Propagation of Ornamental crops

General Information

This document provides guidelines for the biological control of pests during the propagation of ornamental crops (bedding plants, potted foliage plants, flower plants, etc.) from both seed and cuttings. Propagation of young plants is an important part of the production cycle; propagators are asked by their customers (growers of finished products) to provide high quality plants, which also mean 'clean' plants i.e. plants free of pests and diseases. Traditionally, pesticides have been used to control pests but it is extremely difficult if not impossible, even with pesticides, to produce plants with absolutely no pest. Another option to control pests is to use biological control agents (BCA's). Including BCA's in a pest management program also contributes to the management of the development of resistance to pesticides by pests. Furthermore, plants produced by a propagator who implemented a bio-control program are free of residues of pesticides with long-term negative effects on BCA's, which leaves the option opened for his customers to continue with an IPM/bio-control program. This document gives the basics of a general bio-control program of the main pests during propagation of young plants. This general program will need to be adjusted to address the needs of each individual crop. For example, if a crop is not attacked by thrips, it would not be necessary to introduce BCA's against thrips. To discuss this in detail, please contact a Biobest representative or distributor.

Scouting and Monitoring

Scouting needs to be done on a very regular and consistent basis (weekly on the same day) to monitor pest and BCA populations. An excellent tool for monitoring whitefly, thrips, leafminer, fungus gnat and shore fly populations is the use of sticky cards. We normally suggest 10 sticky cards per acre (1 card/4000ft^2) in a production greenhouse but we recommend to increase to 20 sticky cards per acre (1 card/2000ft^2) during the propagation stage; cards should be inspected once a week. Identify, count and record number of pests and BCA's found on cards. All counts (and observations) can be recorded on the Biobest 'Scout-Sheet' or other scouting and monitoring sheets. Some pest problems such as two-spotted spider mite and aphids do not fly and do not show up on sticky cards. Therefore, plants or trays should also be inspected weekly; if any pests and BCA's are found on plants, identify and record observations.

Pests, Biological Control Agents (BCA) & Control Strategy

Whitefly

Whitefly is a common pest in many different ornamental crops. The most common whitefly species found is the greenhouse whitefly (*Trialeurodes vaporariorum*). Silverleaf (tobacco or sweet potato) whitefly (*Bemisia argentifolii* or *B. tabaci*) is far less common and is generally found in Southern regions, but occasionally shows up in Northern USA and Canada when plant material is imported from Southern regions. It is important to identify the whitefly species because BCA's may attack some whitefly species but not others; therefore, whitefly species present in a greenhouse can impact the choice of the BCA's used.

Since greenhouse whitefly is the most common species, we suggest using the Eretmix-System, which contains the BCA's *Encarsia formosa* and *Eretmocerus eremicus*, two parasitic wasps that attack whitefly by parasitization and by feeding on whitefly larva (host-feeding). If silverleaf whitefly is observed in the crop, we suggest also using the Mundus-System, which contains *Eretmocerus mundus*, a parasitic wasp specialized against silverleaf whitefly. Depending on the crop and length of the propagation stage, it might be useful to also introduce the Swirskii-System, which contains the predatory mite *Amblyseius swirskii*.(Introduction rates: Table 1).

Thrips:

Thrips originally always has been a major obstacle for a successful bio-control program in ornamental crops. The western flower thrips *Franklinella occidentalis* is usually the main thrips attacking crops. The best line of defence against thrips is to begin a biological program as early in the crop as possible. If thrips are present in the greenhouse at planting, first instar larva of thrips could be crawling out of the egg within one week after planting; first instar thrips larva is the stage causing most of the

damage. The first instar thrips larva is also the stage most sensitive to the attack of the BCA's contained in the Amblyseius-Breeding-System (predatory mite *Amblyseius cucumeris*) and Swirskii-System (predatory mite *Amblyseius swirskii*), the main products used against thrips. The basis of thrips control is to start early in order to prevent the first instar larva from reaching later stages, which are more difficult to control thrips. There are other thrips predators that could be used but they usually do not fit well into a short-term crops such as propagation of ornamental plants.
We recommend to start a biological control program immediately after seeding or sticking cuttings by introducing the Amblyseius-Breeding-System as a small 'breeder' pile per seeding tray (or cutting tray), which will release *Amblyseius cucumeris* for a period of four weeks (close to duration of propagation in the seeding trays). If the propagation of the crop is longer than six weeks, a second introduction might be required. Overhead watering does not harm the 'breeder' pile as long as it is gentle watering, i.e. with pressure low enough not to 'blast apart' the pile. If heavy watering is necessary at first, we suggest introducing the Amblyseius-Breeding-System later when watering is decreased. It is also possible to use the Swirskii-System, which contains *Amblyseius swirskii*, a predatory mite that feeds on thrips and whitefly larva but that performs best at temperatures above 68°F. So, for the moment, we recommend to use the Swirskii-System in whitefly susceptible crops In case a hotspot of thrips develops, we recommend doing foliar application of the Steinernema-System, which contains the nematode *Steinernema feltiae*. The Hypoaspis-System and the Atheta-System, which contain the predatory mite *Hypoaspis miles* and the predatory rove beetle *Atheta coriaria* respectively, are normally used for fungus gnat and shore fly control. Both BCA's live in the top layer of the potting media and prey on thrips pupating in the soil, thus contributing to thrips control. However, the actual contribution of these two BCA's to thrips control is uncertain and it is not recommended to rely only on them to control thrips

Leafminer:

The control of leafminer is one of the most successful biological control systems. However, the tolerance for damages (mines) is extremely low. Therefore, we recommend using the Diglyphus-System, which contain the parasitic wasp *Diglyphus isaea*. Introduction is done on a weekly basis and should start immediately when leafminer is first detected in the crop. *Diglyphus* immediately stops the leafminer larva in the mine, thus preventing further development of the mine. If leafminer level reaches an average of five or more adult leafminers per sticky card per week, we suggest doing a corrective spray with a compatible pesticide to bring leafminer population down. *Dacnusa sibirica* is another parasitic wasp of leafminer but it is not a viable option since it does not "kill" the leafminer larva instantly in the mine. Scouting for adult leafminers is easily done with yellow sticky cards placed horizontally, which can catch at least 10 times more adult leafminer than vertically placed sticky cards. Often, high level of leafminer damage is found along the walkways and gable ends; horizontally-placed sticky cards are also useful to reduce adult leafminer population in such hot spot. We also recommend monitoring parasitism levels on a weekly basis starting at three weeks after 1st introduction of the Diglyphus-System; dissecting mines and larva with the help of a microscope is the best way to determine parasitism levels. (Introduction rates: Table 1).

Spider mite:

Since two-spotted spider mites (TSSM) are very small and do not fly, they can remain undetected in the crop; so, early detection is important for effective control. Inspect plants on a weekly basis and keep an eye opened for signs of TSSM such as yellowing or spotted leaves.
On the first sign of TSSM in the crop, we recommend introducing the Phytoseiulus-System, which contains the predatory mite *Phytoseiulus persimilis*. In crops very susceptible to TSSM, we recommend introducing the Californicus-System, which contains the predatory mite *Amblyseius californicus*, as a complement to the Phytoseiulus-System. Since *A. californicus* can survive for a longer period of time without TSSM, it is possible to release it preventively. However, *A. californicus* will only slow down the development of TSSM; only using the Phytoseiulus-System and Californicus-System in combination will provide adequate control of TSSM. (Introduction rates: Table 1)

Aphids:

Ornamental plants are hosts to many aphid species including green peach, melon, potato and foxglove (or glasshouse potato) aphids (for detailed identification key, consult the 'Aphid Pest-Info Sheet'). Reproduction of aphids is very fast as they give birth to live youngs, so aphid population can develop very quickly. Often, when aphids are found in the crop, population has already reached a level that requires an intervention with a pesticide.
As a preventive measure, we suggest using the Aphidius-System, which contains *Aphidius colemani*, a parasitic wasp of the green peach aphid and of melon aphid. We strongly recommend using the 'Aphid Banker-System' to complement the Aphidius-System. The 'Aphid Banker-System' consists of barley plants infested with cereal aphids,

which can support a population of *A. colemani*; in other words, it is an 'in-house rearing system of aphid enemies'. The cereal aphid used on the Banker-System attacks monocotyledonous plants only; therefore, the Banker-System should not be used in greenhouse where monocotyledonous plants (e.g. ornamental grasses, lilies) are grown. Upon detection of potato aphid and foxglove/glasshouse potato aphid in the crop, we suggest combining the Ervi-System and the Aphelinus-System, which contains the parasites *Aphidius ervi* and *Aphelinus abdominalis*, respectively. The Aphidoletes-System, which contains *Aphidoletes aphidimyza*, a predatory midge that attacks any aphid species, can be used in hotspots to supplement the work of the parasites. (Introduction rates: Table 1)

Fungus gnat and shore fly

Fungus gnats can be a serious problem at the propagation stage of young plants as well as at the planting stage of small rooted plants. Fungus gnat larva can also attack callus cells of rooting cuttings. Shoreflies can also be a problem; they do not cause damage to plants but their presence decreases the aesthetic value and marketability of the plant.

We suggest using the Hypoaspis-System, which contains the predatory mite *Hypoaspis miles*, as preventive measure against fungus gnats. We suggest to also introduce the Atheta-System, which contains the predatory rove beetle *Atheta coriaria*, as a preventive measure; this BCA will complement the work of the Hypoaspis-System in controlling fungus gnats and it will also control shoreflies. Usually one application soon after seeding or when planting rooted cutting) is enough to establish a population and obtain control of fungus gnats and shoreflies for the whole duration of propagation stage. We also recommend a second introduction when young plants are transplanted (production stage). In case fungus gnat hot spots develop, we suggest using the Steinernema-System, which contains the parasitic nematode *Steinernema feltiae*, as curative measure. (Introduction rates: Table 1).

Trap-Plant and Banker-Plant

'Trap plants' are plants other than the crop grown, which are more attractive to certain pests than the crop itself; trap plants help in the early detection of pests. When BCA's are introduced on trap plants, it creates an "in-house" rearing system of BCA's, hence the term 'Banker-Plants'. If you are interested in implementing this technique in your propagation area, please contact a Biobest representative or distributor.

Impact of pesticides on BCA's

- Pesticides (insecticides, nematicides, fungicides, etc.) can have short or long-term negative effects on one or more stages of the BCA's. Therefore, be careful if or when choosing pesticides to apply while using BCA's.
- If buying plants from an outside source, request a record of the pesticides applied on the plant material you are buying. Some pesticides with long-term residuals can have a negative impact on BCA's for many weeks after their application, even if pesticides were applied before the plant material is brought into your greenhouse. Ask your supplier of plant material to incorporate BCA's as much as possible in his pest management program.
- Effects of pesticides on BCA's are listed in the Biobest's publication "Side Effects Manual" or can be found on Biobest's website (www.biobest.ca);

Additional sources of information

- For detailed information on pests and BCA's mentioned above, consult the corresponding "Pest Info-Sheet" or "Beneficial Info-Sheet", which are all contained on the "Biobest Info-System" CD. To obtain a copy of any info-sheet or of the CD, please contact Biobest directly or a Biobest representative.

Miscellaneous

- Introduction rates of BCA's can be influenced by climate, season and location;
- Always use products as soon as possible after receipt. If storage is unavoidable, keep at recommended temperature (indicated on package) for the shortest amount of time possible;
- Always use products before the expiry date stated on the package;
- - For additional information, please contact a Biobest supplier or technical advisor.

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Table 1: introduction of BCA's against pests in propagation stage of ornamental crops.

Pest	Product (BCA)	Introduction rate	Timing	Application
Whitefly	Use first two product in combination; use third product if Bemisia tabaci is found			
	Eretmix-System (Encarsia formosa & Eretmocerus eremicus)	0.6/ft^2	Weekly	Hang card on plant or structure
	Swirskii-System (Amblyseius swirskii)	50/seeding tray	Once, one week before transplanting	Sprinkle on leaves
	Mundus-System (Eretmocerus mundus)	0.3/ft^2	Weekly	Hang card on plant or structure
Thrips	Always use first product; use second and third products if necessary			
	Amblyseius-Breeding-System (Amblyseius cucumeris)	50/small seeding tray or 100/large tray	Once, after germination or sticking cuttings	Make pile on tray
	Steinernema-System (Steinernema feltiae)	25000/ft^2	If needed	Spray foliage
	Swirskii-System (Amblyseius swirskii)	50 / seeding tray	Once, one week before transplanting	Sprinkle on leaves
Leafminers	Diglyphus-System (Diglyphus isaea)	0.01/ft^2	Weekly, until parasitism >75 %	Release on plants
Two Spotted Spider Mite	Use following two products in combination			
	Phytoseiulus-System (Phytoseiulus persimilis)	0.4 to 0.6 / ft^2	At least 3 times or until population is established	Sprinkle on plants
	Californicus-system (Amblyseius californicus)	0.2 to 0.4 / ft^2	One week after seeding or sticking cuttings	Sprinkle on plants
Aphids (green peach, black melon)	Use first two products in combination; use third product in hotspots or if hyperparasitism of A. colemani has been observed.			
	Aphid Banker-System (barley plant with cereal aphid)	1 plant / acre	Every week	Plant in hanging basket and place in greenhouse
	Aphidius -System (Aphidius colemani)	0.015/ft^2	Weekly until banker plants are producing or control is achieved	Sprinkle on banker plants
	Aphidoletes-System (Aphidoletes aphidimyza)	0.05 to 0.1 / ft^2	Weekly for at least 3 weeks or until control is achieved	Make piles of 250 Aphidoletes near hotspot
Aphids (potato, foxglove)	Use all three products in combination			
	Aphelinus-System (Aphelinus abdominalis)	0.2 to 0.4 / ft^2	Weekly for at least 3 weeks or until control is achieved	Release in crop
	Ervi-System (Aphidius ervi)	0.05 to 0.1 / ft^2	Weekly until control is achieved	Release in crop
	Aphidoletes-System (Aphidoletes aphidimyza)	0.05 to 0.1 / ft^2	Weekly for at least 3 weeks or until control is achieved	Make piles of 250 Aphidoletes near hotspot
Fungus gnats & shore flies	Use first two products in combination as preventive measure; use third if needed as curative measure			
	Hypoaspis-System (Hypoaspis miles)	10/ft^2	Once, after seeding	Sprinkle on soil
	Atheta-System (Atheta coriaria)	0.1/ft^2	Once, after seeding	Sprinkle on soil
	Steinernema-System (Steinernema feltiae)	100000/ft^2	As needed	Drench on soil