Attract-and-Kill of BMSB: A SARE Project Summary

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Conventional Management for BMSB

- ARM or full block sprays of broad spectrum materials
  (Rice et al. 2014; Lee 2015)

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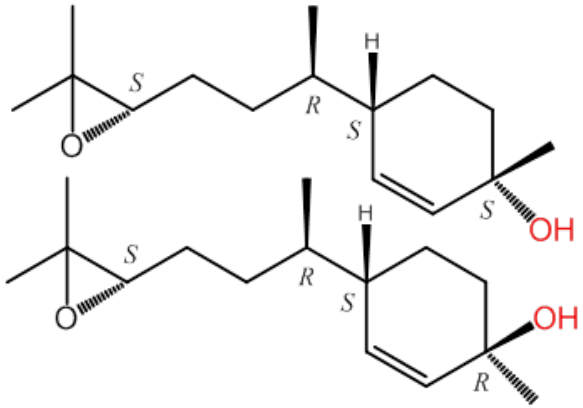
- ARM or full block sprays of broad spectrum materials
  (Rice et al. 2014; Lee 2015)

- Not sustainable in the long term

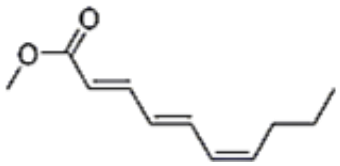
Recent Advances with Pheromones

- BMSB aggregation pheromone identified as two stereoisomers of 10,11-epoxy-1-bisabolen-3-ol (Khrimian et al. 2014)

- Attraction is synergized when combined with methyl decatrienoate (Weber et al. 2014)

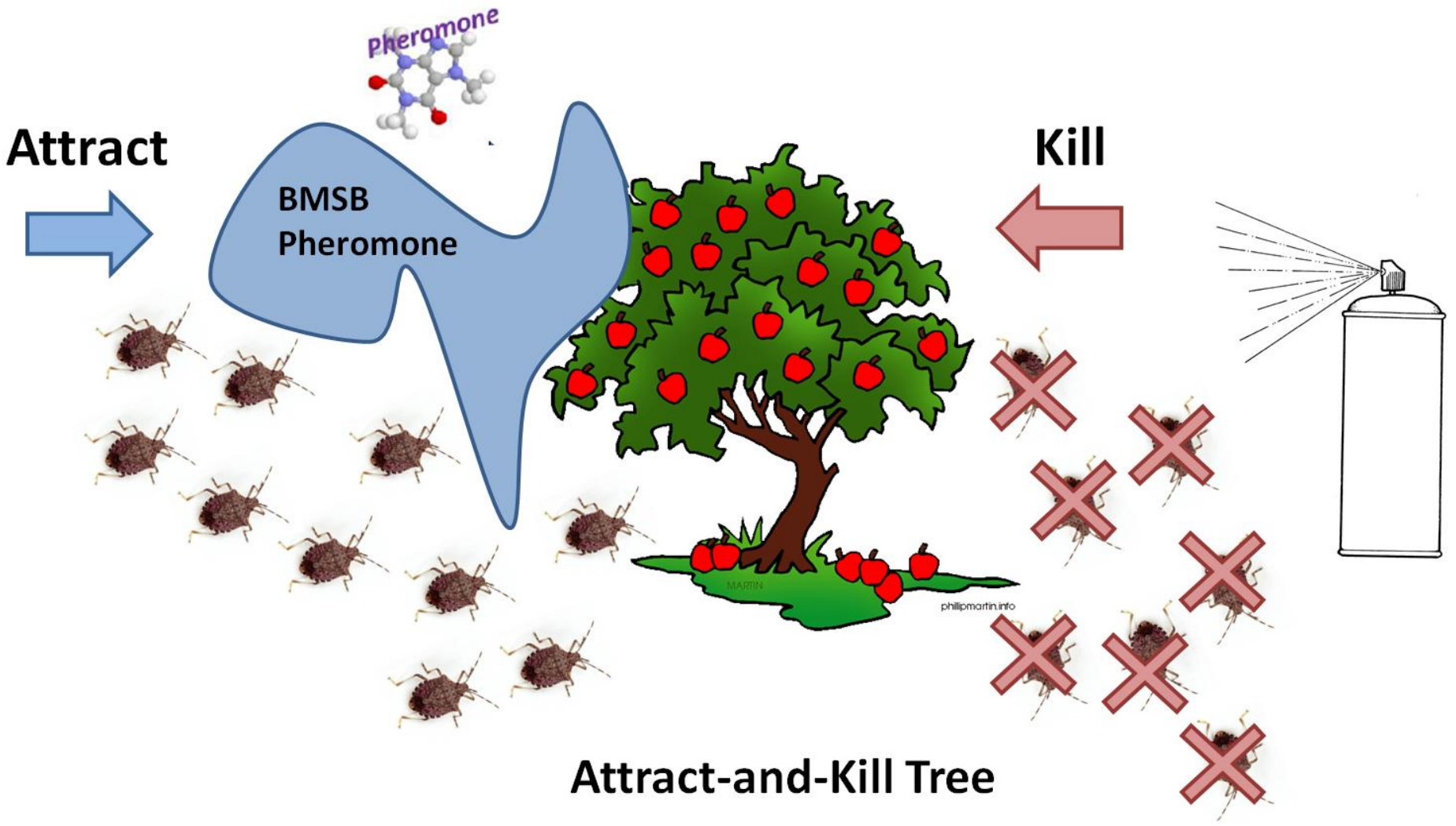


Active components of 10,11-epoxy-1-bisabolen-3-ol

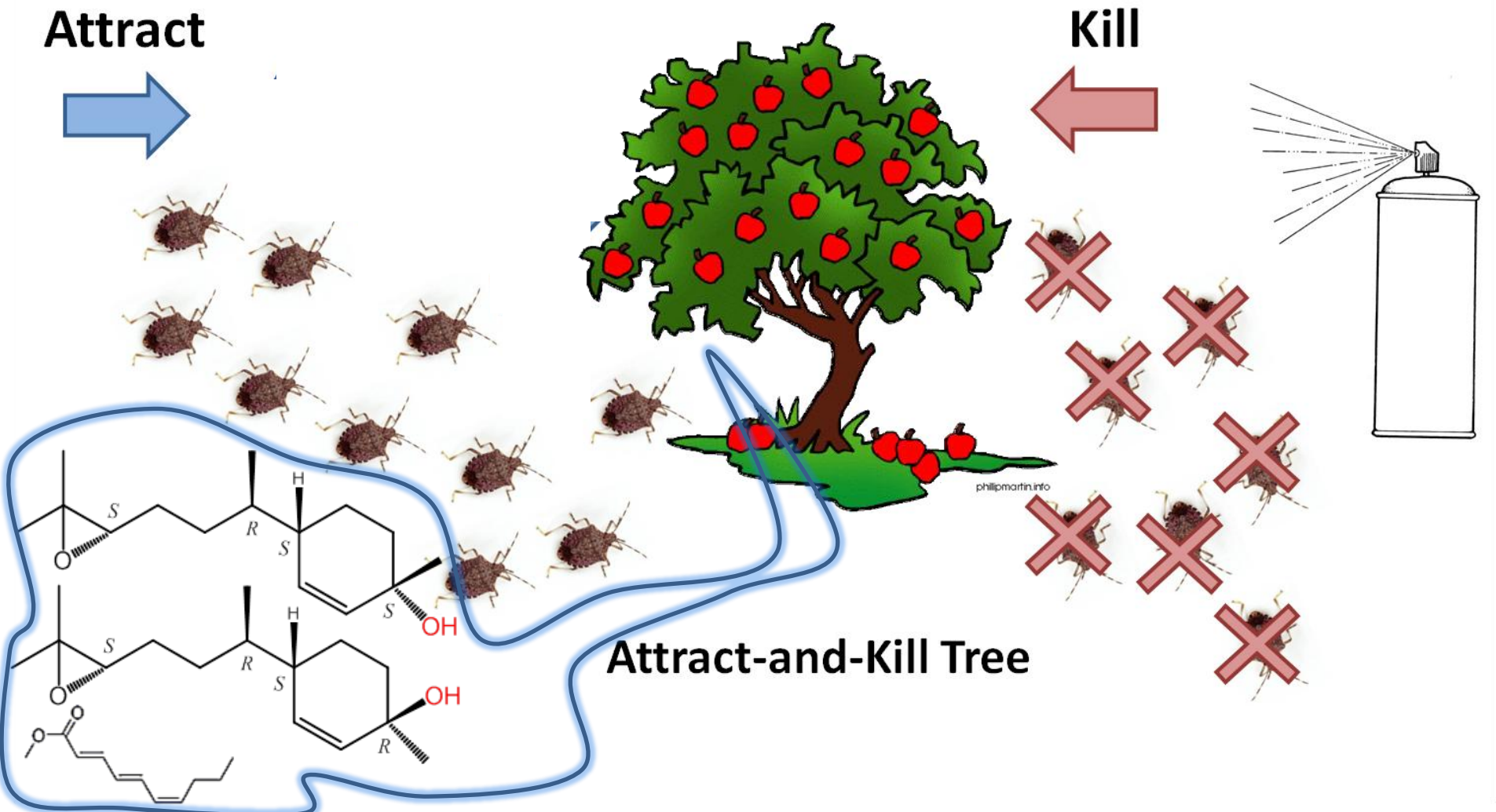


Methyl decatrienoate **(MDT)**

Attract-and-Kill as Alternative Strategy

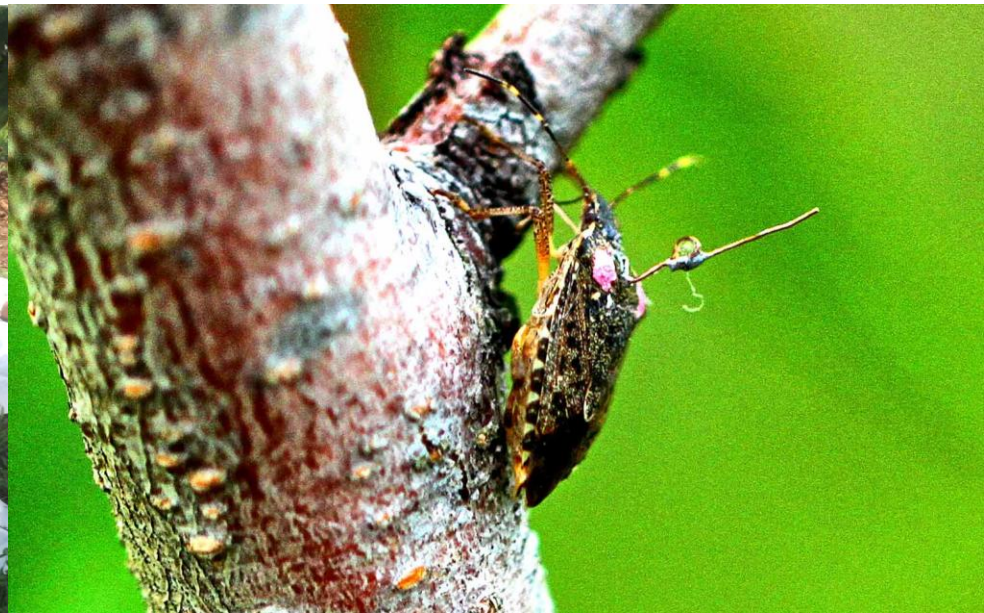


Attract-and-Kill as Alternative Strategy



Preliminary Work with AK

- Over 6 days, killed ~28,000 adults and ~5,000 nymphs at trees with high dose of pheromone (Morrison et al. 2016)
- High retention capacity of AK trees and low spillover into rest of orchard (Morrison et al. 2016)



Commercial Attract-and-Kill

- On 10 farms in 2015 & 2016

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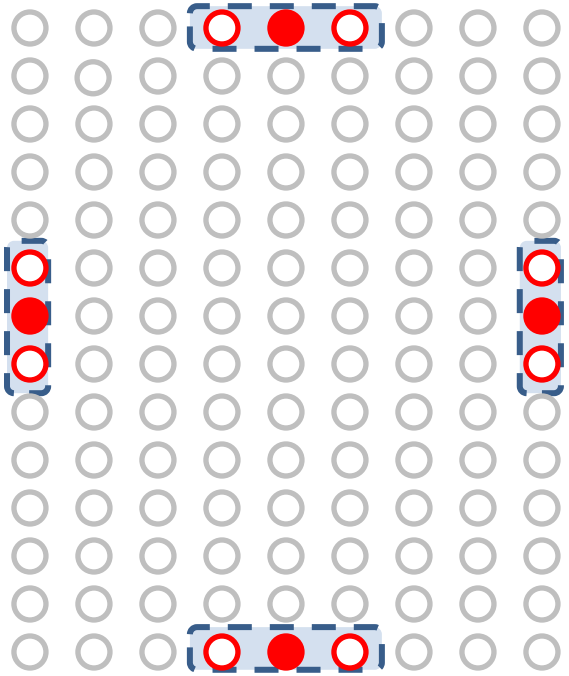
Commercial Attract-and-Kill

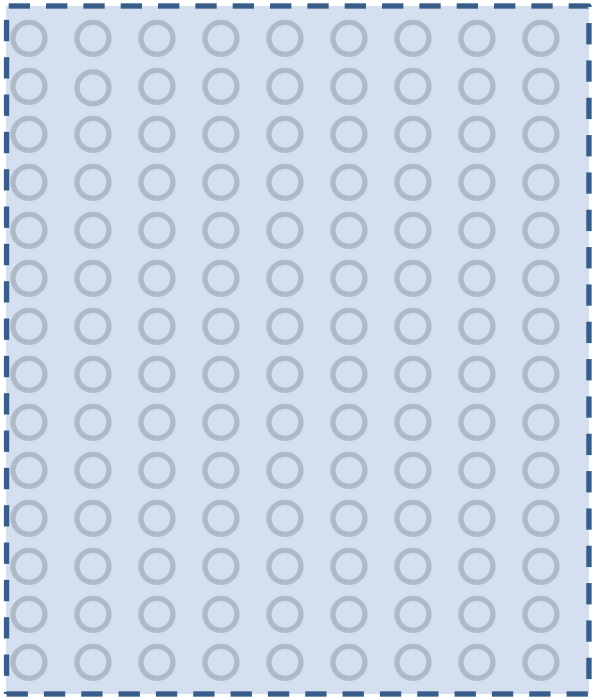
- On 10 farms in 2015 & 2016
- Two treatments: **AK** vs. **grower std.**

Attract-and-Kill Block



vs.

Grower Standard



Commercial Attract-and-Kill

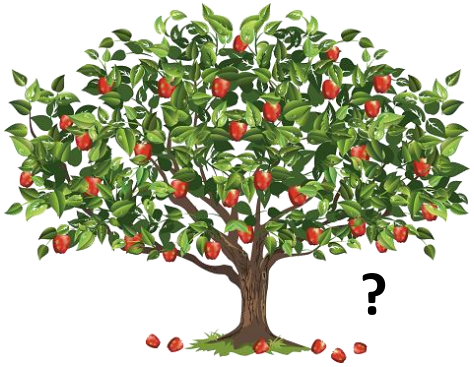
- On 10 farms in 2015
- Two treatments: **AK** vs. **grower std.**

Commercial Attract-and-Kill

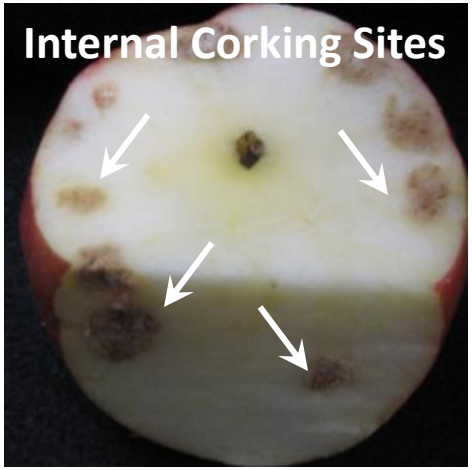
- On 10 farms in 2015
- Two treatments: **AK** vs. **grower std.**
- Safeguard with spray triggered by monitoring trap

Commercial Attract-and-Kill

Damage Incidence per Tree



Early, **mid**, and **harvest**
16 interior trees
4 perimeter trees
4 baited trees



10 fruit per tree

Counts of Killed BMSB on Tarps

At 4 sites across 4 states

23 AK trees

17 Control Trees

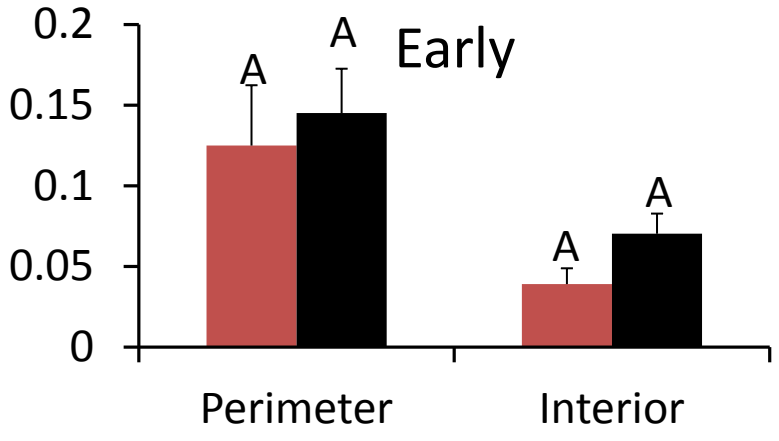
BMSB adults & nymphs

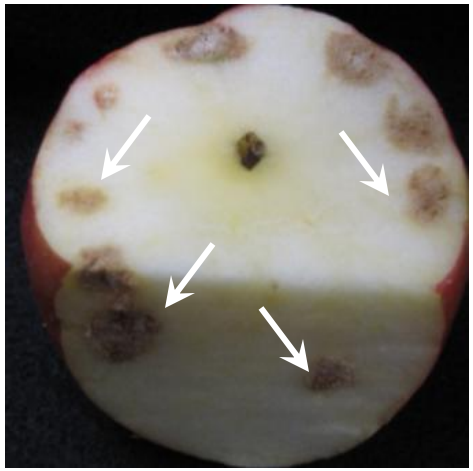
Split Season Into Three Periods

Early	Before Jun 15th
Mid	Jun 15th-Aug 15th
Harvest	After Aug 15th

2015 Results:
Low population year

Results:
Fruit Damage Severity





- Attract-and-Kill
- Grower Standard

ANOVA

Log-transformed

Treatment

$F_{1,398} = 408.1$

$P < 0.0001$

Location

$F_{2,398} = 663.8$

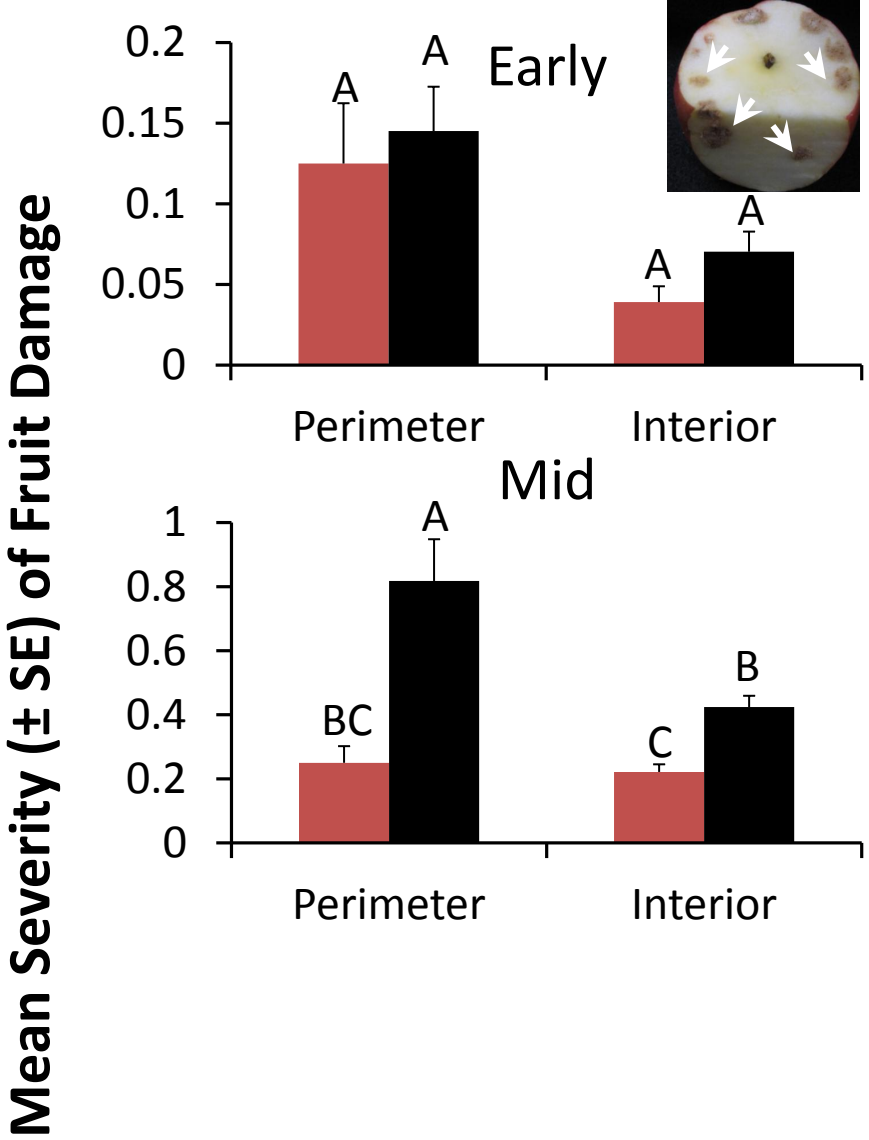
$P < 0.0001$

Period

$F_{2,398} = 4421.6$

$P < 0.0001$

Tukey's HSD



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Fruit Damage Severity

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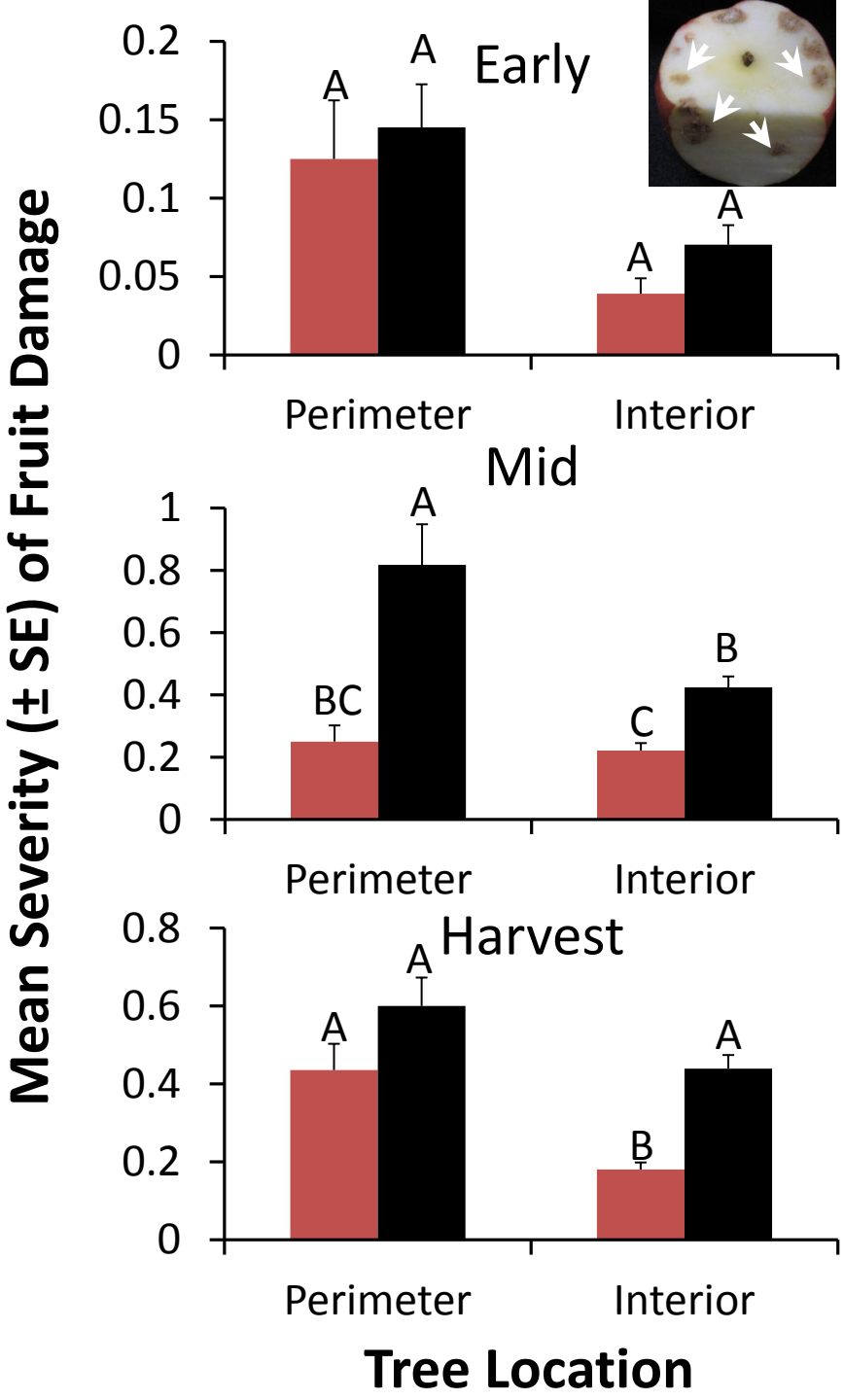

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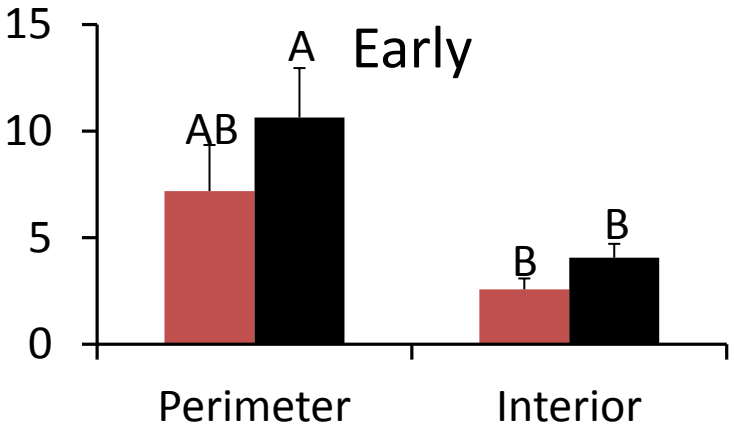
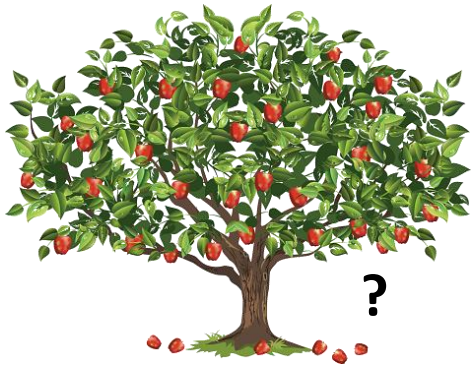
Results:
Fruit Damage Frequency

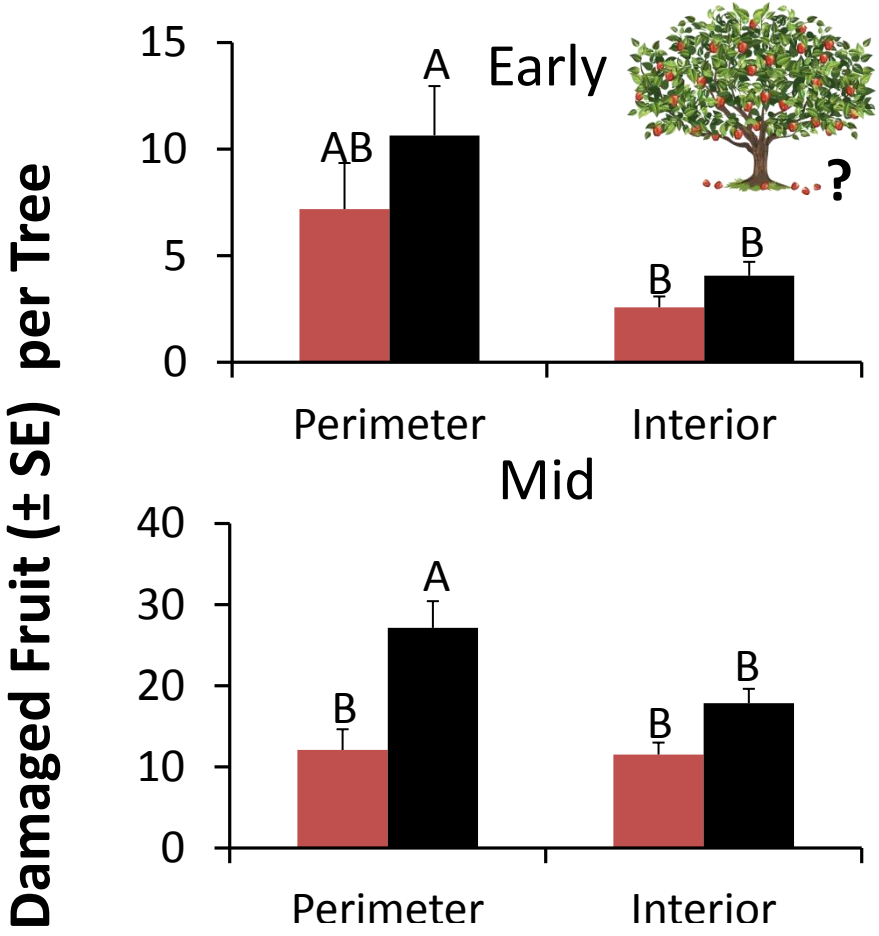




- Attract-and-Kill
- Grower Standard

GLM
Binomial
Likelihood Ratio
Treatment
$\chi^2 = 4.429$
df = 1
$P < 0.04$
Location
$\chi^2 = 13.5$
df = 1
$P < 0.0003$
Period
$\chi^2 = 84.6$
df = 2
$P < 0.0001$
Chi-square
w/Bonferroni correction

Results:
Fruit Damage Frequency



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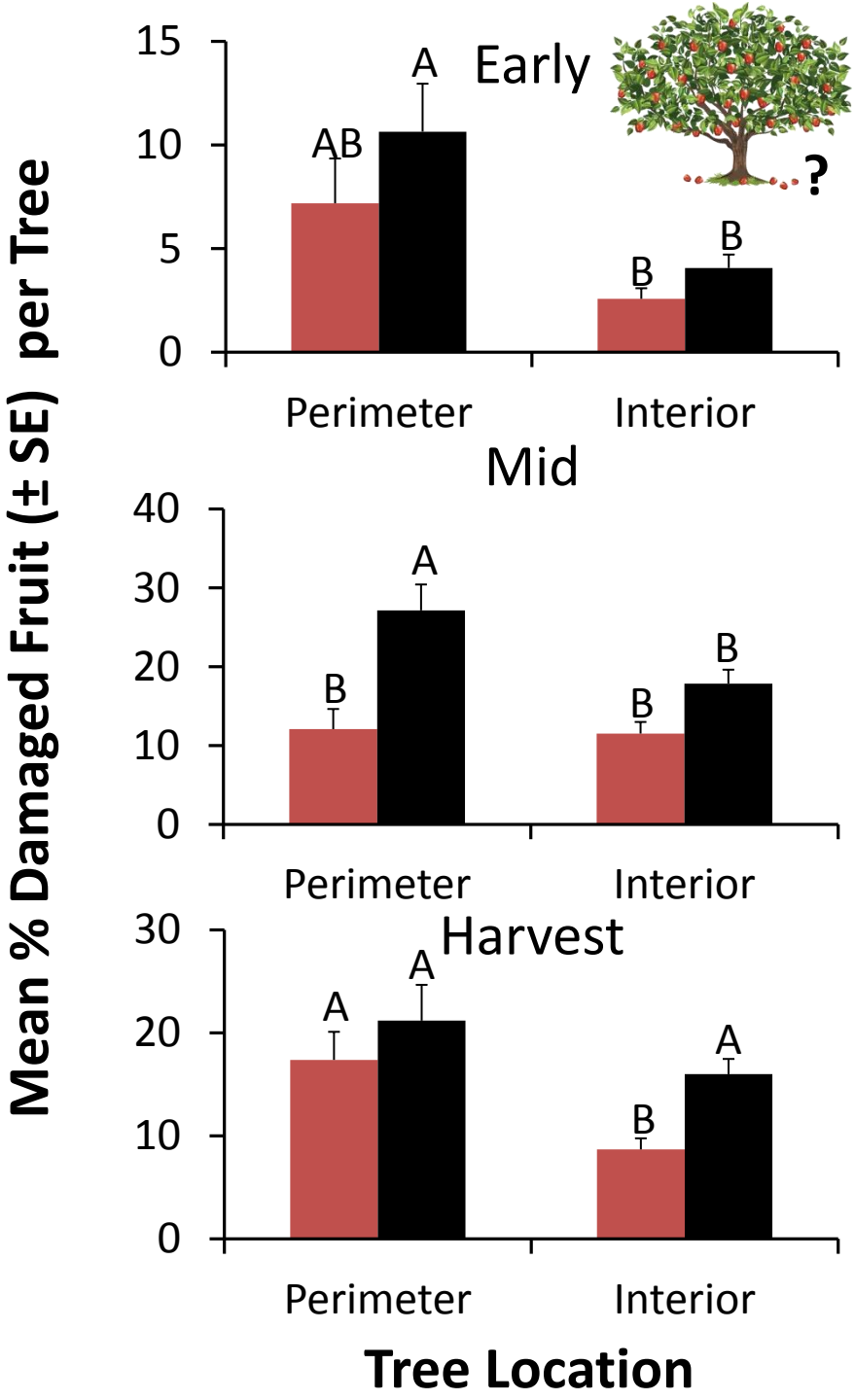

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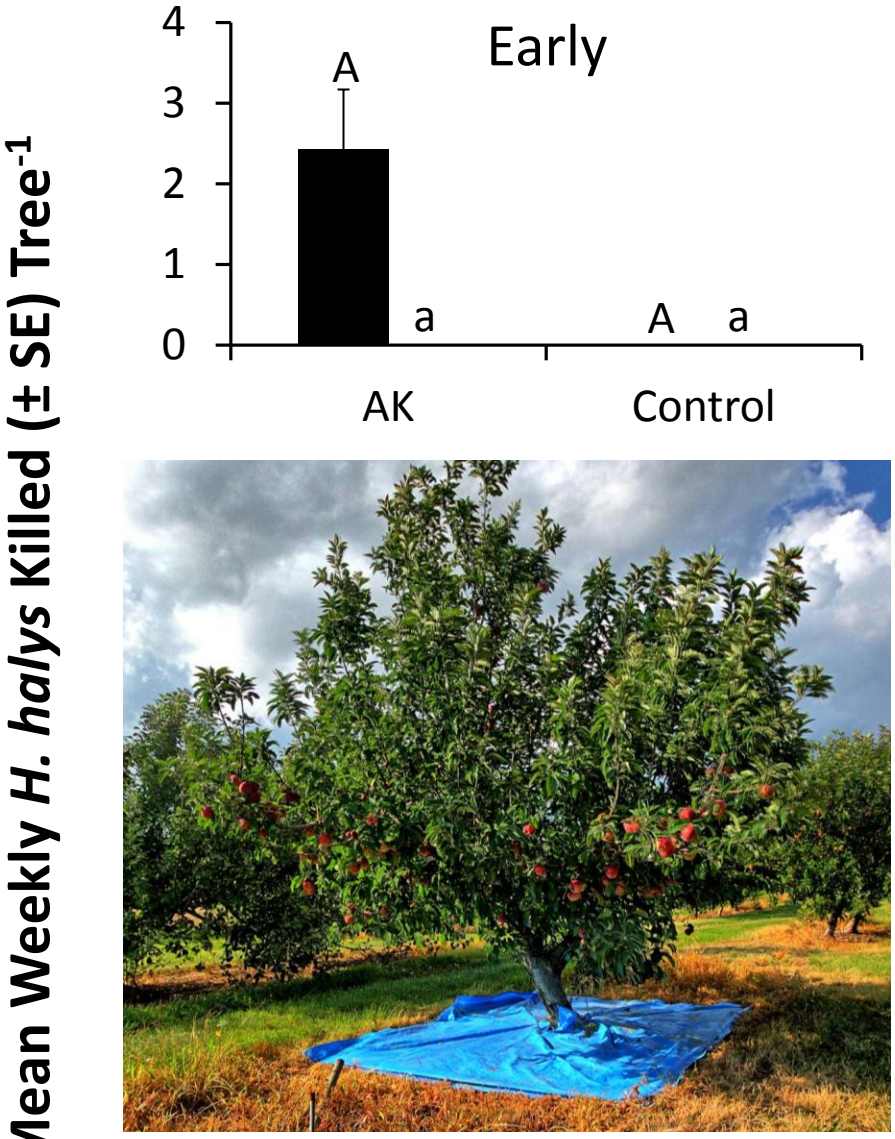

ANOVA
Adults
Log-transformed
Treatment
$F_{1,45} = 0.330$
$P < 0.566$
Period
$F_{2,523} = 124.1$
$P < 0.0001$
Interaction
$F_{2,523} = 37.0$
$P < 0.0001$
Tukey's HSD

ANOVA
Nymphs
Log-transformed
Treatment
$F_{1,45} = 0.01$
$P = 0.999$
Period
$F_{2,523} = 9.38$
$P < 0.0001$
Interaction
$F_{2,523} = 3.0$
$P < 0.05$
Tukey's HSD

Results:
BMSB on Tarps

Adults

Nymphs

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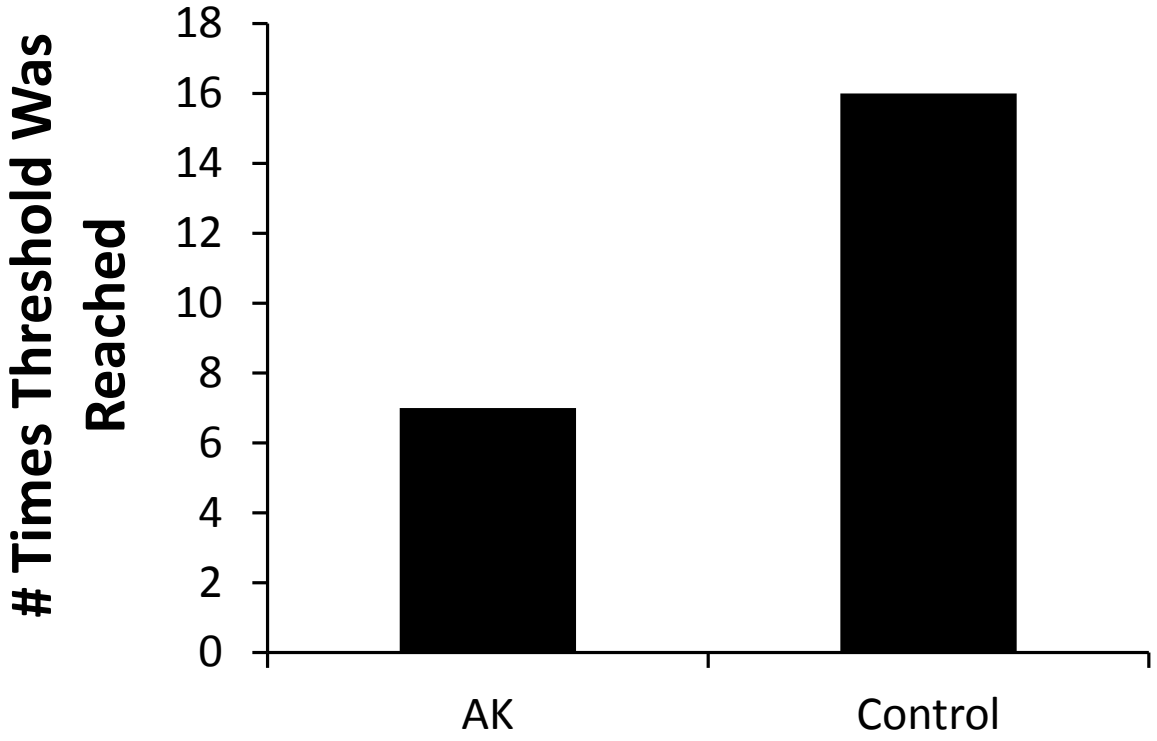


Chi-Square

$\chi^2 = 3.62$

df = 1

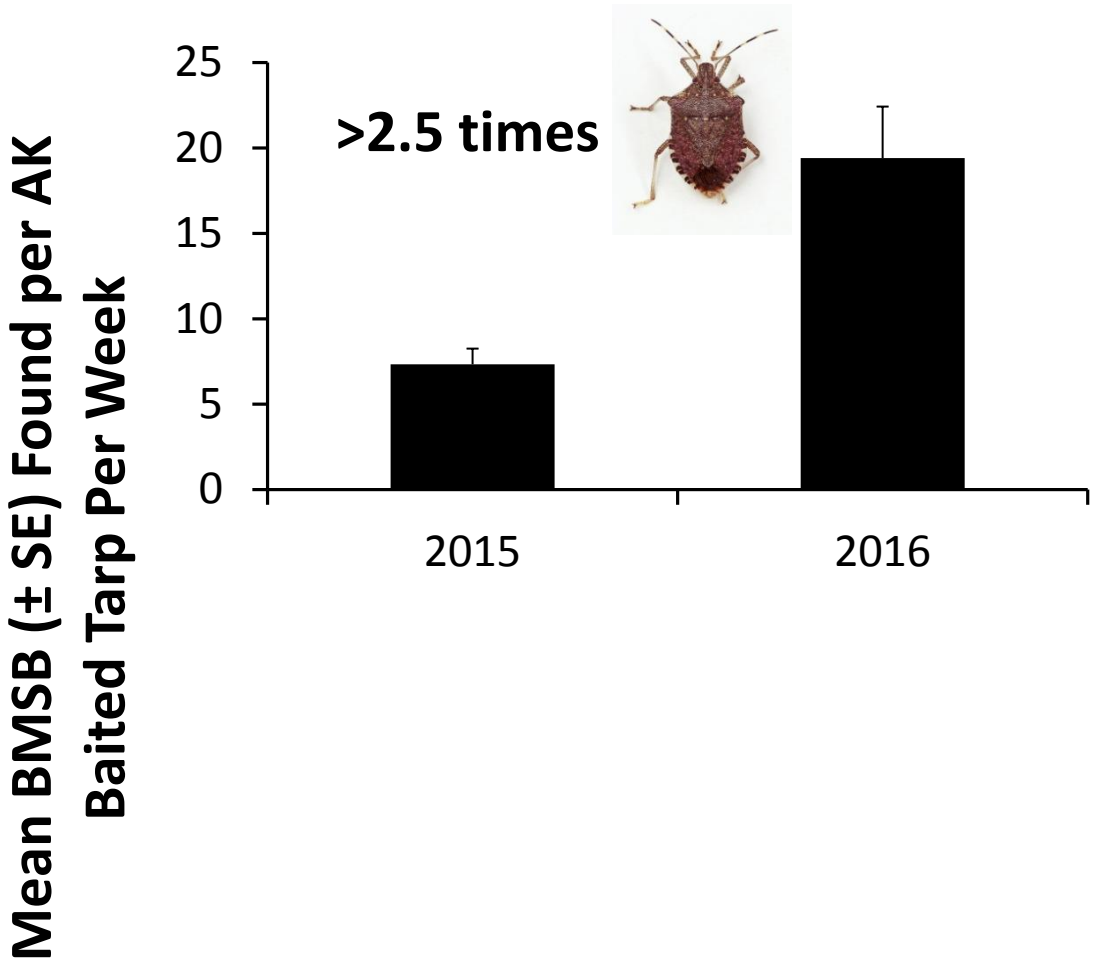
$P < 0.05$

2015 Summary

- At harvest, **half (or less) as frequent and severe of damage** in AK block interior trees compared to grower standard
- Equivalent control in perimeter trees to grower std
- Killing 15 adults per week, per AK tree during the late

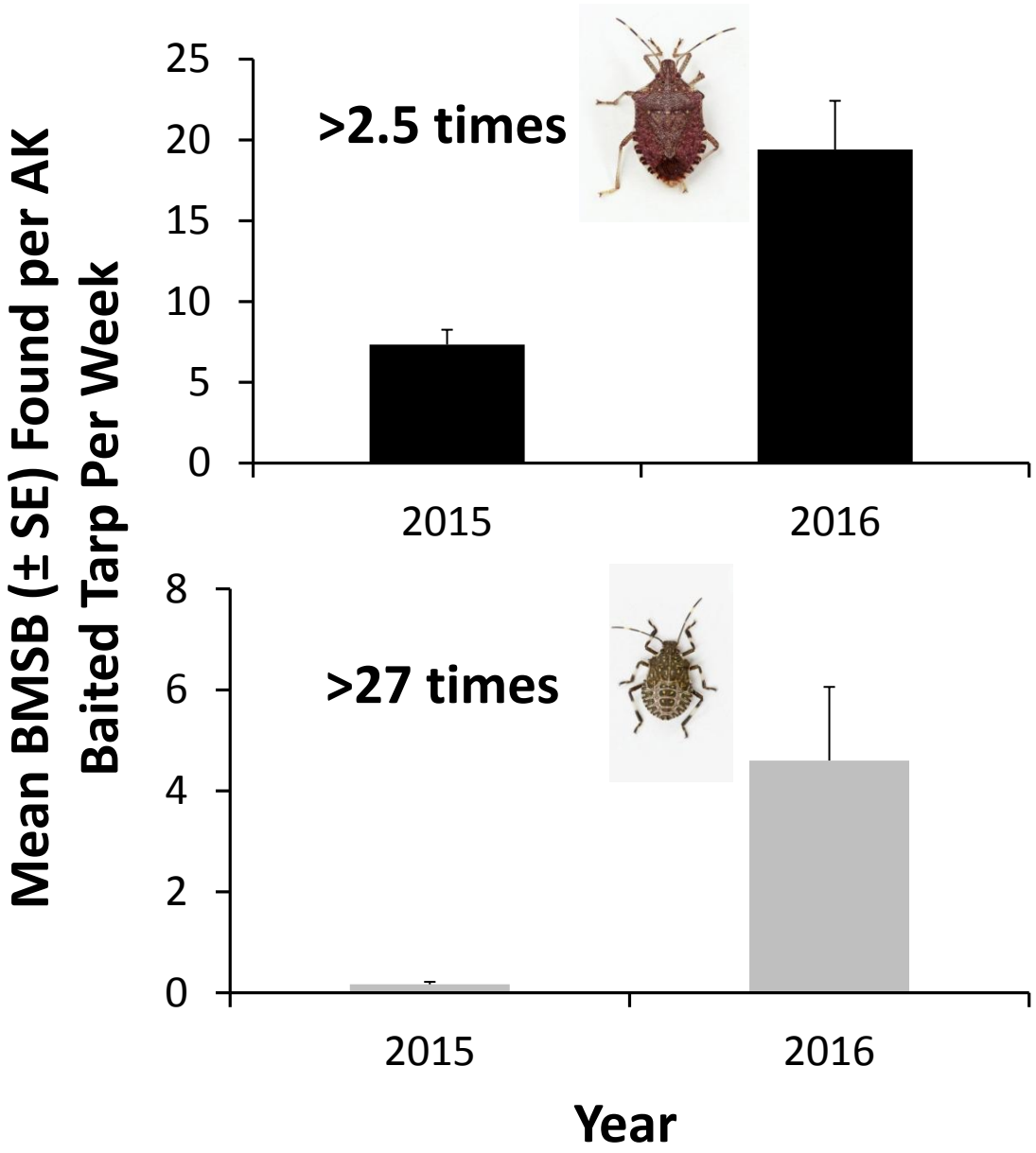
2016 Results:
Higher population year

2016: Higher Populations



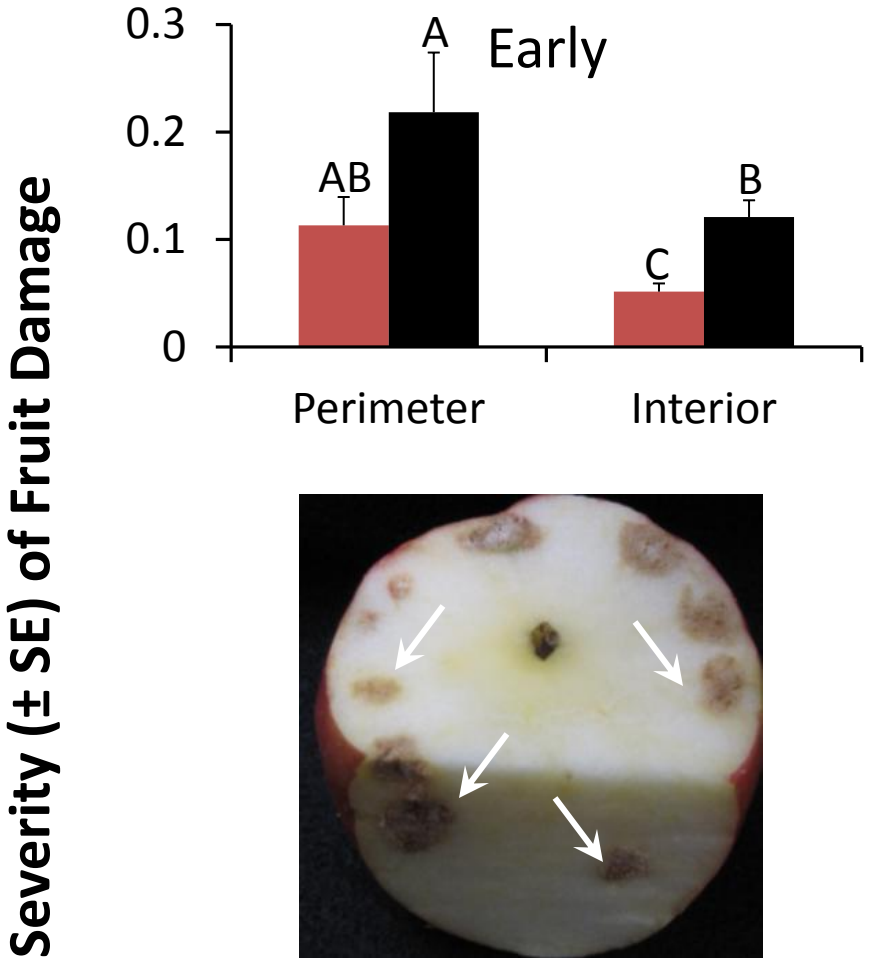
Adults
t = 3.97
P < 0.0001
Nymphs
t = 3.17
P < 0.005

2016: Higher Populations



Adults
t = 3.97
P < 0.0001
Nymphs
t = 3.17
P < 0.005

Results:
Fruit Damage Severity



- Attract-and-Kill
- Grower Standard

ANOVA

Log-transformed

Treatment

$F_{1,400} = 770.0$

$P < 0.0001$

Location

$F_{2,400} = 14.8$

$P < 0.001$

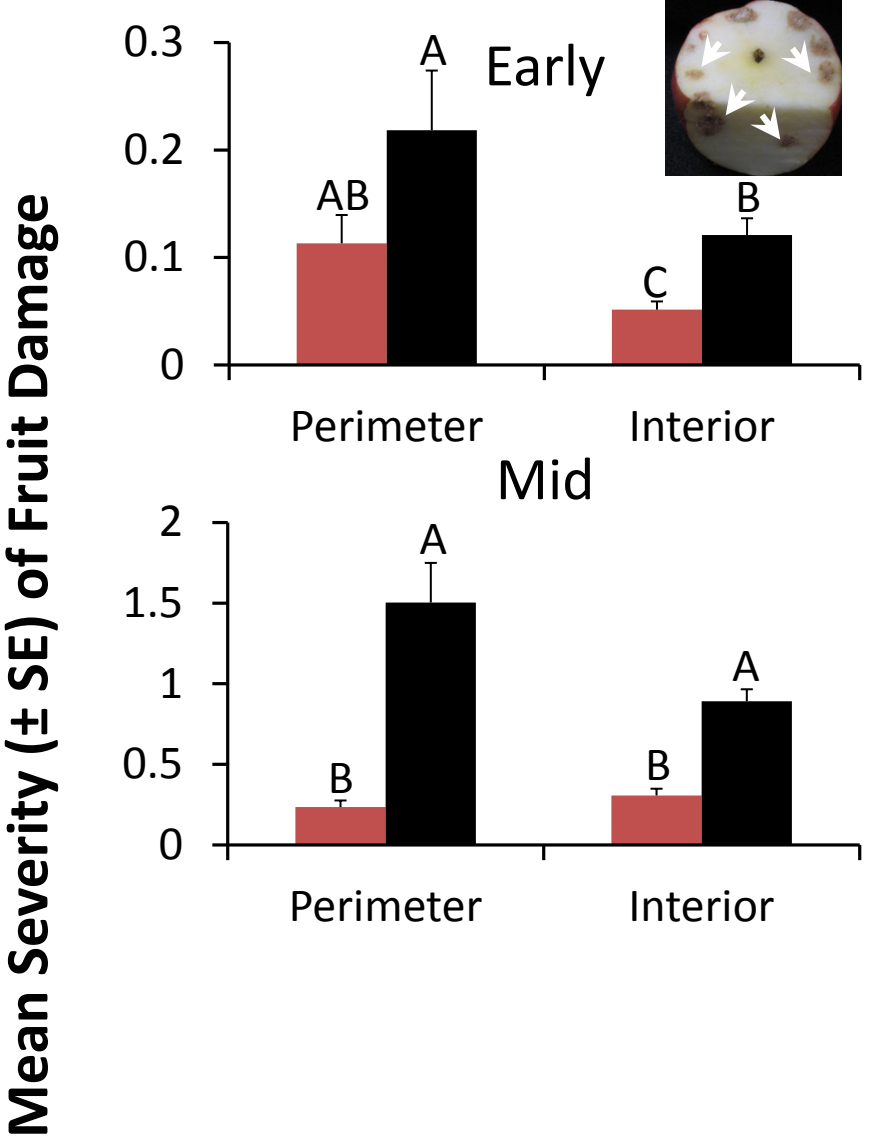
Period

$F_{2,400} = 3191.8$

$P < 0.0001$

Tukey's HSD

Results:
Fruit Damage Severity



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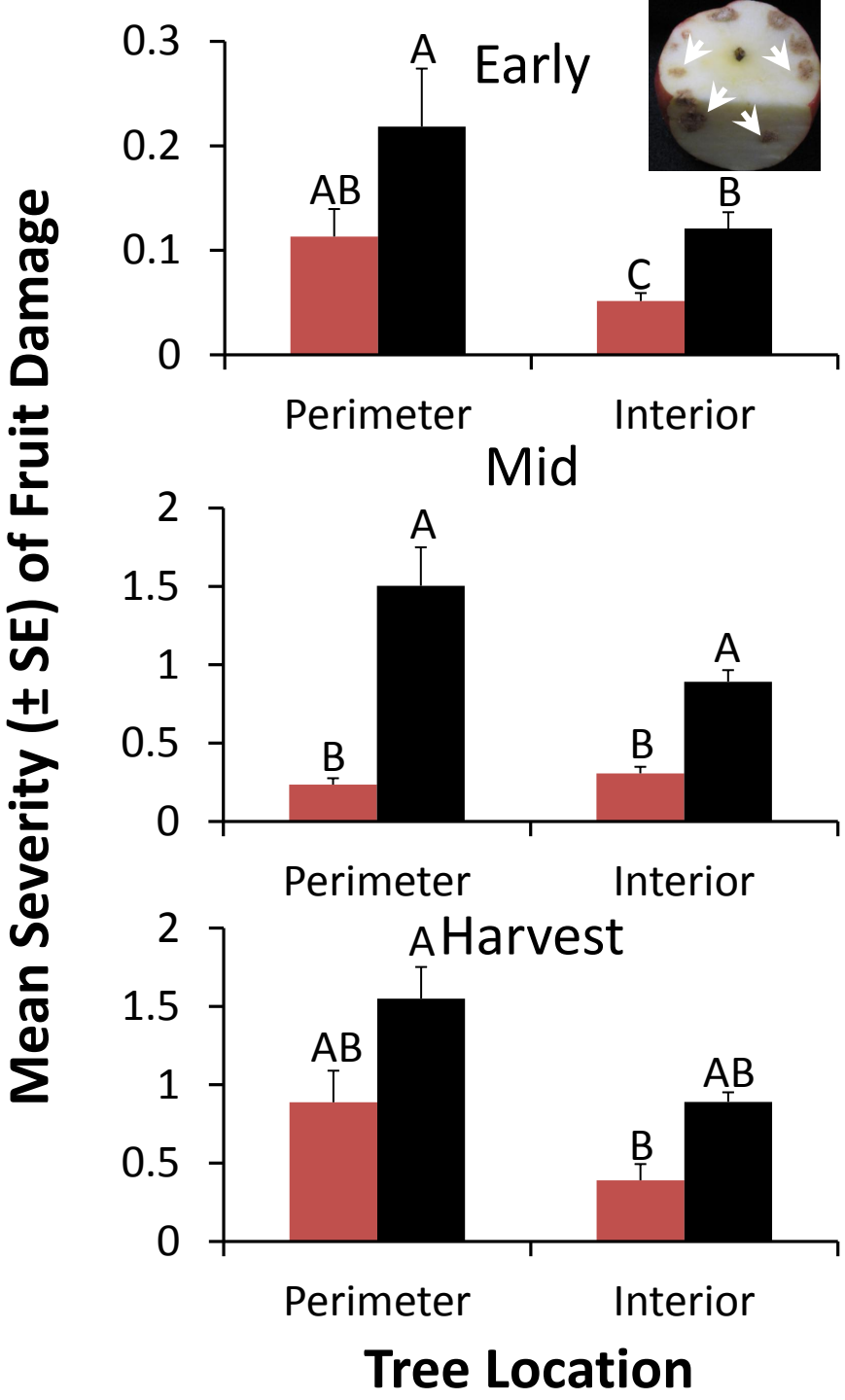

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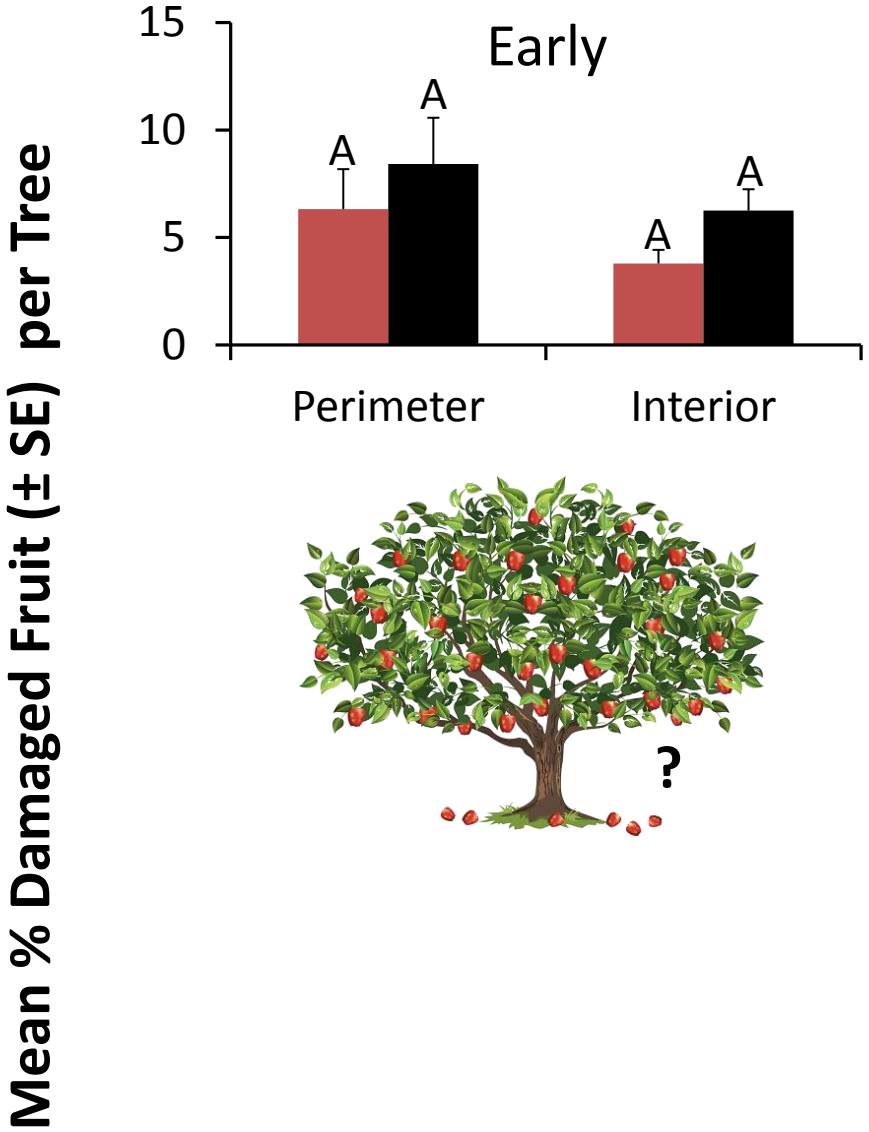

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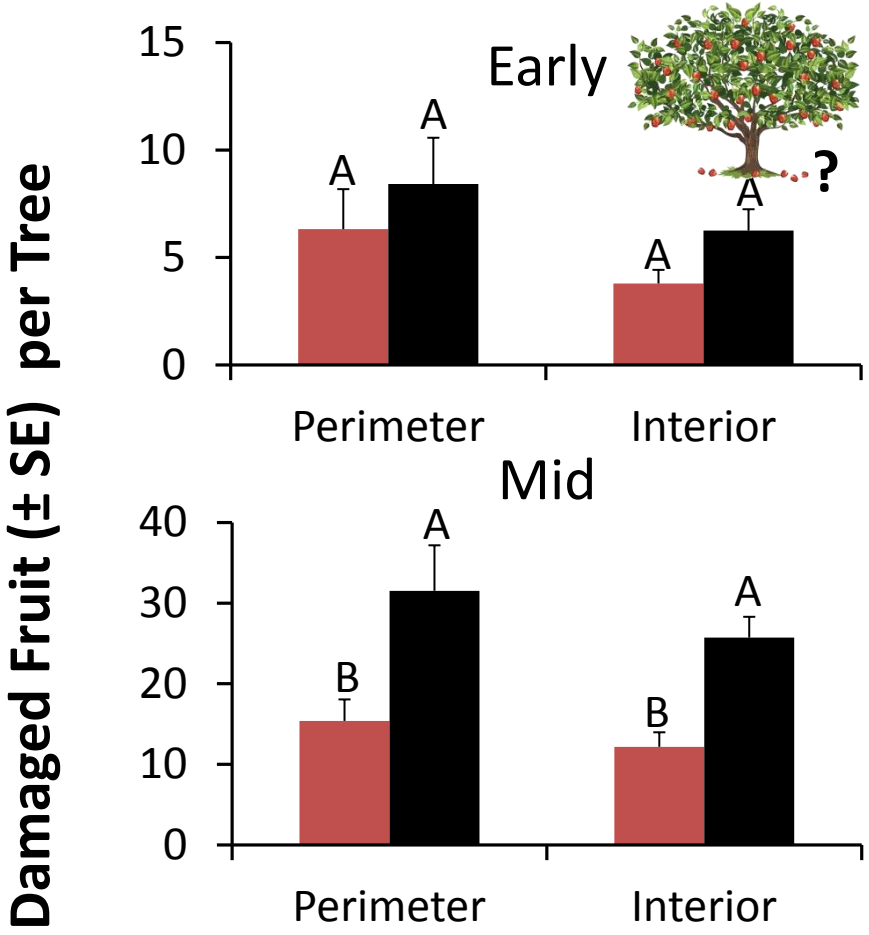
GLM
Binomial
Likelihood Ratio
Treatment
$\chi^2 = 9.12$
df = 1
$P < 0.003$
Location
$\chi^2 = 4.22$
df = 1
$P < 0.04$
Chi-square
w/Bonferroni correction



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Period
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df = 2
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Chi-square
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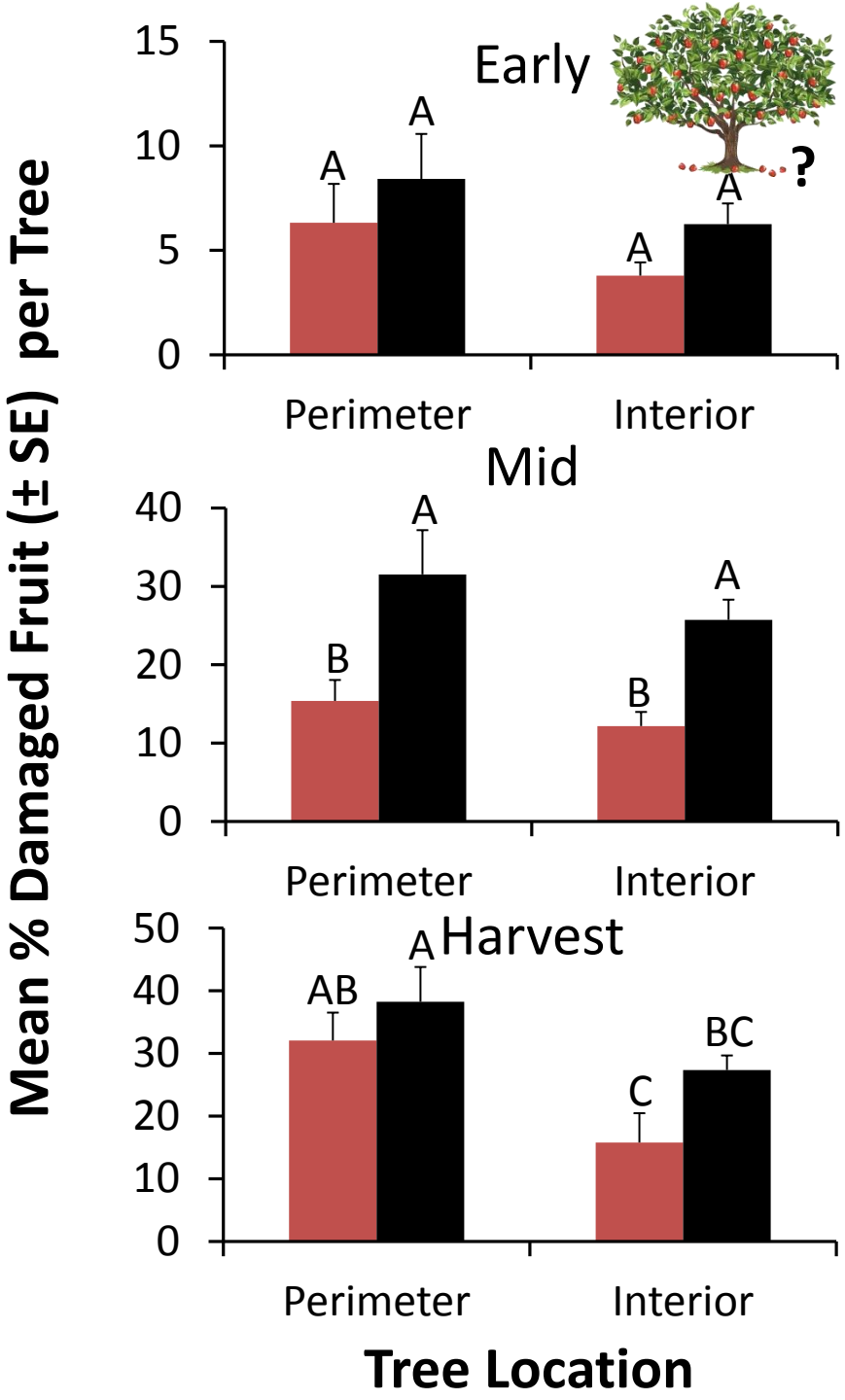

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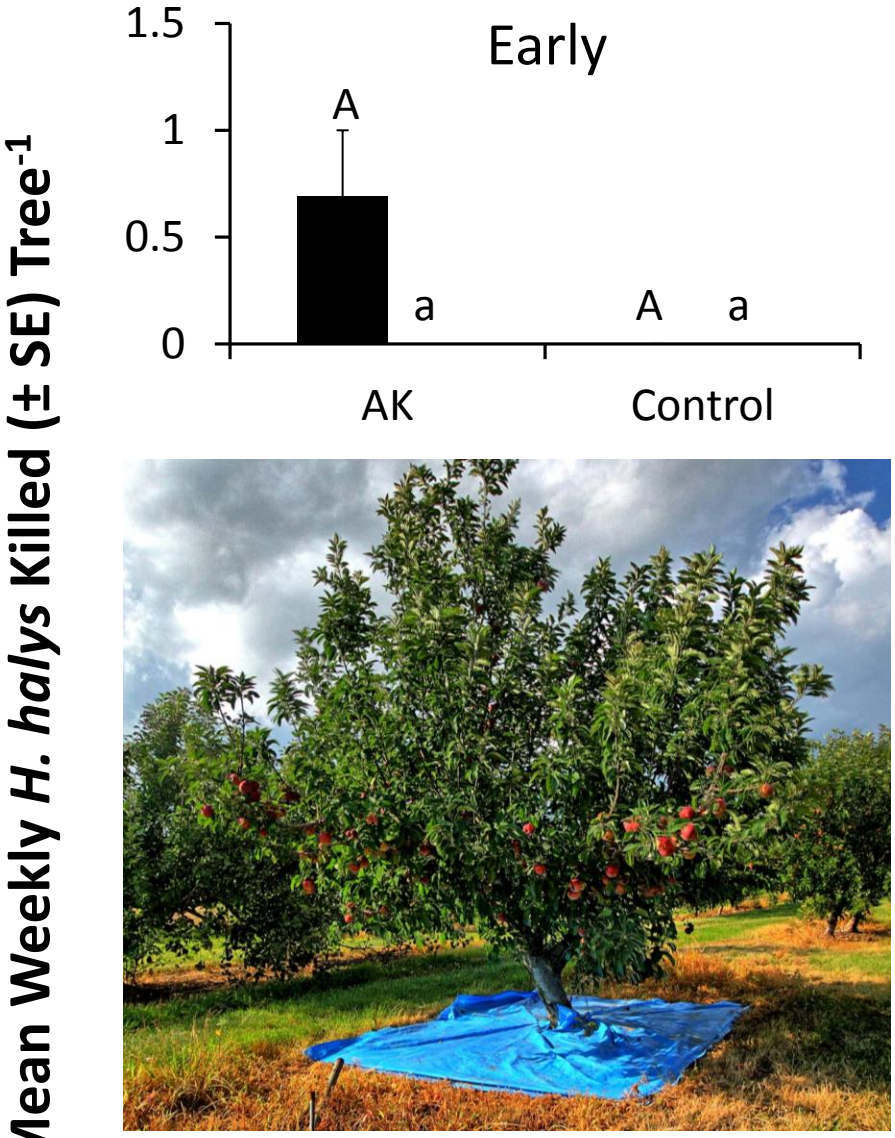

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$P < 0.0001$
Period
$F_{2,40} = 141.7$
$P < 0.0001$
Interaction
$F_{2,40} = 23.4$
$P < 0.0001$
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ANOVA
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$F_{1,40} = 68.1$
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Period
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Interaction
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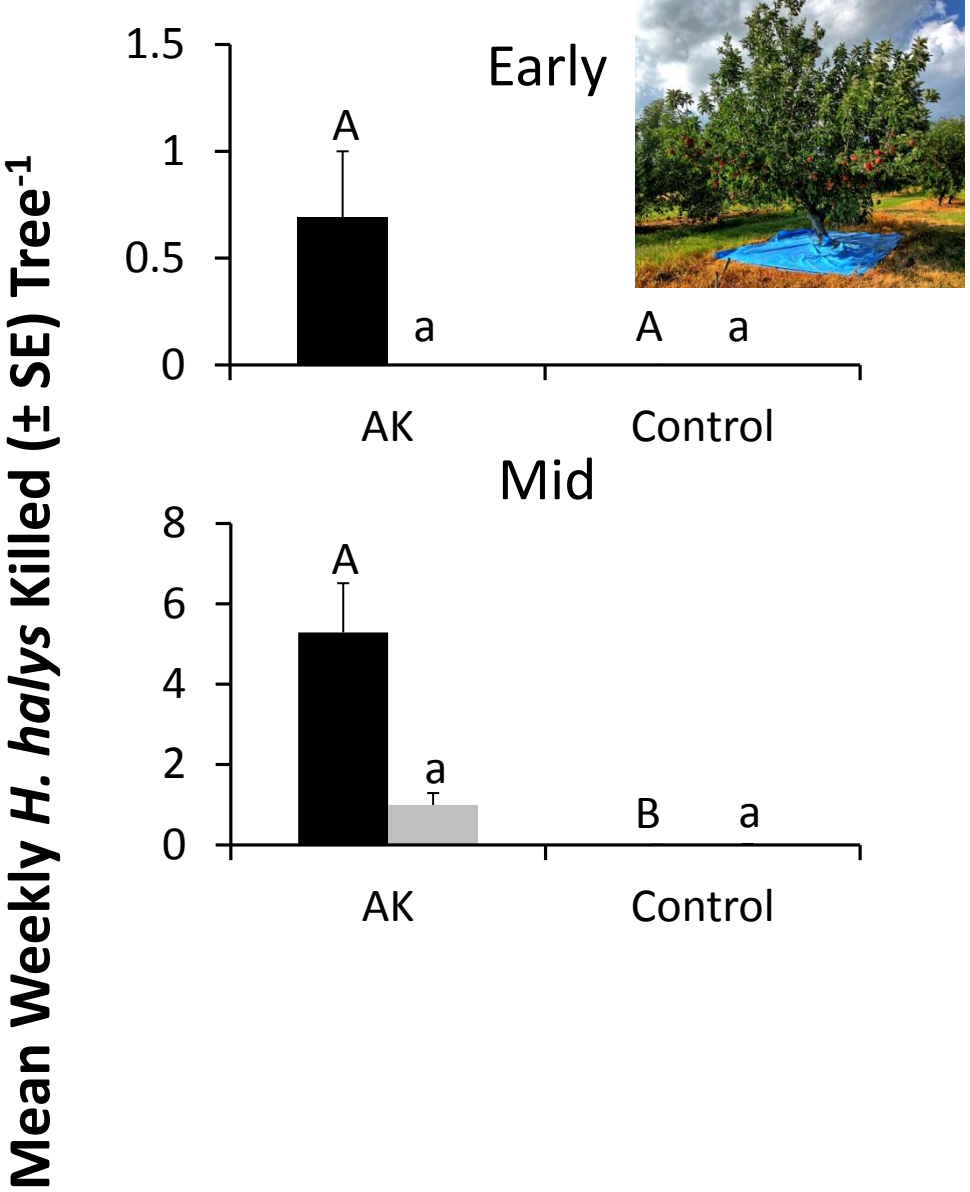
BMSB on Tarps



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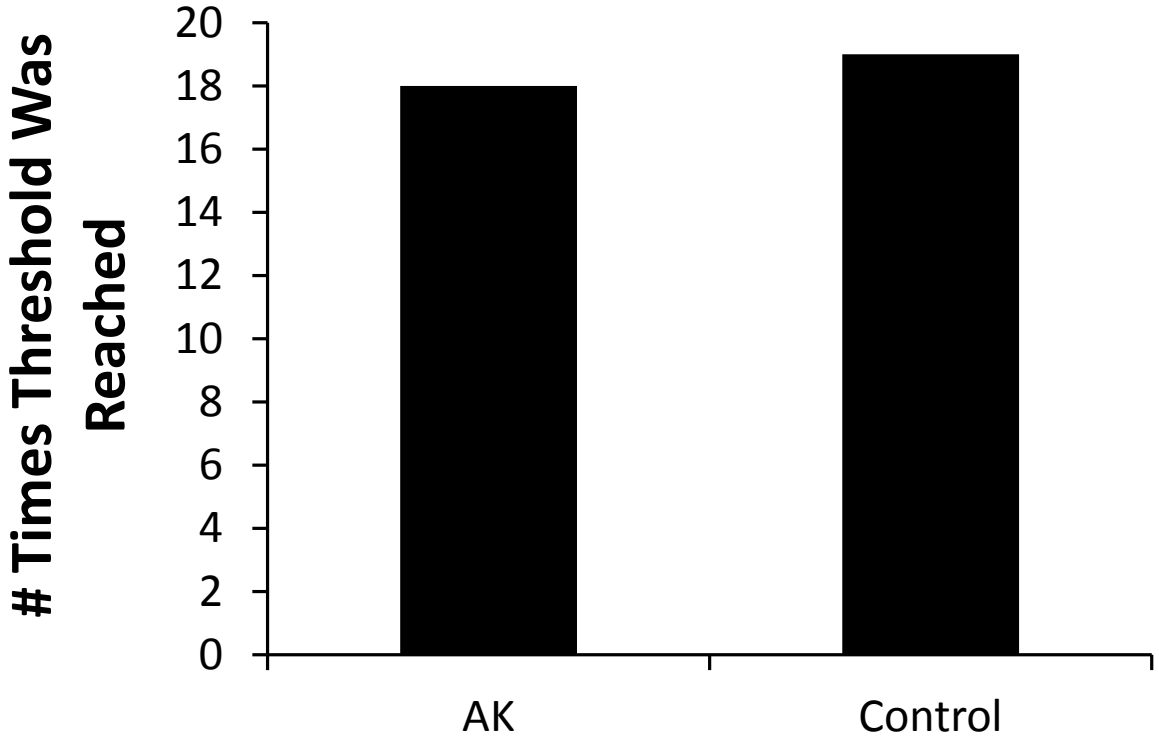
2016 Threshold Summary



Chi-Square

$\chi^2 = 0.027$

df = 1

P = 0.869

2016 Summary

- At harvest, **statistically equivalent frequency and severity of damage** in AK block interior trees compared to grower standard
- Equivalent control in perimeter trees to grower std
- Killing >40 adults per week, per AK tree during late season

Economics Comparisons of Attract-and-Kill

	Attract and Kill	Standard
Mean No. of BMSB Sprays	15	3
Percentage of Trees Sprayed	3-4	100
Percentage of Active Ingredient Applied	20%	100%
Cost of BMSB lures/per A/season	$1500	0
Cost of BMSB Sprays/per A/season	$6-20	$30-100

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Cost of BMSB Sprays/per A/season	$6-20	$30-100

Take Home Messages

- Attract-and-kill is an **effective** pest management strategy
- **But:** not cost effective
- Unless lure price or deployment strategy can be significantly altered, no grower will adopt this

Acknowledgements

- **USDA-ARS, NE SARE**

To learn more about this project and find links to BMSB information, visit

Thank you for your attention!

In the field one morning…