



IPM FUNDAMENTALS
**GREENHOUSE
BIOLOGICAL CONTROL**

IPM FUNDAMENTALS








Photo: *Amblyseius swirski* - BioBest Group

What to apply? When to apply? How to apply?

IPM FUNDAMENTALS

SUGGESTED STRATEGY

- ▶ Thrips biocontrol program as a foundation
 - ▶ Integrate management of other pests into thrips program

Why?





Photo: Western Australia Dept of Primary Industries and Regional Development

IPM FUNDAMENTALS

SUGGESTED STRATEGY

- ▶ Thrips biocontrol program as a foundation
 - ▶ Integrate management of other pests into thrips program

- The one pest you know will be there every year
- Physical damage plus virus considerations
- Spring crop density - multiple levels of plants
- Compatible control methods for other pests



IPM FUNDAMENTALS

BIOLOGICAL PROFILE - THRIPS

- ▶ Thousands of species
- ▶ 5-6 species in U.S. greenhouses
- ▶ Similar biology
 - ▶ Some important differences
 - ▶ Species ID - a process

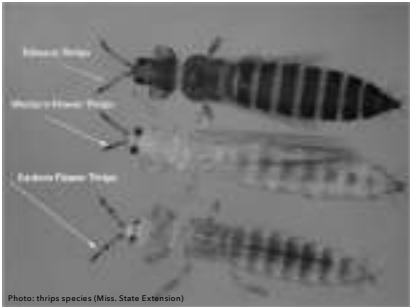
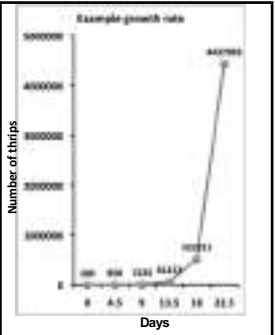


Photo: thrips species (Miss. State Extension)

IPM FUNDAMENTALS

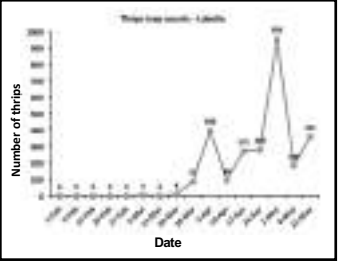
BIOLOGICAL PROFILE - THRIPS



- ▶ Western flower thrips (most common?)
- ▶ Typical life cycle: 7-15 days
- ▶ Rate depends on temperature
 - ▶ Ideal temp: ~86°F
 - ▶ Generation time: 4.3 days (avg)
 - ▶ 8.5 fold increase per generation
- ▶ Egg production increases with pollen

IPM FUNDAMENTALS

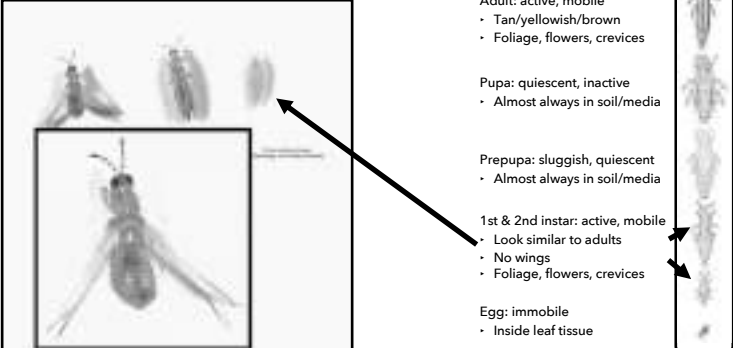
BIOLOGICAL PROFILE - THRIPS



- ▶ Western flower thrips (most common?)
- ▶ Typical life cycle: 7-15 days
- ▶ Rate depends on temperature
 - ▶ Ideal temp: ~86°F
 - ▶ Generation time: 4.3 days (avg)
 - ▶ 8.5 fold increase per generation
- ▶ Egg production increases with pollen

IPM FUNDAMENTALS

BIOLOGICAL PROFILE - WESTERN FLOWER THRIPS



- Adult: active, mobile**
 - Tan/yellowish/brown
 - Foliage, flowers, crevices
- Pupa: quiescent, inactive**
 - Almost always in soil/media
- Prepupa: sluggish, quiescent**
 - Almost always in soil/media
- 1st & 2nd instar: active, mobile**
 - Look similar to adults
 - No wings
 - Foliage, flowers, crevices
- Egg: immobile**
 - Inside leaf tissue

Photos by Nuris Accotto (Ohio State University) Western Flower Thrips life stages. Illustrated by J.B. Eastwood (2004)

IPM FUNDAMENTALS

BIOLOGICAL PROFILE - THRIPS

- ▶ Other species: different sizes & behavior - implications for biocontrol
- ▶ Poinsettia thrips (*Echinothrips americanus*)
 - ▶ Pupates on underside of leaves (not in soil)
- ▶ Onion thrips (*Thrips tabaci*)
 - ▶ Biology similar to western flower thrips
- ▶ Chilli thrips (*Scirtothrips dorsalis*) - smaller
 - ▶ Smaller, pupae often found on leaves & leaf litter
- ▶ Tobacco thrips (*Frankliniella fusca*)
 - ▶ Biology similar to western flower thrips
- ▶ Greenhouse thrips (*Heliathrips haemorrhoidalis*)
 - ▶ Larger, pupae found on plant





Photo: Chilli thrips by Lance Osborne, University of Florida

IPM FUNDAMENTALS

WHAT ARE WE PROTECTING?

- ▶ Vegetative cuttings
 - ▶ From mother plants, international sources
- ▶ Plugs/liners
 - ▶ domestic and international sources
- ▶ Seedlings
- ▶ Small potted plants (4", etc.)
- ▶ Larger finished nursery products
- ▶ Planters
- ▶ Hanging Baskets



A tremendous diversity of plants!

IPM FUNDAMENTALS

THRIPS BIOCONTROL OPTIONS - WHAT TO APPLY?

| | |
|--|---|
| <p>Foliage & Flowers</p> <ul style="list-style-type: none"> ▶ Predatory mites <ul style="list-style-type: none"> ▶ <i>Neoseiulus cucumeris</i> ▶ <i>Amblyseius swirskii</i> ▶ <i>Transeius montdorensis</i> ▶ <i>Amblydromalus limonicus</i> ▶ <i>Amblyseius degenerans</i> ▶ Other predators <ul style="list-style-type: none"> ▶ <i>Orius insidiosus</i> ▶ Beneficial nematodes* ▶ Microbial products <ul style="list-style-type: none"> ▶ Insect pathogens <ul style="list-style-type: none"> ▶ <i>Beauveria</i>, <i>Metarhizium</i>, <i>Isaria</i>, etc. ▶ <i>Botanigard</i>, <i>Met-52</i>, <i>NoFly</i>, <i>Grandevo</i>, etc. | <p>Soil</p> <ul style="list-style-type: none"> ▶ Predatory mites <ul style="list-style-type: none"> ▶ <i>Stratiolaelaps scimitus</i> (a.k.a. <i>Hypoaspis miles</i>) ▶ Other predators <ul style="list-style-type: none"> ▶ <i>Dalotia coriaria</i> (a.k.a. <i>Atheta coriaria</i>) ▶ Microbial products ▶ Beneficial nematodes (<i>Steinernema feltiae</i>) |
|--|---|




Photo: Carlos Coronado adult: Beneficial insectary

IPM FUNDAMENTALS

GENERAL APPROACH

MAKE IT ECONOMICAL MAKE IT MANAGEABLE

1. Many options available - no need to use them all
2. No need to treat all crops in the same way every time

▶ Identify key aspects/crops and concentrate on them

▶ Avoid applying products unnecessarily

Where are outbreaks most likely to happen?

IPM FUNDAMENTALS

GENERAL APPROACH

Where are outbreaks most likely to happen?

▶ Reference biological profile

▶ **Western flower thrips**

- ▶ Typical life cycle: 7-15 days
- ▶ Rate depends on temperature
 - ▶ Ideal temp: ~86°F
 - ▶ Generation time: 4.3 days (avg)
 - ▶ 8.5 fold increase per generation
- ▶ Egg production increases with pollen

IPM FUNDAMENTALS

GENERAL APPROACH

Where are outbreaks most likely to happen?

▶ Reference biological profile

1. Food preferences?
2. Environmental preferences?
3. In your operation:
 - ▶ Where do they have the best opportunities to eat and reproduce for extended periods?
 - ▶ Where is it most difficult to scout and treat for them?
 - ▶ Where is greatest potential to spread to other crops?

▶ **Western flower thrips**

- ▶ Typical life cycle: 7-15 days
- ▶ Rate depends on temperature
 - ▶ Ideal temp: ~86°F
 - ▶ Generation time: 4.3 days (avg)
 - ▶ 8.5 fold increase per generation
- ▶ Egg production increases with pollen

IPM FUNDAMENTALS

GENERAL APPROACH

Where are outbreaks most likely to happen?

1. Food preferences?
 - ▶ WFT can feed on hundreds of plant species (generalist herbivore)
 - ▶ Generalists often display preferences
 - ▶ Depends on what is available
 - ▶ Spring floriculture crops:

| | | |
|-----------|------------|-----------------|
| ▶ Ipomoea | ▶ Marigold | ▶ Ivy geraniums |
| ▶ Dahlia | ▶ Gerbera | ▶ Peppers |
| ▶ Verbena | ▶ Dracaena | |

*Some common species preferred by western flower thrips

IPM FUNDAMENTALS

GENERAL APPROACH

Where are outbreaks most likely to happen?

2. Environmental preferences?
 - “Warm, please!”
 - Why?
 - Development increases with temperature

Warmer temperatures → Faster life cycle → Faster population growth

▶ **Western flower thrips**

- ▶ Typical life cycle: 7-15 days
- ▶ Rate depends on temperature
 - ▶ Ideal temp: ~86°F
 - ▶ Generation time: 4.3 days (avg)
 - ▶ 8.5 fold increase per generation
- ▶ Egg production increases with pollen

IPM FUNDAMENTALS

GENERAL APPROACH

Where are outbreaks most likely to happen?

3. In your operation:

- Where do they have the best opportunities to eat and reproduce for extended periods?
- Where is it most difficult to scout and treat for them?
- Where is greatest potential to spread to other crops?



IPM FUNDAMENTALS



GENERAL APPROACH

Where are outbreaks most likely to happen?

Graeme's list of high-risk crops

- Hanging baskets (but not all of them)
- Verbena, Dracaena, ivy geraniums, bidens, Ipomoea, etc
- All mixed baskets


"Where do the pupae go?"

IPM FUNDAMENTALS

WHAT TO APPLY?

- Adult: active, mobile
 - Foliage, flowers, crevices
- Pupa: quiescent, inactive
 - Almost always in soil/media
- Prepupa: sluggish, quiescent
 - Almost always in soil/media
- 1st & 2nd instar: active, mobile
 - Foliage, flowers, crevices
- Egg: immobile
 - Inside leaf tissue



IPM FUNDAMENTALS

WHAT TO APPLY?

Predatory mites

- Neoseiulus cucumeris* - 1st instar, possibly 2nd instar
- Amblyseius swirskii*

Other predators


- Orius insidiosus* - Adult, 1st & 2nd instar

Microbials

- Beauvaria bassiana* (Botanigard, etc)
- Metarhizium anisopliae* (Met-52, etc)
- Isaria fumosoroseus* (NoFly, etc)

Adult, 1st & 2nd instar, pupae

- Adult: active, mobile
 - Foliage, flowers, crevices
- Pupa: quiescent, inactive
 - Almost always in soil/media
- Prepupa: sluggish, quiescent
 - Almost always in soil/media
- 1st & 2nd instar: active, mobile
 - Foliage, flowers, crevices
- Egg: immobile
 - Inside leaf tissue



IPM FUNDAMENTALS

WHAT TO APPLY?

Predatory mites

- ▶ *Stratiolaelaps scimitus* (a.k.a. *Hypoaspis miles*) - pupae, 1st & 2nd instar

Other predators

- ▶ *Dalotia coriaria* (a.k.a. *Atheta coriaria*) - pupae, 1st & 2nd instar

Nematodes

- ▶ *Steinernema feltiae* - pupae, 1st & 2nd instar, adult (+ eggs?)

Microbials

- ▶ *Beauveria bassiana* (Botanigard, etc)
- ▶ *Metarhizium anisopliae* (Met-52, etc)
- ▶ *Isaria fumosoroseus* (NoFly, etc)

Adult: active, mobile

- Foliage, flowers, crevices

Pupa: quiescent, inactive

- Almost always in soil/media

Prepupa: sluggish, quiescent

- Almost always in soil/media

1st & 2nd instar: active, mobile

- Foliage, flowers, crevices

Egg: immobile

- Inside leaf tissue

IPM FUNDAMENTALS

WHAT TO APPLY - WHICH MITE?

- ▶ Environmental considerations
- ▶ Other pests?
- ▶ Grower preference & strategy

Photo: Amblyseius swirski - BioBest Group

IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES

- ▶ Variety of packaging options

IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES

- ▶ Bulk application
 - ▶ Carrier - bran, vermiculite, others?

Photo: bulk mite application - Leanne Pundt, Univ. Connecticut Extension

IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES



IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES



IPM FUNDAMENTALS



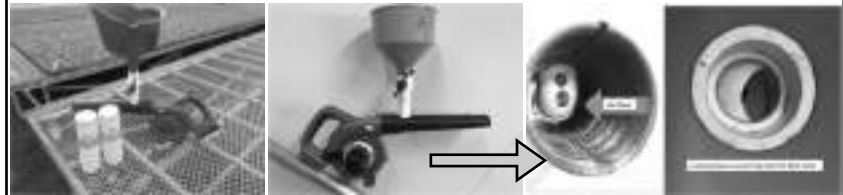
IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES



IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES



IPM FUNDAMENTALS



IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES

- ▶ Tips for mite blowers
 - ▶ Pace yourself
 - ▶ Uniform distribution
 - ▶ High power = dead beneficials
 - ▶ Use medium power or lower



IPM FUNDAMENTALS

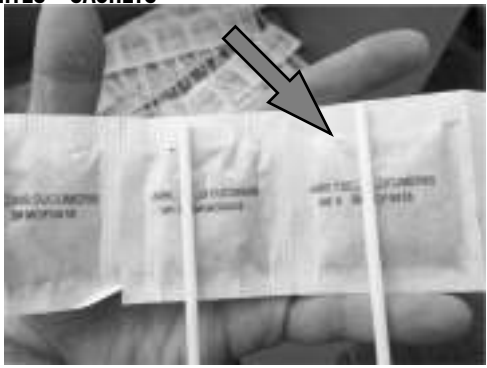
HOW TO APPLY - PREDATORY MITES - SACHETS



IPM FUNDAMENTALS

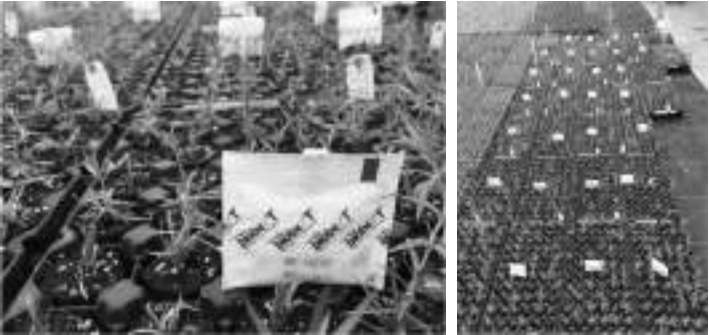
HOW TO APPLY - PREDATORY MITES - SACHETS

- ▶ Portable breeding system
 - ▶ Everything needed for predatory mites to eat and reproduce
 - ▶ Slow release over 4-6 weeks




IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES - SACHETS



IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES - SACHETS



IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES - SACHETS




IPM FUNDAMENTALS

HOW TO APPLY - PREDATORY MITES - SACHETS

- ▶ Portable breeding system
 - ▶ Everything needed for predatory mites to eat and reproduce
 - ▶ Slow release over 4-6 weeks
- ▶ Sachet positioning
 - ▶ Out of the direct sun
 - ▶ Under the canopy
 - ▶ Can get wet


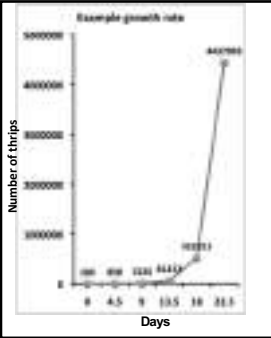
Humidity and temperature are important



IPM FUNDAMENTALS

WHEN TO APPLY - PREDATORY MITES

- ▶ Decision based on:
 - ▶ Experience
 - ▶ Scouting reports
 - ▶ Strategy
 - ▶ Production logistics


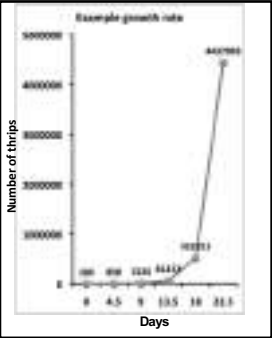



IPM FUNDAMENTALS

WHEN TO APPLY - PREDATORY MITES

- ▶ Application frequency:
 - ▶ Bulk:
 - ▶ Once/7-14 days (common)
 - ▶ Sachet
 - ▶ Once
- ▶ Application rates:
 - ▶ Similar across suppliers
 - ▶ Preventative -vs- curative

Rates and frequency are adjustable

IPM FUNDAMENTALS

HOW TO APPLY - ROVE BEETLES

- ▶ Similar packaging options
 - ▶ Commonly distributed in little piles
 - ▶ Rove beetles - highly mobile, will fly






Photo: Daisio coniro adult - Beneficial insectary



IPM FUNDAMENTALS

HOW TO APPLY - ROVE BEETLES



IPM FUNDAMENTALS


HOW TO APPLY - ROVE BEETLES



IPM FUNDAMENTALS

WHEN TO APPLY - ROVE BEETLES

- ▶ Decision based on:
 - ▶ Experience
 - ▶ Strategy
 - ▶ Production logistics
- ▶ Application rate:
 - ▶ Small piles throughout treatment area
- ▶ Application frequency:
 - ▶ Once/year, once/production cycle?
 - ▶ Commonly used for fungus gnats/shore flies



When targeting thrips: pair with predator of foliar stages

IPM FUNDAMENTALS

HOW TO APPLY - ORIUS

- ▶ Similar packaging options
 - ▶ Commonly distributed in little piles
 - ▶ Rove beetles - highly mobile, will fly






Photo: Orius insidiosus (RSDA)



IPM FUNDAMENTALS

HOW TO APPLY - ORIUS


- ▶ Sprinkled on plants, small piles, "bio boxes"
 - ▶ High mobility -> distribute themselves



IPM FUNDAMENTALS

HOW TO APPLY - ORIUS


- ▶ Banker plants
- ▶ Pollen-heavy plants
 - ▶ Ornamental peppers
 - ▶ 'Purple Flash', others
- ▶ Provides food and reproductive sites to build up populations
- ▶ Mobile *Orius* stations
- ▶ Good in combination with predatory mites



IPM FUNDAMENTALS

WHEN TO APPLY - ORIUS

- ▶ Populations take 6-8 weeks to establish
 - ▶ Long days required
 - ▶ Diapause under short day conditions
 - ▶ Pollen helps sustain *Orius* before thrips are numerous
- ▶ Banker plants - ideally self sustaining
 - ▶ When would you like to have a banker w/ *Orius* established?
 - ▶ How long will it take to grow the banker plants?
 - ▶ Find your target date for deployment and work backwards
 - ▶ May take a couple seasons to optimize the process



IPM FUNDAMENTALS

HOW TO APPLY - NEMATODES

- ▶ Mix with water
 - ▶ Can use almost any spraying device
 - ▶ Drench, sprench, spray, chemigate*, etc.
 - ▶ Avoid using cold water
- ▶ Use spray mixture immediately
- ▶ Keep pressure under 300 psi
- ▶ Remove any fine-mesh screens
- ▶ Keep water agitated
 - ▶ Prevents settling
- ▶ Application type:
 - ▶ Drench - very common
 - ▶ Fungus gnats/shore flies
 - ▶ Thrips pupae
 - ▶ Foliar spray**
 - ▶ Thrips (+ anything else)
 - ▶ Takes planning to be successful
 - ▶ Need to create favorable environment
 - ▶ Economics: use lower rate at more frequent intervals (i.e. once/7 days)

** For an excellent discussion on this topic: see Roger McGaughey's articles for GrowerTalks

IPM FUNDAMENTALS

WHEN TO APPLY - NEMATODES

- ▶ Decision based on:
 - ▶ Target pests
 - ▶ Scouting reports
 - ▶ Strategy
 - ▶ Production logistics
- ▶ Application frequency:
 - ▶ Once, Once/1-6 weeks
 - ▶ Fungus gnats - less often
 - ▶ Thrips - more often
 - ▶ Rate/freq vary across suppliers



Photo: Steinernema/fibron nematodes - Koppert Biological Systems

IPM FUNDAMENTALS

PRACTICES THAT CONTRIBUTE TO SUCCESS

- ▶ Monitor pest activity
 - ▶ Scout - at least once/week
 - ▶ Sticky traps (super easy)
- ▶ Start Clean (sanitation/prevention)
- ▶ Quality checks & post-delivery handling
 - ▶ Inspect and use beneficials as soon as possible
- ▶ Create a strategy
 - ▶ No need to use all available options on every plant in the greenhouse
 - ▶ Be selective – determine where BCAs will bring the biggest benefit



IPM FUNDAMENTALS

TIPS FOR NEW ADOPTERS

- ▶ Start small (a single greenhouse or crop)
- ▶ Work with a consultant
- ▶ Expect some speed bumps as you learn
- ▶ Experiment with a variety of options
- ▶ Don't be afraid to get creative
- ▶ Have fun! (You're using bugs that eat bugs!)



