

Greenhouse Resistance Management Programs



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Information from: http://www.olympichort.com/ohp_research.html

What is greenhouse resistance management?

Many insects and mites can evolve resistance to chemicals that are used too frequently. Rotating chemicals from different chemical classes and utilizing IPM programs to reduce chemical use can help prevent pest resistance.



What is greenhouse resistance management?

In general, biological control and biorational insecticides are used at low pest densities, whereas conventional pesticides may be needed to knock down high pest densities.



Resistance Management Program For Aphids

Order Hemiptera

Family Aphididae

Melon/cotton aphid, *Aphis gossypii*

Green peach aphid, *Myzus persicae*

DESCRIPTION OF THE PESTS

Aphids are distinguished from other insects by the presence of cornicles, tubelike appendages that protrude from the rear of the aphid. The two species most commonly encountered are the green peach aphid (pictured) and the cotton or melon aphid. Green peach aphid is characterized by a depression in the front of the head between the antennae and by long thin, translucent cornicles that extend beyond the tip of the body. Green peach aphids vary in color from yellowish green to rose pink. Winged adults have a dark blotch in the middle of the abdomen.



Resistance Management Program For Aphids

DESCRIPTION OF THE PESTS

Melon aphids are typically dark green, but color variations do occur frequently. The cornicles are relatively short, stout, and always dark. Melon aphids have red eyes and antennae that only reach to the middle of the abdomen. Adult aphids may or may not have wings. Winged aphids are produced as a result of crowding. Green peach aphids produce winged adults at lower population densities than the melon aphid.

The optimal temperature for green peach aphid development is 75°F, whereas optimal temperatures for melon aphids are above 75°F.

**Melon aphids
and mummies**



Resistance Management Program For Aphids

CHEMICAL CONTROL

There are numerous conventional and biorational pesticides registered for aphid control. Detecting aphid infestations before they get out of hand is the most important aspect of a proper control program. Aphids deep within the plant canopy on maturing plants, or in flowers are especially difficult to deal with.

Olympic products that are effective against aphids include Marathon 1%G, 60 WP and Marathon II), Azatin XL, Triact 70 and Olympic Insecticidal Soap.

Marathon 1%G and 60WP are used to provide 8 to 12 weeks of aphid control on crops with longer production cycles. Marathon needs to be applied properly to ensure excellent control.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Marathon II is a sprayable formulation that will provide rapid knock-down and 2 to 4 weeks of control. A tank mix of Marathon II with either Triact 70 or the soap may result in improved coverage and more rapid control.

Azatin XL is an insect growth regulator that needs to be applied twice, 7 days apart, for best results. A tank mix of Azatin with Decathlon has been effective against several insect pests, including aphids.

Triact 70 and Olympic Insecticidal Soap are short-residual materials that are used to rapidly reduce an aphid infestation.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon® 1% Granular - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: Refer to label

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically to the media and will provide superior control of aphids. For best control, apply prior to infestation. Control is 8 to 12 weeks. Avoid leaching for about 10 days and keep media moist. Always read the label.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Marathon® II - Translaminar Systemic Insecticide

For Foliar/Drench Applications for Insect Control in Greenhouse, Nursery and Interiorscapes

Rate: 50 mL (1.7 oz.) per 100 gallons (foliar) See label for drench.

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon II has foliar or drench applications. Marathon II applications should commence before intense insect pressure is present. Marathon II foliar applications have 14 to 28 days of control. Marathon II applied as a drench will provide 8 to 12 weeks of control. Refer to label for correct drench application rates. Compatible with commonly used pesticides and foliar fertilizers. Use of a spreader/sticker is recommended for foliar sprays. Shake well before using.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

For Indoor and Outdoor Use on Ornamentals and Vegetable Crops

Rate: 10-16 oz. per 100 gallons (Curative)

Signal Word: Caution

REI: 4 hours

Spray applications of Azatin XL insect growth regulator will control the nymph stages of the aphid. Tank mix with Decathlon 20 WP synthetic pyrethroid to control adults and nymph stages. Repeat applications at 5 to 7 day intervals. Spreader stickers can enhance performance but should be tested prior to use. Shake well before mixing. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

For Control of a Wide Range of Crawling and Flying Insect Pests on Ornamentals and Nursery Stock

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Spray applications of Decathlon 20 WP synthetic pyrethroid will control the nymph and adult stages of aphids. Tank mix with Azatin XL insect growth regulator to control adult and nymph stages. Spreader stickers can enhance performance but should be tested prior to use. Repeat applications at 5 to 7 day intervals. Always read the label.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Always read the label.

Resistance Management Program For Aphids

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Cinnamite	biological-aldehyde	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Endeavor	pyridine azomethine	12
Enstar II	insect growth regulator	4
Olympic Insecticidal Soap 49.52 CF	potassium salts of fatty acids	12
M-Pede	potassium salts of fatty acids	12
Marathon 1% G	chloronicotinyl	12
Marathon 60 WSP	chloronicotinyl	12
Marathon II	chloronicotinyl	12
Mesurool 75 WP	carbamate	24

Resistance Management Program For Aphids

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Nicotine Smoke	botanical	see worker protection manual
Ornazin 3%	biological-insect growth regulator	12
Orthene TT&O	organophosphate	24
PT 1300 Orthene	organophosphate	24
Thiodan EC, WP	chlorinated hydrocarbon	24
Fulex Thiodan Smoke	chlorinated hydrocarbon	24
Triact 70	horticultural oil	4
Ultrafine Spray Oil	horticultural oil	4

**Winged green peach
aphid adult**



Resistance Management Program For Foliar-Feeding Mealybugs

Order Hemiptera

Family Pseudococcidae

Citrus mealybug, *Planococcus citri*

Longtailed mealybug,
Pseudococcus longispinus

DESCRIPTION OF THE PESTS

Mealybugs are slow-moving sucking insects that have a loose, waxy coating on the body. The citrus mealybug (pictured) is covered with white, powdery wax, except for a faint narrow streak down the middle. It has short, wax filaments along the sides and hind filaments that are about one-fourth as long as the body. The longtailed mealybug has four long terminal wax filaments. It gives birth to live young.



Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon® 1% Granular - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: Refer to label

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically or as a drench. For best control, apply prior to infestation, if possible. Control may take longer in woody plants but should exceed 8 weeks.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Marathon® II - Translaminar Systemic Insecticide

**For Foliar Applications for Insect Control in Greenhouse,
Nursery and Interiorscapes**

Rate: 50 mL (1.7 oz.) per 100 gallons

Signal Word: Caution

REI: 12 hours

Marathon II is for foliar applications only. Marathon II full cover spray should commence before intense insect pressure is present. Marathon II is compatible with commonly used pesticides and foliar fertilizers. The use of a spreader/sticker is recommended. Marathon II can achieve 14 to 21 days control. Always read the label and technical bulletins prior to product use.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

**For Indoor and Outdoor Use on Ornamentals and
Horticultural Crops**

Rate: 12-16 oz. per 100 gallons (Curative)

Signal Word: Caution

REI: 4 hours

Spray applications of Azatin XL insect growth regulator will control the nymphs and crawler stages. Tank mix with Decathlon 20 WP synthetic pyrethroid to control crawler stages of mealybug and scale. Repeat applications at 5 to 7 day intervals. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide/Insecticide

Rate: 0.5% - 1% per 100 gallons

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component in controlling mealybug and scale insects as a rotational product. Applications should be made on a 7 to 10 day spray interval depending on severity of infestation. Apply to runoff at 25 to 40 psi with a hand sprayer or 100 to 200 psi with power equipment. Triact 70 should be mixed in water with a temperature of greater than 45° F. Before mixing, shake well. Triact 70 is tank mix compatible with common pesticides and foliar fertilizers. Triact is a registered trademark of Certis USA.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

**For Broad-Spectrum Control of Crawling and Flying Insect
Pests on Ornamentals and Nursery Stock**

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Spray applications of Decathlon 20 WP synthetic pyrethroid will control the nymphs and crawler stages of mealybug and scale. Tank mix with Azatin XL insect growth regulator to control crawler stages of mealybug and scale is suggested. Repeat applications at 5 to 7 day intervals. Always read the label.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Always read the label.

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Enstar II	insect growth regulator	4
Olympic Insecticidal Soap 49.52 CF	potassium salts of fatty acids	12
Marathon 1% G	chloronicotinyl	12
Marathon 60 WSP	chloronicotinyl	12
Marathon II	chloronicotinyl	12
Ornazin 3%	biological-insect growth regulator	12

Resistance Management Program For Foliar-Feeding Mealybugs

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Orthene TT&O	organophosphate	24
PT 1300 Orthene	organophosphate	24
Triact 70	horticultural oil	4
Ultrafine Spray Oil	horticultural oil	4

Longtailed mealybug



Resistance Management Program For Root Mealybugs

Order Hemiptera

Family Pseudococcidae

Root mealybug, *Rhizoecus* spp.

DESCRIPTION OF THE PESTS

Root mealybugs are below-ground dwelling mealybugs that feed on the roots of plants. These mealybugs have a thin, uniform waxy coating and lack the terminal wax filaments typical of their foliar-feeding relatives.

CHEMICAL CONTROL

A number of pesticides are available. Several examples follow. Rotate with different chemical classes.

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UC Statewide IPM Project
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Resistance Management Program For Root Mealybugs

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

**For Broad-Spectrum Control of Crawling and Flying Insect
Pests on Ornamentals and Nursery Stock**

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Trade Name(s)	Chemical Class	REI (Hrs.)
Decathlon 20 WP	pyrethroid	12
Orthene TT&O	organophosphate	24

Resistance Management Program For Soft Scales

Order Hemiptera

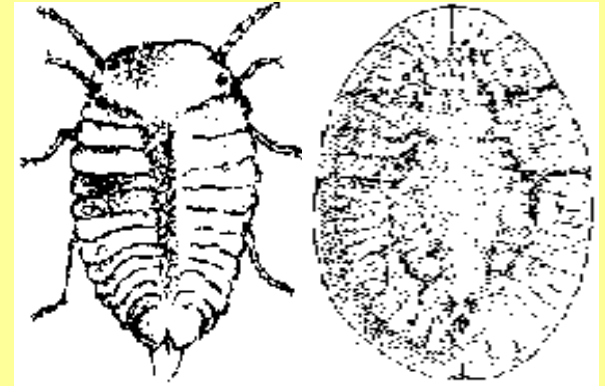
Family Coccidae

Brown soft scale, *Coccus hesperidum*

Hemispherical scale, *Saissetia coffeae*

Black scale, *Saissetia oleae*

Green shield scale, *Pulvinaria psidii*



Brown soft scale
crawler (L) and adult
female

DESCRIPTION OF THE PESTS

Soft scales are typically found on woody and foliage plants. The first nymphal instar is called a crawler and has functional legs. The remaining instars are attached to the leaf or twig and (with the exception of green shield scale) do not move. Soft scales have a conspicuous side-view profile compared to armored scales and also produce honeydew.

Resistance Management Program For Soft Scales

DESCRIPTION OF THE PESTS

Brown soft scale adults are fairly flat in profile, range in color from yellowish green to brown, and are often spotted or mottled to uniform brown. Hemispherical scale adults are round, hard, brown, smooth and shiny. Black scale adults are globular and hardened with ridges on the back that look like the letter "H". Green shield scale has a light yellow-green color as an immature.



Hemispherical scale

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically or as a drench. For best control, apply prior to infestation, if possible. Control may take longer in some woody plant material but should exceed 8 weeks. Always read the label.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Marathon® II - Translaminar Systemic Insecticide

**For Foliar Applications for Insect Control in Greenhouse,
Nursery and Interiorscapes**

Rate: 50 mL (1.7 oz.) per 100 gallons

Signal Word: Caution

REI: 12 hours

Marathon II is for foliar applications only. Marathon II full cover spray should commence before intense insect pressure is present. Marathon II is compatible with commonly used pesticides and foliar fertilizers. The use of a spreader/sticker is recommended. Marathon II can achieve 14 to 21 days control. Always read the label and technical bulletins prior to product use.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

**For Indoor and Outdoor Use on Ornamentals and
Horticultural Crops**

Rate: 12-16 oz. per 100 gallons (Curative)

Signal Word: Caution

REI: 4 hours

Spray applications of Azatin XL insect growth regulator will control the nymphs and crawler stages. Tank mix with Decathlon 20 WP synthetic pyrethroid to control crawler stages of mealybug and scale. Repeat applications at 5 to 7 day intervals. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide/Insecticide

Rate: 0.5% - 1% per 100 gallons

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component in controlling mealybug and scale insects as a rotational product. Applications should be made on a 7 to 10 day spray interval depending on severity of infestation. Apply to runoff at 25 to 40 psi with a hand sprayer or 100 to 200 psi with power equipment. Triact 70 should be mixed in water with a temperature of greater than 45° F. Before mixing, shake well. Triact 70 is tank mix compatible with common pesticides and foliar fertilizers. Triact is a registered trademark of Certis USA.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

**For Broad-Spectrum Control of Crawling and Flying Insect
Pests on Ornamentals and Nursery Stock**

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Spray applications of Decathlon 20 WP synthetic pyrethroid will control the nymphs and crawler stages of mealybug and scale. Tank mix with Azatin XL insect growth regulator to control crawler stages of mealybug and scale is suggested. Repeat applications at 5 to 7 day intervals. Always read the label.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Always read the label.

Resistance Management Program For Soft Scales

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Enstar II	insect growth regulator	4
Olympic Insecticidal Soap 49.52 CF	potassium salts of fatty acids	12
Marathon 60 WSP	chloronicotinyl	12
Marathon II	chloronicotinyl	12
Orthene TT&O	organophosphate	24
PT 1300 Orthene	organophosphate	24
Triact 70	horticultural oil	4
Ultrafine Spray Oil	horticultural oil	4

Resistance Management Program For Armored Scales

Order Hemiptera

Family Diaspididae

Boisduval scale, *Diaspis boisduvali*

Fern Scale, *Pinnaspis aspidistrae*
(pictured)



DESCRIPTION OF THE PESTS

Eggs are laid under the armor of the female where they develop and hatch. The first stage after hatching is the nymphal stage with legs (crawlers). Crawlers may stay under maternal armor several hours until outside conditions are good. After they leave the cover, they wander for minutes to days. At the end of the wandering period they flatten against the leaf or stem and begin to secrete armor.

Resistance Management Program For Armored Scales

DESCRIPTION OF THE PESTS

Newly settled nymphs insert their piercing, sucking mouthparts into plant tissue and start feeding. Nymphs shed their skin as they grow and develop, and towards the end of development, males do not feed. The cast skins, called exuviae, are incorporated into the armor. The armor is non-living and is made of cast skins, threads, and liquid.

Females look like immatures. They remain under armor in one place throughout their lives to feed and reproduce. Males are very different in appearance and behavior from females. They are tiny, winged creatures with eyes and legs. The armor must be pried off to reveal a female insect attached to the plant by thread-like mouthparts. The adult female insect lacks wings, legs, or eyes.

Resistance Management Program For Armored Scales

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

For Indoor and Outdoor Use on Ornamentals and Horticultural Crops

Rate: 12-16 oz. per 100 gallons (Curative)

Signal Word: Caution

REI: 4 hours

Spray applications of Azatin XL insect growth regulator will control the nymphs and crawler stages. Tank mix with Decathlon 20 WP synthetic pyrethroid to control crawler stages of mealybug and scale. Repeat applications at 5 to 7 day intervals. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Armored Scales

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide/Insecticide

Rate: 0.5% - 1% per 100 gallons

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component in controlling mealybug and scale insects as a rotational product. Applications should be made on a 7 to 10 day spray interval depending on severity of infestation. Apply to runoff at 25 to 40 psi with a hand sprayer or 100 to 200 psi with power equipment. Triact 70 should be mixed in water with a temperature of greater than 45° F. Before mixing, shake well. Triact 70 is tank mix compatible with common pesticides and foliar fertilizers. Triact is a registered trademark of Certis USA.

Resistance Management Program For Armored Scales

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

For Broad-Spectrum Control of Crawling and Flying Insect Pests on Ornamentals and Nursery Stock

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Spray applications of Decathlon 20 WP synthetic pyrethroid will control the nymphs and crawler stages of mealybug and scale. Tank mix with Azatin XL insect growth regulator to control crawler stages of mealybug and scale is suggested. Repeat applications at 5 to 7 day intervals. Always read the label.

Resistance Management Program For Armored Scales

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Always read the label.

Resistance Management Program For Armored Scales

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Enstar II	insect growth regulator	4
Olympic Insecticidal Soap 49.52 CF	potassium salts of fatty acids	12
Orthene TT&O	organophosphate	24
PT 1300 Orthene	organophosphate	24
Triact 70	horticultural oil	4
Ultrafine Spray Oil	horticultural oil	4

Resistance Management Program For Whiteflies

Order Hemiptera

Family Aleyrodidae

Greenhouse whitefly,

Trialeurodes vaporariorum (pictured)

Silverleaf whitefly,

Benicia argentifolii

DESCRIPTION OF THE PESTS

The greenhouse whitefly adult is 0.9 (male) to 1.1 mm (female) long, with four wings, sucking mouthparts, a powdery waxy coating over the body, and wings that give the body a white color. The wings are held nearly parallel to the leaf and cover the abdomen when the adult is at rest. The life stages are: egg, four nymphal instars, pupa, adult.



Resistance Management Program For Whiteflies

DESCRIPTION OF THE PESTS

Eggs are partially inserted into the leaf, initially they are yellowish, but close to hatching they turn a purplish brown. The first nymphal instar is called a crawler and has functional legs, while the remaining instars are attached to the underside of the leaf and do not move. The end of the fourth instar is called a pupa. The pupal stage is the most important for determining whitefly species identification. Greenhouse whitefly pupae are oval and have vertical sides, giving the pupa a cakelike appearance from the side. Along the perimeter of the upper surface is a fringe of filaments and relatively large wax filaments project above the upper surface of the body. The greenhouse whitefly can complete one generation in 21 to 26 days at 81°F.

Resistance Management Program For Whiteflies

DESCRIPTION OF THE PESTS

The silverleaf whitefly adult is 0.8 (male) to 1.0 mm (female) long, with four wings, and sucking mouthparts. The white, waxy coating is not as thick as it is on the greenhouse whitefly and its yellow body has a whitish hue rather than a white color. Wings are held at the sides of the body, partially exposing the back of the abdomen when the adult is at rest. There are also seven life stages. Eggs are partially inserted into the leaf, and remain yellowish until hatching. The first nymphal instar is called a crawler and has functional legs; the remaining instars are attached to the leaf and do not move. The end of the fourth instar is called a pupa. Silverleaf whitefly pupae are ovoid, with a slightly pointed hind end and red eye spots. The pupa is flat and does not have a marginal fringe of filaments. Silverleaf whiteflies can complete development in 16 (86°F) to 31 (68°F) days.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon® 1% Granular - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: Refer to label

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically or as a drench. For best control, apply prior to infestation, if possible. Control may take longer in woody plants but should exceed 8 weeks.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Marathon® II - Translaminar Systemic Insecticide

For Foliar Applications for Insect Control in Greenhouse, Nursery and Interiorscapes

Rate: 50 mL (1.7 oz.) per 100 gallons

Signal Word: Caution

REI: 12 hours

Marathon II is for foliar applications only. Marathon II full cover spray should commence before intense insect pressure is present. Marathon II is compatible with commonly used pesticides and foliar fertilizers. The use of a spreader/sticker is recommended. Marathon II can achieve 14 to 21 days control. Always read the label and technical bulletins prior to product use.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

For Indoor and Outdoor Use on Ornamentals and Horticultural Crops

Rate: 12-16 oz. per 100 gallons (Curative)

Signal Word: Caution

REI: 4 hours

Biorational insecticide that is sometimes used as a tank mix with Decathlon 20 WP synthetic pyrethroid. Repeat applications at 5 to 7 day intervals. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide/Insecticide

Rate: 0.5% - 1% per 100 gallons

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component as a rotational product in a resistance management program. Applications should be made on a 7 to 10 day spray interval depending on severity of infestation. Apply to runoff at 25 to 40 psi with a hand sprayer or 100 to 200 psi with power equipment. Triact 70 should be mixed in water with a temperature of greater than 45° F. Before mixing, shake well. Triact 70 is tank mix compatible with common pesticides and foliar fertilizers. Triact is a registered trademark of Certis USA.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

**For Broad-Spectrum Control of Crawling and Flying Insect
Pests on Ornamentals and Nursery Stock**

Rate: 1.9 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

**Broad spectrum insecticide that is sometimes used as a
tank mix with Azatin XL insect growth regulator. Repeat
applications at 5 to 7 day intervals. Always read the label.**

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Always read the label.

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Endeavor	pyridine azomethine	12
Enstar II	insect growth regulator	4
Olympic Insecticidal Soap 49.52 CF	potassium salts of fatty acids	12
M-Pede	potassium salts of fatty acids	12
Marathon 1% G	chloronicotinyl	12
Marathon 60 WSP	chloronicotinyl	12
Marathon II	chloronicotinyl	12

Resistance Management Program For Whiteflies

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Ornazin 3%	biological-insect growth regulator	12
Orthene TT&O	organophosphate	24
PT 1300 Orthene	organophosphate	24
Triact 70	horticultural oil	4
Ultrafine Spray Oil	horticultural oil	4

Silverleaf whitefly



Scott Bauer
USDA ARS
www.insectimages.org

UGA1320093

Resistance Management Program For Thrips

Order Thysanoptera

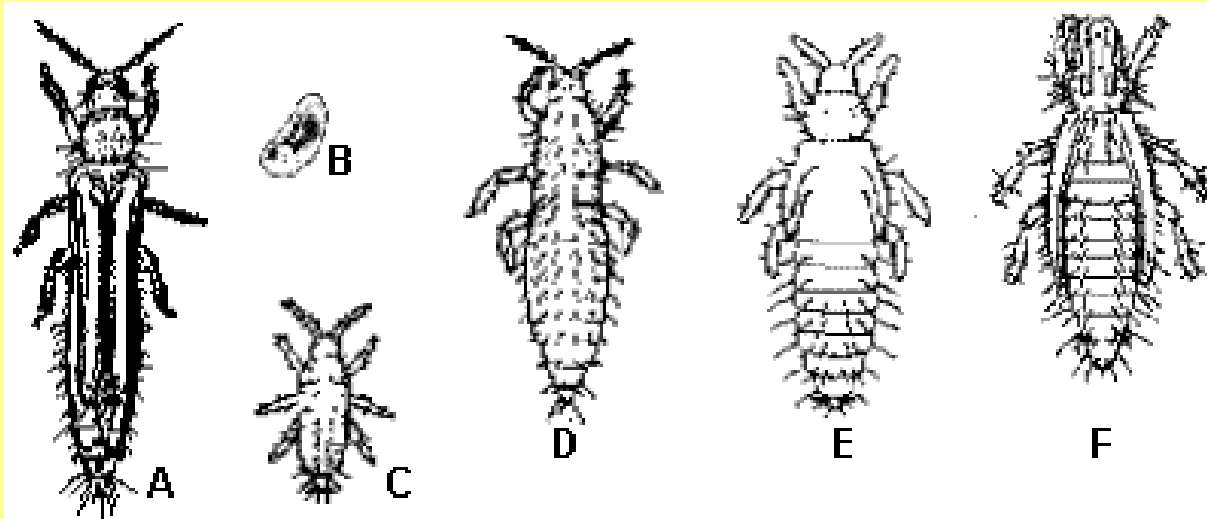
Family Thripidae

Western flower thrips, *Frankliniella occidentalis*

Greenhouse thrips, *Heliothrips haemorrhoidalis*

DESCRIPTION OF THE PESTS

Thrips are tiny insects that have four featherlike wings, each consisting of a thick supporting strut with fine hairs on the front and hind edges. Thrips go through six life stages: egg, first instar, second instar, prepupa, pupa, and adult. Thrips insert eggs into plant tissue. The first two instars and adults feed by piercing and removing contents of individual plant cells.



Resistance Management Program For Thrips

DESCRIPTION OF THE PESTS

Western flower thrips (pictured on right) has three color forms. There is a pale form that is white and yellow, except for slight brown spots or blemishes on the top of the abdomen; an intermediate form with a dark orange thorax and brown abdomen; and a dark form that is dark brown. Western flower thrips usually feed in enclosed tissues such as flowers, buds, or growing tips. Adults also feed on pollen and on spider mites. The prepupa and pupal stages take place in the soil beneath infested plants. 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).



Resistance Management Program For Thrips

DESCRIPTION OF THE PESTS

Adult greenhouse thrips 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 in size until they fall off and another one begins to form, resulting in a characteristic spotting of the infestation area with black specks of fecal material.



Greenhouse thrips

Jack Kelly Clark
University of California

Resistance Management Program For Thrips

CHEMICAL CONTROL

There is no single pesticide that will provide total western flower thrips control. Olympic products registered for western flower thrips control include Azatin XL (botanical insect growth regulator, 4hr REI) Decathlon (pyrethroid, 12hr REI), Insecticidal Soap 49.52 CF (potassium salts of fatty acids, 12hr REI), and Marathon (chloronicotinyl, 0-12hr REI).

A tank mix of Azatin XL and Decathlon is used by many growers for thrips (and other insect) control. Another effective tank mix is Azatin XL and one of the Beauveria bassiana products (Botanigard or Naturalis).

To avoid resistance, rotate between pesticides with different modes of action. A suggested pesticide rotation program for western flower thrips follows. The same pesticides can be used for greenhouse thrips.

Resistance Management Program For Thrips

CHEMICAL CONTROL

I. Pesticides and pesticide tank mixes that can be used to reduce an established western flower thrips population.

A. Mode of action group 1

Orthene 97 TT&O (8 oz/100 gallons). Orthene, an organophosphate insecticide, is labeled on only a relatively few crops, but has been effective against western flower thrips. Rose and orchid growers should use Orthene in their thrips management programs.

Mesuroi 75WP (8-16 oz/100 gallons). Mesuroi is a carbamate insecticide that has been effective against western flower thrips. Do not apply carbamate insecticides following organophosphate insecticide applications, because the two chemical classes have similar modes of activity.

Resistance Management Program For Thrips

CHEMICAL CONTROL

B. Mode of action groups 1 & 3

Tame/Orthene TR (Use amount depends on canister size). This aerosol “tank mix in a can” combines an organophosphate and a pyrethroid insecticide. The combination should be useful for controlling thrips in flowers.

C. Mode of action group 2

Thionex 50WP (16 oz/100 gallons) and 3EC (2/3 qt/100 gallons). Thionex, an organochlorine (cyclodiene) insecticide, has replaced Thiodan, but both Thionex formulations are identical to the Thiodan formulations. Adding a pyrethroid insecticide (mode of action group 3), such as Decathlon 20 WP, as a tank mix will increase control.

Resistance Management Program For Thrips

CHEMICAL CONTROL

D. Mode of action groups 6 & 26

Avid (8 fl oz/100 gallons). Avid, a glycoside pesticide, has been effective against western flower thrips. A tank mix with Azatin XL (12 to 16 fl oz/100 gallons) may improve control.

E. Mode of action groups 3 & 26

Decathlon (1.9 oz/100 gallons) + Azatin XL (12-16 fl oz/100 gallons) tank mixes have been effective against a number of insect pests, including thrips.

F. Mode of action group 5

Conserve SC (6-22 fl oz/100 gallons). Conserve is a spinosyn pesticide that has been very effective against western flower thrips. It can be used on mature crops to kill thrips in flowers. Activity is very rapid, but residual life is short - a few days at most. Use other products in rotation.

Resistance Management Program For Thrips

CHEMICAL CONTROL

II. Pesticides and pesticide tank mixes that can be used when western flower thrips populations are low and/or virus disease is not a factor.

A. Mode of action groups Biopesticides & 26

BotaniGard or Naturalis-T&O (label rates) + Azatin XL (12-16 fl oz/100 gallons). Botanigard and Naturalis are classified as biopesticides, and contain strains of a naturally-occurring fungus (*Beauveria bassiana*). Make at least three applications, 5 to 7 days apart. Use when thrips numbers are low.

These products will not control high thrips populations. A tank mix with Azatin XL will significantly increase the activity of the *B. bassiana*.

Resistance Management Program For Thrips

CHEMICAL CONTROL

B. Mode of action group 15

Pedestal (6-8 fl oz/100 gallons). Pedestal is a benzoylurea insect growth regulator. As an insect growth regulator it is effective only against larval stages. The addition of a spray adjuvant is suggested to improve coverage.

Pedestal has a different mode of action than Preclude (see next slide) or Azatin. Label directions are to make only one application, then at least two applications of products with different modes of action before another Pedestal application. Do not make a second Pedestal application within 30 days.

Resistance Management Program For Thrips

CHEMICAL CONTROL

C. Mode of action group 7

Preclude Total Release Aerosol (The number of cans to use depends on can size) is classified as a carbamate insecticide but it also is an insect growth regulator. As such, it will not directly affect adult thrips, only the immature (larval) stages. Repeat after 7 days. Some growers apply Preclude regularly (e.g. every week or two) along with other products.

Enstar II (5-10 fl oz/100 gallons) is now labeled for thrips control. This insect growth regulator should be applied twice, 7 days apart.

Resistance Management Program For Thrips

CHEMICAL CONTROL

D. Mode of action group 4

Marathon II (1.7 fl oz/100 gallons). Marathon II is a chloronicotinyl insecticide in a liquid formulation. For best results against WFT it should be applied as a spray. It is most effective against aphids and whiteflies, but will provide some control of thrips feeding on foliage. Addition of a spray adjuvant is suggested to improve coverage. Tank mixing with a pyrethroid insecticide, such as Decathlon 20 WP, may improve control.

E. Mode of action groups oils and soaps

Spray Oils such as Triact 70 and Ultra-fine Oil, or Insecticidal Soaps (0.5-1.0 gallons/100 gallons) will kill thrips hit directly by sprays, and may repel thrips (and other insects) for a time after the spray has dried. Treatments are most effective against thrips feeding on foliage.

Resistance Management Program For Thrips

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Avid 0.15 EC	glycoside	4
Azatin XL	biological-insect growth regulator	4
BotaniGard 22 WP	microbial	4
BotaniGard ES	microbial	12
Conserve	spinosyn	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
DuraPlex	carbamate	24
Mesurol 75 WP	carbamate	24
Naturalis-T&O	microbial	4
Nicotine	botanical	see worker protection manual

Resistance Management Program For Thrips

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Ornazine 3%	biological-insect growth regulator	12
Orthene TT&Os	organophosphate	24
PT 1300 Orthene	organophosphate	24
Preclude	insect growth regulator	12

**White feeding scars and
black excrement from
greenhouse thrips**

Jack Kelly Clark
University of California



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Resistance Management

Program For Fungus Gnats

Order Diptera

Family Sciaridae

Darkwinged fungus gnats, *Bradysia* spp.



Jack Kelly Clark
University of California

DESCRIPTION OF THE PEST

Fungus gnats are small (2-5 mm long) mosquito-like flies with dark wings, delicate legs, and long antennae. They lay their eggs in soil, and the eggs hatch about four days later. There are four larval instars that increase in size up to about 0.33 inch (8 mm). Larvae are clear, with visible internal organs, and have shiny black head capsules. Initially larvae feed on root hairs and algae; later, larvae may feed on the insides of roots. When populations are high, larvae may bore into larger roots or stems that are in the soil. Larvae will also feed on leaves touching the soil. One generation may complete development in 21 to 40 days.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Because fungus gnat larvae can be most damaging during rooting or shortly after potting rooted cuttings, it is important to protect susceptible crops. This usually means to make an application within 10 to 14 days after potting to prevent larval damage. If adults are present, it's a good idea to reduce their numbers as well.

There are some excellent products in several pesticide categories registered for fungus gnat control in greenhouses. Olympic products registered for fungus gnat larval control are Azatin XL (azadirachtin insect growth regulator, 4hr REI), Marathon II, Marathon 1%G or 60 WP (chloronicotinyl, 12hr REI), and Decathlon (pyrethroid, 12hr REI).

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Azatin XL is an insect growth regulator that will disrupt larval development to adulthood. There are no direct effects on adults. Make two drench, or “sprench”, applications 7 to 10 days apart. Other labeled insect growth regulators are Adept, Citation, Distance, and Enstar II (all 12 hr REI). Ornazin (12hr REI) is another azadirachtin-based insect growth regulator.

Other registered products include Duraguard (organophosphate, 24hr REI) and *Bacillus thuringiensis israeliensis* (microbial, 4hr REI).

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Marathon is one of the best materials for fungus gnat control. There currently are no other registered products in this chemical class. Marathon is registered for control of fungus gnat larvae only, not adults. Only one application of Marathon will be needed. However, if the goal is to apply Marathon for control of foliar-feeding pests such as aphids or whiteflies, an early application for fungus gnat control will be too soon for best control of those pests. This is because the root system will not be developed enough to take up and translocate enough of the systemic insecticide for long-term insect control.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

All liquid and powder formulations for larval control will be applied as drenches or “sprenches”. Drench volume will vary with pot size and media type, but generally is 0.5 to 1 fluid ounce per inch of pot diameter. The objective should be to evenly distribute the active ingredient throughout the media without any loss through leaching. Sprench applications are made by applying a spray to the medium surface followed by irrigation as for drenches. Applications should be made to media that is moderately moist (e.g. the day following irrigation), not saturated or dry.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Pyrethroid insecticides to control fungus gnat adults, such as Decathlon should be used along with products for larval control for faster control. These products are applied as high- or low-volume sprays. Other pyrethroids that are used for fungus gnat adult control include Astro (12hr), Mavrik (12hr), Scimitar (24hr), Talstar (12hr), and Tame (24hr).



Larva and adult darkwinged fungus gnats

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon® 1% Granular - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: Refer to label

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically to the media. Only apply to plant material with active healthy root system for systemic activity. Avoid leaching for 10 days. Keep media moist.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Marathon® II - Translaminar Systemic Insecticide

**For Foliar/Drench Applications for Insect Control in
Greenhouse, Nursery and Interiorscapes**

**Rate: 50 mL (1.7 oz.) per 100 gallons (foliar) See label for
drench.**

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon II has foliar or drench applications. Applications should commence before intense insect pressure is present. Foliar applications have 14 to 28 days of control. Drench will provide 8 to 12 weeks of control. Refer to label for drench application rates. Marathon II is compatible with common pesticides and foliar fertilizers. Use of a spreader/sticker is recommended for foliar sprays. Shake well before using.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

For Indoor and Outdoor Use on Ornamentals and Vegetable Crops

Rate: 8 oz. per 100 gallons as a drench

Signal Word: Caution

REI: 4 hours

Drench applications of Azatin XL insect growth regulator will control the pupal and larval stages of fungus gnats. After drench applications of Azatin XL are accomplished, apply an application of Decathlon 20 WP synthetic pyrethroid to control adult stages of fungus gnats. Repeat applications at 7 day interval. Shake well before mixing. Always read the label. Azatin is a registered trademark of Certis USA.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

**For Control of a Wide Range of Crawling and Flying Insect
Pests on Ornamentals and Nursery Stock**

Rate: 1.3 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Spray applications of Decathlon 20 WP synthetic pyrethroid will control the adult stages of fungus gnat. After spray applications of Decathlon 20 WP are accomplished, an application of Azatin XL insect growth regulator, to control larval and pupal stages of fungus gnats is suggested. Spreader stickers may enhance performance. Repeat applications at 7 day intervals. Always read the label.

Resistance Management Program For Fungus Gnats

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Enstar II	insect growth regulator	4
Gnatrol (<i>B.t. israeliensis</i>)	microbial	4
Marathon 1% G	chloronicotinyl	12
Marathon 60 WSP	chloronicotinyl	12
Marathon II	chloronicotinyl	12
Ornazin 3%	biological-insect growth regulator	12
Orthene TT&Os	organophosphate	24
PT 1300 Orthene	organophosphate	24

Resistance Management Program For Shore Flies

Order Diptera

Family Ephydriidae

Shore flies, *Scatella stagnalis*

DESCRIPTION OF THE PEST

This fly breeds in over-watered conditions in association with algae. The adult is small (2 mm) and dark. The overall

appearance is similar to a fruit fly; having short antennae and shorter legs than fungus gnats. The pair of dark wings has three white spots on each wing. When the fly is at rest, there appears to be five spots because the wings overlap.

Small, oblong eggs are laid in algal scum where larvae feed. Shore fly larvae have no distinct head capsule, and the body is opaque yellow, white, or brown. Both the dark brown pupa and the larva have a forked air tube at the rear end.



Resistance Management Program For Shore Flies

CHEMICAL CONTROL

Marathon® 60 WP G&N in WSP - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: 1 x 20 gram packet in appropriate amount of water

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon® 1% Granular - Systemic Insecticide

For Systemic Insect Control in Ornamental Crops

Rate: Refer to label

Signal Word: Caution

REI: 0-12 hours (read label)

Marathon is applied topically to the media. Avoid leaching for about 10 days. Keep media moist.

Resistance Management Program For Shore Flies

CHEMICAL CONTROL

Azatin® XL - Insect Growth Regulator

For Indoor and Outdoor Use on Ornamentals and Vegetable Crops

Rate: 8 oz. per 100 gallons as a drench

Signal Word: Caution

REI: 4 hours

Must contact insect. Repeated applications as necessary. Label permits low-volume application.

Pupa (left) and larva of shore fly



Resistance Management Program For Shore Flies

CHEMICAL CONTROL

Decathlon™ 20 WP - Synthetic Pyrethroid

For Control of a Wide Range of Crawling and Flying Insect Pests on Ornamentals and Nursery Stock

Rate: 1.3 oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Label permits low-volume application. Do not use through any type of irrigation system. Spreader stickers may enhance performance. Repeat applications at 7 day intervals. Always read the label.

Resistance Management Program For Shore Flies

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Azatin XL	biological-insect growth regulator	4
Decathlon 20 WP	pyrethroid	12
DuraGuard	organophosphate	24
Enstar II	insect growth regulator	4
Marathon 1% G	chloronicotinyl	12
Marathon 60 WSP	chloronicotinyl	12
Orthene TT&Os	organophosphate	24
PT 1300 Orthene	organophosphate	24

Resistance Management Program For Spider Mites

Class Arachnida

Order Acari

Family Tetranychidae

Twospotted spider mite, *Tetranychus urticae*



DESCRIPTION OF THE PEST

Twospotted spider mites are web-forming mites that pierce plant cells and remove their contents. All spider mites have two body segments and four pairs of legs as adults.

Twospotted spider mite adults, as the name suggests, have two large dark spots on the sides of their yellowish green bodies. These mites lay round eggs that hatch into six-legged larvae. The subsequent stages, the protonymph and deutonymph stages, are eight-legged as are the adults. Spider mites have many generations per year and can rapidly increase in number.

Resistance Management Program For Spider Mites

Spider mites are among the pests known for their ability to develop resistance to pesticides used to control them. This is partly because of their biology, their wide host plant range, and the difficulty of contacting them with pesticides.

The key to managing pesticide resistance is minimizing the use of pesticides. One of the best ways to do this is with a pest scouting and monitoring program. Knowing what pests are there, where they are and some estimate of the infestation level will help a control program at the beginning and throughout the entire crop production cycle. When possible, use alternatives to pesticides to reduce pest numbers. In the case of spider mites, alternatives may include eliminating weeds that harbor mite infestations, maintaining greenhouse temperature and humidity within moderate ranges, and introducing predatory mites.

Resistance Management Program For Spider Mites

Pesticides will be needed for spider mite control in most greenhouses - especially during hot weather. In addition to minimizing pesticide use, another principle of pesticide resistance management is to not depend on one or two kinds of chemistry for control, but to rotate among at least three (preferably four) different chemical modes of action.

A chemical application is only as good as the coverage obtained. Most of the products need to contact the mites or the leaf surfaces on which they walk, to be effective. Judo, Pylon and TetraSan have translaminar activity; i.e. the active ingredient moves from upper to lower leaf surfaces - and vice-versa - after application. This helps a bit if coverage is less than perfect, but good coverage will result in even better control.

Resistance Management Program For Spider Mites

CHEMICAL CONTROL

Pylon® miticide

For use on ornamental crops grown in commercial greenhouses.

Rate: 2.6 fl. oz. - 5.2 fl. oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Pylon is a member of the new class of miticides known as pyrroles. With good contact and stomach activity, its mode of action is different from other miticide classes. Pylon works well as a rotational miticide for the control of spider mites. Pylon should be applied in combination with other miticides with a different mode of action when used in a subsequent crop in the same greenhouse structure.

Resistance Management Program For Spider Mites

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide

Rate: Ranges from 1% to 2% (Refer to label)

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component in controlling mites as a rotational product. Spray should be made on a 7 to 14 day interval depending on severity of the pest problem. Apply to runoff at 25 to 40 psi with hand sprayer or 100 to 200 psi with power equipment. Before mixing, shake well. Mix in water with a temperature of greater than 45° F. (Read and follow label directions.) Avoid contact with open bloom unless you have local experience. Always read the label.

Resistance Management Program For Spider Mites

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Caution is advised on plants with open bloom. Testing is recommended. Always read the label.

Resistance Management Program For Spider Mites

Following are two pesticide rotation programs. The first one is for a low mite infestation and the second is for controlling high mite numbers. The application frequency will need to be adjusted, depending on temperatures and other environmental conditions. Do not apply any product more often than allowed on the label!

Stippling caused by spider mites



Resistance Management Program For Spider Mites

I. Low Initial Infestation

Application	Miticide, Suggested Rates	Chemical Class	Residual	REI (Hrs)
1	Judo™ 480SC (2-4 oz/100 gal)	Tetrionic acid	21-28 days	12
2	Pylon® 2SC (2.6 oz/100 gal)	Pyrroles	21-28 days	12
3	Floramite™ (2-4 oz/100 gal)	Carbazate	21-28 days	12
4	Judo™ 480SC (2-4 oz/100 gal)	Tetrionic acid	21-28 days	12
5	Pylon® 2SC (2.6 oz/100 gal)	Pyrrole	21-28 days	12

Resistance Management Program For Spider Mites

II. High Initial Infestation

Application	Miticide, Suggested Rates	Chemical Class	Residual	REI (Hrs)
1	Triact® 70 (0.5-1 oz/100 gal)	Clarified hydrophobic extract of Neem oil	3-7 days	12
2	Judo™ 480SC (2-4 oz/100 gal)	Tetronic acid	21-28 days	12
3	Pylon® 2SC (2.6 oz/100 gal plus TetraSan™ 5WDG (8-16 oz/100 gal))	Pyrrole + 2,4 Dipheny-loxzone	21-28 days	12
4	Floramite™ (2-4 oz/100 gal)	Carbazate	21-28 days	12
5	Judo™ 480SC (2-4 oz/100 gal)	Tetronic acid	21-28 days	12

Resistance Management Program For Spider Mites

ADDITIONAL CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Akari	phenoxypyrazole	12
Avid	glycoside	12
Cinnamite	biological-aldehyde	4
Floramite	PDZ	4
Hexygon	thiazolidinone	12
Kelthane	organochlorine	12
M-Pede	potassium salts of fatty acids	12
Olympic Insecticidal Soap	potassium salts of fatty acids	12
Ovation	tetrazine	12
Pylon	pyrrole	12
Sanmite	pyridazinone	12

Resistance Management Program For Spider Mites

ADDITIONAL CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Triact 70	hydrophobic extract of neem oil	4
Ultra-fine Oil	paraffinic oil	4
Vendex	organotin	48



Infestation

Resistance Management Program For Tarsonemid Mites

Class Arachnida

Order Acari

Family Tarsonemidae

Cyclamen mite,

Phytonemus pallidus

Broad mite,

Polyphagotarsonemus latus



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University of California

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DESCRIPTION OF THE PESTS

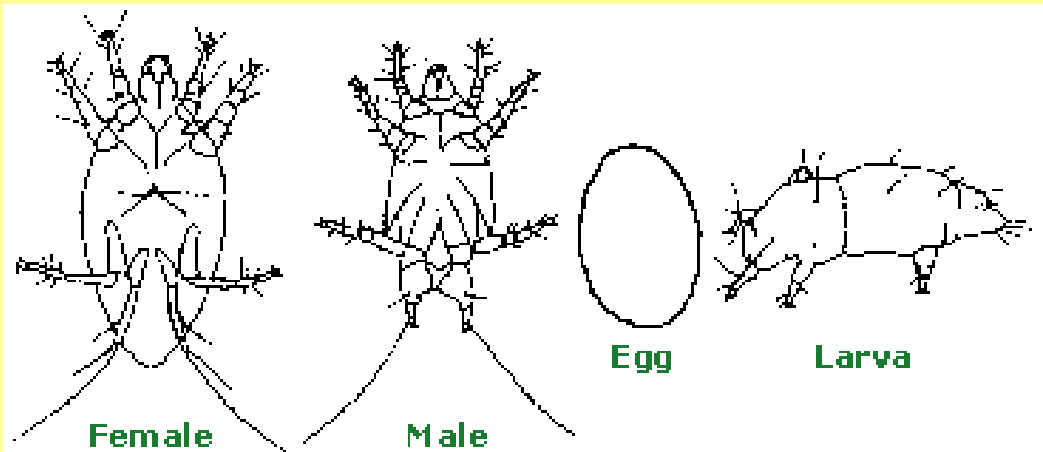
Tarsonemid, or thread-footed mites are tiny and cannot be readily seen without magnification (20X to 40X). The life stages of these thread-footed mites are: egg, nymph, pseudopupa, and adult (one less stage than for spider mites).

Resistance Management Program For Tarsonemid Mites

DESCRIPTION OF THE PESTS

Eggs of the cyclamen mite are one-half the length of the adult and are oval shaped. Eggs of the closely related broad mite are distinguishable from cyclamen mite eggs by rows of white pegs on the egg's upper surface. Immature stages of these mites are white. These mites get the name “thread-footed” from the appearance of the hind pair of legs in the adult female, which is threadlike; adult males, on the other hand, have stout legs for clasping the female. Adult males carry female pseudopupae on their back. As soon as the adult female emerges, they mate.

Life cycle of
cyclamen mite



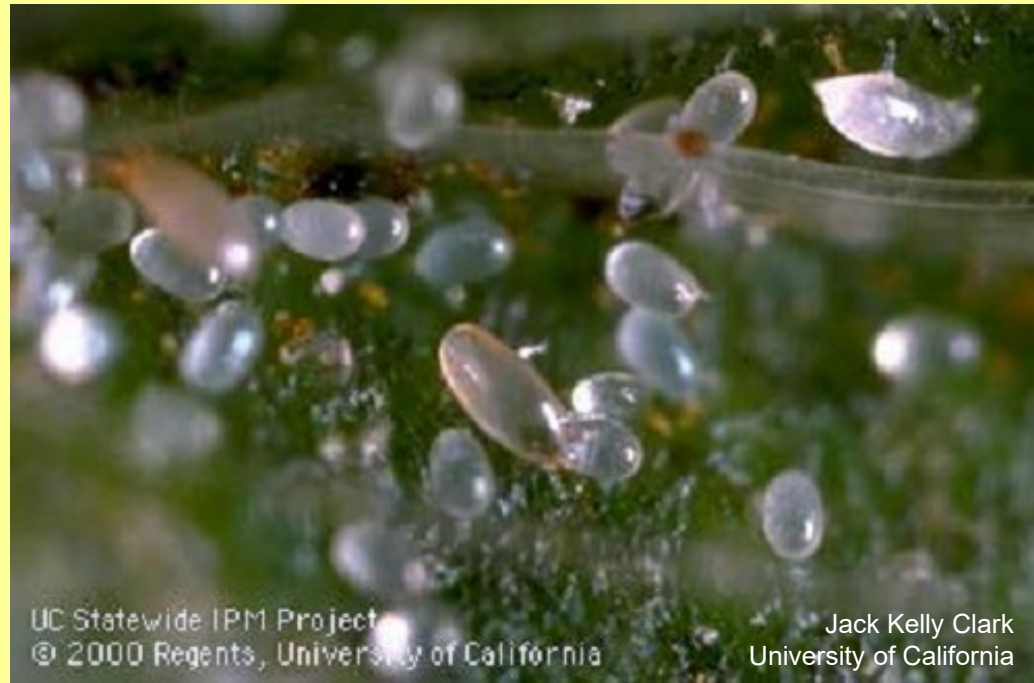
Resistance Management Program For Tarsonemid Mites

DESCRIPTION OF THE PESTS

Cyclamen mite (pictured on right) is generally found on growing terminals, in buds, or on unfolding leaflets.

Development is optimal under moderately warm (60° to 80°F) temperatures and high humidity (80 to 90%). Broad mite is similar

to cyclamen mite, but is found mostly on undersides of plant leaves. Mites disperse between plants on air currents and by mechanical transport such as on clothing. These mites can complete one generation in 7 to 21 days.



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Resistance Management Program For Tarsonemid Mites

CHEMICAL CONTROL

Pylon® miticide

For use on ornamental crops grown in commercial greenhouses.

Rate: 2.6 fl. oz. - 5.2 fl. oz. per 100 gallons

Signal Word: Caution

REI: 12 hours

Pylon is a member of the new class of miticides known as pyrroles. With good contact and stomach activity, its mode of action is different from other miticide classes. Pylon works well as a rotational miticide for the control of tarsonemid mites. Pylon should be applied in combination with other miticides with a different mode of action when used in a subsequent crop in the same greenhouse.

Resistance Management Program For Tarsonemid Mites

CHEMICAL CONTROL

Triact® 70 - Clarified Hydrophobic Extract of Neem Oil

Broad Spectrum Fungicide/Miticide

Rate: Ranges from 1% to 2% (Refer to label)

Signal Word: Caution

REI: 4 hours

Triact 70 is an effective component in controlling mites as a rotational product. Spray should be made on a 7 to 14 day interval depending on severity of the pest problem. Apply to runoff at 25 to 40 psi with hand sprayer or 100 to 200 psi with power equipment. Before mixing, shake well. Mix in water with a temperature of greater than 45° F. (Read and follow label directions.) Avoid contact with open bloom unless you have local experience. Always read the label.

Resistance Management Program For Tarsonemid Mites

CHEMICAL CONTROL

Insecticidal Soap 49.52 CF - Insecticidal Soap

For Use on Fruits, Nuts, Vegetables, and Ornamentals

Rate: Refer to label

Signal Word: Warning

REI: 12 hours

Insecticidal Soap 49.52 CF can be used as an effective component of integrated pest management. Use freshly mixed solution. Use soft water if possible. If water has high mineral content, use a water softener or compatible agent before adding concentrate. Avoid applications in direct sun or temperatures above 85° F. Spray thoroughly for control. Caution is advised on plants with open bloom. Testing is recommended. Always read the label.

Resistance Management Program For Tarsonemid Mites

CHEMICAL CONTROL

Trade Name(s)	Chemical Class	REI (Hrs.)
Avid	glycoside	12
Cinnamite	biological-aldehyde	4
Kelthane	organochlorine	12
M-Pede	potassium salts of fatty acids	12
Olympic Insecticidal Soap	potassium salts of fatty acids	12
Pylon	pyrrole	12
Sanmite	pyridazinone	12
Triact 70	hydrophobic extract of neem oil	4
Ultra-fine Oil	paraffinic oil	4