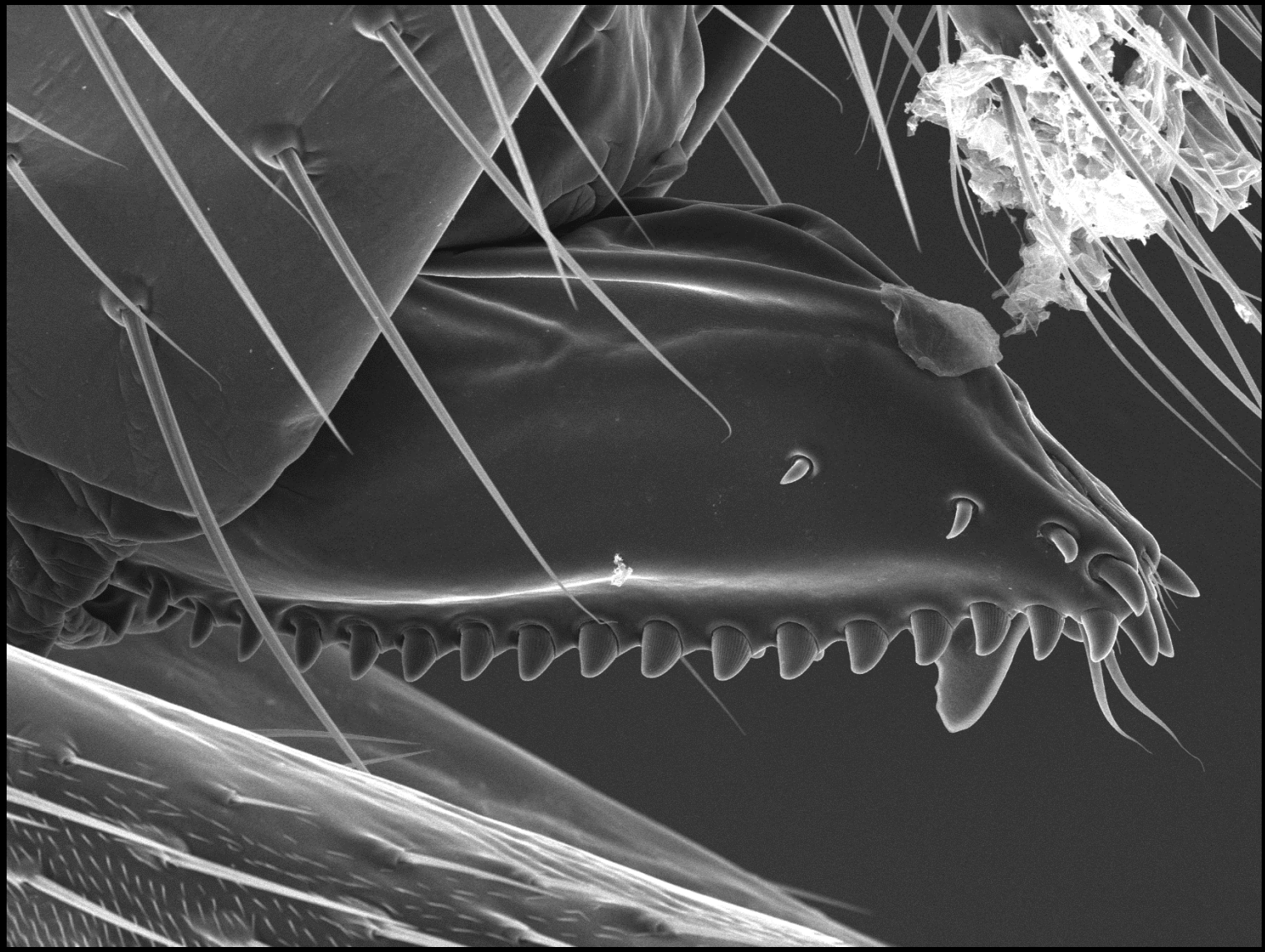
SPOTTED WING DROSOPHILA: Implications and Management in Vineyards

Heather Leach and Rufus Isaacs

Spotted wing Drosophila

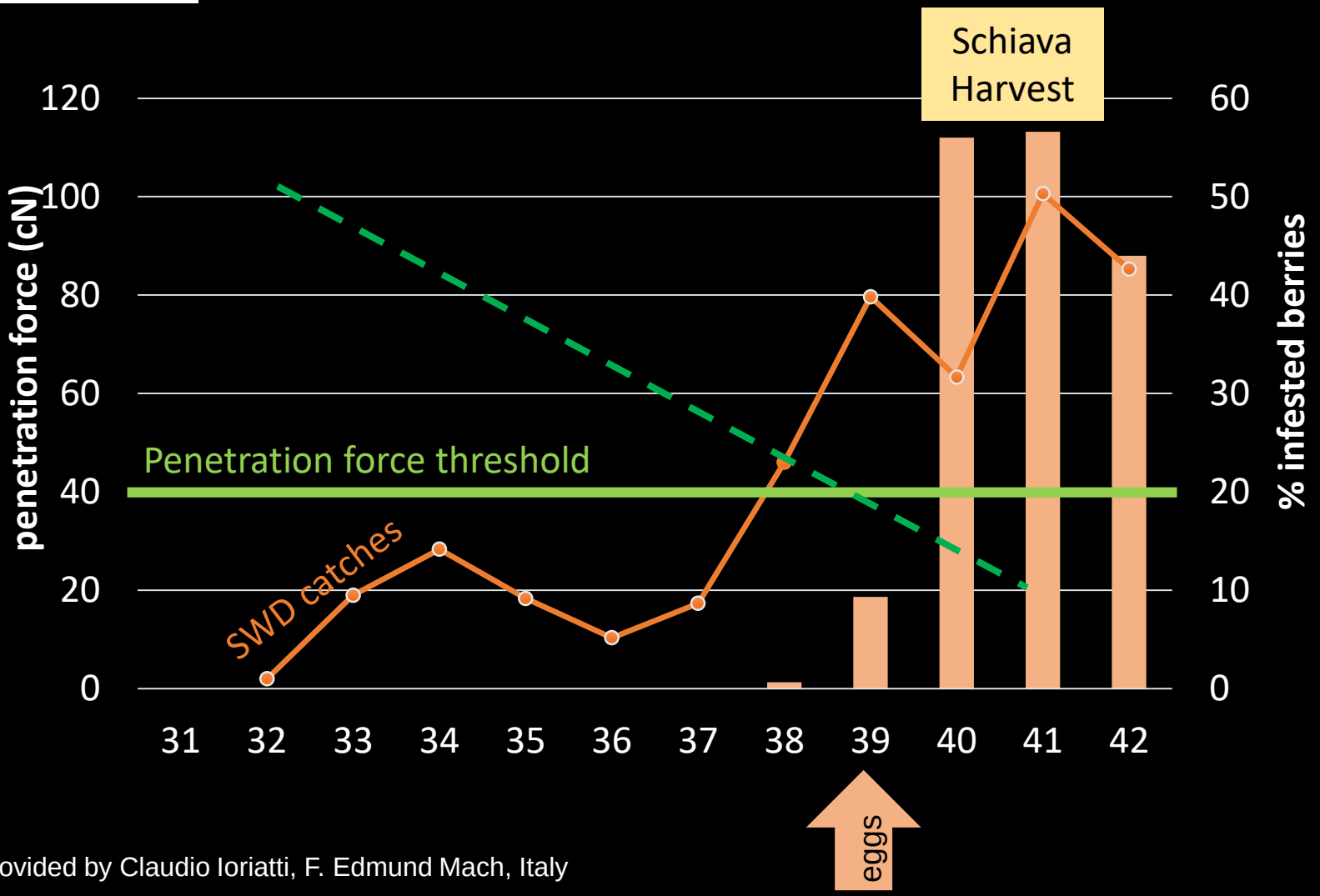
First detected in U.S. in 2008 (California)
Major pest of soft-skinned fruits

Serrated ovipositor



Field observations of SWD infestation

Trento region, Italy

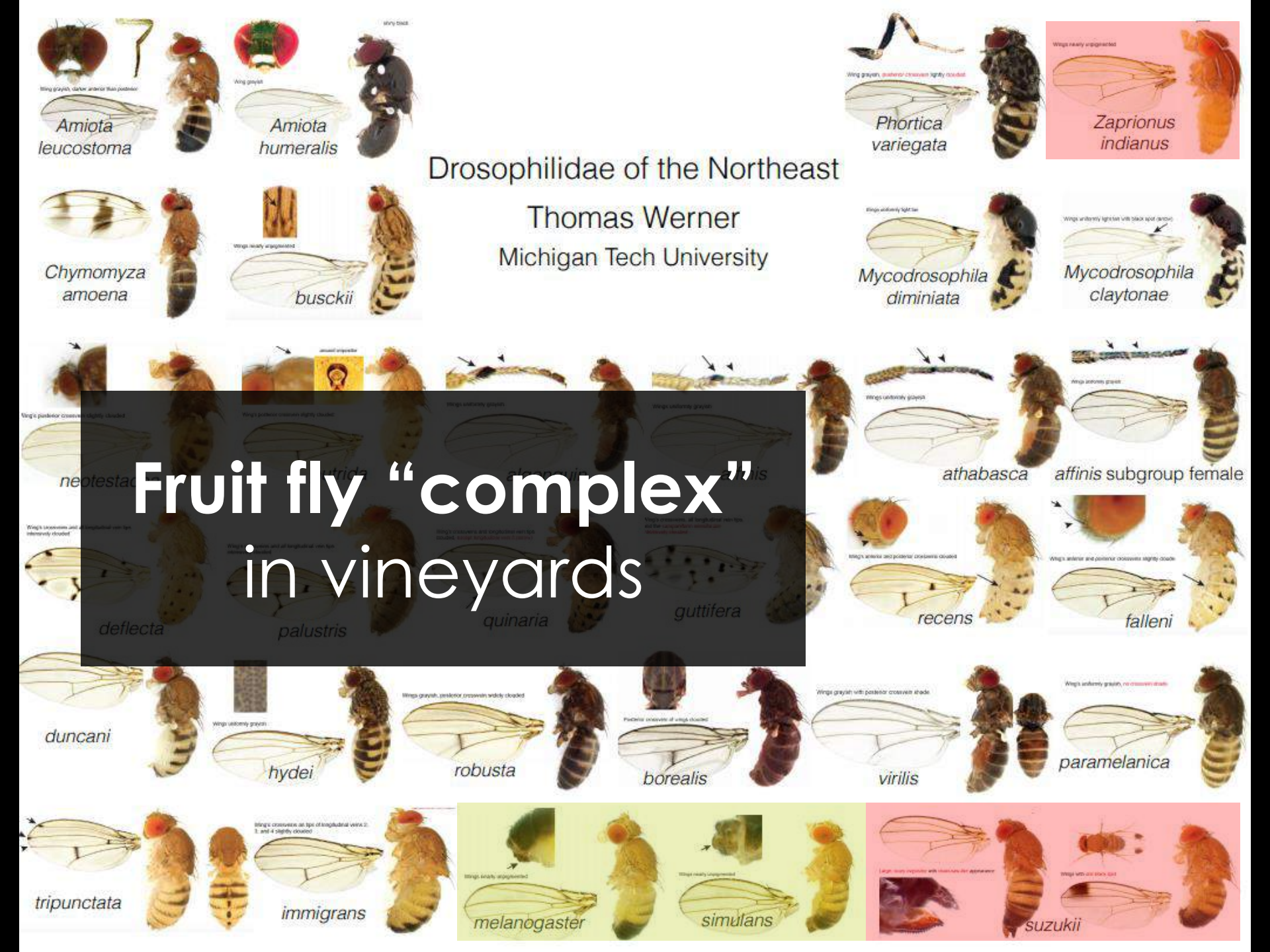


Slide provided by Claudio Ioriatti, F. Edmund Mach, Italy

Variety and penetration force matters!

		Uninjured	Injured
Variety	Penetration force[1] (cN)	*D. suzukii* eggs laid[2]	*D. suzukii* eggs laid[1]
Petit Manseng	16.6 ± 0.3a	0b	3.9 ± 1.8b
Petit Verdot	15.1 ± 0.4b	0b	7.3 ± 1.3ab
Viognier	9.2 ± 0.26c	4.38 ± 1.4a	7.8 ± 1.8ab
Vidal Blanc	16.6 ± 0.3a	0 b	14.5 ± 2.9a
Cabernet Franc	16.4 ± 0.5a	2.07 ± 0.9a	6.2 ± 1.9ab
Pinotage	14.6 ± 0.2b	0.14 ± 0.1b	11.2 ± 2.6ab

Data from Shrader et al. 2018



Fruit fly "complex" in vineyards

Fruit flies become problematic once fruit has been damaged

Fruit flies are most problematic in **thin-skinned** varieties or **injured fruit** (e.g. grape berry moth, yellow jackets, bird/hail damage)

Fruit flies may facilitate and spread sour rot

VA Tech

Wounded grapes

Hail, birds, yellow jackets, grape berry moth, SWD

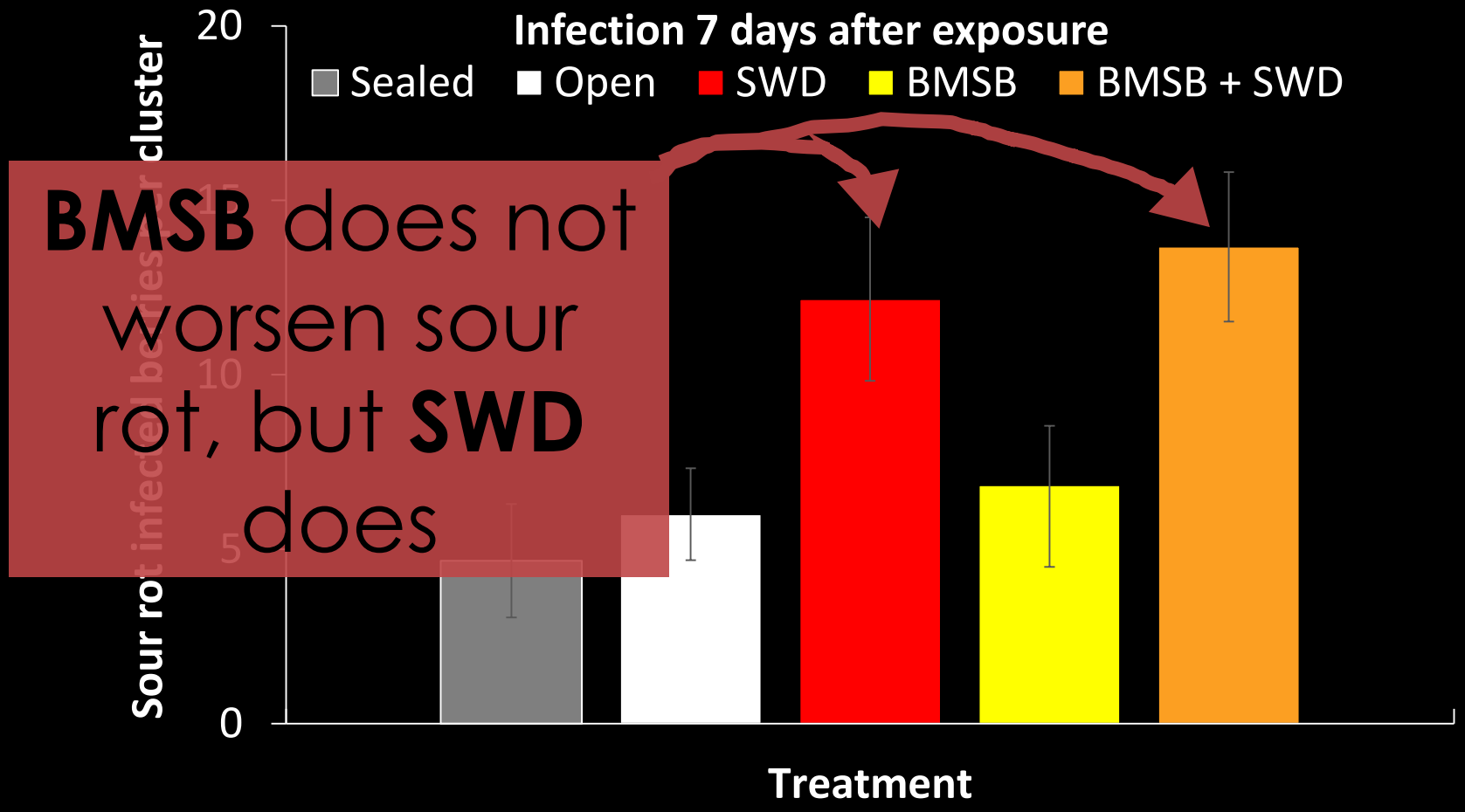
↓

Onset of sour rot

↓

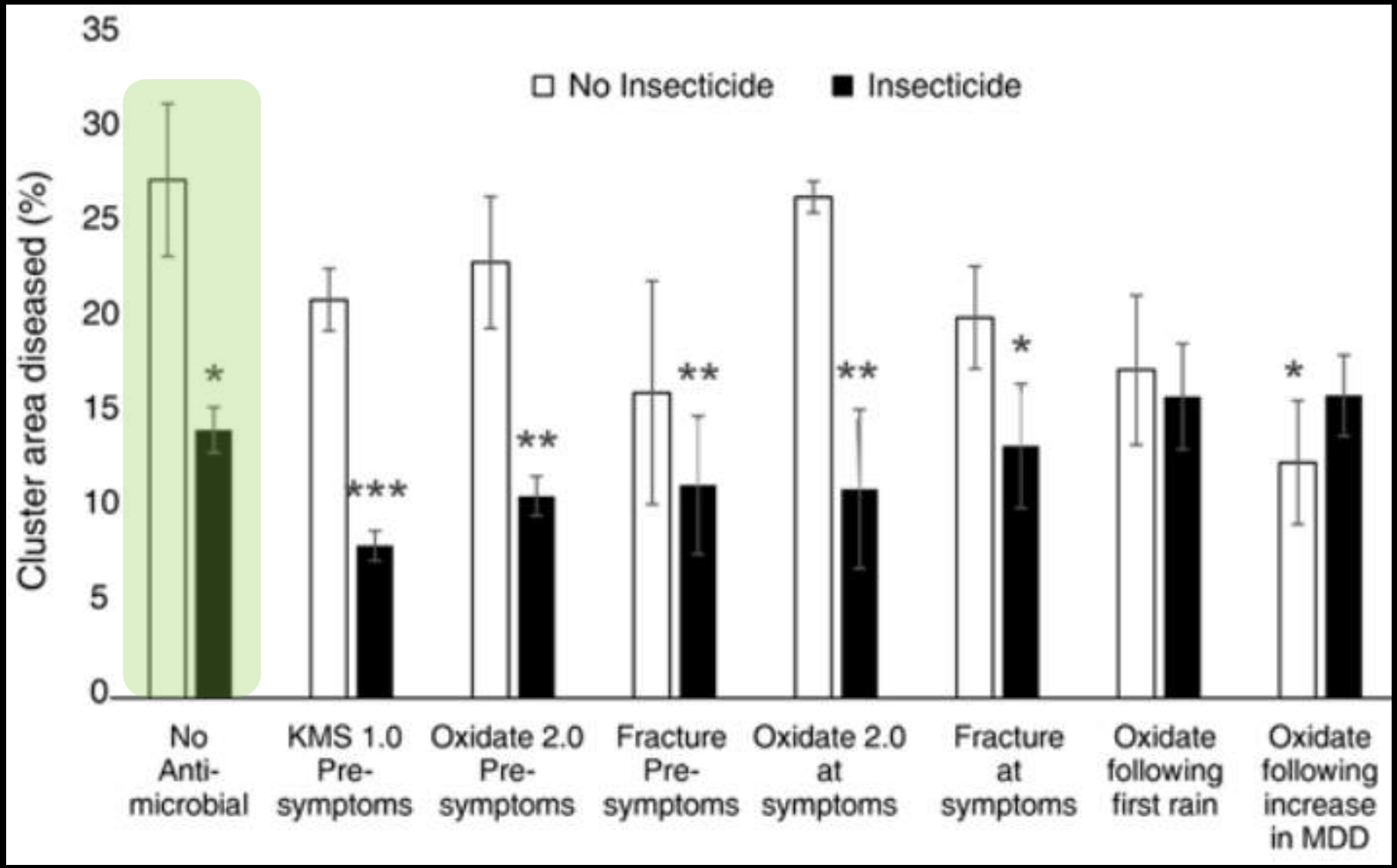
Spread and continuation of sour rot

Do SWD and brown marmorated stink bug make sour rot even worse?



Slide provided by Rufus Isaacs

Insecticides reduce sour rot better than antimicrobials alone



Data from Megan Hall, Cornell University

Short pre-harvest interval (PHI) insecticides for grapes

Trade name	Active ingredient	Chemical class	PHI (days)
Malathion	malathion	organophos.	3
Baythroid XL	cyfluthrin	pyrethroid	3
Mustang Max 0.8 EC	zeta-cypermethrin	pyrethroid	1
Scorpion 35 SL	dinotefuran	neonicotinoid	1
Venom 70 SG	dinotefuran	neonicotinoid	1
Belay 2.13 SC	clothianidin	neonicotinoid	0
Leverage	cyfluthrin+imidaclo.	pyreth+neonic	3
Aza-direct	azadiractin	biological	0
Pyganic	pyrethrum	pyrethrum	0.5
Evergreen	pyrethrum+PBO	pyrethrum	0.5

Remember the label is the law!
…and check with your processor/winemaker

Slide provided by Rufus Isaacs

Insecticide efficacy against vinegar flies

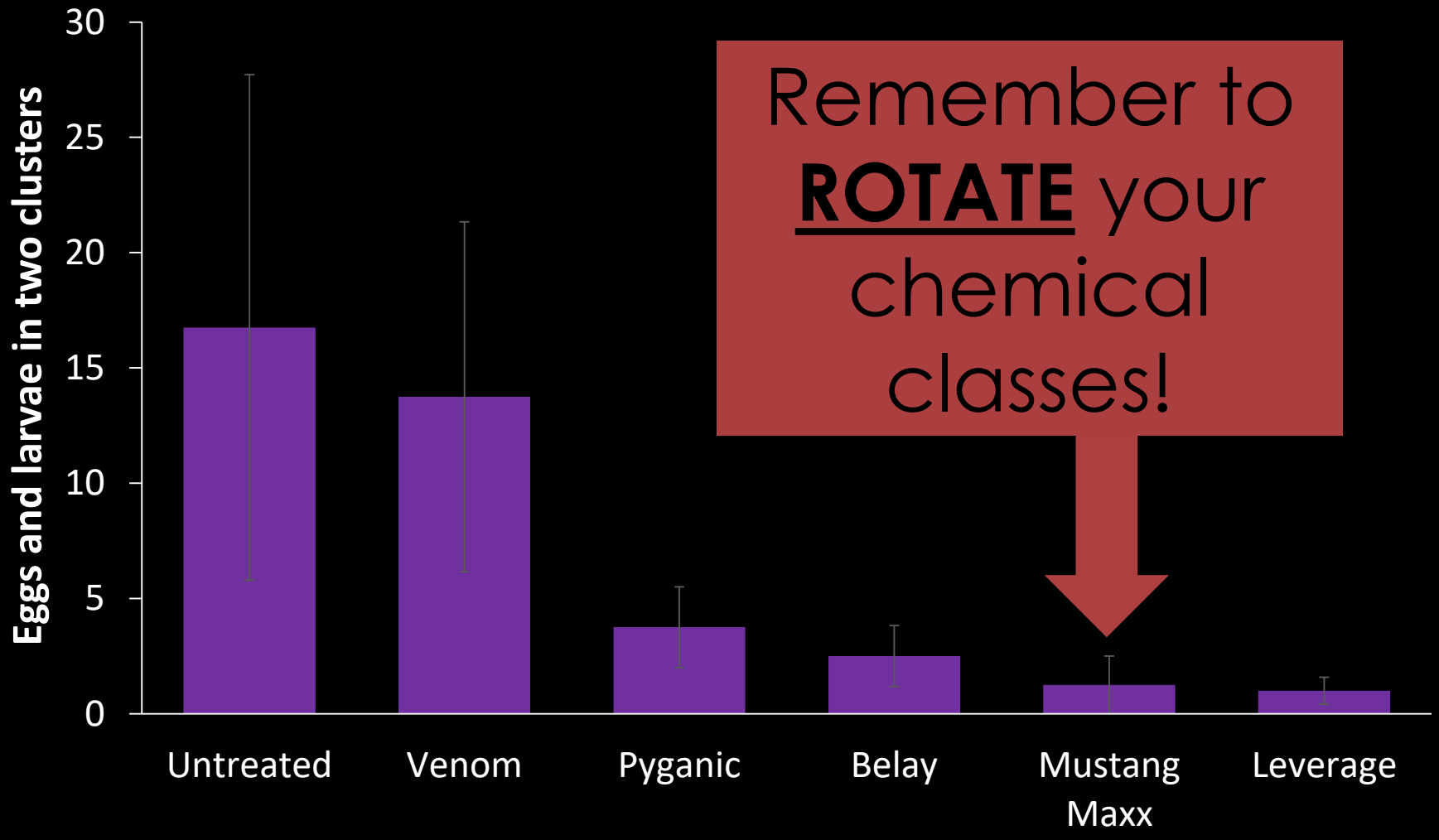
Insecticides applied between veraison and harvest (4 applications)

Treatments

- **Untreated**
- **Mustang Maxx (4 oz)**
- **Leverage (3.2 oz)**
- **Venom (3 oz)**
- **Belay (4 oz)**
- **Pyganic (32 oz)**
- **Delegate (5 oz) + Mustang Maxx (4 oz)**

Clusters collected at harvest

Drosophila at harvest



Slide provided by Rufus Isaacs

Can biological control help?

Classical biological control being evaluated, pending release with USDA

Kent Daane

Five naturally occurring parasitoids found in U.S.

Leptopilina boulardi **[L]**

Leptopilina heterotoma **[L]**

Asobara tabida **[L]**

Pachycrepoideus vindemiae **[P]**

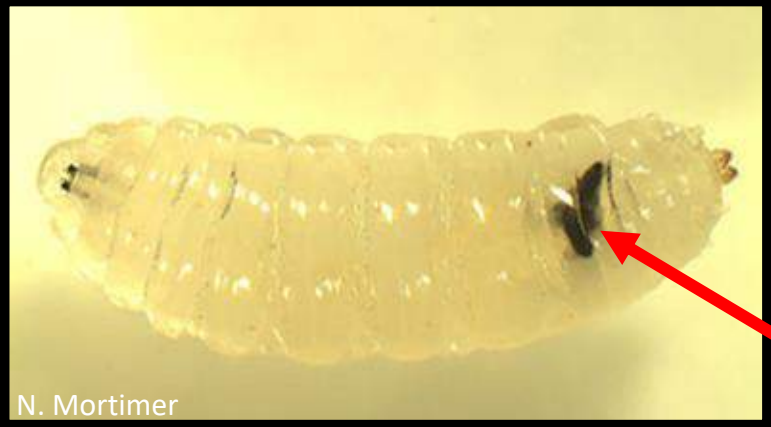
Trichopria drosophilae **[P]**

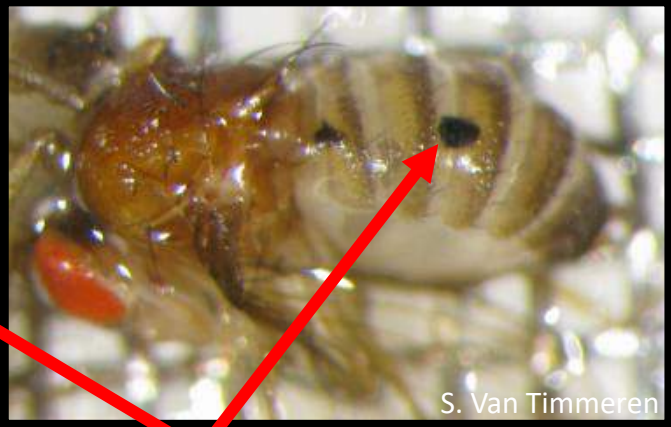
[L] = Larval parasitoid
[P] = Pupal parasitoid

SWD parasitism rates in field

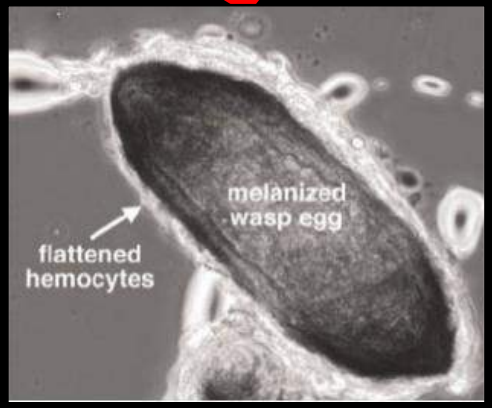
<2%

Encapsulation: resistance to parasitism


N. Mortimer


S. Van Timmeren

SWD is highly resistant to parasitism



From Balint & Schlenke 2012

P. vindemiae attacking SWD pupae

Provided by C. Bezerra and V. Walton, Oregon State University

Footage by Briana Price (speed 2x faster)

Naturally occurring parasitoids across the U.S.

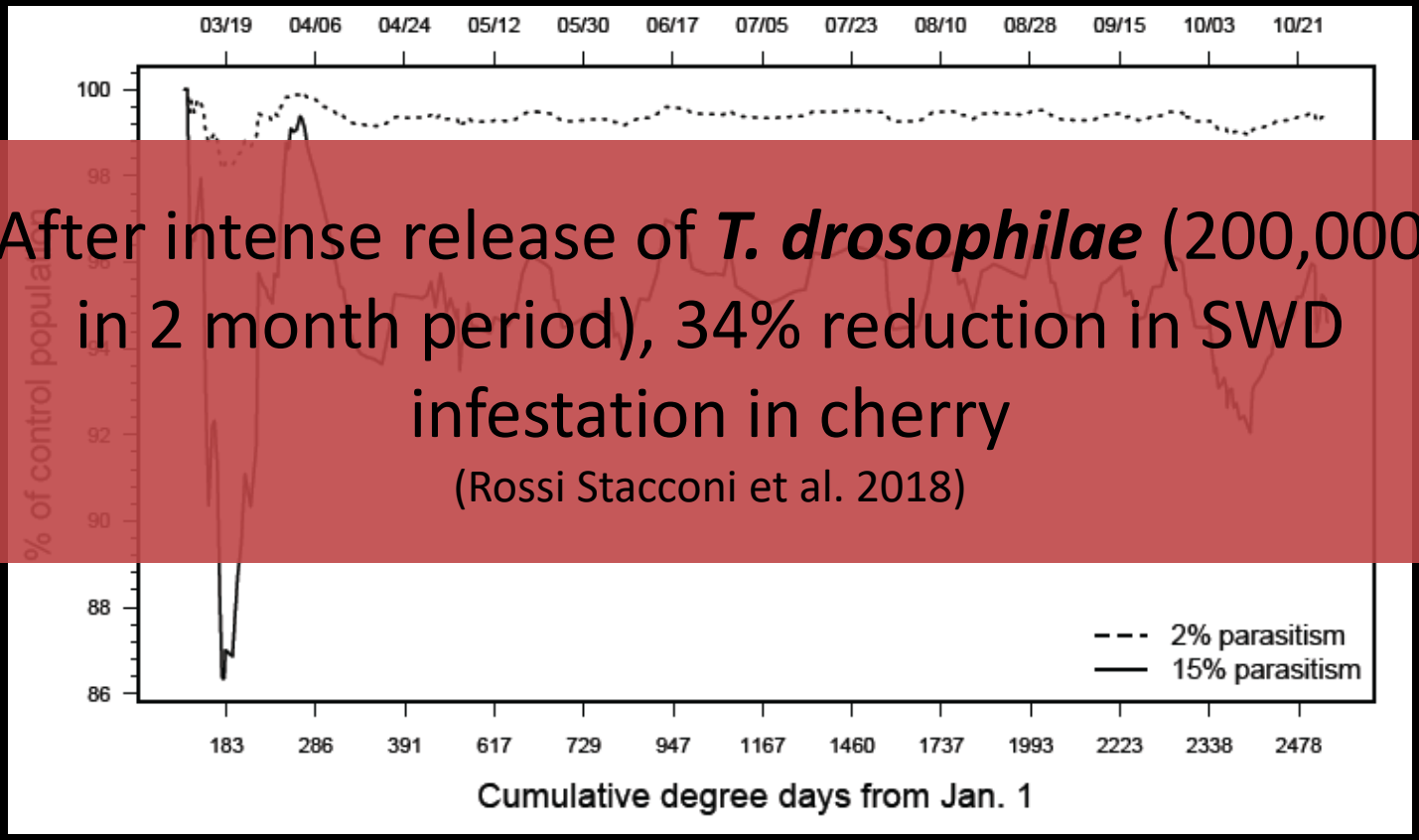
Larval Parasitoids [L]	
Leptopilina heterotoma	CA
Leptopilina boulardi	CA, VA, NC
Asobara tabida	MI, NY

Pupal Parasitoids [P]	
Pachycrepoideus vindemiae	CA, VA, MI, NC, OR, NY
Trichopria drosophilae	CA, NC

Best candidate endemic parasitoids are *P. vindemiae* and *T. drosophilae*

P. vindemiae has a greater known distribution

Low parasitism rate has minimal influence on SWD population



After intense release of ***T. drosophilae*** (200,000 in 2 month period), 34% reduction in SWD infestation in cherry

(Rossi Stacconi et al. 2018)

Wiman NG, Dalton DT, Anfora G, Biondi A, Chiu JC, Daane KM, Gerdeman B, Gottardello A, Hamby KA, Isaacs R, Grassi A. 2016. *Drosophila suzukii* population response to environment and management strategies. J Pest Sci. 89(3):653-65.

Summary

SWD is a **complex** of fruit flies in vineyards

Fruit flies can mediate and spread sour rot – **managing fruit flies may reduce sour rot**

Fruit flies are highly likely to develop resistance – **rotate your chemical classes!**

SPOTTED LANTERNFLY:

detection and management in vineyards

Heather Leach, Ashley Leach, Michela Centinari, David Biddinger, Greg Krawczyk, Andrew Harner, Lauren Briggs, Liz Deecher, Julie Urban

Penn State Entomology

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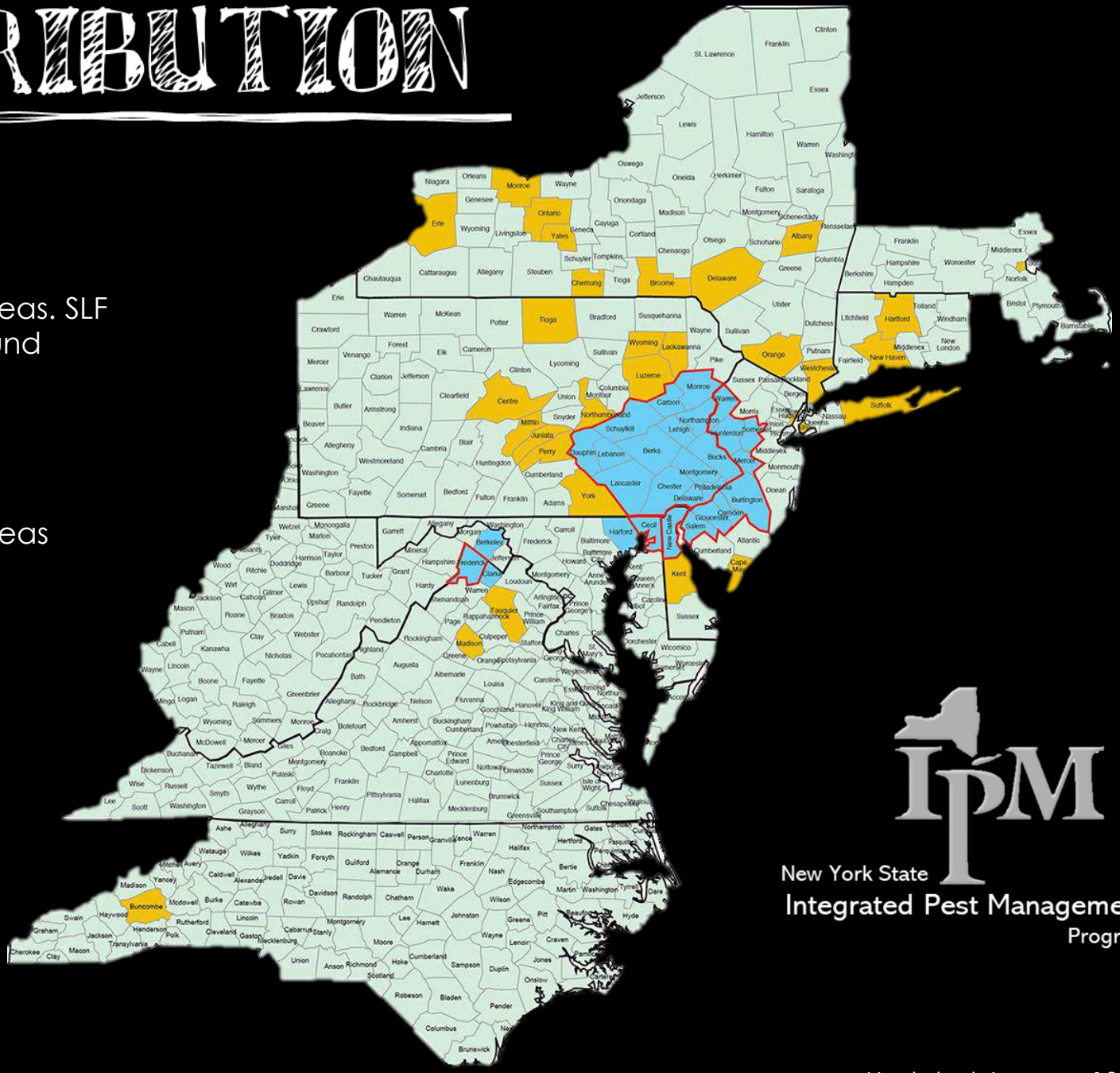
DISTRIBUTION

- NY external quarantine areas. SLF infestation found
- SLF found, no infestation
- Internal state quarantine areas



New York State
Integrated Pest Management
Program

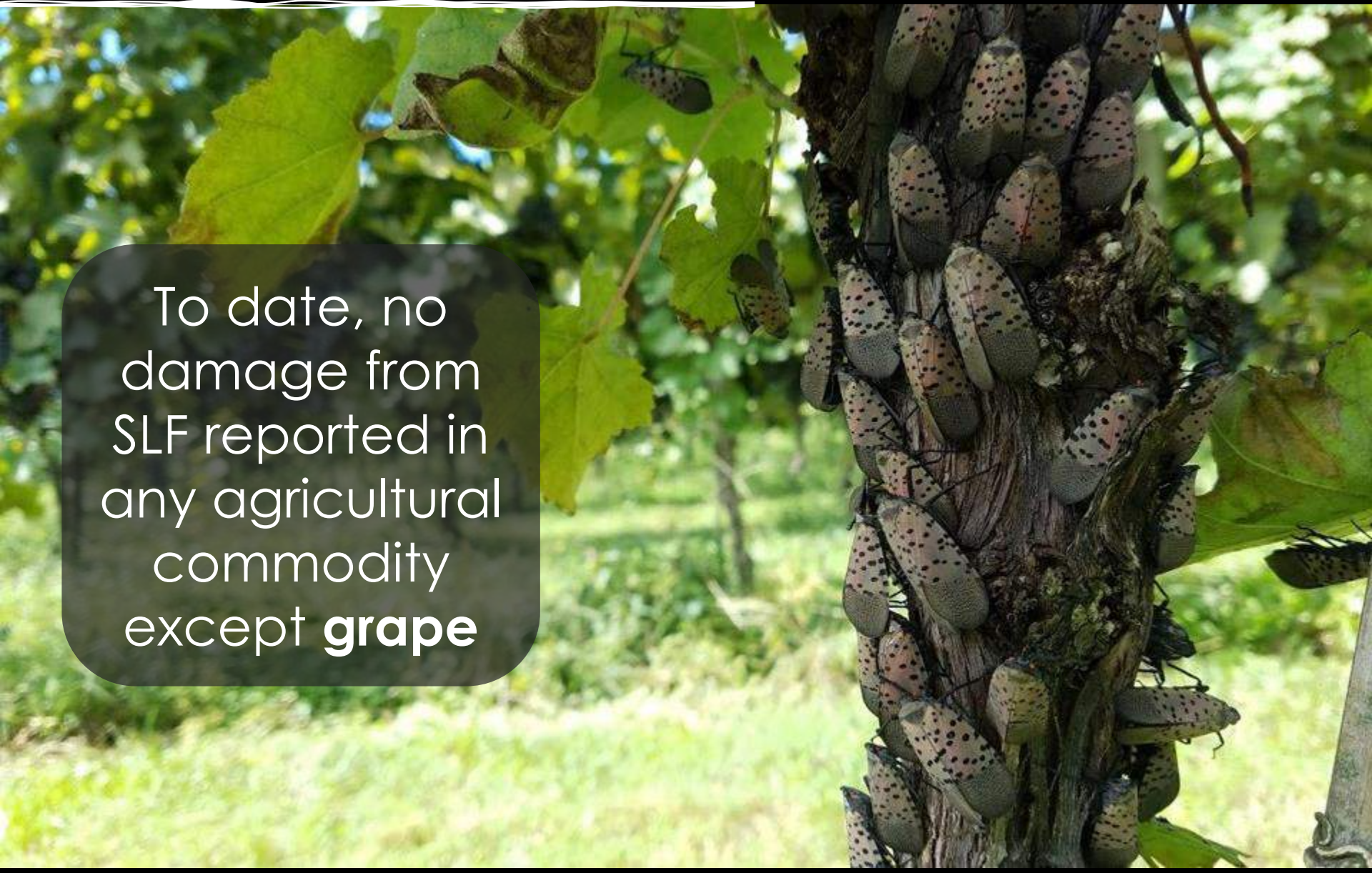
PennState

Updated January 10, 2020

SLF in tree fruit

SLF in hops

SLF in vineyards



To date, no damage from SLF reported in any agricultural commodity except **grape**

Honeydew & sooty mold

SLF egg masses

SLF egg masses

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SLF egg masses

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SLF egg masses


Brandon Zimmerman


Jenny Armstrong Powell


Zil Fessler


Lori LaCava Beatrice


Liz Willow

SLF vineyard pressure

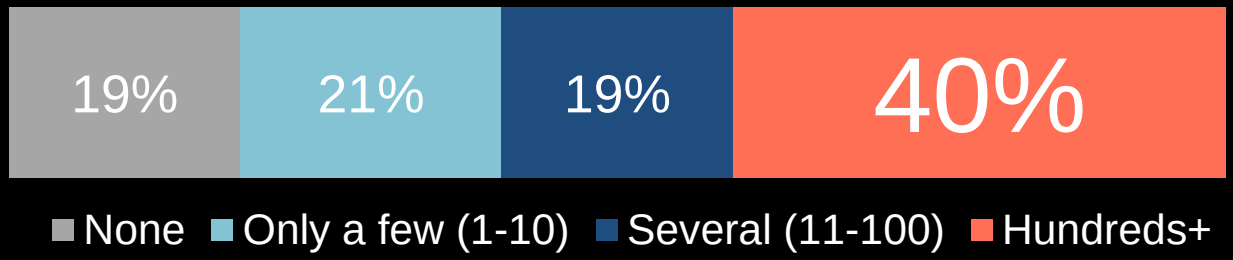
SLF vineyard pressure

SLF vineyard pressure

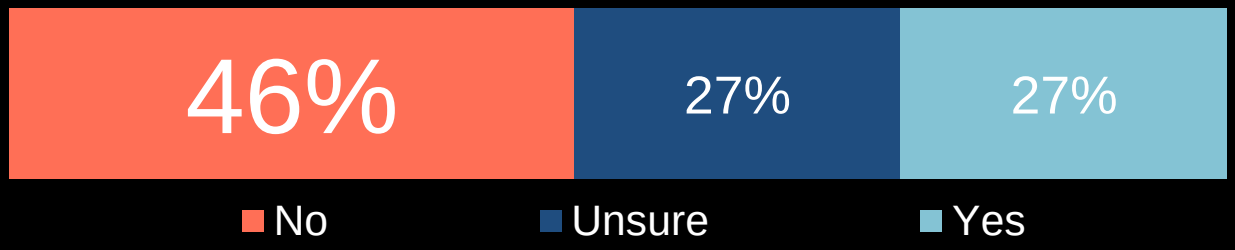
SLF vineyard pressure

Grower impact survey

How many SLF do you have in your vineyard?



Have your vines been **damaged** by SLF?



N = 42
Mean acreage = 9.9 (Range 0.5-50)
Total acreage = 415

Feeding damage is difficult to evaluate!


Rich Blair

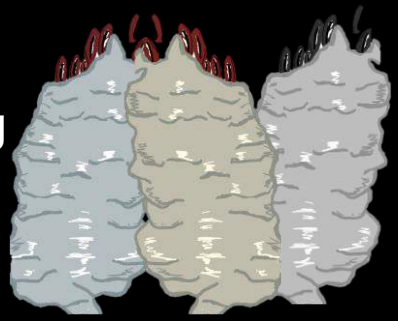
Feeding damage is difficult to evaluate!

Grower options

Spray **insecticides**

Remove **tree-of-heaven** and/or use as a trap tree

Remove **egg masses** in winter



Remove **tall trees** surrounding vineyard

Postpone planting new vines until we have a better solution

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SLF damage to vines

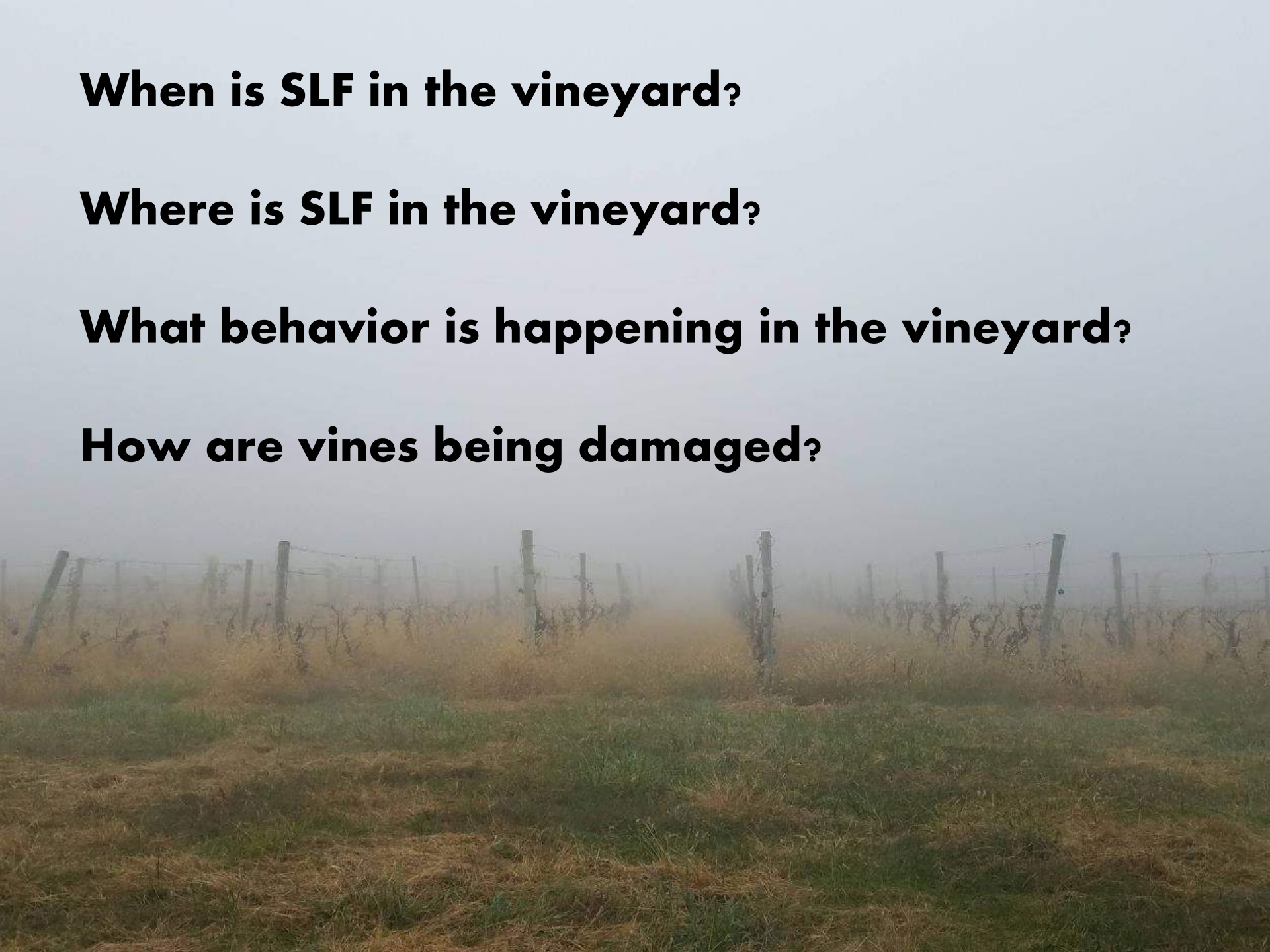
Vineyards reporting yield losses and vine death from SLF

>80% of growers managing for SLF with 30% reporting damage (n=48)

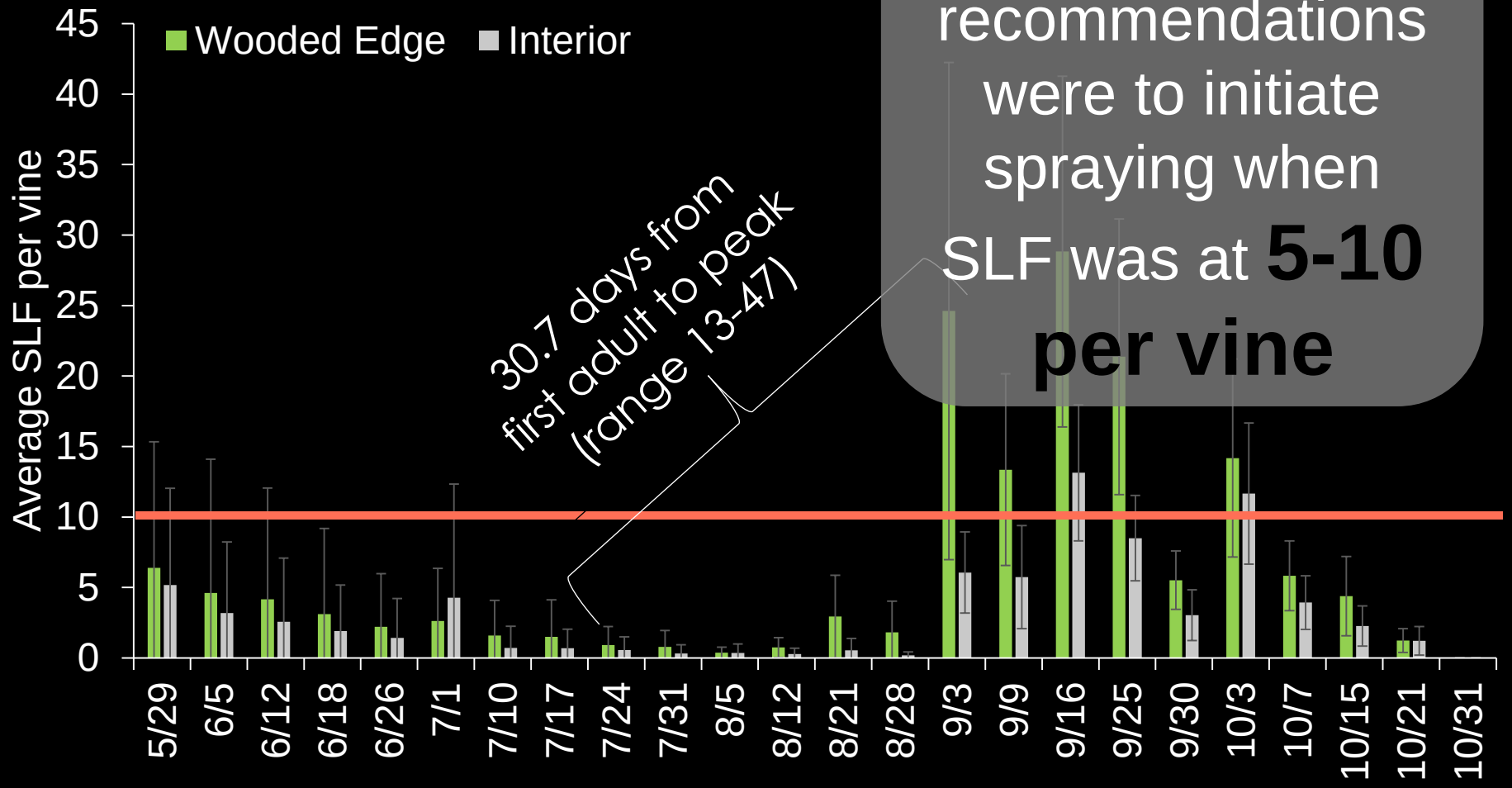
Average number of insecticide applications went from 4 to 14 in response to SLF in just two years (2016 to 2018)

Average insecticide costs per acre went from $54 to $147

H. Leach


When is SLF in the vineyard?
Where is SLF in the vineyard?
What behavior is happening in the vineyard?
How are vines being damaged?

SLF phenology



South Korean recommendations were to initiate spraying when SLF was at **5-10 per vine**

2018 & 2019 data from 9 SE PA vineyards

Leach and Leach, unpublished

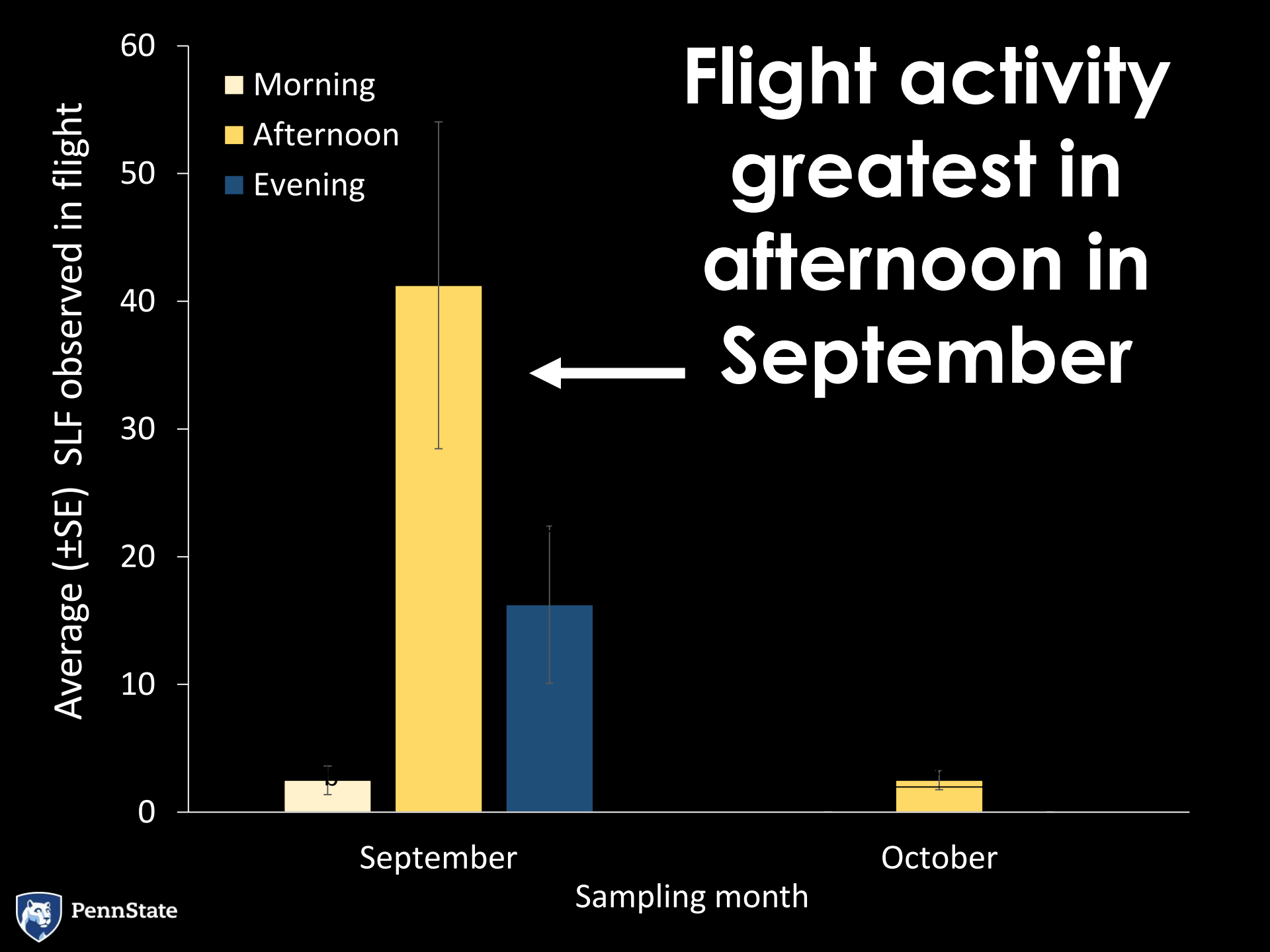

25
51
199
306
595

When is SLF active?

Morning

Afternoon

Evening


Flight activity greatest in afternoon in September
Morning
Afternoon
Evening
Average (±SE) SLF observed in flight
60
50
40
30
20
10
0
September
October
Sampling month
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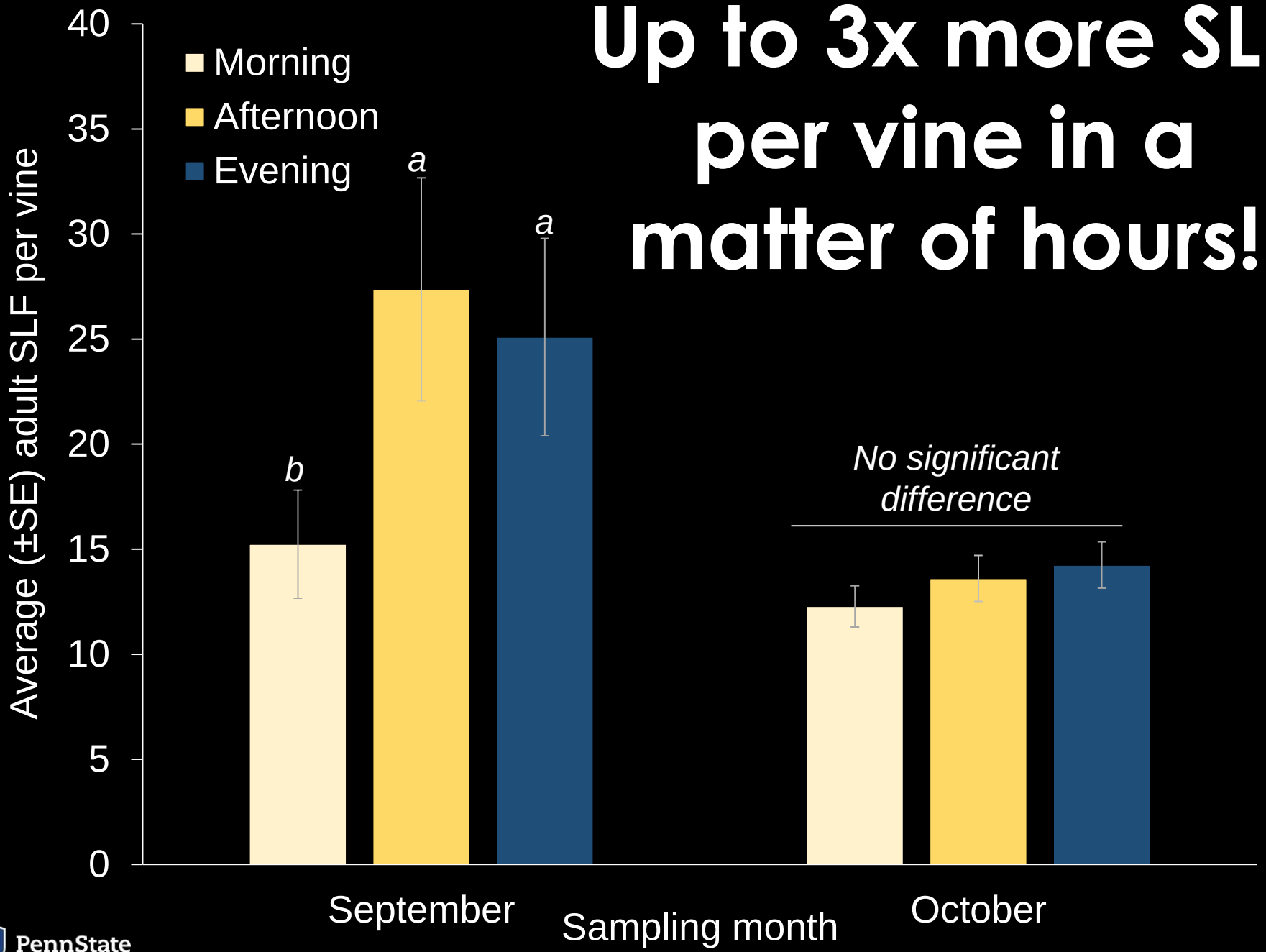
Up to 3x more SLF per vine in a matter of hours!



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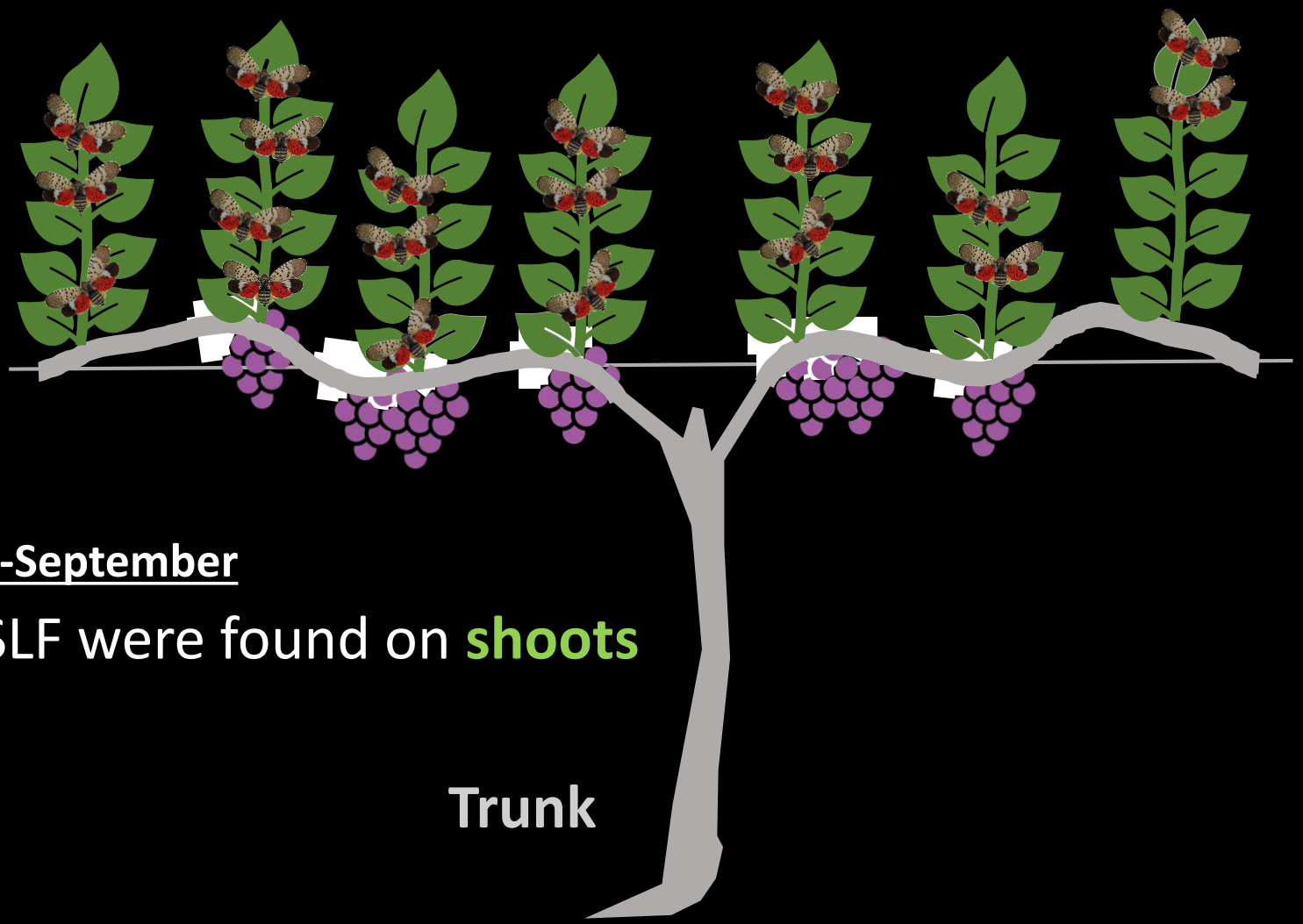
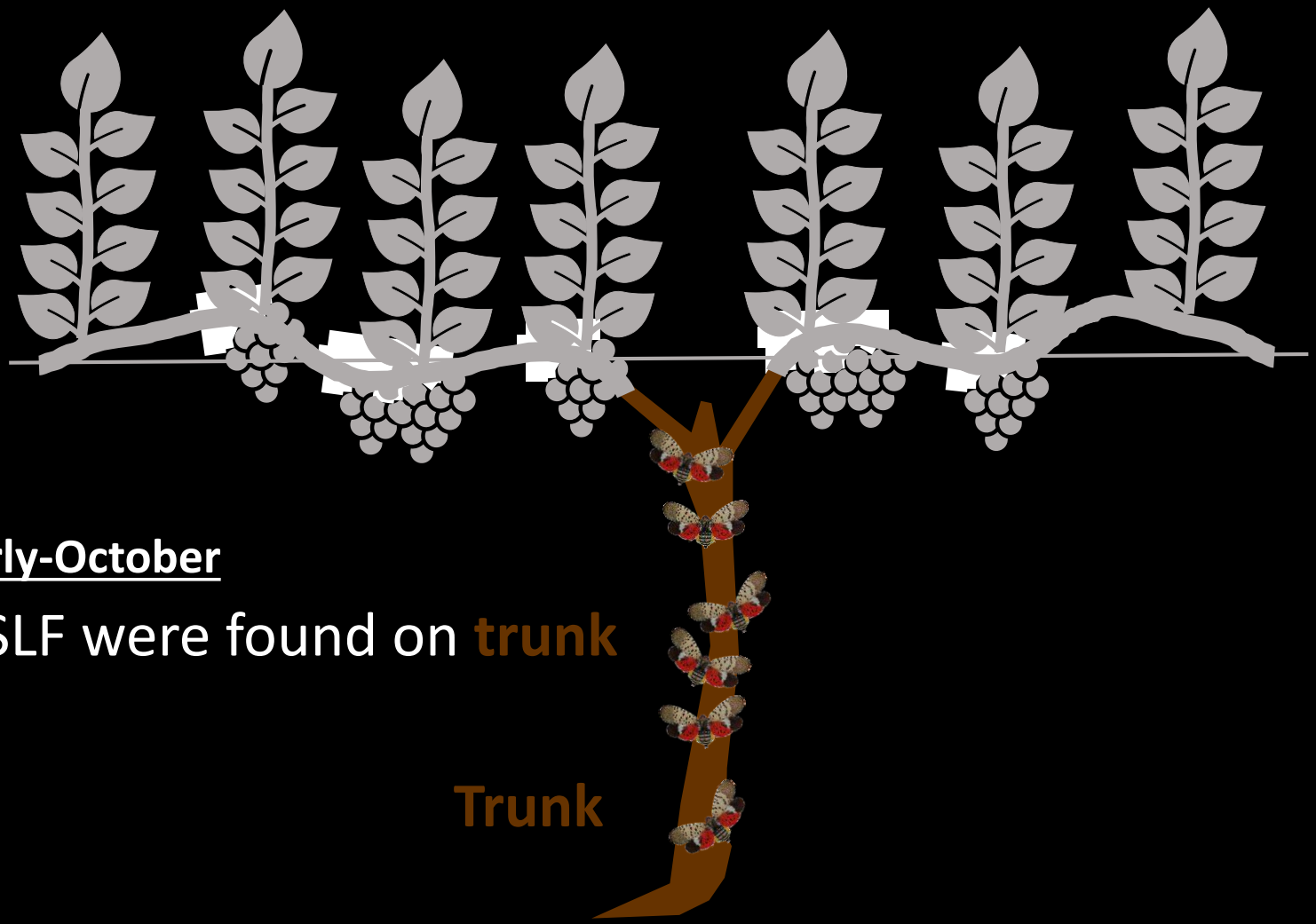


Mid-September

49% of SLF were found on **shoots**

Leach and Leach, in prep. Slide provided by A. Leach



Early-October

71% of SLF were found on **trunk**

Leach and Leach, in prep. Slide provided by A. Leach

How does SLF feeding affect grapevine physiology?

Michela Centinari, Andrew Harner, Heather Leach, Lauren Briggs, Julie Urban

How does SLF feeding affect grapevine physiology?

How do different levels of SLF feeding affect:

Carbon assimilation and photosynthetic efficiency of leaves

Accumulation of **carbohydrates and nutrients** in fruit and storage (trunk, stem, roots) tissues

Bud freeze tolerance (cold hardiness)

Evaluating the Impacts of Spotted Lanternfly on Grapevine Health to Develop More Targeted Control Approaches (2019)
(Centinari, Urban, Leach, Eissenstat)

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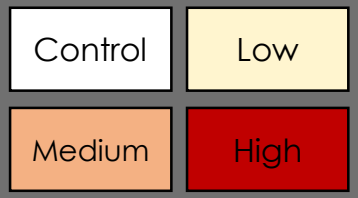
pennsylvania
DEPARTMENT OF AGRICULTURE

How does SLF feeding affect grapevine physiology?

4 density treatments on 16 mature vines (cv. ‘Riesling’)

Control = (0 SLF/shoot = **0 per vine**)
Low (4 SLF/shoot = **41 per vine**)
Medium (8 SLF/shoot = **98 per vine**)
High (12 SLF/shoot = **200 per vine**)



x 6 feeding cycles

Plants were exposed to a total of six 4-day feeding cycles

Trials began on August 26 and ended on October 18

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When is SLF in the vineyard?

SLF populations peak in **mid-late September**

When is SLF in the vineyard?

SLF populations peak in mid-late September

Where is SLF in the vineyard?

SLF populations are highest near the **wooded edge**, first feeding on the shoots followed by the trunks

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SLF populations are highest near the wooded edge, first feeding on the shoots followed by the trunks

What behavior is happening in the vineyard?

SLF are mostly inactive in the morning, but feed heavily in the afternoon and evening

SLF flight activity is highest in the afternoon, and populations may increase on the vine throughout the day

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SLF flight activity is highest in the afternoon, and populations may increase on the vine throughout the day

How are vines being damaged?

High levels of SLF feeding reduce photosynthesis, transpiration, brix values, and cold hardiness


MANAGEMENT

Phenology in Korean vineyards

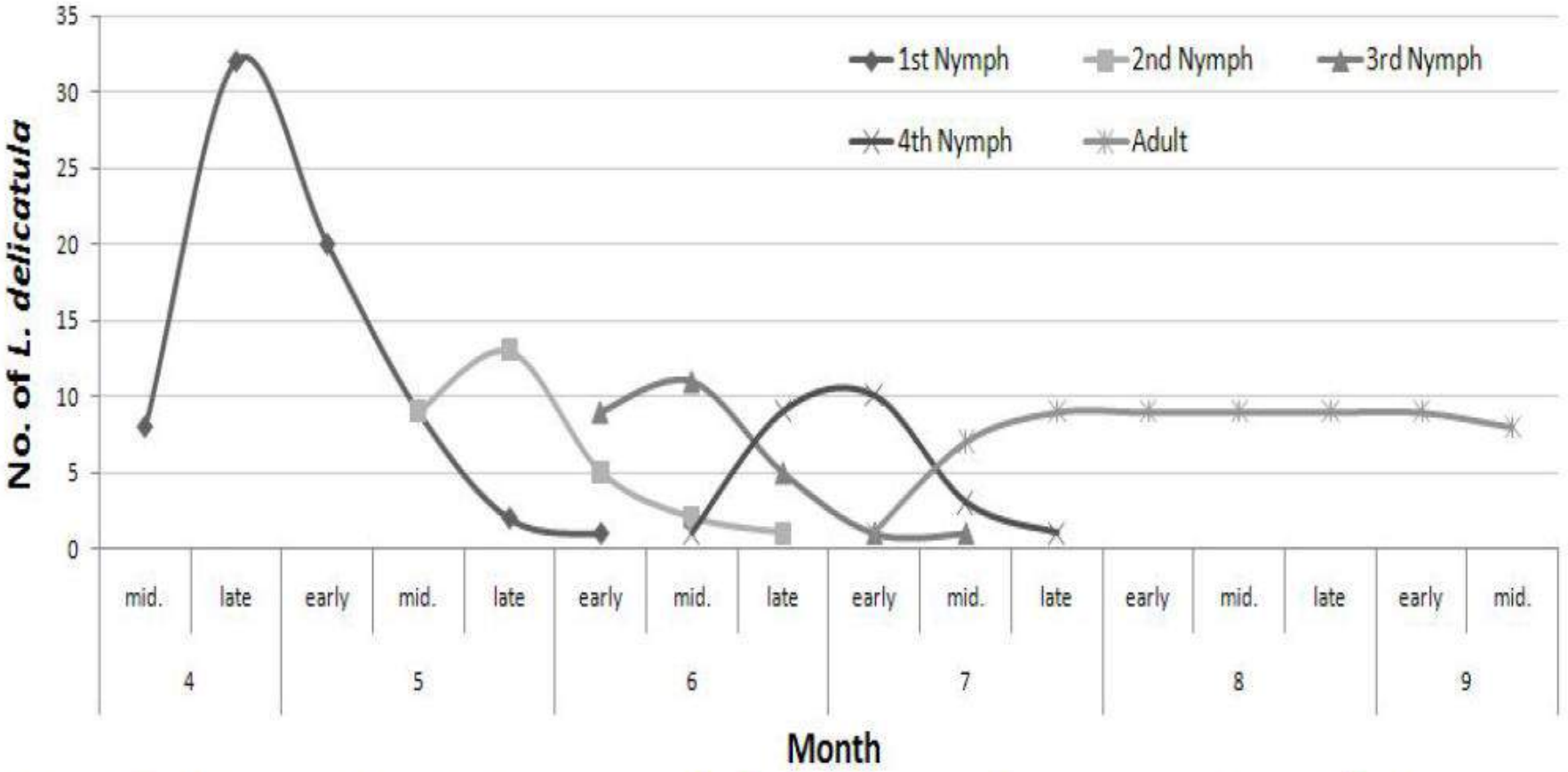

Fig. 3. Life cycle of *Lycorma delicatula* at the vineyard in Okchoen of Chungbuk 2008~2009. A, Occurrence of *L. delicatula*; B, Number of *L. delicatula*

Song 2010

Phenology in Korean vineyards

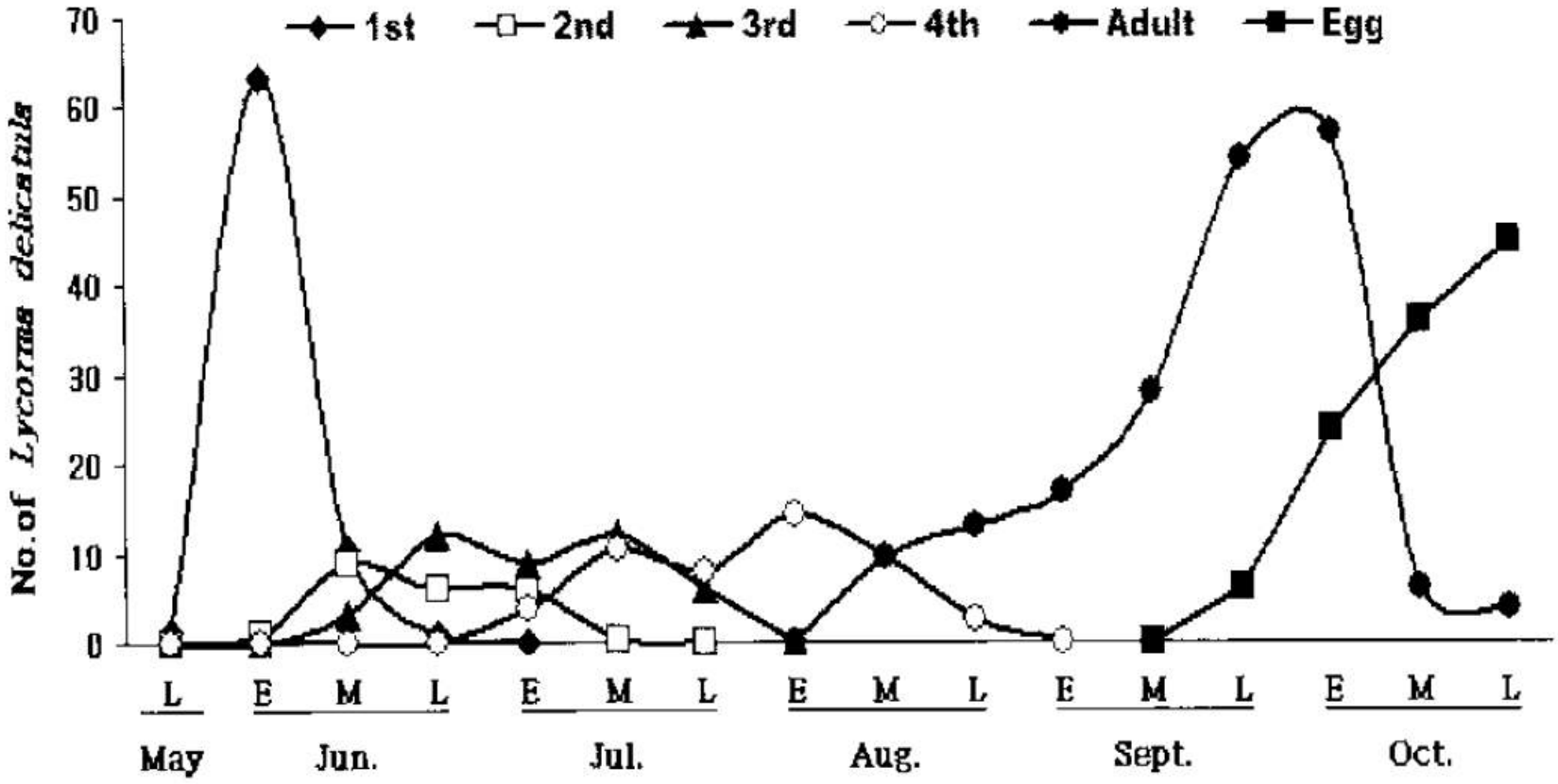

Fig. 1. Seasonal occurrence of *Lycorma delicatula* at the vineyards in Okcheon, Chungbuk province.

Lee et al. 2011

observed in Jincheon-Gun and Okcheon-Gun (Table 3). When nymphs are observed in nearby forests, it seems that imagoes will fly into vineyards to lay eggs. Because Lycorma Delicatula completes one life cycle during a year, the amount of chemical control for Lycorma Delicatula in vineyards can be reduced by chemically controlling the nymphs in the area around the vineyard. This phenomenon was observed in area that Lycorma Delicatula was spreading but there weren't Lycorma Delicatula's eggs in the vineyard. However, this does not protect against nymphs in the future, as imagoes will still fly into the vineyard and lay eggs, even when nymphs are chemically controlled in the vineyard. Therefore, a physical barrier to keep imagoes from flying into vineyard is also required.

Song 2010, M.S. Thesis, Chung-buk National University Graduate School

SLF insecticide trials

Nymph & adult assays in 2018 & 2019

Potted plants sprayed with insecticides, 10 replicates per compound

SLF introduced to sprayed plants using mesh cages

SLF mortality was measured 48 hrs after 0, 7, and 14 DAT

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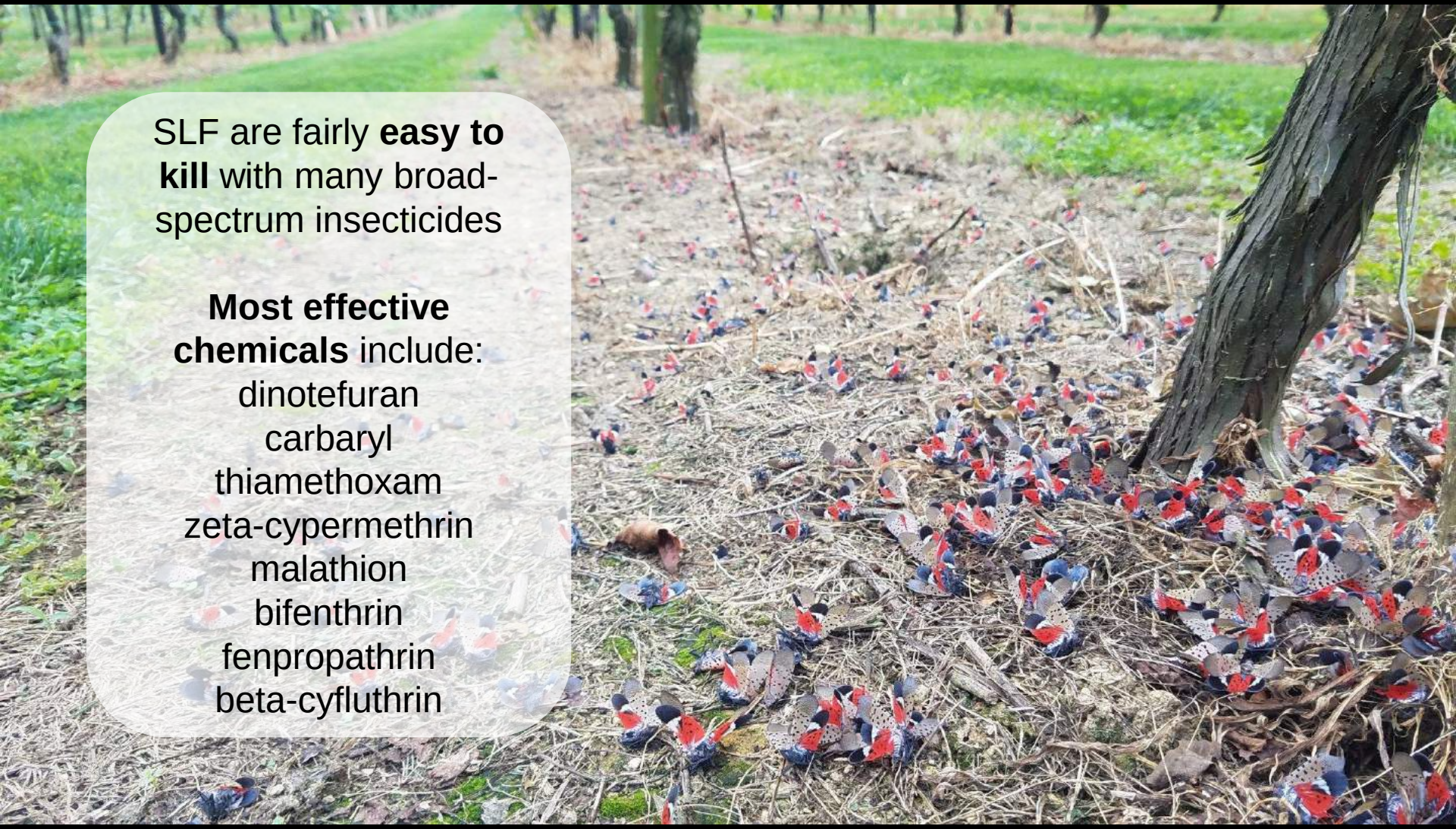
SLF insecticide trials

Most commonly used

Trade Name	Active Ingredient	Control Method	PHI (days)	REI (hours)	Labeled for SLF on Grape in PA?	Life Stage Tested	Longevity	SLF Activity
Brigade 10WSB	bifenthrin	C, I	30	12	Yes, 2(ee)	Nymphs, adults	****	++++
Actara 25WDG	thiamethoxam	S, C, I	5	12	Yes, 2(ee)	Nymphs, adults	****	++++
Scorpion 35SL	dinotefuran	S, C, I	1	12	Yes, 2(ee)	Nymphs, adults	***	++++
Carbaryl 4L	carbaryl	C, I	7	12	No Note: Sevin XLR has 2(ee)	Nymphs, adults	***	++++
Danitol 2.4EC	fenpropathrin	C, I	21	24	No	Nymphs	**	++++
Malathion 8F	malathion	C, I	3	12	Yes, 2(ee)	Nymphs, adults	**	++++
Mustang Maxx 0.8EC	zeta-cypermethrin	C, I	1	12	Yes, 2(ee)	Nymphs, adults	**	+++
Avaunt 30DG	indoxacarb	C, I	7	12	Yes, 2(ee)	Nymphs, adults	*	++
Imidan 70WP	phosmet	C, I	14	336	Yes, 2(ee)	Nymphs, adults	*	++ for nymphs; 0 for adults
Assail 30SG	acetamiprid	S, C, I	3	48	Yes, 2(ee) on nymphs only	Nymphs, adults	*	+
JMS Stylet Oil	Paraffinic oil	C	14	4	No	Egg masses	Unknown	++
Lorsban Advanced	chlorpyrifos	C	35	24	No	Egg masses	Unknown	++++

Leach et al. 2019, Crop Protection

SLF insecticide trials



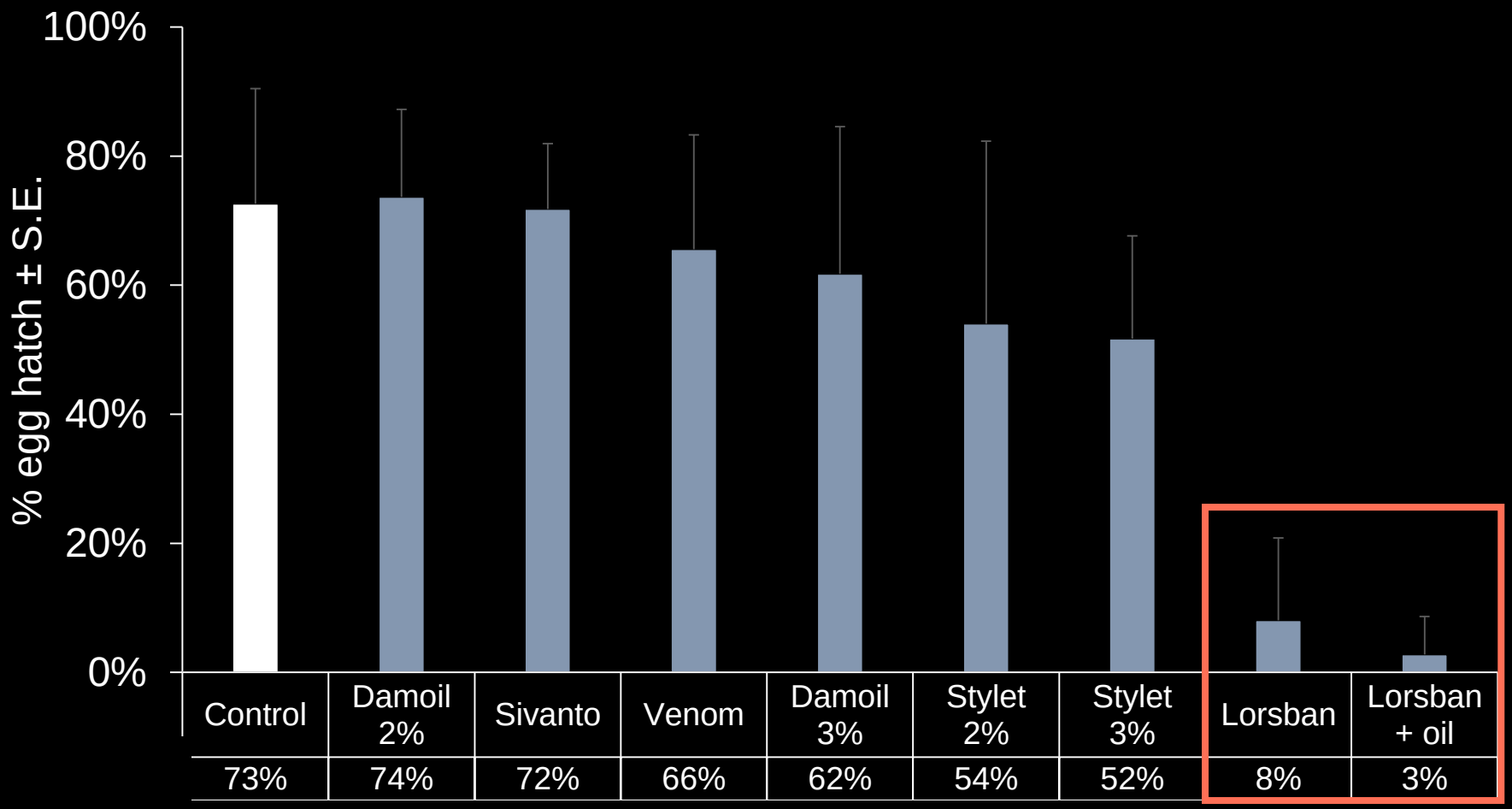
SLF are fairly **easy to kill** with many broad-spectrum insecticides

Most effective chemicals include:

dinotefuran
carbaryl
thiamethoxam
zeta-cypermethrin
malathion
bifenthrin
fenpropathrin
beta-cyfluthrin

SLF ovicide trials

Spring 2019



Control	Damoil 2%	Sivanto	Venom	Damoil 3%	Stylet 2%	Stylet 3%	Lorsban	Lorsban + oil
73%	74%	72%	66%	62%	54%	52%	8%	3%

Data provided by Greg Krawczyk, Penn State

Biological control

Generalist predators are attacking SLF at low levels

Photos by H. Leach

Biological control

Fungal pathogens

Two fungal pathogens in PA found attacking SLF

In 2018, ***Batkoa major*** found attacking SLF in one location with >80% mortality

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Fungal pathogens

Two fungal pathogens in PA found attacking SLF

In 2015, ***Beauveria bassiana*** found attacking SLF in multiple locations and at low levels


H. Leach

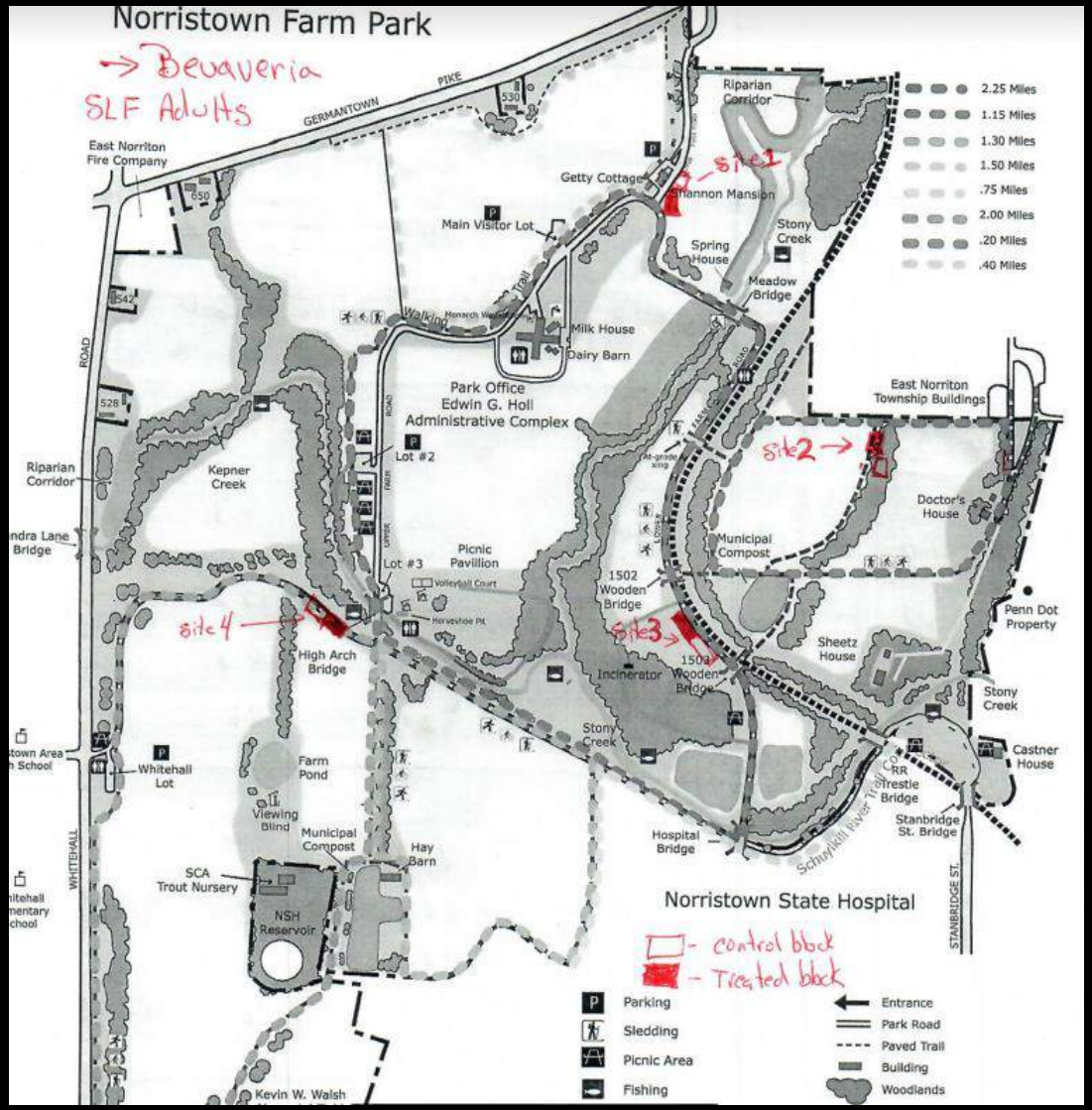
PennState

Use of *Beauveria*

Applications of *B. bassiana* (BoteGHA) were made in woodlots with high SLF pressure in **early July and mid-August**

July applications reduced nymph populations by **46%**

August application did not offer significant control



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Foreign exploration

Map courtesy of Kim Hoelmer & Juli Gould

Egg masses and nymphs collected beginning in 2015

Two parasitoid species found: ***Anastatus orientalis*** and ***Dryinus stantoni***

Both are currently in **U.S. quarantine facility**

USDA SCRI CAPS grant

$7.3 million over 4 years to 10 institutions

To quantify the insect's impact on at-risk specialty crops and **immediately develop management tactics** to reduce the damage in areas where spotted lanternfly is established.

To perform essential fundamental research on the pest's basic biology, ecology and behavior, and to develop biological control tactics contributing to **long-term sustainable solutions**.

To **deliver management solutions** to specialty-crop stakeholders and the public through the extension networks of the partnering land-grant universities, USDA agencies and the Northeastern IPM Center.

Penn State (PI: Julie Urban)

USDA-ARS

USDA-APHIS

Cornell University

Northeast IPM Center

Rutgers

Virginia Tech

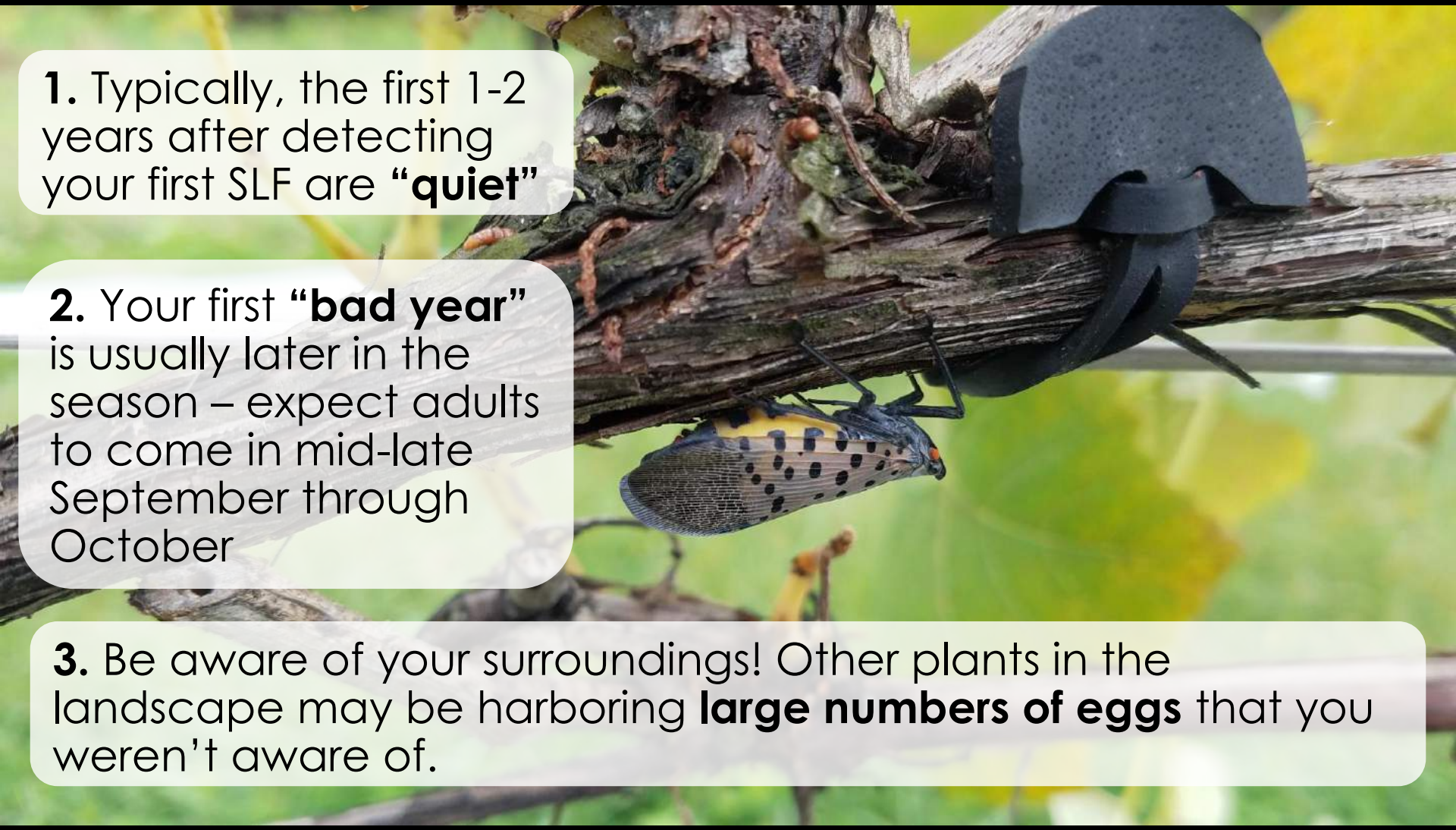
University of Delaware

Temple University

University of Rhode Island

PennState

If you've just seen one/a few…



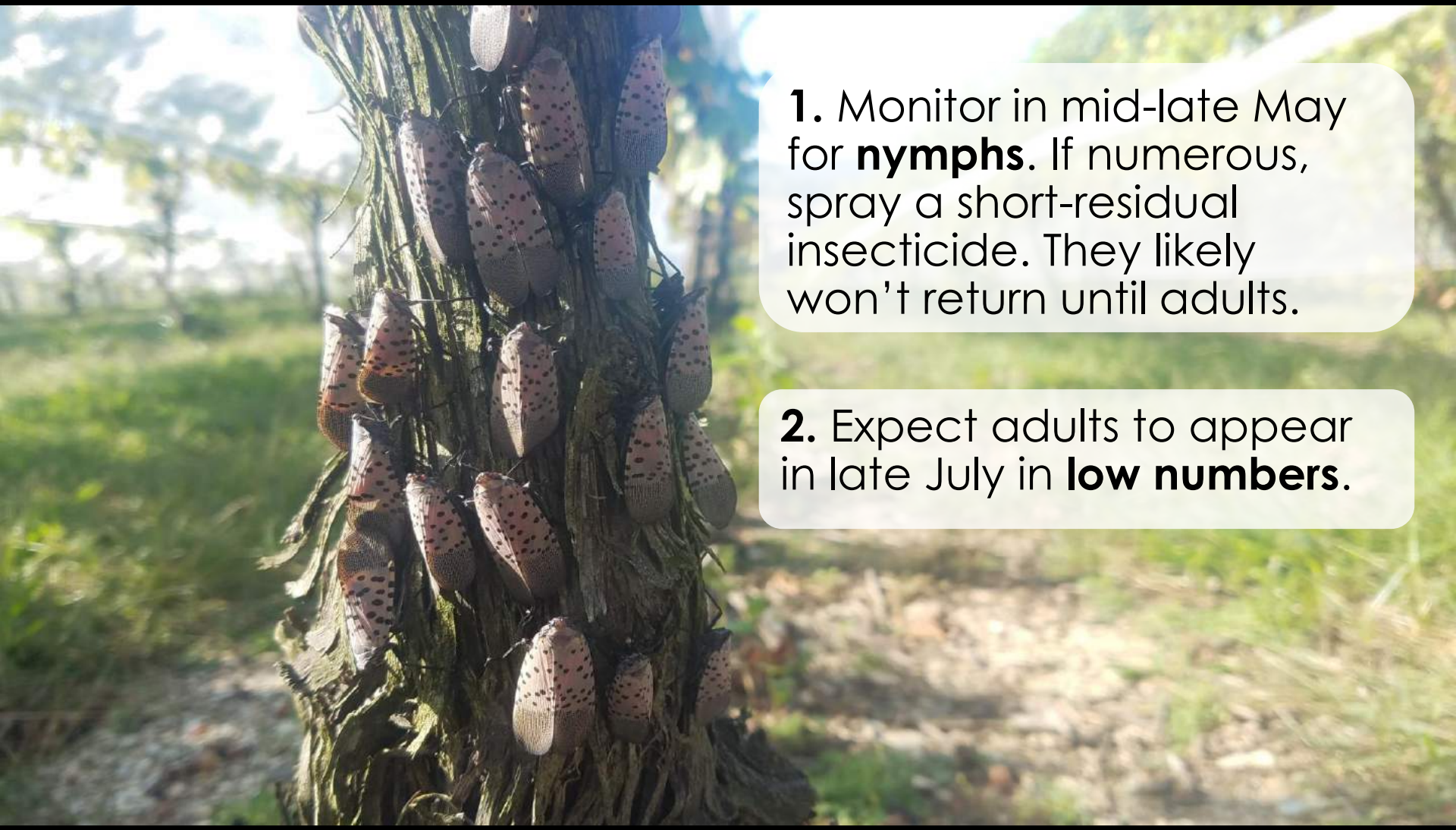
1. Typically, the first 1-2 years after detecting your first SLF are **"quiet"**

2. Your first **"bad year"** is usually later in the season – expect adults to come in mid-late September through October

3. Be aware of your surroundings! Other plants in the landscape may be harboring **large numbers of eggs** that you weren't aware of.

H. Leach

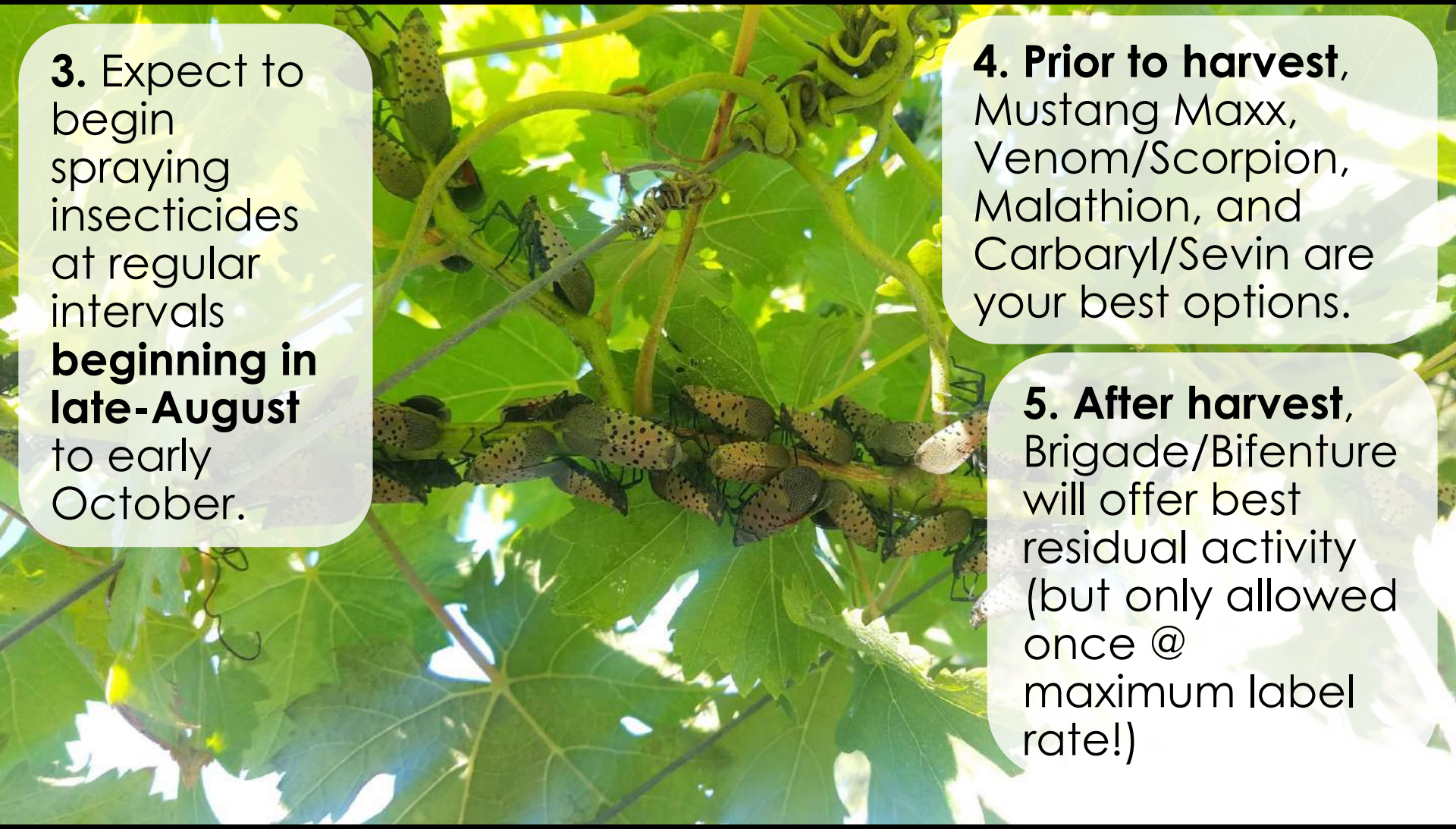
If you're inundated…



1. Monitor in mid-late May for **nymphs**. If numerous, spray a short-residual insecticide. They likely won't return until adults.

2. Expect adults to appear in late July in **low numbers**.

If you're inundated…

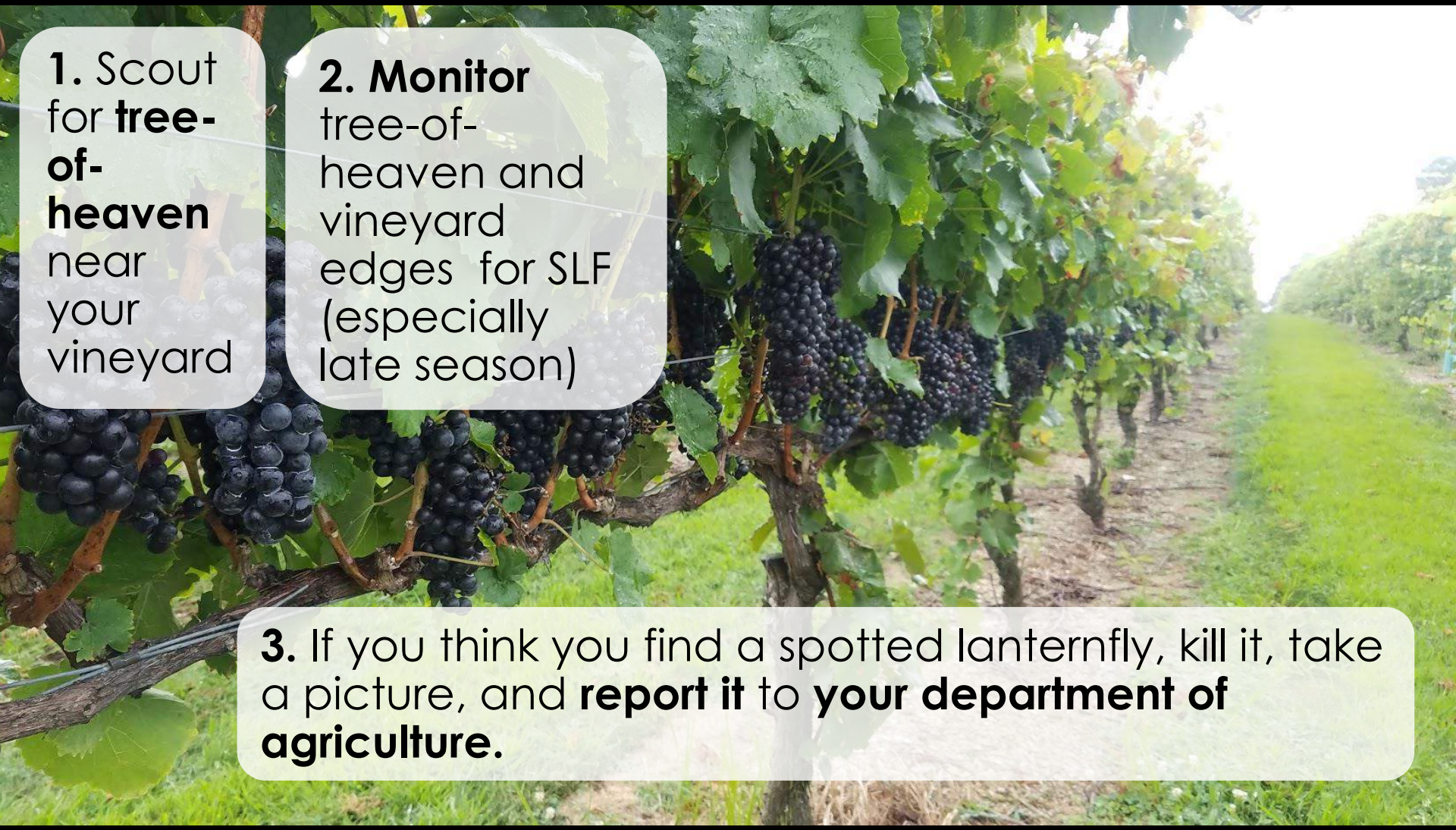


3. Expect to begin spraying insecticides at regular intervals **beginning in late-August** to early October.

4. Prior to harvest, Mustang Maxx, Venom/Scorpion, Malathion, and Carbaryl/Sevin are your best options.

5. After harvest, Brigade/Bifenture will offer best residual activity (but only allowed once @ maximum label rate!)

If you don't yet have SLF...



1. Scout for **tree-of-heaven** near your vineyard

2. Monitor tree-of-heaven and vineyard edges for SLF (especially late season)

3. If you think you find a spotted lanternfly, kill it, take a picture, and **report it** to **your department of agriculture.**


THANK
YOU!
Vynecrest Winery
Folino Estate
Bergeist Vineyards
Setter Ridge Vineyards
Domaine Pterion
Manatawny Creek Winery
Maple Springs Winery
Calvin Beekman
Martin Kubek
Stony Run Winery
PennState
USDA
pennsylvania
DEPARTMENT OF AGRICULTURE