directly attacked with releases of adult *Aphidoletes*, but control of the Melon aphid will only occur by prevention, as the Melon aphid reproduces and disperses faster than the biocontrols can handle. For major infestations, rates of 6000 per hectare per week should be neutrally released until the numbers are back in manageable levels. In order to achieve quick recovery, the ratio of *Aphidoletes* to aphids

must be in the order of 1 to 100. This could require extremely large numbers of *Aphidoletes* for a quick cure or a longer time frame for recovery. All species of aphids are controlled by *Aphidoletes*. *Aphidius matricariae* will easily control and cycle with Green Peach Aphid.

Main Season:

Spider mites should be surrounded by *P. persimilis*. The treated area should be the hot spot and then two more unaffected plants, as the spider mites are probably on these unaffected plants. The *persimilis* should be placed high on the treated plants as they will be forced to disperse throughout the entire plant. A ratio of 1 *persimilis* to 100 spider mites will achieve control in 2 weeks. A typical attack on a single plant hot spot would be 1000 *persimilis* on the affected plant, 500 *persimilis* on the immediate adjacent plants, and 200 *persimilis* on all of the plants within the treatment circle. The hot spot should be flagged and traffic should be diverted. As the humidity drops in the house, the volunteering *Feltiella* will disappear. Hot spots will flare up more frequently due to the decline in the flying predators. *Stethorus puntillum* should be released at a rate of 0.1 per square meter every 2 weeks. The *Stethorus* are not intimidated by low humidity and high temperature and will easily be seen feeding on the dome of the plants. 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 catalinae* 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 0.1 to 1 per square meter, depending on level of infestation. In extremely hot situations (over 30 Celsius) whitefly adults will only live for a few days (instead of months) and will not lay eggs. See below; Whitefly Strategy Overview.

Aphid control should shift entirely to *Aphidoletes*, as *Aphidius* will now be infested with hyperparasites. Any aphid banking system should be converted to *Aphidoletes* by introducing *Aphidoletes* directly onto the bankers. Please note that we do not recommend any Aphid Banking System. See below; Aphid Strategy Overview.

Late Season:

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 daylength begins to noticeably decrease and the evening temperatures drop, the spider mites begin diapausing. In a diapause state, spider mite are more resistant to chemicals and are not as attractive to the beneficials. If chemicals should be used, it would be at this time. Hopefully the whitefly is under control so a spray of Avid will not cause a whitefly outbreak.

If the whitefly is not in good control, it will begin to runaway in the fall. Adding trap Eggplants will help if the plants are vacuumed daily. Adding parasites beyond 6 per square meter 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 all 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 and 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. *Aphidius* can work very well in the fall, especially if they were not used in the summer, reducing the pressure of the hyperparasites.

Spider Mite Strategy Overview:

Cleanup is essential. Physical spraying, chemical spraying, and *Hypoaspis* will all have extremely high returns on investment. Cleanup must occur before the fall weather becomes

apparent. Once spider mites begin developing the “red phase”, they will become unattractive to the predatory mites and more resistant to the chemical sprays.

Spider mites love Cucumbers. The fast growing plants help displace the wandering spider mites away from their predators. Frequent animal traffic assists in the dispersal. Whenever possible, have the staff avoid the known hot spots until the end of a shift. The coveralls of every worker should be washed or frozen every night in order to minimize dispersal of the spider mites.

Fans should be carefully directed so that they achieve the desired effect but don't blow directly onto the plants. Increased air movement lowers the humidity at the leaf surface, chasing away the predators. The result is that the spider mites will enjoy a predator free area that will lead to plant death and an out of control hot spot.

P. persimilis is still the main beneficial. The leaf product will work about twice as fast and with half the inoculums compared to the product in a granular carrier. Our growers have found that releasing the P.p. above the infestation will improve the arrest of spread, as the P.p. will disperse better on the plant. 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, but must be applied before the plants are damaged, as the damage is permanent and will reduce the humidity so that the persimilis will still avoid the area after it has moved down into the canopy. Therefore, prevention and preventative control is the key to spider mite management. The “20 to 1” introductions early in the year are very effective in preventing run-away infestations.

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. *Encarsia Max* will reduce the weekly cost by allowing you to use very low rates (as low as 0.5 per meter square). *Encarsia Max* live longer, fly farther, and are actually smarter than refrigerated *Encarsia*. All of Applied's *Encarsia* are held above 11 degrees Celcius and are never refrigerated. *Encarsia Max* is guaranteed to be no older than 48 hours from harvest.

Using Eggplant as a trap/banker can be very effective, although, in our experience, *Encarsia Max*, starting clean, will be all you need. Whitefly have a very advance 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 the *Bemisia* 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.

Thrip Strategy Overview:

The fact that Cucumbers do not produce pollen is a major reason why thrips are a major pest. The “slow-release” bag was created specifically for the Cucumber so that *cucumeris* could continuously be generated and move out onto the plant. The *cucumeris*, however, can only feed on the early instar thrips. The eggs of the thrip 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. *Hypoaspis* at the pupating site will help prevent the thrip from successfully cycling in the house. *Orius* are aggressive predators and will feed on all mobile stages of thrips as well as loopers, aphids, and whitefly, but are expensive and will leave the house if conditions are not to their liking.

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, but 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 thrips 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.

Plants such as fennel will give the thrips a sweeter alternative to cucumber flowers and will concentrate the Orius with the thrips. The fennel will also attract local Orius species from outside, into 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 3000 per hectare per week will protect the crop from aphids.

Tables: Weekly: (per square meter)

| Whitefly | 0 to 2 per card | 2 to 10 per card | More than 10 per card |
|-----------------------------|-----------------------------|--------------------------------|-------------------------------|
| <i>Encarsia Max</i> or | 0.5 to 1 per m ² | 1 to 4 per m ² | 4 to 8 per m ² |
| <i>Encarsia</i> and | 1 to 2 per m ² | 2 to 6 per m ² | 6 to 10 per m ² |
| <i>Delphastus</i> | none | 0.1 to 0.25 per m ² | 0.25 to 1 per m ² |
| | | | |
| Spider Mite | 0 to 10 per leaf | 10 to 100 per leaf | More than 100 per leaf |
| <i>P. persimilis Max</i> or | 1 leaf per plant | 10 leaves per plant | 25 leaves per plant |
| <i>P. persimilis</i> and | 100 mites per plant | 1000 mites per plant | 2000 mites per plant |
| <i>Stethorus</i> | 0.01 per m ² | 0.1 per m ² | 0.5 per m ² |
| | | | |
| Aphid | 0 to 1 per leaf | 1 to 10 per leaf | More than 10 per leaf |
| <i>Aphidoletes</i> and/or | 0.25 per m ² | 0.5 per m ² | 1 per m ² |
| <i>Aphidius Max</i> | 0.05 per m ² | 0.1 per m ² | 0.5 per m ² |
| | | | |
| Thrip | 0 to 1 per flower | 1 to 3 per flower | More than 3 per flower |
| <i>A. cucumeris</i> | 60 mites per plant | 90 mites per plant | 120 mites per plant |
| <i>Orius</i> | 0.05 per m ² | 0.1 per m ² | 0.5 per m ² |