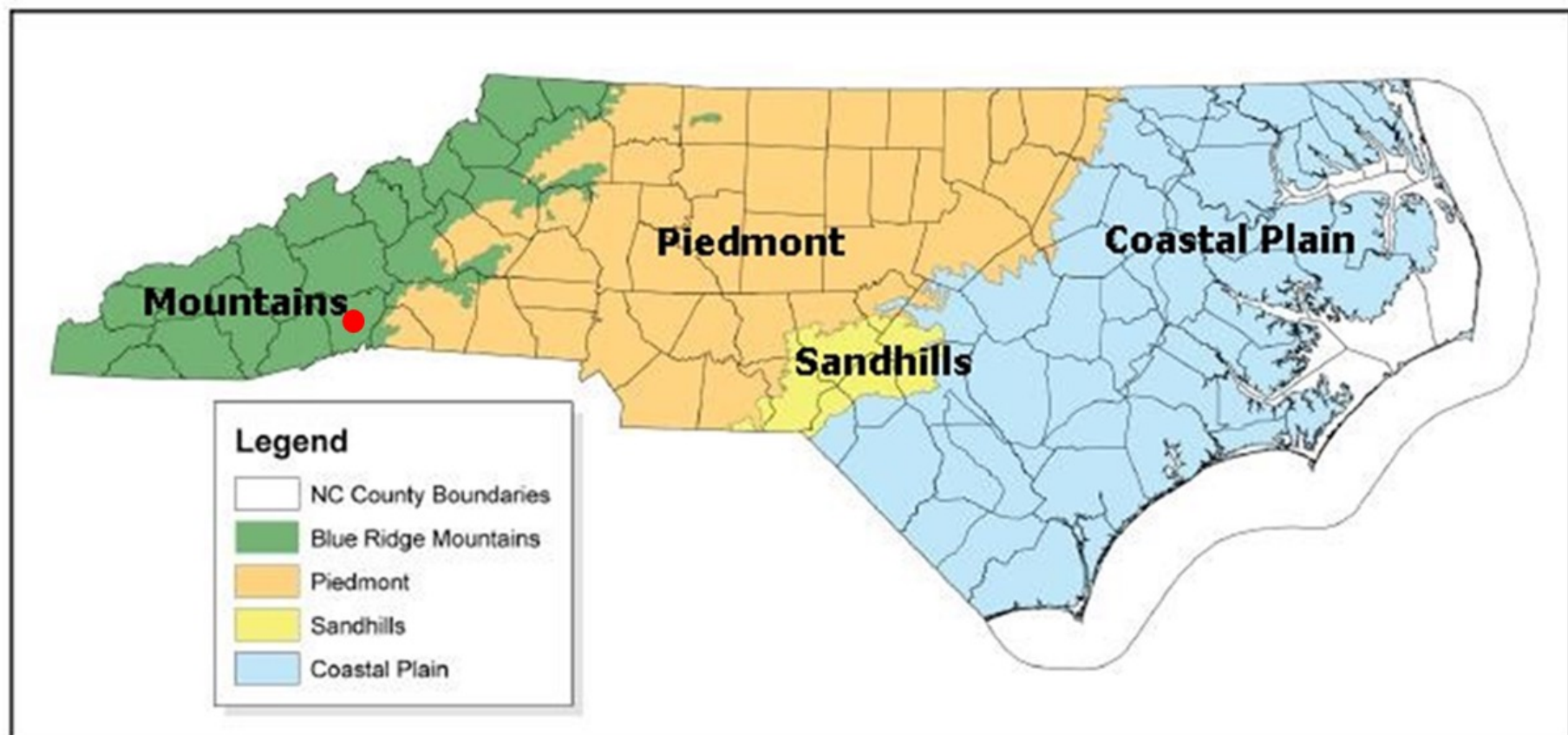




Insect Management in Vegetable Crops

**Jim Walgenbach
Dept Entomology, NC State Univ
MHCREC, Mills River, NC**

NC STATE UNIVERSITY



Whitefly Pests of Vegetables in the Southeast



**Banded winged
whitefly**



**Greenhouse
whitefly**



**Silverleaf
whitefly**



Foliar Insecticide Options for Whitefly

MoA	Insecticide	Rating
4A	Admire	E
4A	Assail	E
4A	Actara	E
4A	Venom	E
4D	Sivanto	E

MoA	Insecticide	PHI
7C	Knack	E
16	Courier	G
23	Oberon	G
23	Movento	G
28	Coragen	G
28	Exirel	G
29	Beleaf	E

Soil-Applied Systemic Insecticides

MoA	Insecticide	Transplant Tray	Transplant water	Drip chemigation
4A	Admire	X	X	X
4A	Platinum		X	X
4A	Venom		X	X
4D	Sivanto		X	X
28	Coragen		X	X
28	Verimark	X	X	X
29	Beleaf		X	X
4A+28	Durivo*		X	X

*Premix containing AIs of Coragen and Platinum

Foliar Application

vs.

Drip Chemigation



Insect Management in Vegetables

Cucurbits



**Fruiting
Vegetables**



Brassicas



Key Cucurbit Pests

Pest	Cucumber	Squash, Pumpkin	Watermelon
Aphids	X	X	X
Cucumber beetle	X	X	X
Pickleworm	X	X	X
Squash bug	—	X	—
Spider mites	X	x	X
Squash vine borer	—	X ¹	—

¹Squash vine borer is a common pest in gardens and small plantings, but rarely is it a pest in commercial plantings.

Focus of Cucurbit Pest Management

1. Cucumber beetle is ubiquitous and can require control from shortly after plant emergence through harvest.
 - First 3 wks post emergence most critical
2. Aphids, squash bug and mites vary in intensity and time of infestation. Insecticides can be applied on an as-needed basis.
3. Pickleworm is a late-season pest and usually does not require control before August.

Cucumber Beetles

Spotted cucumber beetle
Diabrotica undecimpunctata



Stripped cucumber beetle
Acalymma vittatum
Diabrotica virgifera virgifera



Cucumber Beetle Damage



Control



**AdmirePro (10 fl oz/A)
@ First true leaf (6/18)**



Repeated Pyrethroid Applications

- Flare aphid populations
- Flare twospotted spider mite populations
- Flare whitefly populations

Aphids

Melon aphid
Aphis gossypii



Green peach aphid
Myzus persicae



Squash Bug



Pickleworm





Rindworms

- A complex of lepidopteran larvae that feed on mature fruit, often near harvest
 - Armyworms, cutworms, cabbage looper, corn earworm
- Selection of insecticides should be based on short preharvest interval
 - Soil applied diamides (Coragen, Verimark) will not control rindworms
 - Use the same foliar insecticides as recommended for pickleworm

Relative Effectiveness Table – Soil Application

Insecticide	PHI	Cuc Beelte	Aphids	Squash bug	Pickle- Worm
Admire	21	E	E	E	—
Belay		G	G	F	—
Platinum	30	E	E	G	—
Venom		G	—	E	—
Sivanto	21	—	E	G	—
Coragen	1	—	—	—	G
Verimark	1	—	E	—	G

Relative Effectiveness Table – Foliar Application

Insecticide	Cucumber Beetle	Aphids	Squash bug	Pickle-worm
Admire	E	E	E	—
Assail	E	E	G	—
Venom	E	—	E	—
Sivanto	—	F	E	—
Beleaf	—	E	—	—
Avaunt	—	—	—	E
Radiant	—	—	—	E
Coragen, Harvanta	—	—	—	E
Verimark, Exirel	—	G	—	E
Intrepid	—	—	—	E
Pyrethroids	E	—	E	E

Pyrethroids Labelled on Cucurbits

Common name	Trade name	PHI
Alpha cympermethrin	Fastac	1
Beta cyfluthrin	Baythroid	0
Bifenthrin	Brigade	3
Cyfluthrin	Tombstone	0
Esfenvalerate	Asana	3
Fenpropathrin	Danitol	7
Lambda-cyhalothrin	Warrior, Karate	1
Permethrin	Pounce, Perm-Up	0
Zeta cypermethrin	Mustang Max	1

Insect Management in Vegetables



Fruiting Vegetables



Key Mid- to Late-Season Pests (Fruiting through Harvest)

Direct Pests

Tomato fruitworm

Armyworms

Stink bugs

Thrips

Tomato pinworm

Indirect Pests

Spider mites

Aphids (Potato, GPA)

Whiteflies

Corn Earworm/Tomato Fruitworm



Beet Armyworm



The beet armyworm moth.

Photo by J. R. Baker, NC State University



Southern Armyworm



Yellowstriped Armyworm

Cabbage Looper



Foliar Program Approach

- In every spray, assume lepidopterans are a potential pest
 - Tomato fruitworm – late May thru Sept
 - Armyworms – most common in August-Sept
 - Cabbage Looper – more sporadic, but Aug-Sept and more common in recent years.

Insecticide Options for Lepidopterans (Foliar, Soil)

Insecticide	Fruitworm	Armyworm	Looper
Avaunt (F)	E	E	E
Coragen (F, S)	E	E	F
Radiant (F)	E	G	G
Exirel (F) Verimark (S)	E	E	F
Intrepid (F)	G	E	E
Proclaim (F)	G	E	E
Rimon (F)	E	E	G
Pyrethroids (F)	G	F	G
Bt's (e.g., Dipel, Xentari)	G	G	G
Entrust	E	E	E



Brown Stink Bug



Brown Marmorated Stink Bug



Options for Stink Bug Control

- A general rule is that an insecticide effective stink bugs should be applied at 3-wk intervals in the absence of an effective monitoring system.
- Populations are most intense near corn and rows adjacent to woods – Aug & Sept.
- Drip chemigation with Venom
- Insecticides

Neonicotinoids

Venom/Scorpion

Actara

Pyrethroids

Brigade

Danitol

Warrior

Proaxis

Carbamates

Lannate

Thrips Species in Vegetables



Flower thrips (*F. tritici*): A common species infesting flowers of many crops and weed species. Ubiquitous from late May through August. It's importance as pest is questionable

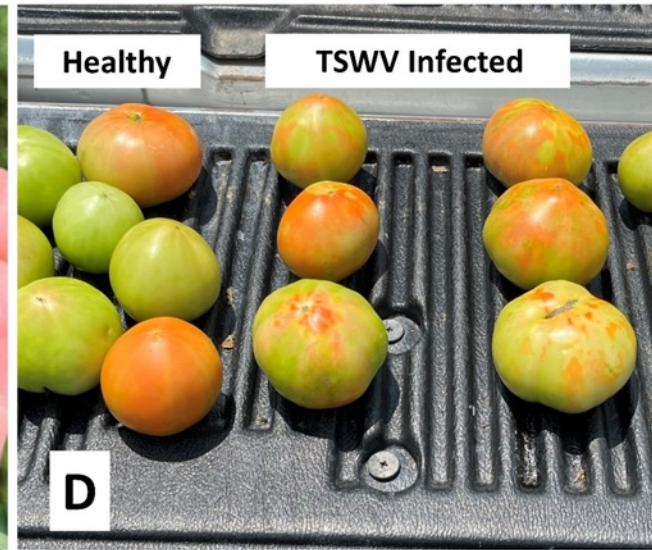
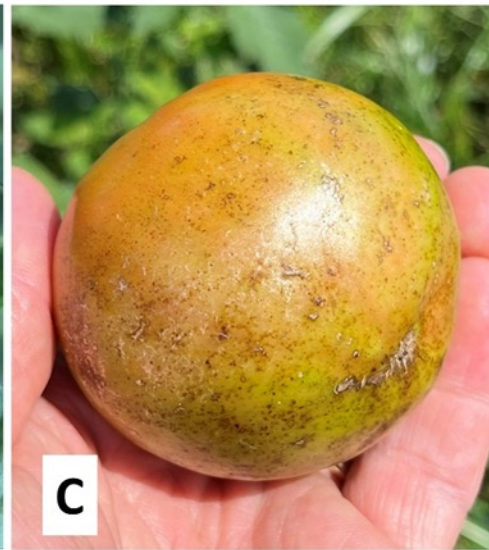
Western flower thrips: Feeds on flowers of many crops and weed species, but also on foliage/fruit of tomatoes. Also transmits TSWV. Most common from June through August. Exhibits an aggregated distribution on areawide scale.

Tobacco thrips: Early season pest that transmits TSWV primarily in April/early May. Important seedling pest of cotton.

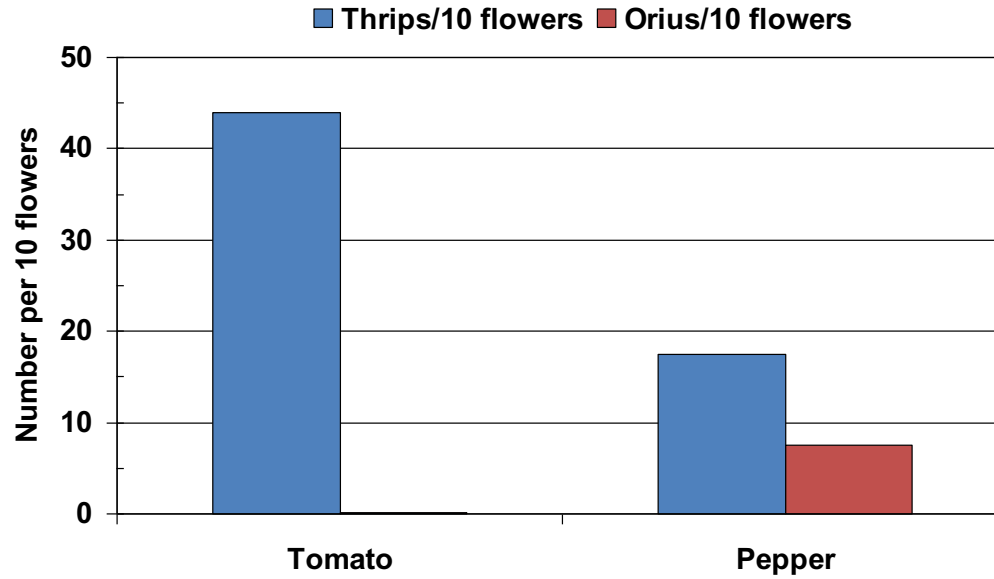
Thrips as Pests of Tomatoes & Peppers

- Vectors of TSWV
 - Tobacco thrips (April-May, eastern NC)
 - Western flower thrips (June-Aug)
- Direct/indirect damage to crop
 - Western flower thrips (roughened fruit, leaf damage to tomato)
 - Eastern flower thrips (dimpling of tomato)

Western Flower Thrips



Western Flower Thrips and *Orius insidiosus* in Tomato and Pepper Flowers



Thrips Insecticides

Insecticide	Eastern Flower Thrips	Tobacco Thrips	Western Flower Thrips
Lannate	E	E	E*
Dimethoate	E	E	G
Admire	G	G*	—
Assail	G	G*	—
Venom	G	G*	—
Radiant	E	E	E*
Beleaf	G	G	G*
Agri-Mek	G	G	F
Rimon	G	G	G
Torac	G	G	G

*Insecticide resistant populations can affect the performance of products.

Twospotted Spider Mite



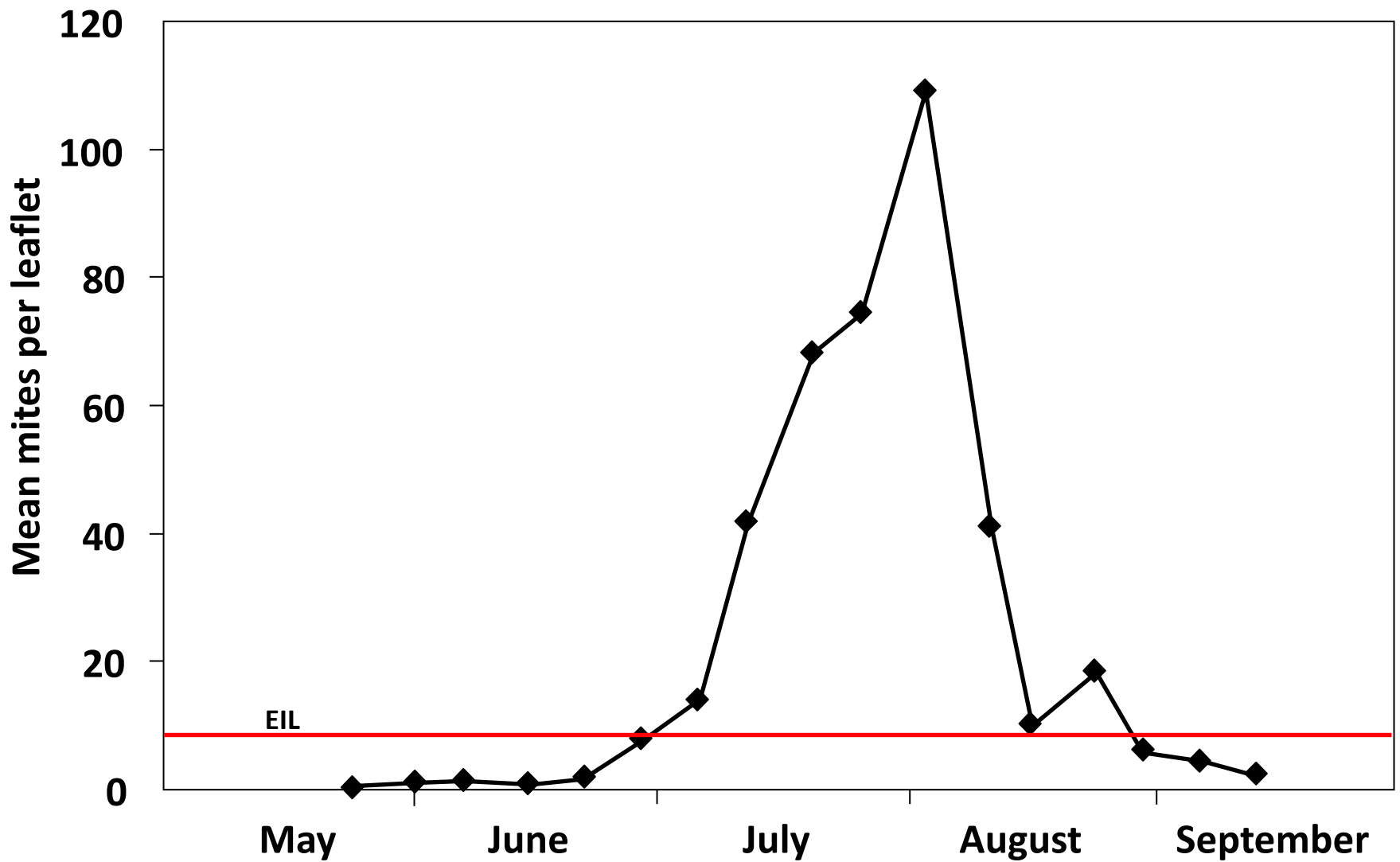
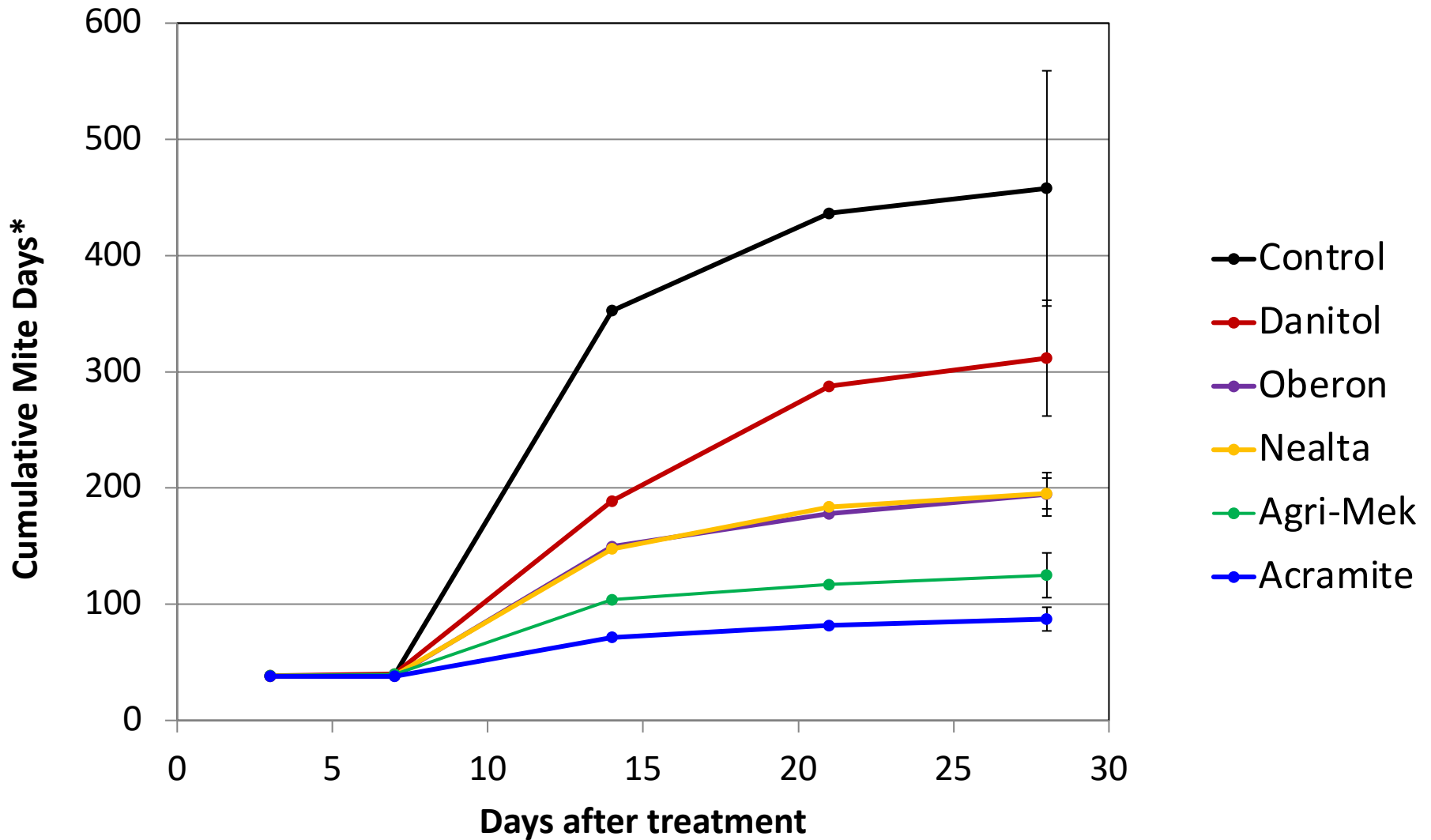


Fig. 1. Twospotted spider mite populations on field-grown tomatoes. Mills River, NC

Tomato Miticide Trial



* CMD, mean density between successive sample dates * sample interval (days)

Predatory mite - *Phytoseiulus persimilis*

- Feeds exclusively on spider mites
- Highly mobile, voracious feeder
- Native to Chile
- Naturalized in NC Piedmont
- Can be purchased (or reared) and released into fields
- Commonly used in greenhouse production.



Insect Management in Brassica Crops



Key Pests of Brassica's

Non-Lepidoptera

- Seedcorn maggot
- Cabbage maggot (mtns)
- Harlequin bug
- Cabbage aphid
- Vegetab Weevil

Lepidoptera

- Imported Cabbage worm
- Cabbage Looper
- Diamondback moth
- Cabbage webworm
- Cross-striped cabbageworm
- Armyworms

Flea Beetles

Striped flea beetle



Pale striped flea beetle



Harlequin Bug



Vegetable Weevil



Pyrethroids

Radiant

Avaunt

Entrust

Pyganic

Lepidoperan Pests

- Diamondback moth
- Imported cabbageworm
- Cabbage looper
- Cross-striped cabbageworm
- Cabbage webworm
- Armyworms



Imported Cabbageworm



Cabbage Looper



Cross-striped cabbageworm



Cabbage Webworm



Principles of Lepidopteran Control

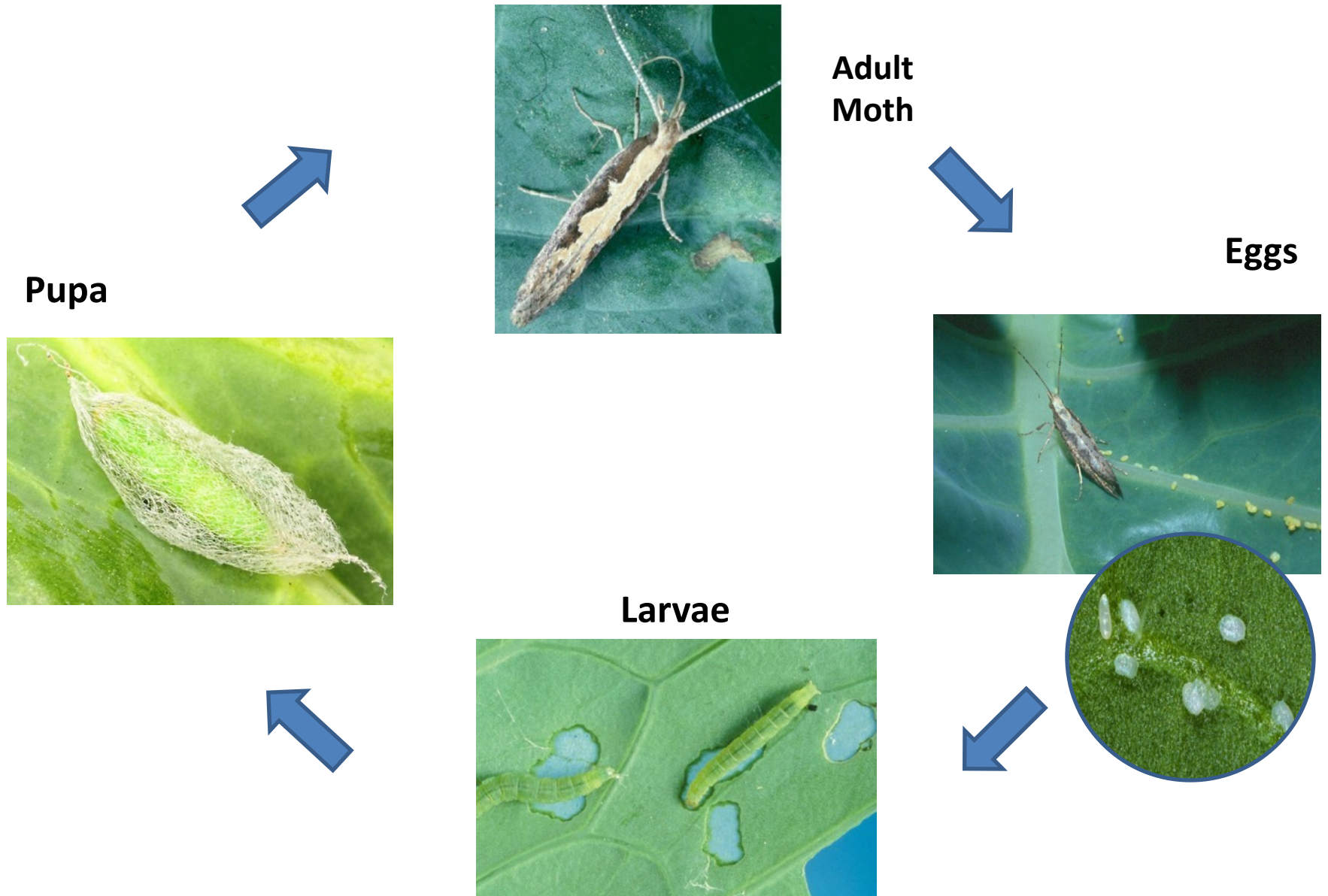
- Many insecticides have excellent activity against caterpillars
- Broad spectrum insecticides can disrupt natural enemies and result in pest outbreaks – Pyrethroids.
 - Apply pyrethroids only when necessary (Harlequin bug)
- Insecticides
 - Avaunt, Bt, Coragen,, Intrepid, Proclaim, Radiant, Rimon,
- Rotating chemical class (MOAs) is important for insecticide resistance management, particularly against DBM.
 - DO NOT rotate every spray, spray the same product for 2 – 3 weeks then rotate. Expose a generation to only class of chemistry.

Relative Efficacy of Insecticides

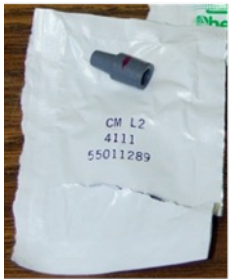
Insecticide	MOA Group	Diamondback Moth*	Cabbage Looper*	Imported Cabbage worm	Striped Cabbage worm
Avaunt	22A	G	E	E	E
Bts (Dipel, Xentari)	11A	G	E	E	E
Coragen, Exirel, Harvanta	28	E	E	E	E
Dibrom	1B	E	F	E	F
Intrepid	18	F	E	E	E
Proclaim	6	E	E	E	E
Radiant (Entrust)	5	G	G	E	E
Rimon	15	F	G	E	E
Torac	21A	G	F	E	F

*Insecticide-resistant can affect the performance of certain insecticides against some populations.

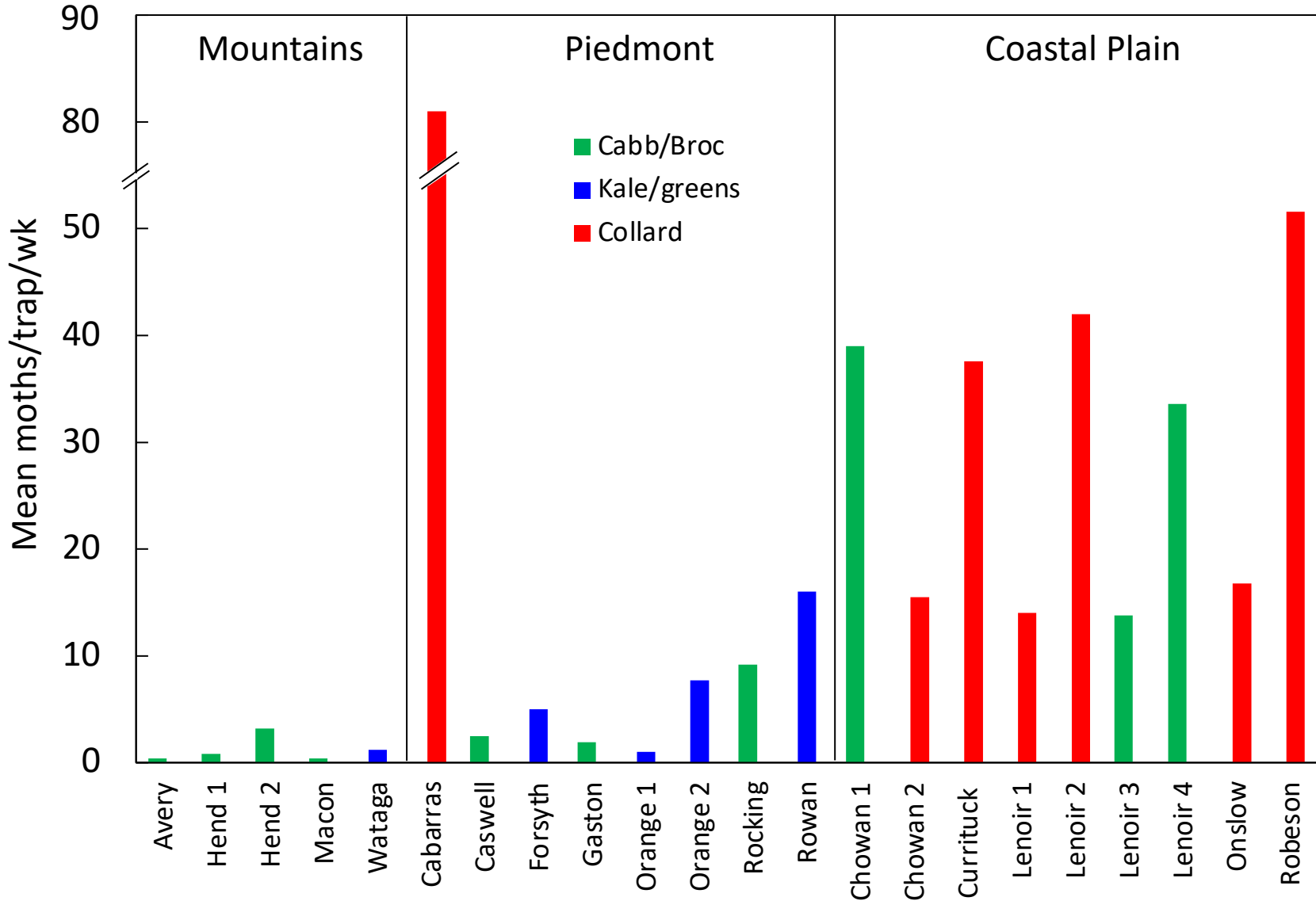
Diamondback Moth Life Cycle



Sex Phermone: Species-specific chemical emitted by females to attract males of the same species.



Seasonal Weekly Average DBM Populations



Insecticide Resistance Management (IRM) Practices for Diamondback Moth

- Avoid soil applied Coragen or Verimark
- Only spray when necessary - Thresholds
 - 10% of plants infested with eggs or larvae
 - 0.3 DBM larvae per plant (1 per 3 plants)
- Rotate insecticides with different MOA **among generations**, not within generations.
 - Early spring – 3 week spray rotations
 - Summer – 2-wk spray rotations
- Avoid Pyrethroids – flare DBM populations

DBM-Recommended Insecticides MOA

Brand name	Common name	MOA Group	*Efficacy Rating
Coragen	Chlorantraniliprole	28	E
Exirel, Verimark	Cyantraniliprole	28	E
Harvanta	Cyclaniliprole	28	E
Proclaim	Emamectin benzoate	6	E
Avaunt	Indoxacarb	22B	E
Dipel, Xentari	<i>Bacillus thuringiensis kurstaki</i> <i>Bacillus thuringiensis aizawai</i>	11A	G
Dibrom	Naled	1B	G
Radiant	Spinetoram	5	G
Torac	Tolfenpyrad	21A	G
Rimon	Novaluron	15	F
Intrepid	Methoxyfenozide	18	F

*Efficacy ratings deviate due to local population-resistance profile.