

Sept 19 2017: GH/nursery production, IPM for thrips



UC Statewide IPM Project
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Learn2Grow®

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What is greenhouse IPM?

- * A system utilizing multiple methods
- * A decision making process
- * A risk reduction system
- * Information intensive
- * Biologically based
- * Cost effective
- * Site specific
- * Multiple tactics:
 - legal, cultural, physical,
 - genetic, biological, chemical



What is greenhouse IPM?

When developing an IPM program, it is important to know what pests you have. Learn the major characteristics for pest and damage identification and how to monitor for the pests.

Determine threshold levels for each pest. At low densities, biological control and biorational pesticides may be used. High pest densities may call for conventional pesticides, but these should be avoided whenever possible to conserve beneficials.



What is greenhouse IPM?

Preventative thinking



Assume cuttings will arrive with thrips.

- **Misting weekly botanigard sprays (3x)**
- **Nematodes weekly**
- **Mites weekly, bridges help mites move around**
- **Banker plants, for thrips use ornamental peppers for pollen feeding, for Orius use gerbera**

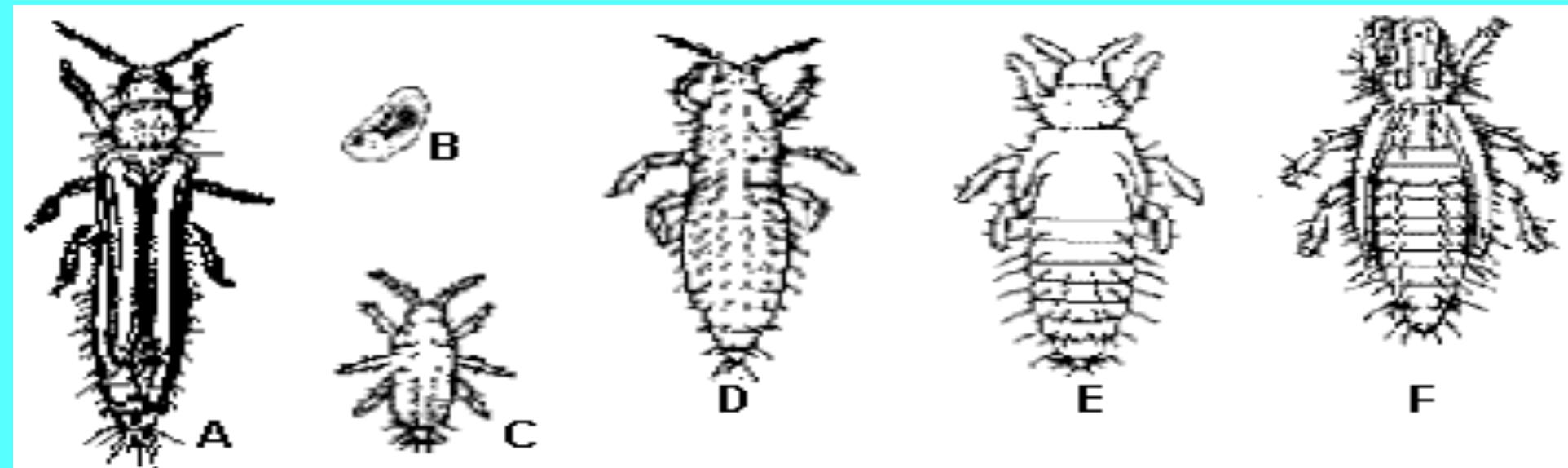
Species of thrips

IPM Program For Thrips

Order Thysanoptera, Family Thripidae

DESCRIPTION OF THE PESTS

- four featherlike wings, with fine hairs on the edges.
- six life stages: egg, first instar, second instar, prepupa, pupa, and adult.
- Thrips insert eggs into plant tissue or in soil.
- The first two instars and adults feed by piercing +sucking
- Adult feeding is rasping damaging creating long lesions.
- Look for black fecal spots.



IPM Program For Thrips

DAMAGE

- **Thrips primarily feeds on flowers but also sometimes on new vegetative growth, whereas greenhouse thrips feeds primarily on foliage. Direct feeding damage includes streaking, spotting, and tissue distortion.**
- **On orchids, western flower thrips feeding and egg laying will leave translucent 'pimpling' spots on petals and leaves.**
- **The stippling damage caused by thrips feeding on individual cells is often confused with mite stippling.**
- **Western flower thrips can vector tomato spotted wilt virus as well as many other viruses.**

IPM Program For Thrips

DESCRIPTION OF THE PESTS

The Eastern flower thrips (*Frankliniella tritici*),

- Very common before western flower thrips
- Thrips feed on over many plant species.
- Feed on all plant parts.



IPM Program For Thrips

DESCRIPTION OF THE PESTS

- The chilli thrips or yellow tea thrips, *Scirtothrips dorsalis*, is an extremely successful invasive species from Asia over the last twenty years.
- Chilli thrips feed on over 100 plant species.
- Feed on all plant parts.



IPM Program For Thrips

DESCRIPTION OF THE PESTS

Western flower thrips (WFT)
(*Frankliniella occidentalis*)

- has three color forms.
pale form, is white and yellow,
intermediate form with a
dark orange thorax and brown
abdomen; and a dark form.



- Western flower thrips usually feed in enclosed tissues such as flowers, buds, or growing tips. Adults also feed on pollen and on spider mites. Eggs laid in plant leaves. Females will lay male eggs if unmated and female eggs are produced once mating has occurred. Development times to complete one generation of western flower thrips varies from 11 days (77° to 87°F), to 44 days (50° to 60°F).

IPM Program For Thrips

DESCRIPTION OF THE PESTS

Greenhouse thrips, *Heliethrips haemorrhoidalis*, are tiny, black, insects with whitish to translucent wings folded back over their thorax and abdomen. Legs are also a whitish color. Nymphs are whitish to slightly yellowish in color and produce a globule of fecal fluid at the tip of their abdomen. These globules of fluid increase result in black specks on foliage.



Biocontrol

IPM Program For Thrips

BIOLOGICAL CONTROL

Commercially available predators to help control western flower thrips are:

- minute pirate bug, *Orius* spp.
- predatory mites, *Amblyseius swirskii* “Swirskii mite”, *Neoseilus cucumeris* and *Hypoaspis miles*. *Hypoaspis miles* are soil-inhabiting and feed on thrips pupae.
- parasite of greenhouse thrips is *Thripobius semileteus* (right).
- In soil use nematodes
- Use fungus *Beauveria* or *Metarhizium*



Jack Kelly Clark
University of California

IPM Program For Thrips

CULTURAL CONTROL

- **Because western flower thrips and greenhouse thrips feed on a large variety of plant species, keep production areas free of weeds, which can serve as hosts for thrips populations.**
- **Most commercially available screens have pore sizes slightly larger than the width of the western flower thrips thorax (145 microns), meaning that some winged adults can penetrate these openings. However, covering openings to the greenhouse with fine screens does exclude most thrips. Be sure that the ventilation system on an existing greenhouse can accommodate the reduced flow caused by a fine screen or else the system will need to be modified.**

IPM Program For Thrips

CULTURAL CONTROL

- **Carefully inspect plants being brought in to start a new crop to ensure that they are free of thrips and other pests. A holding area where plants are kept for about 11 to 12 days is useful so that plants can be inspected for any infestations that may develop. Treat any infested plants if necessary.**
- **Blue sticky cards are most attractive to western flower thrips. However, yellow cards are easier to count and more commonly used for insect monitoring. Place yellow sticky cards vertically in the crop canopy, with the lower one-third of the trap in the leaves and the upper two-thirds above the leaves. As the crop grows, the traps will need to be raised. Three traps per cultivar is adequate.**

IPM Program For Thrips

MONITORING and WHEN TO TREAT

- It is important to note that correct identification of pest thrips is essential in a monitoring program.
- Most insecticides must be applied at least two times, 5 to 7 days apart, for efficacy against western flower thrips.

White feeding scars and black excrement from greenhouse thrips

Jack Kelly Clark
University of California



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Detecting virus

IPM Program For Thrips

MONITORING FOR VIRUSES

It is also important to monitor for viruses that western flower thrips vector, such as impatiens necrotic spot virus (INSV) and tomato spotted wilt virus (TSWV) (both are tospoviruses).

It is difficult to diagnose tospovirus infections of greenhouse plants using visual symptoms alone because symptoms can vary. Tospovirus symptoms often mimic symptoms caused by other problems, such as nutritional deficiencies.

Tospovirus infections may be systemic (i.e., virus symptoms are spread throughout the plant) or non-systemic (i.e., the virus symptoms are confined to a specific part of the plant). Tospoviruses, however, may be present even though the plant shows no symptoms.

IPM Program For Thrips

MONITORING FOR VIRUSES

The symptoms of tospovirus infections in floral crops are:

- Brown, black, or white spots
- Necrosis on the leaf petiole
- Yellow mottling or variegation
- Death of young plants or terminal meristems of older plants
- Brown or black cankers on the stem
- Stunting
- Veinal necrosis
- Concentric ring spots
- Mosaics
- Line or zonal patterns

**Begonia with tomato
spotted wilt virus**



IPM Program For Thrips

MONITORING FOR VIRUSES

Early warning is critical to the control of western flower thrips and to the prevention of tospovirus infections. Indicator plants are often used to detect thrips and virus problems. Indicator plants should meet at least one of the following criteria:

- Indicator plants should be more attractive to pests than the producing crop**
- Pests or pathogen must develop faster on indicator plants**
- Indicators must show feeding damage or virus symptoms more readily**
- Indicator plants should not contribute to the spread of the virus being monitored**

IPM Program For Thrips

MONITORING FOR VIRUSES

Petunia plants (*Petunia x hybrida*) are excellent indicators for presence of western flower thrips and transmission of tospoviruses because petunias are not systemically infected with either TSWV or INSV. In response to a tospovirus infection, petunias show a hypersensitive response: rapid death of plant tissues that also kills the invading virus.

The following petunia cultivars are excellent indicator plants:

- Calypso
- Super Blue Magic
- Blue Carpet
- Cascade Blue
- Summer Madness
- Burgundy Madness
- Red Cloud
- Super Magic Coral



Lesions on petunia leaves caused by feeding of western flower thrips

IPM Program For Thrips

- **MONITORING FOR VIRUSES**

Remove flowers from indicator plants before placing them in greenhouses because petunia flower petals do not express local lesions and attract western flower thrips away from leaves.

- Flag indicator plants with blue pie pans or metal sheets to increase effectiveness since western flower thrips are most sensitive to blue colors.
- Look for feeding scars, which are whitish and have an irregular outline. Brown or black-edged lesions will develop on the edges of thrips feeding scars within 3 days if a tospovirus has been transmitted. If a tospovirus outbreak occurs in the greenhouse, look for patterns of injury that correlate with variations in air movement, humidity, and temperature.
- Control measures include removal of infected plants and controlling or excluding thrips.

IPM Program For Thrips

MONITORING FOR VIRUSES

In addition to the use of indicator plants, there are several kits designed specifically to test for tospoviruses vectored by western flower thrips. The test kits are available from www.agdia.com.



Insecticides

Chemical class/mode of activity

The mode of action is the mechanism that kills the insects.

1. Organophosphates and Carbamates

Inhibit the enzyme cholinesterase. This prevents the termination of nerve impulse transmission.

2. Pyrethroids and Chlorinated Hydrocarbons

Destabilize nerve cell membranes.

3. Neonicotinyls

Work on central nervous system, cause over-stimulation and blockage of the postsynaptic nicotine acetylcholine receptors.

4. Novel insecticides

Mode of action specific.

IRAC numbers

- **The Insecticide Resistance Action Committee (www.irc-online.org) has assigned IRAC numbers for each chemical class, and these numbers are on labels to make it easier to rotate classes of insecticides and prevent resistance**
- **Neonicotinoid class, 4A**
- Carbamates, class 1A**
- Organophosphates, class 1B are in the same group as the mode of action (cholinesterase inhibition) is the same.**

Most insecticides kill bees by contact

Organophosphates (OP), pyrethroids (P), carbamates (C) are toxic to bees.

- Dimethoate (OP) is highly toxic, LD₅₀ 15 ng/bee
- Chlorpyrifos (OP) is toxic, LD₅₀ 70 ng/bee
- Methyl parathion (OP) is highly toxic, LD₅₀ 11 ng/bee
- Coumaphos (OP) is 180 times less than methyl parathion, with LD50 of 2030 ng/ bee
- Esfenvalerate (P) is highly toxic, LD₅₀ 15 ng/bee
- Cyfluthrin (P) is highly toxic, LD₅₀ 37ng/bee
- Beta-cypermethrin (P) is extremely toxic, LD50 2 ng/bee
- Lambda cyhalothrin (P) is highly toxic, LD₅₀ 38 ng/bee
- Permethrin (P) is extremely toxic, LD₅₀ 8 ng/bee
- Carbaryl (C) is extremely toxic, LD₅₀ 1 ng/bee



Systemic insecticides

Organophosphates

aldicarb (Temik), oxamyl (Vydate), dimethoate (Cygon)

Neonicotinoids

imidacloprid (Marathon, Merit), clothianidin, thiamethoxam, dinotefuran

Novel mode of action

pymetrozine (Endeavor)

Translaminar, or local, systemic activity

Microbial- abamectin (Avid)

IGR- pyriproxyfen (Distance)

PR- chlorfenapyr (Pylon)

SP- spinosad (Conserve)

OP- acephate (Orthene)

C- carbofuran (Furadan)



There are 6 common neonicotinoid insecticides that are all systemic. When applied to the soil or sprayed on the leaves the insecticides are translocated from roots throughout the plant. The AI is the active ingredient and the trade name is the name for the product given by the manufacturer.

| Active Ingredient | Trade Name |
|-------------------|---|
| acetamiprid | Tristar, Assail |
| clothianidin | Poncho (GMO seed treatment), Arena, Celero |
| dinotefuran | Scorpion, Safari |
| imidacloprid | Gaucho (GMO seed treatment), Marathon, Merit, Admire |
| thiacloprid | Calypso |
| thiamethoxam | Actara, Adage, Cruiser (GMO seed treatment), Flagship, Meridian |



Insecticides for thrips GH, nursery

Thrips control

- **Pylon | Foliar applications are typically made twice, seven days.**

**Certain fruiting vegetables are on the label.
total-release aerosol version is now available.
GH use only.**

- **Avid | Tank mixed with a neem-based insect growth regulator (IGR), such as Azatin O, AzaGuard or Molt-X and applied as a foliar application is effective when applied two times, seven days apart.**

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Insecticides for thrips GH, nursery

Thrips control

Sirocco

- **Overture (pyridaly)** A slower-acting insecticide, taking up to seven days to see significant reductions in adult thrips populations from a foliar application.

- **Kontos (spirotetramat)** Drench applications show very good results, though they're slow to take full effect (up to three weeks). Foliar spray shown variable results. Geraniums + dracaena damaged Kontos.

Insecticides for thrips GH, nursery

Thrips control

- **Nematodes | *Steinernema feltiae* have been assisting growers to control the pupal stages of WFT. Applications to the media every two to three weeks is recommended to augment other control efforts. This approach adds excellent fungus gnat control at the same time.**
- **Microbial insecticides
BotaniGard, Preferal, Metarhizium, Grandevo**

Insecticides for thrips GH, nursery

Thrips control

- IGRs, are generally used in combination with adulticides or after a good knockdown has been achieved with other products.**

Pedestal has long been a part of thrips-control programs, causing death at the point of molting.

Enstar is labeled for thrips.

Insecticides for thrips GH, nursery

Thrips control

- Neonicotinoid insecticides, such as Flagship, Safari and Tristar, have shown effectiveness against thrips.**
- Mesurol was one of the more effective products for thrips control, but results have been more inconsistent in recent years. Mesurol is a restricted-use pesticide in all states.**
- Aria is a feeding blocker labeled for thrips suppression, but won't provide an immediate knock-down.**

New insecticides GH, nursery

Thrips control

- XXpire has two active ingredients, spinotoram and Isoclast, which shares the mode of action with Conserve. Need to be paid to rotations with other MOAs.**
- Mainspring has a brand new MOA and has activity against thrips from a spray or a drench.**

Insecticides for thrips GH, nursery

Siroco, 6 (bifenazate (floramite) and abemectin)

mites

Foliar

REI 12 hrs

IRAC 6

Insecticides for thrips GH, nursery

Preferal (natural fungus *Isaria fumosorosea* Apopka 97 strain, SEPRO) microbial insecticide is a naturally-occurring fungus that infects both foliage and soil dwelling insects such as whiteflies, aphids, thrips, weevils, psyllids, leafminers, spider mites, mealybugs

Foliar and soil

Limited effect on beneficials

OMRI listed

REI 4 hrs

IRAC unknown

Insecticides for thrips GH, nursery

Grandevo (**Chromobacterium subtsuggae**
strain praa4-1, biopesticide, microbial,
Marrone bio innovations)

Chewing and sucking insects, and mites

Fruits, vegetables, ornamentals, turf, field, GH

Foliar

Reduced fecundity and egg hatch, repellency

Repels bees, toxic to nontargets

OMRI listed

REI 4 hrs

IRAC unknown

Insecticides for thrips GH, nursery

Rycar (pyrifluquinazon, SEPRO) insecticide,
miticide, greenhouse

**Whiteflies, aphids, leaf hoppers, chilli thrips,
malybugs**

Translaminar, oral

Repels bees, toxic to nontargets

REI 12 hrs

IRAC unknown

Insecticides for thrips GH, nursery

Fulcrum, 7C (11% pyriproxifen, OHP)

insecticide, IGR, greenhouse

**Fungus gnats, shore flies, whiteflies, aphids,,
mealybugs, leafminers, scales**

Foliar, translaminar

Relatively not toxic to nontargets

REI 12 hrs

IRAC 7C

Insecticides for thrips GH, nursery

Xxpire, 4C (sulfloxaflor+ spinetoram, DOW)

**insecticide, miticide, greenhouse, nursery,
landscape**

Effective on 39 pests

Systemic, translaminar

Reduced fecundity and egg hatch, repellency

Less toxic to nontargets 3hrs after drying

REI 12 hrs

IRAC isoclast (4c)

**In Sept 2015 use stopped by (9th circuit
court)**

Insecticides for thrips GH, nursery

Mainspring, 28 (cyantraniliprole,
Syngenta) greenhouse, interiorscapes
insects whiteflies, aphids, thrips, mealybugs,
leaf hoppers (sucking) and chewing
Foliar, translaminar, soil, systemic
Reduced fecundity and egg hatch, repellency
Toxic to bees bees and nontargets
REI 4 hrs
IRAC 28

Insecticides for thrips GH, nursery

Kontos, 23 (spirotetramat, Syngenta)

**insecticide, greenhouse, nursery,
interiorscape**

Foliar, translaminar, soil, systemic

**Lepidoptera, leafminers, spider mites, thrips
(immature), cyclamen mite, broad mite,
whiteflies, spittlebugs**

**Toxic to bee larvae and beneficial insect
larvae**

REI 24 hrs

IRAC 23

Insecticides for thrips GH, nursery

Enfold, 6, RUP (emamectin benzoate, Syngenta) insecticide, greenhouse, nursery,

Contact-Systemic

Lepidoptera, leafminers, spider mites, pear psylla

Highly toxic to bees and beneficials

REI 12 hrs

IRAC 6



1. Properties: Pyrethroids

Contact insecticides that destabilize nerve cell membranes. Chemistry based on botanical extracts of pyrethrum.

Do not last long on plants.

Toxic to fish and cats.

Toxic to bees.

Low mammalian toxicity.

Active ingredients

Bifenthrin (Talstar)

Cyfluthrin (Decathalon)

Deltamethrin (Deltagard)

Fluvalinate (Mavrik)

Lambda-cyhalothrin (Scimitar, Battle)

Permethrin (Astro, Spectracide)

1. Pyrethroid toxicity to humans

Insecticide (Common Name)

bifenthrin

Trade Name(s)

Talstar

Classification

pyrethroid

LD₅₀

Oral (mg/kg)

375

LD₅₀

Dermal (mg/kg)

>2000

Manufacturer

FMC



2. Properties: Neonicotinoids

Work on central nervous system, cause overstimulation and blockage of the postsynaptic nicotine acetylcholine receptors.

Long duration of environmental persistence.

Highly toxic to bees.

Low mammalian toxicity.

Active ingredients

Imidacloprid

Clothianidin

Thiamethoxam

Dinotefuran

2. Neonicotinoid toxicity to humans

Insecticide (Common Name)

imidacloprid

Trade Name(s)

**Merit, Marathon,
Provado, Admire**

Classification

neonicotinoid

LD₅₀

Oral (mg/kg)

460

LD₅₀

Dermal (mg/kg)

2000

Manufacturer

Bayer

3. Properties: Organophosphates

Inhibit the enzyme cholinesterase. This prevents the termination of nerve impulse transmission.

Long lasting.

Toxic to bees.

Long term effects on humans so most of these insecticides are taken off the market.

Active ingredients

Acephate (Orthene) and malathion for homeowner use.

Chlorpyrifos (golf courses and nursery only).

Dimethoate not very available, previously used for birch leaf miner sawfly

3. Organophosphate toxicity to humans

Insecticide (Common Name)

acephate

Trade Name(s)

Orthene

Classification

organophosphate

LD₅₀

Oral (mg/kg)

235

LD₅₀

Dermal (mg/kg)

400

Manufacturer

Valent

3. Organophosphate toxicity to humans

Insecticide (Common Name)

dimethoate

Trade Name(s)

Cygon

Classification

organophosphate

LD₅₀

Oral (mg/kg)

235

LD₅₀

Dermal (mg/kg)

400

Manufacturer

UAP



4. Properties: Carbamates

Inhibit the enzyme cholinesterase. This prevents the termination of nerve impulse transmission.

Short acting.

Toxic to bees.

Low mammalian toxicity.

Active ingredients

Carbaryl

4. Carbamate toxicity to humans

Insecticide (Common Name) **Trade Name(s)**

carbaryl

Sevin

| | | |
|-----------------------|------------------------|------------------------|
| Classification | LD₅₀ | LD₅₀ |
| carbamate | Oral (mg/kg) | Dermal (mg/kg) |
| | 246 | >4000 |

Manufacturer

Drexel

5. Unique class toxicity to humans

Insecticide (Common Name)

chlorantranipirole

Trade Name(s)

Acelepryn

Classification

**anthranilic
diamide**

LD₅₀

Oral (mg/kg)

>5000

LD₅₀

Dermal (mg/kg)

>5000

Manufacturer

Dow

5. Unique class toxicity to humans

Insecticide (Common Name)

pymetrozine

Trade Name(s)

Endeavor

Classification

pyridine

LD₅₀

Oral (mg/kg)

>5000

LD₅₀

Dermal (mg/kg)

>2000

**Inhibits sucking
mouthparts**

Manufacturer

Syngenta

6. Microbial insecticides

Products of natural microbes.
Specific in action.

Active ingredients

Abamectin (Avid, by Syngenta): Toxic to bees

Spinosad (Conserve, by Dow): Low bee toxicity

Bacillus thuringiensis var. *kurstaki*

Bacillus thuringiensis var. *tenebrionis*

Bacillus thuringiensis var. *israelensis*

All 3 *B.t.* varieties have low toxicity to bees

6. Microbial insecticide toxicity to humans

Insecticide (Common Name)

spinosad

Trade Name(s)

Conserve, Entrust

Classification

microbial

LD₅₀

Oral (mg/kg)

3783

LD₅₀

Dermal (mg/kg)

>5000

Manufacturer

Dow

8. Properties: Insect growth regulators

Kill immature insects as they develop, by either disrupting the molting process, or by producing sterile adults. All but neem products can kill aquatic crustaceans. Do not apply near streams.

Active ingredients

Halofenozide (Mach 2 by Dow): Used on turf for moths and grubs

Tebufenozide (Confirm by Dow)

Cyromazine (Citation by Syngenta)

Diflubenzuron (Dimilin by Uniroyal)

Fenoxycarb (Precision by Syngenta)

Hexythiazox (Hexygon by Gowan)

7. Insect growth regulator toxicity to humans

Insecticide (Common Name)

halofenozide

Trade Name(s)

MACH2

Classification

molting

accelerator

LD₅₀

Oral (mg/kg)

>2850

LD₅₀

Dermal (mg/kg)

>2000

Manufacturer

Dow

8. Miticides compatible with beneficials

Long residual:

Hexythiazox (Hexygon by Gowan)

Bifenazate (Floramite by OHP)

Clofentazine (Ovation by Scotts)

Chlorfenapyr (Pylon by BASF)

8. Miticide toxicity to humans

Miticide (Common Name)

hexythiazox

Trade Name(s)

Hexygon

Classification

carboxamide

LD₅₀

Oral (mg/kg)

>5000

LD₅₀

Dermal (mg/kg)

>5000

Manufacturer

Gowan