

What we know and don't know about the Allium leafminer's threat to the U.S. Allium industry

Session V: Joint IARS - NARC- NOA Session

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Brian Nault¹, Shelby Fleischer², Timothy Elkner³, Ethan Grundberg⁴, Teresa Rusinek⁵, Riley Harding¹ and Brandon Lingbeek²

¹Cornell Univ., Geneva, NY, ²Penn State Univ., Univ. Park, PA, ³Penn State Univ., Manheim, PA, ⁴Cornell Coop. Ext., Middletown, NY, ⁵Cornell Coop. Ext., Highland, NY

Leafminer pests (Diptera: Agromyzidae) of Allium crops in U.S.

American serpentine leafminer
(*Liriomyza trifolii*)



Vegetable leafminer
(*Liriomyza sativae*)



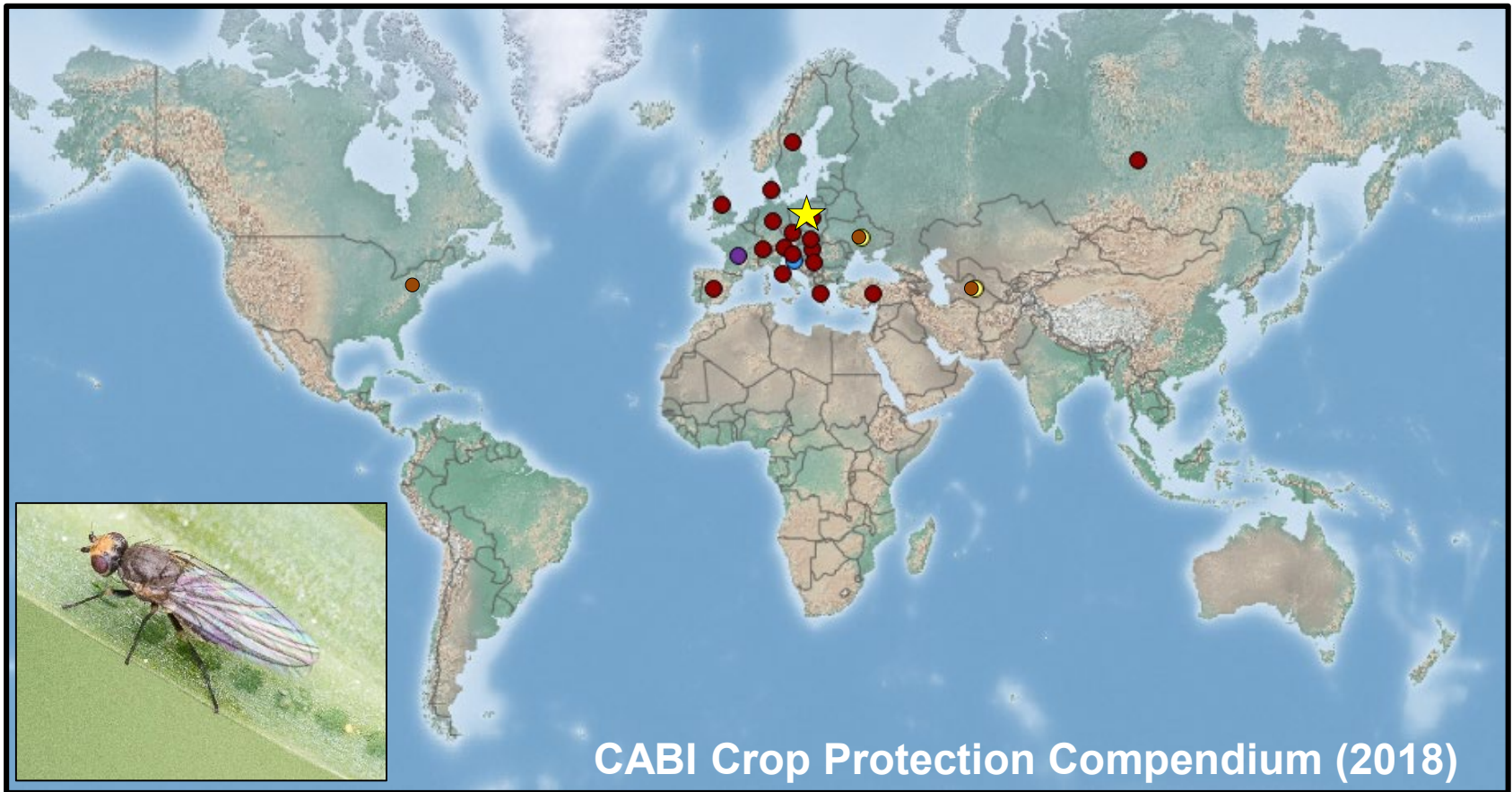
Allium leafminer (ALM) , *Phytomyza gymnostoma* (Loew)



***New invasive pest of *Allium* spp. in North America; detected in 2015**

Photo: Andre Megroz

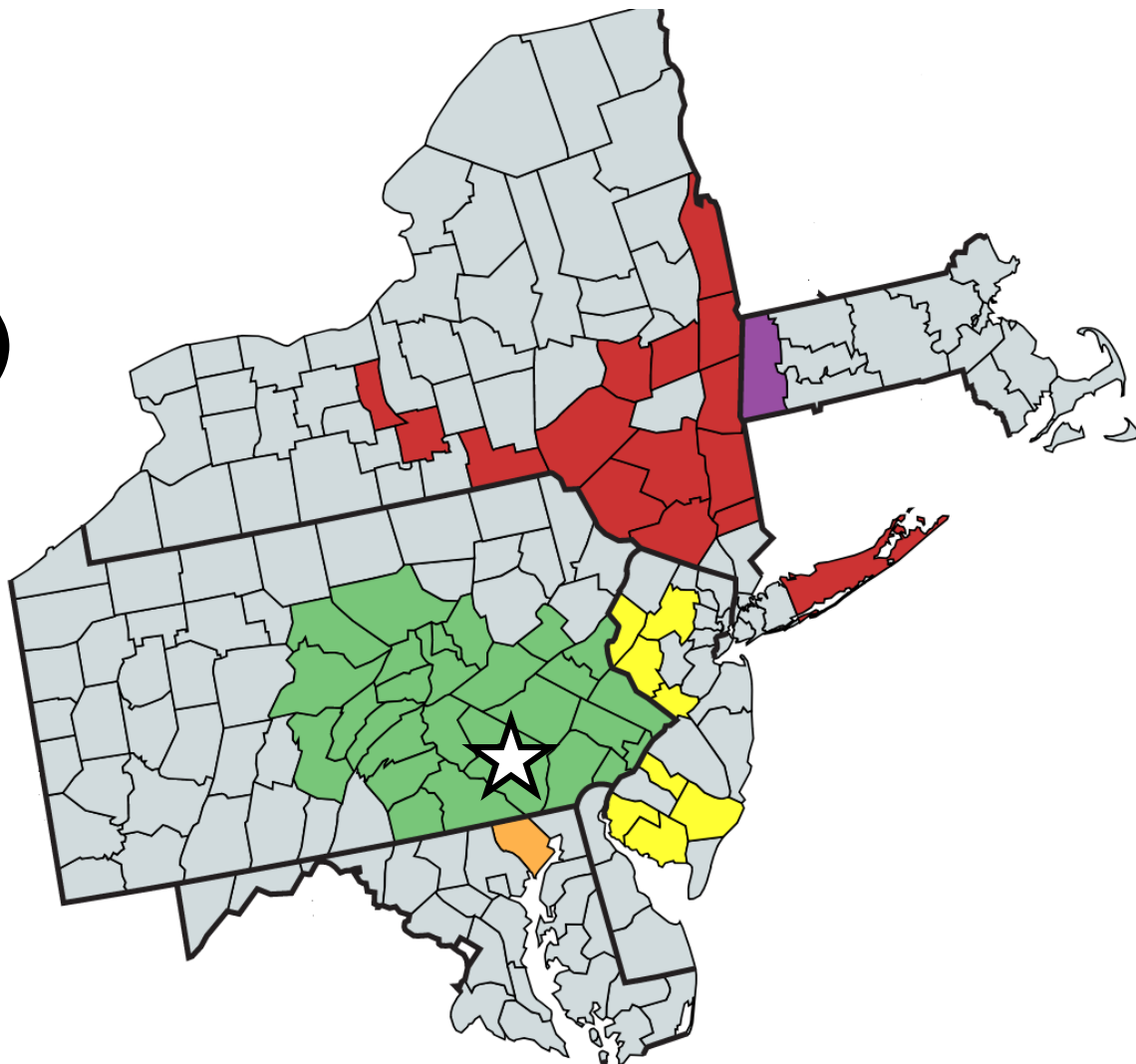
World distribution of *Allium* leafminer



- ★ Origin – Poland (1858)
- 21 countries in Europe; 2 in Asia; 1 in NA

North American distribution of *Allium leafminer*

- ☆ First detected
in Lancaster
County, PA (2015)
- Confirmed in MA,
MD, NJ, NY & PA
(as of May 2019)



Damage by Allium leafminer



- Oviposition marks cause cosmetic injury to scallions and chives
- Oviposition marks are not an issue for bulb onion, leeks, etc.

Damage by Allium leafminer



- Eggs hatch from some oviposition marks and larvae mine down the leaf to the lower portions of the plant where they will pupate

Damage by Allium leafminer

Larva (8 mm)

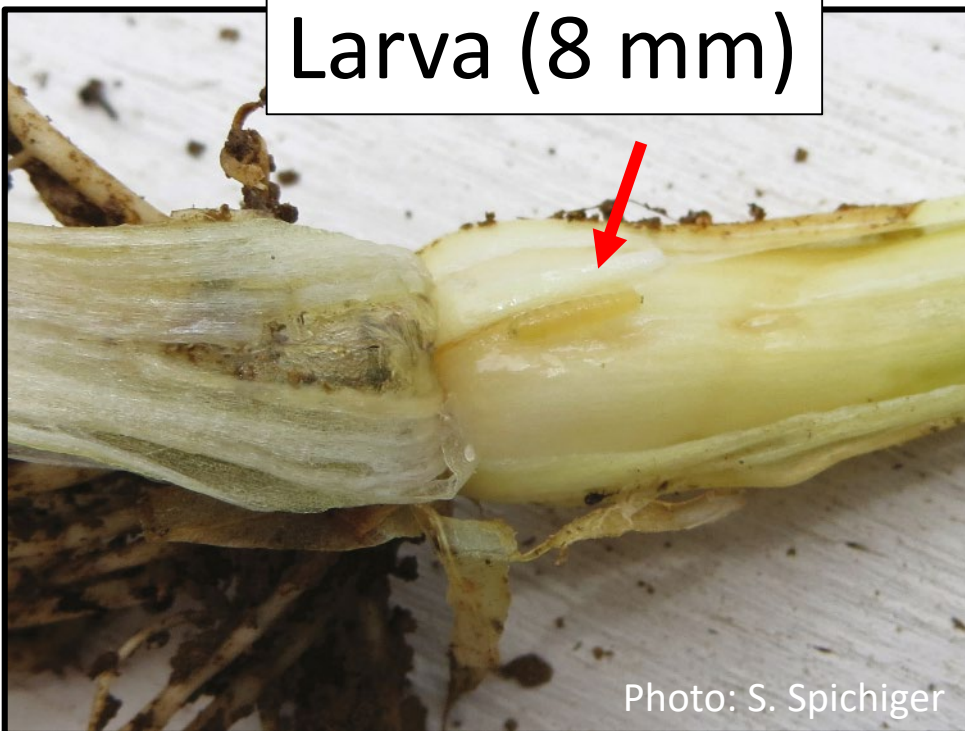


Photo: S. Spichiger

- Larval feeding and associated bacterial rot makes leeks and scallions unmarketable

Pupa
3-4 mm

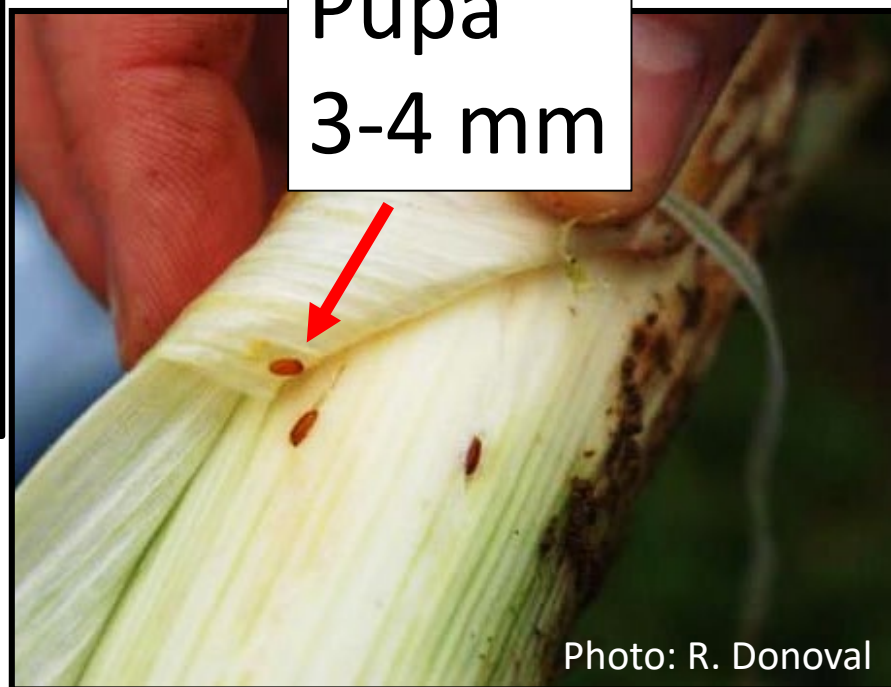


Photo: R. Donoval

Damage by Allium leafminer

- Economic loss from ALM damage has not occurred in conventional bulb onion fields
- ALM pupae-infested onion bulbs not yet encountered, but larvae found; however, ALM pupae found in garlic.

Bulb onion



Garlic



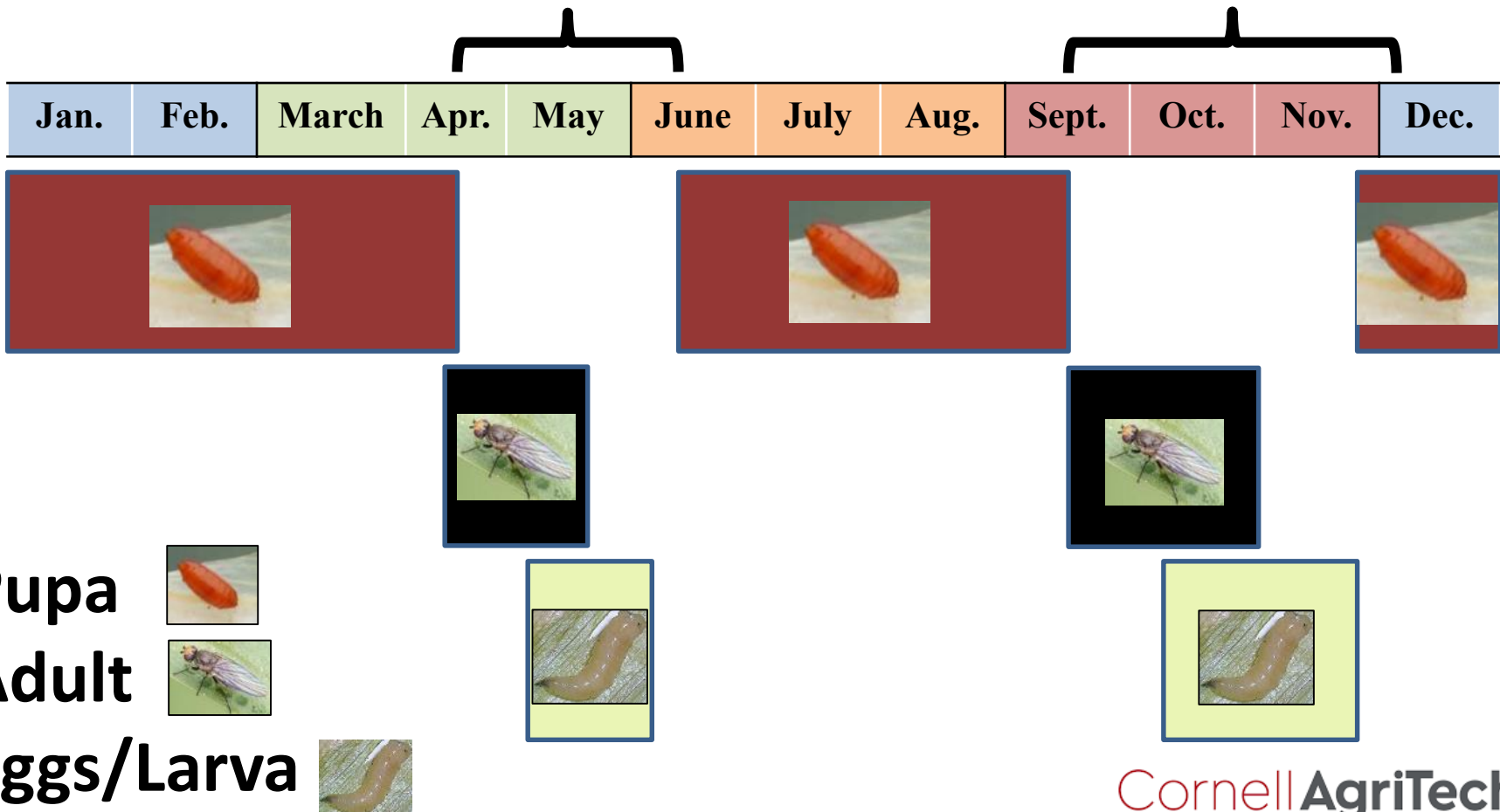
Allium leafminer attacks many *Allium* spp.

Common name	<i>Allium</i> species	Damage observed
Wild Onion	<i>Allium canadense</i>	Yes
Nodding Onion	<i>Allium cernuum</i>	Yes
→ Onion	<i>Allium cepa</i>	Yes
→ Scallion	<i>Allium fistulosum</i>	Yes
Giant Onion	<i>Allium gygantheum</i>	Yes
Field garlic	<i>Allium oleraceum</i>	-
Mediterranean Onion	<i>Allium paniculatum</i>	-
→ Leek	<i>Allium porrum</i>	Yes
→ Garlic	<i>Allium sativum</i>	Yes
Chive	<i>Allium schoenoparasum</i>	Yes
Round-headed leek	<i>Allium sphaerocephalon</i>	-
Ramps	<i>Allium tricoccum</i>	Yes
Garlic chives	<i>Allium tuberosum</i>	Yes
Wild garlic	<i>Allium vineale</i>	Yes

Life Cycle of ALM in Northeast

Spring Generation

Fall Generation



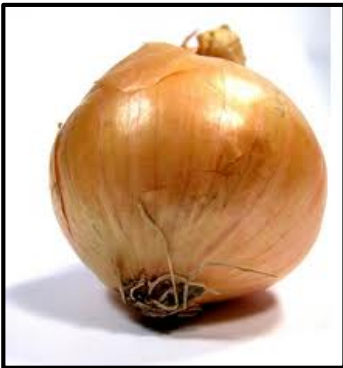
Periods when onion foliage is available for ovipositing ALM in Northeast

Transplanting
└───┐
Sowing seeds
└───┐

Jan.	Feb.	March	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
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seeded onion

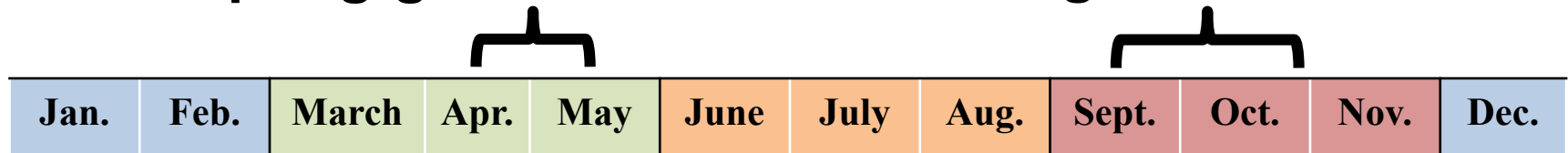
transplanted onion



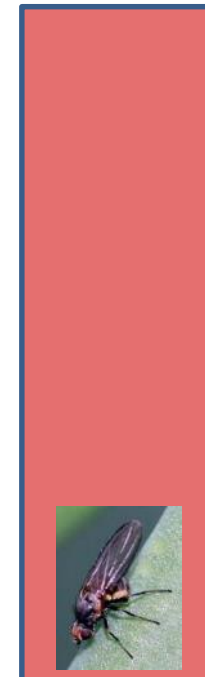
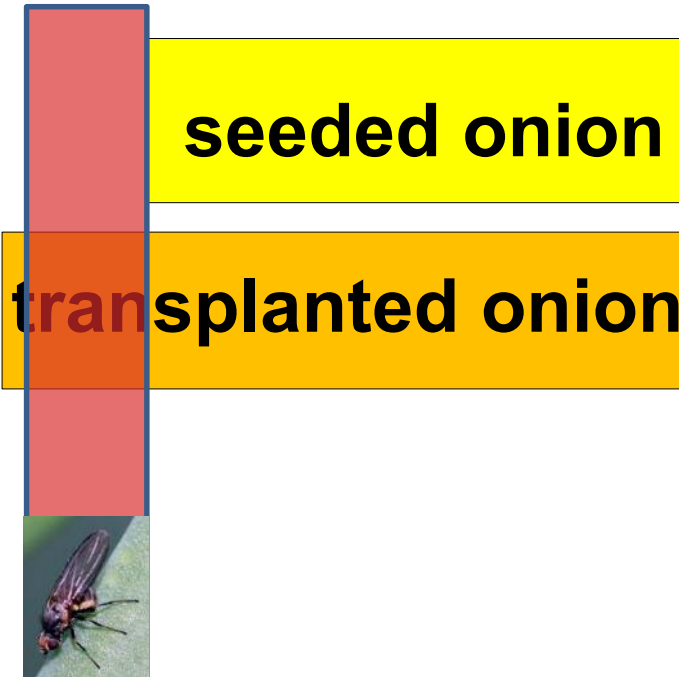
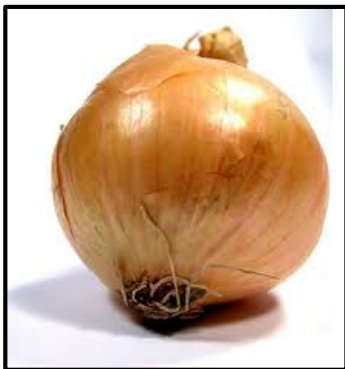
Periods when onion foliage is available for ovipositing ALM in Northeast

Spring-generation adults

Fall-generation adults



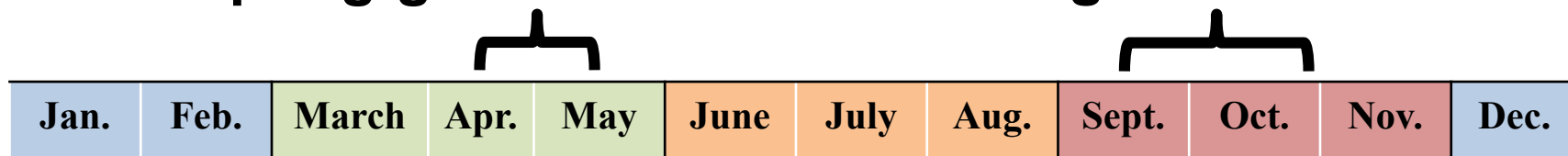
***Only transplanted onions are at risk for ALM infestation**



Periods when other *Allium* foliage is available for ovipositing ALM in NE

Spring-generation adults

Fall-generation adults



Scallions and wild *Allium* spp.

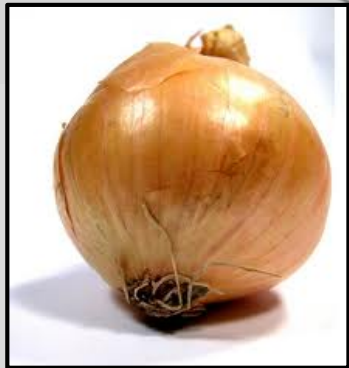
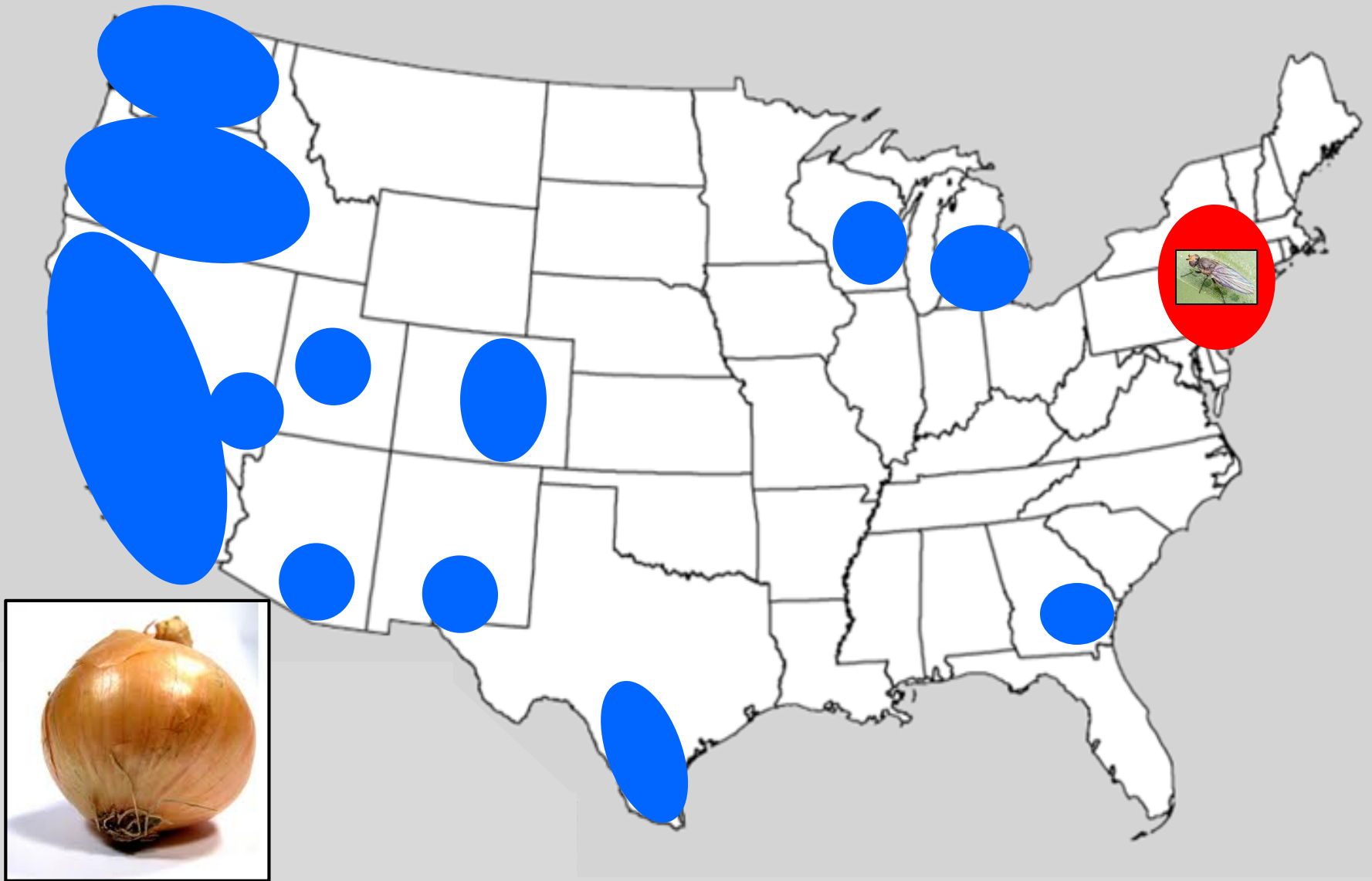


leek

***Scallions and leeks are at high risk for ALM infestation**

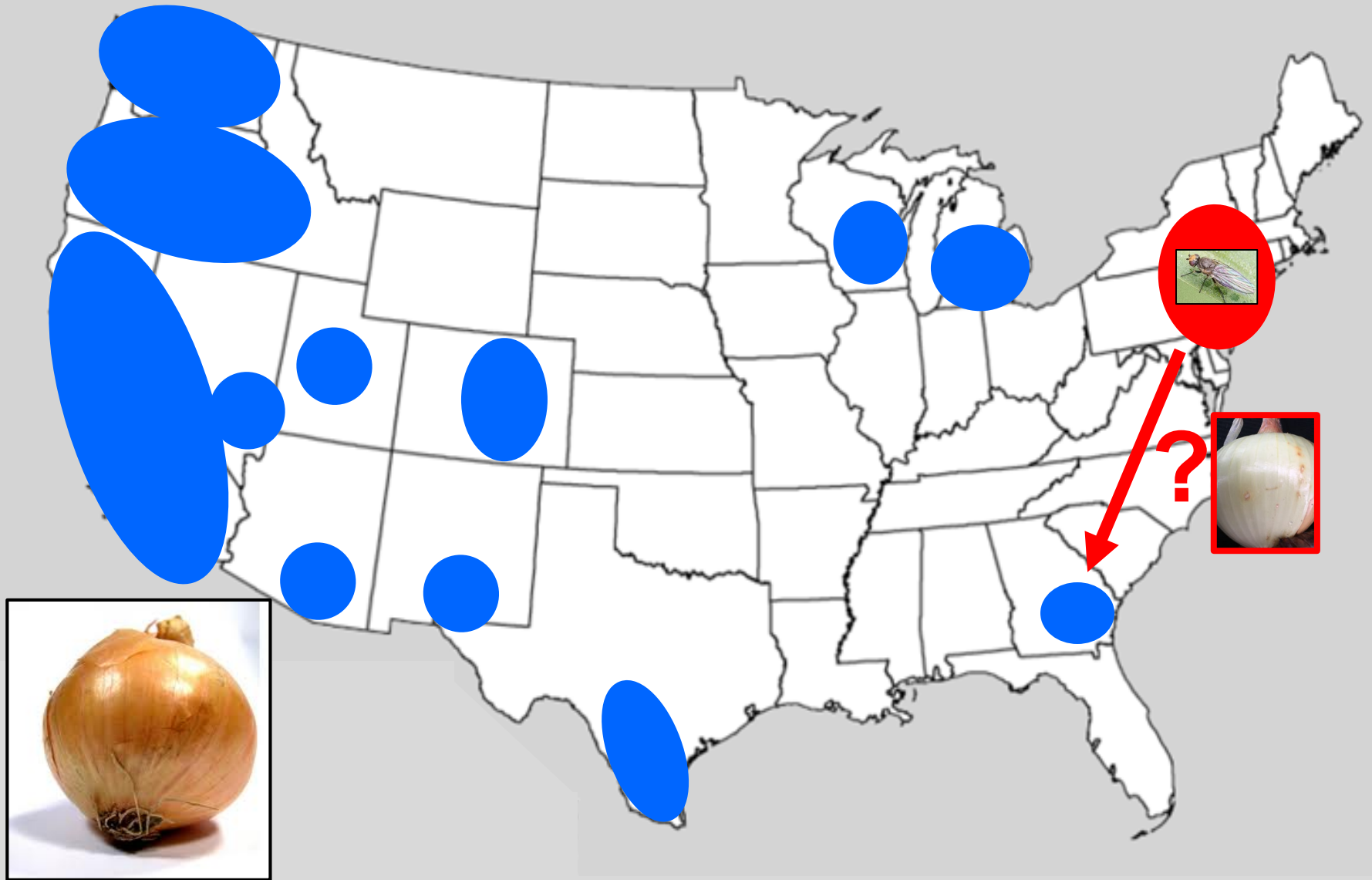


Risk of ALM infesting other onion regions?



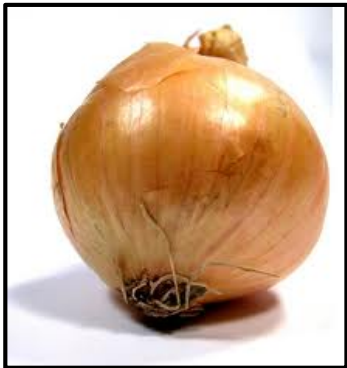
● - Allium leafminer detected

Risk of ALM infesting other onion regions?

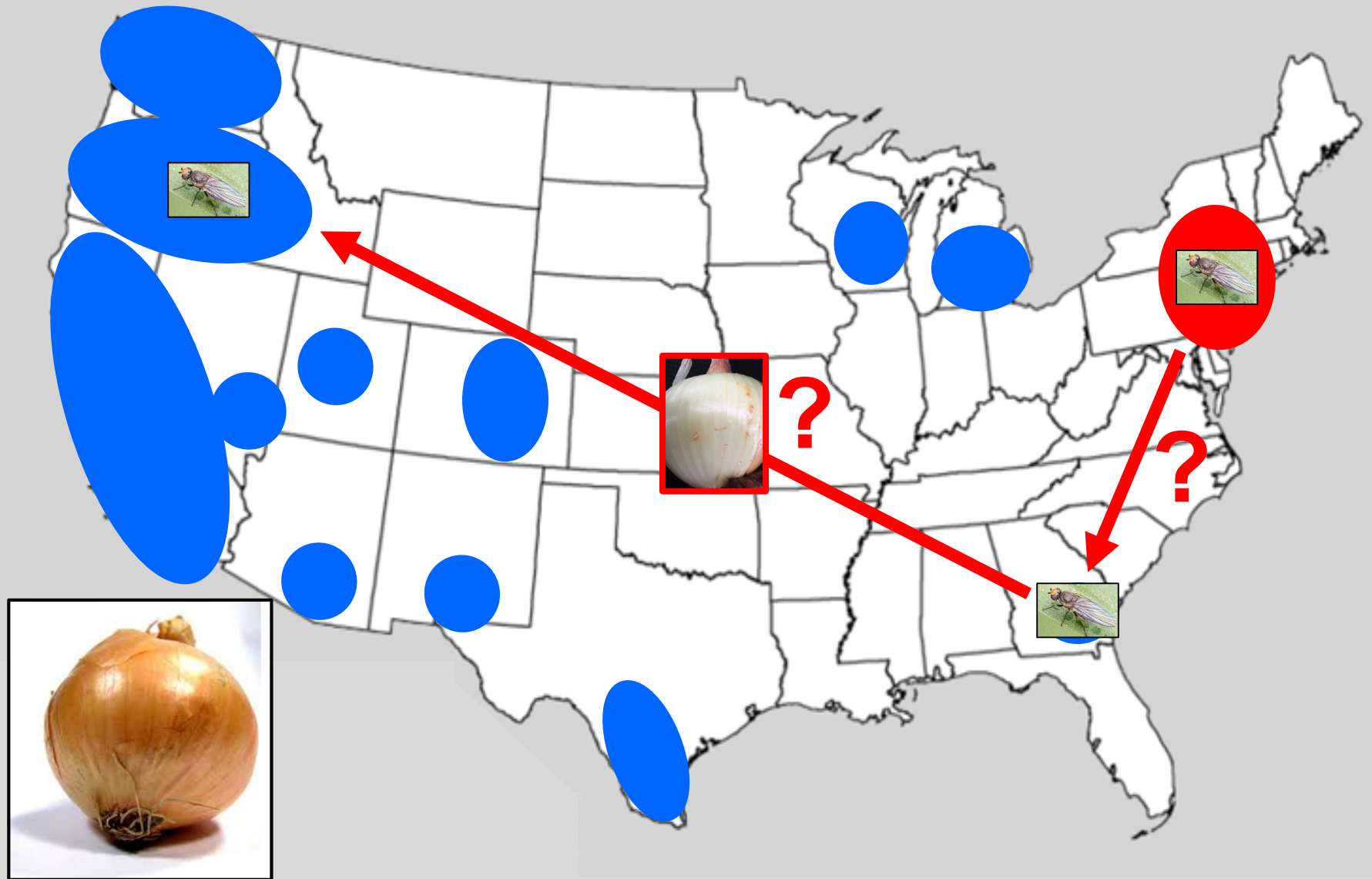


● - Allium leafminer detected

Fall-generation adults?



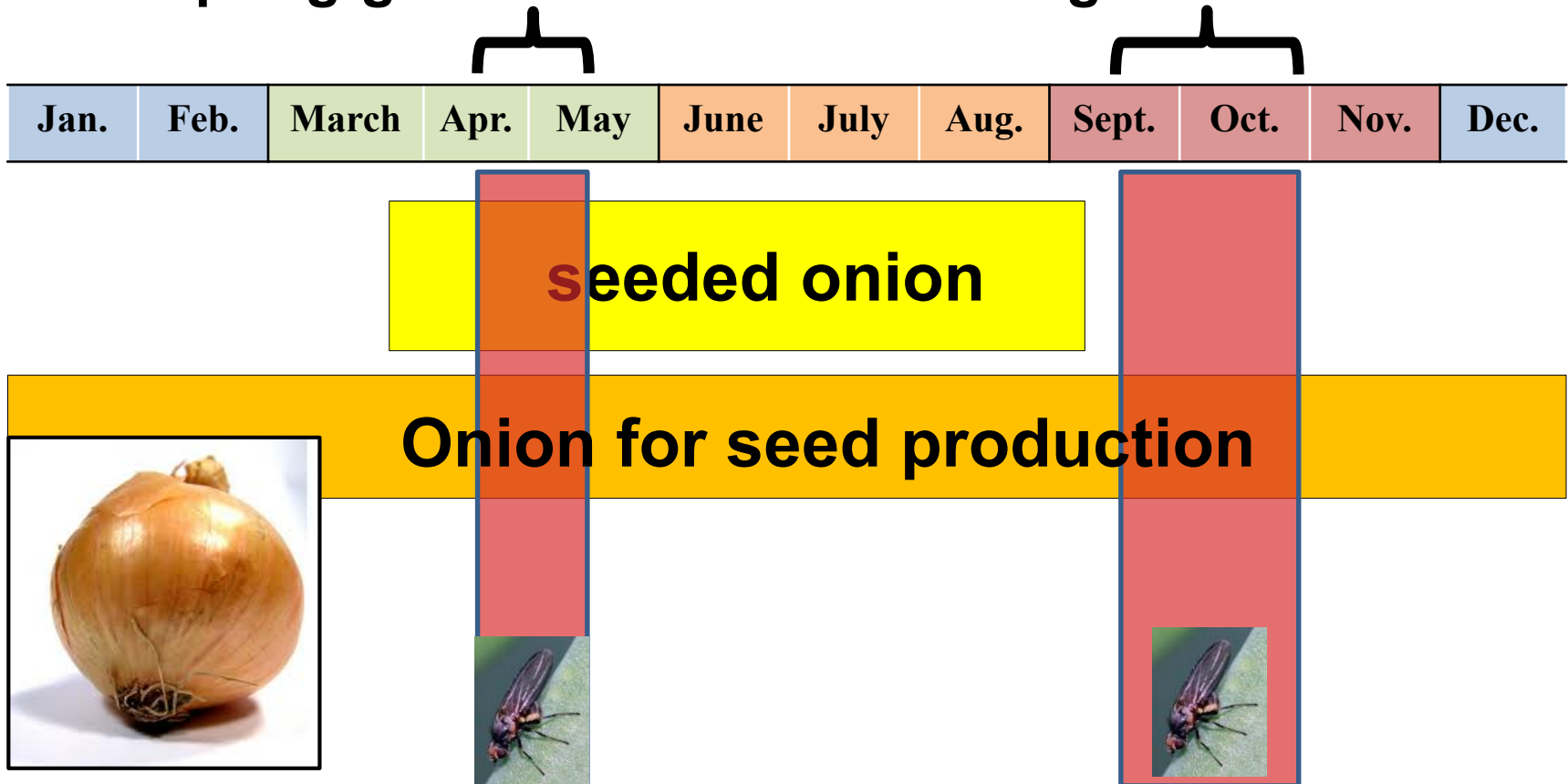
Risk of ALM infesting other onion regions?



● - Allium leafminer detected

Potential periods when onion foliage would be available for ALM in Northwest

Spring-generation adults? Fall-generation adults?



What is at stake for the U.S. onion industry?

- **If ALM becomes established in the Vidalia onion region in Georgia or anywhere in the western US, this could jeopardize international export markets (e.g., Asia).**
- **If ALM becomes established in the pacific northwest (Idaho, Oregon and Washington), onions will not be able to be sold to California, which has a quarantine in place.**

Management possibilities for Allium leafminer on Allium crops



Management possibilities for Allium leafminer on Allium crops

Plant Resistance

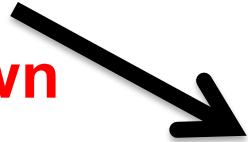
➤ None known



Management possibilities for Allium leafminer on Allium crops

Plant Resistance

➤ None known



Cultural Control

➤ Reflective mulch, row covers, delayed planting, crop rotation, trap cropping?

Management possibilities for Allium leafminer on Allium crops

Plant Resistance

➤ None known



Cultural Control

➤ Reflective mulch, row covers, delayed planting, crop rotation, trap cropping?

Biological Control

➤ Parasitoids

Management possibilities for Allium leafminer on Allium crops

Plant Resistance

➤ None known

Chemical Control

➤ Insecticides

Cultural Control

➤ Reflective mulch, row covers, delayed planting, crop rotation, trap cropping?

Biological Control

➤ Parasitoids



Management possibilities for Allium leafminer on Allium crops

Plant Resistance

➤ None known

Chemical Control

➤ Insecticides

Cultural Control

➤ Reflective mulch, row covers, delayed planting, crop rotation, trap cropping?

Biological Control

➤ Parasitoids



Insecticides for ALM control in Europe

- Insecticides used effectively for Allium leafminer control on selected *Allium* crops

Active ingredient (IRAC classification)

- abamectin (**Agri-Mek**) (6)
- acetamiprid (**Assail**) (4A)
- cypermethrin + chlorpyrifos (3A + 1B)
- cyromazine (**Trigard**) (17)
- dimethoate (**Dimethoate**) (1B)
- fenitrothion (1B)
- imidacloprid w and w/o deltamethrin (4A + 3A)
- novaluron (15)
- spinosad (**Entrust**) (5)

(Coman and Rosca 2011; Tallotti et al. 2003, 2004)



Objectives

- 1) To evaluate insecticides and application strategies for managing Allium leafminer in:**
 - **a) Transplanted onions in New York (Spring)**
 - **b) Scallions in New York (Fall)**
 - **c) Leeks in Pennsylvania (Fall)**
- 2) Timing foliar insecticide applications to optimize Allium leafminer management:**
 - **Leeks in New York (Fall)**

Objective 1a: Allium leafminer control in bulb onion in New York in spring 2018



Products evaluated for ALM control in onion in NY in 2018

Product*	Act. ingred. (IRAC Group)		Rate per Acre
Untreated control	-		-
Lannate LV	methomyl	(1A)	48 fl oz
Warrior II w/Zeon Tech.	lambda-cyhalothrin	(3A)	1.92 fl oz
Admire Pro	imidacloprid	(4A)	1.3 fl oz
Assail 30SG	acetamiprid	(4A)	8 oz
Scorpion 35SL	dinotefuran	(4A)	7 fl oz
Radiant SC	spinetoram	(5)	8 fl oz
Agri-Mek SC	abamectin	(6)	3.5 fl oz
Trigard	cyromazine	(17)	2.66 oz
Movento	spirotetramat	(23)	5 fl oz
Exirel	cyantraniliprole	(28)	13.5 fl oz
PyGanic Specialty	pyrethrin	(3A)	17 fl oz
Entrust SC	spinosad	(5)	7 fl oz
Aza-Direct	azadirachtin	(unknown)	32 fl oz
Surround WP	kaolin clay	(unknown)	25 lbs

Conventional

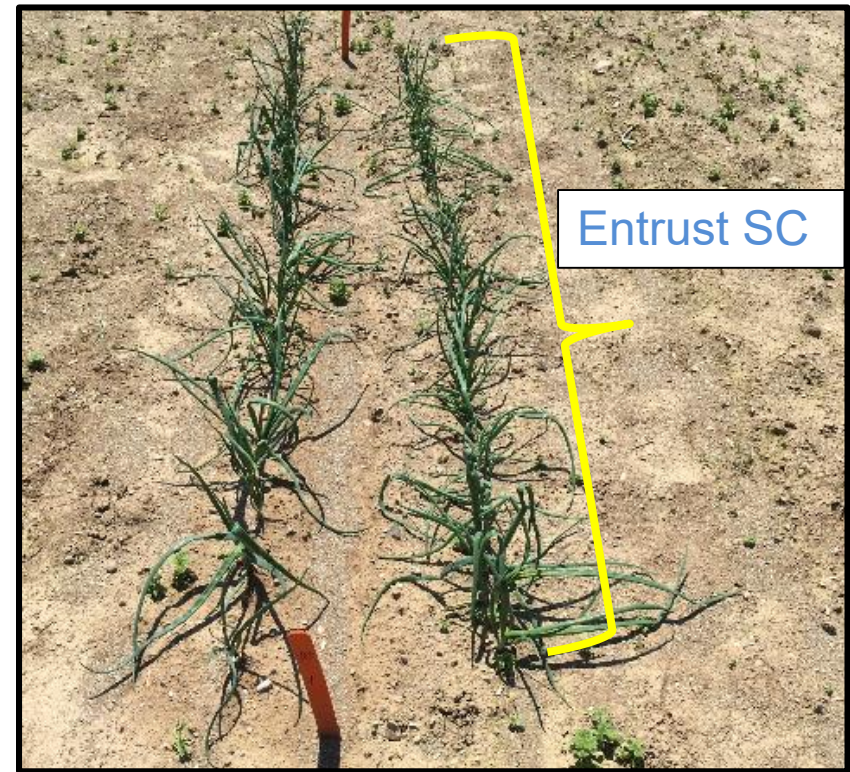


*Conventional co-applied with LI-700 @ 0.25% v:v; OMRI-listed co-applied with Nu-Film @ 8 fl oz/acre

Methods for bulb onion trial in spring 2018

Red Hook, NY

- One row of onions per plot was treated with **Entrust SC** @ 1 fl oz/10,000 bare-root plants to protect against seedcorn maggots



- 14 foliar-applied products were applied on May 7, 14, 21 and 29

Methods for bulb onion trial in spring 2018

Red Hook, NY

- Twenty plants per experimental unit were removed and **inspected for larvae and pupae**
- Foliar-applied products was the main plot factor and **Entrust-dipped** plants was the sub-plot factor; $n=4$
- Mixed model for split-plot design (Proc Mixed); Tukey HSD; $P<0.05$



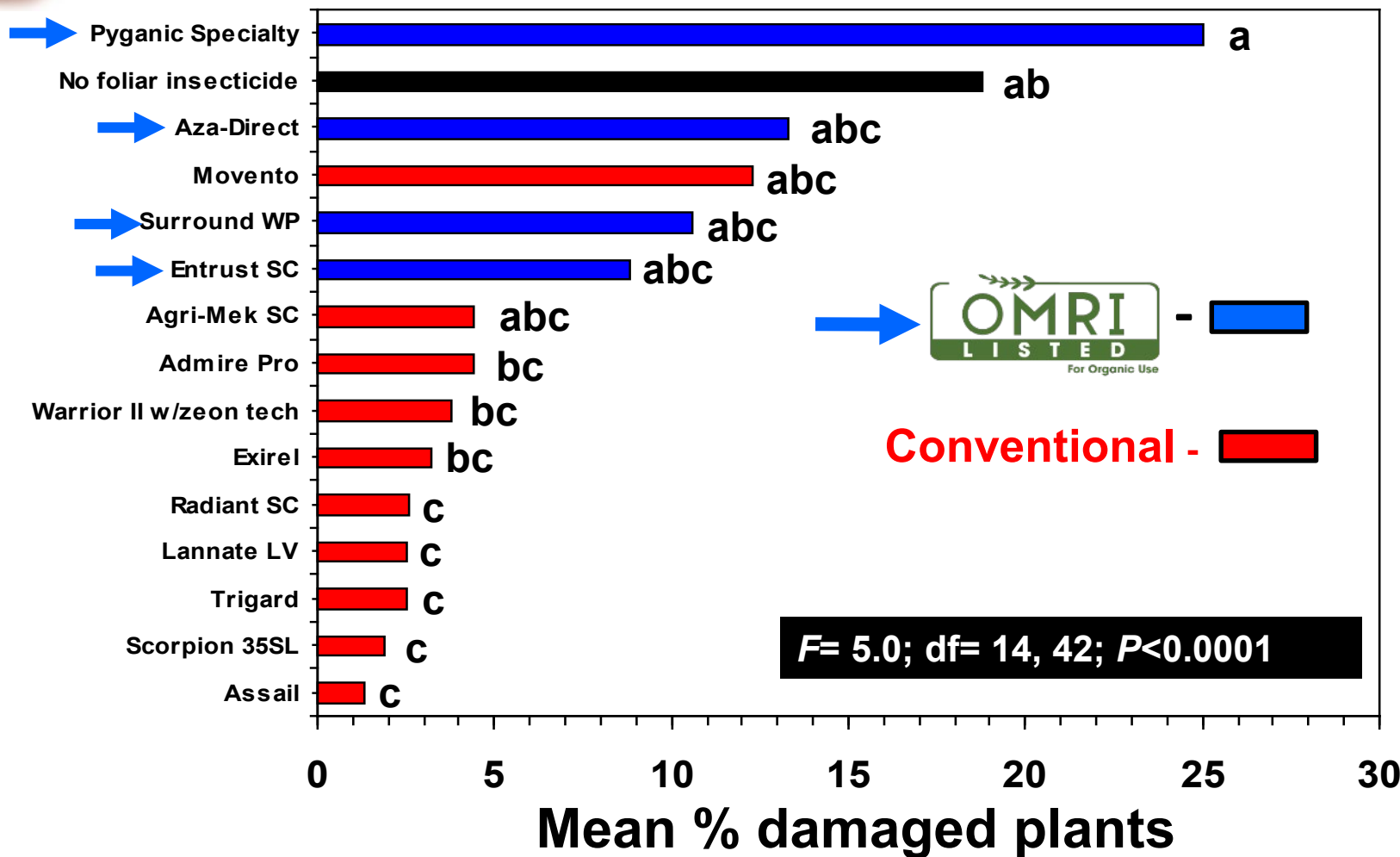
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Damage for all foliar treatments averaged across those dipped or not in **Entrust**



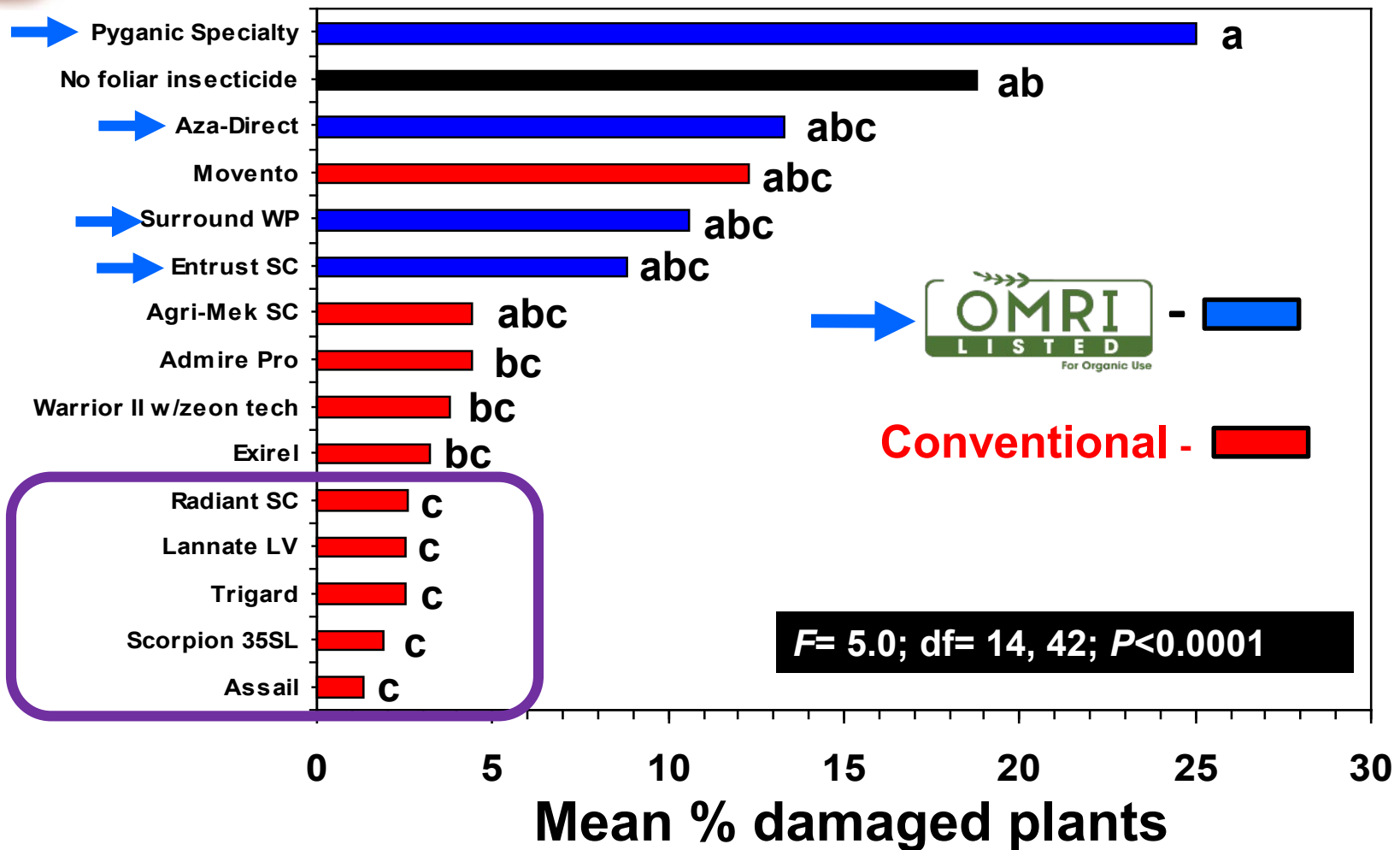
cv. 'Highlander' Red Hook, NY (n = 8) 2018



Damage for all foliar treatments averaged across those dipped or not in **Entrust**



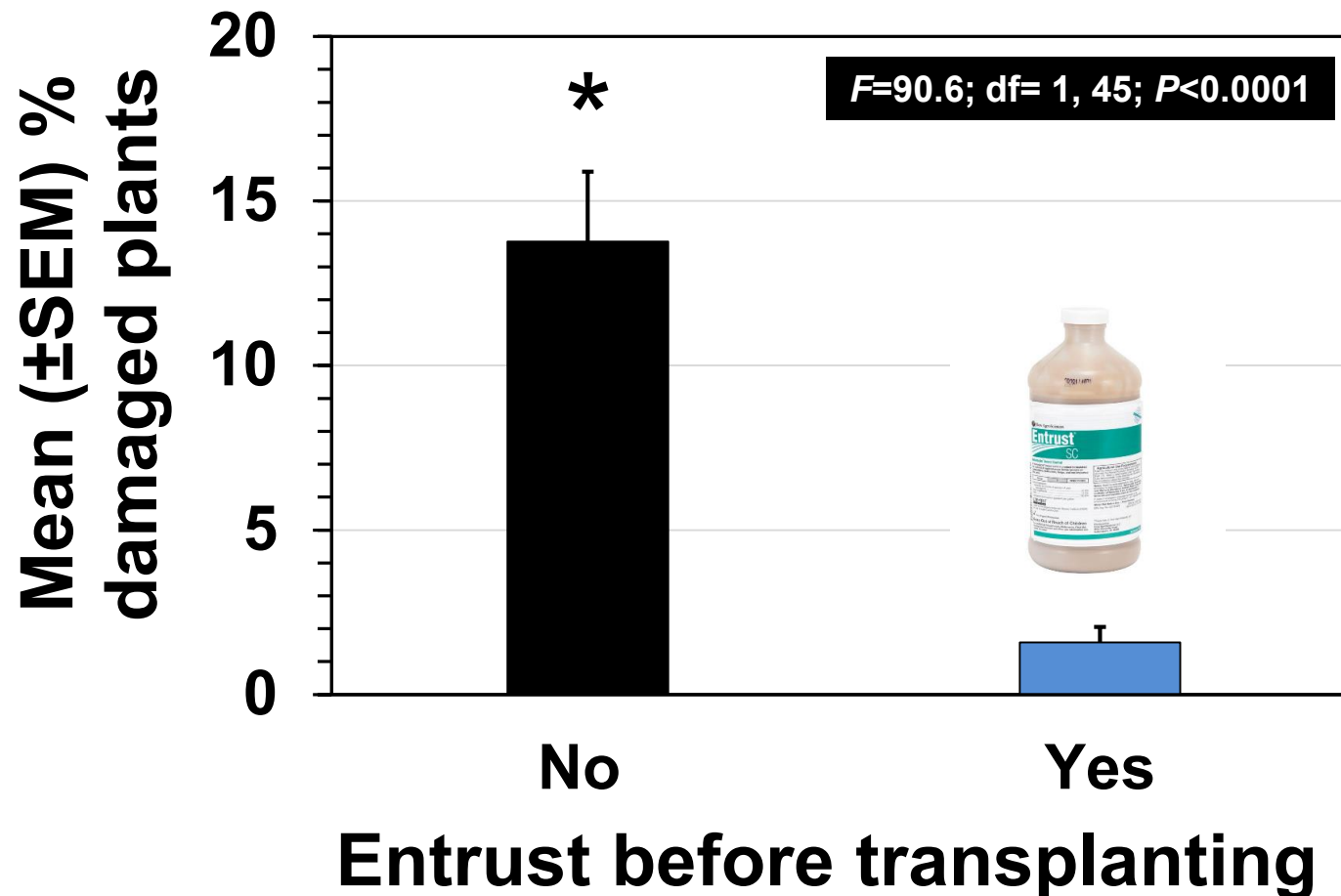
cv. 'Highlander' Red Hook, NY (n = 8) 2018



Damage pooled across treatments that were or were not dipped in Entrust



cv. 'Bradley' Red Hook, NY (n = 4) June 18, 2018



Objective 1b: Allium leafminer control in scallions in New York in fall 2018



Products evaluated for ALM control in scallions in NY in 2018

Product	Act. ingred. (IRAC Group)		Rate per Acre
Untreated control	-		-
Lannate LV	methomyl	(1A)	48 fl oz
Warrior II w/Zeon Tech.	lambda-cyhalothrin	(3A)	1.92 fl oz
Admire Pro	imidacloprid	(4A)	1.3 fl oz
Assail 30SG	acetamiprid	(4A)	8 oz
Scorpion 35SL	dinotefuran	(4A)	7 fl oz
Radiant SC	spinetoram	(5)	8 fl oz
Agri-Mek SC	abamectin	(6)	3.5 fl oz
Trigard	cyromazine	(17)	2.66 oz
Exirel	cyantraniliprole	(28)	13.5 fl oz
PyGanic Specialty	pyrethrin	(3A)	17 fl oz
Entrust SC	spinosad	(5)	7 fl oz
Entrust SC + M-Pede	spinosad + fatty acids	(5)	7 fl oz + 1.5% v:v
Entrust SC	spinosad	(5)	1 fl oz/10K plants
Aza-Direct	azadirachtin	(unknown)	32 fl oz

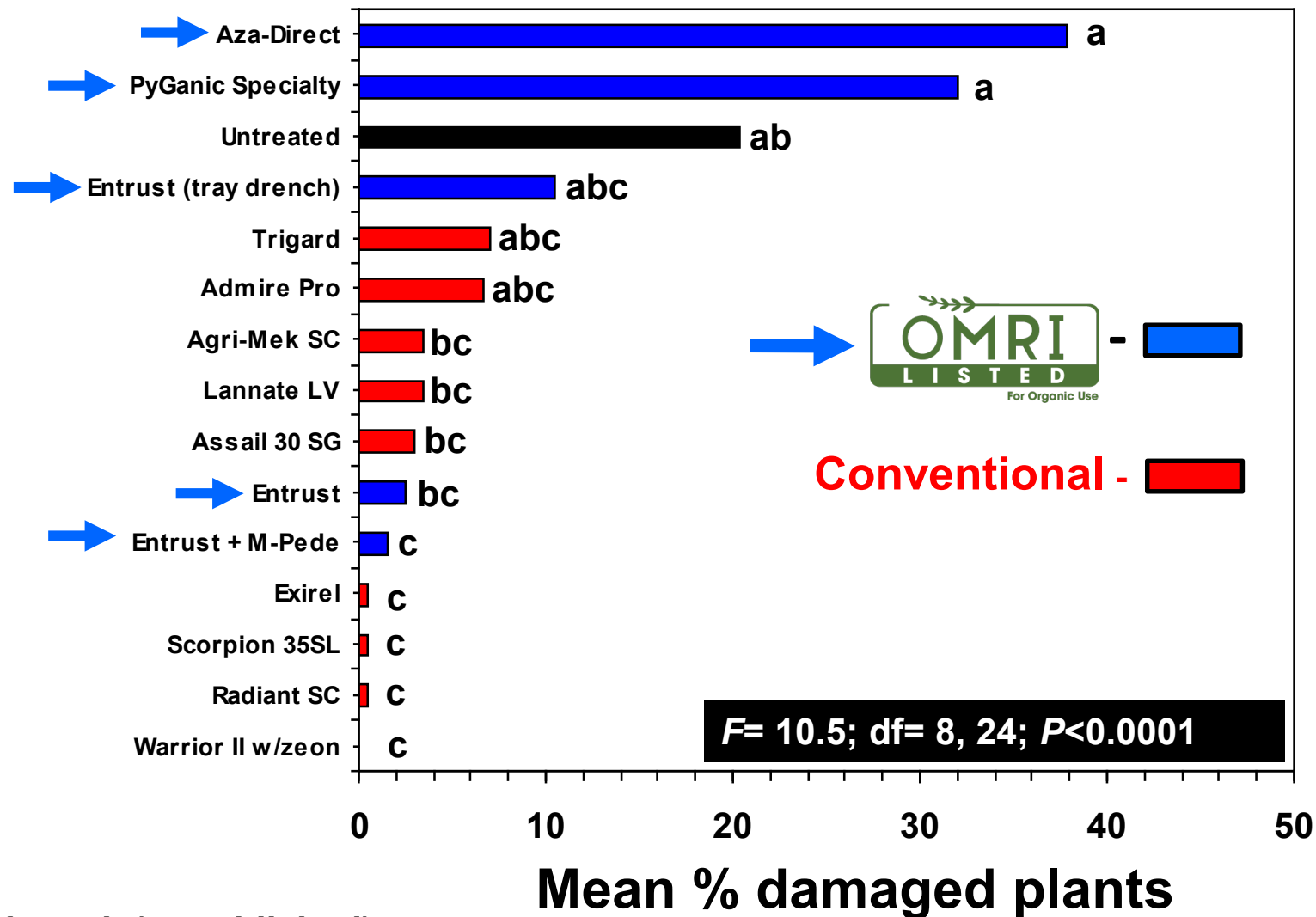
Conventional



*Conventional co-applied with LI-700; OMRI-listed co-applied with Nu-Film, except Entrust + M-Pede

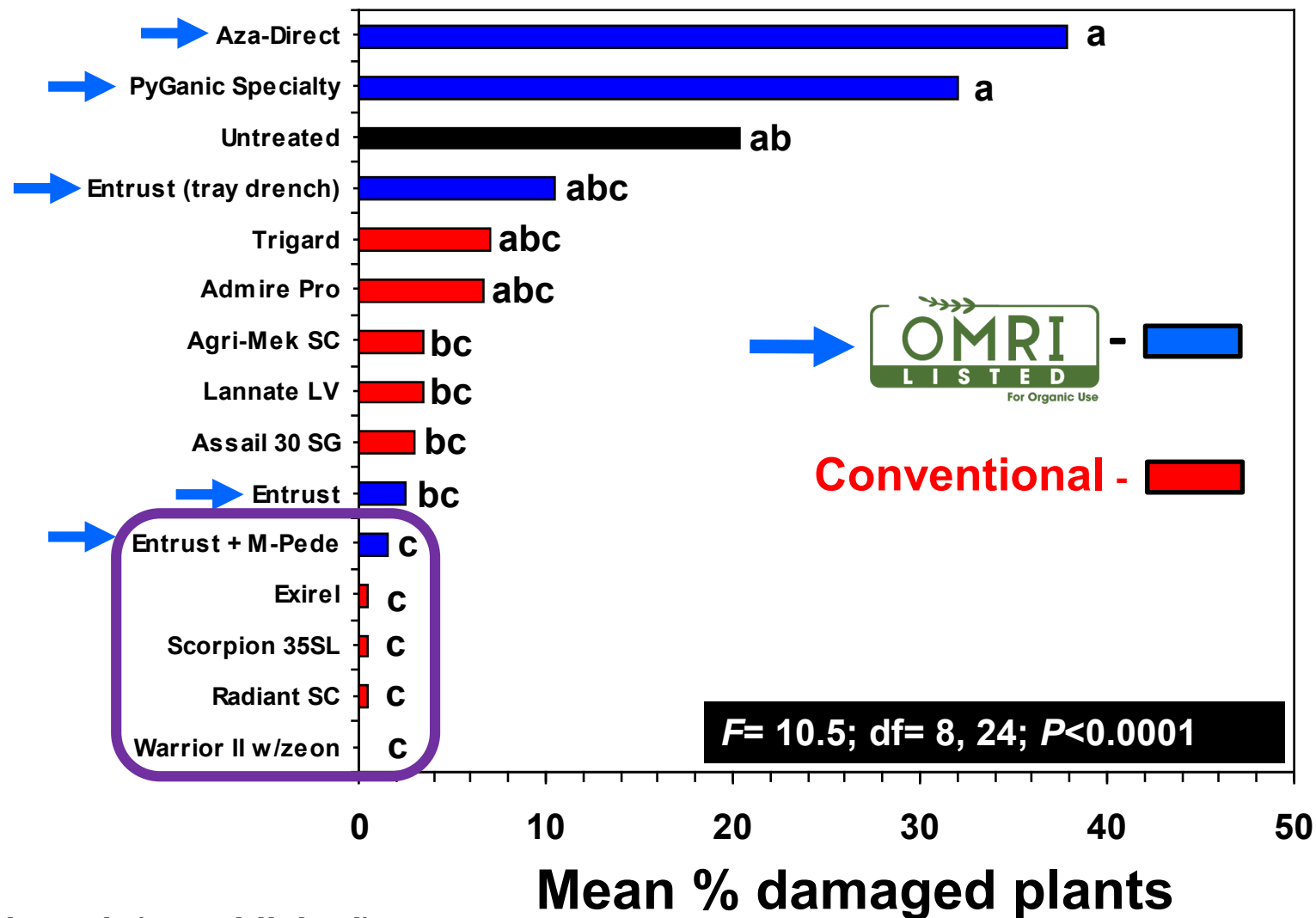
Damage for all treatments

cv. 'Nabechan F1' Red Hook, NY (n = 4) 2018 Total sprays= 6

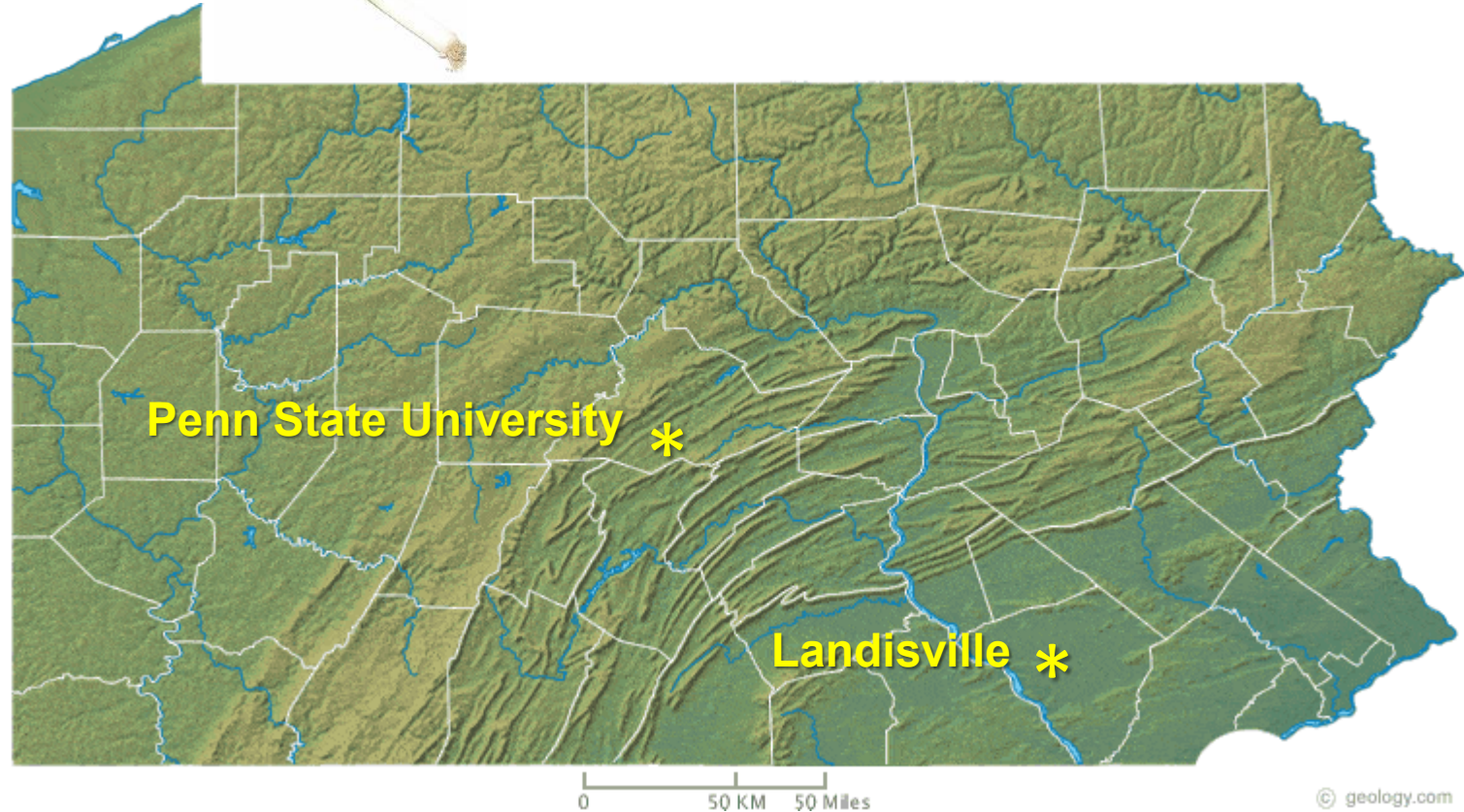


Damage for all treatments

cv. 'Nabechan F1' Red Hook, NY (n = 4) 2018 Total sprays= 6



Objective 1c: Allium leafminer control in leeks in Pennsylvania in fall 2018



Products evaluated in fall leek trial in PA in 2018

Product	Act. ingred. (IRAC Group)		Application method	Rate per Acre
Untreated	-		-	-
Scorpion 35 SL	dinotefuran	(4A)	Foliar	7 fl oz
Scorpion 35 SL	dinotefuran	(4A)	Through drip	10 fl oz
Radiant SC	spinetoram	(5)	Foliar	10 fl oz
Exirel	cyantraniliprole	(28)	Foliar	20 fl oz
Verimark	cyantraniliprole	(28)	Through drip	10 fl oz
Aza-Direct	azadirachtin	(unknown)	Foliar	48 fl oz
Azera	azadirachtin + pyrethrin	(unknown + 3A)	Foliar	48 fl oz
Pyganic Specialty	pyrethrin	(3A)	Foliar	32 fl oz

Conventional



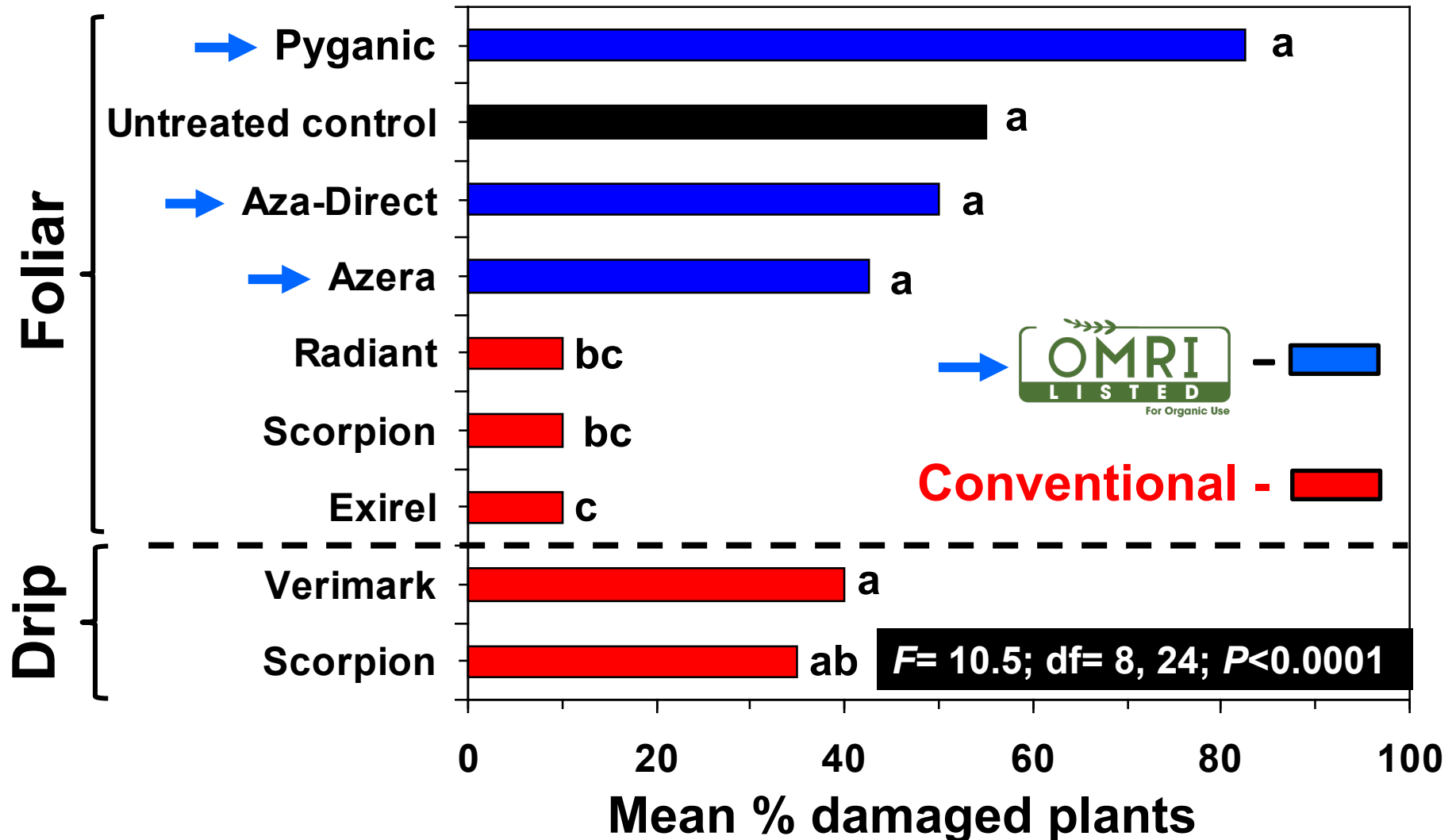
*Conventional co-applied with LI-700 @ 0.25% v:v; OMRI-listed co-applied with M-Pede @ 1.5% v:v

*Five weekly foliar applications were made beginning on 9/26; Drip applications on 9/24, 10/4 & 10/24



Damage for all treatments

cv. 'Tadrona' Landisville, PA (n = 4) 2018





Summary – Obj. 1

- **Effective insecticides and application strategies**
 - Entrust as a dip treatment for bare-root onions before transplanting (not labelled)
 - Foliar sprays of Exirel, **Radiant***, **Scorpion*** and **Entrust*** (for organic); " * " = labeled for leafminers on bulb vegetables
 - Drip-applied treatments were not effective



Objectives

1) To evaluate insecticides and application strategies for managing Allium leafminer in:

- a) Transplanted onions in New York (Spring)
- b) Leeks in Pennsylvania (Fall)
- c) Scallions in New York (Fall)

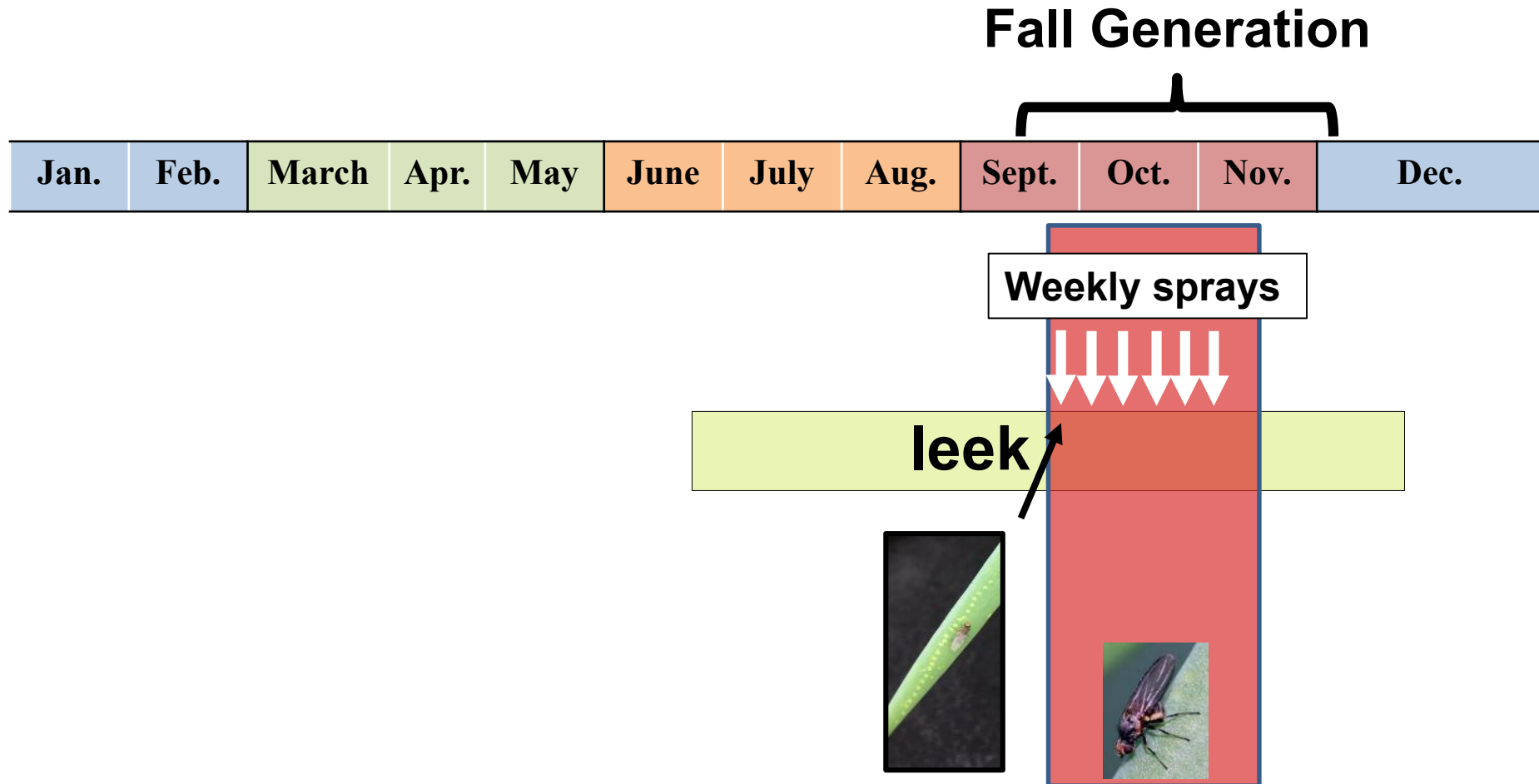
2) Timing foliar insecticide applications to optimize Allium leafminer management:

- Leeks in New York (Fall)

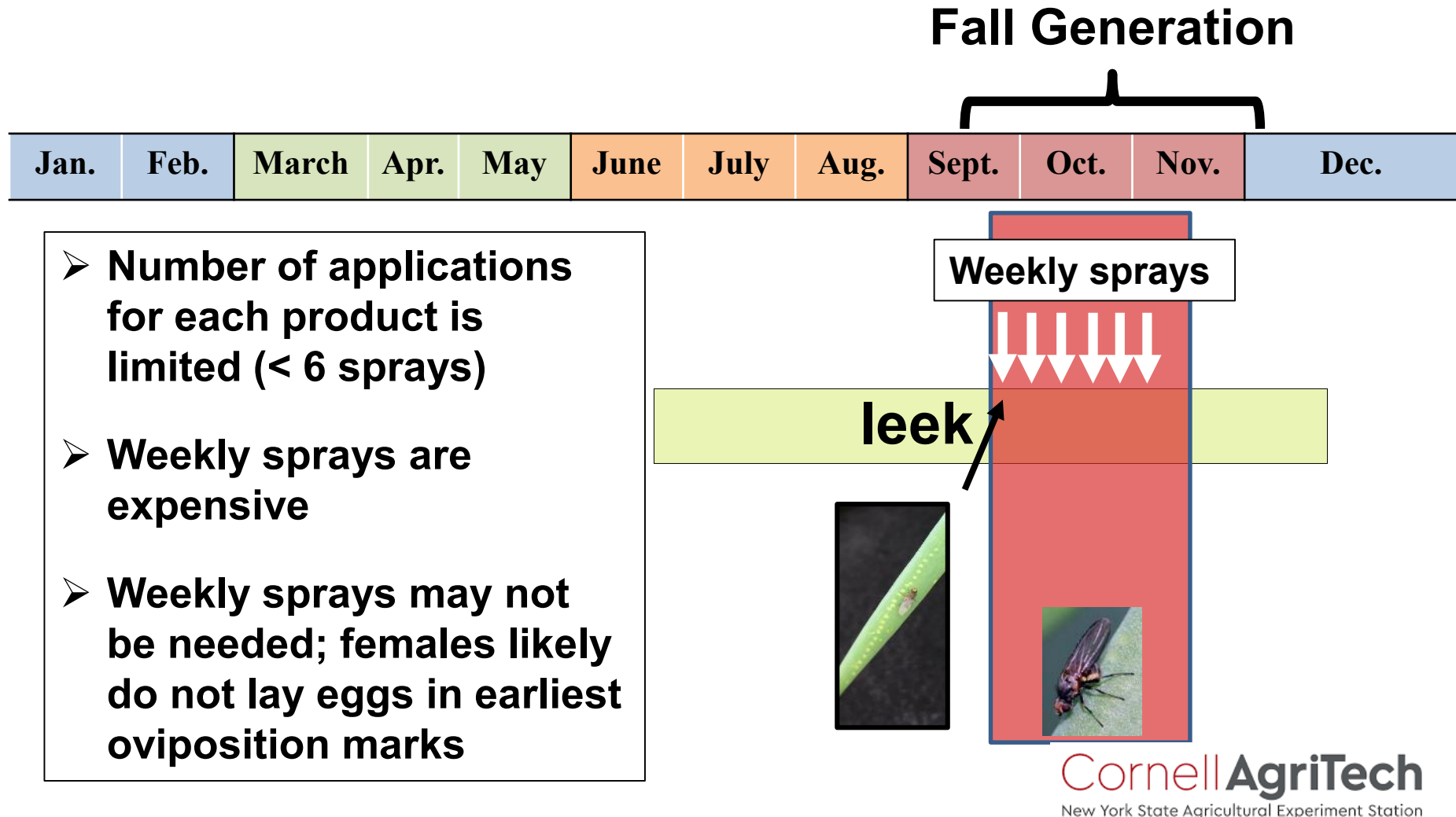
Objective 2: Allium leafminer control in leeks using insecticides at different timings in NY in fall 2018



Need to optimize number of applications for ALM control



Need to optimize number of applications for ALM control





Methods for fall leek timing trial Hurley, NY 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total # sprays
A							
B							
C							
D							
E							
F							
G							
H							
Untreated							



Methods for fall leek timing trial Hurley, NY 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total # sprays
A	X	X	X	X	X	X	6
B							
C							
D							
E							
F							
G							
H							
Untreated	-	-	-	-	-	-	0

- Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v
- Spray dates Sept. 14, 21, 28 and October 5, 12 and 19



Methods for fall leek timing trial Hurley, NY 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total # sprays
A	X	X	X	X	X	X	6
B	X	X					2
C		X	X				2
D			X	X			2
E				X	X		2
F							
G							
H							
Untreated	-	-	-	-	-	-	0

➤ Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v



Methods for fall leek timing trial Hurley, NY 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Total # sprays
A	X	X	X	X	X	X	6
B	X	X					2
C		X	X				2
D			X	X			2
E				X	X		2
F	X		X				2
G		X		X			2
H			X		X		2
Untreated	-	-	-	-	-	-	0

➤ Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v

Mean % damage in fall leek timing trial cv. 'Megaton' Hurley, NY (n = 4) 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Mean % damaged plants
A	X	X	X	X	X	X	10 e
B	X	X					91 ab
C		X	X				53 bcd
D			X	X			31 de
E				X	X		48 cd
F	X		X				71 abc
G		X		X			43 cd
H			X		X		46 cd
Untreated	-	-	-	-	-	-	99 a

➤ Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v

Grundberg & Rusinek (unpublished)

$F = 16.8$; $df = 8, 24$; $P < 0.0001$

Cornell AgriTech
New York State Agricultural Experiment Station

Mean % damage in fall leek timing trial cv. 'Megaton' Hurley, NY (n = 4) 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Mean % damaged plants
A	X	X	X	X	X	X	10 e
B	X	X					91 ab
C		X	X				53 bcd
D			X	X			31 de
E				X	X		48 cd
F	X		X				71 abc
G		X		X			43 cd
H			X		X		46 cd
Untreated	-	-	-	-	-	-	99 a

➤ Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v

Grundberg & Rusinek (unpublished)

$F = 16.8$; $df = 8, 24$; $P < 0.0001$

Cornell AgriTech
New York State Agricultural Experiment Station

Mean % damage in fall leek timing trial cv. 'Megaton' Hurley, NY (n = 4) 2018

Insecticide timing treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Mean % damaged plants
A	X	X	X	X	X	X	10 e
B	X	X					91 ab
C		X	X				53 bcd
D			X	X			31 de
E				X	X		48 cd
F	X		X				71 abc
G		X		X			43 cd
H			X		X		46 cd
Untreated	-	-	-	-	-	-	99 a

➤ Entrust SC applied at 6 fl oz/acre with M-Pede @ 1.5% v:v

Grundberg & Rusinek (unpublished) $F= 16.8; df= 8,24; P<0.0001$



Summary – Obj. 2

- **Effective insecticides and application strategies**
 - Entrust as a dip treatment for bare-root onions before transplanting (not labelled)
 - Foliar sprays of Exirel, Radiant*, Scorpion* and Entrust* (for organic); " * " = labeled for leafminers on bulb vegetables
 - Drip-applied treatments were not effective
- **Six weekly applications provided the best control, but also the pair of weekly applications that began two weeks after the first oviposition mark**



Remaining Questions

- **What is the risk that ALM will become a serious pest of bulb onion?**
- **What is the risk that ALM will continue to spread to other locations across North America?**
- **How best to monitor its geographical spread?**
- **How best to control this pest in the long term?**
- **ALM establishment in other areas of the US could dramatically affect interstate markets and foreign export markets. What is a good game plan?**

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Natasha Field
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Penn State

Dana Roberts
Carley McGrady

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- The Foundation for Food and Agricultural Research – Rapid Outcomes from Agricultural Research Program
- New York Farm Viability Institute
- NY State Department of Agriculture and Markets



United States Department of Agriculture
National Institute of Food and Agriculture



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