Biocontrol Starting In Propagation

Greenhouse IPM Workshop – January 17-19, 2018

Greg Bryant

IPM Technical Specialist (Northeast Region)

Bioline Agrosciences

GBryant@biolineagrosciences.com

Bioline AgroSciences

The Importance of Starting Clean

Bioline AgroSciences

Starting Clean With Biocontrol

- Starting pest free is critical for any pest management program
- Biocontrol – needs to be free from pests **and** pesticide residues! What is acceptable?
- Is zero pest tolerance possible? Consequences of trying?
- Potential for “Double Trouble”

Bioline AgroSciences

Starting Clean With Biocontrol

- The reactions of growers can trigger propagator actions
- The choices of breeders and cutting producers can have major impacts on pest management later on – not just for biocontrol
- Positive and constructive communication between breeder, propagator, and grower is very important

Bioline AgroSciences

Starting Clean With Biocontrol

- Even an ideal pesticide strategy does not mean free of all pests
- Start with biocontrol as early as possible
- In propagation you can “grow” BCA’s as your young plants grow!

Bioline AgroSciences

Pest Management and Residues

- 2011 – Canadian growers, poor results from biocontrol in poinsettias
- 2012 – 10 samples of unrooted cutting sent off for testing
- Found AI from 24 insecticides and 20 fungicides
- Half had Orthene – major contributor to failure of *Eretmocerus* – 16 wk residual

- Abamectin (Avid®)
- Buprofezin (Talus®)
- Fenazaquin (miticide)
- Pyridaben (Sanmite®)
- Pyriproxifen (Distance®)
- Spinosad (Conserve®)
- Spiromesifen (Judo®)
- Thiacloprid (neonic)
- Thiamethoxam (Flagship®)
- Novaluron (Pedestal®)

- Acephate (Orthene®)
- Acetamiprid (Tristar®)
- Bifenthrin (Talstar®)
- Clothianidin
- Cyfluthrin (neonic)
- Imidacloprid (Marathon®)
- Lambda-cyhalothrin
- Methamidiphos (Monitor®)
- Methomyl (Lannate®)
- Omethoate
- Oxamyl (Vydate®)

Bioline AgroSciences

Starting Early is Critical… Why?

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

68°F 6 days | 3 + 3 days | 6 days | up to 60 days

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

68°F	6 days	3 + 3 days	6 days	up to 60 days
86°F	3 days	1.5 + 1.5 days	3 days	20 - 40 days

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

68°F	6 days	3 + 3 days	6 days	up to 60 days
86°F	3 days	1.5 + 1.5 days	3 days	20 - 40 days

Amblyseius spp. (L1 only)

Orius insidiosus

Steinernema feltiae

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

68°F	6 days	3 + 3 days	6 days	up to 60 days
86°F	3 days	1.5 + 1.5 days	3 days	20 - 40 days

Amblyseius spp. (L1 only)

Orius insidiosus

Steinernema feltiae

Hypoaspis miles

Atheta coriaria

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

	Egg	Larva 1 & 2	Pupa	Adult
68°F	6 days	3 + 3 days	6 days	up to 60 days
86°F	3 days	1.5 + 1.5 days	3 days	20 - 40 days

Amblyseius spp. (L1 only)
Orius insidiosus
Steinernema feltiae

Hypoaspis miles
Atheta coriaria

Orius insidiosus
S. feltiae

Bioline AgroSciences

Thrips life cycle and BCA target

Egg
(In leaf tissue)

Larva
1 & 2
(on plant → exposed)

Pupa
(in soil)

Adult
(on plant → exposed)

68°F	6 days	3 + 3 days	6 days	up to 60 days
86°F	3 days	1.5 + 1.5 days	3 days	20 - 40 days

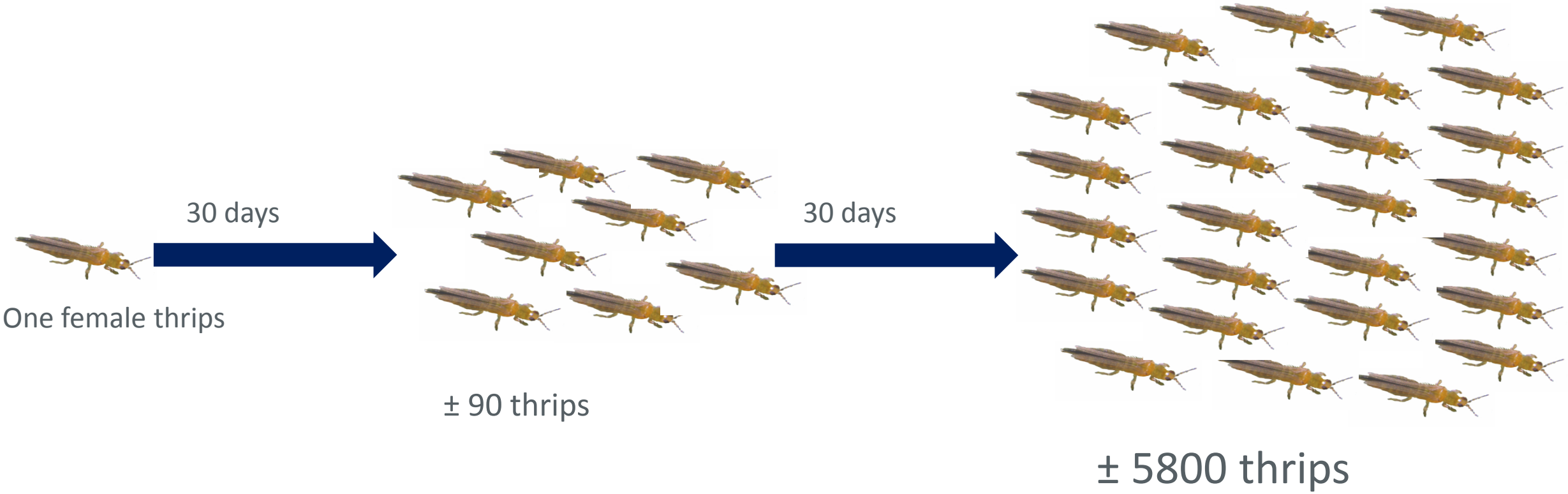
Amblyseius spp. (L1 only)
Orius insidiosus
Steinernema feltiae

Hypoaspis miles
Atheta coriaria

Orius insidiosus
S. feltiae

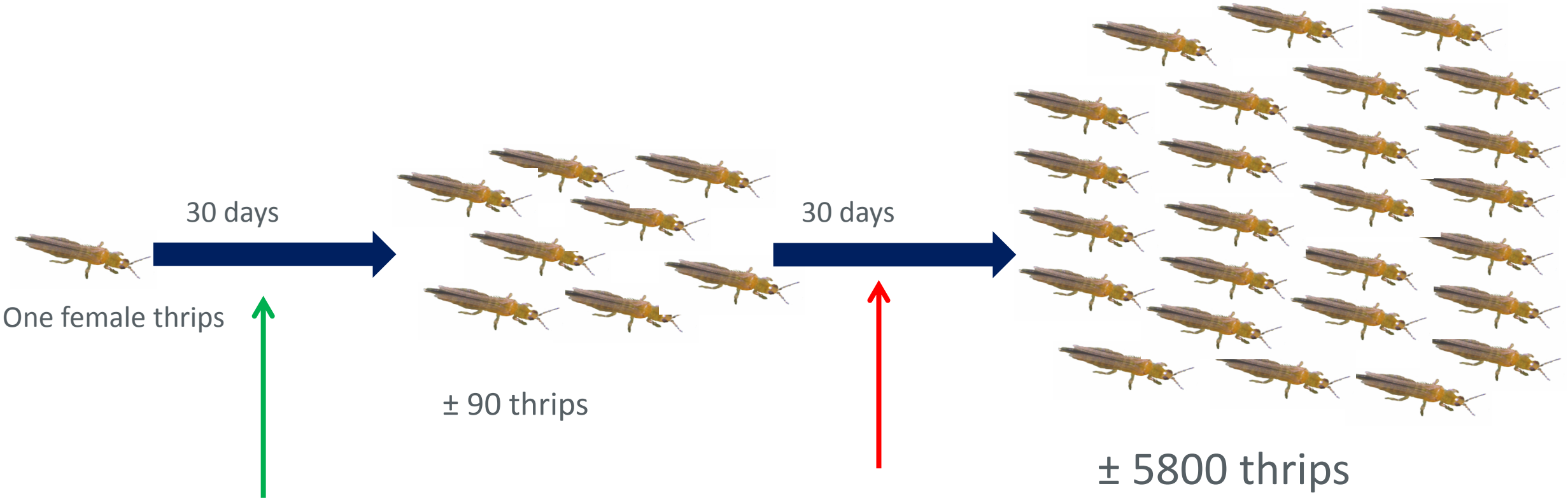
Bioline AgroSciences

Development of Thrips in 60 Days (at 68°F) in Cucumbers



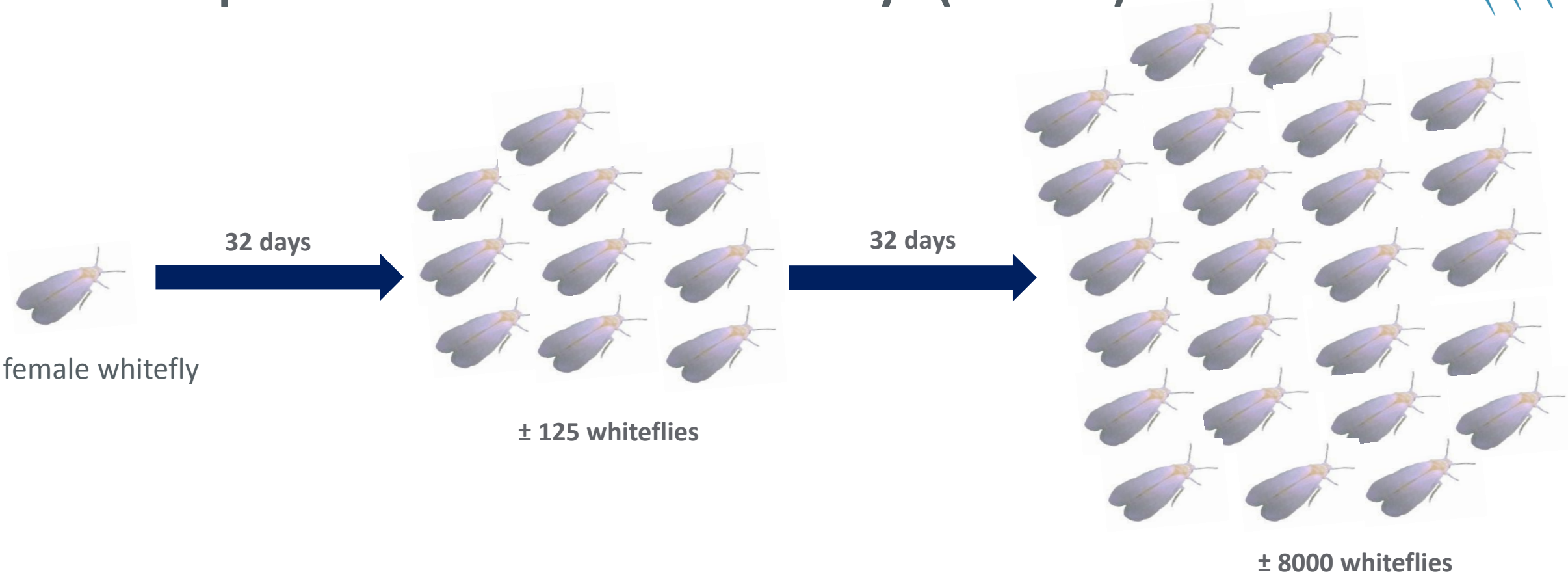
Bioline AgroSciences

Development of Thrips in 60 Days (at 68°F) in Cucumbers



Bioline AgroSciences

Development of Whiteflies in 64 Days (at 68°F) in Tomatoes



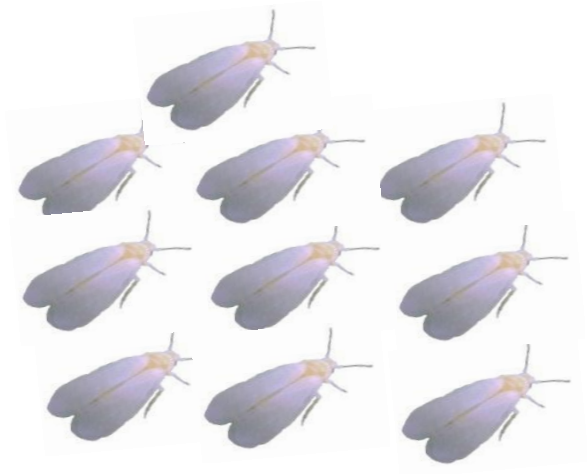
Bioline AgroSciences

Development of Whiteflies in 64 Days (at 68°F) in Tomatoes

One female whitefly

32 days

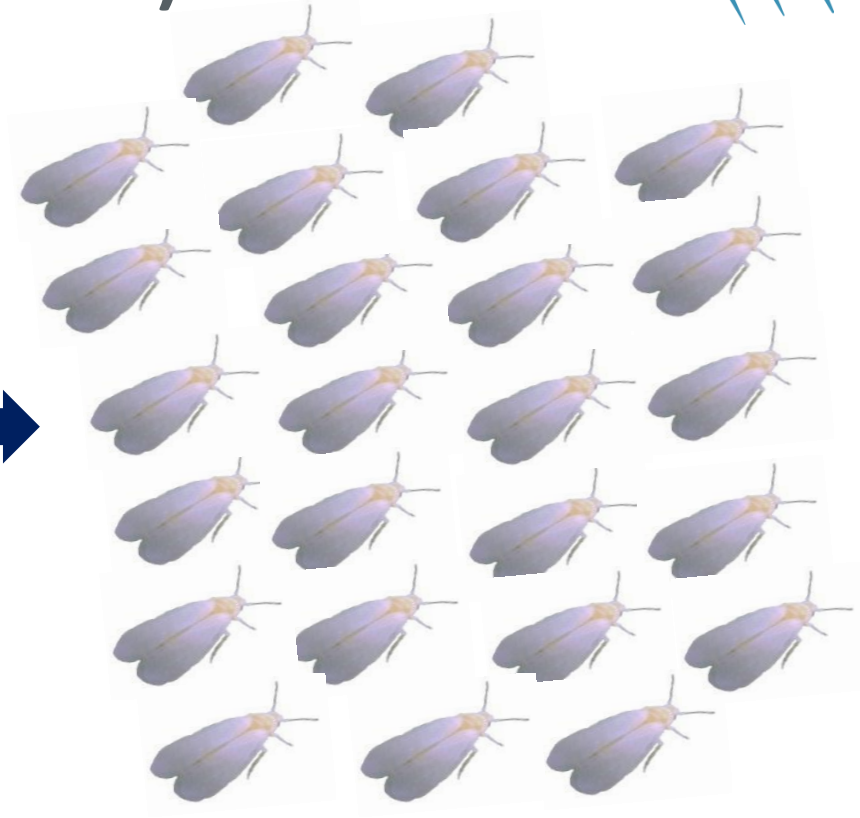
Start here = Success



± 125 whiteflies

32 days

Too late = Disappointment



± 8000 whiteflies

Bioline AgroSciences

Aphid Development

- Very explosive populations – most are born pregnant
- Quickly becoming the #1 pest problem worldwide
- Four major pest species in greenhouses – crop specific
- Almost impossible to ‘repair’ an out of hand situation with BCA’s, especially in ornamentals

Bioline AgroSciences

Some Reasons Why Biocontrol Can Fail

- **Starting too late!**
- Reactive vs proactive
- “Trying” biological control
- Not starting clean → pest and residues
- Scouting and monitoring!
- Not taking all pest and disease problem into consideration
- Poor planning → Supply of BCA’s (forecasting)

Bioline AgroSciences

Some Reasons Why Biocontrol Can Fail

- Poor management (application of BCA's)
- No technical support
- Not checking quality of BCA's
- **Fear of loss → bailing at tipping point → Trust**
- Expectations vs threshold
- Cost → Reducing input
- Compatibility with traditional crop protection products

Bioline AgroSciences

To Spray or Not to Spray?

Bioline AgroSciences

To Spray or Not to Spray?

No Spray Required!

Tipping point has been reached

Control has been achieved

Bioline AgroSciences

Set A Good Foundation: How To Successfully Use Biocontrol in Propagation

Bioline AgroSciences

Ornamental Propagation – A Proactive Approach

Trays and Liners – Typical Pest Problems:

- Thrips, Aphids, Fungus Gnats, Whitefly, and TSSM

BCA's used during propagation:

- *Amblyseius cucumeris* or *swirskii* depending on climate/pest/crop (sachet on stick preferred method)
- *Hypoaspis miles (Stratiolaelaps scimitus)* – Hypoline™
- *Atheta (Dalotia) coriaria* – Staphyline™
- *Steinernema feltiae* – Exhibitline™ sf
- *Aphidius colemani* (with banker plants)

Bioline AgroSciences

Take Your Plants For A Dip

- Mix of Botanigard, Rootshield, and Nematodes – note: only use WP formulations

Bioline AgroSciences

Best Defense Against Thrips and Whiteflies: A Preventative Approach

Bioline AgroSciences

Predatory Mites 101 - *Amblyseius spp.*

- Generalists (thrips L1, broad mites, whitefly eggs, TSSM) and many can feed on pollen – different species have preferred foods
- *Amblyseius spp* are very hard (impossible) to ID in the crop
- All mites are wingless – distribution is **critical**

Bioline AgroSciences

Predatory Mites 101 - *Amblyseius spp.*

- Eggs often found on leaf hairs
- Results show breeding systems (sachets) result in more consistent production of mites in the crop
- Carrier – bran, bran/vermiculite, vermiculite (Amblyline Flo). Breeder material is **always** bran

Bioline AgroSciences

Amblyseius cucumeris

- Best for prevention of thrips while pest pressure is low – eats 3 to 4 L1 thrips/day
- Strong side effect on broad mites
- Can be used in wide range of crops
- Active from 58-86°F
- No diapause – active at low light levels
- Can establish in some crops where pollen is available
- Release rates – crop and technique dependent:
  - 10 mites per sq. foot WEEKLY as broadcast
  - 1 sachet per plant, plug tray, liner
  - Sachet last 4 – 8 weeks

Bioline AgroSciences

Amblyseius swirskii

- Best for prevention of thrips and whiteflies during low pest pressure
- Prey on L1 thrips, whitefly eggs, and pollen
- Strong side effect on broad mites
- Can be used in wide range of crops (not tomatoes)
- Active from 68-105°F, prefers warm/hot
- Sensitive to low temperatures and light (< 66°F)
- Can establish in crops with pollen
- Very useful for situations with higher temperatures or in crops where both thrips and whitefly are present
- Release rates – crop and technique depending:
  - 10 mites per sq. foot WEEKLY as broadcast
  - 1 sachet/plant, plug tray, liner
  - Sachet last 4 – 8 weeks

Bioline AgroSciences

What Is The Best Method For Introducing *Amblyseius* Mites?

Situation Dependent

Bioline AgroSciences

Breeder Piles

- Same product that goes in sachets but packed in bulk
- Shorter longevity compared to sachets
- Can be more cost effective for smaller pot sizes/plugs
- Rate:
  - 2.5 ml – 5 ml per plug/pot
  - 50 – 100 mites per pile

Bioline AgroSciences

Broadcasting

- Less bran = less pray mites
- Predatory mites do not sustain or establish in crops without pollen or prey
- Need weekly applications to get population high enough to be effective
- Can be useful in short-term crops or before transplanting young plants
- Amblyline Flo – 100% vermiculite
- Release rates:
  - 10 – 25 mites per sq. ft. weekly

Bioline AgroSciences

Broadcasting

- Less bran = less pray mites
- Predatory mites do not sustain or establish in crops without pollen or prey
- Need weekly applications to get population high enough to be effective
- Can be useful in short-term crops or before transplanting young plants
- Amblyline Flo – 100% vermiculite
- Release rates:
  - 10 – 25 mites per sq. ft. weekly

Bioline AgroSciences

Sachets On A Stick

What's in the sachet?

- Bran
- Bran Mite
- Food for the bran mite – fungus
- Predatory Mite

Humidity is vital for longevity of the sachet

Bioline AgroSciences

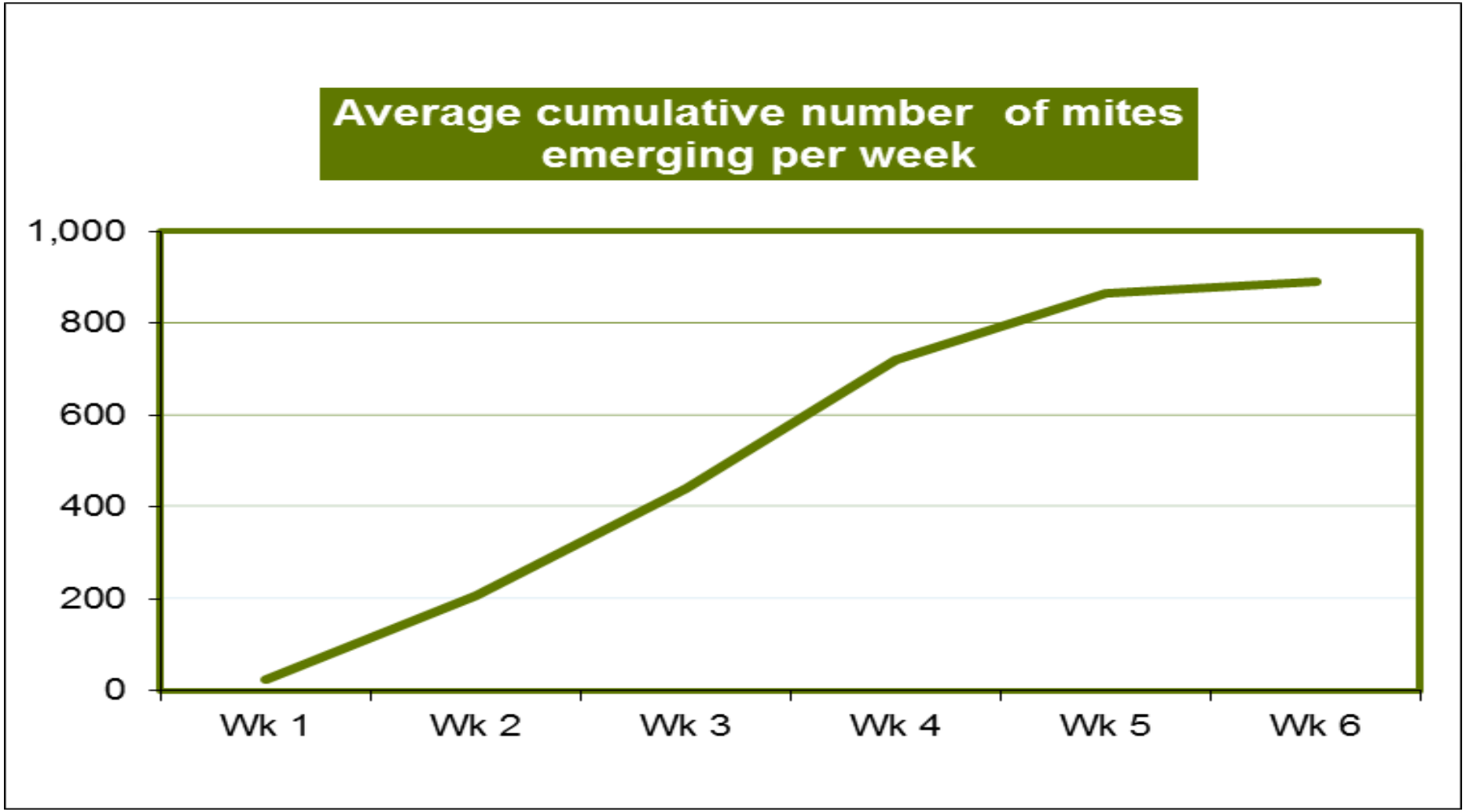
Sachets On A Stick

Advantages

- Water-resistant paper
- Exit hole protected by flap
- Slim plastic stick, fits well into plug trays or liners
- Sachet hung and melted onto the stick – won't fall off
- 6 to 8 weeks reproduction and release of mites
- Consistently more mites with Sachets vs Broadcasting or Breeder Piles
- No waste of mites that fall between the pots

Bioline AgroSciences

Run out from sachets over time



Bioline AgroSciences

How To Tell Predator From Prey

Bran mite vs *Amblyseius sp.*

Bioline AgroSciences

But How Do I Protect Against Adult Thrips?

Bioline AgroSciences

Orius insidiosus

- Five nymphal stages, then molts into an adult
- Eats larvae **and** adults of thrips
- Also feeds on other small pest, such as TSSM and moth eggs
- Can kill up to 80 adult thrips per day!!
- Can feed and establish on pollen – banker plants!




Bioline AgroSciences

Orius insidiosus

- Long establishment time (2 generations – around 60 days)
- To enhance establishment, can be fed with Bugfood™ (*Ephestia* eggs) → increase fecundity
- Active at temperatures above 59°F
- Diapause sensitive → less active at low light levels
- Recommended use with banker plants
- Release rates:
  - 4 – 6 weekly introductions of 1 – 2 *Orius* per banker plant
  - In hotspots → 2 – 5 / sq. feet with 2 to 3 introductions

Bioline AgroSciences

Orius Banker Plants

- Start pepper seedlings early (late October, early November)
- Black Pearl variety has been replaced by **Purple Flash** (38% better reproduction of *Orius* → More consistent flowering/pollen)
- If you buy in seedlings, are there any pesticide residues?!
- Need 80 to 100 pots per acre – 3 plugs per pot
- Use an **aphid banker system** in the same facility since aphid control can affect the *Orius* development (pesticides)
- Place one *Amblyseius cucumeris* sachet on a stick in each banker plant to control thrips while establishing *Orius*

Bioline AgroSciences

Orius Banker Plants

- Late February start *Orius* introductions of 1 to 2 *Orius* per banker plant weekly for 4 to 6 weeks
- Feed *Orius* with *Ephestia* eggs to increase egg laying
- Start checking bankers around mid April by tapping the plants onto a white cloth or sheet of paper
- Look for Orius nymphs (5 nymph stages) – This means they are reproducing on the plants
- Maintain the system (watering and pruning)
- Don’t throw out the parts you pruned off right away! You could be throwing out *Orius*

Bioline AgroSciences

What About Soil Pests?

Bioline AgroSciences

Atheta (Dalotia) coriaria - Staphyline

- Soil dwelling insect (rove beetle)
- Eats pupae of thrips, fungus gnat larvae and eggs, shorefly larvae
- Active from 50°F
- Adults fly and are nocturnal
- Often can be found underneath pots and trays
- Apply ASAP to the soil of young plants
- Rate:
  - 0.2 beetles/sq.ft. once
  - If used in propagation stage at 0.2 beetles per sq foot, use half rate (0.1 /sq ft) after transplanting

Bioline AgroSciences

Hypoaspis miles (Stratiolaelaps scimitus) - Hypoline

- Soil dwelling mite
- Eats fungus gnat larvae and eggs, pupae of thrips
- Active from 59°F
- Can be mixed with *Atheta* just prior to introduction
- Apply ASAP to the soil of young plants
- Rates:
  - 10 – 25 mites per sq foot, once
  - If used in propagation stage at 10 mites per sq foot, use half rate (5 mites/sq ft) after transplanting

Bioline AgroSciences

Aphid Protection - Preventative And Reactive Approaches

Bioline AgroSciences

Which Aphid BCA Should You Use?

Aphid parasitoid wasps

- Much better searchers
- Specific to aphid species
- > 300 eggs per female
- Deposit egg inside the aphid
- Develops into mummified aphids
- **Preventive** releases or banker plants for best results – best course of action

Aphid predators

- Perform better in aphid colonies
- Not picky eaters – will feed on multiple species of aphid
- Kill aphids by consuming their fluids or eating the aphid completely
- Need large amount of aphids to reproduce
- Excellent tool for cleaning up outbreaks – **Reactive**

Bioline AgroSciences

Aphidius Colemani – Parasitoid Wasp

- Best used as prevention for aphids
- **Only** effective against smaller aphids (green peach, melon/cotton)
- Shipped as mix of mummies and adult wasps
- Will not diapause – not sensitive to low light levels
- Will work at 60°F – best between 70 and 75°F
- Rate:
  - 100 wasps per banker plant for 4 to5 weeks
  - 1000 per 20k sq ft weekly

Bioline AgroSciences

Aphid Predators - Controlling Aphid Hotspots And Larger Aphid Species

- Predatory Midge – *Aphidoletes aphidimyza*
  - *Aphidoletes* can be used preventatively – weekly releases
- Lacewing Larvae – *Chrysoperla spp.*
- Lady Beetles – *Adalia*

Bioline AgroSciences

Know Your Aphids!
Smaller Species

Green Peach Aphid

Cornicles same color as body, but tips are black

Melon/Cotton Aphid

Always have solid black cornicles

Bioline AgroSciences

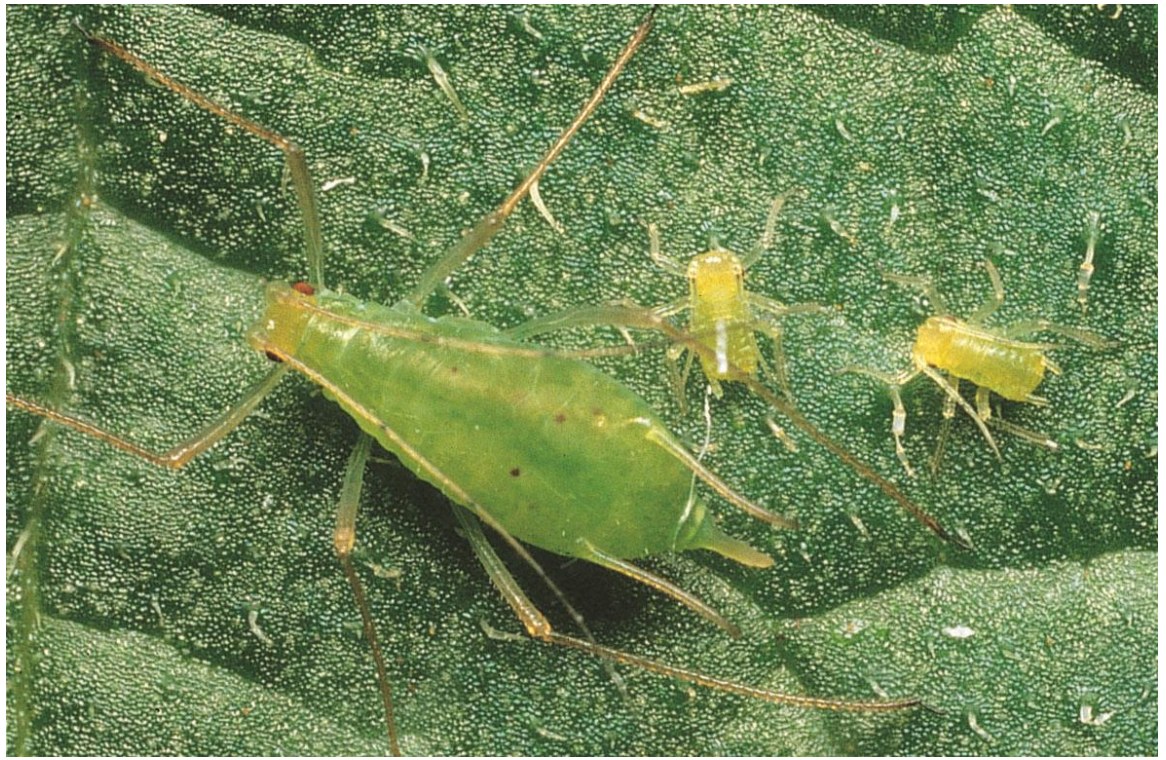
Know Your Aphids!
Larger Species

Foxglove Aphid

Dark spots on body right at cornicles

Potato Aphid

Shaped differently – long, often has dark stripe



Bioline AgroSciences

Aphid Banker Plants – How Do They Work?

- Typically use cereal grain
- Inoculated with Bird Cherry Oat Aphids (*Rhopalosiphum padi*)
- These aphids only survive on monocotyledous plants
- BCOA are a very suitable host for the *Aphidius colemani*
- When pest aphids show up, *A. colemani* will already be established in the greenhouse

Bioline AgroSciences

Aphid Banker Plants – How To Get Started

- Receive a plug of cereal grain inoculated with BCOA
- Break the plug into a few pieces and stick into the center of pots
- Seed more grains around the plug and wait for those to germinate
- Put plants into a protected area until ready to go into greenhouse

Bioline AgroSciences

Aphid Banker Plants – How To Get Started

- Start out with two banker plants per acre and add one more every other week until the end of the season
- Add 100 wasps per banker plant for 4 – 5 weeks
- Should find at least 10 wasps per week on sticky cards
- Hanging basket along walkways seems to work best

Bioline AgroSciences

Aphid Banker Plants – Maintaining the System

- Many growers use a combination of supplied BCOA and their own production
- Build your own cages
- Use an old soda machine
- Have a dedicated walk-in cooler for BCOA production
- Protection methods are not to keep aphids in, but to keep *Aphidius* and other BCAs out
- Always use double-screening for ventilation and preferably multiple cages!

Bioline AgroSciences

Aphid Banker Plants – Maintaining the System

- Inoculated grains inside cage
- Seed new pots with grains and immediately place next to inoculated plants
- Aphids will naturally infest newly germinating grains
- Creates a steady supply of fresh banker plants
- Maintain as far from greenhouse as possible

Bioline AgroSciences

What To Do If You Find Spider Mites?

Bioline AgroSciences

Phytoseiulus persmilis

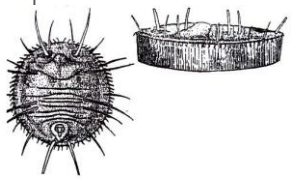
- **Only** feeds on TSSM – not available in sachets
- Preys on all stages of spider mites
- Will eat 6 adults, 20 eggs, or a combination each day
- Can be used in wide range of crops
- Active from 60-95°F (16-35°C)
- Quick reproduction and establishment
- One of the few BCA's that is releases after pest problem is detected
- Rates:
  - 0.6 to 1 mite/sq. ft for 3 to 4 consecutive weeks
  - In hot spots 20 – 30 mites/sq.ft. (hotshot)
  - Produced in Oxnard, CA.

Bioline AgroSciences

Different Species Of Whitefly

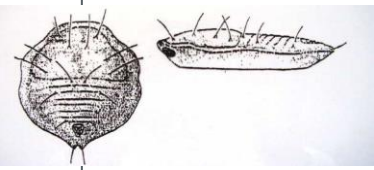
Greenhouse whitefly

- *Trialeurodes vaporariorum*
- Adult: bigger than B.t.
- View from top : more triangle shape
- Colour is whiter due to more wax excrement
- Egg : first days white, later brown – black (purple)
- Pupae: oval white casket with **ring of wax strings**
- Parasitized by *Encarsia formosa* and *Eretmocerus eremicus*



Silver leaf whitefly

- *Bemisia tabaci*
- Smaller than T.v.
- View from top: elongated
- More yellow due to less wax excrement
- Egg: light yellow-green, later light brown
- Pupae: flat, transparant / yellowish color (adult is visible → **red eyes**)
- Parasitized by *Eretmocerus eremicus*



Bioline AgroSciences

Encarsia formosa - Encarline Card/Mix

- Parasitizes larvae of greemhouse whitefly – larvae turn black
- Some host feeding (3 – 4 L1/day)
- Will not parasitize *Bemisia*
- Can be used in wide range of crops
- Active from 59°F – 85°F
- 99% females
- Very sensitive for sulphur and traditional pesticides
- Available on cards and in blisters (mixed product)
- Preventative approach recommended
- Release rates depending on crop
  - Ornamental crops → 0.6 – 1 wasp/ sq. ft (hostfeeding)
  - Vegetable crops → 0.015 – 0.6 wasp/ sq. ft (establishing)

Bioline AgroSciences

Eretmocerus eremicus – Eretline Blister/Card

- Parasitizes larvae of greenhouse **and** *Bemisia* whitefly – larvae turn yellow/tan
- **Aggressive** host feeding (20 – 30 L1/day)
- Can be used in wide range of crops
- Active from 68°F – prefers warmer temperatures (77 – 84°F)
- Less active at low light levels in winter
- Available in blisters (and cards, but cards are **not** the preferred method)
- Preventative approach recommended
- Release rates depending on crop
  - Ornamental crops → 0.6 – 1 wasp/ sq. ft (hostfeeding)
  - Vegetable crops → 0.015 – 0.6 wasp/ sq. ft (establishing)

Bioline AgroSciences

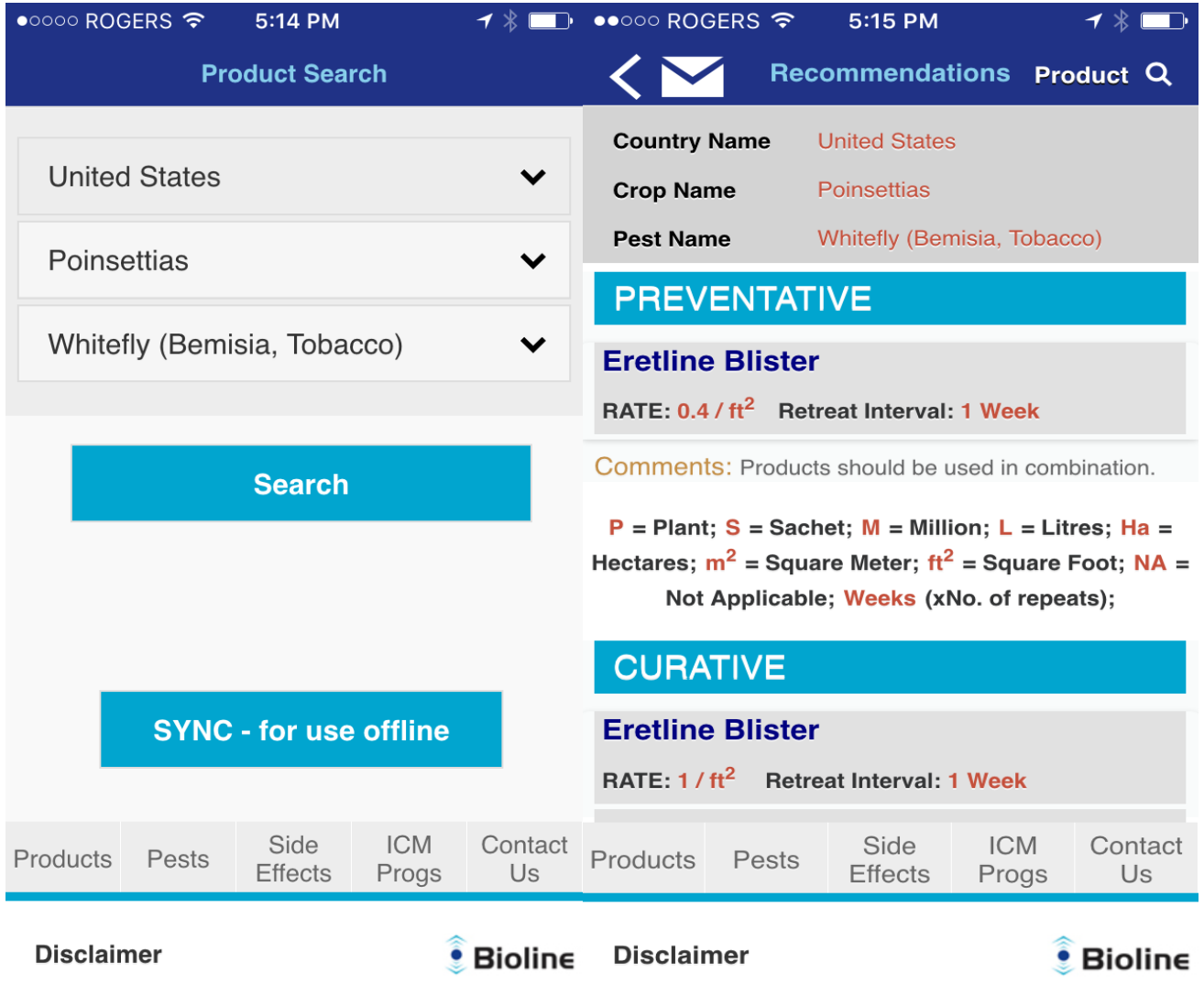
Cards vs Blister Packs – What's The Difference?

- *Encarsia formosa* can hatch from both sides of pupal case
- *Eretmocerus eremicus* can only hatch on top side of pupa!
- Pupa stuck on card vs pupa loose in blister pack
- Protection with blisters from ants or other environmental conditions such as watering with loose pupa → *Aphidius colemani* and *Aphidoletes aphidimyza* also available in blisters
- Blisters preferred method for *Eretmocerus* since it produces a better hatch rate

Bioline AgroSciences

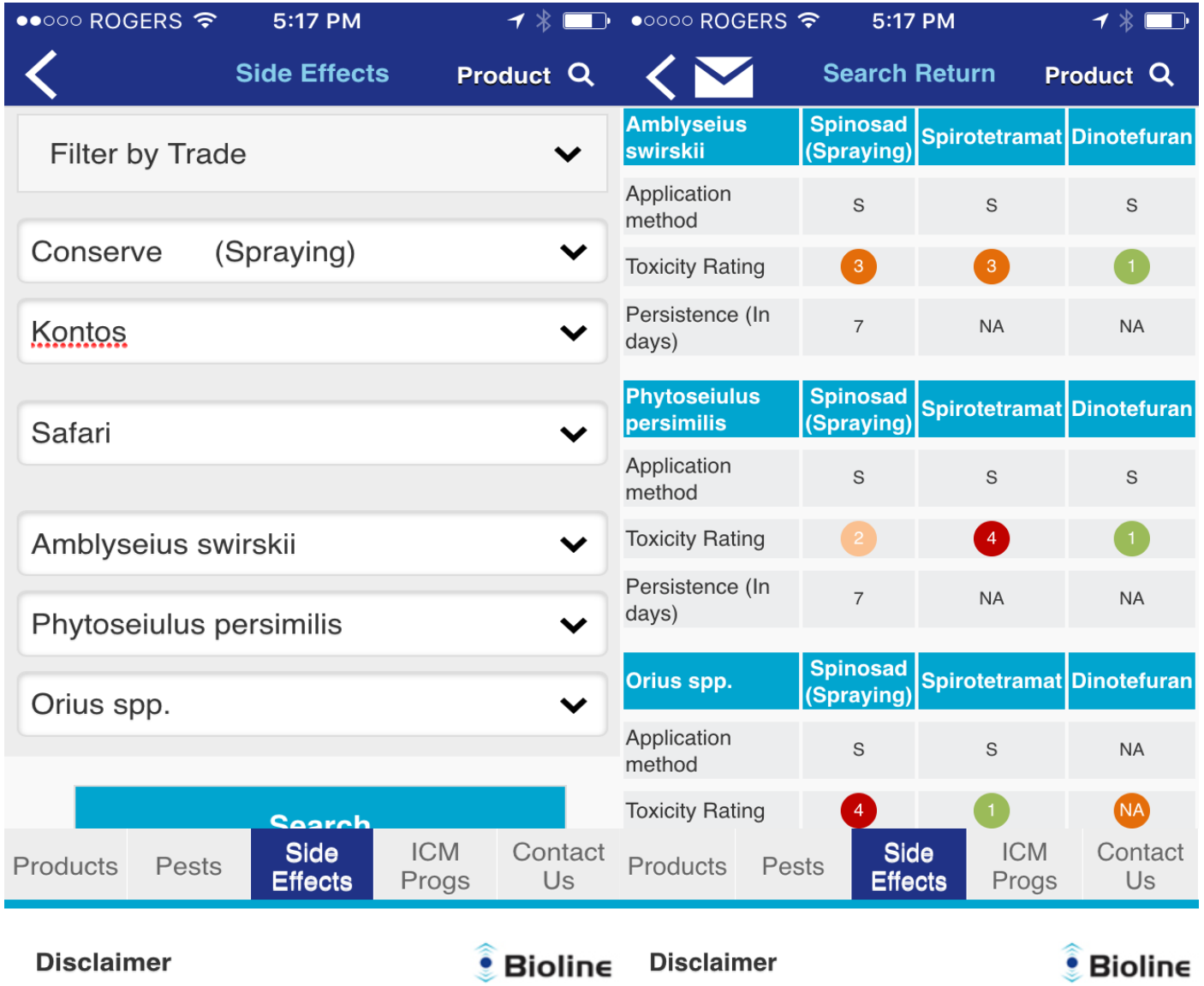
Bioline App – More Info about BCA's and Compatibility

- Apple, Android, and Microsoft compatible – free download
- Technical information per pest, BCA and strategies
- Compatibility data
- Trade name and A.I.



Bioline AgroSciences

Bioline App:



Bioline AgroSciences

Keys to a Successful Biocontrol Program

- Ongoing education, knowledge, communication and networking
- Discuss biocontrol with other growers – share tips and ideas
- Start as early as possible, even before the crop has started – Planning!
- Use resources (technical support) and follow rate recommendations
- Proactive approach greatly increases success rate
- Understand life cycle of both pest and BCA
- Treat IPM program as a whole ecosystem
- Check compatibility if/when a traditional product is considered
- Communicate with young plant material suppliers

Bioline AgroSciences

Thank you!

Discussion and Questions?

- Greg Bryant
- IPM Technical Specialist (Northeast Region)
- Bioline Agrosciences
- GBryant@biolineagrosciences.com

Bioline AgroSciences