Organic Approaches to Insect Management on Cucurbit Crops

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THE OHIO STATE UNIVERSITY

Your crops?

- **Market**
  - To sell?
  - Own consumption?
- **Approach?**
  - Certified organic?
  - Fully organic but not certified?
  - Close to organic?
  - Not organic?

Insect pests

- **Key pests**
  - Cucumber beetles
  - Squash vine borer
- **Occasional pests**
  - Squash bug
  - Squash beetle
  - Whiteflies
  - Spider mites
  - Seedcorn maggot
  - Melon aphid

Cucumber beetles: key pests

Feeding damage

Vectors of bacterial wilt disease

Bacterial wilt of cucurbits: Vectored by cucumber beetles

- Transmitted in feces
- Enter via plant wound
- Moisture needed
- Cotyledon stage most susceptible

Russ Ottens, University of Georgia, Bugwood.org

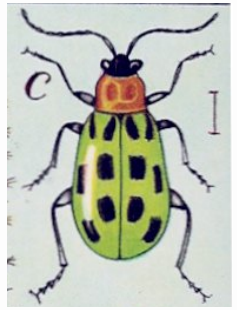
Bacterial wilt & cucumber beetles

- **Infective beetles**
  - Overwintering
    - 1%
  - 2nd generation (Jul-Sep)
    - 8-12%
  - More if feeding longer (72 hrs *vs* 12 hrs)

Beetle species in cucurbits

- **Known vectors:**
  - Striped cucumber beetle
  - Spotted cucumber beetle

striped



spotted

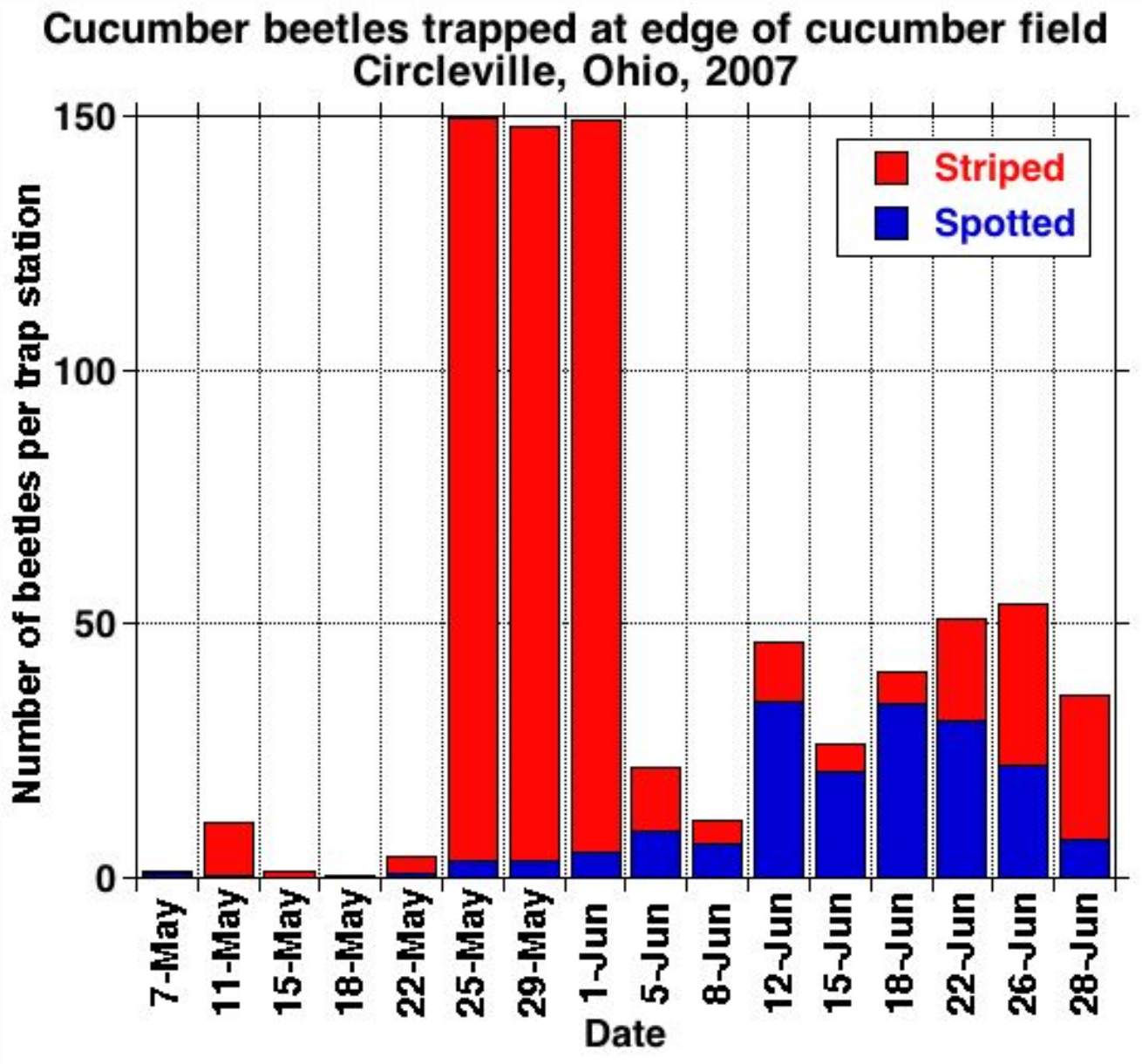
- **Not known to vector:**
  - Western corn rootworm beetle
  - Northern corn rootworm beetle
  - Pale-striped flea beetle

western

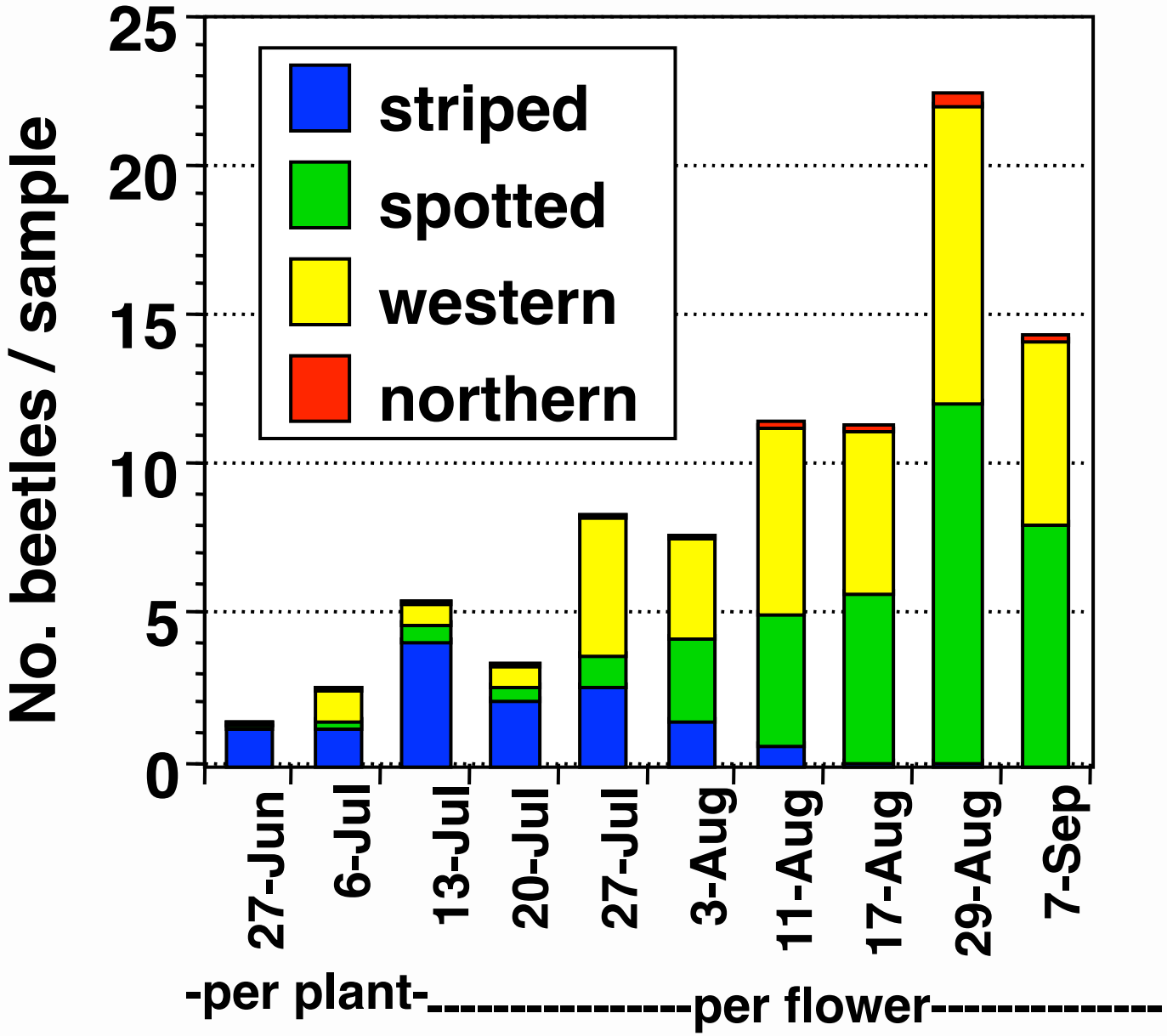
pale-striped

northern

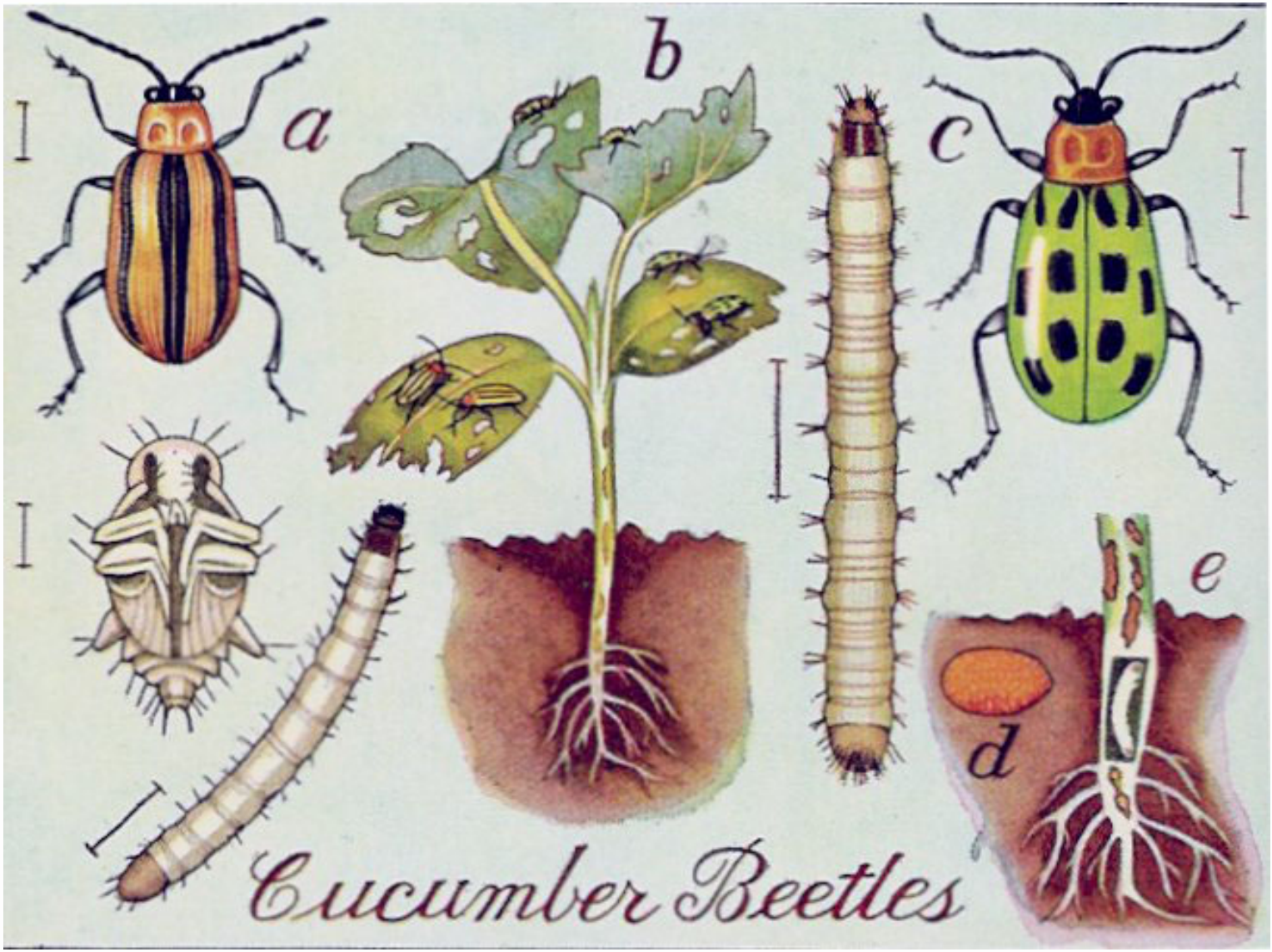
Seasonal progression of beetle species



Seasonal progression of beetle species on squash



Life Cycle



Biocontrol??

Natural enemy of cucumber beetles

- Parasitoid fly, *Celatoria setosa*
- Looks like a small house fly
- Kills adult cucumber beetles
- Common in Ohio
- We need to encourage its survival!

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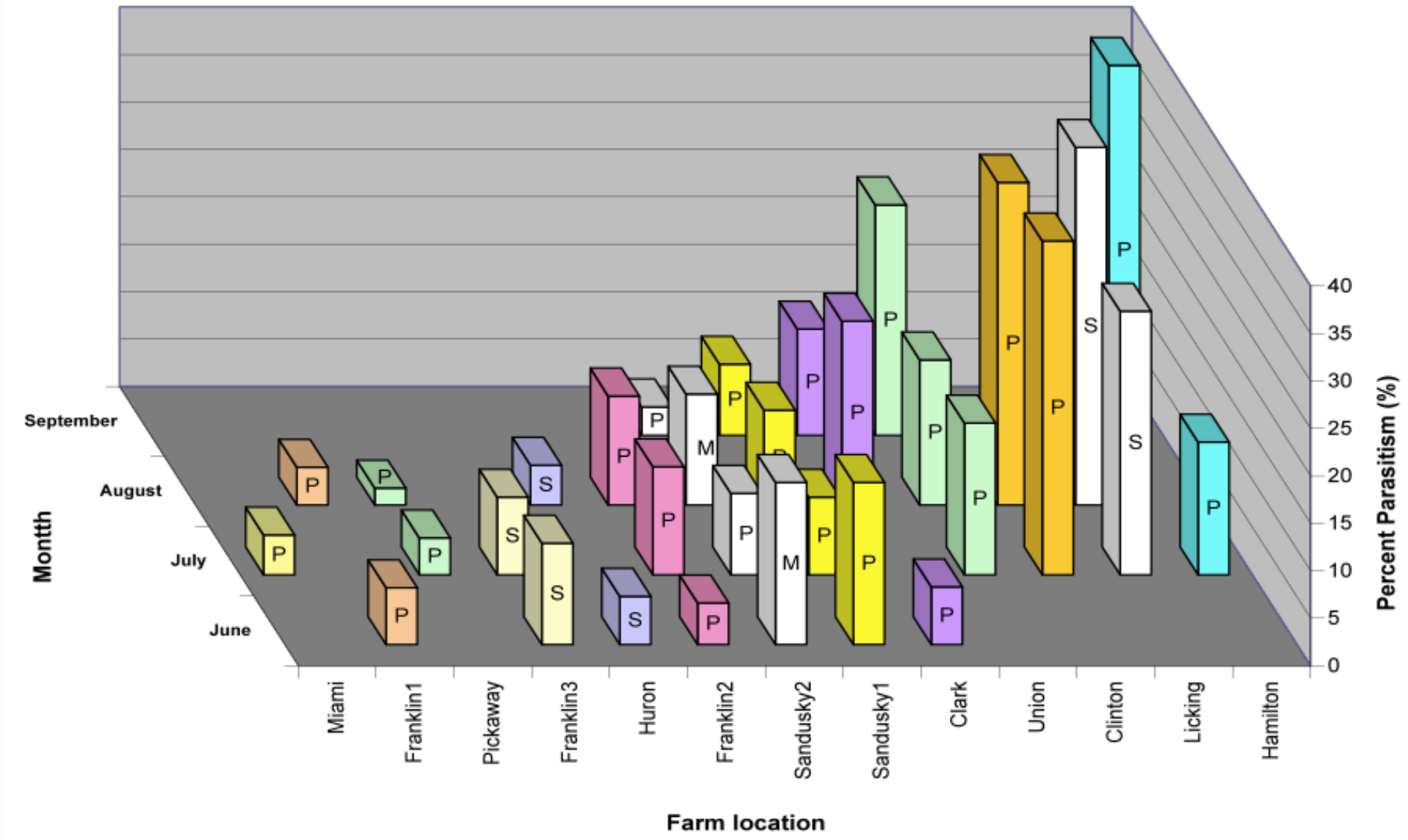
- We need to encourage its survival!
- Studies by Stephanie Miller, 2003-04

Survey of parasitism of striped cucumber beetle by *Celatoria setosa*, 2003

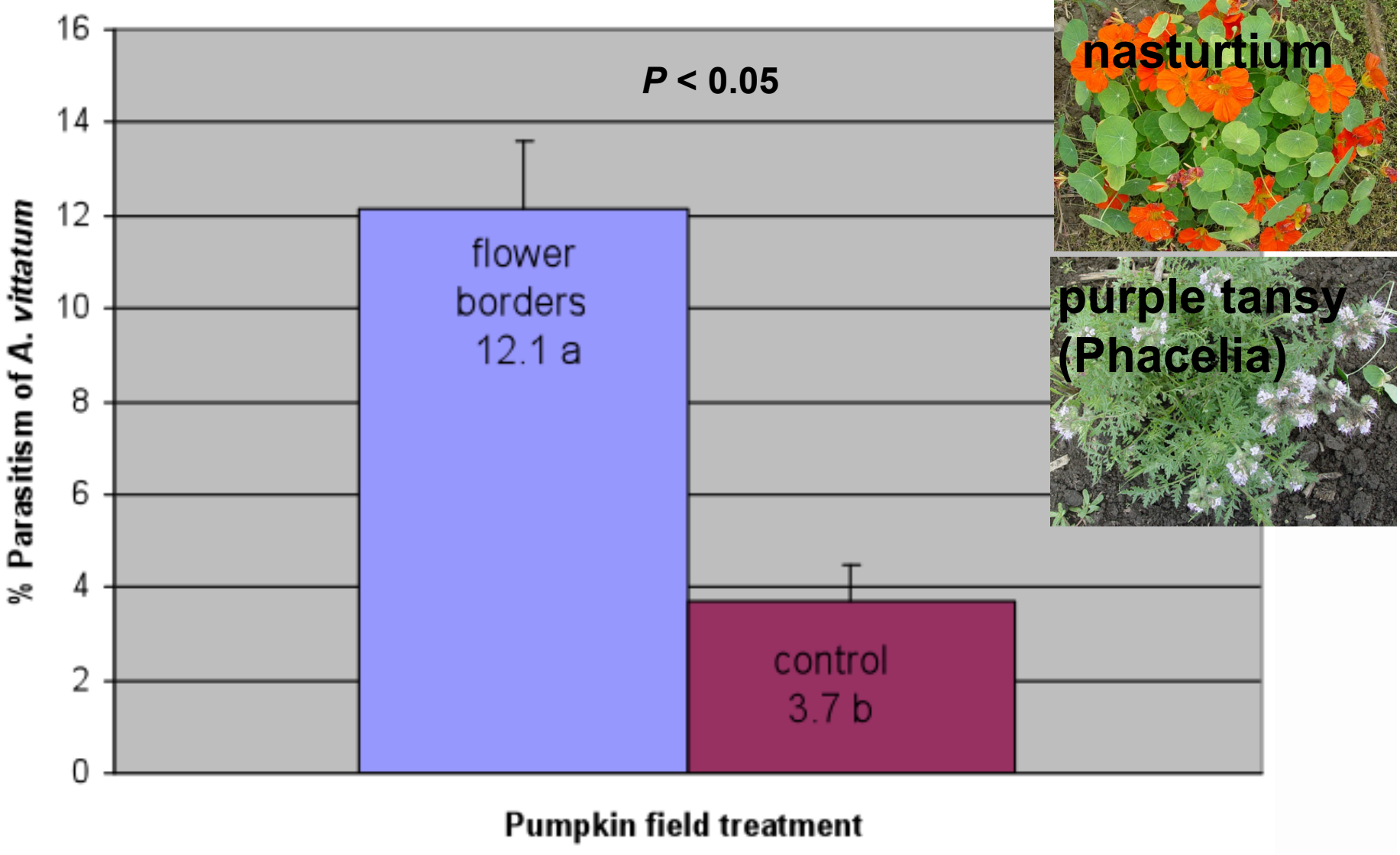


P= pumpkin; S = squash; M = melon

Insectary planting as refuge for natural enemies

- Adult parasitoids need nectar
- Adult predators need pollen
- Plant flowering border at field edge to enhance biocontrol

Parasitism of striped cucumber beetle by *Celatoria setosa* at 4 sites, 2004



Longevity of *Celatoria setosa* in presence of flowers in lab

Trial	Food treatment	Longevity Mean ±SE (days lived)	Range (days lived, min-max)	Total no. of flies treated
2003	Nasturtium and Honey	**7.6** ± 0.7 a	0.5 - 18	40
	Honey	**5.6** ± 0.6 b	1 - 14	48
	Purple tansy and Honey	**4.6** ± 0.5 b	1 - 6	14
	Dill and Honey	**4.3** ± 0.8 b	0.5 - 11.5	15
	Dill only	**1.3** ± 0.1 c	0.2 - 2.5	14
2004	Nasturtium and Honey	**9.5** ± 1.9 a	6 - 15	4
	Purple tansy and honey	**8.3** ± 3.7 a	0.5 - 15	4
	Honey	**7.3** ± 1.1 a	5.5 - 10	4
	Purple tansy only	**3.8** ± 0.8 b	2.0 - 5	4
	Nasturtium only	**2.8** ± 0.6 b	1 - 4	4
	Water only	**0.8** ± 0.1 c	0.5 - 1.0	4

Conservation biological control of cucumber beetle:

studies 2014-2015 by Molly Dietrich

- Characterize predator community
- Pitfall sampling for predators
- Predation on cucumber beetle eggs
  - Above & below ground
  - Video surveillance
- Gut contents analysis

Predatory Natural Enemies

- **Wolf spiders**
  - Most small: thumbnail size
  - Feed on adult cuke beetles
  - Hunting spiders, no nests
  - Beetles avoid wolf spiders
    - Thus feed less on crop
  - Helps to provide perennial refuge
    - Unmated females overwinter
    - Protected areas: shrubby fencerows, woodlots

Predatory Natural Enemies

- **Harvestmen or Daddy-long-legs**
  - –Susceptible to dehydration

Predatory Natural Enemies

- **Ground beetles**
  - Predatory as adults & larvae
- **Rove beetles**
  - Scavengers
  - Likely eat eggs

Predatory Natural Enemies

- **Lady beetles**
  - Many species
  - Prey as adults & larvae
  - Eat aphids & other prey

Bacterial wilt project

- **USDA/SCRI = Specialty Crop Research Initiative**
- **Multi-disciplinary**
- **Multi-State**
  - Iowa, Ohio, Kentucky, Pennsylvania
  - Ohio: Sally Miller, Karen Goodell, Mary Gardiner, Jim Jasinski, C. Welty
- **2013 & 2014**

Field trial on crop management

- **Compare 2 systems:**
  - Both with cover crop
  - 1) Full tillage & black plastic
  - 2) Strip tillage & no black plastic
- **Each w/ & w/o row covers**
- **Each in organic & conventional**
- **Each in summer squash & cantaloupe**

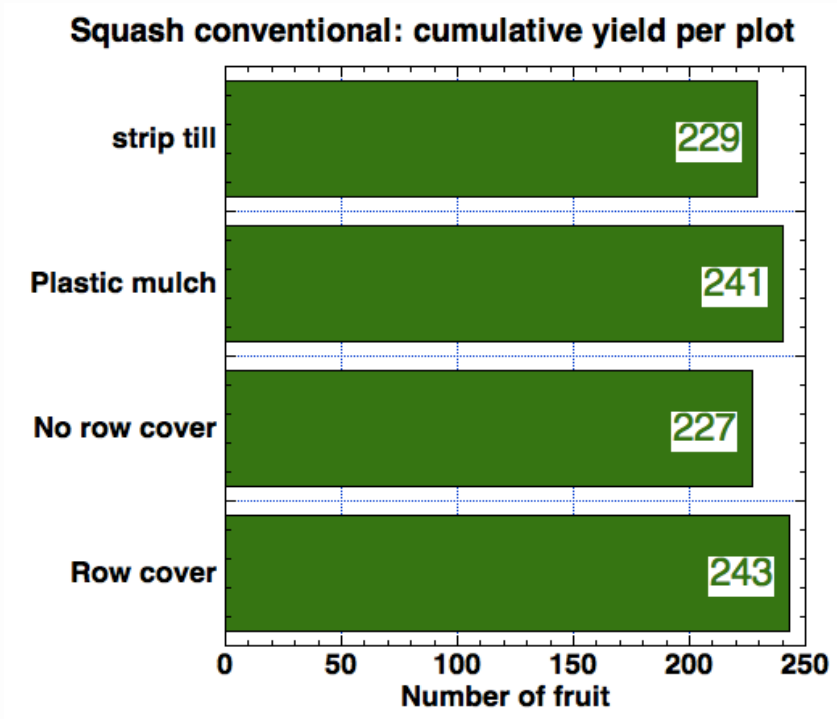
Cucurbit field trials, 2013 & 2014

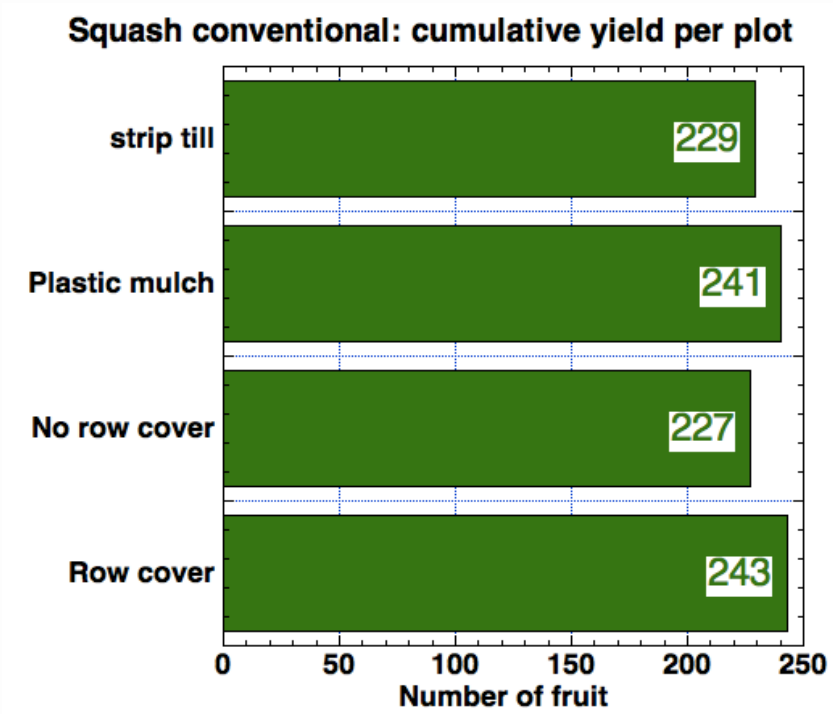
Element	*Conventional*	*Organic*
Cover crop killing	Herbicide	Roller-crimper
Fertilizer	Synthetic	Natural
Seed treatment	Fungicide only	None
Transplant media	Standard	Organic
Treatment at planting	Admire soil drench	None
Insecticide at threshold	Asana	Entrust + CideTrak D

cover crop of rye, pea, canola

conventional till

strip till


Squash conventional: cumulative yield per plot
strip till
Plastic mulch
No row cover
Row cover
229
241
227
243
0
50
100
150
200
250
Number of fruit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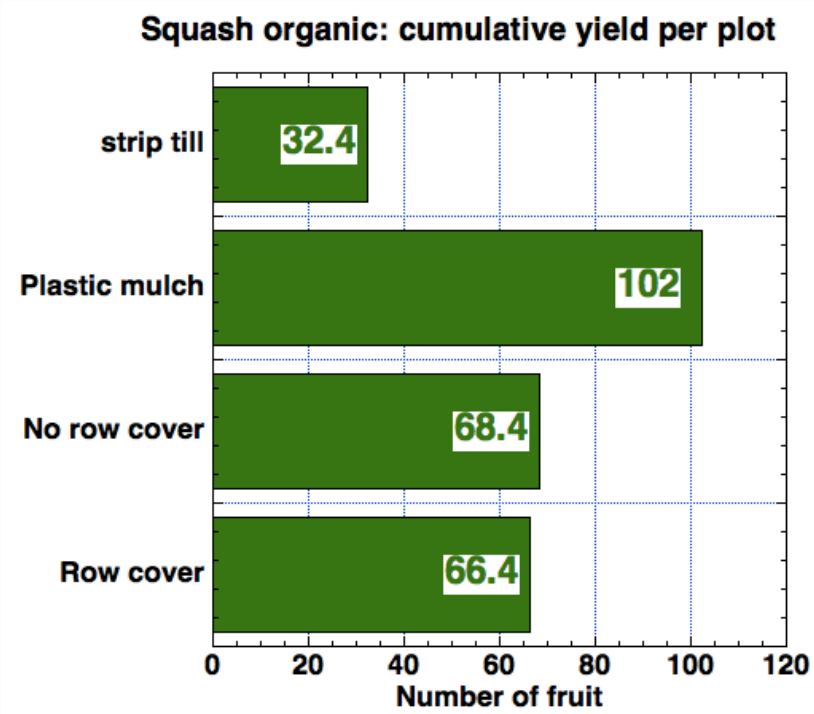
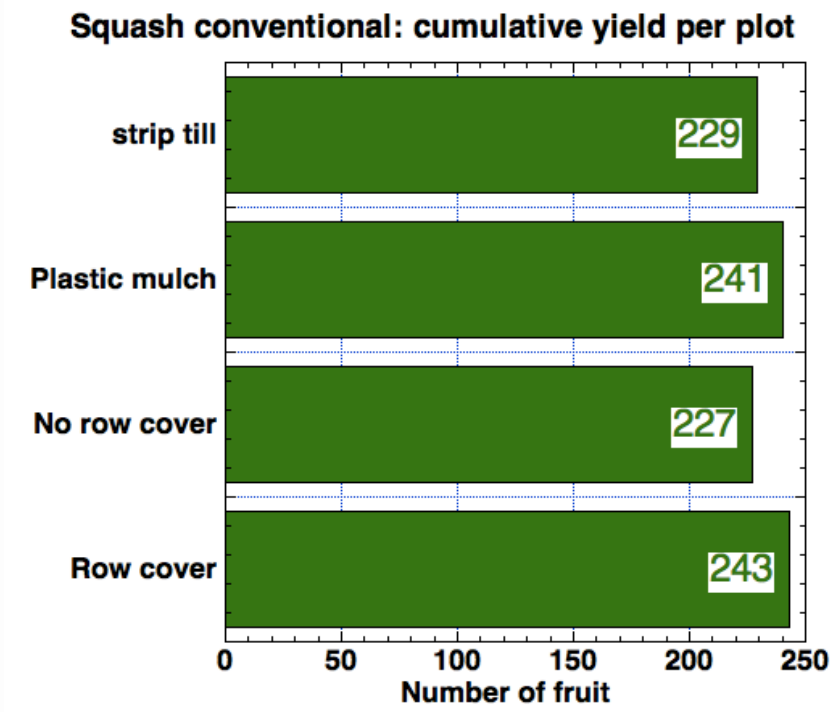
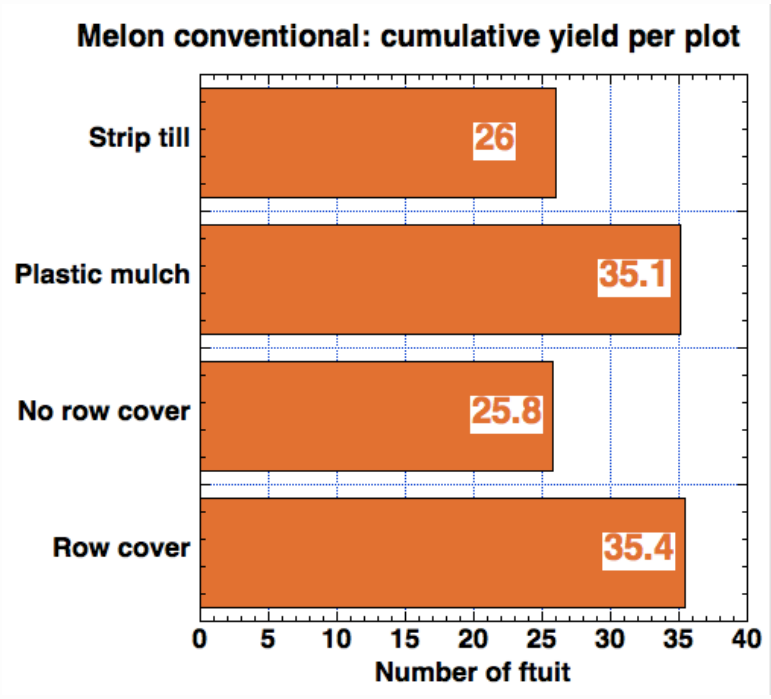
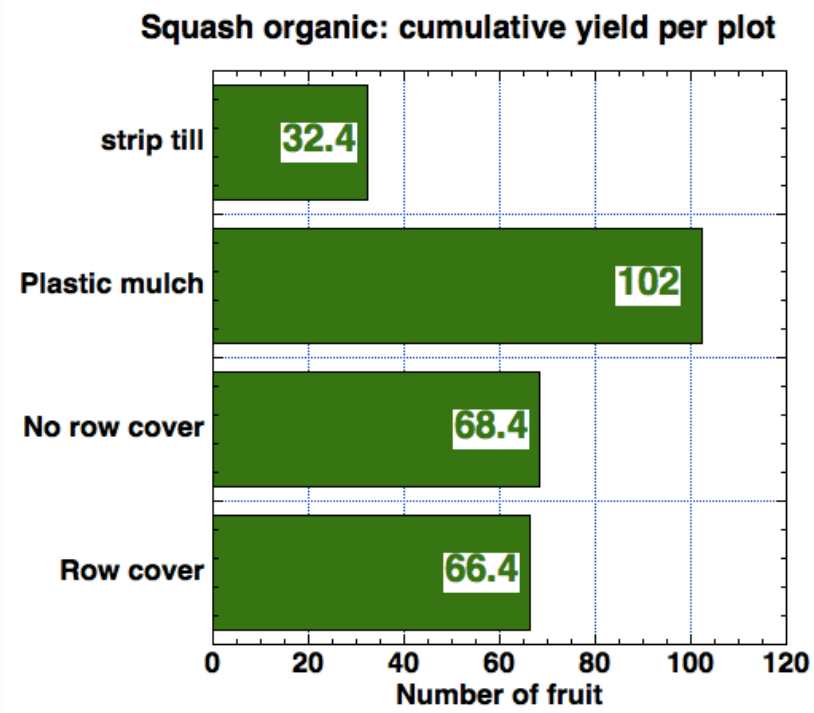

Squash organic: cumulative yield per plot
strip till
Plastic mulch
No row cover
Row cover
32.4
102
68.4
66.4
0
20
40
60
80
100
120
Number of fruit


Squash conventional: cumulative yield per plot
strip till
Plastic mulch
No row cover
Row cover
229
241
227
243
0
50
100
150
200
250
Number of fruit


Melon conventional: cumulative yield per plot
Strip till
Plastic mulch
No row cover
Row cover
26
35.1
25.8
35.4
0
5
10
15
20
25
30
35
40
Number of ftuit


Squash organic: cumulative yield per plot
strip till
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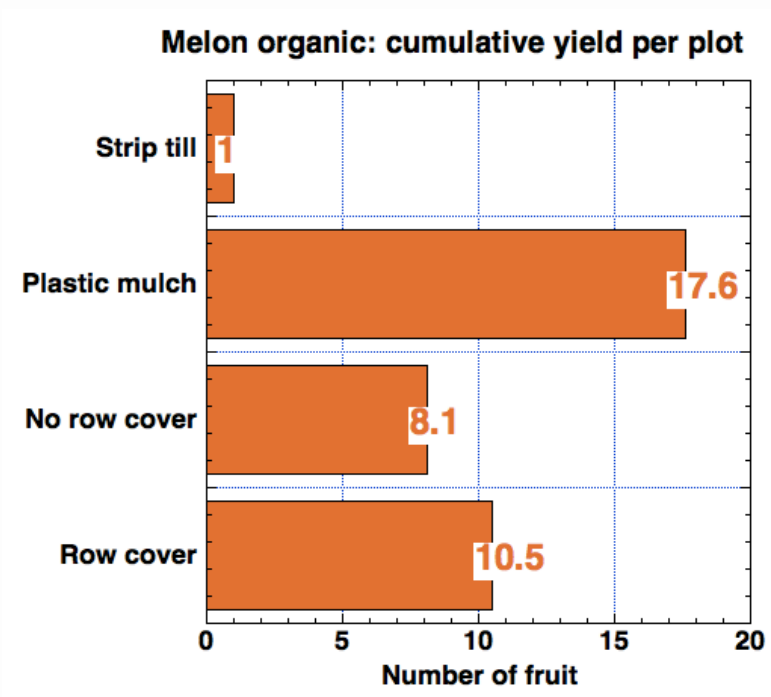
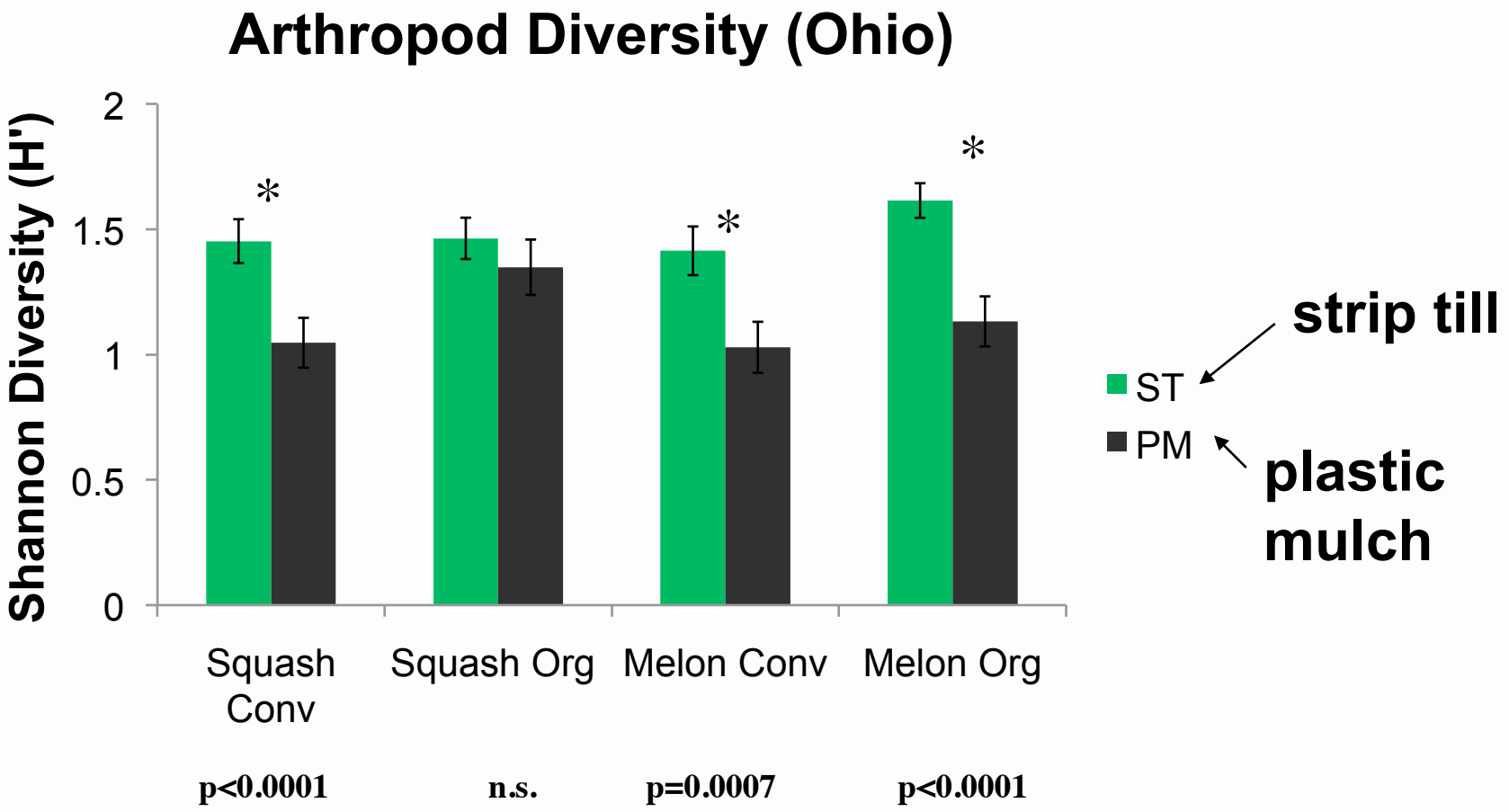
No row cover
Row cover
32.4
102
68.4
66.4
0
20
40
60
80
100
120
Number of fruit


Melon organic: cumulative yield per plot
Strip till
Plastic mulch
No row cover
Row cover
1
17.6
8.1
10.5
0
5
10
15
20
Number of fruit

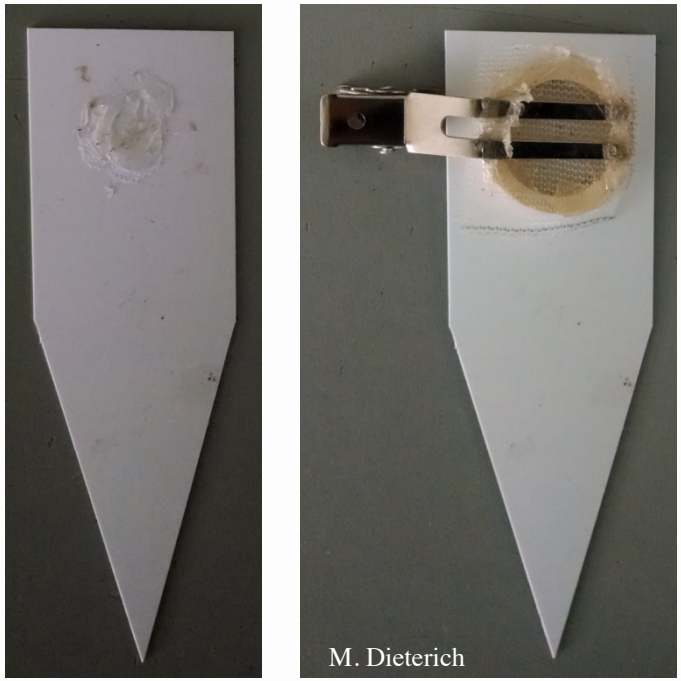
1. Pitfall trap results

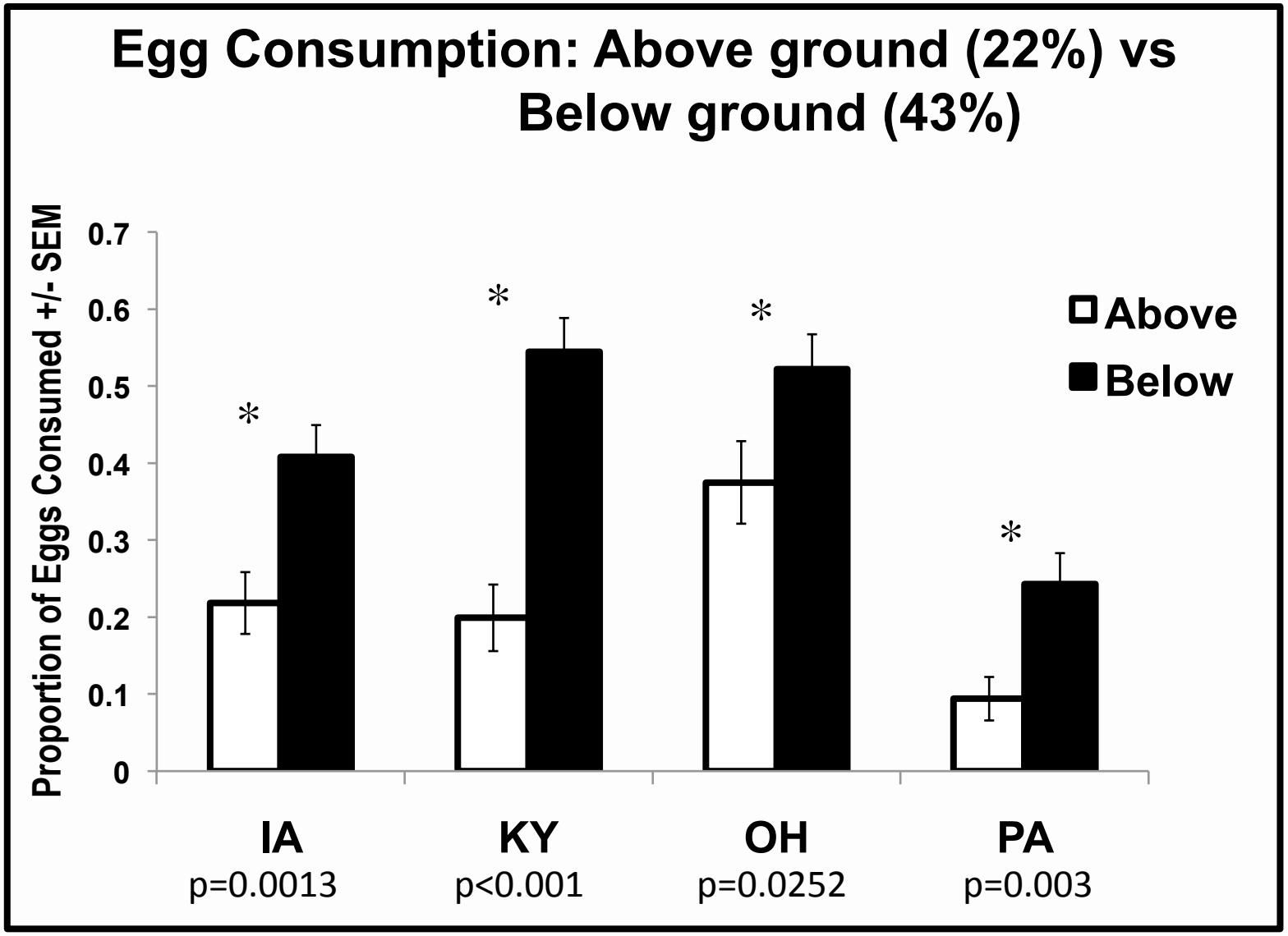


2. Sentinel Egg Study

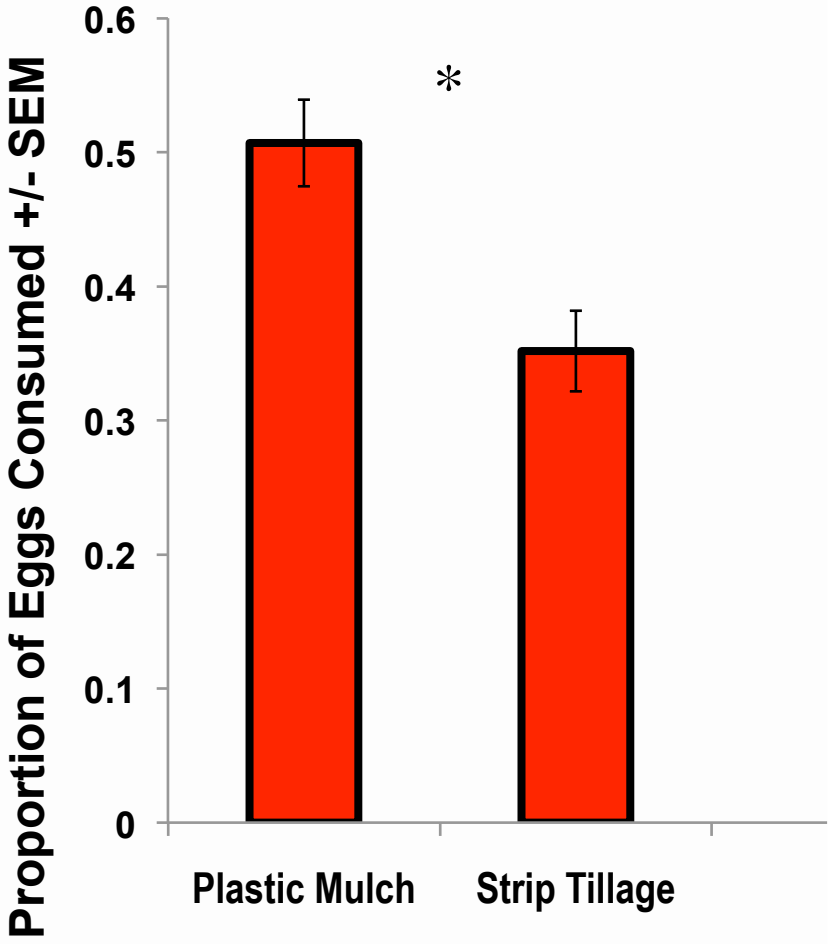
4 sites: Ohio, Kentucky, Iowa, Pennsylvania

- 24 hours




Egg Consumption: Above ground (22%) vs Below ground (43%)
Proportion of Eggs Consumed +/- SEM
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Above
Below
*
*
*
*
IA
p=0.0013
KY
p<0.001
OH
p=0.0252
PA
p=0.003

Below Ground Egg Consumption:
Plastic Mulch vs StripTillage



p=0.0066

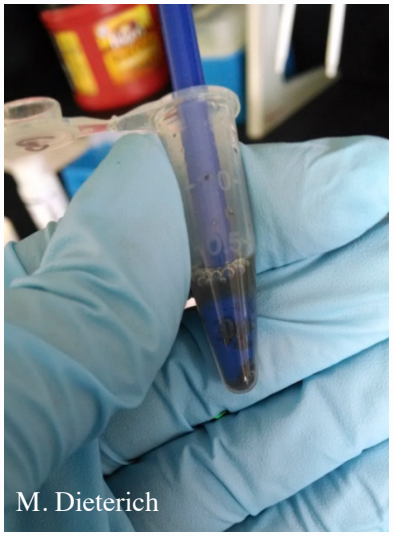
3. Video surveillance of predators eating beetle eggs

- Ants
- Spiders
- Harvestmen
- Ground beetles
- Rove beetles
- Lady beetle larvae
- Crickets & grasshoppers
- Centipedes
- Other: flies, lacewing larvae, mites, thrips, springtails

4. Molecular Gut Content Analysis

Collect

DNA extraction

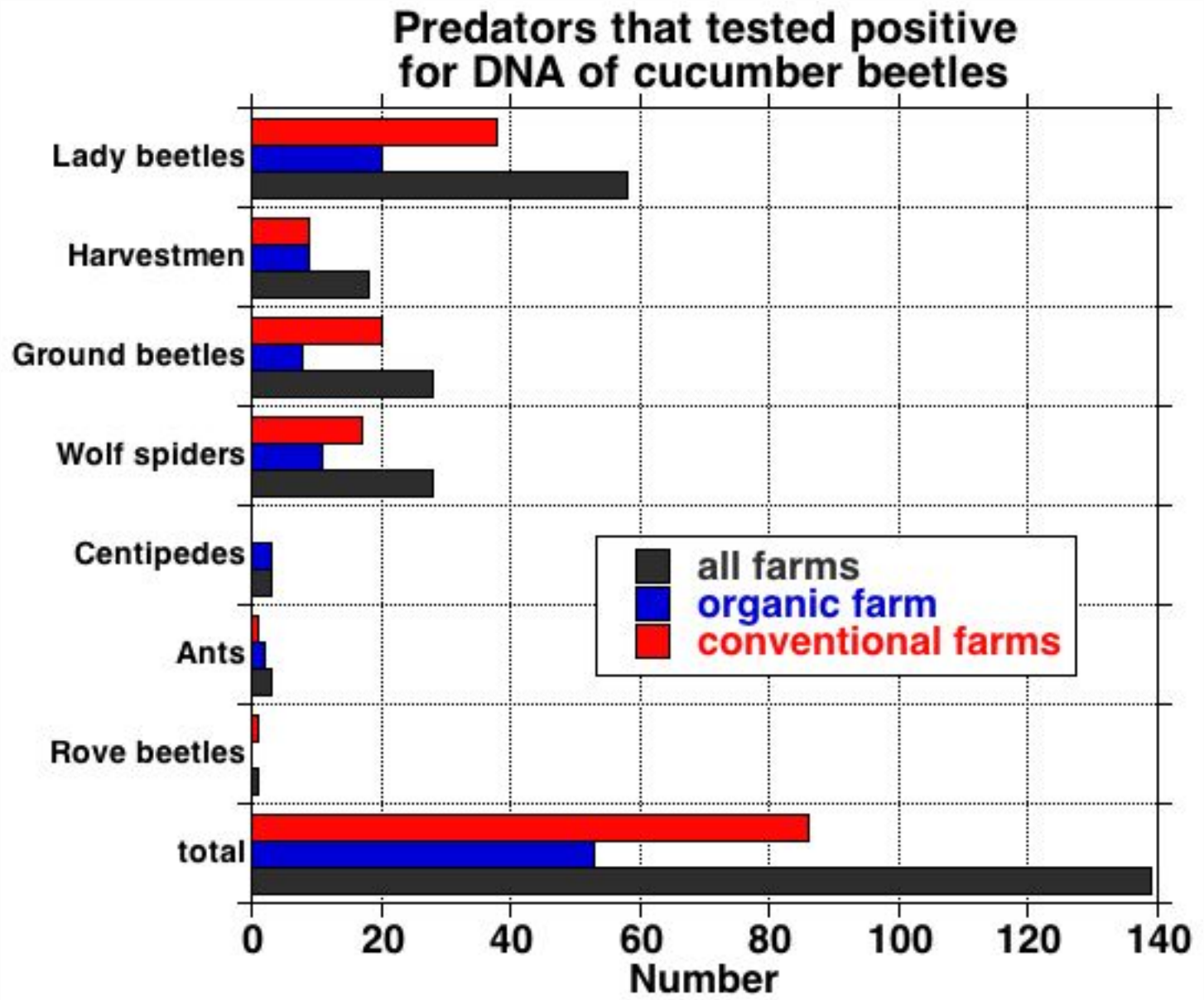


Develop species-specific primers

Molecular Gut Content Analysis

Predator group	Number tested	% positive
Lady beetles	137	42.3%
Harvestmen	122	14.8%
Ground beetles	200	14.0%
Wolf spiders	421	6.7%
Centipedes	56	5.4%
Ants	174	1.7%
Rove beetles	105	1.0%
Total	1215	11.4%

Molecular Gut Content Analysis



Recent trials on management of cucumber beetles & bacterial wilt

- Row covers
- Trap cropping
- Insecticides (organic)
- Mass trapping

Extended-duration row cover for cantaloupe

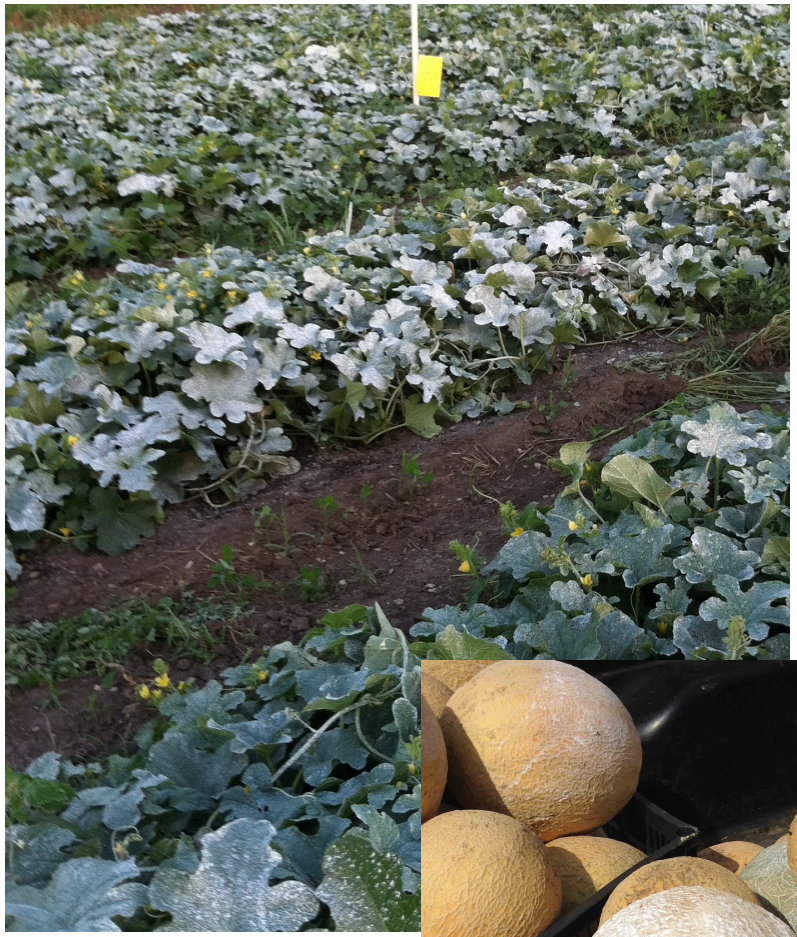
- **SARE projects**
  - –2011 & 2012
  - –2014 & 2015
- **Celeste Welty, Mary Gardiner, & Sally Miller (Ohio State)**
- **& Mark Gleason & Jean Batzer (Iowa State)**

Extended-duration row cover

- **Lightweight row covers**
  - Agribon-19
- **4 treatments**
  - No row cover
  - Remove at anthesis
  - Open ends at anthesis, remove all 10 days after anthesis
  - Remove 10 days after anthesis
- **Control after removal: ‘Surround’**

Row cover removal, 7/19/2012

Surround (kaolin), 7/28/2012



NovaSource®
Tessenderlo Group

Surround® WP

Crop Protectant

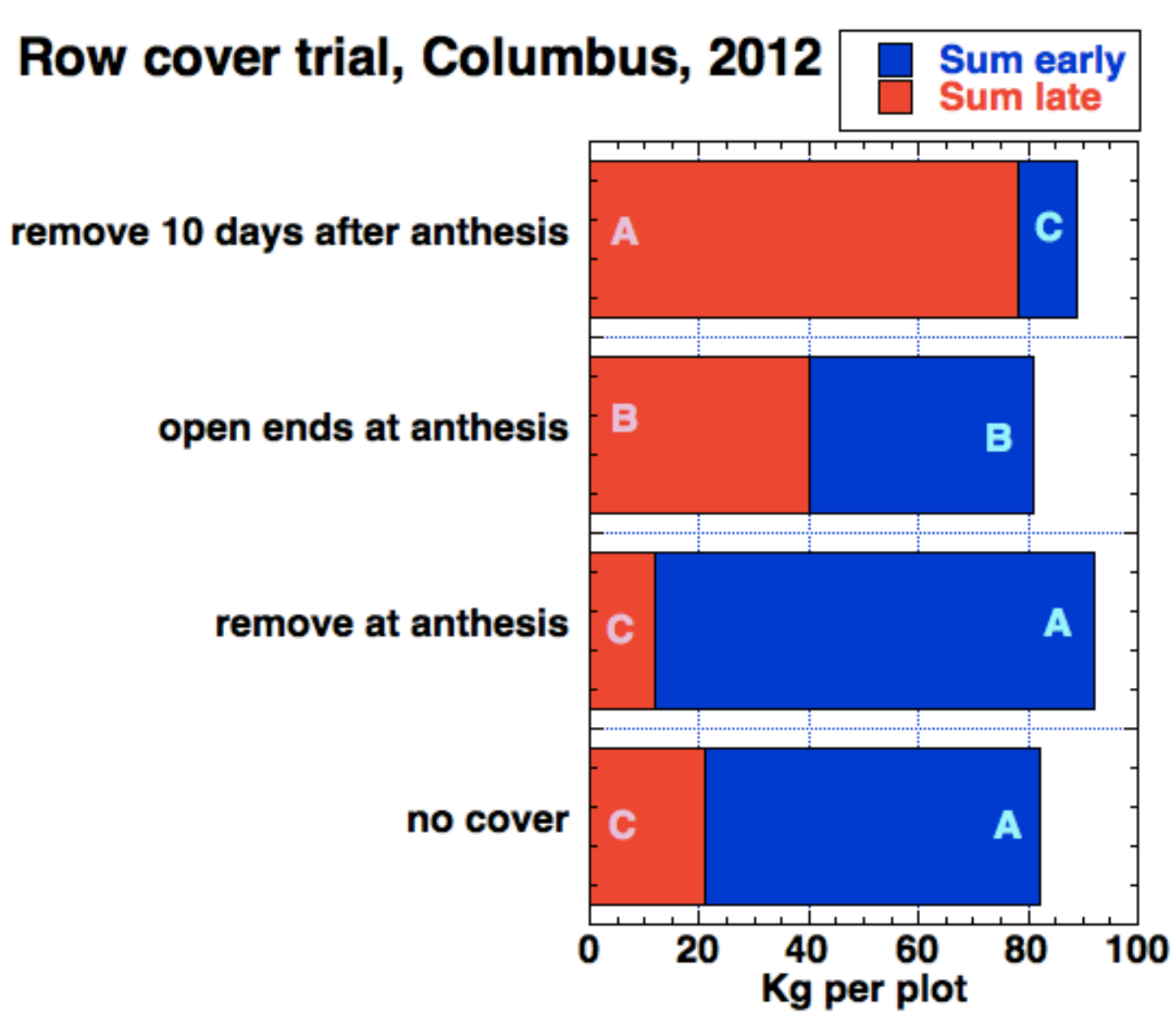
OMRI™ Listed
Organic Materials Review Institute

Cucurbit Vegetables
Such as cucumber, summer and winter squash, pumpkin, citron melon, muskmelon, and watermelon

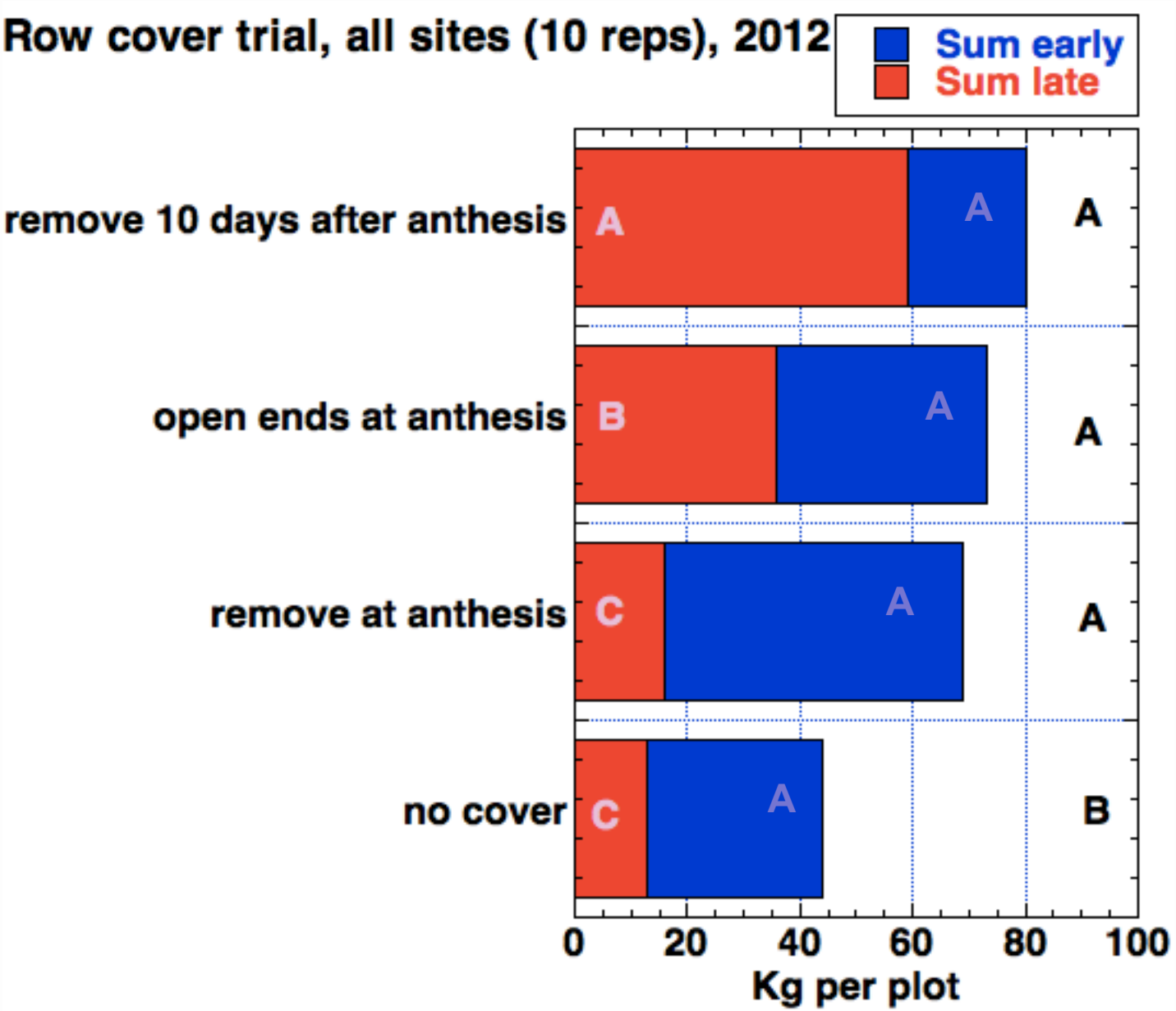
PEST	LBS/ACRE	APPLICATION INSTRUCTIONS
Cucumber beetle, grasshoppers	25-50	Suppression only*. Start prior to infestation, applying every 5-7 days, with the first two applications 3 days apart.
Powdery mildew		Suppression only*. Apply every 7-14 days as required to maintain coverage.
Sunburn and heat stress	25-100	See I D.
*If complete control is needed, consider using supplemental controls.		

Cost ~ $22 for 25-lb bag

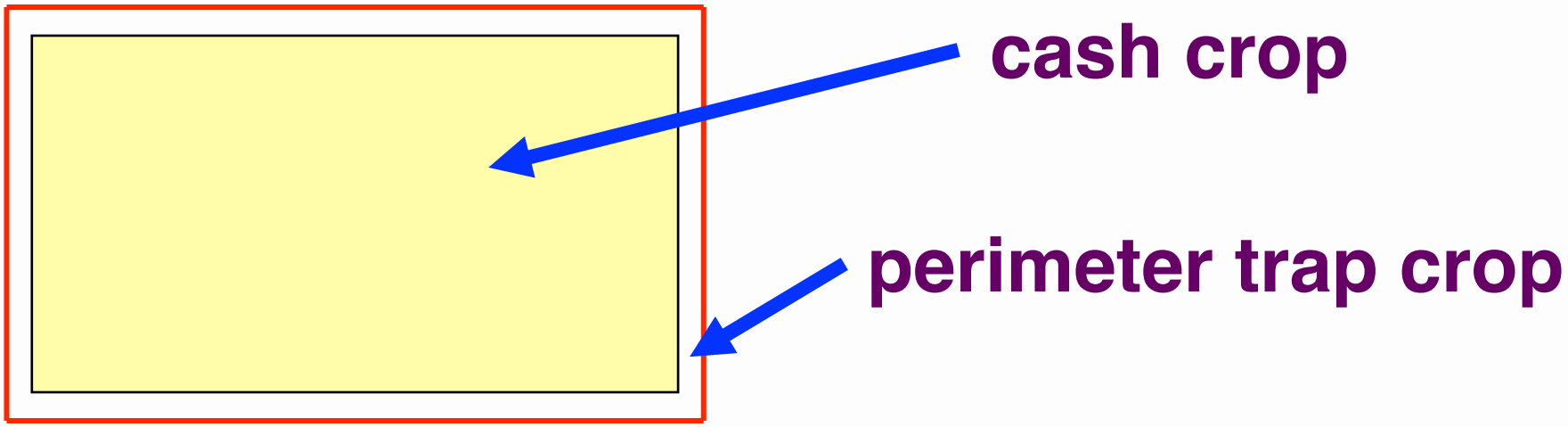
Cumulative yield



Cumulative yield



Trap cropping



- Planting time options
  - Same time
  - 2 weeks early for trap crop *
- Insecticide
  - Use if > threshold
  - Expect less in cash crop

Cucurbit crop species

- ***Cucurbita maxima:*** **hubbard squash**
  Turk's turban
  giant 'pumpkin'
- ***Cucurbita pepo:*** **pumpkins**
  zucchini
  yellow straightneck
  acorn squash
- ***Cucurbita moschata:*** **butternut squash**
- ***Cucurbita mixta:*** **cushaw squash**

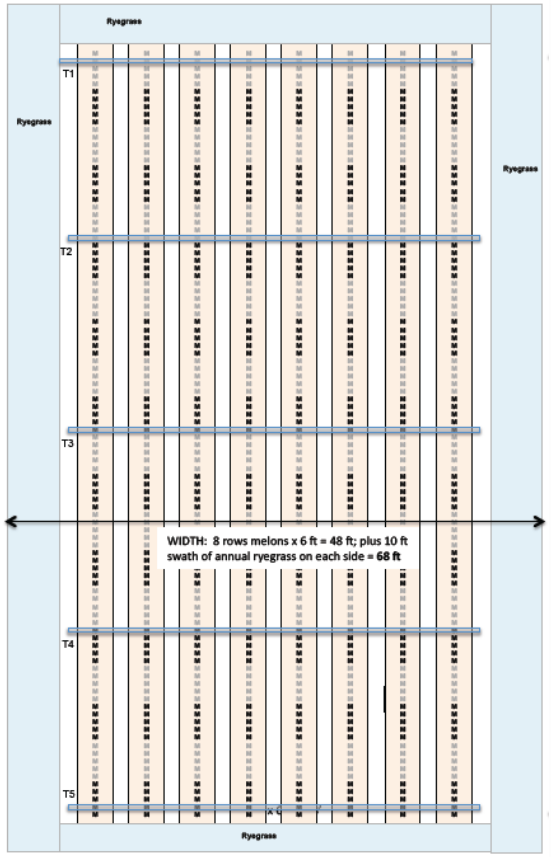
- ***Cucumis sativus:*** **cucumber**
- ***Cucumis melo:*** **cantaloupe**
- ***Citrullus lanatus:*** **watermelon**

Perimeter trap crop trial

- 1 plot = 8 rows cantaloupes
- 2 treatments:
  - 1) With buttercup squash perimeter
    - 2-rows
    - Plant 2 weeks earlier
  - 2) With ryegrass perimeter
- Separated 500-1000 meters
- 1 rep @ 4 sites in Ohio

Perimeter trap crop trial

500 - 1000 meters



Cantaloupe surrounded by perimeter trap crop of buttercup squash

Perimeter trap crop trials

- **2011 & 2012**
  - Melon plots 8 rows x 50 ft = 0.06 acre
  - Admire used as transplant drench
- **2014 & 2015**
  - Melon plots 8 rows x 200 ft = 0.2 acre
  - No Admire used at planting

Scouting weekly

Thresholds:

- **All season:**
  - 1 beetle per plant
- **3-step:**
  - Seedling: **0.5** beetle/plant
  - Until 1st female flower: **1** beetle/plant
  - After 1st flower: **3** beetles/plant

weeks over threshold

Site	Melons within ryegrass	Melons within squash	Squash
Fremont			
Columbus	Expect more weeks	Expect fewer weeks	Expect more weeks
Wooster/Frye			
Wooster/Snyder			

weeks (of 8) over threshold, 2011

Site	Melons within ryegrass	Melons within squash	Squash
Fremont	4	5	5
Columbus	3	2	4
Wooster/Frye	1	0	3
Wooster/Snyder	1	1	3
mean	2.2	2.0	3.8

Yes, fewer than squash

Yield in trap crop trial, 2011

Site	melons inside ryegrass		melons inside squash	analysis
Kg Total	763	<	920	$P = 0.46$
Kg Marketable	503	<	648	$P = 0.43$
N Total	308	<	352	$P = 0.56$
N Marketable	180	<	214	$P = 0.59$

Trend of higher yield but not statistically significant

weeks (of 8) over threshold, 2012

Site	Melons within ryegrass	Melons within squash	Squash
Fremont	5	4	6
Columbus	4	2	6
Wooster/Frye	4	2	8
Wooster/Snyder	1	1	6
mean	3.5	2.2	6.5

Yes, fewer!

Yield in trap crop trial, 2012

Yield	melons within ryegrass		melons within squash	analysis
Kg Total	847	<	1030	$P = 0.07$
Kg Marketable	572	<	668	$P = 0.39$
N Total	434	<	514	$P = 0.17$
N Marketable	235	<	264	$P = 0.55$

Trend of higher yield but not statistically significant

Problem! Squash vine borer

- **Must be considered**
  - –Kills the trap crop
  - –Symptoms confused with BW
- **Controlled by pyrethrins+PBO ('Evergreen Pro'), 6 sprays in 2012**
- **By Asana in 2014 & 2015**



Perimeter trap crop trials

- 2011 & 2012
  - Melon plots 8 rows x 50 ft = 0.06 acre
  - Admire used as transplant drench
- **2014 & 2015**
  - **Melon plots 8 rows x 200 ft = 0.2 acre**
  - **No Admire used at planting**

weeks over threshold, 2014

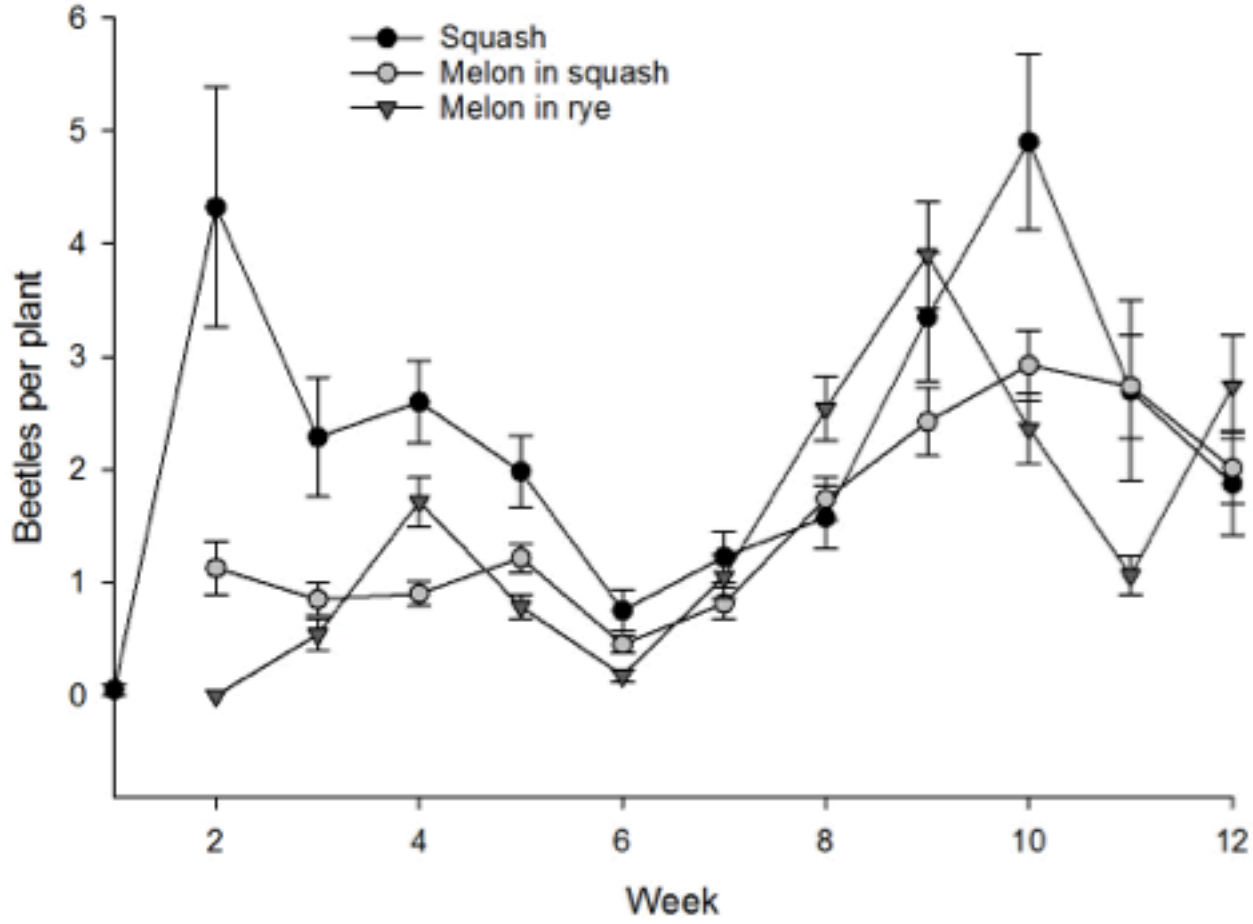
Site	Melons within ryegrass	Melons within squash	Squash
Columbus			
Fremont	Expect more weeks	Expect fewer weeks	Expect more weeks
Wooster/Unit2			
Wooster/Snyder			

weeks over threshold, 2014

Site	Melons within ryegrass	Melons within squash	Squash
Columbus	7	8	10
Fremont	4	5	8
Wooster/Unit2	1	2	2
Wooster/Snyder	0	3	3

Not more Slightly fewer Yes, more

Seasonal trend in beetle density in trap crop trial, 2014



weeks over threshold, 2015

Site	Melons within ryegrass	Melons within squash	Squash
Columbus	6	7	6
Fremont	5	6	4
Wooster/Frye	4	4	2
Wooster/Snyder	5	4	1

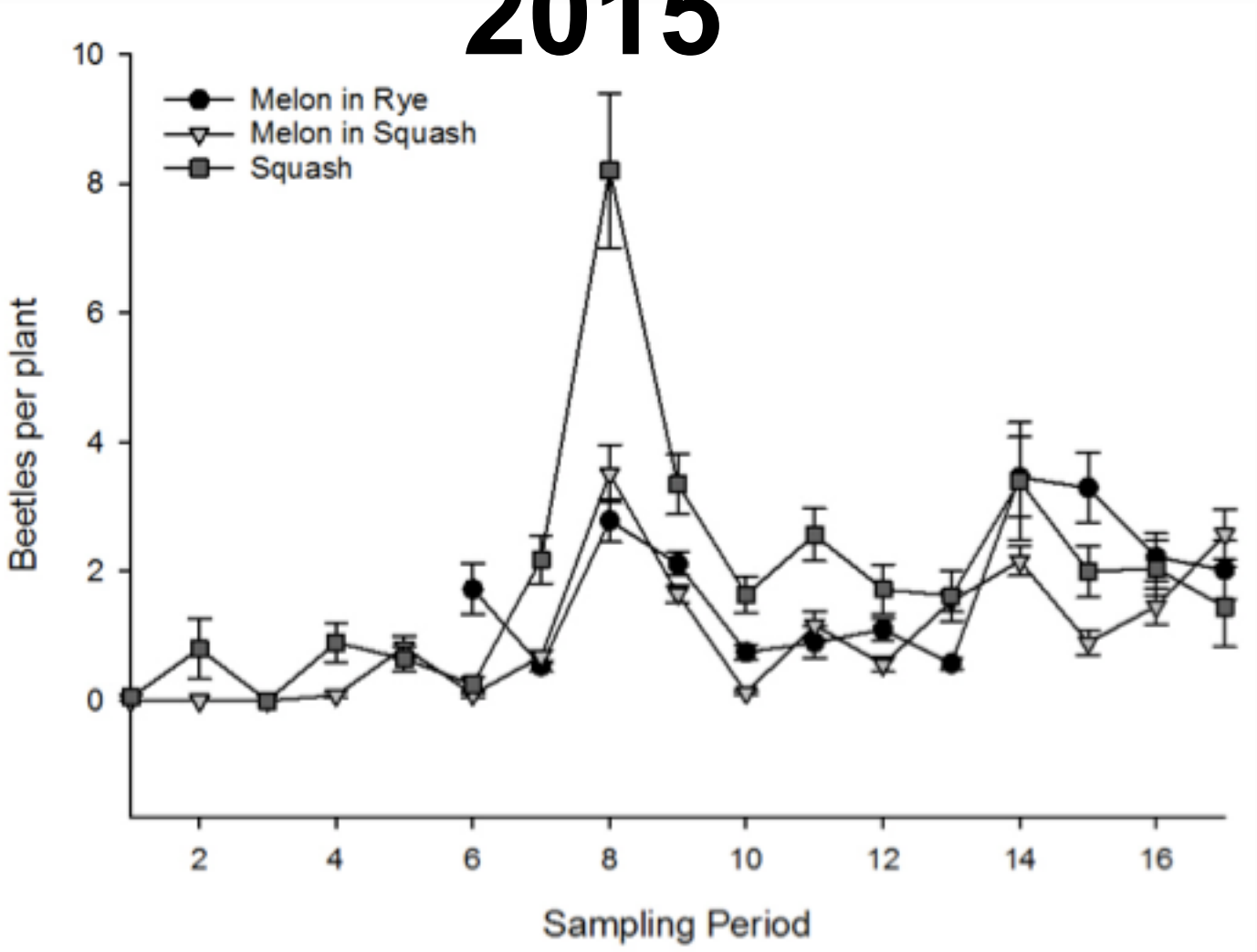
Not fewer!

↑ Not more

↑ Not fewer

↑ Not more

Seasonal trend in beetle density in trap crop trial, 2015



Incidence of bacterial wilt:
expect lower incidence with trap crop

Year	Treatment	% wilt	
2014	No trap crop	34%	NS
	With trap crop	21%	
2015	No trap crop	35%	NS
	With trap crop	24%	

Yes, lower with trap crop, but not significantly lower

Trap crop trials: summary

Factor	Result
Bacterial wilt in melons	Lower with trap crop
Number of insecticide sprays in melons	Not lower with trap crop
Yield of marketable melons	Not higher with trap crop

Trap crop trials: why trends not as expected?

- Beetles abundant?
- Need lower threshold?
- Rain excessive?
- No Admire at-plant?
- Better in smaller plots (8 rows x 50 ft) than larger plots (8 rows x 200 ft)?

Control of cucumber beetles with insecticides?

- **Seed or soil applied:**
  - No current options for organic
- **Foliar applied**
  - Some options for organic
  - Beware of toxicity to bees

Cucumber beetle & OMRI insecticides

Active ingredient	Product
pyrethrins?	PyGanic
spinosad?	Entrust
kaolin?	Surround
neem oil?	Trilogy
Beauveria?	Mycotrol

Cucumber beetle & OMRI insecticides

Active ingredient	Product	
pyrethrins?	PyGanic	
spinosad?	Entrust	← not target
kaolin?	Surround	
neem oil?	Trilogy	← not target
Beauveria?	Mycotrol	

Cucumber beetle & OMRI insecticides

Active ingredient	Product
pyrethrins?	PyGanic
spinosad?	Entrust
kaolin?	Surround
neem oil?	Trilogy
Beauveria?	Mycotrol
any + stimulant?	CideTrak D

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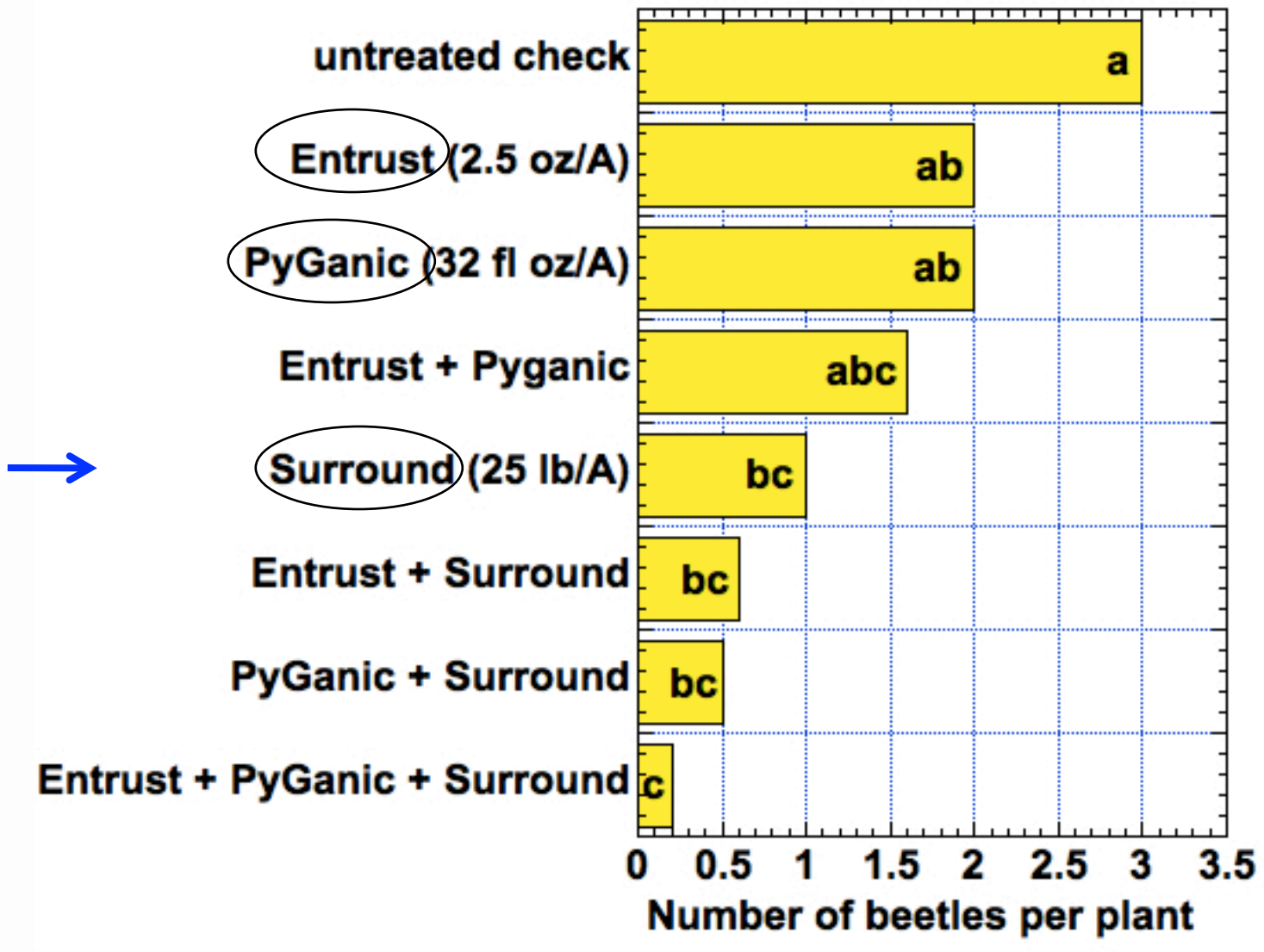
kaolin?	Surround
neem oil?	Trilogy
Beauveria?	Mycotrol
any + stimulant?	CideTrak D
pyrethrins + PBO	EverGreenPro

← not OMRI

Cucumber beetle trial, UMass, 2009: 3 foliar applications



- pyrethrins
- = pyrethrum?
- = pyrethroids?

- **pyrethrum: the raw natural product from dried flowers**
  - Dalmatian Chrysanthemum (*Chrysanthemum cinerariaefolium*) →
  - Persian Chrysanthemum (*Chrysanthemum coccineum*)

- **pyrethrum**: the raw natural product from dried flowers
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  - pyrethrin II
  - cinerin I
  - cinerin II
  - jasmolin I
  - jasmolin II

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  - pyrethrin II
  - cinerin I
  - cinerin II
  - jasmolin I
  - jasmolin II
- **pyrethroids**: synthetic mimics of pyrethrins

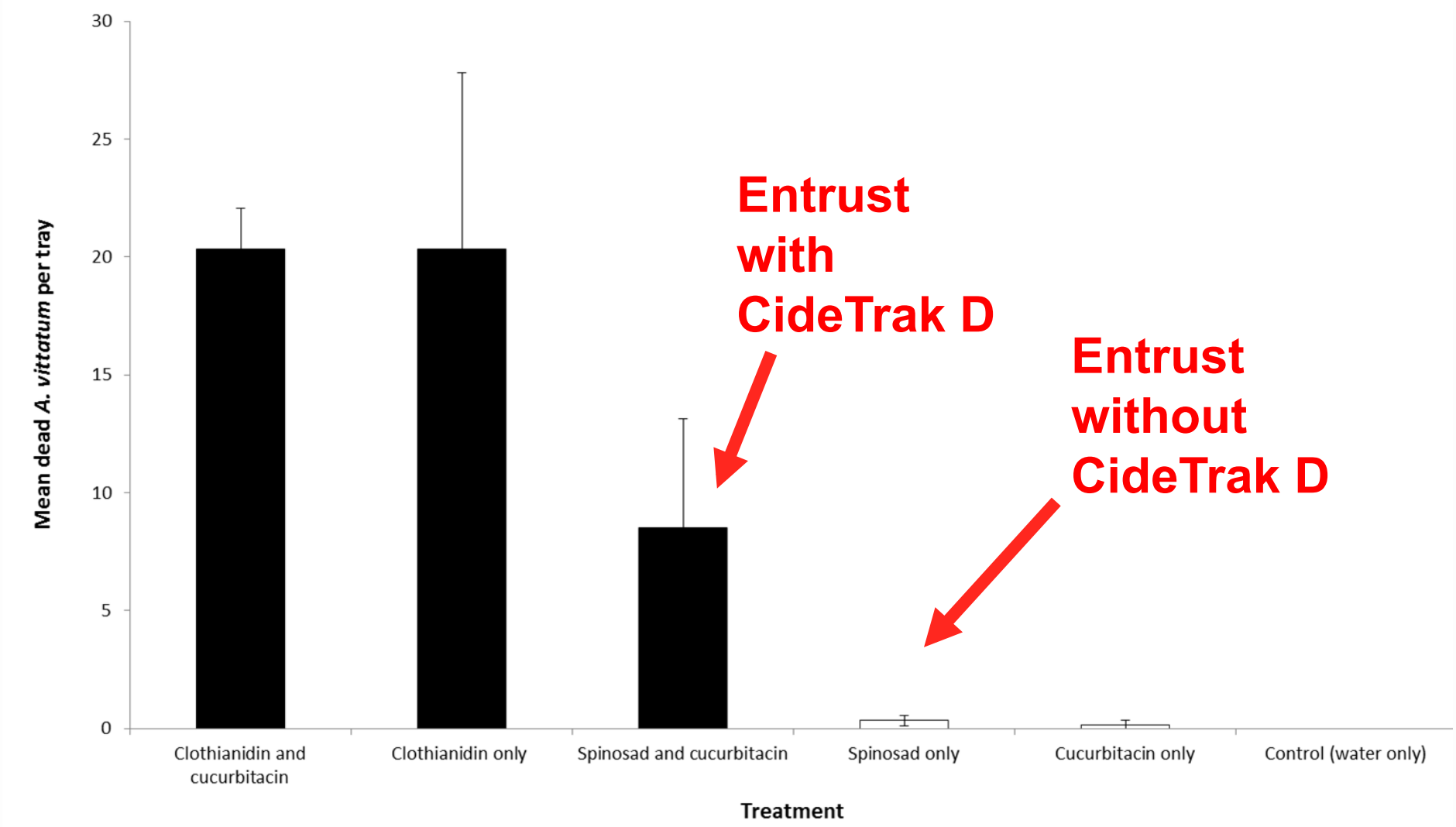
pyrethrins & OMRI?

- **pyrethrum**
  - On OMRI list
- **pyrethrins alone**
  - Such as PyGanic
  - On OMRI list
- **pyrethrins + PBO**
  - Such as EverGreen Pro 60-6
  - Not on OMRI list
- **pyrethroids**
  - Not on OMRI list

What's PBO?

- PBO = piperonyl butoxide
- A synergist
- When mixed with some insecticides, makes them more active
  - Most common with pyrethrins
  - Also with pyrethroids & carbamates
- Prevents enzymes from detoxifying the a.i. before it acts on target site
- Semi-synthetic derivative of safrole
- Safrole is extracted from sassafras

Trial in KY on insecticide-bait interactions with CideTrak D and striped cucumber beetle



From Logan Minter and Ric Bessin, University of Kentucky


CideTrak D

- Gustatory stimulant
- Buffalo gourd root powder
- Cucurbitacin
- Not insecticide
- Mix with insecticide
- 3.1 oz/A
- On OMRI list (as adjuvant)
- Made by Trécé Inc.
- Cost $92.50 for 4-lb bag

Cucurbita foetidissima

Cantaloupe field trial, 2015: row covers & organic insecticides

Trt	1st month	2nd month
1	Row cover	Entrust + CideTrak-D
2	Row cover	Surround
3	Row cover	(nothing)

Cantaloupe field trial, 2015: row covers & organic insecticides

Trt	1st month	2nd month
1	Row cover	Entrust + CideTrak-D
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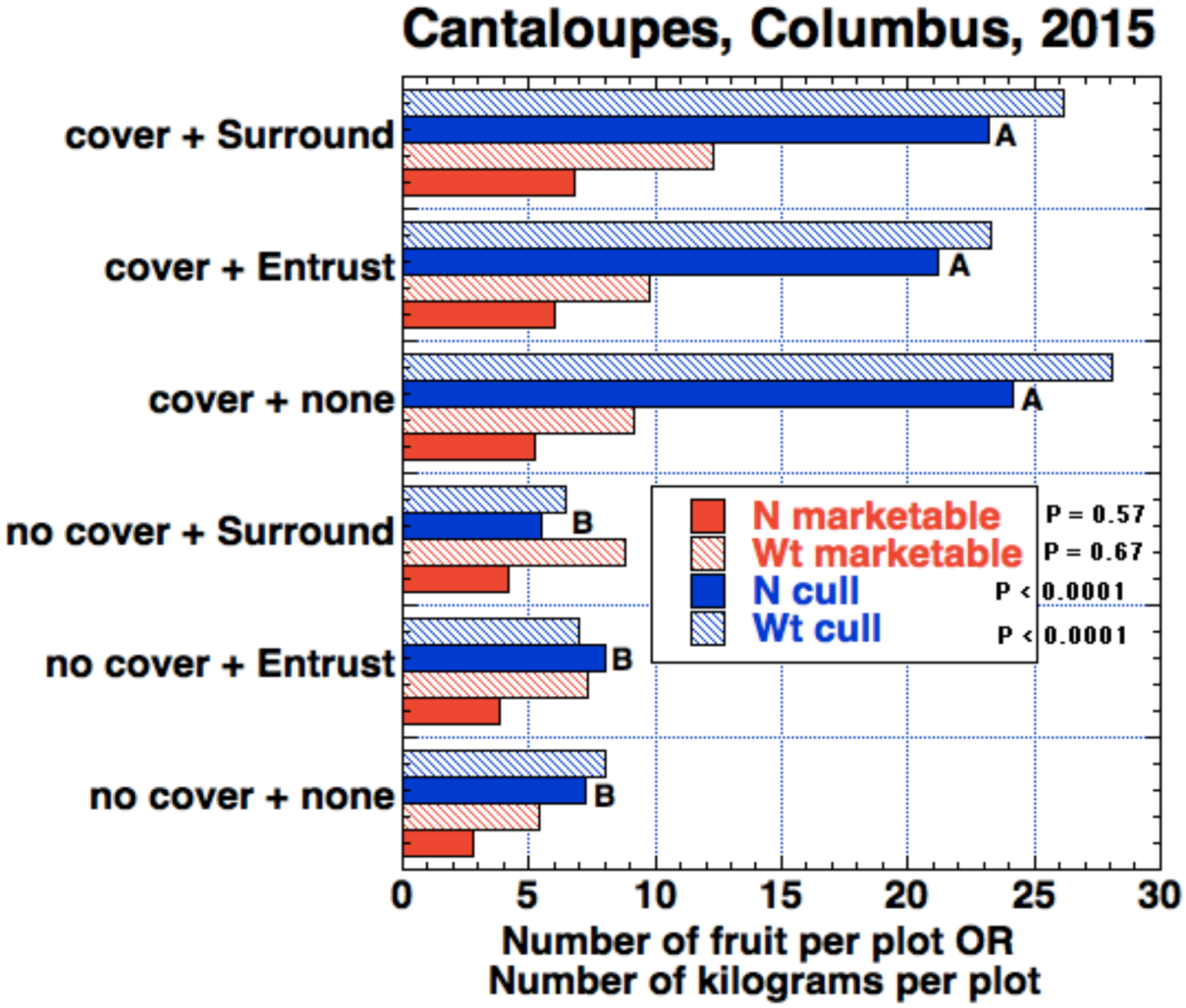
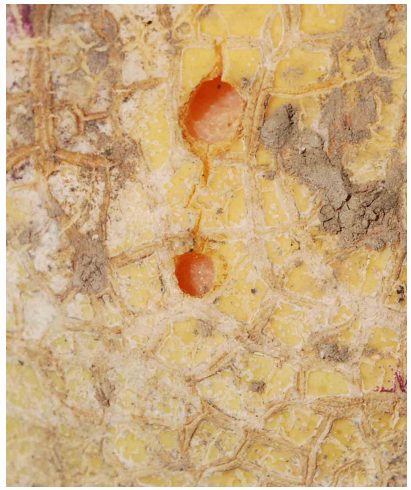
3	Row cover	(nothing)
4	No row cover	Entrust + CideTrak-D
5	No row cover	Surround
6	No row cover	(nothing)

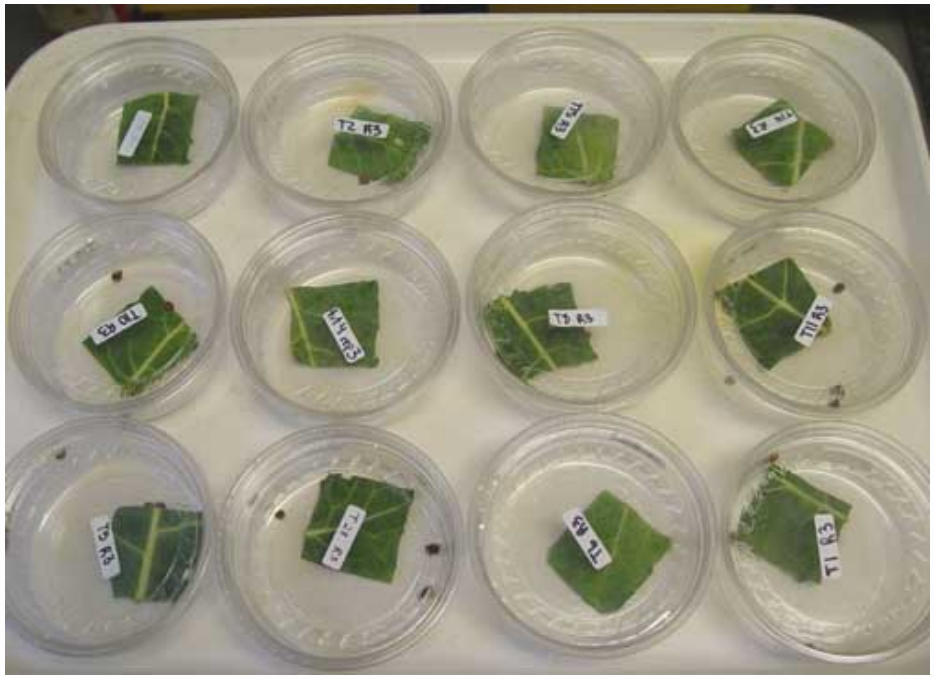

Cantaloupes, Columbus, 2015
cover + Surround
cover + Entrust
cover + none
no cover + Surround
no cover + Entrust
no cover + none
A
A
A
B
B
B
N marketable
Wt marketable
N cull
Wt cull
P = 0.57
P = 0.67
P < 0.0001
P < 0.0001
0
5
10
15
20
25
30
Number of fruit per plot OR
Number of kilograms per plot

Culls in cantaloupe field trial, 2015

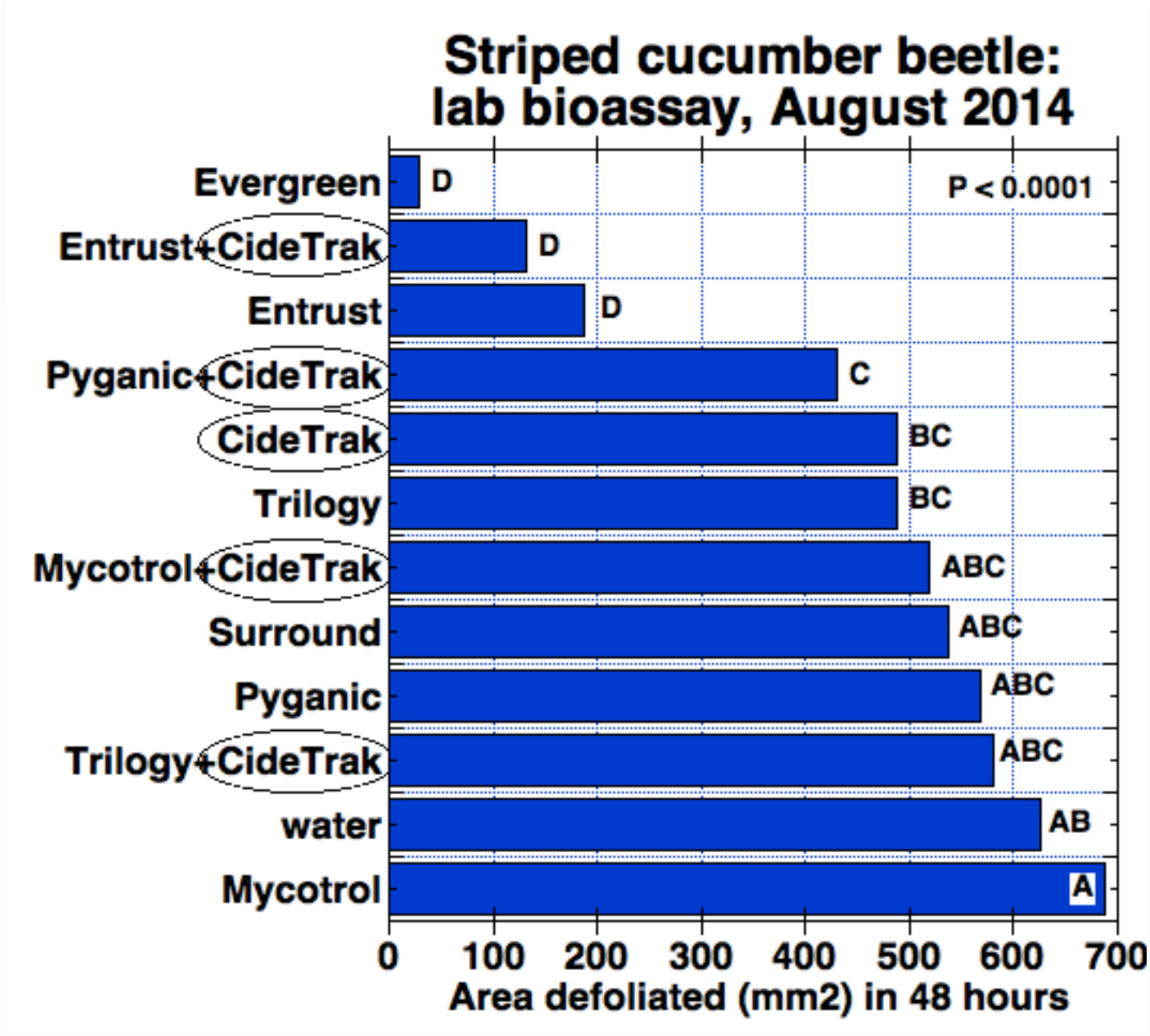
1	Appearance (small, poor netting)	76%
2	Rots	12%
3	Deep feeding by beetles	10%
4	Rodent gnaws	2%

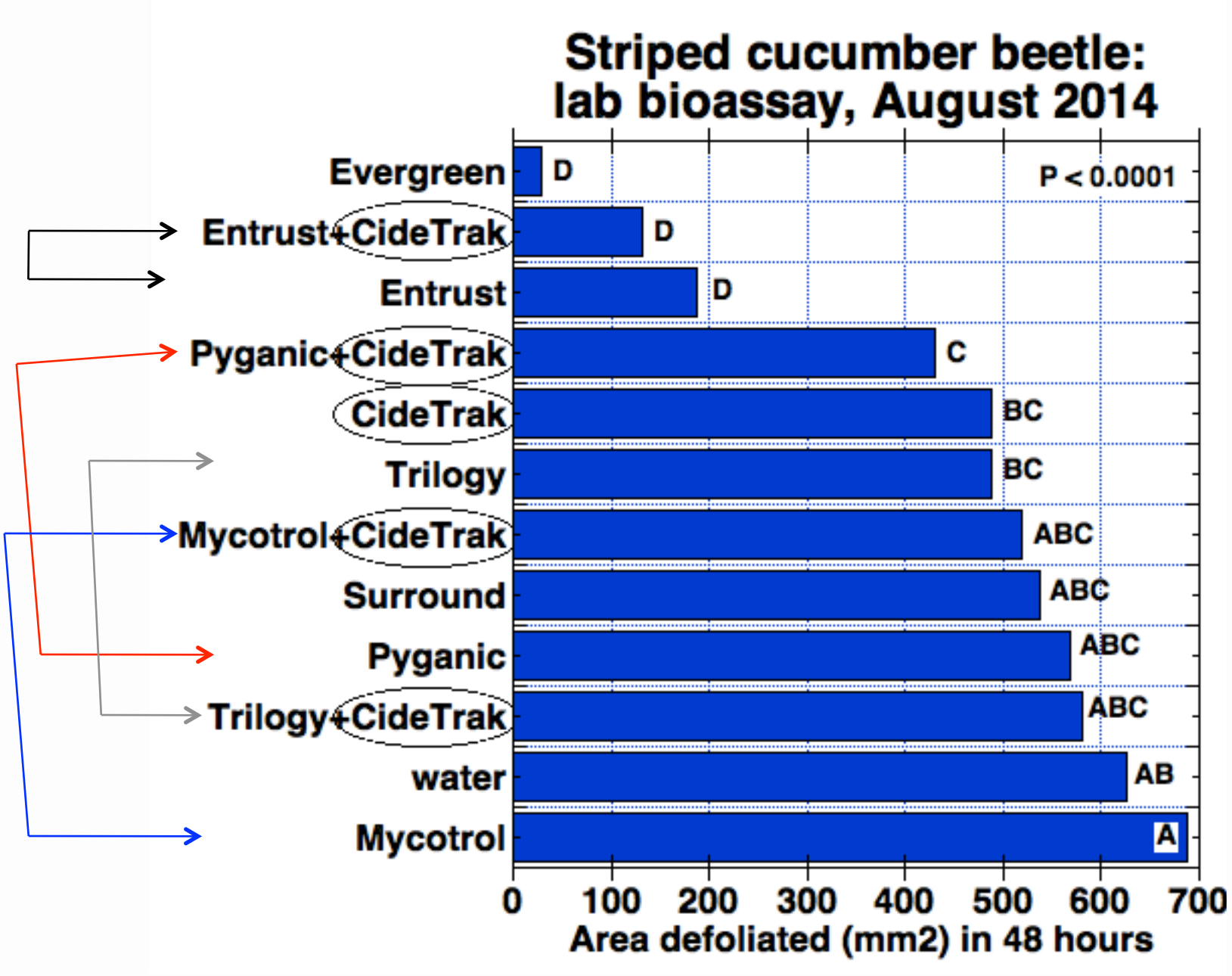


Lab bioassays to evaluate insecticide efficacy



- Defoliation
- Mortality


Striped cucumber beetle:
lab bioassay, August 2014
P < 0.0001
Evergreen
Entrust+CideTrak
Entrust
Pyganic+CideTrak
CideTrak
Trilogy
Mycotrol+CideTrak
Surround
Pyganic
Trilogy+CideTrak
water
Mycotrol
D
D
D
C
BC
BC
ABC
ABC
ABC
ABC
AB
A
0
100
200
300
400
500
600
700
Area defoliated (mm2) in 48 hours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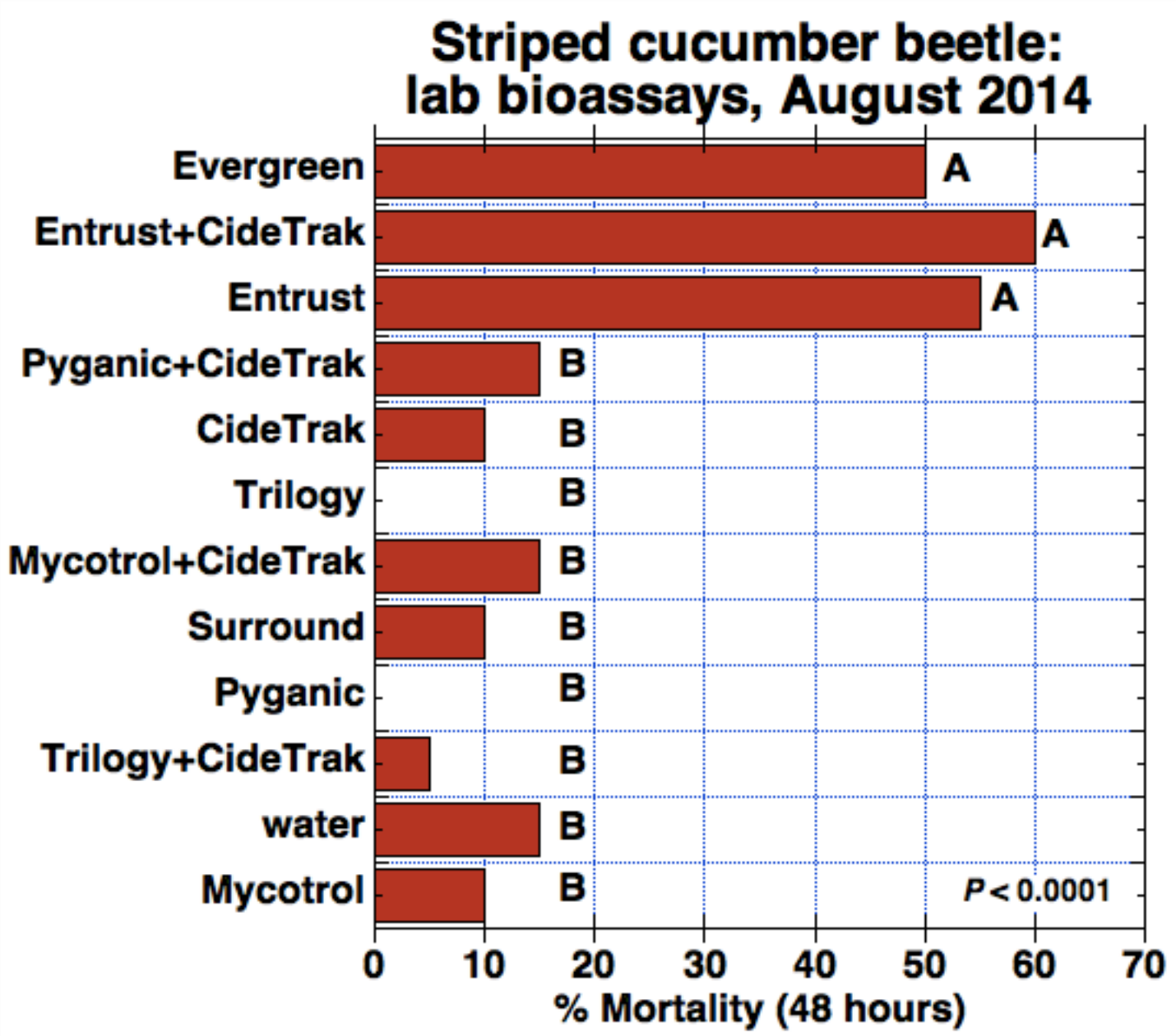
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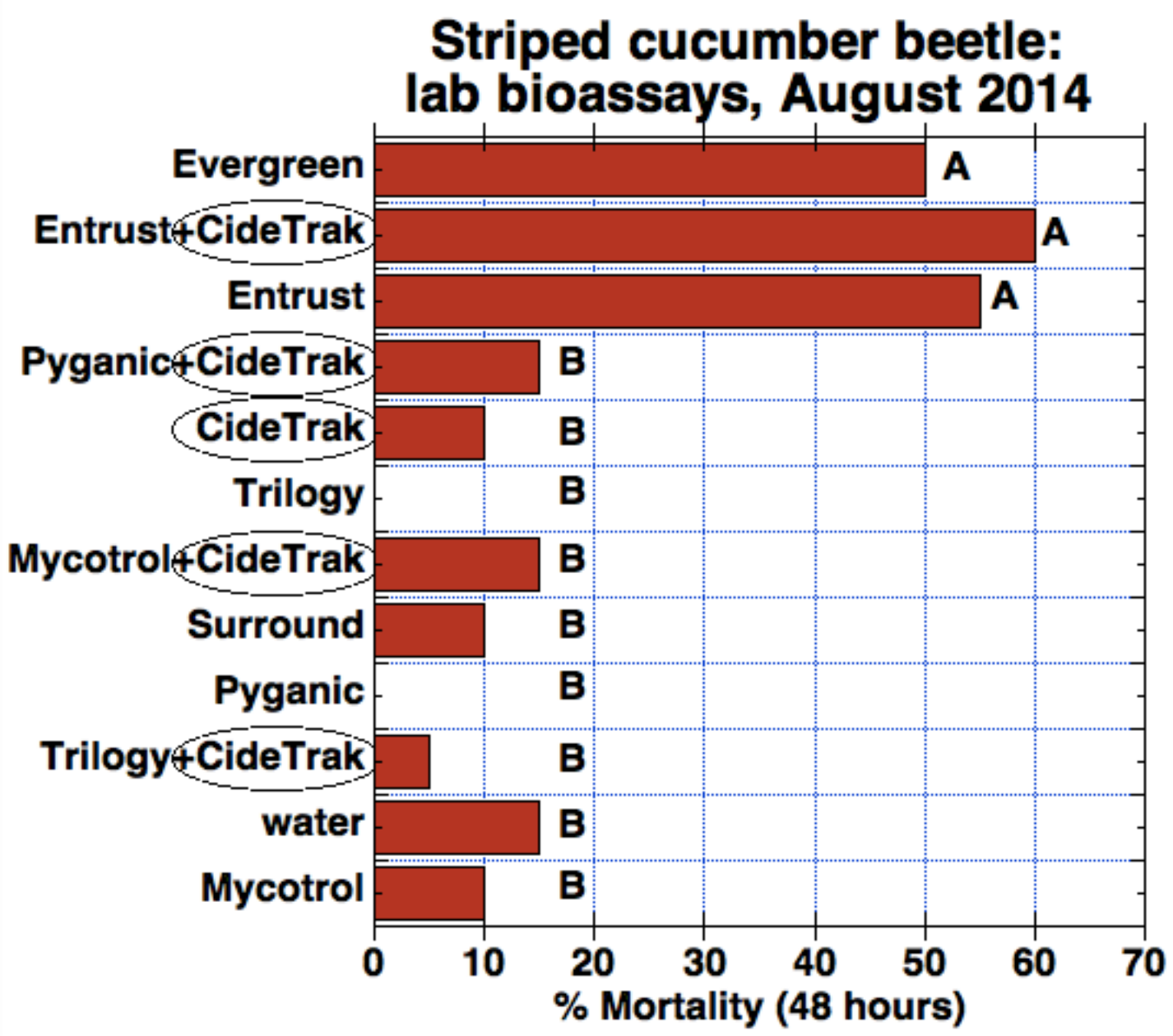
0
10
20
30
40
50
60
70
% Mortality (48 hours)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B
B
B
B
0
10
20
30
40
50
60
70
% Mortality (48 hours)

Behavioral control: early-season trap-out with kairomone bait

- Trécé Inc.
- Poison bait: cucurbitacin + carbaryl (inside trap)
- Volatile lure: mimic squash flowers

Mass trapping

- with kairomone trap & box of plants treated with systemic insecticide
- before seeding the crop

Potted squash plants treated with soil drench of Admire

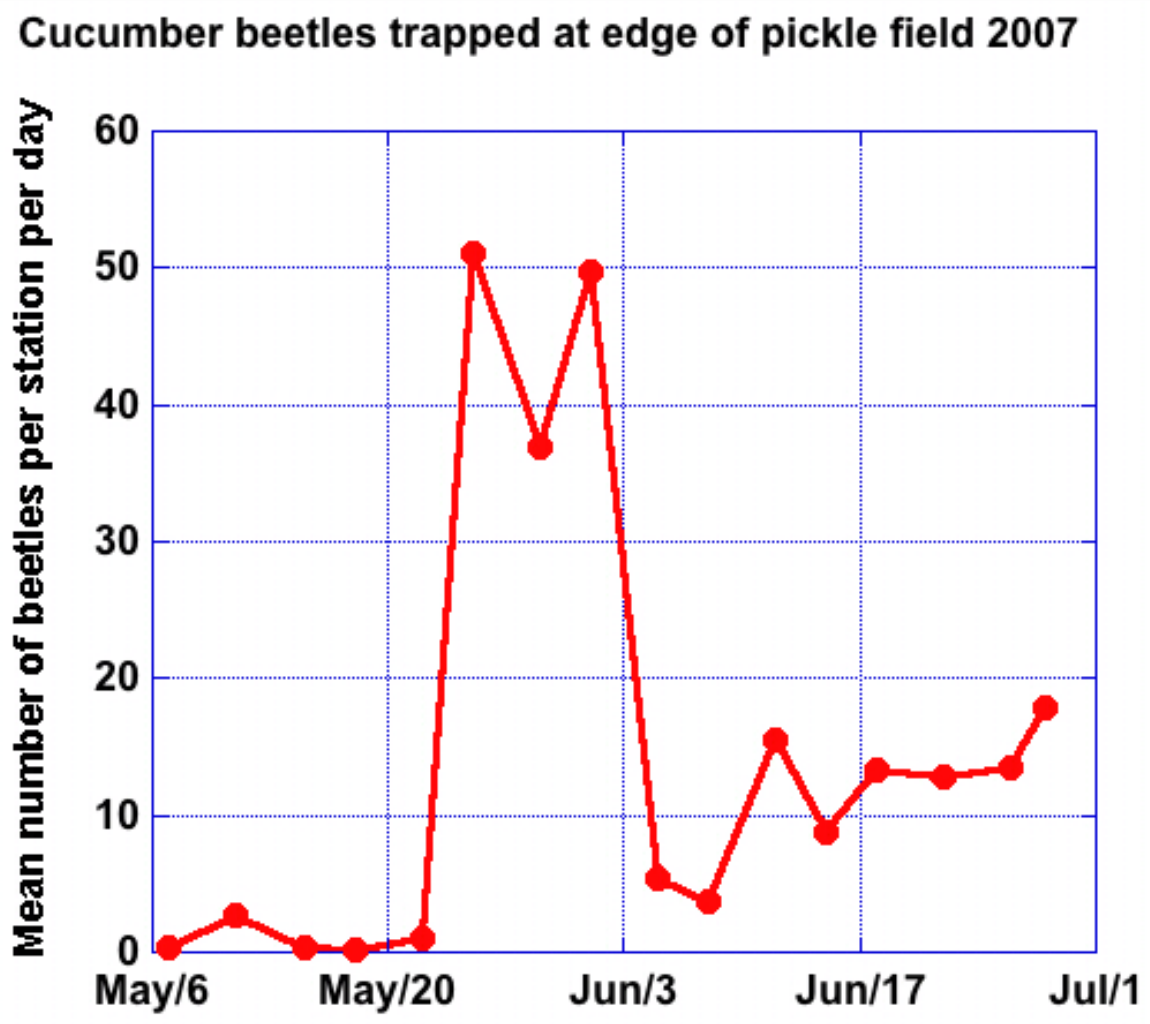
5 traps at the edge of 1 plot

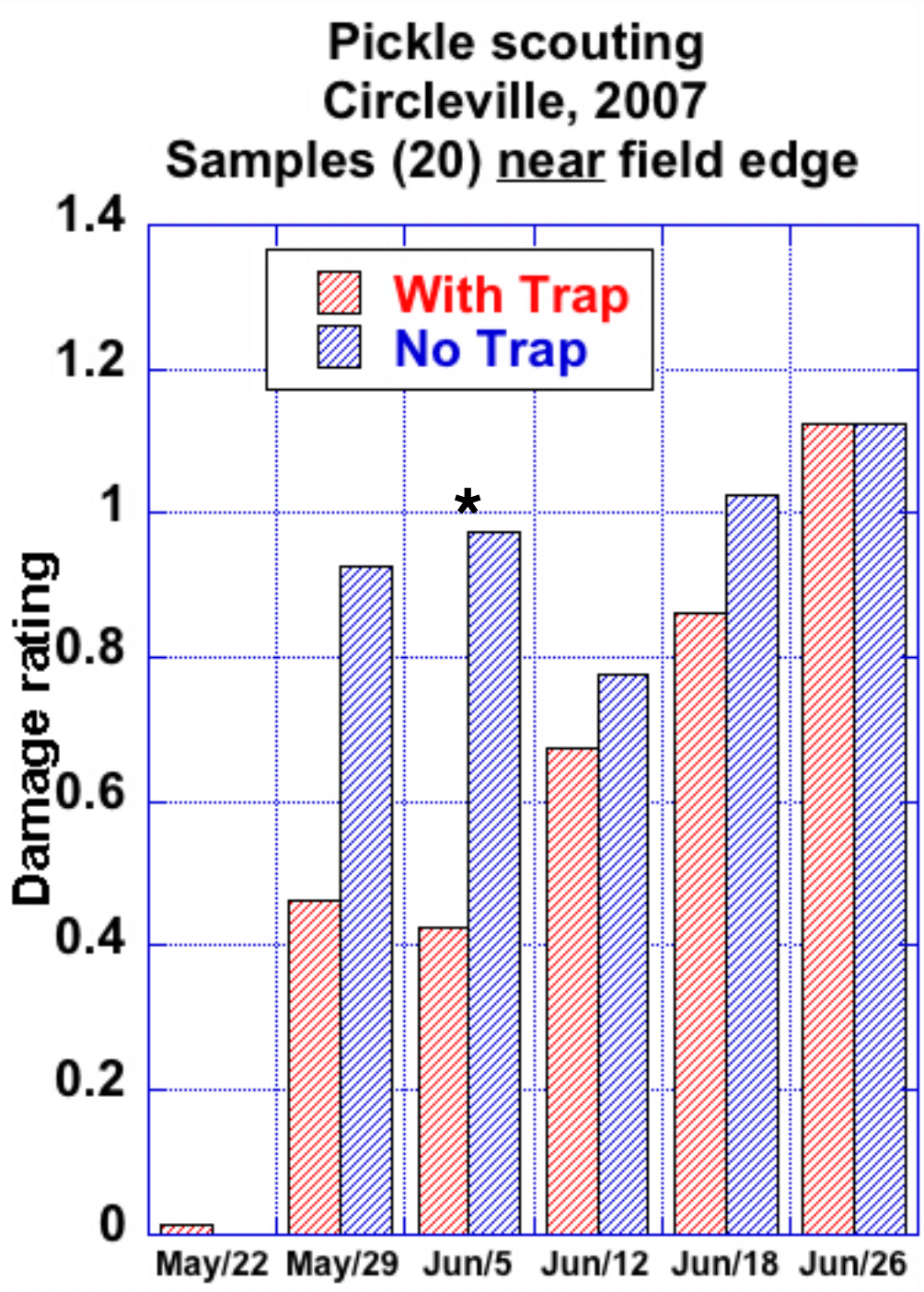
traps 20 ft apart

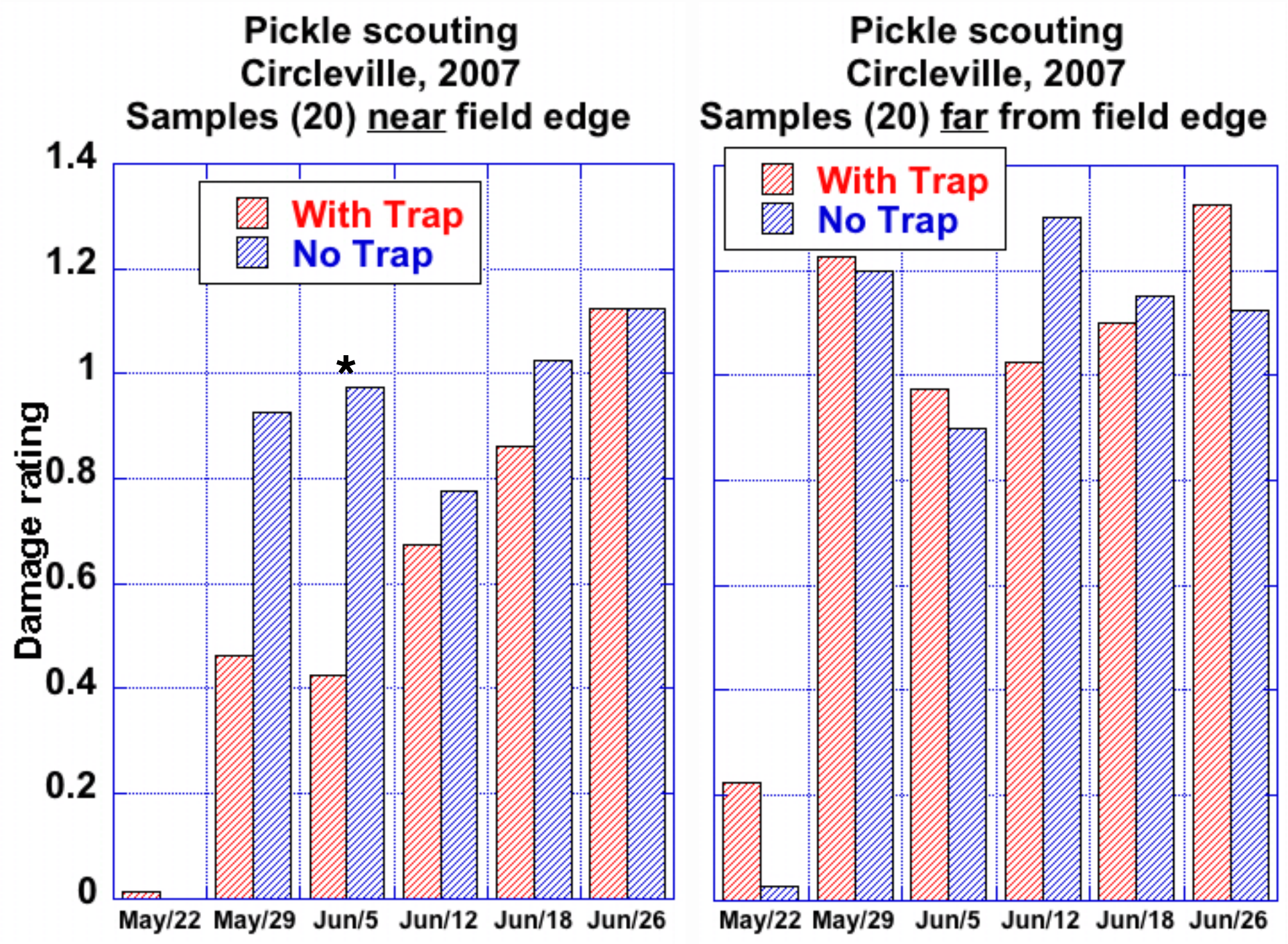
Last year's field of pickling cucumber

Results with mass trapping

- 20 stations
- 8 weeks
- 15,099 beetles
- Max 51 beetles/ station/day
- Peak 5/25 – 6/1




Pickle scouting
Circleville, 2007
Samples (20) near field edge
With Trap
No Trap
Damage rating
1.4
1.2
1
0.8
0.6
0.4
0.2
0
*
May/22
May/29
Jun/5
Jun/12
Jun/18
Jun/26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0.2
0
*
May/22
May/29
Jun/5
Jun/12
Jun/18
Jun/26
Pickle scouting
Circleville, 2007
Samples (20) far from field edge
With Trap
No Trap
May/22
May/29
Jun/5
Jun/12
Jun/18
Jun/26

Early Season Trap-Out Trial: Conclusions

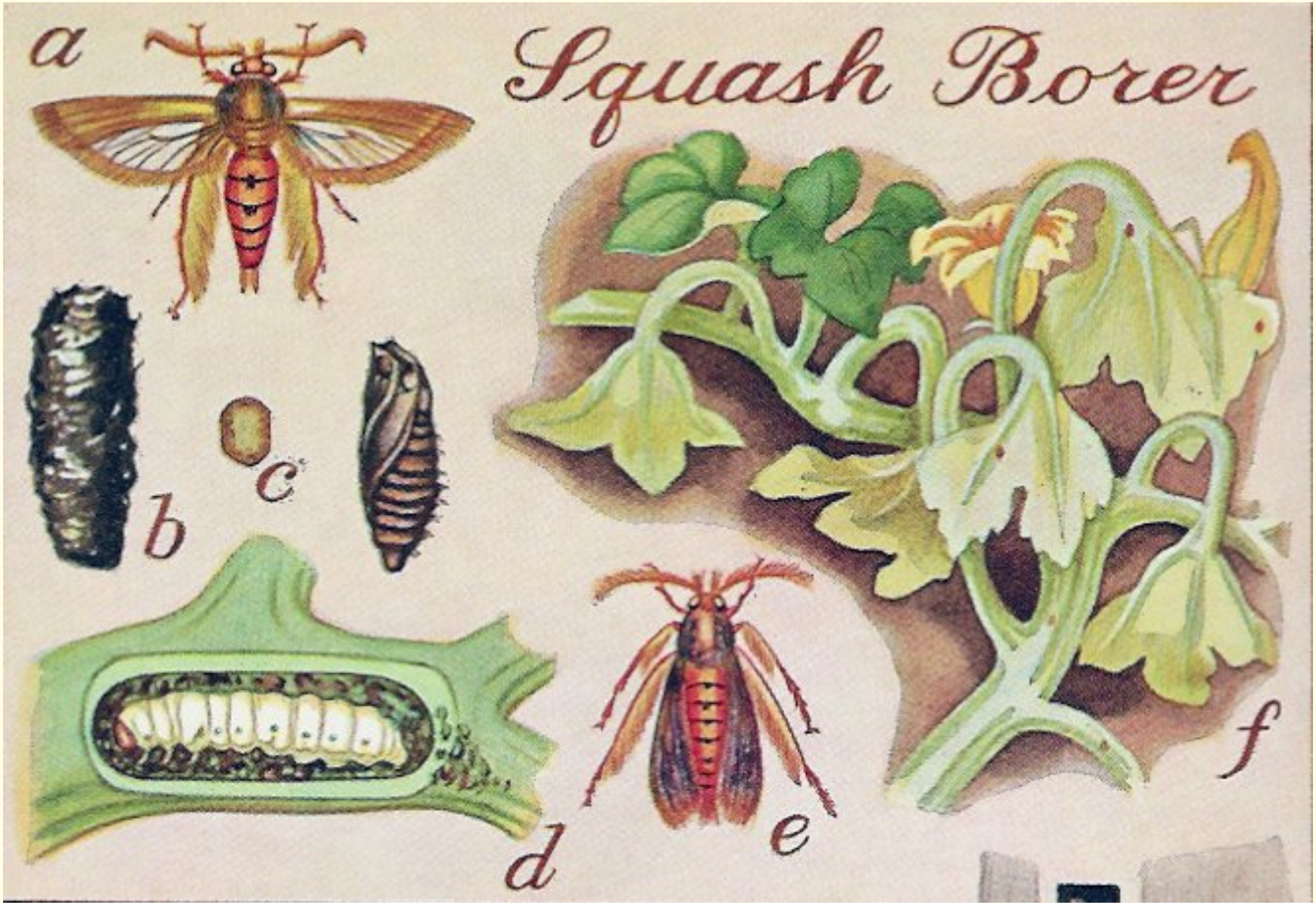
- **Conclusions:**
  - Many beetles removed by trapping stations
  - Trapping had little effect on reducing damage
  - Most beetles trapped after crop up, not before
- **Future:**
  - Could try traps on all sides of field
  - Need to test substitute for carbaryl in bait

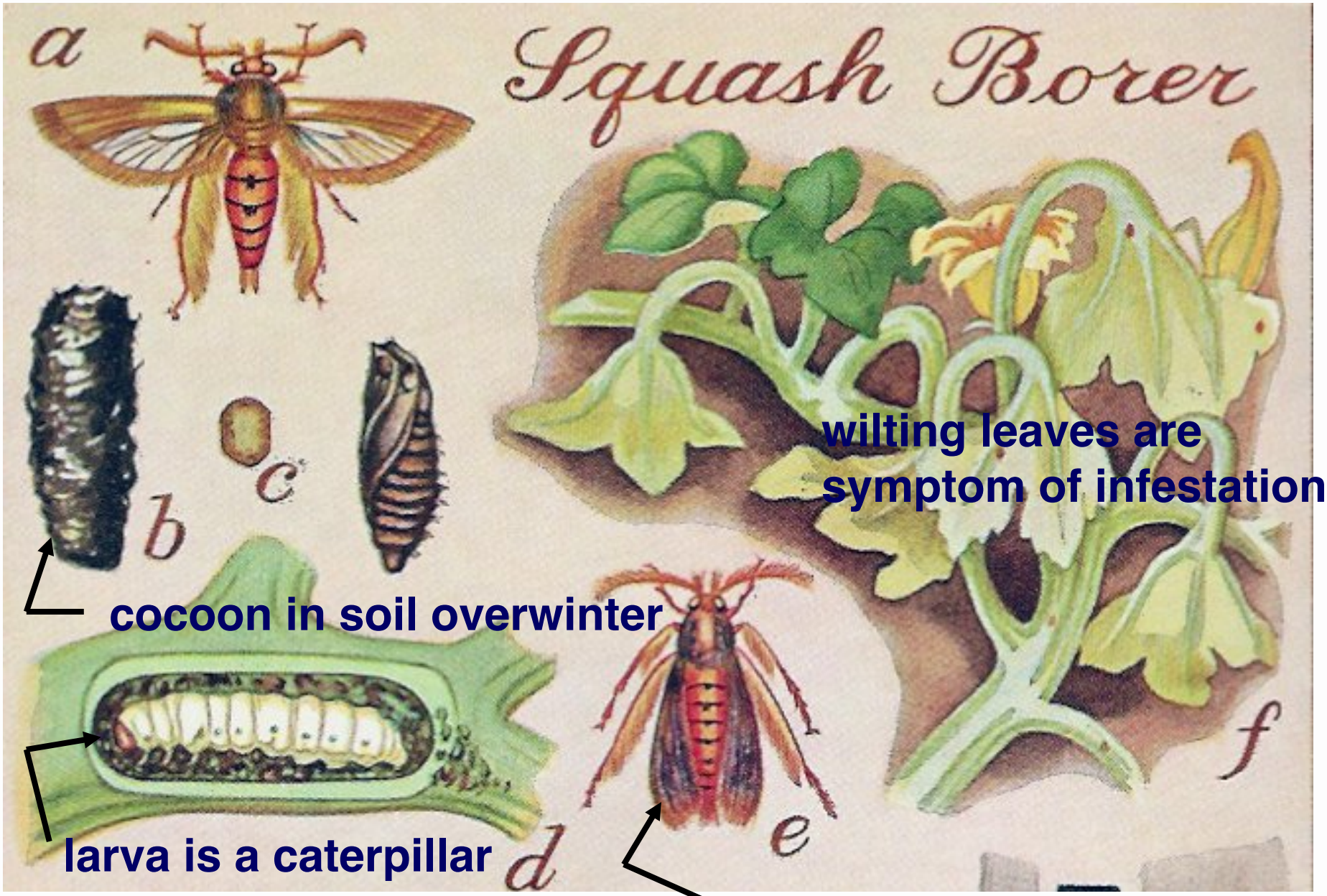
Mechanical control for small areas:

Removal by aspirator

- Aspirator = Mouth-operated suction device
- $8 – 14 from:
  - BioQuip
  - Forestry Suppliers
  - Gempler's
- Good for flea beetles, bean leaf beetle, cucumber beetle

Squash Vine Borer




Squash Borer
a
b
c
d
e
f
wilting leaves are
symptom of infestation
cocoon in soil overwinter
larva is a caterpillar
adult is a day-flying moth

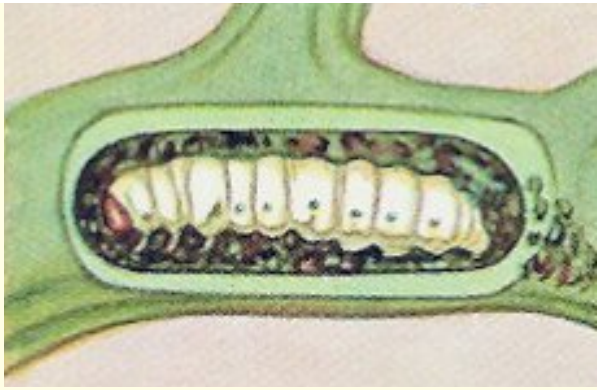
Squash vine borer

- Larva bores into stem at base
- Infest squash, gourd, pumpkins
- Plants often die
- Moths lay eggs in late June & early July

Squash Vine Borer: Management

- **Cultural**
  - Till soil to destroy pupae
  - Plant late for main crop
  - Small planting early as trap crop
- **Mechanical**
  - Row covers (until flowering)
  - Surgical removal!

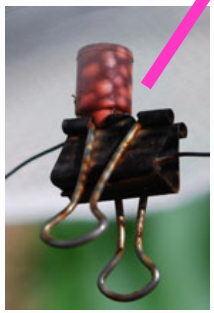
Squash Vine Borer: insecticides



- Direct spray at base of stems
- Timing:
  - Minimum 2 sprays 1 week apart
  - maximum 4 sprays 1 week apart
  - Start at time of egg hatch
    - Estimate by catch of moths in trap
    - Usually late June til late July
    - Peak hatch usually early July
- Product: pyrethrins + PBO

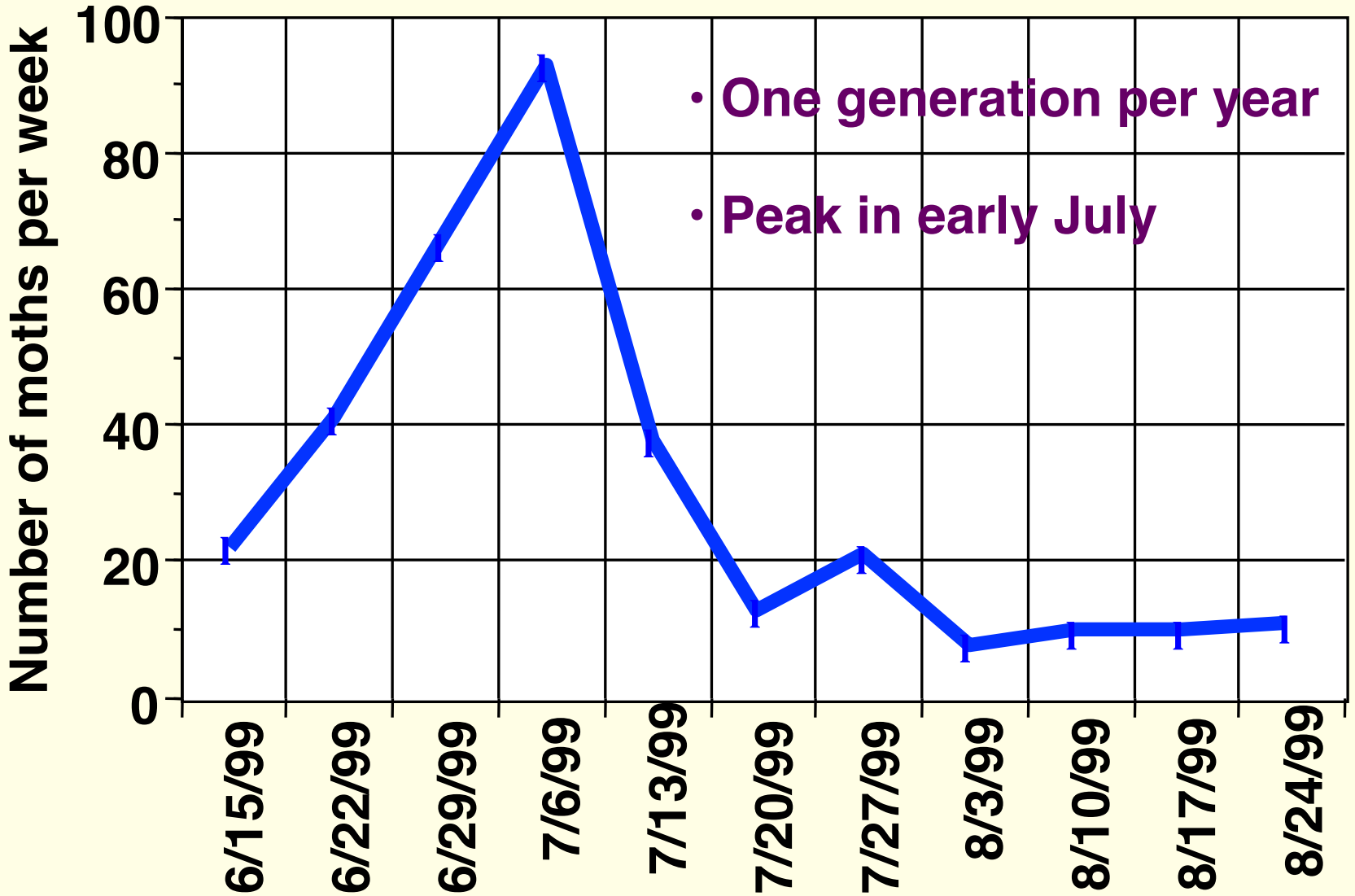
Squash vine borer: monitoring

- **Pheromone lure available**
  - Attract male moths
  - Helps estimate egg hatch
- **Supplies from 'Great Lakes IPM', Vestaburg Michigan:**
  - Scentry 'Heliothis' trap @ $55
  - Lures @$2.25, change lure every 4 weeks
  - Alternative: unitrap $9.95



Squash vine borer moths in pheromone trap

Columbus, Ohio



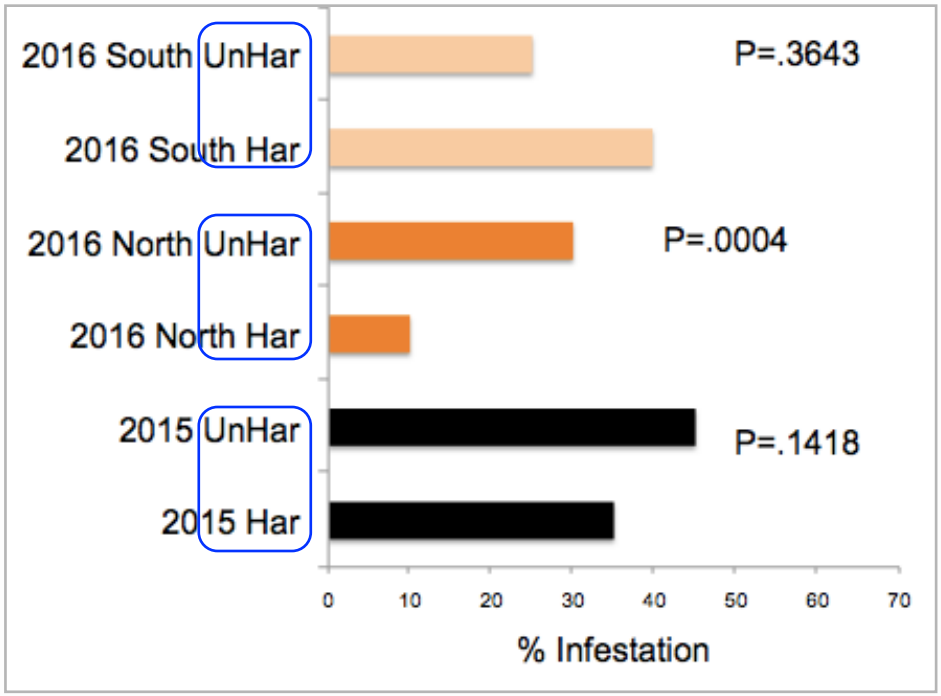
Squash vine borer management in zucchini

- **Thesis project by Mike McFarland**
  - **M.S. in entomology, 2016**
- **Potential for trap cropping**
- **Efficacy of delayed planting**
- **Field trials 2015 & 2016**

Trap crop for SVB management?

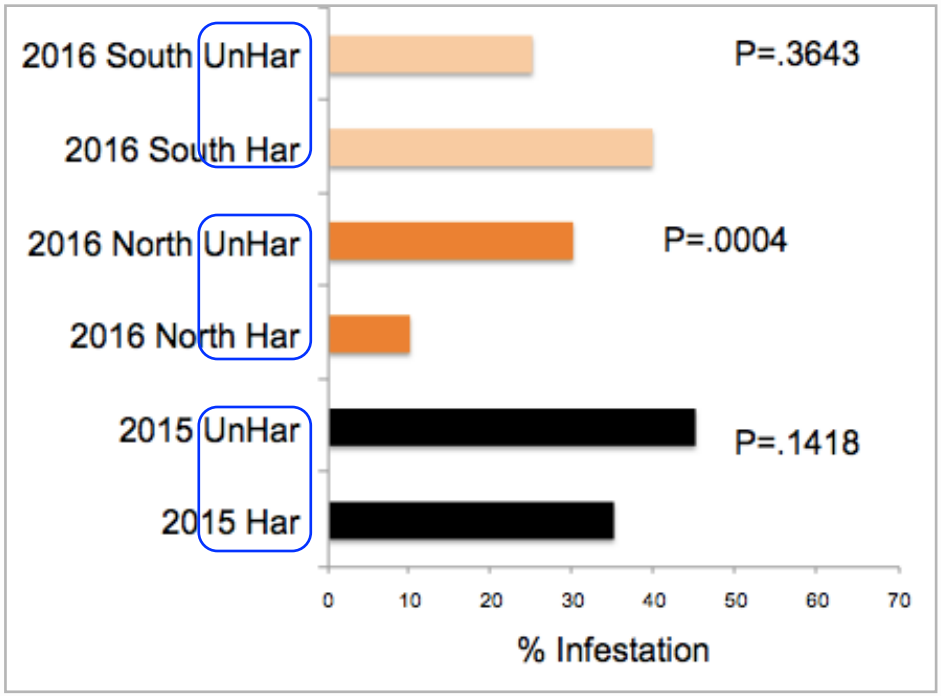
- **SVB infestation higher in plants never harvested than in adjacent plants harvested frequently**
- **Factors evaluated:**
  - **Harvest *vs* no harvest**
  - **Early *vs* late planting**
  - **With *vs* without row cover**

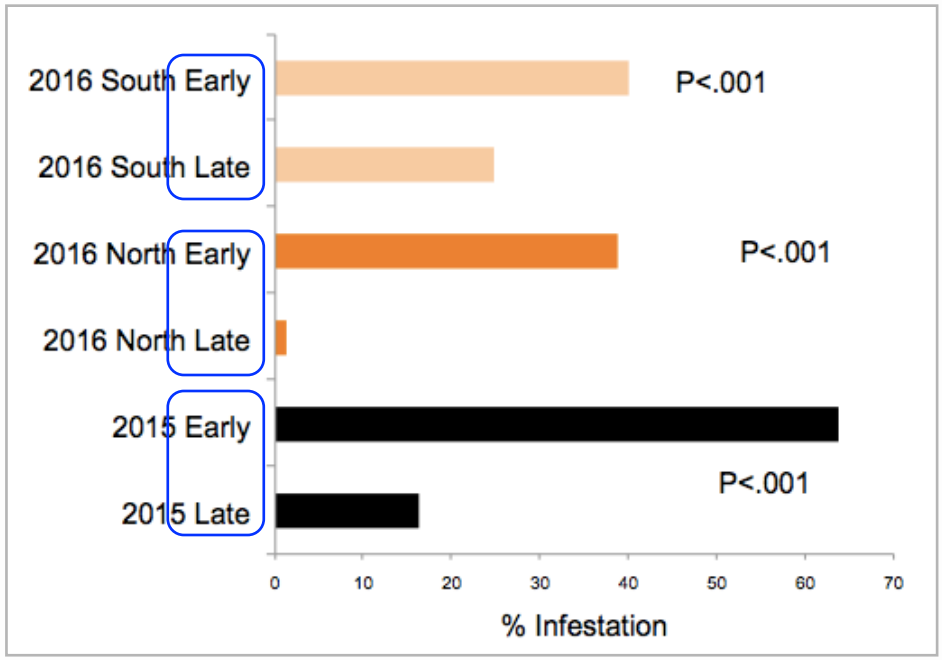
Trap crop for SVB management?



- Unharvested more infested in 2 of 3 sites

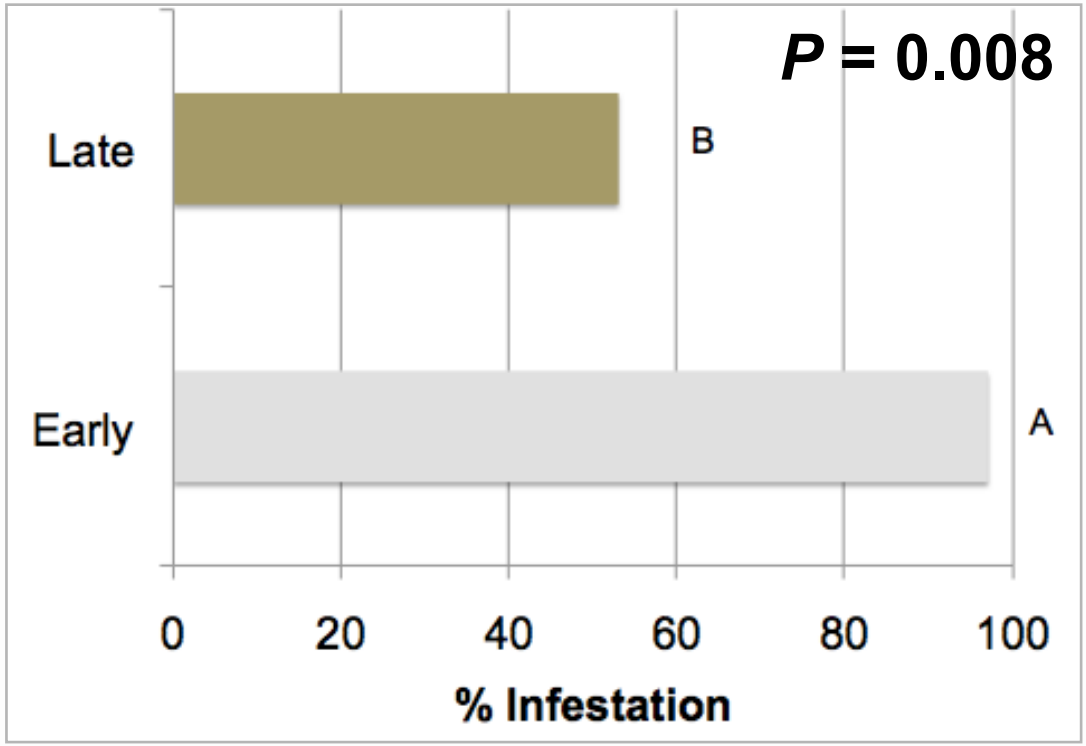
Trap crop for SVB management?





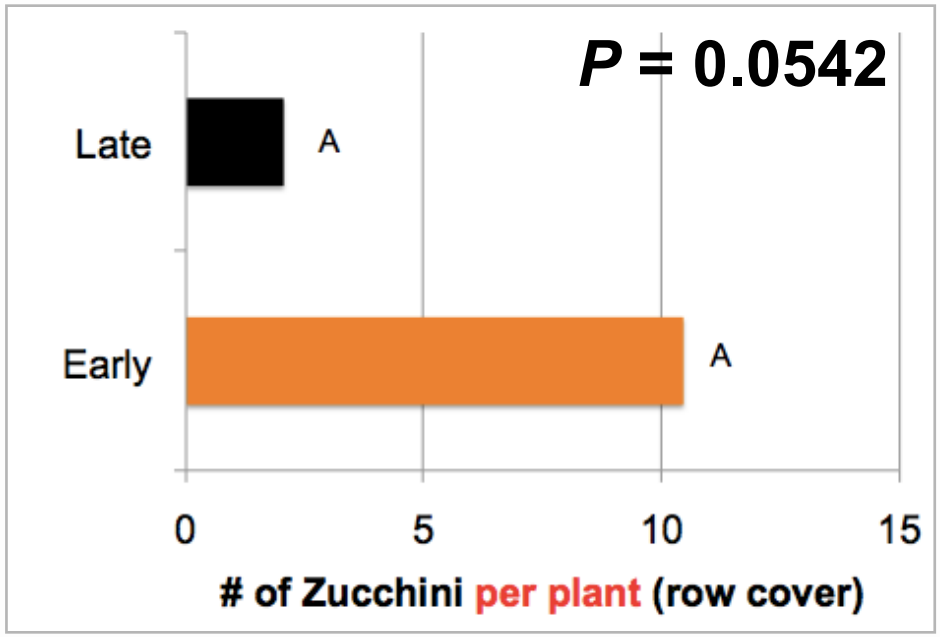
- Unharvested more infested in 2 of 3 sites
- Early planting more infested than later planting

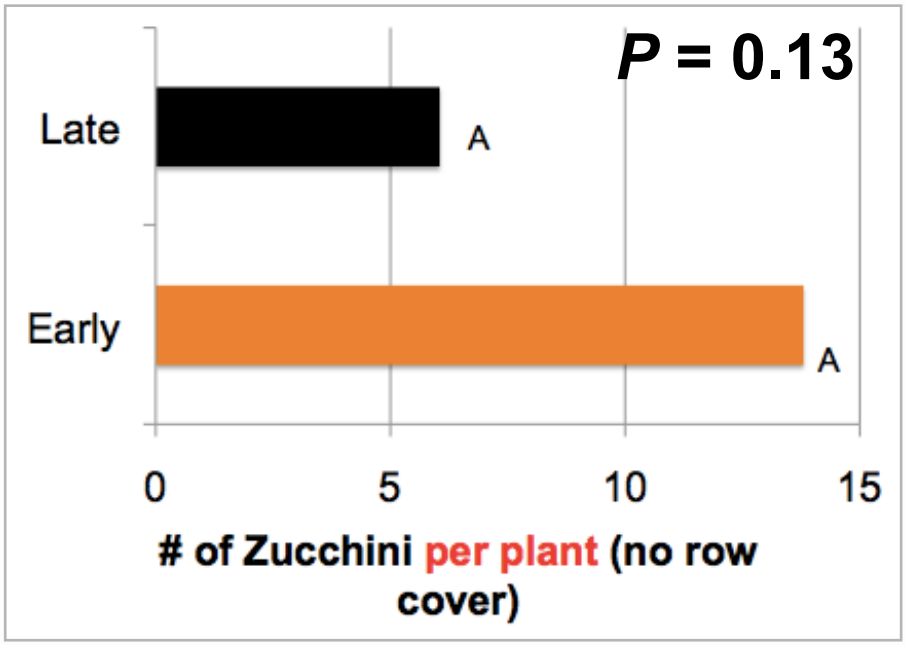
Delayed planting for SVB management: Effect on infestation?



- Conducted at 10 garden sites
- Planted mid-May & mid-June
- Early planting more infested than later planting
- Early might have acted as trap crop

Delayed planting: effect on total yield? & interaction with row covers?





- Conducted at 10 garden sites
  - 5 sites with row covers
  - 5 sites without row covers
- Early planting produced higher yields
- Future: reduce delay to 2 or 3 weeks

Squash bug

eggs

adult

eggs hatching

young nymphs

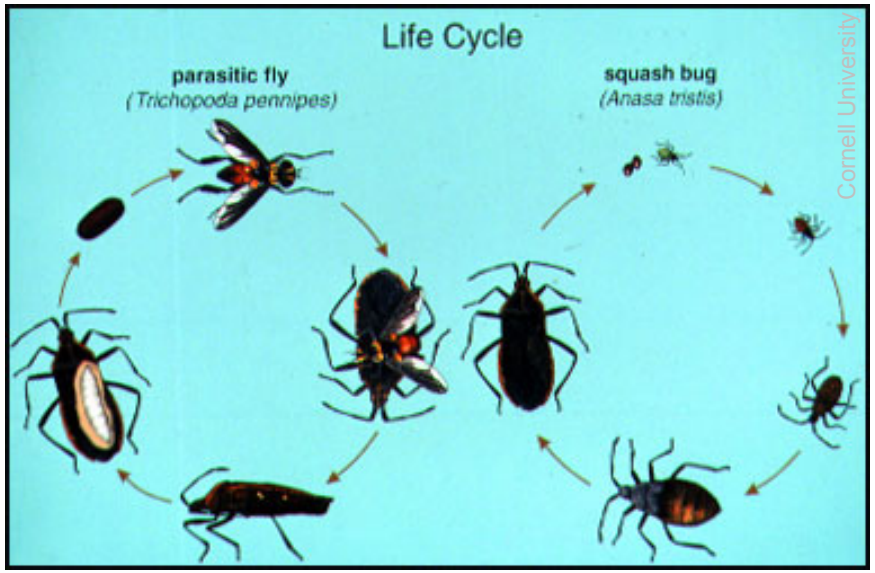
older nymphs

Squash Bug: Damage

Zucchini plant killed by squash bug.

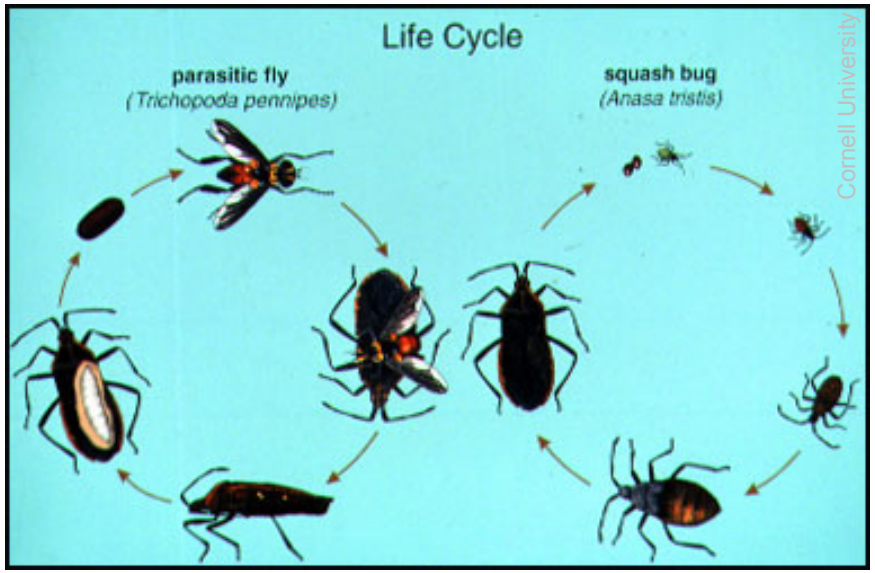
- **Suck sap: leaves, stems**
  - Patches turn black, die
- **Plants wilt**
  - can die
  - can live but not develop fruit
- **Bugs feed on fruit before harvest**

Squash Bug: Biological control



- **Feather-legged fly**
  - ***Trichopoda pennipes***
  - **lays eggs on adult or large nymph**

Squash Bug: Biological control



- **Feather-legged fly**
  - ***Trichopoda pennipes***
  - **lays eggs on adult or large nymph**
- **Egg parasitoid wasps**
  - ***Gryon pennsylvanicum***
  - ***Ooencyrtus anasae***

Removal by shelter traps

- Board or shingle trap
- Check every morning

Squash Bug: Management

- **Cultural control**
  - Rotate with non-cucurbit crops
  - Promote early growth of crop
  - * Destroy crop remains
- **Mechanical control**
  - Row covers (until flowering)
  - Hand picking, especially eggs
  - Shelter traps: board or shingle

Squash beetle

- Defoliator, skeletonizer
- More in southern Ohio than north
- On melons as well as squash

Silverleaf whitefly

(also known as sweetpotato whitefly)

- **Common greenhouse pest**
- **Abundant outdoors in 2017**

squash

tomato

beans

lettuce

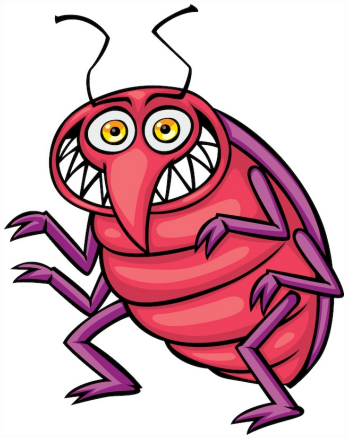
Silverleaf whitefly

- Need magnifier to see immatures on underside of leaves

Silverleaf whitefly

- **Damage:**
  - Leaf scorch
  - Sooty mold
- **Control:**
  - Insecticidal soap

the end



Info on fruit & veg. pests

u.osu.edu/pestmanagement

Questions?

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office phone: 614 292 2803

cell phone: 614 746 2429