

In 2016, 69% of Canadian greenhouses use biocontrol for insects and 45% for pathogens.



**March 17, 2022, IPM and Biocontrol in greenhouses, nurseries, and hoop houses for MDA recertification credit, MLA certification, and general learning**

Since 2015 our yearly workshop on IPM and Biocontrol in greenhouses and hoop houses discusses pesticide safety and IPM and BC programs for specific insect and pathogen pests. Biocontrol agents for greenhouses and hoop houses can be successfully used to control pests to decrease pesticide use and improve worker safety. Live insects and pathogens can be purchased online from many different businesses that rear biocontrol agents for release. Registration can be found at [MNLA](http://mnl.org), [MN Nursery and Landscape Association](http://mnl.org), under education events at [mnl.org](http://mnl.org) starting in Jan 2022, contact Gwendolen Nystrom, [gwendolen@mnl.org](mailto:gwendolen@mnl.org) or Vera Krischik, [krischik001@umn.edu](mailto:krischik001@umn.edu) for more information

**March 17 2022 schedule for BC IPM Workshop, Midland Hills CC, hot buffet lunch**

- 8:00-9:00 MN Depart Ag, Certification information, Brian Clarke
- 9:00-9:30 Greenhouse, western flower, and chilli thrips and banker plants for Orius: ID, BC, insecticides, and management, VK UM
- 9:30-10:00 Review of IPM thresholds and management for foliar diseases, Carter Kent, Bioworks
- 10:00-10:30 Rome, Italy is besieged with pine tortoise scale from the US: Sale insects and management, Vera Krischik UM
- 10:30-11:30 EPA registered insecticides and compatibility with biocontrols, Julie Graesch, Bioworks
- 11:30-12:00 Hot Buffet Lunch
- 12:00-12:30 Growers forum, questions and learning experiences; Why use biocontrol, safety or cost efficiency???
- 12:30-1:00 Case study with thrips and releasing BC, Heidi Doering Koppert
- 1:00-1:30 Introduction to greenhouse pests and biocontrol agents, Marissa Shuh, UM Regional Ext, Farmington, MN
- 1:30-2:00 Pesticide storage practices, Jolene Hendrix, UM
- 2:00-2:30 Steps in implementing an IPM program, preventative and rescue treatments, Rachel Sporer, Biobest
- 2:30-3:00 Installing bumblebees and implementing pollinator friendly management, Vera Krischik UM
- 3:00-3:30 Fill out survey and MDA forms

**Program speakers and participants**

Brian Clarke, MDA; Gwendolen Nystrom, MNLA; Heidi Doering, Koppert biocontrol, MI; Carter Kent, Bioworks, NY; Julie Graesch, Bioworks, NY; Adam Nuell, Carlin Sales, MN; Vera Krischik, Entomology, UM; Jolene Hendrix, Pesticide Safety, UM; Marissa Schuh, IPM, Extension Educator UM; Rachel Sporer, Biobest; Krischiklab websites related to IPM, <https://ncipmhort.cfans.umn.edu/> and <http://pesticidecert.cfans.umn.edu/>

ABOVE AND BEYOND IS WHERE WE BEGIN



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# EPA REGISTERED INSECTICIDES & COMPATIBILITY WITH BIOCONTROLS

**Julie Graesch,**  
**Biological Program Manager**  
[jgraesch@bioworksinc.com](mailto:jgraesch@bioworksinc.com)



**BioWorks®**

## PRESENTATION OVERVIEW

- The IPM toolbox
- Pesticides, pollinator safety and market trends
- Compatibility:
  - Biopesticide
  - Natural enemy
- Integrated IPM programs

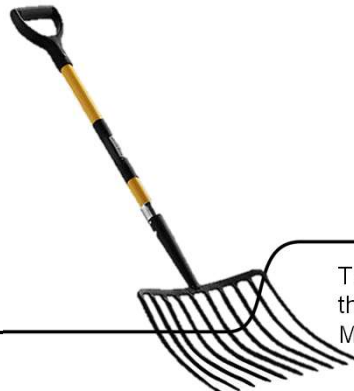
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# COMPONENTS OF A BIOLOGICAL PROGRAM

## Biological Program = Preventative Programs

- Scouting and monitoring
- Sanitation
  - Clean up crop residues, disinfect benches, flood tables, drip lines, etc.
- Exclusion
  - Screen vents, know where/why hot spots occur
- Cultural
  - Mass trapping
  - Irrigation and fertilization



## • Biopesticides

- Entomopathogenic nematodes & fungus, Oils, soaps, naturally derived pesticides

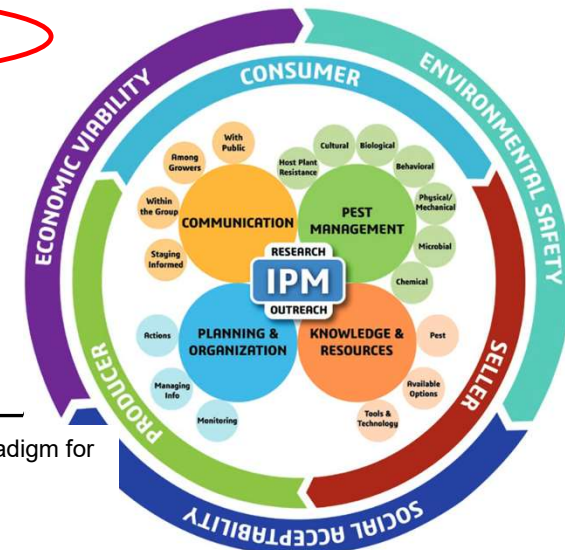
## • Natural enemies (predators & parasitoids)

- Depends on insect species and severity

## • Chemical insecticides

- As needed

The New Integrated Pest Management Paradigm for the Modern Age, Journal of Integrated Pest Management, (2019) 10(1): 12; 1-9



# IPM = PITCHFORK APPROACH

- IPM ≠ no insecticides
  - Timing/intelligent use
    - Prevent pest resistance
    - Preserve natural enemies/pollinators
- Programs:
  1. Biopesticide & pesticide program
  2. Natural enemy & biopesticide/pesticide
    - Compatibility important

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**PESTICIDES,  
POLLINATOR SAFETY,  
& MARKET TRENDS**

# CONVENTIONAL INSECTICIDE MANAGEMENT

**Insecticides** (rotate across MOAs to avoid resistance)

## Ornamental Crops

Apply as foliar sprays at label rates and intervals.

- MOA 4A – Flagship 25WG, Safari 20 SG, TriStar 8.5 SL
- MOA 4C & 5 – XXpire WG (will not control the Q-biotype)
- MOA 7A – Enstar AQ
- MOA 7C – Distance (will not control the Q-biotype), Fulcrum (will not control the Q-biotype)
- MOA 9B – Endeavor (suppression only), Rycar (not for outdoor use)
- MOA 15 – Pedestal (avoid use on poinsettias)
- MOA 16 – Talus DF (will not control the Q-biotype)
- MOA 21A – Hachi-Hachi SC (suppression only, see label for phyto cautions), Sanmite (will not control the Q-biotype)
- MOA 23 – Judo (see label for phyto cautions), Kontos (see label for phyto cautions)
- MOA 29 – Aria (suppression only)
- MOA UN tank mixes – BotaniGard, Mycotrol ESO, Preferal, SuffOil-X or Ultra-Pure Oil tank mixed with AzaGuard, Azatin O or Molt-X

Apply as media drenches at label rates and intervals.

- MOA 4A – Flagship 25WG, Safari 20 SG
- MOA 23 – Kontos (see label for phyto cautions)

**Edible Crops** (review product labels for approved crops, some labels allow transplants only)

Apply as foliar sprays at label rates and intervals.

- MOA 4A – Flagship 25WG, Safari 20 SG, TriStar 8.5 SL
- MOA 7C – Distance (will not control the Q-biotype)
- MOA 9B – Fulfill (suppression only)
- MOA 16 – Talus DF (will not control the Q-biotype)
- MOA 23 – Kontos
- MOA UN tank mixes – BotaniGard, Mycotrol ESO, Preferal, SuffOil-X or Ultra-Pure Oil tank mixed with AzaGuard, Azatin O or Molt-X

Apply as media drenches at label rates and intervals.

- MOA 4A – TriStar 8.5 SL (tomato only)
- MOA 23 – Kontos

From: Technical Reference Guide For Greenhouses and Nurseries, GGS Pro

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# COMMON PESTS AND THEIR NATURAL ENEMIES

- **Thrips**

- *Orius insidiosus*
- *Amblyseius cucumeris*
- *Amblyseius swirskii*
- *Stratiolaelaps scimitus*
- *Dalotia coriaria*
- *Steinernema feltiae*

- **Aphids**

- *Aphidius colemani*
- *Aphidius ervi*
- *Aphidius matricariae*
- *Aphelinus abdominalis*
- *Aphidoletes aphidimyza*
- *Chrysoperla rufilabris*

- **Whitefly**

- *Encarsia formosa*
- *Eretmocerus eremicus*
- *Amblyseius swirskii*
- *Dicyphus hesperus*
- *Delphastus catalinae*

- **Mites** (spider, broad)

- *Amblyseius cucumeris*
- *Amblyseius californicus*
- *Amblyseius andersoni*
- *Amblyseius swirskii*
- *Phytoseiulus persimilis*

- **Fungus gnats**

- *Steinernema feltiae*
- *Dalotia coriaria*
- *Stratiolaelaps scimitus*

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# MARKET TRENDS

## All Three Categories of Biologicals are Rapidly Growing

\$3.5B (17% CAGR)

**Biopesticides  
Biocontrol  
Bioprotection**



\$2.5B (13% CAGR)

**Biostimulants**  
*Crop Enhancement  
Stress Reduction*



\$1.6B (13% CAGR)

**Biofertilizers  
Bionutrients**



## Biologicals Could Equal Chemicals in ~20 Years!

Source:  
Shane Thomas,  
Upstream Insights

Growth rate (CAGR)	12 %
Number of periods	<b>Biologicals</b> 21
Initial value	10,600,000,000 \$
Final value	114,520,791,603.36 \$

Growth rate (CAGR)	3 %
Number of periods	<b>Synthetics</b> 21
Initial value	61,300,000,000 \$
Final value	114,036,057,245.79 \$

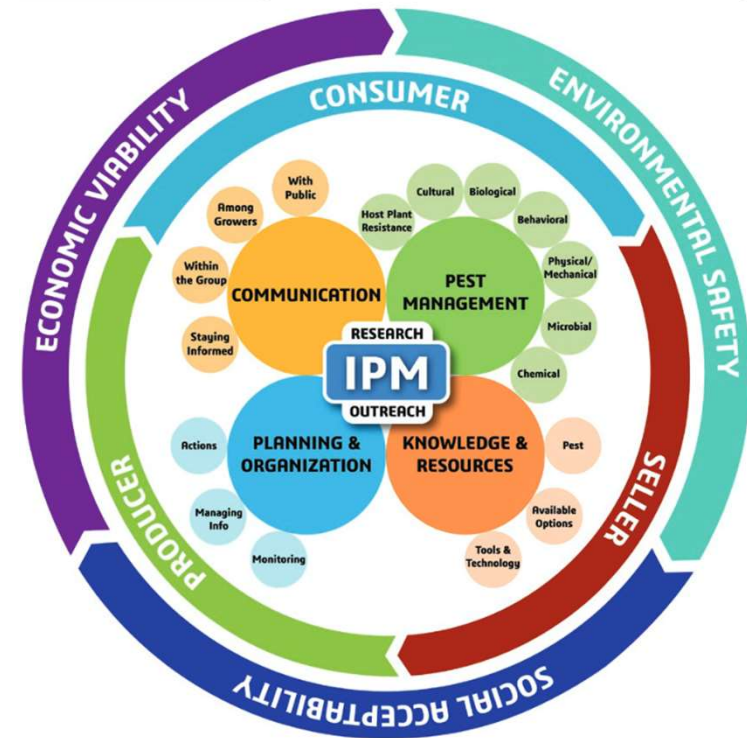
Info from Biocontrol USA 2022 presentation by Pam Marrone

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# WHY IS THE MARKET TRENDING TO BIOCONTROL?

- Health & safety
  - Plant, worker, environment
- Labor savings
  - Pesticide applicators
  - No/low REI/PHI/MRL
- Consumer demand
- Pest resistance



The New Integrated Pest Management Paradigm for the Modern Age, Journal of Integrated Pest Management, (2019) 10(1): 12; 1–9

# PHASING-OUT SOME PESTICIDES

- EU & CAN: Restricted/banned pesticides
- US: Walmart moved to protect pollinators
  - Source 100% fresh produce & floral from growers using IPM by 2025
  - Must phase out:
    - Chlorpyrifos
    - Neonicotinoids
    - & other level-I bee precaution pesticides



Photo by Julie Graesch

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<https://progressivegrocer.com/walmart-moves-protect-pollinators-pesticides>

## Bee precaution pesticide ratings <https://www2.ipm.ucanr.edu/beeprcaution/>

Guidance on how to reduce bee poisoning, based on reported pesticide effects on adults and brood of honey bees and other bee species. Ratings are for the pesticide active ingredient, the common name.\*

**I** Do not apply or allow to drift to plants that are flowering including weeds. Do not allow pesticide to contaminate water accessible to bees including puddles.

**II** Do not apply or allow to drift to plants that are flowering including weeds, except when the application is made between sunset and midnight if allowed by the pesticide label and regulations. Do not allow pesticide to contaminate water accessible to bees including puddles.

**III** No bee precaution, except when required by the pesticide label or regulations.

## 2020 Understanding Pesticide Toxicity to Pollinators

Vera Krischik, Dept. Entomology, University of Minnesota, [kris001@umn.edu](mailto:kris001@umn.edu), 612.625.7044



Photo by Julie Graesch

<input checked="" type="checkbox"/> Common name (Example trade name)	Type	Mode of action	Rating	Other effects on bees	Toxic to honey bee brood	Toxic to other bee species
<input checked="" type="checkbox"/> ABAMECTIN (Agri-Mek)	Acaricide; 6; Insecticide 6		I	—	—	✓
<input checked="" type="checkbox"/> ABAMECTIN bait (Cling Ant Bait)	Insecticide 6		III	—	—	✓
<input checked="" type="checkbox"/> ACEPHATE (Orthene)	Acaricide; 1B; Insecticide 1B		I	—	—	✓
<input checked="" type="checkbox"/> AZADIRACTIN (Neemix)	Acaricide; UN; Insecticide UN		II	—	—	—
<input checked="" type="checkbox"/> BACILLUS THURINGIENSIS SSP. ISRAELENIS (Gnatrol, VectoBac)	Insecticide 11A		III	—	—	—
<input checked="" type="checkbox"/> BACILLUS THURINGIENSIS SSP. KURSTAKI (Blorbit, Javelin)	Insecticide 11A		III	—	—	—
<input checked="" type="checkbox"/> BEAUVERIA BASSIANA (BotaniGard)	Insecticide UNF		II	—	—	✓
<input checked="" type="checkbox"/> BIFENAZATE (Acramite)	Acaricide 20D		II	—	—	✓
<input checked="" type="checkbox"/> BIFENTHRIN (Brigade)	Acaricide; 3A; Insecticide 3A		I	FRAC3 FRACM05	—	✓
<input checked="" type="checkbox"/> CHLORFENAPYR (Phantom, Pylon)	Acaricide; 13; Insecticide 13		II	—	—	✓

# IRAC PEST RESISTANCE

**Insecticides/miticides:** ~30 chemical MOA, 7 UN MOA

- **Western flower thrips**
  - 7 chemical groups/sub-group
    - 1A, 1B, 2A, 2B, 3A, 4A, 5, 6, 7C
- ***Bemisia* whitefly**
  - 6 chemical groups/sub-group
    - 1A, 1B, 2A, 2B, 3A, 4A, 7C, 9B
- **Two spotted spider mites**
  - 9 chemical groups/sub-group
    - 1A, 1B, 3A, 6, 10A, 12B, 19, 20B, 21A, 23



<https://irac-online.org/>

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**BIOCONTROL MAY  
EVENTUALLY CHOOSE  
YOU...**

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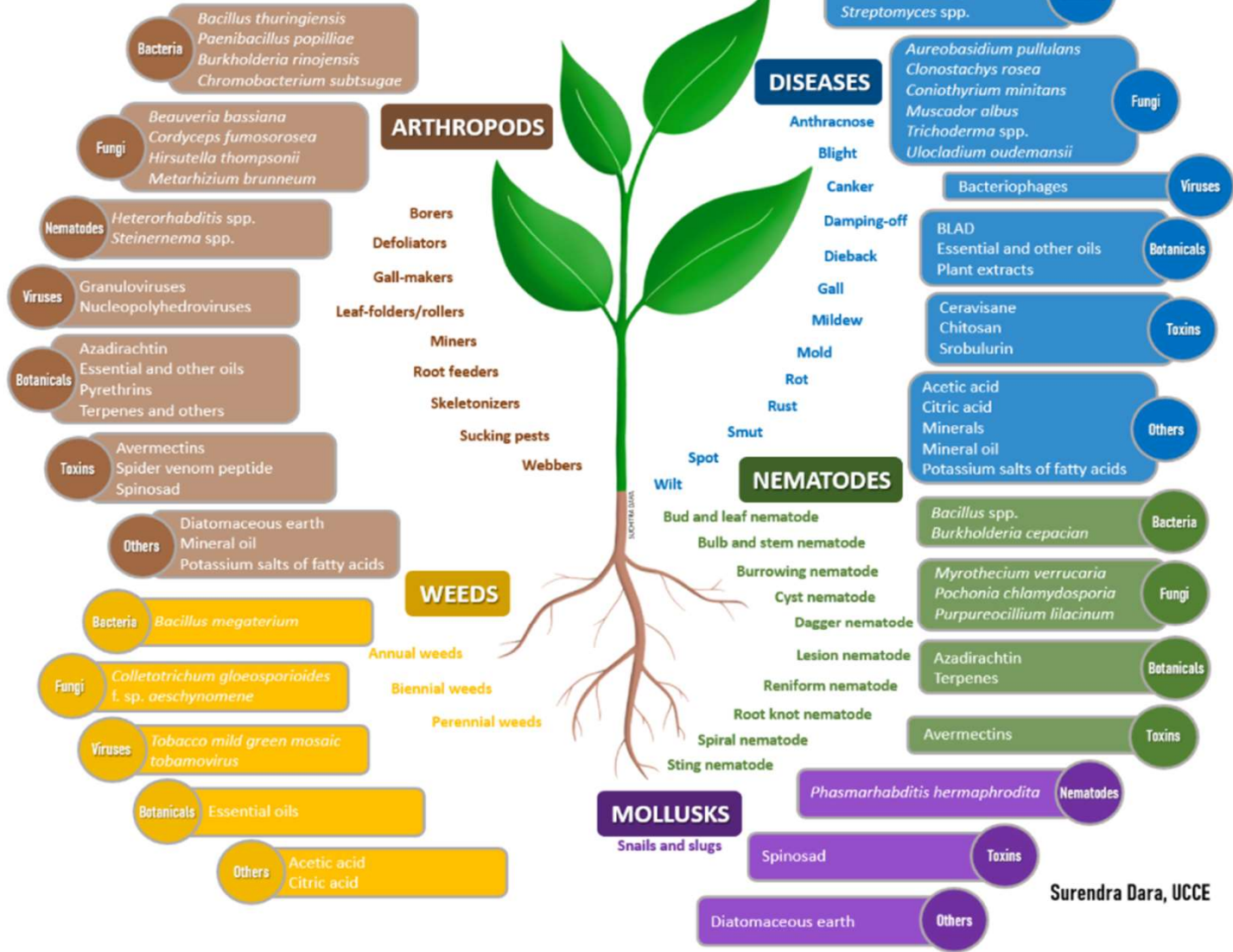


# COMPATIBILITY: BIOPESTICIDES NATURAL ENEMIES



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# Biopesticides and their categories against various pests



CHECK  
COMPATIBILITY  
OF ALL INPUTS!

Surendra Dara, UCCE



# BIOPESTICIDE COMPATIBILITY: OVERVIEW

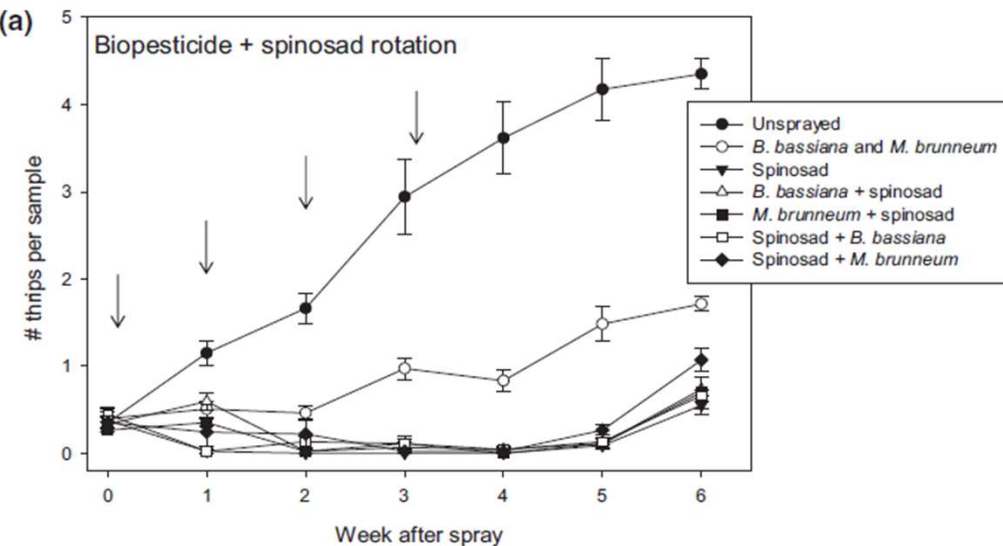
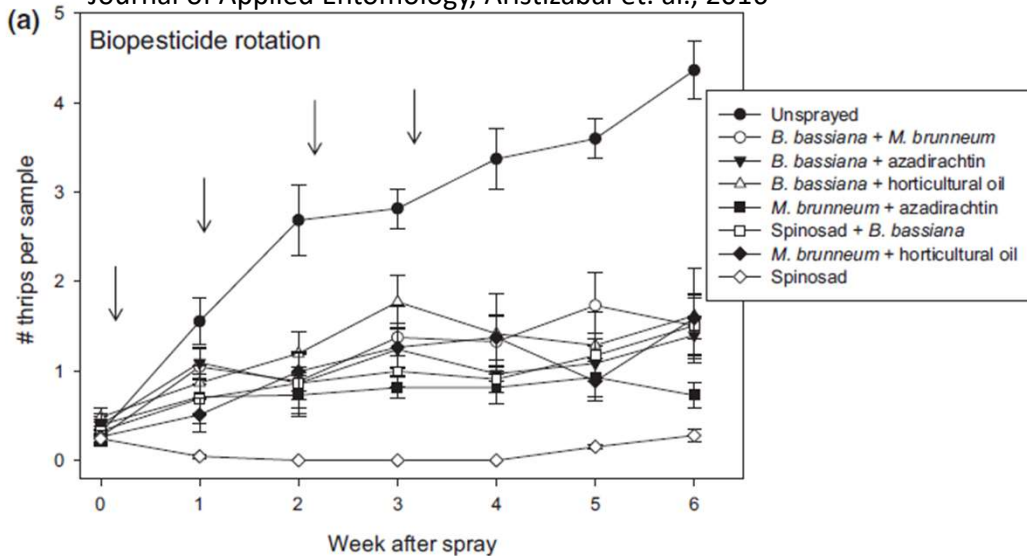
- Importance
- Physical (jar test)
- pH – some pesticides require to maintain a specific pH
  - Consult the product label
- Microbial compatibility
  - Tank mix
  - Spray Test – rotation



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Journal of Applied Entomology, Aristizabal et. al., 2016



## COMPATIBILITY IMPORTANCE

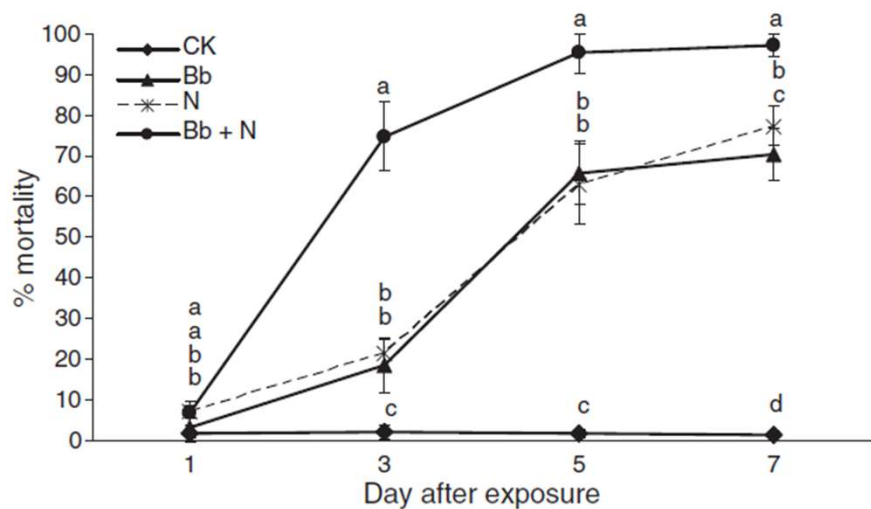
### Efficacy of biorational insecticides against chili thrips infesting roses under nursery conditions

- Biopesticides alone reduced thrips by 48-71% compared to control (not shown)
- Similar results when applied in rotation
- 87-92% control was achieved when biopesticides were rotated with Spinosad
  - Manage pesticide residues
  - Reduced resistance to synthetic pesticides

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# COMPATIBILITY IMPORTANCE



**Figure 1** Cumulative mortality (mean % ± SE) in second instars of *Bemisia tabaci* on eggplant applying different treatments (single or integrated) of *Beauveria bassiana* (Bb:  $10^7$  conidia  $\text{ml}^{-1}$ ) with neem (N: 0.5%) compared with control (CK). Means with the same letter within the same day are not significantly different (two-way ANOVA:  $P > 0.05$ ).

## Compatibility of the insect pathogenic fungus *Beauveria bassiana* with neem against *Bemisia tabaci* on eggplant

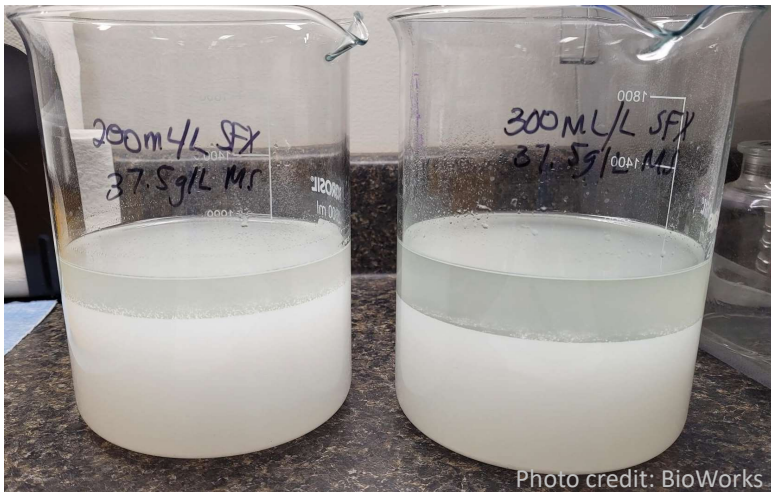
- Tank mixes of compatible biopesticides can enhance efficacy
  - 20-28% additional mortality when combined

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# PHYSICAL COMPATIBILITY

Looking for flocculation, clabber, temperature changes, foaming, etc.



**Incompatible, separation**



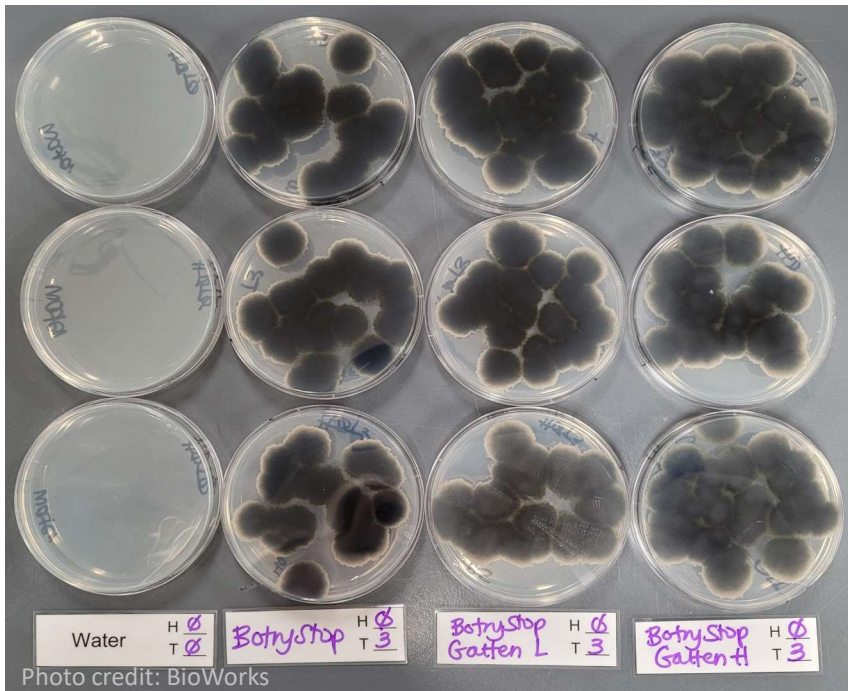
**Compatible, last two mix bottles look homogenous and no difference to controls**

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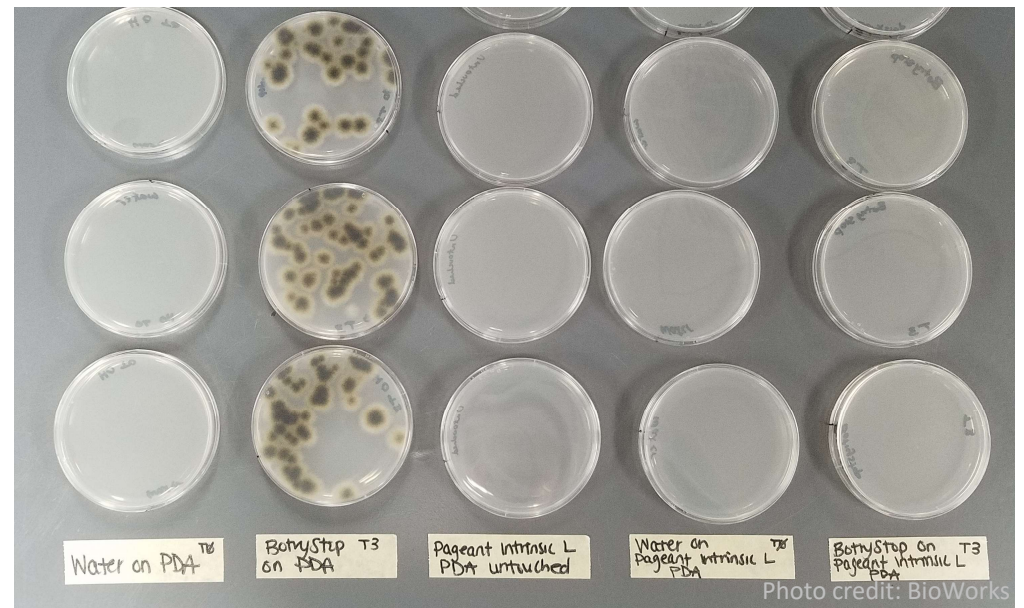


# MICROBIAL COMPATIBILITY - TANK MIX

## Compatible



## Incompatible

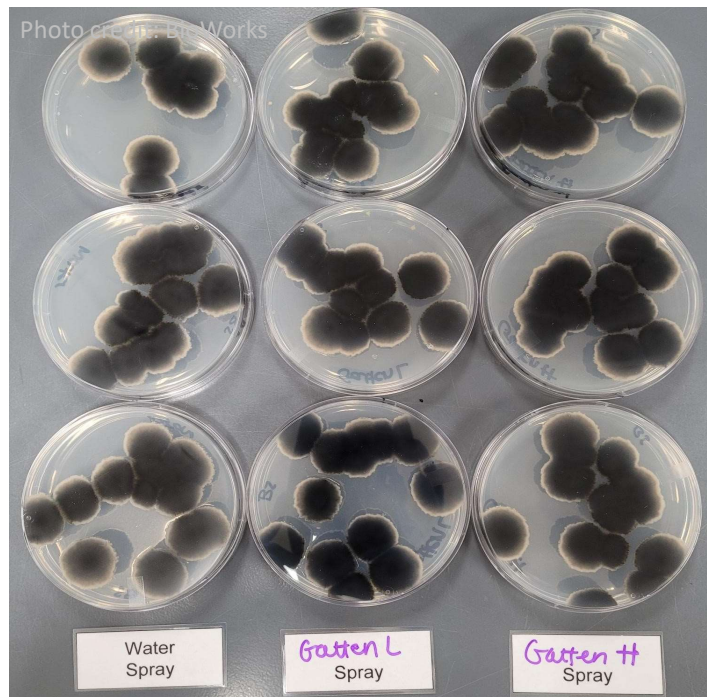


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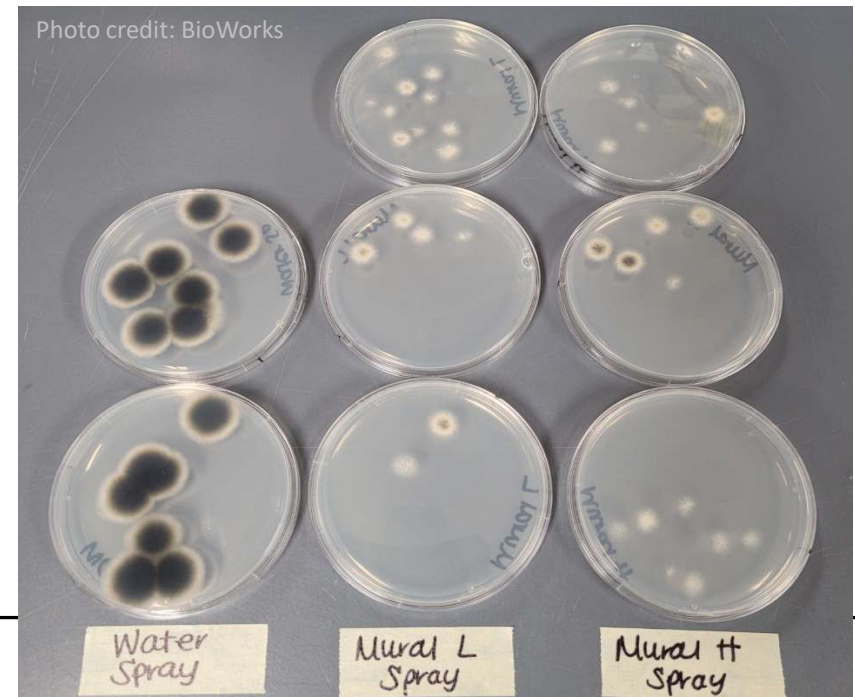


# MICROBIAL COMPATIBILITY – SPRAY TEST

## Compatible



## Incompatible



# COMPATIBILITY RESOURCES

## BOTANIGARD® 22WP

Active Ingredients: *Beauveria bassiana* strain GHA

A biological insecticide (mycoinsecticide – wettable powder).

Registered for use in: USA

Available Size: 1 lb

REI: 4-hour

PHI: 0-day

.....

### RESOURCES



Label



Sell Sheet



SDS



Compatibility



## BotaniGard® : Product Compatibility

All products tested for compatibility and reported in this document have been evaluated for impact on *Beauveria bassiana* strain GHA spores and physical compatibility only. Tests were not carried out to evaluate impact on the partner product integrity or for plant phytotoxicity. Compatibility has been tested at normal tank mix dilutions, not in concentrated stock tank dilutions (such as for injecting at 1:100). Physical compatibility can be impacted by your water quality, tank residues, or the addition of other materials in the spray tank.

- Read and follow label directions for all tank mix materials.
- Always maintain constant agitation in your spray tank.
- Make applications of tank mix solutions as soon as possible after mixing.

All chemistries available have not been tested. As a rule of thumb, for unlisted products, wait 4-5 days before or after a fungicide application to apply BotaniGard. Most insecticides will not harm BotaniGard. Ask your distributor for information regarding specific products.

\*Compatibility with spores applies to BotaniGard® ES, BotaniGard® 22WP, Mycotrol® ESO and Mycotrol® WPO.

Adjuvants			
Active Ingredient(s)	Brand Name	Maximum Tested Rate	Compatibility
Alkylaryl polyoxyethylene glycols and isopropyl alcohol + sodium ethylene diamine tetra-acetate	1st Choice® 2220	4 fl oz/100 gal	Yes
Cottonseed oil and adjuvant	1st Choice® 4440	1 gal/100 gal	Yes
Cottonseed oil and adjuvant	1st Choice® 9300	2 gal/100 gal	Yes
Alkylaryl polyoxyethylene glycols and isopropyl alcohol	1st Choice® Spreader Sticker	1 gal/100 gal	Yes
Mineral oil	6E	1 gal/100 gal	Yes, phyto concern
Mineral oil	7N	1 gal/100 gal	Yes, phyto concern
Alkylaryl polyethylene glycols, free fatty acids & isopropyl alcohol	Activate® Plus	2 qt/100 gal	Yes
Aklylphenol ethoxylate, alcohol ethoxylate, tall oil fatty Acids	Activator® 90	2 qt/100 gal	Yes
Petroleum Oil & polyol fatty acid esters	Agicide Activator®	6 qt/100 gal	Yes
Ethoxylated soybean derived surfactants	Agra Wet®	1 qt/100 gal	Yes
Petroleum oil & polyol fatty acid esters	Agridex®	8 qt/100 gal	Yes, poor emulsion with ES
Ammonia	Ammonia®	1 pint/100 gal	Yes-ES; NO-22WP
Nonionic Surfactant (Alkyl Aryl Alkoxyolate) 20% Free Fatty Acids	Amway APSA-80 Spreader®	1 pint/100 gal	Yes
Ethoxylated Alkyl Phenols	Aquagro® 2000L	1 pint/100 gal	Yes
	Aquatrol®	16 fl oz/100 gal	Yes
	Armublend 650®	3 qt/100 gal	Yes
	Atlox 775®	3 qt/100 gal	Yes
Polyoxyethylene hexitan ester	Atplus 201®	2 qt/100 gal	NO

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# NATURAL ENEMY COMPATIBILITY

Photo by Julie Graesch



Photo by Julie Graesch



Photo by Julie Graesch



Photo by Julie Graesch



Photo by Matt Foertmeyer




## BEFORE YOU SPRAY... CONSIDER...

- Tipping point reached?
- Increase releases (rate/frequency)
- Switching/adding natural enemies
- Biopesticide spot treatments



Photo by Ron Valentine

# NATURAL ENEMY COMPATIBILITY (LETHAL EFFECTS)



**International Organisation for Biological and Integrated Control (IOBC)**  
West Palearctic Regional Section (WPRS)

**Organisation Internationale de Lutte Biologique et Intégrée (OILB)**  
Section Régionale Ouest Paléarctique (SROP)

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**IOBC-WPRS OILB-SROP**

- About IOBC-WPRS
- Membership
- Expert Groups
- IP & IPM
- Publications
- Download & Links
- Member areas
- IOBC Global

**IOBC-WPRS Pesticide Side Effect Database**

**Introduction**


- The database
- Origin of the data
- Which data have been retained?
- How to enrich the database?

Imidacloprid OR Select Test Species OR Select Species Group

search clear search

Legends

Active ingredient	Product	g/l or kg	Cat.	Test species	Species Group	Cat. of test	Dose tested (a/ ha)	IOBC toxicity class	Effects and duration of activity	Field site (crop-country)	Remarks	Ref.
Imidacloprid	Confidor 200SL	200	I.	Trichogramma cacoeciae	Parasitic hymenoptera	Initial toxicity	20g	4B				Abdelgander & Hassan, 2002
Imidacloprid	Confidor 200SL	200	I.	Psylla concolor	Parasitic hymenoptera	Initial toxicity	30g	4B				Aden et al., 2011
Imidacloprid	Confidor 200SL	200	I.	Psylla concolor	Parasitic hymenoptera	Semi-field	60g	3				Aden et al., 2011
Imidacloprid	Confidor 200SL	200	I.	Orius laevigatus	Plant dwelling predator	Initial toxicity	25g	4B				Angeli et al., 2005
Imidacloprid	Confidor 200SL	200	I.	Phytoseiulus persimilis	Predatory mite	Extended lab	70g	4.1	4 (0-3DAT), 1 (10DAT)			Blumel & Hausdorf, 2002
Imidacloprid	Confidor 200SL	200	I.	Phytoseiulus persimilis	Predatory mite	Extended lab	20g	4.1	4 (0DAT), 2			Blumel & Hausdorf, 2002



Advice Products News About us

**Side Effect Manual**


**Active ingredient** **Commercial product** **Beneficial organism**

Filter Clear Selection

- 2,4.D
- abamectin
- acephate
- acequinocyl
- acetamiprid
- acrinathrin
- Adoxophyes orana Granulose Virus
- alachlor
- aldicarb
- alphacypermethrin
- amitraz
- atrazine
- azadirachtin
- azinphos-methyl

Filter Clear Selection

- Chrysopa carnea
- Coleoptera
- Cryptolaemus montrouzieri
- Dacnusa sibirica
- Delphastus pusillus
- Diglyphus isaea
- Encarsia formosa
- Eretmocerus spp.
- Euseius gallicus
- Feltiella acarisuga
- Hypoaspis spp.
- Macrolophus pygmaeus
- Nematodes
- Nesidiocoris tenuis



Home Company Distribution

Home > Side effects

Select

**Beneficial organism** **Agent**

Tradename Active ingredient

Type here

- Metarhizium anisopliae strain ESALQ E9
- Metarhizium brunneum
- Beauveria bassiana strain ESALQ PL63
- adoxophyes orana granulovirus
- Steinernema feltiae
- Bacillus thuringiensis var. aizawai
- Bacillus thuringiensis var. israelensis
- Bacillus thuringiensis var. kurstaki
- Bacillus subtilis
- Beauveria bassiana ATCC 74040
- Beauveria bassiana GHA
- mineral oil JMS STYLET OIL
- potassium salts of fatty acids

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# NATURAL ENEMY COMPATIBILITY (SUB-LETHAL EFFECTS)

- **Physiological effects**
  - Development
  - Adult longevity
  - Immunology
  - Fecundity
  - Sex ratio
- **Behavioral effects**
  - Mobility
  - Navigation/orientation
  - Feeding behavior (repellent, antifeedant, reduced olfactory)
  - Oviposition behavior
  - Learning performance

**Many studies have documented sublethal effects;  
however, only mortality tests are considered**

Reference: The sublethal Effects of Pesticides on Beneficial Arthropods, Annu. Rev. Entomol. 2007. 52:81–106

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Photo by Julie Graesch

# PESTICIDE USE WITH NATURAL ENEMIES

## Should never be used (4):

- Toxic
- Persist 2-3 months

## Clean up & spot sprays (3):

- Moderately toxic
- Persist 2-3 weeks

## IPM tools (2):

- Slightly toxic but has a place
- Short to no residual

## Somewhat compatible (1):

- Non-toxic, minimal sub-lethal effects
- Short to no residual

Toxicity Rating Chart\*

IPM Impact Rating <sup>1</sup>	Mortality /Reduction	Toxicity
1	<25%	Non-Toxic
2	25-50%	Slightly Toxic
3	50-75%	Moderately Toxic
4	>75%	Toxic

1. Side-effects Database, IPM Impact, 2019

<http://www.omafra.gov.on.ca/english/crops/hort/news/grower/2005/02gn05a1.htm>

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# SHOULD NEVER BE USED (4)

- Toxic
- Persist 2-3 months
  - Marathon, Orthene, Dursban, Permethrin (IRAC 4A, 1B, 3A)

		acephate		chlorpyrifos		imidacloprid		permethrin	
		s	i	s	i	s	i	s	i
Amblyseius swirskii	Nymph/adult	?	i	?	i	3	1	?	i
	Persistence	?	i	?	i	?	i	?	i
Aphidius spp.	Larva	4		4		4	1	4	
	Adult	4		4		4	1	4	
	Persistence	?	i	?	i	?	i	-	>8 w
Aphidoletes aphidimyza	Larva	2		4		4	1	4	
	Adult	4		4		4	1	4	
	Persistence	>8 w		?	i	?	i	-	>8 w
Encarsia formosa	Larva	4		4		3	1	4	
	Adult	4		4		4	1	4	
	Persistence	>8 w		?	i	?	i	-	>8 w

Side effects Koppert		ORTHENE x acephate		DURSBAN x chlorpyrifos		WOPRO IMIDACLOPRID 70WG x MARATHON imidacloprid	
		SP	DR	SP	SPK	SP	DR
Amblyseius swirskii x	population	4		4		3	1
	adult						1
	persistence	6 - 8 w				3 w	0 w
Aphidius colemani x	adult	4		4		4	1
	larva						
	mummy			4		4	1
	persistence						0 w
Aphidoletes aphidimyza x	adult	4		4		4	1
	larva	2				4	1
	persistence	8 - 12 w					0 w

# CLEAN UP & SPOT SPRAYS (3)

- Moderately toxic
- Persist 2-3 weeks
  - Avid, Pylon (IRAC 6, 13)



Active Ingredient	Product	Rate	IRAC	Target	Mode of Action	Field Use	Rate	Toxicity
Abamectin	Vertimec 18EC	18th	I.	<i>Phytoseiulus persimilis</i>	Predatory mite	Extended lab	13.5g	4th
Abamectin	Vertimec	18g	I.	<i>Orius insidiosus</i>	Plant dwelling predator	Initial toxicity	18g	4th
Abamectin	Vertimec	18th	I.	<i>Araneae</i>	Plant dwelling predator	Field	9g	1
Abamectin	Abamectin DVA 18EC	18th	I.	<i>Amblyseius largoensis</i>	Predatory mite	Initial toxicity	1.08g	3rd
Chlorfenapyr	Pirate	240	I.	<i>Orius insidiosus</i>	Plant dwelling predator	Initial toxicity	200 g	2
Chlorfenapyr	Chlfenamy F	100	I.	<i>Aphidius gifuensis</i>	Parasitic hymenoptera	Initial toxicity	20g	4th
Chlorfenapyr	Intrepid		I.	<i>Amblyseius californicus</i>	Predatory mite	Field aged	96g	1

Side effects		AVID abamectin	PYLON chlorfenapyr
Koppert		SP	SP
Amblyseius swirskii	population		3
	adult	4	
	persistence	< 2 w	
Aphidius colemani	adult	4	4
	larva		1
	mummy		1
	persistence	1 w	> 4 w
Aphidoletes aphidimyza	adult	4	3
	larva	4	4
	persistence	1 w	4 w
Encarsia formosa	adult	4	4
	larva		1
	pupa	1	
	persistence	3 w	3 w

# IPM TOOLS (2)

- Slightly toxic but has a place
- Short to no residual
  - Oil, soap, botanicals, Ventigra, MainSpring, Kontos, Endeavor

## Compatibility with Beneficial Arthropods

Insect	Lifestage	Mortality	Exposure Type
<i>Amblyseius swirskii</i>	Adult motiles	23% (%reduction compared to UTC)	Direct Spray- insect and plant
<i>Euseius tularensis</i>	Mixed population	0% (%reduction compared to UTC)	Field Spray
<i>Neoseiulus californicus</i>	Adult motiles	5%	Indirect- dry residue
<i>Orius insidiosus</i>	Adults	15%	Indirect- dry residue
<i>Coccinella septempunctata</i>	larvae	10%	Indirect- dry residue
<i>Chrysoperla carnea</i>	larvae	3%	Indirect- dry residue
<i>Phytoseiulus persimilis</i>	Adult motiles	10%	Indirect- dry residue

Ventigra  
Insecticide

Side effects <b>Koppert</b>		ENDEAVOR <sup>x</sup> pymetrozine		JMS STYLET OIL <sup>x</sup> SPRAYING OIL mineral oil	M-PEDE <sup>x</sup> potassium salts of fatty acids
		SP	DR	SP	SP
<b>Amblyseius swirskii</b> <sup>x</sup>	population		1	4	
	adult	1		3	3
	egg	1			
	persistence	0 w	0 w		0 w
<b>Aphidius colemani</b> <sup>x</sup>	adult	2	2	1	4
	mummy	1	1	1	
	persistence	1 w		0 w	
<b>Aphidoletes aphidimyza</b> <sup>x</sup>	adult	2	1	1	4
	larva	3	2	1	
	persistence			0 w	0 w

# SOMEWHAT COMPATIBLE (1)

- Non-toxic, minimal sub-lethal effects
- Short to no residual
  - Microbials, botanicals (IRAC UN, UNB, UNE, UNF, UNM)

Beauveria bassiana GHA	Botanigard 22WP		I.	<i>Orius laevigatus</i>	Plant dwelling predator	Extended lab	7x500g (7D)	2
Beauveria bassiana GHA	Botanigard ES9601		I.	<i>Orius laevigatus</i>	Plant dwelling predator	Extended lab	7x1000ml (7D)	1
Beauveria bassiana GHA	Botanigard ES		I.	<i>Nesidiocoris tenuis</i>	Plant dwelling predator	Semi-field	250 g	1
Beauveria bassiana GHA	Botanigard ES		I.	<i>Orius insidiosus</i>	Plant dwelling predator	Semi-field	250 g	1



Side effects		adoxophyes orana granulovirus x	azadirachtin x	pyrethrins x
<b>Koppert</b>		SP	SP	SP
Amblyseius swirskii x	population	1	2	
	adult		1	
	persistence			
Aphidius colemani x	population			
	adult	1	1	4
	larva	1	1	
	mummy			1
	persistence		0 w	1 w
Aphidoletes aphidimyza x	adult	1	1	4
	larva	1	1	4
	persistence			> 1 w



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# INTEGRATED IPM PROGRAMS



**BioWorks®**

# START CLEAN, STAY CLEAN

## IPM Strategy for thrips in chrysanthemums

Vineland Research & Innovation Center

### DIP

incoming cuttings  
assume thrips are  
already there



### BROADCAST

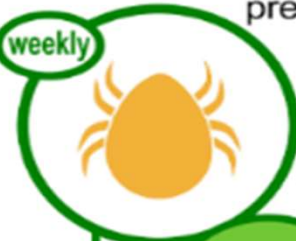
mites during  
propagation  
if desired



### BROADCAST

predatory mites  
when plants  
are pot tight

weekly



### START EARLY

release soil predators &  
spray bio-pesticides  
right after potting



### SPRENCH

nematodes  
til canopy  
closes

1-2



weekly

### switch to SACHETS

after spacing



### SUPPORT

with bio-pesticides &  
predators as needed



### CLEAN-UP

with 1-2 final  
pesticide  
sprays  
before  
shipment  
if needed



**MASS TRAP** with sticky cards or tape





Photo by Bri-Anna Jaksic

**Egg**  
(In leaf tissue)



Photo by Julie Graesch

**Larva 1 & 2**  
(on plant → exposed)



**Pupa**  
(in soil)



Photo by Julie Graesch

**Adult**  
(on plant → exposed)

86°F 3 days

1.5 + 1.5 days

3 days

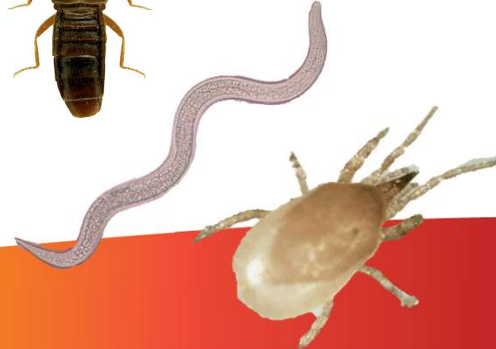
20 – 40 days

Compatible application:  
oil, soap,  
mycoinsecticides,  
MainSpring, Kontos

*Orius*  
*A. swirskii*  
*A. cucumeris*

*Dalotia*,  
*S. scimitus*  
*S. feltiae*

*Orius*  
*S. feltiae*



*A. swirskii*



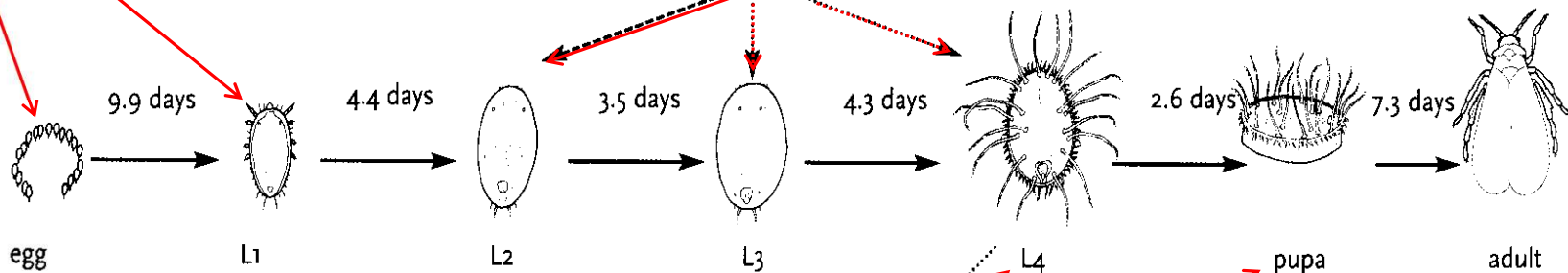
*E. formosa*



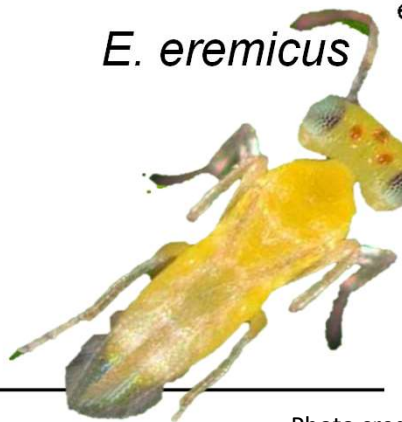
Compatible application: oil, soap, mycoinsecticides, botanicals, Ventigra, MainSpring, Kontos, Endeavor

*Delphastus catalinae*

from egg to adult: 32 days



*E. eremicus*



*D. hesperus*

*Delphastus catalinae*



from egg to adult : 27 days

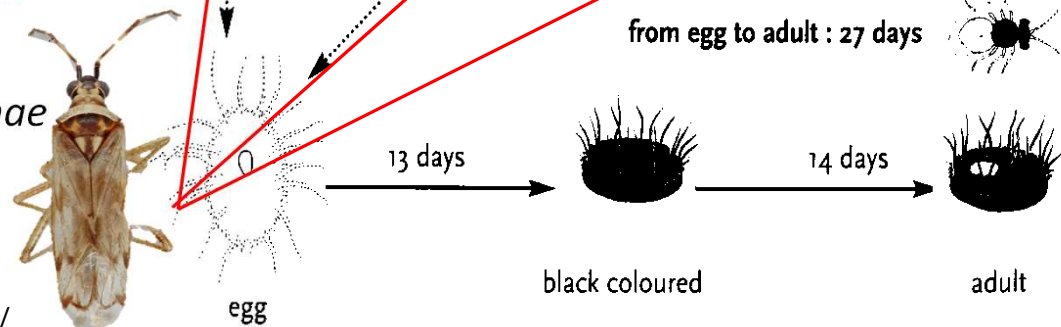


Photo credit: <https://bioplanet.eu/en/delphastus-catalinae-2/>

## IPM PROGRAM TOOLS REVIEW

- Scouting & monitoring
- When pest pressure is high... reach for your biopesticides
- Dipping starts clean
- Understand compatibility
- Spot treat



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## TAKE HOME MESSAGE

- **Biocontrol Mindset:**
  - Ask not what your natural enemies can do for you, but what you can do for your natural enemies
  - “What can I still spray?” to “How do I avoid spraying?”
- Get comfy with compatibility
- Timing is everything

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# COMPATIBILITY RESOURCES

- IOBC <https://www.iobc-wprs.org/>
- Koppert <https://sideeffects.koppert.com/>
- BioBest <https://www.biobestgroup.com/en/side-effect-manual>
- IPM Impact <https://www.ipmimpact.com/>
- BioWorks <https://www.bioworksinc.com/ask-us/>
- BASF <https://betterplants.basf.us/products/nemasys--beneficial-nematodes.html>
- Canada Onfloriculture/OMAFRA GH Floriculture Registered Pesticides 2019: <https://onfloriculture.com/>
- Biopesticide companies
- Natural enemy companies



- OMAFRA Greenhouse Floriculture Registered Pesticide Spreadsheet 2019. Updated Information on Pesticide Products for use on Greenhouse Ornamental crops can be found in this downloadable and editable spreadsheet. This file contains all information growers need to make an informed decision. This includes phytotoxicity, compatibility with natural enemies, and direct links to the most recent label. Detailed notes can be found in cells with a red tab in the corner.

Product/Brand	Phytotoxicity	Compatibility	Rate	Notes
ES1		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES2		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES3		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES4		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES5		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES6		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES7		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES8		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES9		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1
ES10		Do not apply to soft-bodied insects.	10 g/m <sup>2</sup>	1

IPM IMPACT Home About IPM About IPM Impact Side-effects Database



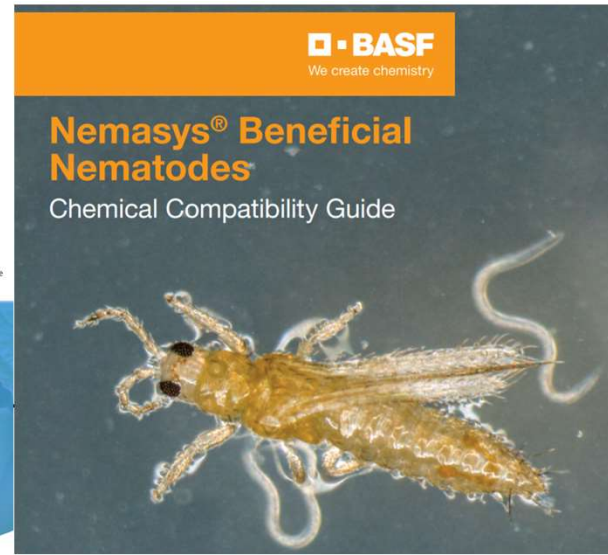
## Biological Control Agents (BCAs) Use with BioWorks Products:

BotaniGard® 22WP | Mycotrol® WPO | Molt-X® | SuffOil-X®  
RootShield®, RootShield®PLUS+ | BotryStop® | CEASE® | MiiStop®SP

The introduction of Biological Control Agents (BCAs) is often the first line of defense and a key component of an Integrated Pest Management (IPM) strategy, either in greenhouses or open field crops. Understanding the potential impact of BioWorks products over BCA species is essential to the success of a pest management program. This document provides important insight on the possible side-effects of BioWorks biopesticides on most used species of BCAs, and the best way to minimize the risks associated with using both components as part of a pest management strategy.

Please refer to product labels for complete application details. Always read and follow label directions.

BCAs and their use with Insecticides		
BotaniGard 22WP and Mycotrol WPO foliar sprays		
Genus, species	Type	Recommendation
<i>Amblyseius (= Neoseiulus) andersoni</i>	predatory mite	Ok to apply
<i>Amblyseius californicus</i>	predatory mite	Ok to apply
<i>Amblyseius cucumeris</i>	predatory mite	Ok to apply
<i>Amblyseius fallacis</i>	predatory mite	Ok to apply
<i>Amblyseius swirskii</i>	predatory mite	Ok to apply



# ADDITIONAL IPM RESOURCES

- Consultants such as <https://bugladyconsulting.com>
- Universities and extension services (contact your local extension office)
- Vineland Research & Innovation Center <https://www.vinelandresearch.com/>
- ANBP <http://www.anbp.org/>
- Markets and Markets <https://www.marketsandmarkets.com/agriculture-market-research-173.html>
- IPM: <http://greenhouseipm.org/> & [http://greenhouseipm.org/2017/10/thrips\\_series/](http://greenhouseipm.org/2017/10/thrips_series/)
- Crops that attract insects [https://www.canr.msu.edu/news/crops\\_that\\_are\\_insect\\_magnets\\_in\\_the\\_greenhouse](https://www.canr.msu.edu/news/crops_that_are_insect_magnets_in_the_greenhouse)
- IRAC <https://irac-online.org/> & FRAC <https://www.frac.info/>
- MSU/IRAC pesticide resistance database <https://www.pesticideresistance.org/>
- BPIA: <https://www.bpia.org/>
- Canada Onfloricuture Blog <https://onfloricuture.com/>
- Walmart <https://progressivegrocer.com/walmart-moves-protect-pollinators-pesticides>
- Bee Precaution pesticide rating <https://www2.ipm.ucanr.edu/beeprecaution/>
- ESA <https://www.entsoc.org/>
- GrowerTalks Magazine <https://www.growertalks.com/> 5 part series on best practices for biocontrol and many more great articles!



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# THANK YOU!

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