A Systems Approach to implementing Biological Control How to put it all together

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Biobest Biological Systems

January 3, 2011

Presented by: Biobest USA Inc.

Traditional Pest Management

How can we do less of this and …….

Implementing BCA's

….. and do more of this…..

Implementing BCA's

….. or this…..

Implementing BCA's

….. or this…..

Implementing BCA's

….. or this…..

Implementing BCA's

….. or this…..

Implementing BCA's

….. and this…..

Implementing BCA's

….. and this…..

Breeder pile
Amblyseius cucumeris

Automated dropper to apply ABS System – *Amblyseius cucumeris* in breeder piles

Implementing BCA's

….. and this…..

Regular size
Amblyseius cucumeris
ABS sachet

NEW:
Mini ABS *Amblyseius cucumeris* sachet
1 sachet per plant

Implementing BCA's

….. and this…..

Implementing BCA's

….. and even this …. (Biobolo – automated introduction technique for BCA's)

Implementing BCA's

….. and use it as a marketing tool (retail)…..

Implementing BCA's

…. and use it as a marketing tool (retail)…..

Implementing BCA's

and that with maintaining or even increasing quality (or production) of the products that you grow!!!!

How to switch from a traditional program to implementing BCA's?

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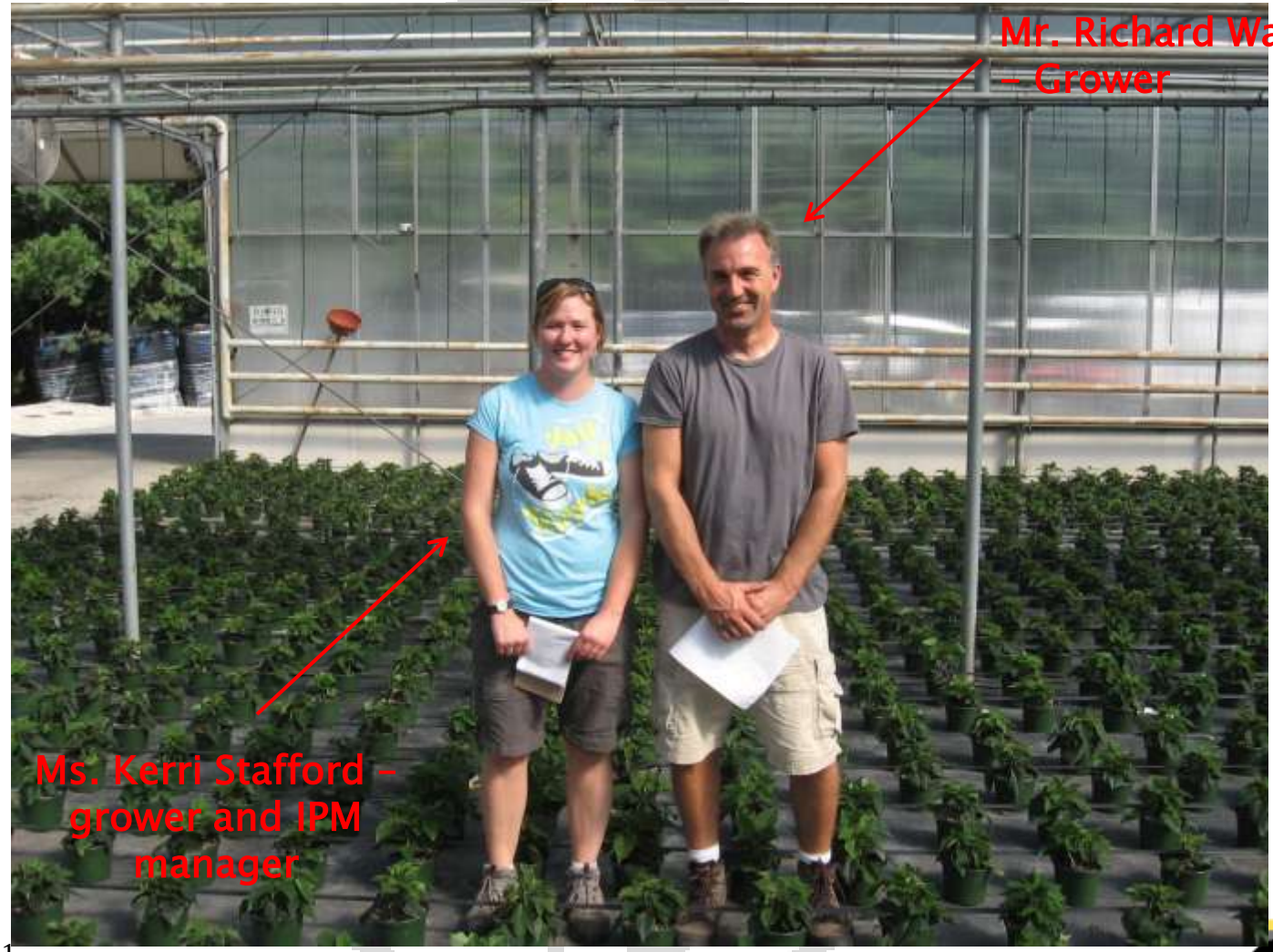
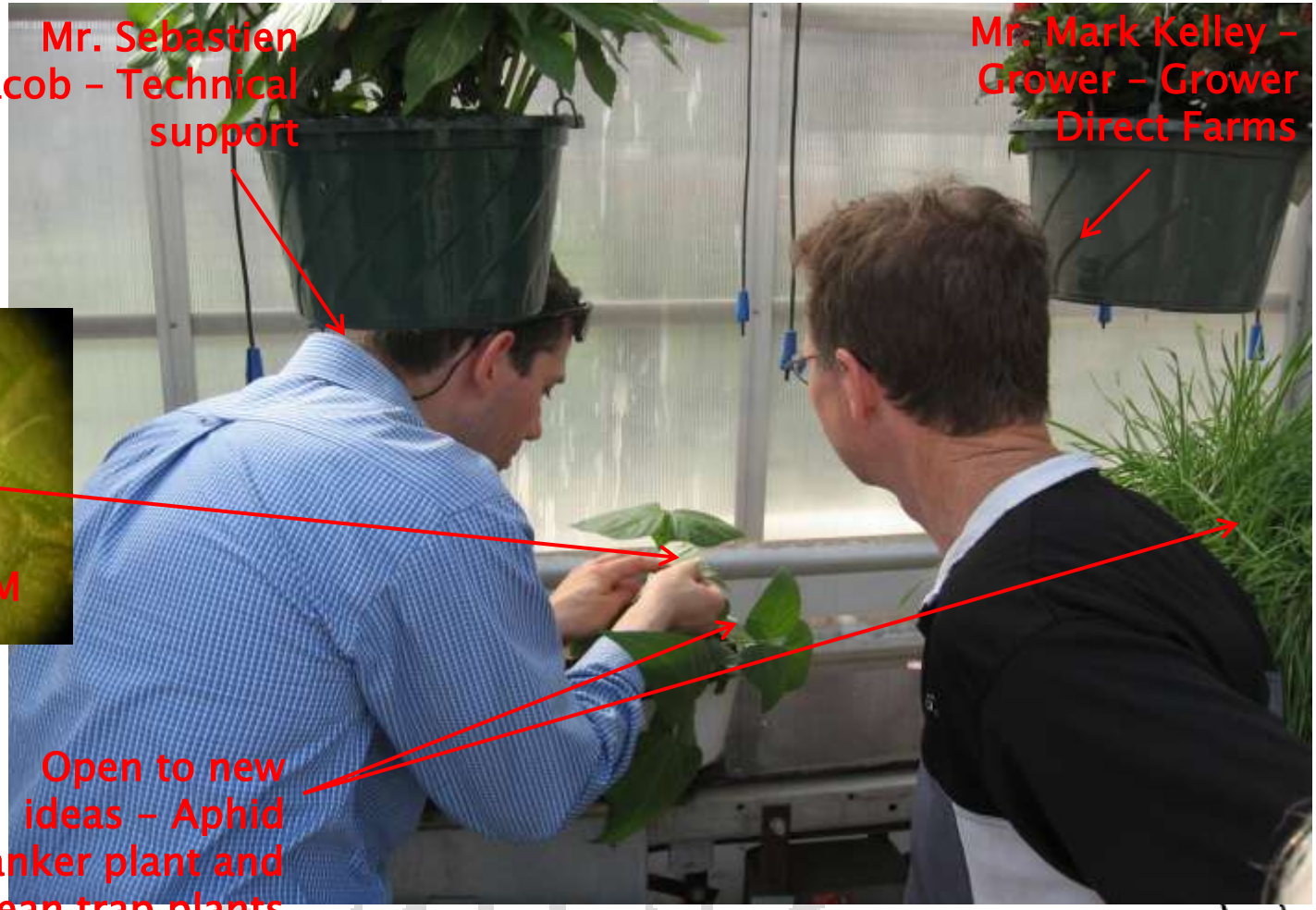
Making a change !



Making a change !



Making a change !

Using banker plants in both production and retail…..

Mr. George Cluff
owner Eden Farms

Making a change !

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Making a change!

- **Both management and grower(s) need to be involved in a decision to make a change**
- **Determination is extremely important → We are going to make this work! People make it work!!**
- **BCA's need to be seen as a systems approach!**
- **A biological control program is PREVENTING problems, not fixing problems.**
- **Bio-control programs work best is BCA's are used as the 'first line of defense' for all pest problems**

Three Key Words (PPM):

- **PRO-ACTIVE**
- **PLANNING**
- **MANAGEMENT**

10 Keys to a successful program

January 3, 2011

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10 Keys to a successful program

1. **Educate yourself and talk to IPM/Biological control specialists**
2. **Delegate responsibility → appoint someone in the organization to monitor and execute strategy**
3. **Review pest problems of previous year(s).**
4. **Review pesticide use in previous year and more important the last 3 – 4 months.**
5. **Develop and start a solid and consistent monitoring procedure. Record the data that is collected! This includes pesticide use.**
6. **Develop a plan for transition period**

10 Keys to a successful program

7. **Set a date for starting point of biological control**
8. **Develop a strategy for BCA's based on your production planning and that is solid for your situation. Look at all pest problems and include banker and trap plant techniques in your strategy.**
9. **If possible, start bio-control in propagation part of your production. If you get rooted or unrooted cuttings in from an outside source, inspect incoming material and talk to your propagator/supplier about pesticide use and your intentions of using BCA's.**
10. **Don't give up, even if first attempt is difficult.**

1) Education – What do you know about the pest problems you have? What about the mode of action of pesticides you used and what about the BCA's you are going to use?

An example with Thrips and Whitefly……
what do you know about Thrips and Whitefly?

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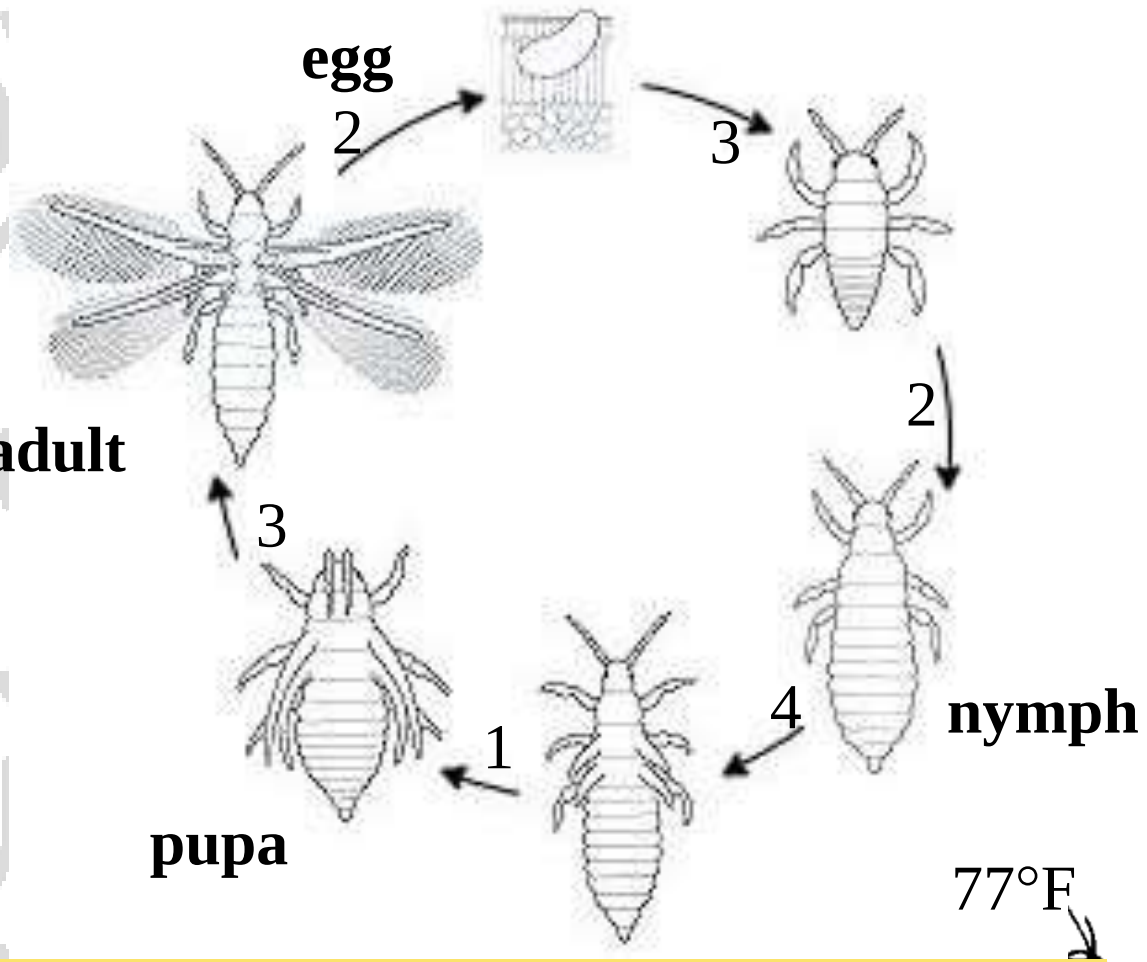
Thrips

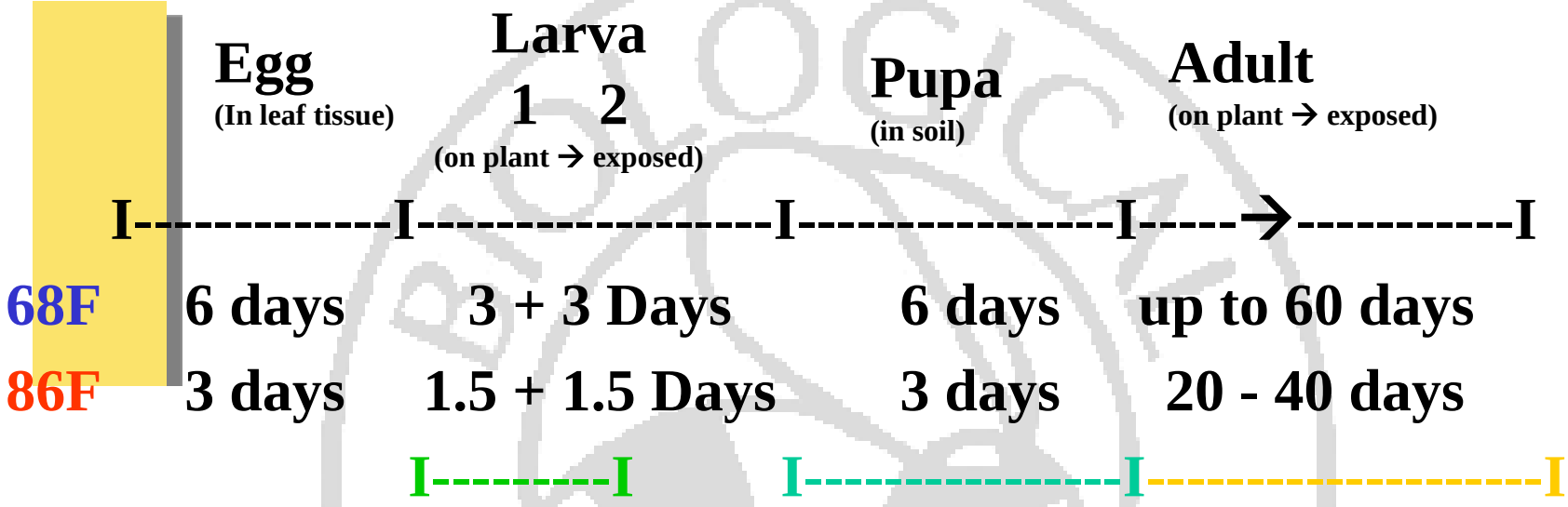
Different thrips species found in the industry:

- ***Frankliniella occidentalis*** **(WFT – most common)**
- ***Franklinella intonsa*** **(European Flower Thrips)**
- ***Franklinella tritici*** **(Eastern Flower Thrips)**
- ***Thrips tabacii*** **(Onion Thrips)**
- ***Echinothrips americanus***
- ***Scirtothrips dorsalis*** **(Chili Thrips)**

Thrips - WFT



Thrips – WFT development



- Fecundity in vegetative stage of crop → 4 – 5 eggs / female
- Fecundity when pollen available → 15 eggs per female

Biological Control of Thrips

Amblyseius cucumeris

Biological Control of Thrips

Amblyseius swirskii

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Biological Control of Thrips

Orius insidiosus

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Biological Control of Thrips

Steinernema feltiae (R. buitenhuis AAFC – Harrow)

Biological Control of Thrips

Hypoaspis spp

Biological Control of Thrips

Atheta

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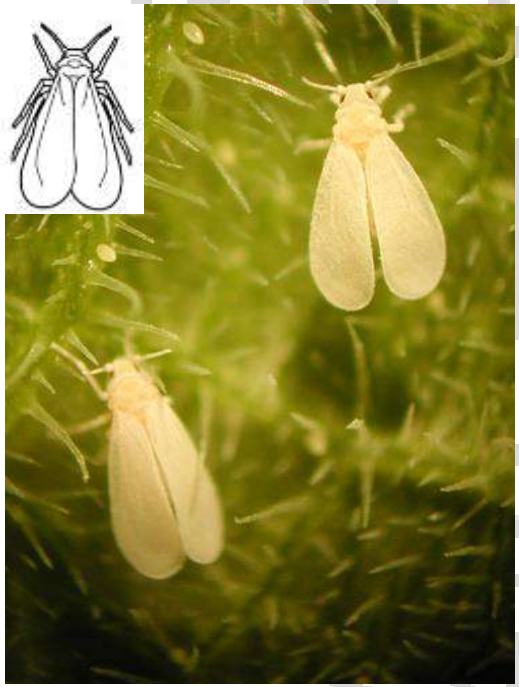
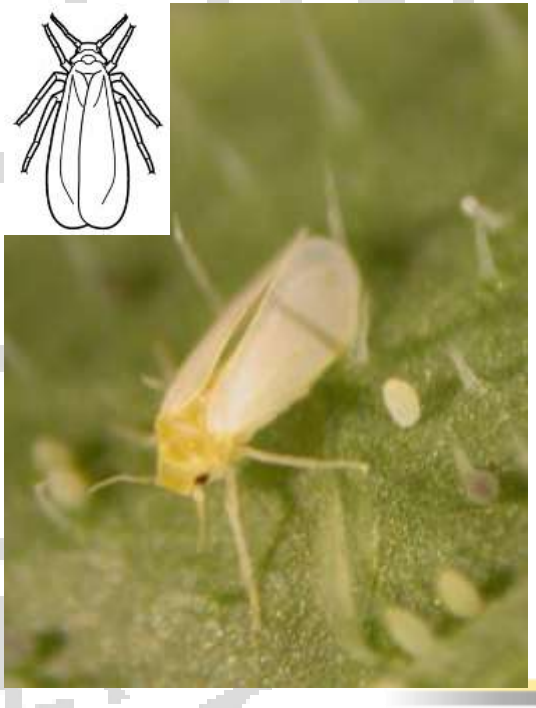
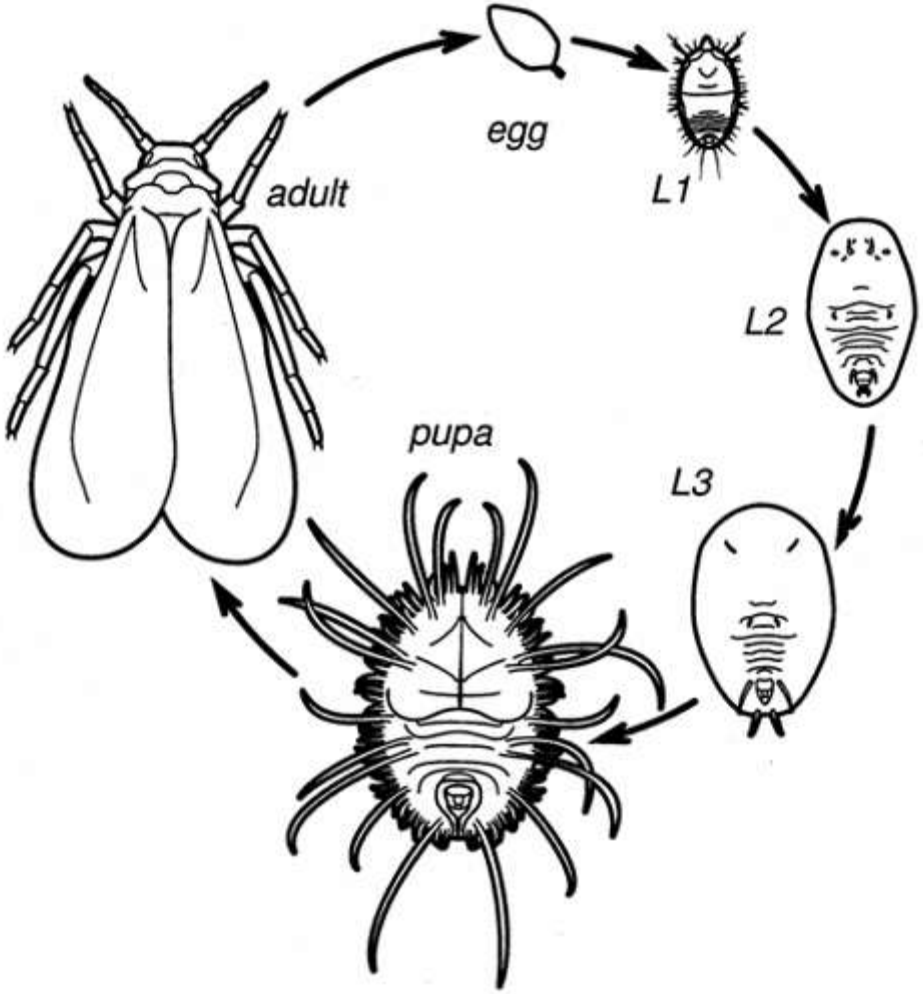
Whitefly

- **Species**
  - ***Trialeurodes vaporarium* (greenhouse whitefly)**
  - ***Bemisia tabaci* (silver leaf whitefly)**



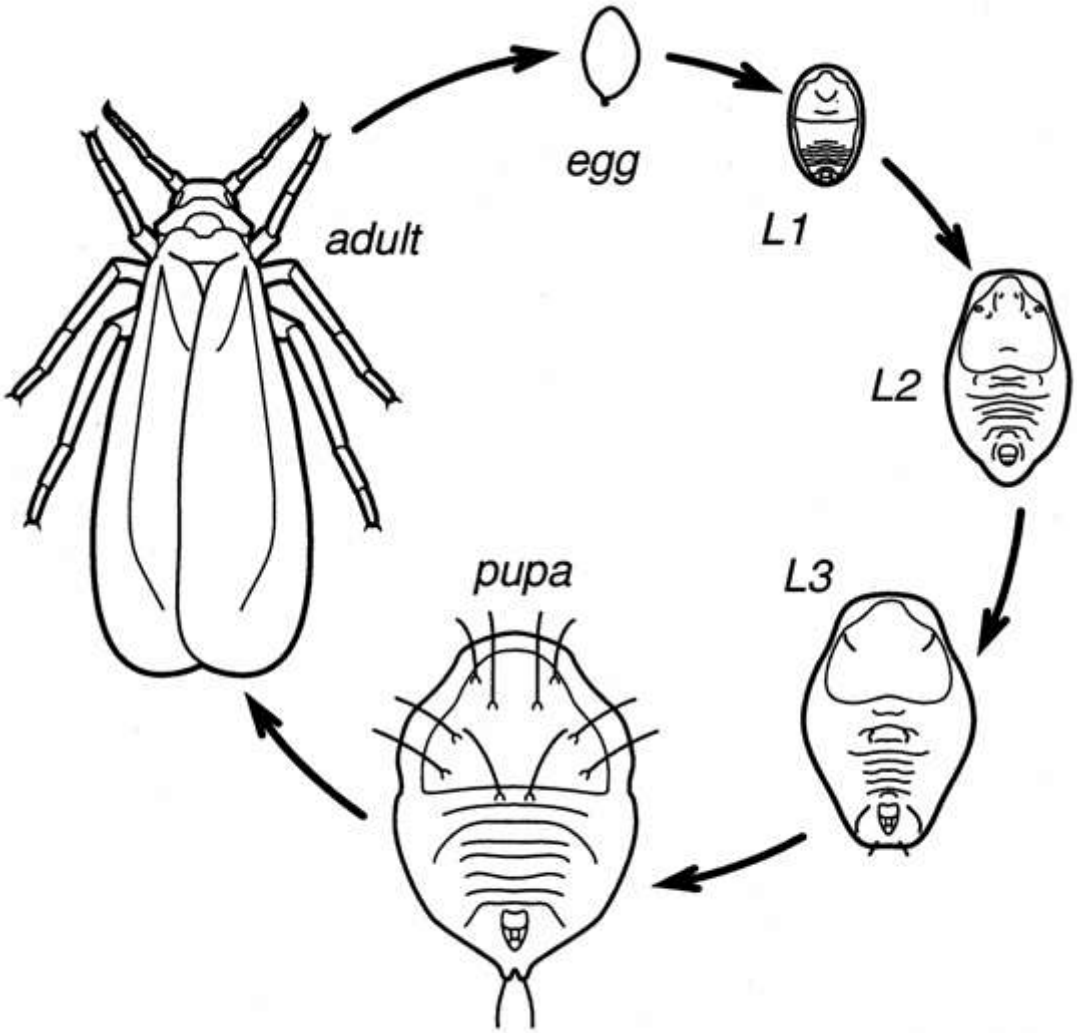


Trialeurodes vaporariorum : Greenhouse Whitefly - Life cycle



	T. vaporariorum	
	60 °F	**79 °F**
Egg	**16.0**	**6.9**
L1	**8.2**	**3.6**
L2	**5.0**	**2.2**
L3	**5.2**	**2.3**
Pupa	**15.0**	**6.5**
Total	**49.4**	**21.5**

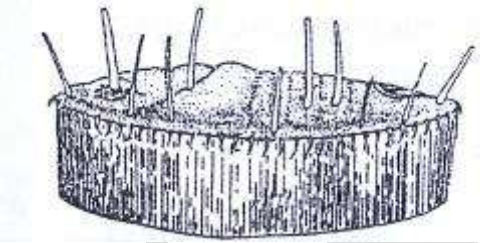
Bemisia tabaci : Silver Leaf Whitefly - Life cycle



	B. tabaci	
	60 °F	**79 °F**
Egg	**21.0**	**6.7**
L1	**11.8**	**3.7**
L2	**9.0**	**2.9**
L3	**10.4**	**3.3**
Pupa	**18.1**	**5.7**
Total	**70.3**	**22.3**

Greenhouse WF vs. Silver Leaf WF

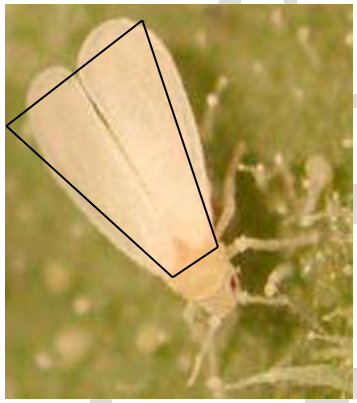
T. vaporariorum vs. *B. tabaci*

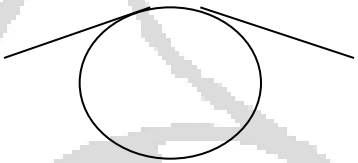
	T. vaporariorum	*B. tabaci*
Egg	First 1 – 2 days white Afterwards brownish - black	First yellowish green Afterwards brownish
$L_{1\rightarrow3}$	Very difficult to differentiate	
Pupa	 Oval shaped White, transparent, box shaped with corona	 Irregularly shaped Flattened, yellowish, transparent, no corona

Greenhouse WF vs. Silver Leaf WF
T. vaporariorum & B. tabaci

Adult

T. vaporariorum

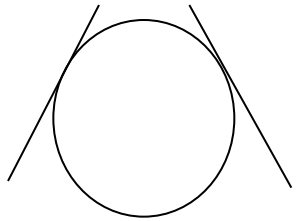




> B. tabaci

More white wax powder production → white aspect

B. tabaci



< T. vaporariorum

Less white wax powder production → yellowish aspect

Biological Control of WF

Encarsia formosa

Biological Control of WF

Eretmocerus eremicus

Biological Control of WF

Eretmocerus mundus

Biological Control of WF

Amblyseius swirskii

Biological Control of WF

Delphastus

Biological Control of Whitefly

2) Responsibility → Who is going to take the lead with pest management approach?

Management → Responsibility

Management → Responsibility

- **Determine who is going to take the lead. Managing pest management is a key.**
- **In large operations → Appoint an IPM manager/scout**

Responsibilities:

- **Monitoring & Scouting → and processing the information gathered**
- **Education other staff where possible → they can be your eyes (reward system at some greenhouses)**
- **Managing planning and ordering of BCA's, pesticide (spot) sprays if needed, and introductions of BCA's**

3) Review pest problems of previous years

Review previous years

- What were your pest problems (all of them) and in which crops
- This information is important to complete point 8
- Do not make the mistake to focus ONLY on the pest that bothered you the most --> System approach
- Review where some of your pest problems originate from? → review suppliers → More later in point 9

4) Review pesticide use in the last year and more importantly the last 3 – 4 months!

Review pesticide history

Why?

- **Some products have a long residual effect**
- **Some products can stick around on the greenhouse structure and even if the previous crop is gone, it can still negatively impact BCA's → Example Thiodan (no longer registered for greenhouse use) and *Encarsia formosa.***
- **Products to avoid for example are Thiodan, Orthene, Talstar, Decis, Malathion, Plant Fume 103 (yes, I still saw some this year ;-)**
- **Check the 'side effect list'**

Pesticides and effects on the BCA's → what can I still spray?

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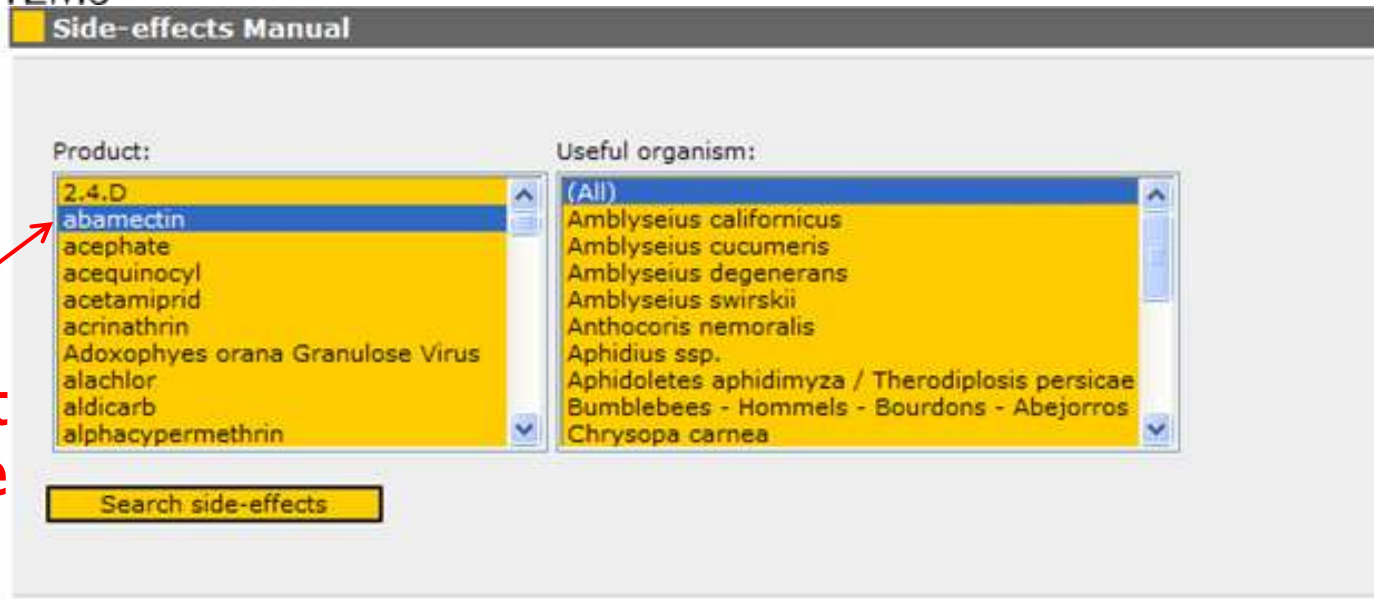
Pesticides and BCA's

- Testing compatibility of pesticides → lots of effort to screen products
- Many older generation pesticides are not compatible
- Many newer generation pesticides are much more IPM and BCA's friendly
- IOBC guidelines for pesticide compatibility classification (www.iobc-wprs.org)
- Direct and residual effects
- Check at www.biobest.ca and look for side effects
- Active ingredient driven

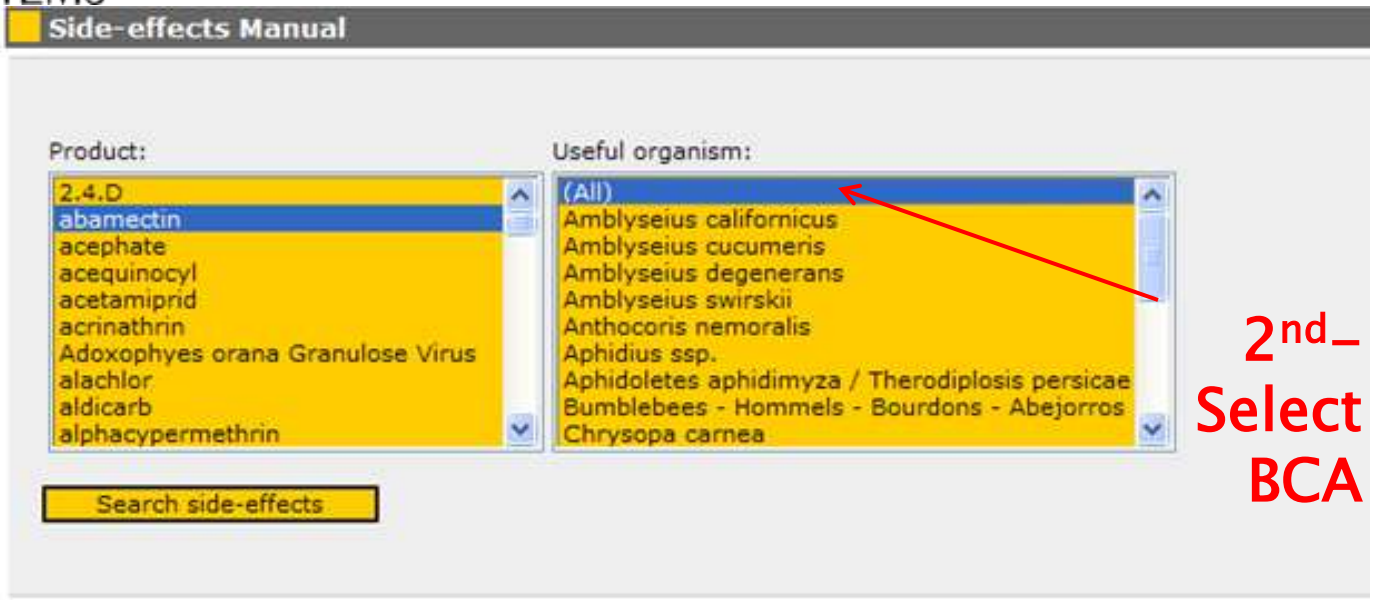
Pesticides and BCA's



1st Select pesticide

		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying 2 5 d
Amblyseius degenerans	Application Nymph/Adult Persistence	spraying 4 1 w
Amblyseius swirskii	Application Nymph/Adult Persistence	spraying 4 -
Anthocoris nemoralis	Application Adult Nymph Persistence	spraying 4 4 1 w

Pesticides and BCA's



		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying 2 5 d
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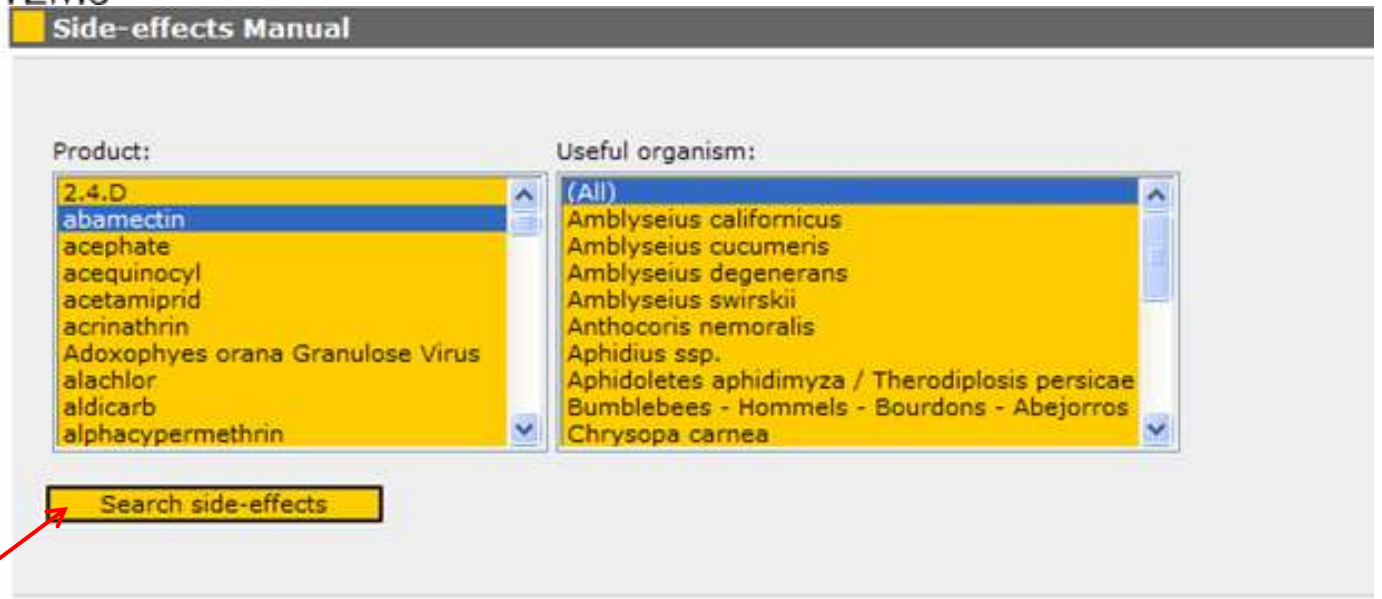
Anthocoris nemoralis	Application Adult Nymph Persistence	spraying 4 4 1 w

Pesticides and BCA's



3rd– Click here for results

		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying 2 5 d
Amblyseius degenerans	Application Nymph/Adult Persistence	spraying 4 1 w
Amblyseius swirskii	Application Nymph/Adult Persistence	spraying 4 -
Anthocoris nemoralis	Application Adult Nymph Persistence	spraying 4 4 1 w

Pesticides and BCA's

Type of application tested

		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying - 5 d
Amblyseius degenerans	Application Nymph/Adult Persistence	spraying 4 1 w
Amblyseius swirskii	Application Nymph/Adult Persistence	spraying 4 -
Anthocoris nemoralis	Application Adult Nymph	spraying 4 4

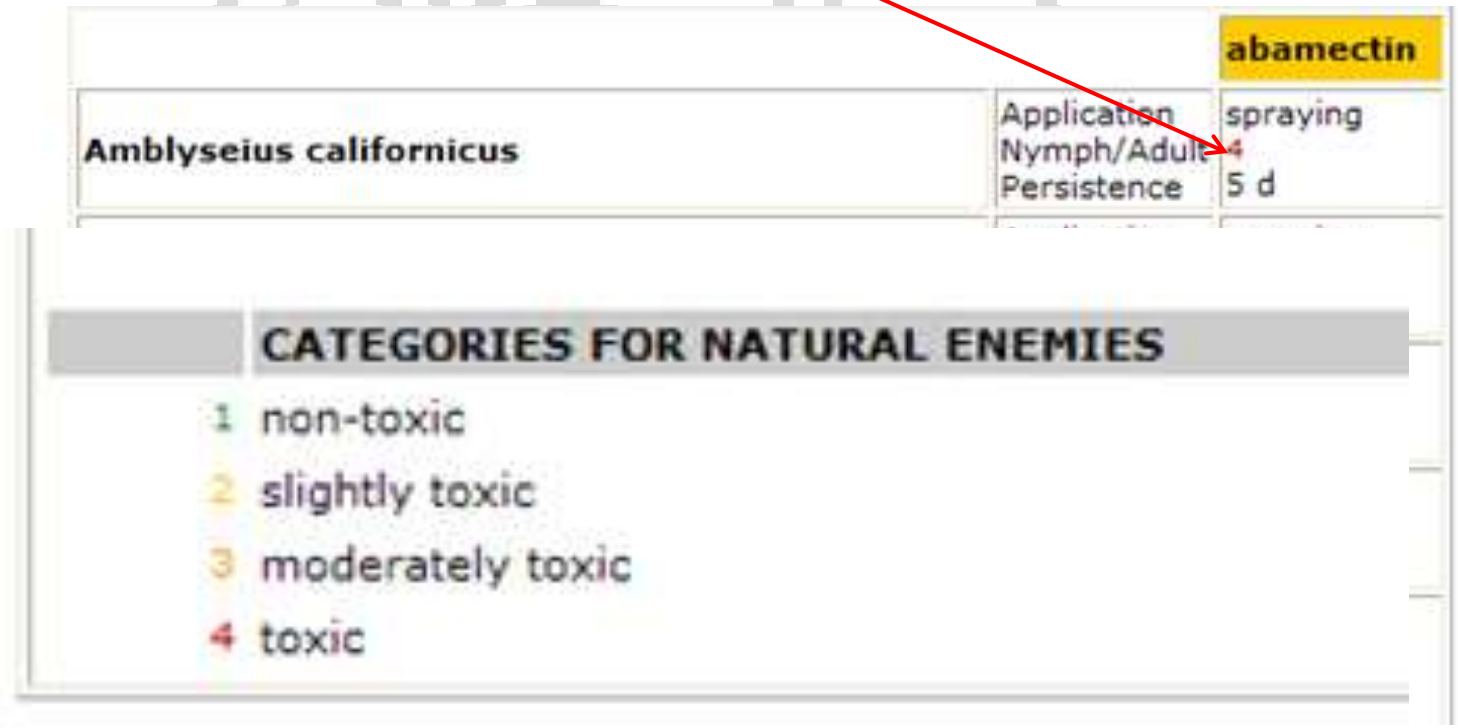
Pesticides and BCA's

Level of toxicity

		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying 5 d
Amblyseius degenerans	Application Nymph/Adult Persistence	spraying 4 1 w
Amblyseius swirskii	Application Nymph/Adult Persistence	spraying 4 -
Anthocoris nemoralis	Application Adult Nymph	spraying 4 4

Pesticides and BCA's

Level of toxicity



		abamectin
Amblyseius californicus	Application	spraying
	Nymph/Adult	4
	Persistence	5 d

	CATEGORIES FOR NATURAL ENEMIES
1	non-toxic
2	slightly toxic
3	moderately toxic
4	toxic

Pesticides and BCA's

Persistence of toxicity

		abamectin
Amblyseius californicus	Application Nymph/Adult Persistence	spraying 4 5 d
Amblyseius cucumeris	Application Nymph/Adult Persistence	spraying 5 d
Amblyseius degenerans	Application Nymph/Adult Persistence	spraying 4 1 w
Amblyseius swirskii	Application Nymph/Adult Persistence	spraying 4 -
Anthocoris nemoralis	Application Adult Nymph	spraying 4 4

Side-Effects – Some recent work! (2009)

Amblyseius swirskii → a newer BCA on the block.....

Amblyseius swirskii Residue trial

- **Application on population**

		Mortality (%Abbott) on Residue of ... Days						
		0	1	3	7	14	21	28
Tracer (Conserve/Success)	spinosad	96	100	100	100	75	79	78
	IOBC	4	4	4	4	3	4	4
Vertimec (Avid)	abamectin	96	100	100	100	92	75	78
	IOBC	4	4	4	4	4	3	4
Talstar	bifenthrin	100	100	100	100	100	100	96
	IOBC	4	4	4	4	4	4	4

Pesticides and BCA's

What can happen with 'IPM compatible' pesticides:

- **A pesticide product can be safe for some BCA's you use, but not for others that you also use → could create an snowball effect → compounds problems**
- **For example conserve (spinosad) is a category 1 product for the predatory mites *Amblyseius calfornicus*, *Amblyseius cucumeris*, *Phytoseiulus persimilis*, but not as compatibe to use to use for *Amblyseius swirskii*, the whitefly parasites *Encarsia* and *Eretmocerus spp*, and *Orius*. The result of a full house application of a product such as this could be ok for the TSSM control, but the thrips control could be affected negatively, and the whitefly control will be affected for sure if this would be in a whitefly susceptible crop.**

Pesticides and BCA's

What can happen with 'IPM compatible' pesticides:

- **Another example is Floramite. This product is often used as a safe compatible product, but……it does affect *Phytoseiulus persimilis* (category 2 products + 1 week residual), *Amblyseius swirskii* (category 3 products), *Aphidius spp* (category 3) and *Aphidoletes aphidimyza* (category 4 product) → so when TSSM is an issue and the BCA's above are used you could reduce the TSSM population, but at the same time also reduce *Phytoseiulus persimilis* numbers, reduce *Amblyseius swirskii* numbers which could results a few weeks later in Thrips and Whitefly outbreaks, and significantly impact aphid control…..as both *Aphidius spp* and *Aphidoletes* are negatively affected!**

Pesticides and BCA's

What can happen with 'IPM compatible' pesticides:

- **Another example: Imidacloprid through the irrigation system is much safer for BCA's than a foliar application. Applied systemically it is compatible with *Amblyseius cucumeris* and *A. californicus*, is a category 2 for *Phytoseiulus*, and it is also a category 2 product for both *Orius* adults and nymphs plus a week residual. Hydroponic pepper growers who have used imidacloprid in the past have experienced that their *Orius* population decreases by approximately 50 – 60 %. Approximately 3 weeks after application they experience typically a looper/caterpillar outbreak and in some cases results in a thrips outbreak (especially thrips species not affected by *Amblyseius* spp.) This is a result as *Orius*, when the population is established also feeds on moth eggs.**

Pesticides and BCA's

What can happen with 'IPM compatible' pesticides:

- **A strategy is as strong as the weakest link**
- **Any full house treatment with a pesticide can disturb the overall strength of the system/strategy!**
- **There are very few pesticides that are truly completely compatible to an overall pest management strategy with multiple BCA's in the system.**

5) Develop a solid scouting/monitoring system for your facility

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Monitoring & Scouting

- **Should be implemented in any solid pest management system**
- **ONLY WAY to monitor pest levels and pest populations**
- **Key to prevent problems from happening (early warning system)**
- **10 sticky cards per acre (10 by 25 cm) is sufficient**
- **Consistent system important → remove cards from the greenhouse the same day each week. Replacing more efficient then marking the cards**
- **Process the data collected with computer software (Excel sheets available)**

Monitoring & Scouting

Monitoring data

Monitoring Overview

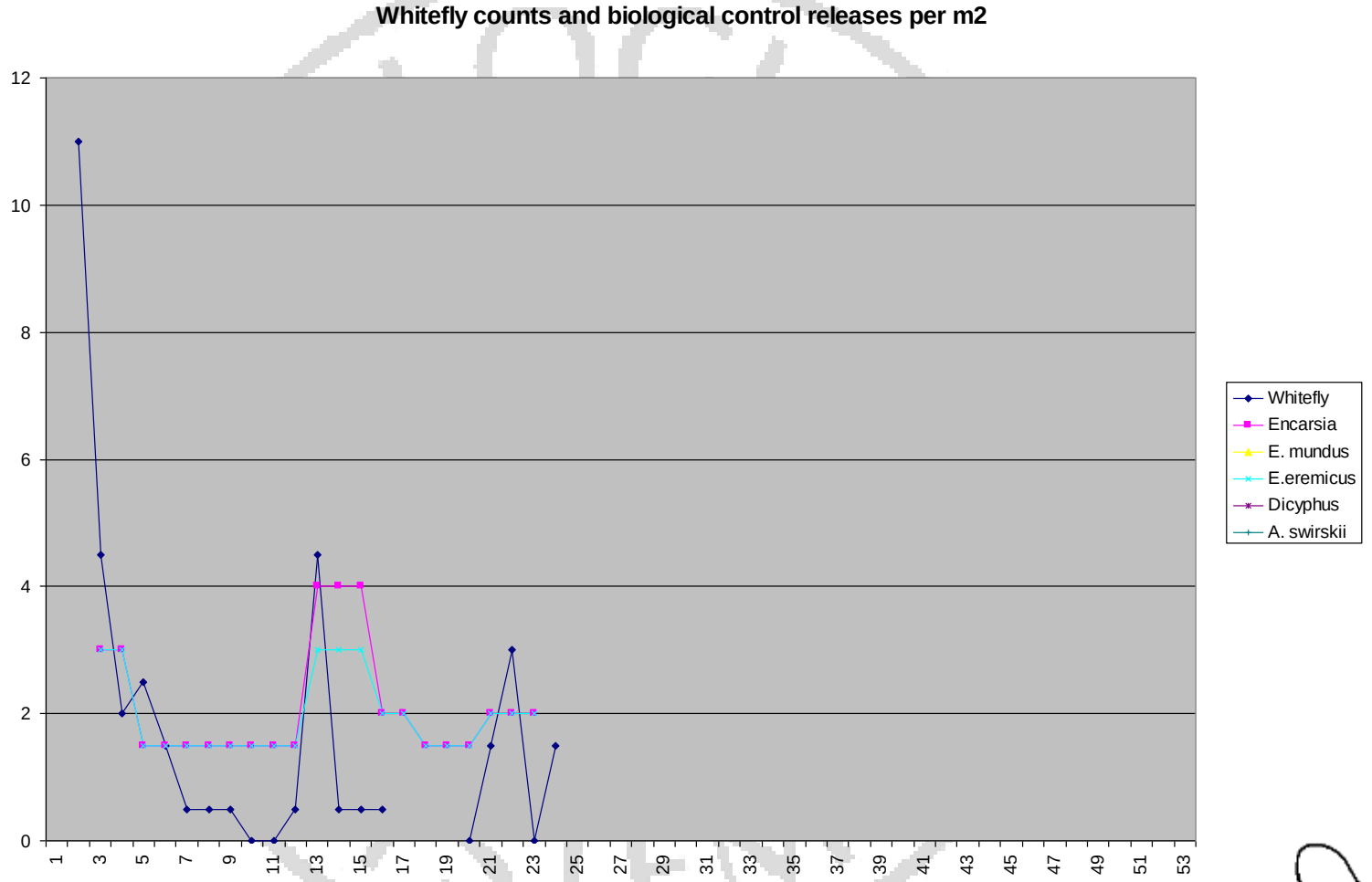
BIOBEST CANADA LTD.

Company name: Smits GH	**Zone/compartment: 1**	**Size: 4000** m2 / Sq.F	**Crop(s): Poinsettia**
Date:	**Week #:**	**# of Sticky cards in zone:** 10	**Employee name: Joe**

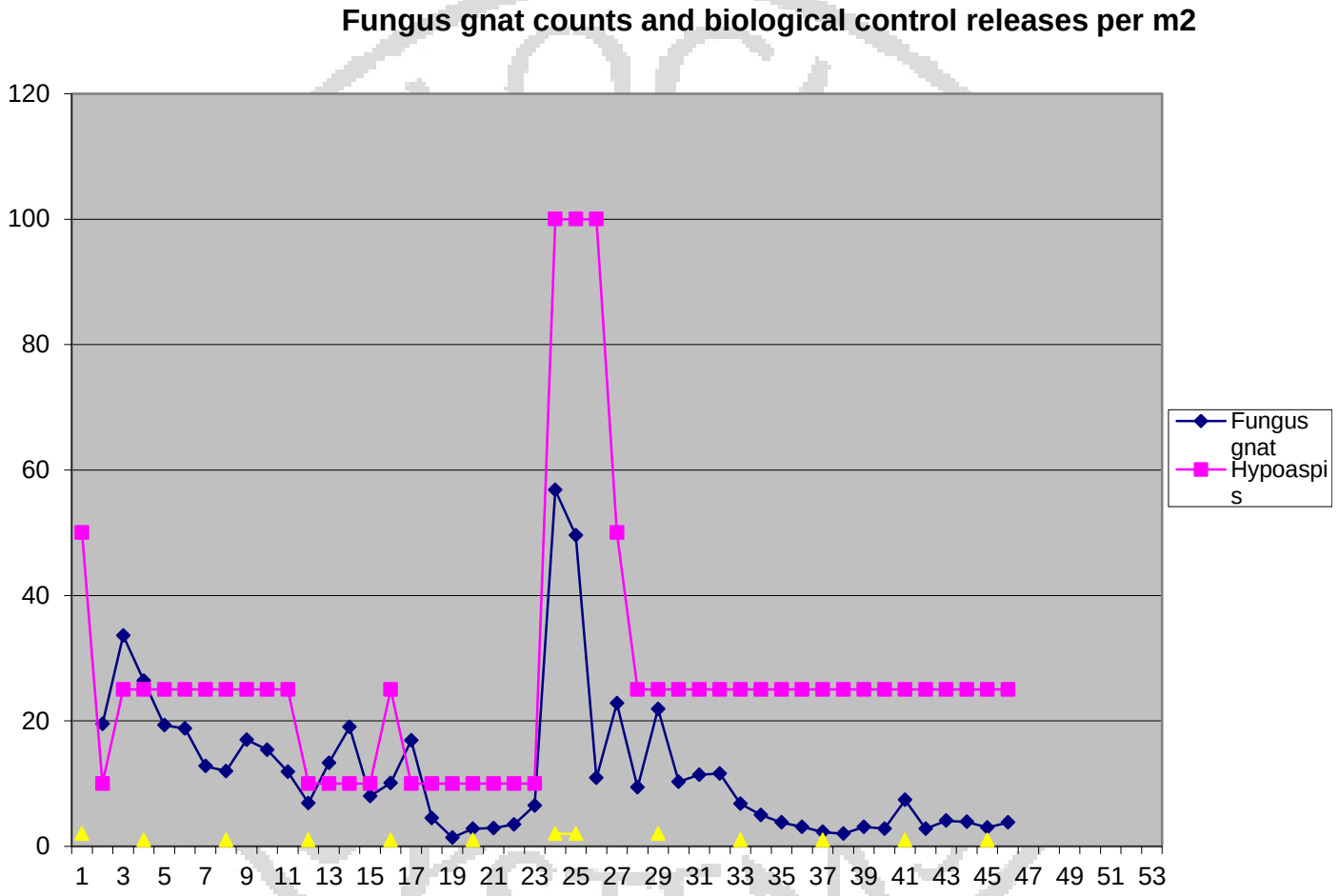
	Sticky Cards																									
Pest	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**Average**
Whitefly																										**0.0**
Thrips																										**0.0**
Aphid (winged)																										**0.0**
Fungus gnat																										**0.0**
Shore fly																										**0.0**
Lygus																										**0.0**
Leafminer																										**0.0**
Other:																										**0.0**
Biologicals	(A = Absent P = Present)																									
Encarsia																										
Eretmocerus																										
Orius																										
Aphidius																										
Conosia																										
Other:																										
Other:																										
Visual crop monitoring (inspect plants for presence of pest and or biologicals)																										
Spider Mite:																										
Aphid:																										
Other:																										
Other:																										
Other:																										

Notes:	1) To obtain the best possible information it is recommended to use 10 bug scan yellow sticky cards (10 x 15 cm) per acre as a minimum.
	2) For pest section, count the # of each individual pest on each stick card. Make sure that the # of sticky cards is filled out in yellow cell.
	3) For monitoring biologicals, the actual number can be recorded. However, just P (present) or A (absent) can be sufficient information.
	4) Monitoring with sticky cards is important information in IPM. However, make sure the crop is inspected for pest and biologicals as well.

Monitoring data



Monitoring data



6) Develop a plan for the transition period

7) Set a date for starting your pest management program that includes BCA's

Transition period

- **If you have used pesticides with a long residual effect → give yourself lots of time → up to 16 weeks**

In the transition period you cane use products that:

- **Are not compatible with BCA's, but have a short residual effect (less then 2 weeks on the most important BCA's) → examples are Avid, Marathon, Tristar, Safari, Sanmite.**
- **Products that are 'compatible' with BCA's and have a short residual effect such as → Floramite, Endeavor, Distance, Judo**
- **Prefer the first group to apply resistance management with the 'compatible' products**

Starting your new program

Never start a biological control program in the middle of a growing season, for example:

- **Poinsettia growers should not start in September introducing BCA's, but immediately when the crops starts, in June/July**
- **It is too risky to start releasing BCA's late March or early April in a spring crop!!**

Key is to match the start of a BCA program with the start of a new season

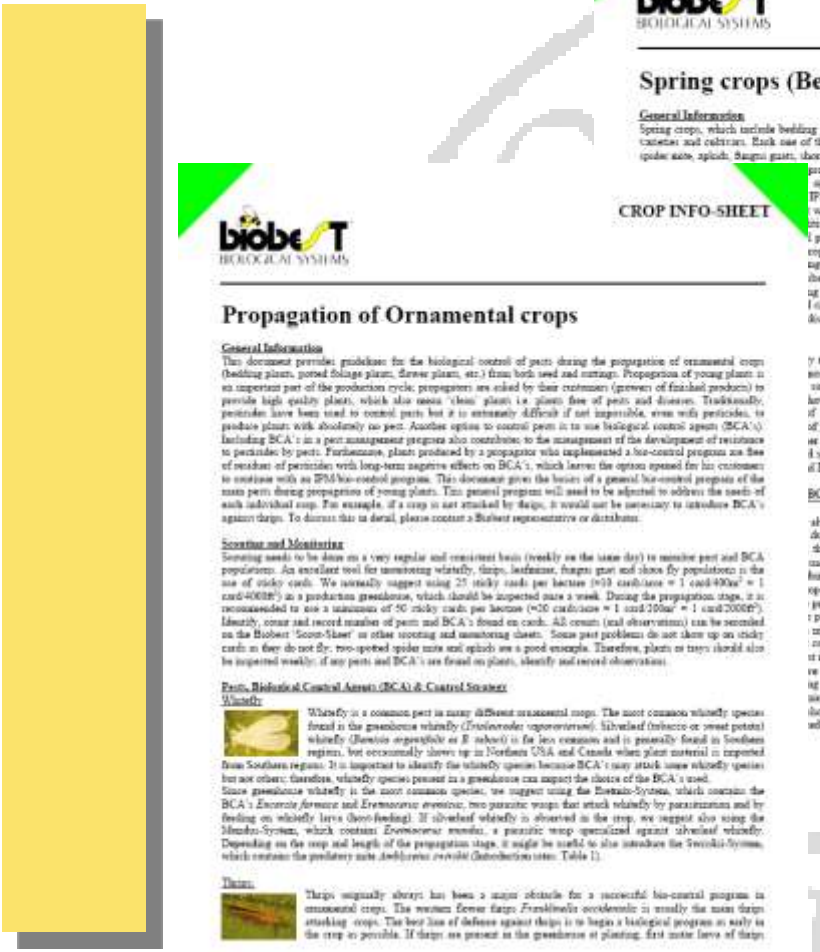
Exceptions are year round cut flower growers or potted plant growers → choose the time of the year with the least pest pressure to start

8) Develop a pest management strategy that fits your operation and the crops you grow!

Develop a strategy?

- This is the heart of your pest management program and the PRO-ACTIVE & PLANNING part of the 'PPM' approach
- Guideline (crop-info sheets) available for several crops. However there is no 'one fit for all' strategy as the ornamental industry is very diversified (poinsettia might be the exception)
- Strongly consider using banker and trap plants!!
- Develop a strategy that fits your operation
- Use your production planning as a guide
- Many of the BCA's are introduced preventive and early (immediately after planting) → plan your BCA introduction accordingly.

BIOLOGICAL SYSTEMS



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 means '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 propagations 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 using 25 sticky cards per hectare (=10 cards/acre = 1 card/400m² = 1 card/4000ft²) as a production greenhouse, which should be inspected once a week. During the propagation stage, it is recommended to use a minimum of 50 sticky cards per hectare (=20 cards/acre = 1 card/200m² = 1 card/2000ft²). 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 do not show up on sticky cards as they do not fly; two-spotted spider mite and aphids are a good example. 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 Encarsia-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 *Frankliniella occidentalis* is usually the main thrips attacking crops. The best line of defence against thrips is to begin a biological program as early as the crop as possible. If thrips are present in the greenhouse at planting, first instar larva of thrips

BIOLOGICAL SYSTEMS

CROP

Spring crops (Bedding Plants & Hanging B

General Information

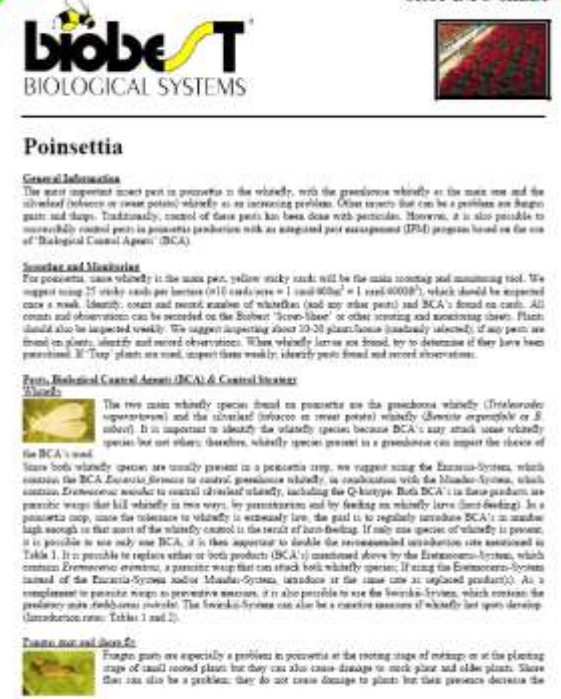
Spring crops, which include bedding plants and hanging baskets represented by a very diverse n
cucumis and cultivars. Each one of these crops can be sensitive to one or many of a variety of
spider mite, aphids, fungus gnats, thorsflies, whitefly and leafminers. With this in mind, the easiest
program is to have a pro-active approach with mostly preven
against the most common pest. Furthermore, it is a good
IPM technical support person. For example, if you know that a
would then be good idea to use a higher rate of thrips predat
ritional pest management program and an IPM/bio-control pro
l program versus a pro-active approach on the IPM bio-contr
rogram often comment that it has reduced them of sprays a
ng and rates, when they really don't have time for anything el
ibes standard guidelines for the use of bio-control agents in a
ng plants and hanging baskets. This general program will ne
l crop. For example, if a crop is not attacked by thrips, it would
discuss this in detail, please contact a Biobest representative or

y regular and consistent basis (weekly on the same day) to m
monitoring whitefly, thrips, leafminer, fungus gnat and shore fl
suggest using 25 sticky cards per hectare (=10 cards/acre =
leaves, which should be inspected once a week. During the pr
of 50 sticky cards per hectare (=20 cards/acre = 1 card/200m
of pests and BCA's found on cards. All counts (and observa
er scouting and monitoring sheets. Some pest problems do n
d spider mite and aphids are a good example. Therefore, plant
d BCA's are found on plants, identify and record observations.

BCA) & Control Strategy

always has been a major obstacle for a successful bio-contr
during the first phase of the crop when plants start to flower as most crops, wasp
the pollen available is a very attractive food source for adult thrips, and thrips
suddenly increase, which can result in serious damage to flowers; this is often the
during the winter and spring. The western flower thrips *Frankliniella occidentalis* is
opic. The best line of defence against thrips is to begin a biological program as early
present in the greenhouse at planting. first instar larva of thrips could be curveling
planting; first instar thrips larva is the stage causing most of the damage. The first
most sensitive to the attack of the BCA contained in the Amblyseius-Breeding-
cucumeris); the main product used against thrips. The basis of thrips control is to
st instar larva from reaching later stages, which are more difficult to control thrips.
re recommend to start the bio-control program as soon as the plants are planted in
ng basket. We suggest introducing the Amblyseius-Breeding-System as a small
sheet or hanging basket); the breeder pile will release *Amblyseius cucumeris* for a
should be repeated every 4 to 6 weeks. In cases where plants are stuck in trays that
ed afterwards), it is recommended to introduce one breeder pile per tray. Overhead

CROP INFO-SHEET



BIOLOGICAL SYSTEMS

CROP INFO-SHEET

Poinsettia

General Information

The most important insect pest in poinsettia is the whitefly, with the greenhouse whitefly as the main one and the silverleaf (tobacco or sweet potato) whitefly as an increasing problem. Other insects that can be a problem are fungus gnats and thrips. Traditionally, control of these pests has been done with pesticides. However, it is also possible to successfully control pests in poinsettia production with an integrated pest management (IPM) program based on the use of 'Biological Control Agents' (BCA).

Scouting and Monitoring

For poinsettia, since whitefly is the main pest, yellow sticky cards will be the main scouting and monitoring tool. We suggest using 25 sticky cards per hectare (=10 cards/acre = 1 card/400m² = 1 card/4000ft²), which should be inspected once a week. Identify, count and record number of whiteflies (and any other 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. Plants should also be inspected weekly. We suggest inspecting about 10-20 plants/acres (randomly selected); if any pests are found on plants, identify and record observations. When whitefly larvae are found, try to determine if they have been parasitized. If 'Tan' plants are used, inspect them weekly; identify pests found and record observations.

Pests, Biological Control Agents (BCA) & Control Strategy

Whitefly

The two main whitefly species found on poinsettia are the greenhouse whitefly (*Trialeurodes vaporariorum*) and the silverleaf (tobacco or sweet potato) whitefly (*Bemisia argentifolii* or *B. tabaci*). 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 both whitefly species are usually present in a poinsettia crop, we suggest using the Encarsia-System, which contains the BCA *Encarsia formosa* to control greenhouse whitefly, in combination with the Mundus-System, which contains *Eretmocerus mundus* to control silverleaf whitefly, including the Q-biotype. Both BCA's in these products are parasitic wasps that kill whitefly in two ways; by parasitization and by feeding on whitefly larva (host-feeding). In a poinsettia crop, since the tolerance to whitefly is extremely low, the goal is to regularly introduce BCA's in number high enough so that most of the whitefly control is the result of host-feeding. If only one species of whitefly is present, it is possible to use only one BCA; it is then important to double the recommended introduction rate mentioned in Table 1. It is possible to replace either or both products (BCA's) mentioned above by the Eretmocerus-System, which contains *Eretmocerus eremicus*, a parasitic wasp that can attack both whitefly species. If using the Eretmocerus-System instead of the Encarsia-System and/or Mundus-System, introduce at the same rate as replaced product(s). As a complement to parasitic wasps in preventive measure, it is also possible to use the Swirskii-System, which contains the predatory mite *Amblyseius swirskii*. The Swirskii-System can also be a curative measure if whitefly hot spots develop. (Introduction rates: Tables 1 and 2).

Fungus gnat and shore fly

Fungus gnats are especially a problem in poinsettia at the rooting stage of cuttings or at the planting stage of small rooted plants but they can also cause damage to mark plant and older plants. Shore flies can also be a problem; they do not cause damage to plants but their presence decreases the

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BIOLOGICAL SYSTEMS

Poinsettia

Table 1: Preventive introduction of BCA's against pests of poinsettia.

Pest	Product (BCA)	Introduction rate	Timing	Application
	Use the first two products in combination; use of third product is optional			
Whitefly	Encarsia-System (Encarsia formosa)	3/m²	Weekly, start as early as possible	Hang card on pot rim
	Mundus-System (Eretmocerus mundus)	4/m²	Weekly, start as early as possible	Hang card on pot rim
	Swirskii-System (Amblyseius swirskii)	50 A. swirskii/m²	Once on rooted cuttings before transplanting and once before first spacing	Sprinkle on plants
	Use following two products in combination			
Fungus gnats & shore flies	Hypoaspis-System (Hypoaspis miles)	If starting with rooted cuttings, 150/m² at planting. If starting with unrooted cuttings, 100/m² when sticking cuttings + 50/m² after transplanting cuttings.		Sprinkle on soil
	Atheta-System (Atheta coriaria)	If starting with rooted cuttings, 2/m² at planting. If starting with unrooted cuttings, 1/m² when sticking cuttings + 1/m² after transplanting cuttings.		Sprinkle on soil

For all products, introduction rates are based on the area occupied at the time of the introduction. N.B.: 1 m² = 10 ft².

Table 2: Curative introduction of BCA's against pests of poinsettia.

Pest	Product (BCA)	Introduction rate	Timing	Application
	Use one of the following two products			
Whitefly	Swirskii-Breeding-System (Amblyseius swirskii)	1 sachet/m² (if plants touching)	As needed	Hang sachet on plants
	Swirskii-System (Amblyseius swirskii)	100 A. swirskii/m²	As needed	Sprinkle on plants
Fungus gnats	Steinernema-System (Steinernema feltiae)	1000000/m² or 10000/pot	As needed	Drip or drench on soil
Thrips	Steinernema-System (Steinernema feltiae)	250000/m²	Weekly for at least 3 weeks	Spray foliage

For all products, introduction rates are based on the area occupied at the time of the introduction. N.B.: 1 m² = 10 ft².

So how does this work in the real World ?

OVW greenhouses, Pompton Plains, NJ implementing BCA in their pest management strategy
8 acres (5 indoors, 3 outdoors)

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OVW – How do they do it?

- Decision to implement BCA's was made based on poor results with their traditional approach especially on TSSM and Thrips in 2006
- Started planning and developing a strategy in September 2006 to start a pest management program in December of that year
- Decided to use banker and trap plant systems
- Head grower planned introduction of BCA based on production planning
- Succeeded in the first year with only two small spot sprays for aphids with a compatible pesticide (less than 1000 sq. feet)
- Complete story, GM Pro February by Suzanne Wainwright - Evans

OVW – Strategy & Planning?

2008 Bug Control OVW planning

Week	A. cucumeris	Hypoaspis	Atheta	Orius	Aphidius	A. Swirskii
43(10-22)		50,000	1000			
47(11-19)		125,000	1000		1 aphid banker	
52(12-24)	400,000	250,000	3000			
2(1-7)	400,000	250,000	1000			
3		125,000				
4(1-21)		125,000	3000			
5		125,000				
6(2-4)		250,000	3000			
7	300,000	250,000				
8(2-18)	400,000	250,000	3000			
9		250,000				
10(3-3)	200,000	250,000	3000			
11		250,000				
12(3-17)	200,000	250,000	3000			
13		250,000				
14(3-31)	300,000	250,000				
15		125,000				
16(4-14)	200,000	125,000				
23(6-2)	700,000	500,000	3000			
25(6-16)	500,000	375,000	3000			
27(6-30)	500,000	250,000	3000			
29(7-14)	500,000	125,000	3000			
30(7-21)	500,000	125,000				
	$2,193	$4,095	$2,805			

- **BCA use planned based on production planning**
- **Fine tune where necessary ‘on the go’**
- **Some pest problems, like TSSM, are released when detected, so not in planning**
- **PRO-ACTIVE & PLANNING**

Bio-control in Action

Start releasing BCA early on in the crop

Bio-control in Action

Monitoring important!

Bio-control in Action

Aphid banker plants:

Bio-control in Action

Pepper plants to establish and support Orius:

Bio-control in Action

Bean trap plant for Two Spotted Spider Mite:

Bio-control in Action

Plants with Orius also used outside:

IMPORTANT to NOTE:

- **Consider using banker and trap plants → this re-creates sustainability of some of the BCA's used, which is missing compared to the greenhouse vegetable growers!**
- **Use BCA's as your first line of defense for all your pest problems!!! Only when there is no option, consider a 'compatible' pesticide and if possible, apply spot sprays**

Why:

- **Example of Endeavor and *Orius*, Floramite and *Amblyseius swirskii***
- **Strategy is as strong as the weakest link!**

9) Importance of Propagation

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What is a ‘clean’ plant?

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‘Clean’ propagation?

- History in the greenhouse vegetable industry
- Vegetable growers experienced young plants coming in from propagators with pest problems (especially whitefly and thrips)
- Growers pressure propagators to deliver a ‘clean’ plant (meaning NO insects or mites)
- Propagators response → heavy pesticide program (including non selective pesticides)
- Plants would still arrive with (lower) pest levels, but with difficult residuals of pesticides = long residual effects on BCA’s
- Main reason why growers had disappointing results implementing BCA’s

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‘Clean’ propagation?

- **Current situation → Vegetable propagators are now using BCA’s and selective, compatible, short residual pesticides**
- **Many vegetable propagators supply customers with a ‘plant report’ that includes pest management information**
- **Vegetable grower can start their pest management program with BCA’s immediately**

What is a ‘clean’ cutting?

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‘Clean’ propagation and ornamentals

- Many cuttings and propagation materials are coming in from outside the country
- In many situations, cuttings do have pest(s) present in higher or lower levels. Poinsettia → whitefly, Chrysanthemum and spring bedding plant → Thrips and others
- Lots of guess work on pesticides that have been applied on stock plants, rooted or unrooted cuttings at breeders and propagators
- Some pesticides such as Orthene or Thiodan have a long negative residual effect on BCA’s
- Heavy pesticide use in propagation can lead to problems with resistance of pesticides → growers are ‘stuck’ with resistant pest problem(s)

Worst situation:

Plants/cuttings that come in with long residual pesticide residues AND still carry (possibly resistant) pest problems!

This makes any pest management program started difficult, but is a disaster for those growers whom are using BCA's as part of their pest management program

‘Clean’ propagation and ornamentals

Propagation

- Propagation that includes (frequently applied) pesticides does not guarantee that the young plants/cuttings are free of insects and mites.
- Propagators using long residual pesticides leave very limited OPTIONS for their customers, the growers, to implement BCA’s.
- Propagators using selective short residual pesticides and/or BCA’s, leave the option to the grower, their customer, to either use a traditional pest management program OR a program that includes BCA’s

‘Clean’ propagation and ornamentals

What can we do as an industry to improve ‘clean’ cuttings and young plants?

- **Growers acceptance/tolerance of the fact that some (low) level of pest is to be expected to be present on young plant material and cuttings**
- **Breeders and propagators adapt to pest management practices that do not use long residual pesticides, include rotation of pesticides (minimize resistance development), minimize pesticide use, and implement BCA’s**
- **Communication between breeders/propagators and growers (plant report? Develop an industry standard?)**

Cuttings and propagation

Incoming plant material: What can we do to minimize input of unwanted guests?:

- **Inspect the product BEFORE bringing it into the greenhouse or place where you are planting → check in warehouse as you then can still avoid bringing it in**
- **Pro-actively → dip / submerge rooted or unrooted cuttings in a nematode solution (*Steinernema spp*) and / or *Beauveria bassiana* (Botanigard)**
- **Be aware of risk of spreading disease problems when dipping. Avoid this technique with susceptible plant material and apply as sprench after sticking/planting.**

Dipping & sprenching

BCA's in action in propagation

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BCA's in action in stock plants

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BCA's in action in stock plants

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BCA's in action in propagation

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IMPORTANT:
Communication between breeders/propagators and growers allows to plan and execute a solid pest management strategy that is successful for all involved!

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10) Don’t give up, even if a first attempt is difficult

Conclusion:

If you are considering implementing BCA's:

- **Start planning a strategy early (months ahead)**
- **Review the pesticides you are currently using**
- **Bio control is a pro active approach and needs to be executed consistently → talk with your supplier**
- **Include banker and trap plants where possible**
- **Look at the complete pest picture. Best results are achieved with minimal pesticide (even 'compatible' products) interference. If needed, try spot application if possible.**
- **Propagation and incoming plant material can have an impact on overall results → communicate with your suppliers / propagators / breeders**

2010 Bio-Control Tech meeting!

January 3, 2011

'Bug' people meeting
– talking about bugs!

Questions and discussion….

Thank you!

Biobest says thanks to:
Orie van Wingerden (OVW) Greenhouses, Pompton Plains, NJ
Micheal's Greenhouses, Cheshire, CT.
Grower Direct Farms, Somers, CT
Peace Tree Farms, Kintnersville, PA
Cavicchio's, Sudbury, MA
Harster Greenhouses, Flamborough, Ontario, Canada
and all other growers who have documented their experience with pictures

January 3, 2011

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