2022 Update on Thrips and INSV

Daniel K. Hasegawa
Research Entomologist
USDA-ARS, Salinas CA

Pest Management Meeting
9/3/2022

USDA Agricultural Research Service

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Thrips/INSV biology and monitoring

- Symptomology
- Thrips life cycle and transmission of INSV

Thrips/INSV epidemiology

- Discrepancies in distribution
- Thrips monitoring
- Temperature data

Thrips flower surveys: crops vs. non-crops

Immune priming

Receptor interference

INSV genome sequencing

INSV host range

- Top 10 hosts
- Top 10 hosts as thrips reproductive hosts
- Weed abatement (example)


Western flower thrips: vector for INSV

Western flower thrips, *Frankliniella occidentalis*

<u>Vector management challenges:</u>

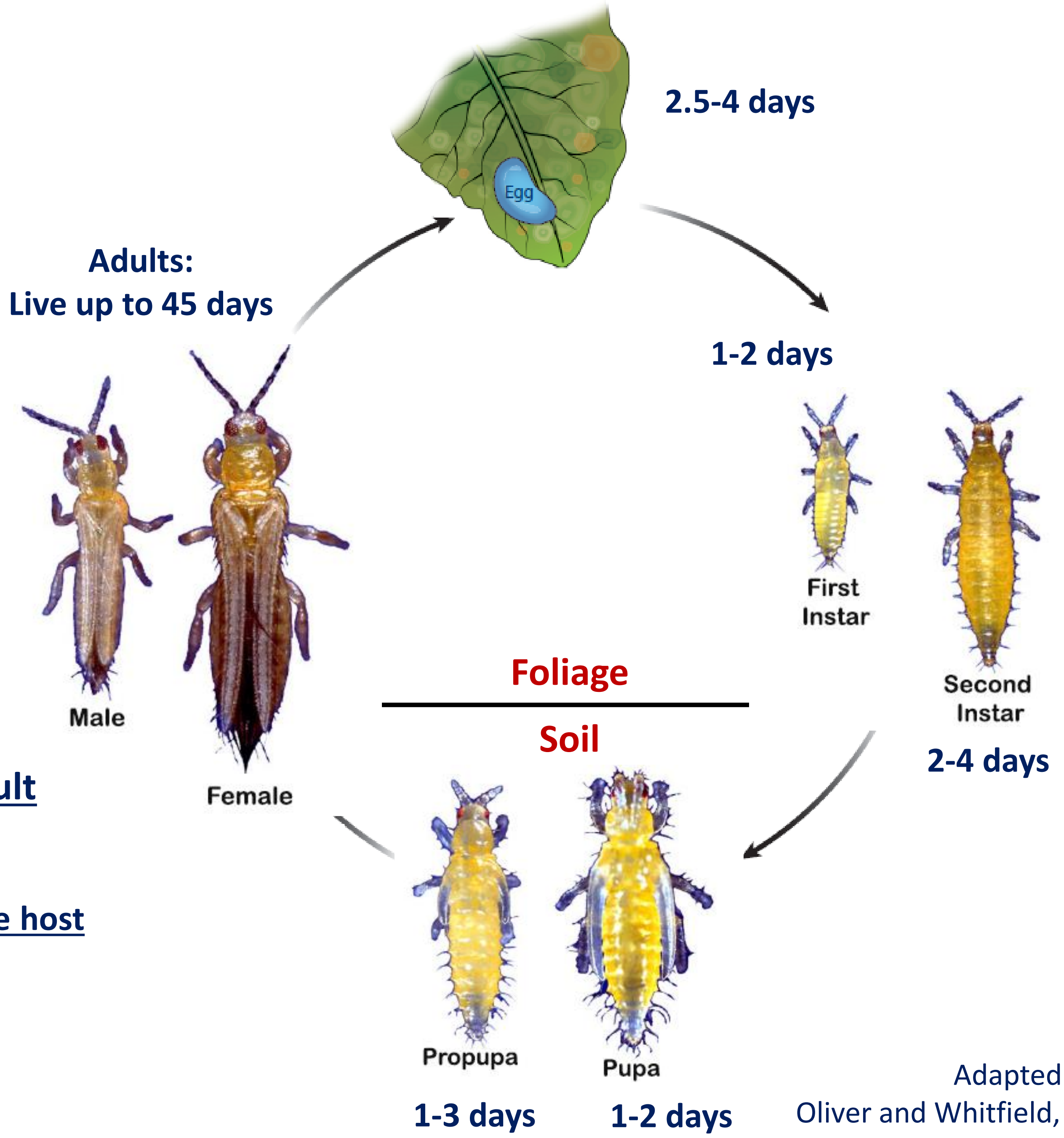
- Small (1-2 mm), cryptic, high fecundity
- Limited chemical options in CA lettuce
    - ~20% organic production in 2021
- Host range = 100s of plants

<u>Virus Management challenges:</u>

- Lack of genetic-based resistance to INSV in lettuce
- Host range = 100s of plants

<u>Virus must be acquired as larvae to transmit as an adult</u>

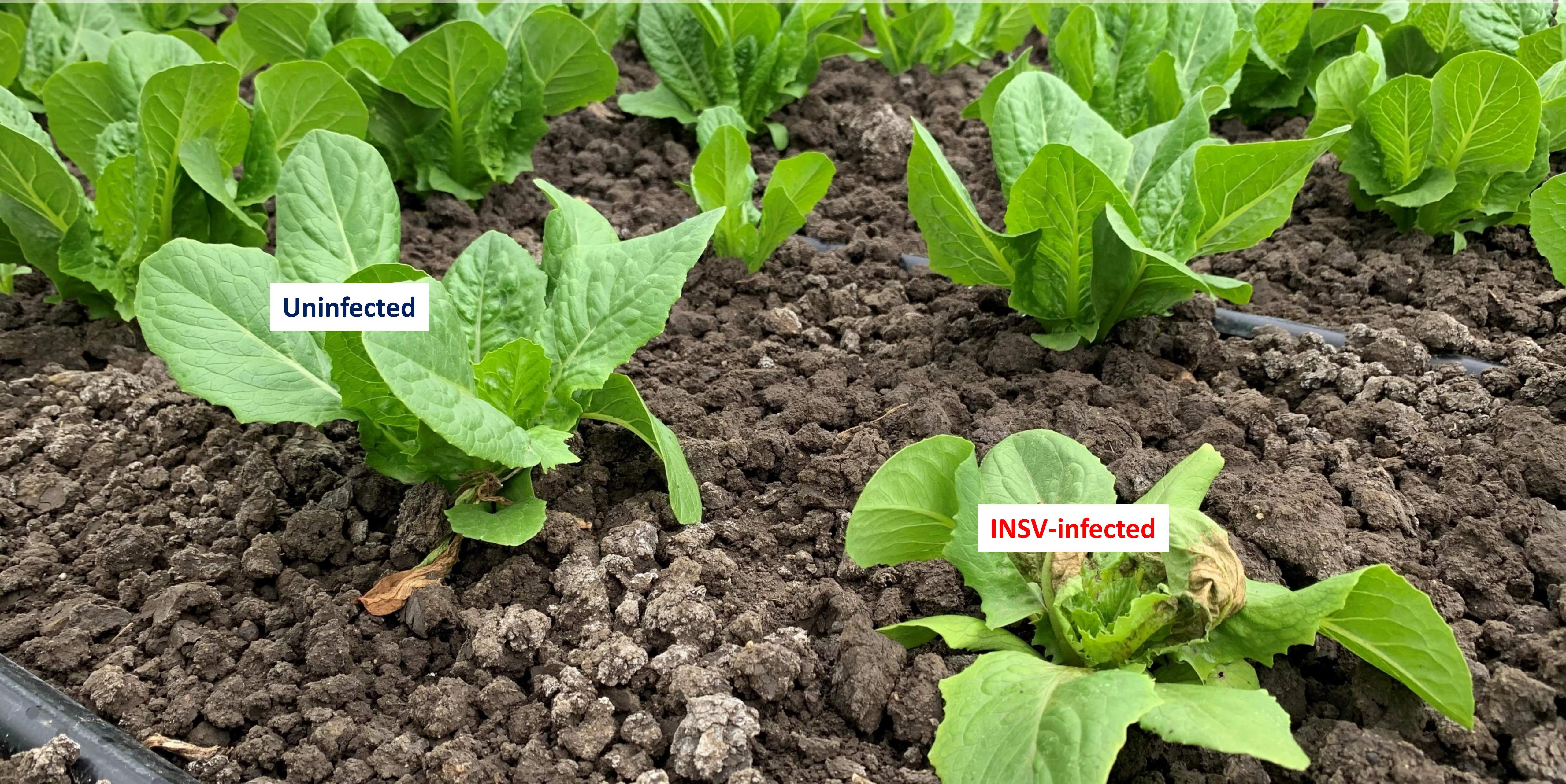
- Adults transmit the virus.
- Virus is not passed from adult to offspring.
- Plants that are infected with INSV must be a <u>reproductive host</u> for western flower thrips for virus acquisition to occur.



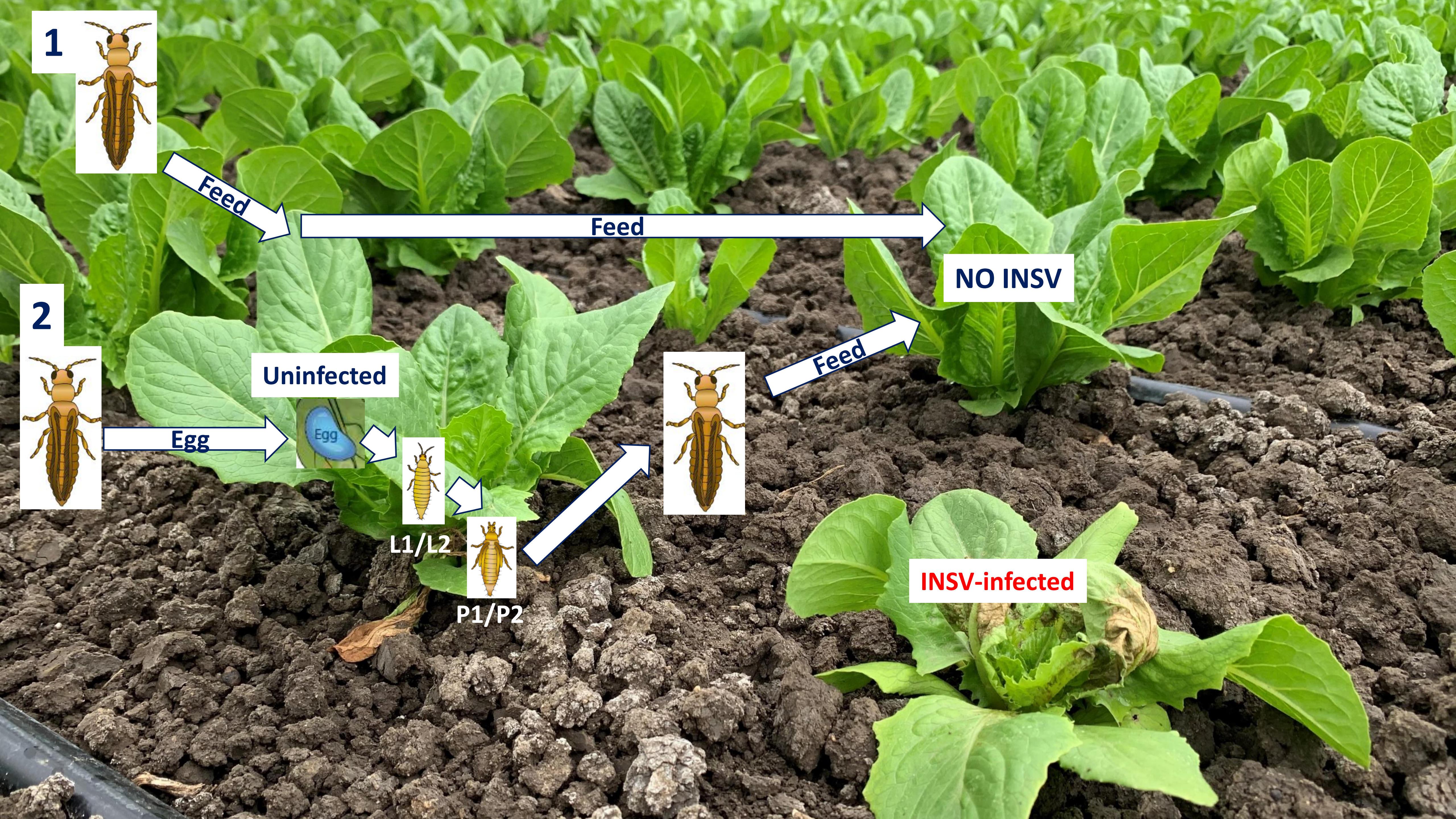
Adapted from
Oliver and Whitfield, 2016
Rotenberger et al., 2020

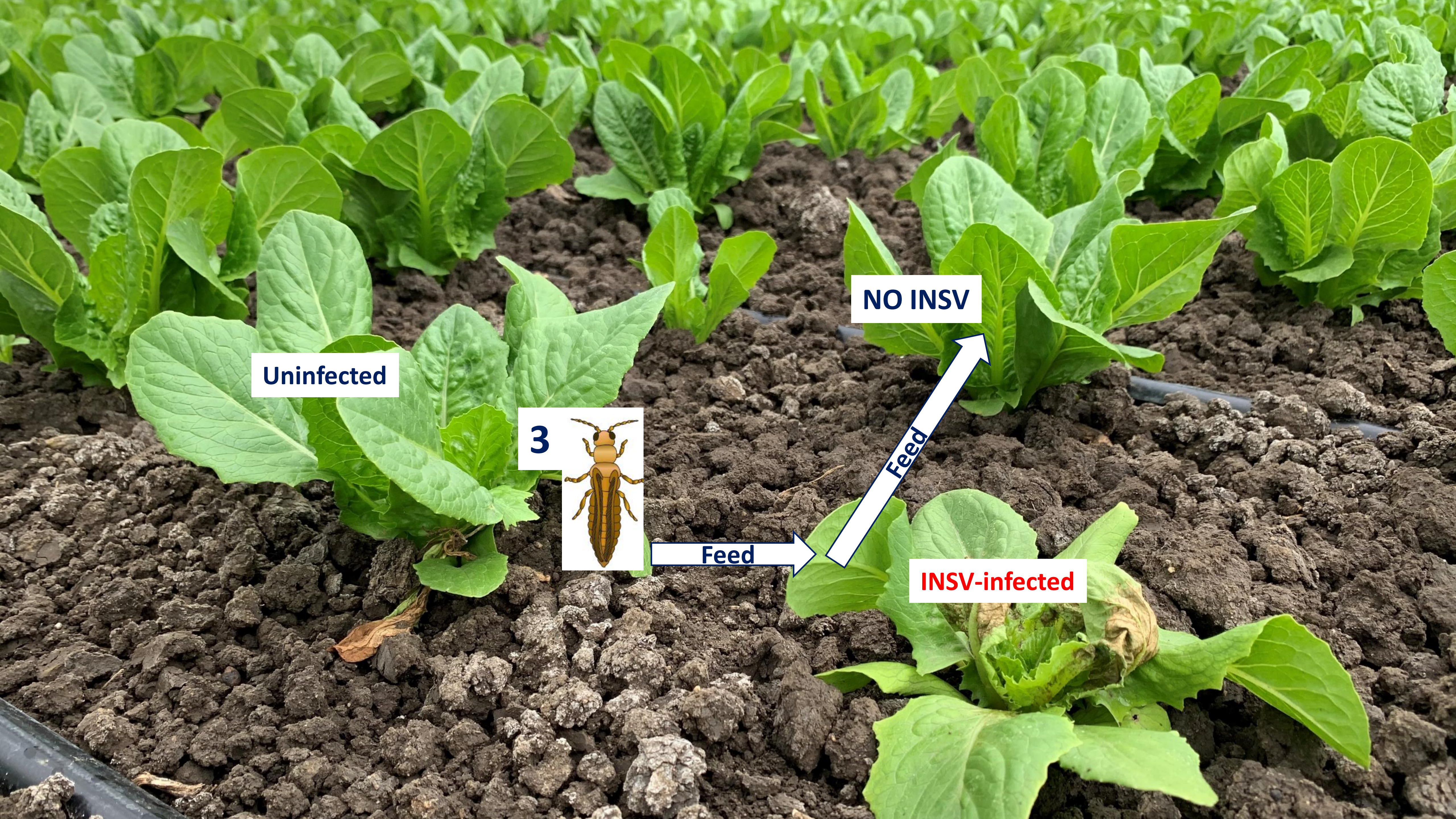
- INSV symptoms in lettuce: ~10-14 days
- Thrips larvae can acquire the virus before symptoms appear

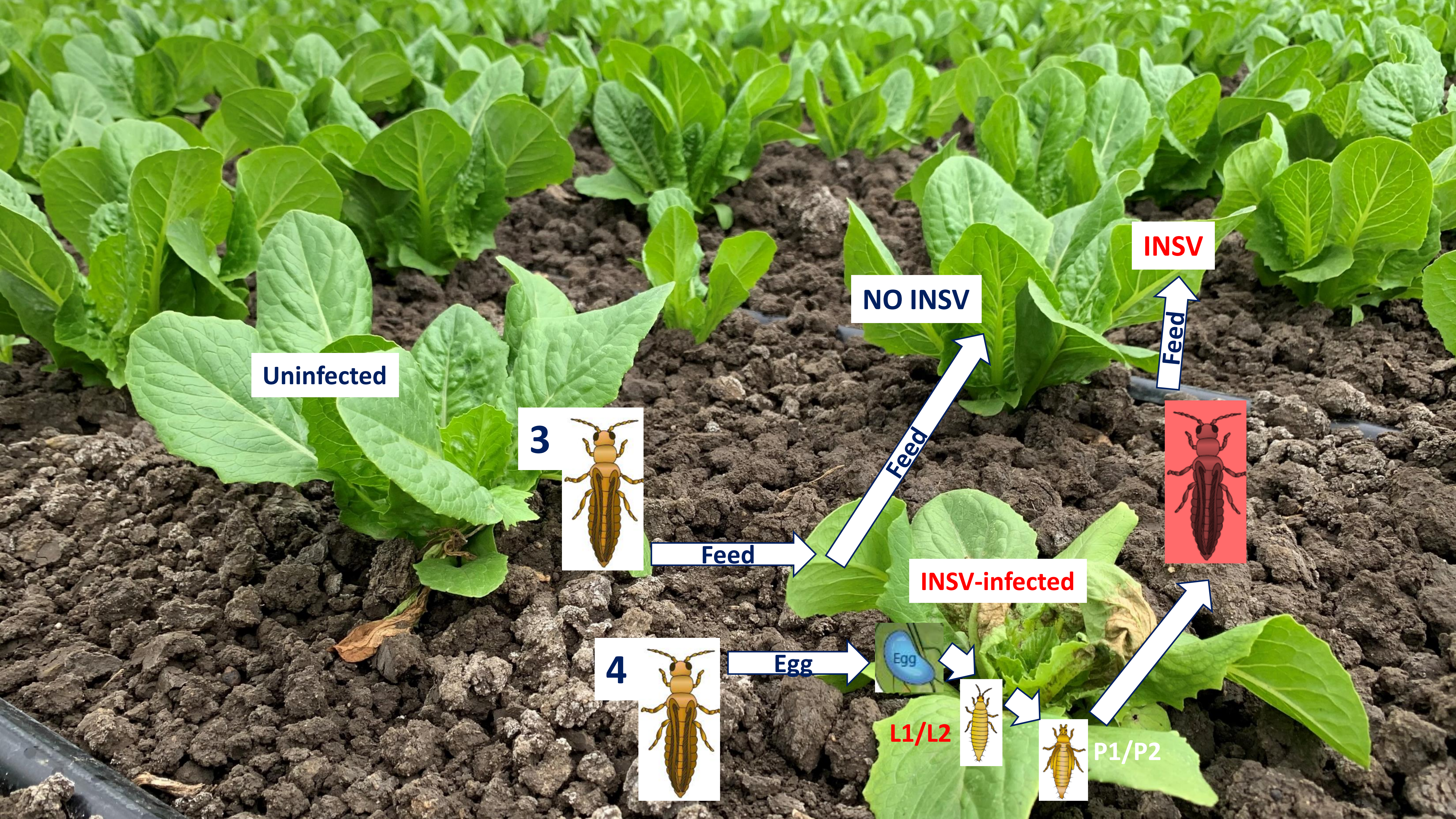
Thrips transmission of tospoviruses




1
Feed
Feed
NO INSV
Uninfected
INSV-infected

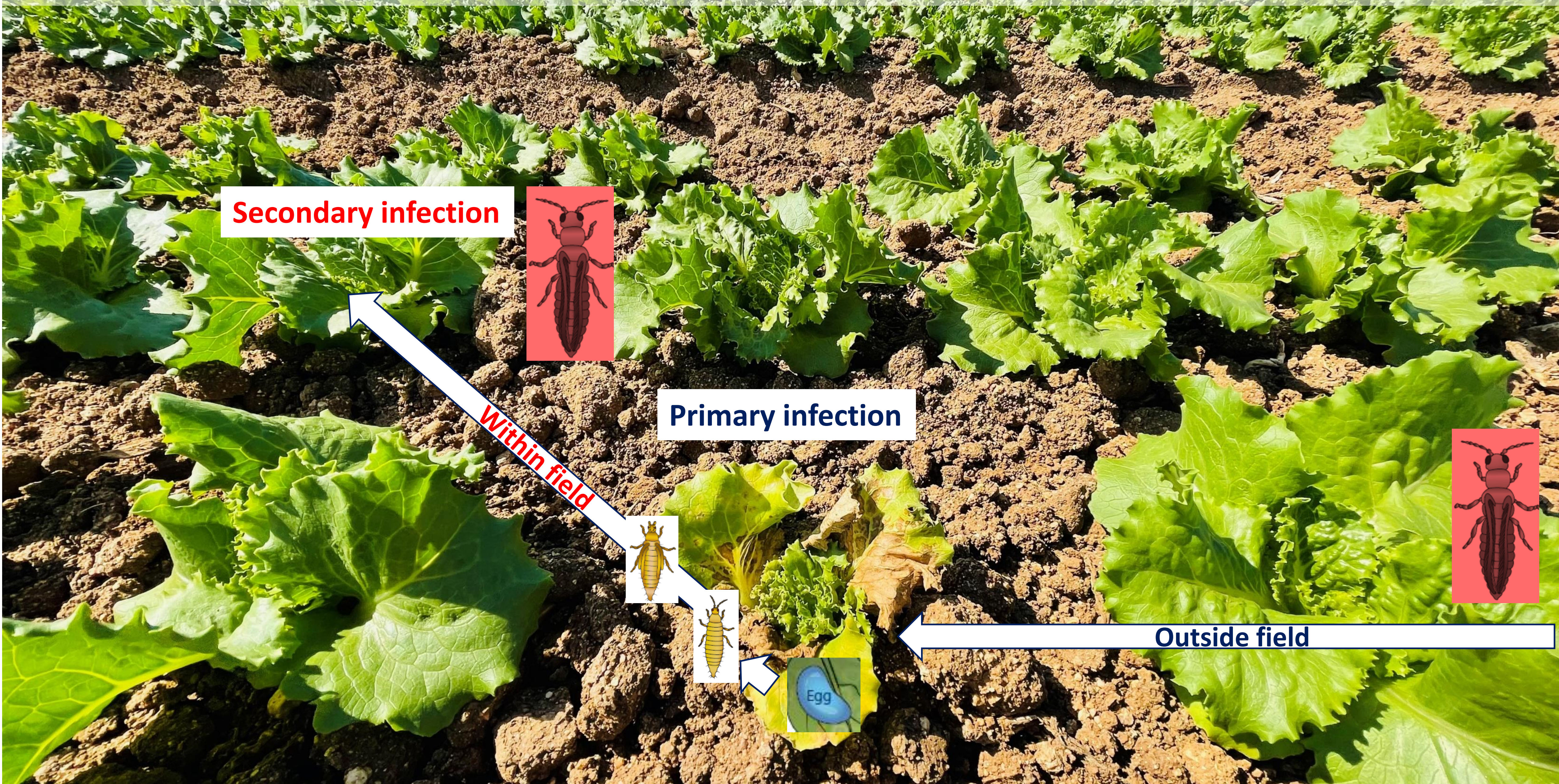

1
Feed
Feed
NO INSV
2
Uninfected
Egg
Egg
L1/L2
P1/P2
Feed
INSV-infected


Uninfected
3
Feed
NO INSV
Feed
INSV-infected



Uninfected
3
Feed
NO INSV
Feed
INSV
Feed
INSV-infected
4
Egg
Egg
L1/L2
P1/P2

Two types of infection



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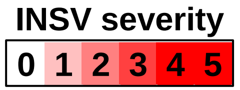
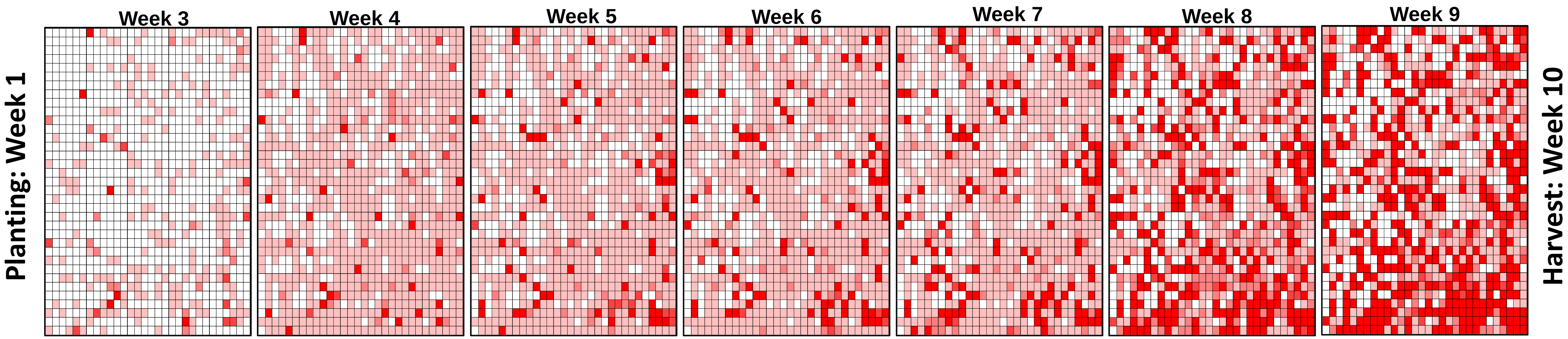
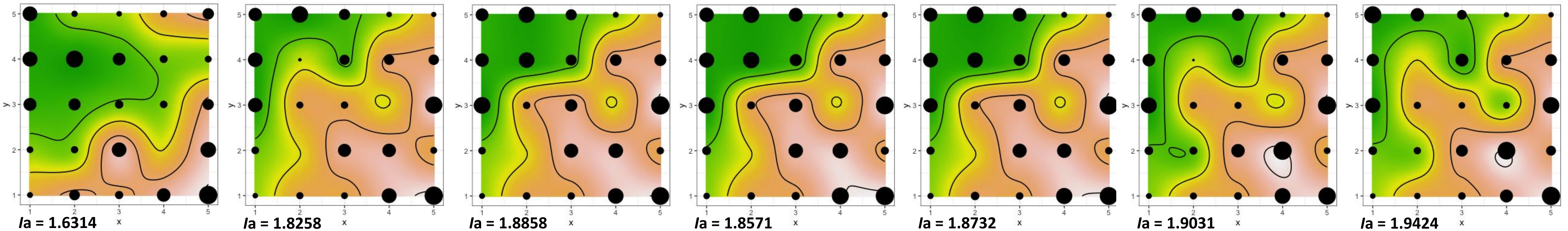
INSV incidence strongly aggregates



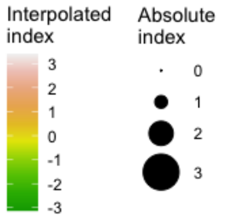
INSV Severity



INSV Incidence



Ia = 1.6314	*Ia* = 1.8258	*Ia* = 1.8858	*Ia* = 1.8571	*Ia* = 1.8732	*Ia* = 1.9031	*Ia* = 1.9424
Pa = 0.0100	*Pa* < 0.0001	*Pa* < 0.0001	*Pa* < 0.0001	*Pa* < 0.0001	*Pa* < 0.0001	*Pa* < 0.0001



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Hasegawa and Del-Pozo, 2022

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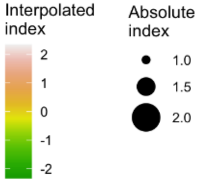


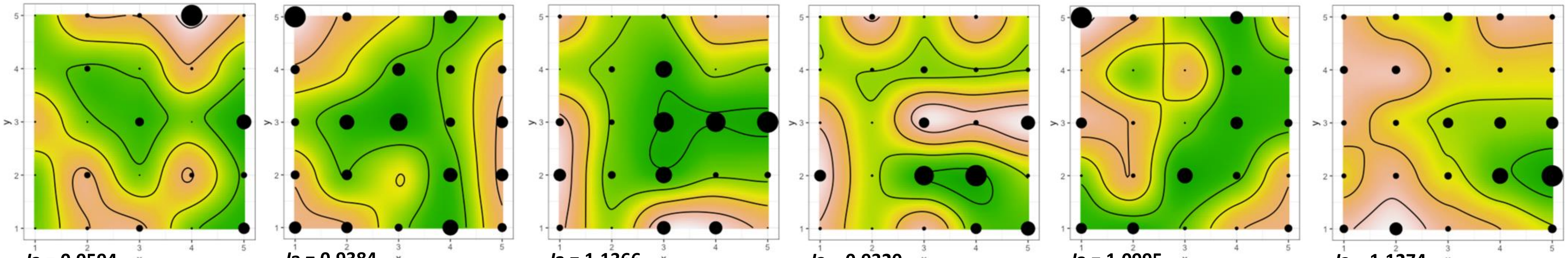
Planting: Week 1

Harvest: Week 10

Thrips Abundance

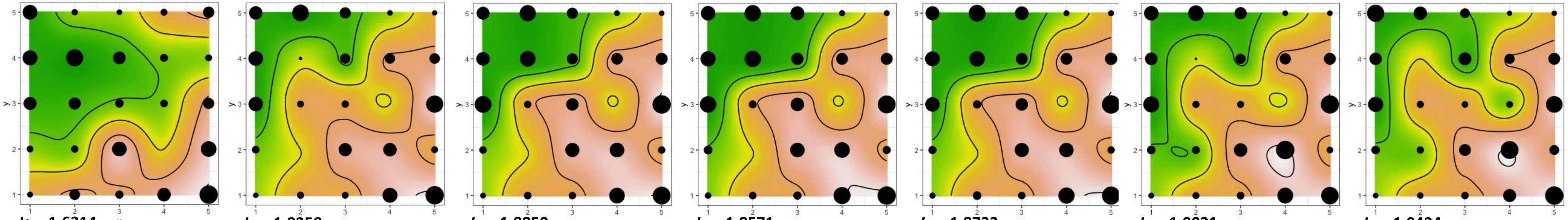
Week 3 | **Week 4** | **Week 5** | **Week 6** | **Week 7** | **Week 8** | **Week 9**

Thrips not recovered in sampling



Week 4	*Ia* = 0.9594	*Pa* = 0.5400
Week 5	*Ia* = 0.9384	*Pa* = 0.6700
Week 6	*Ia* = 1.1366	*Pa* = 0.1500
Week 7	*Ia* = 0.9320	*Pa* = 0.6300
Week 8	*Ia* = 1.0995	*Pa* = 0.2600
Week 9	*Ia* = 1.1274	*Pa* = 0.1700

INSV Incidence



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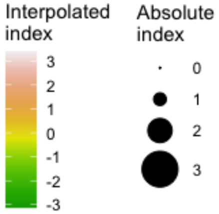
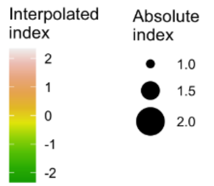


Thrips distribution does not *always* equal INSV distribution

Hasegawa and Del-Pozo, 2022

Thrips abundance increases over time



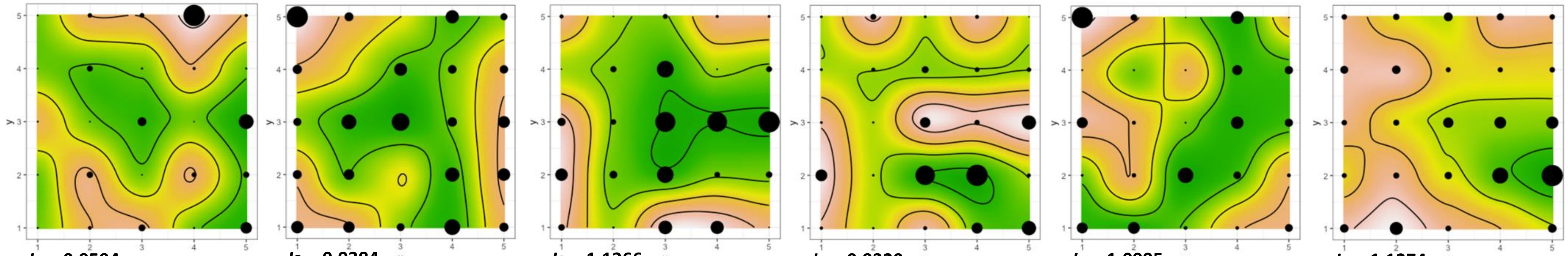
Thrips Abundance

Planting: Week 1

Week 3

Thrips not recovered in sampling

Week 4 | **Week 5** | **Week 6** | **Week 7** | **Week 8** | **Week 9**



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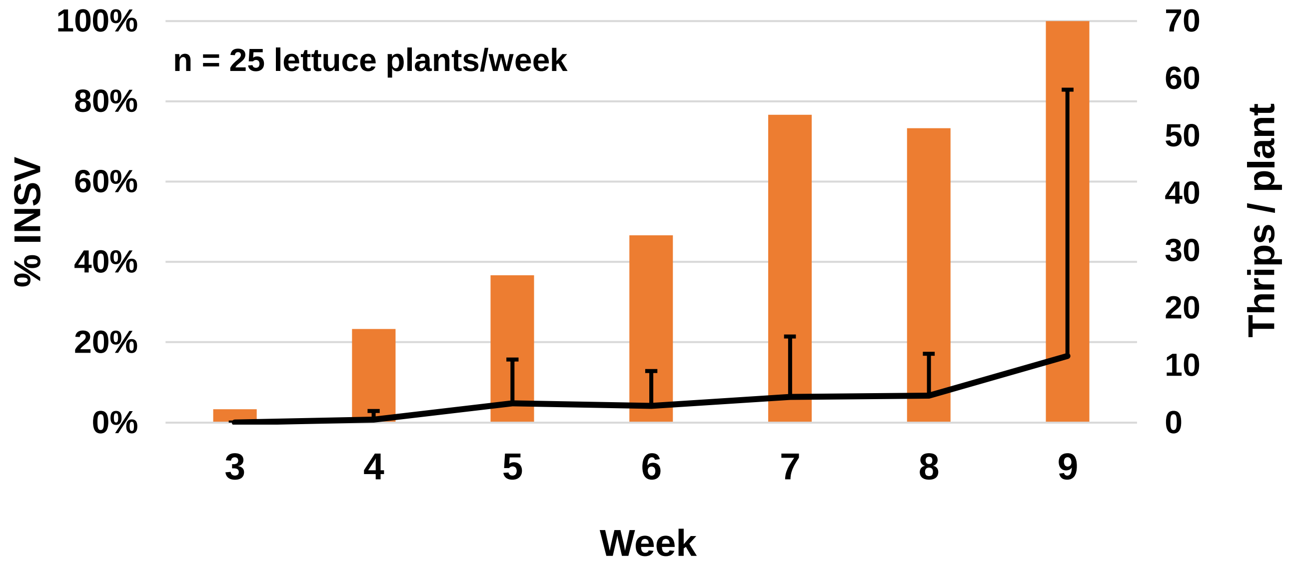
Harvest: Week 10



Hasegawa and Del-Pozo, 2022

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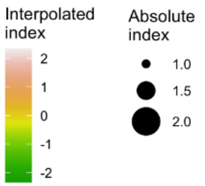

Thrips Abundance

Planting: Week 1

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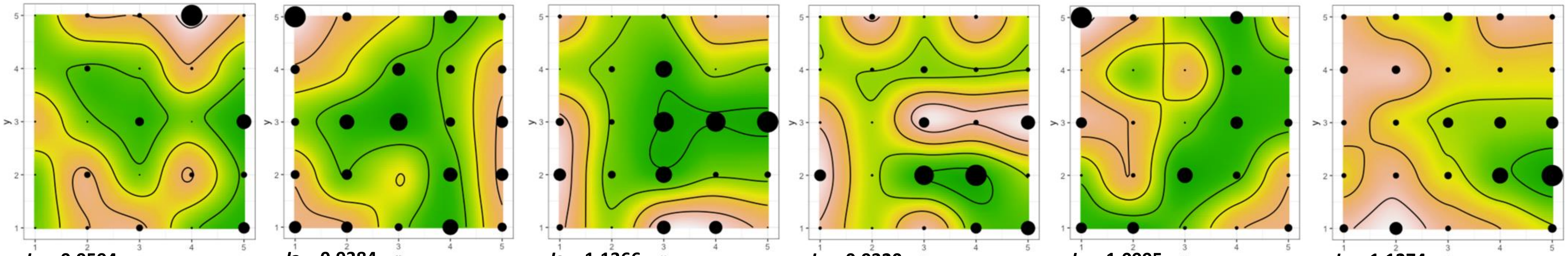

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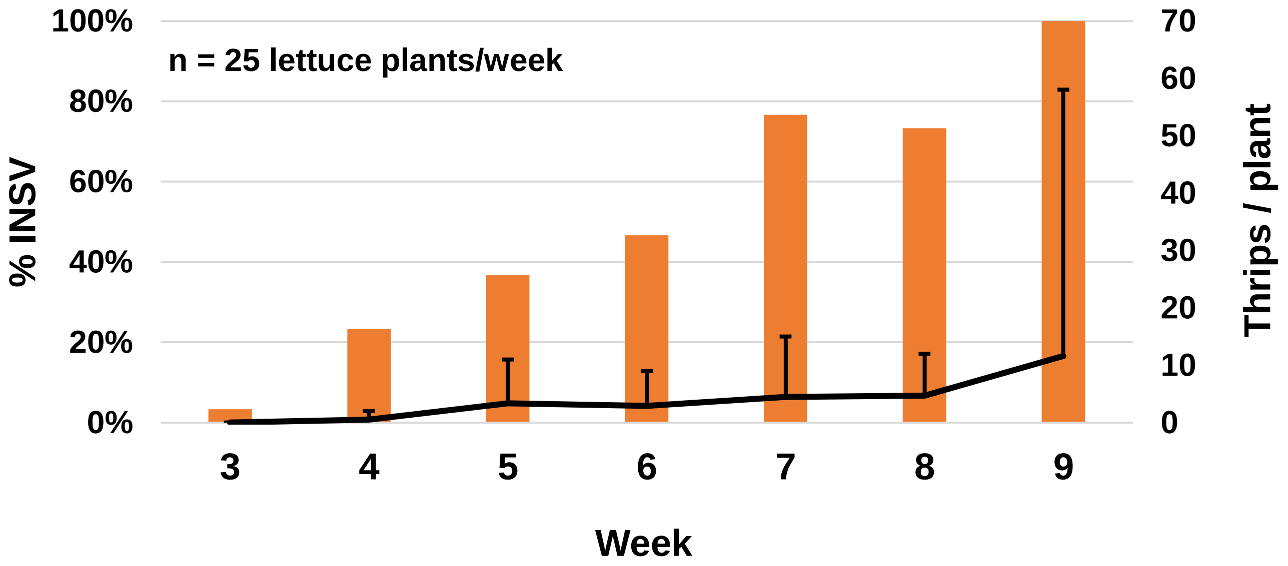
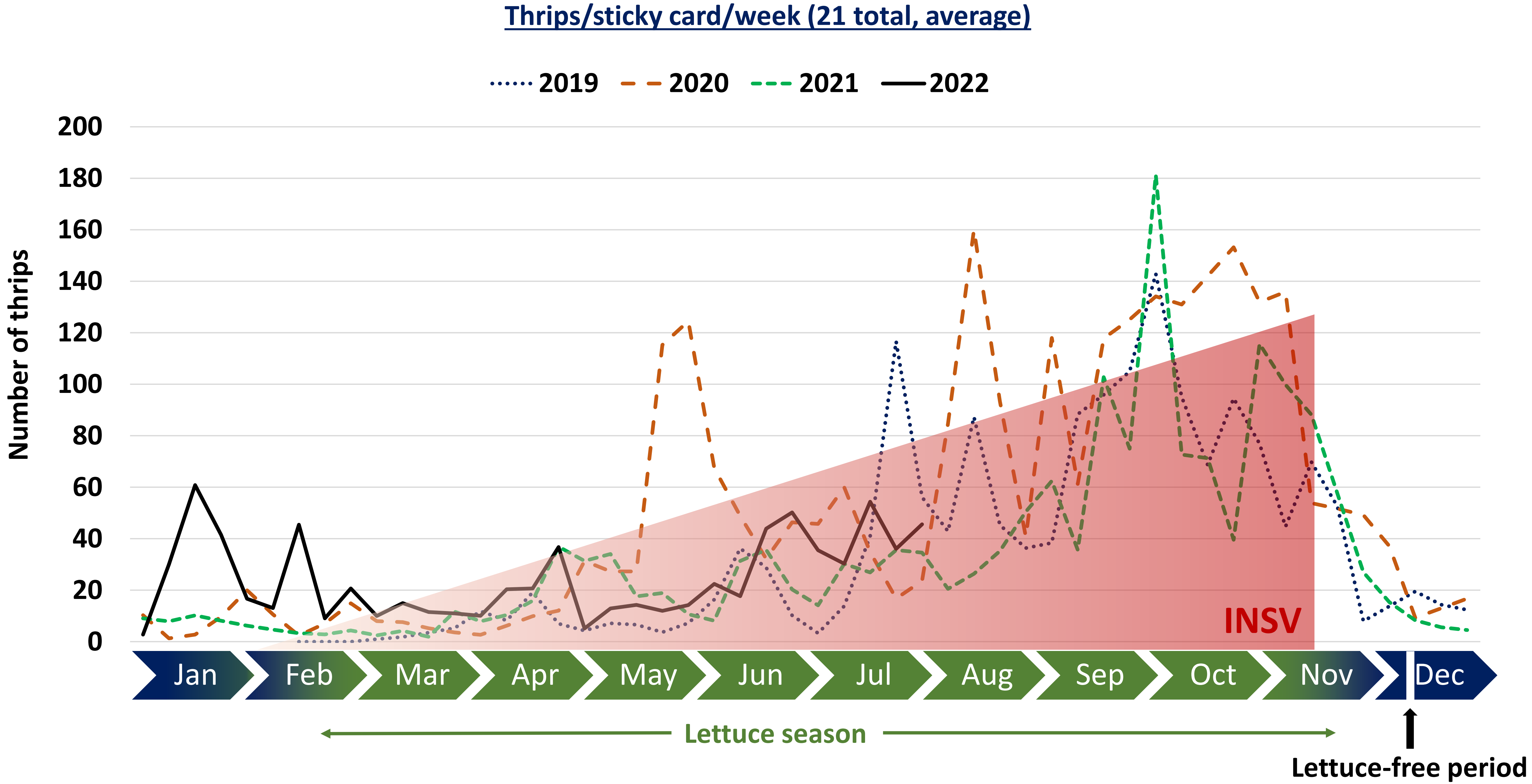
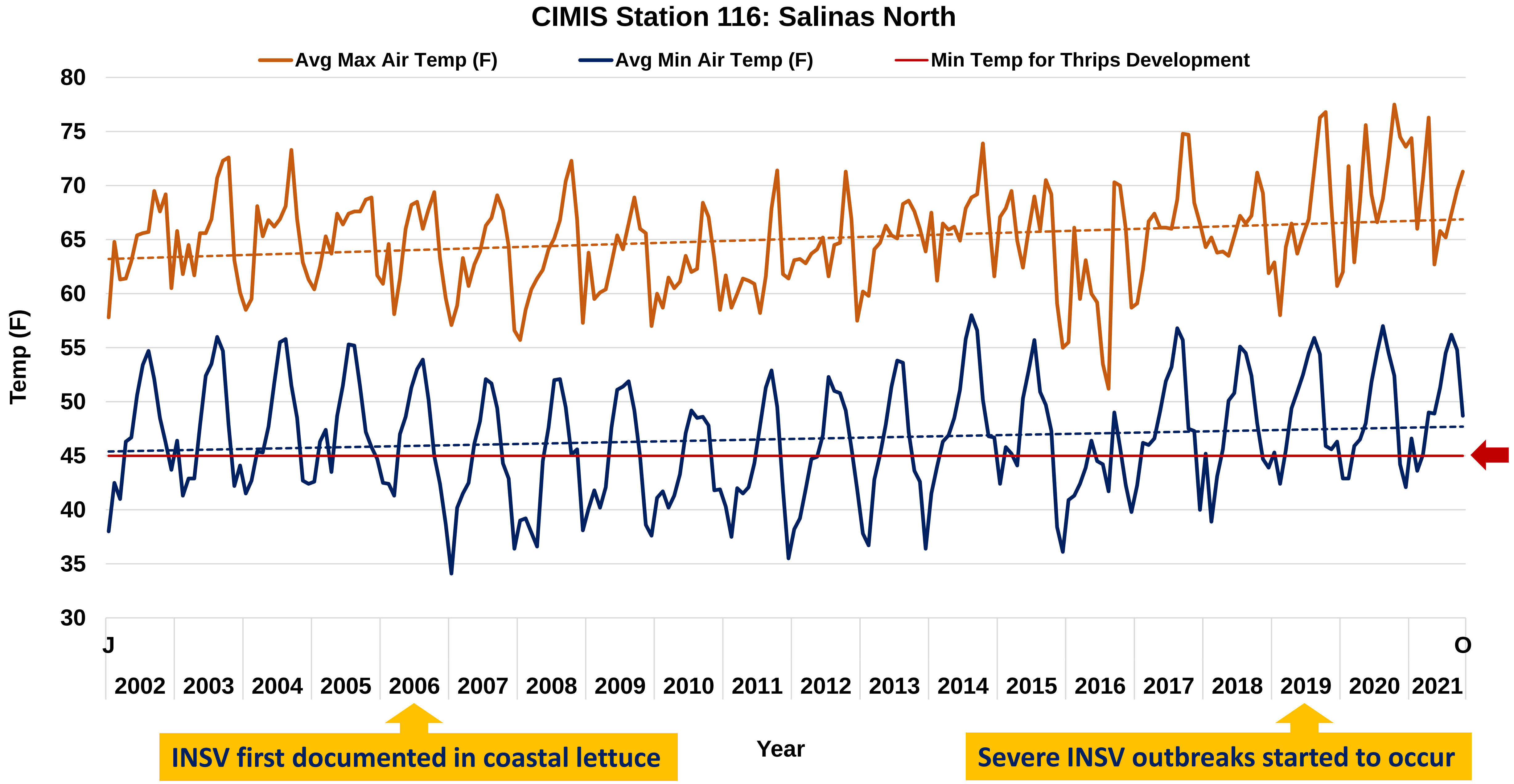


Hasegawa and Del-Pozo, 2022

Salinas Valley thrips monitoring network



Air temperature: 20 years



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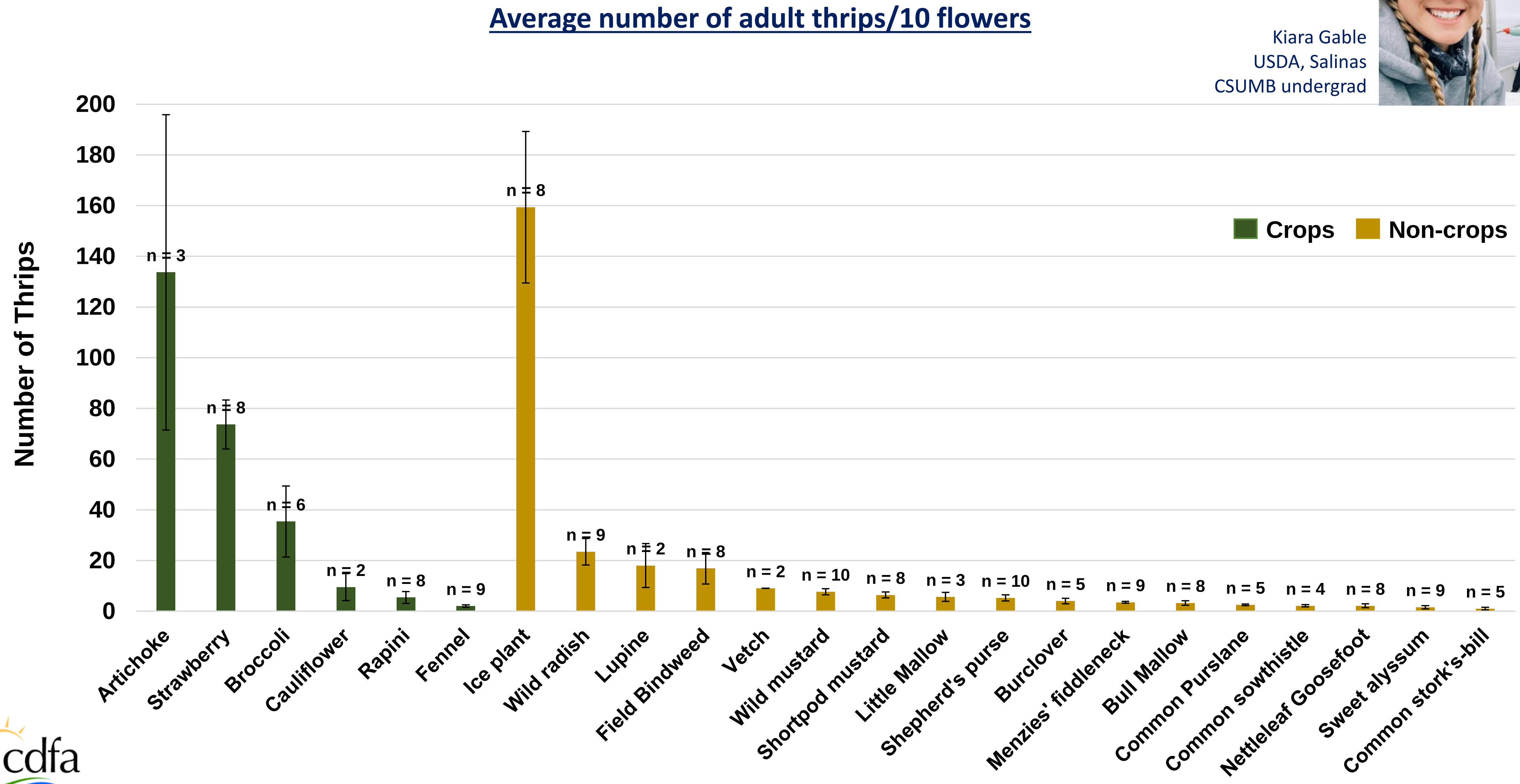
Thrips abundance in crops and non-crops

Kiara Gable
USDA, Salinas
CSUMB undergrad



CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

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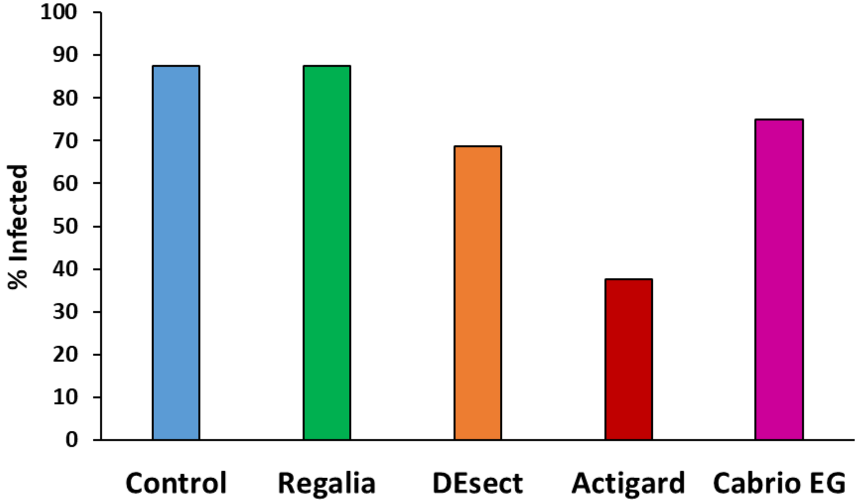
Enhancing Virus Control in Lettuce and Melons by Optimizing Immunity Priming Approaches

2.5 years (2021 – 2024); Year 1: Greenhouse trials

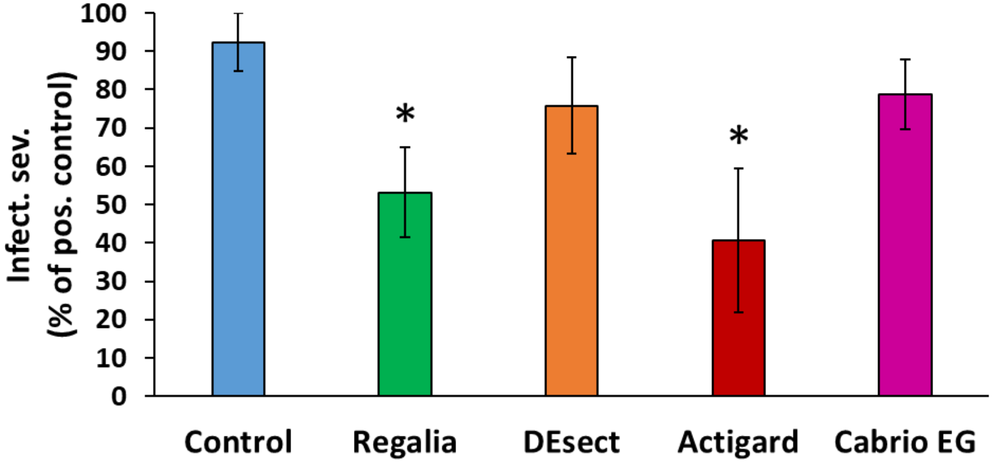
Dr. Kerry Mauck
Assistant Professor of Entomology, UC Riverside

1. Actigard (AI = acibenzolar-*S*-methyl [ASM]).
2. Regalia (AI = extract of Giant Knotweed *Reynoutria sachalinensis*).
3. Cabrio EG (AI = pyraclostrobin).
4. DEsect (AI = silicon dioxide).

INSV incidence



INSV severity



CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

California Environmental Protection Agency dpr Department of Pesticide Regulation

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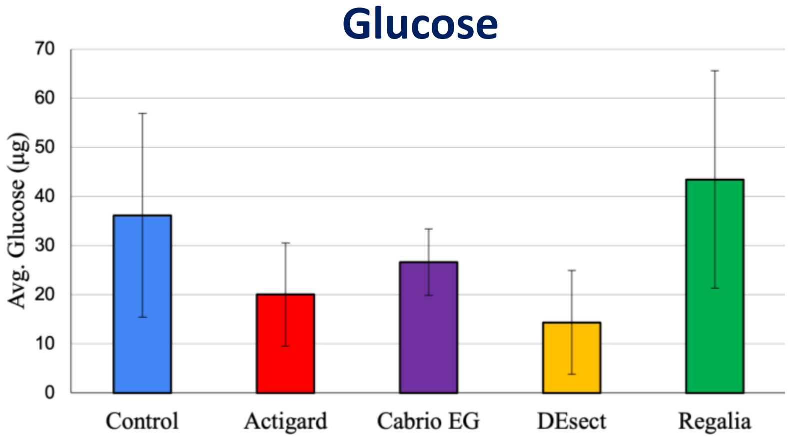
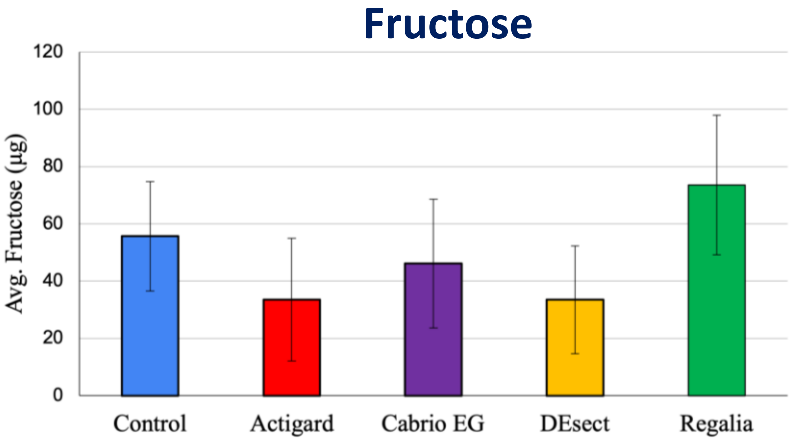
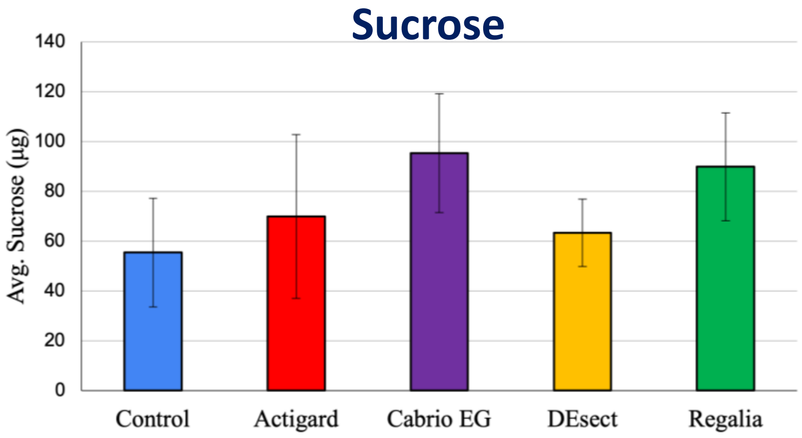
Plant metabolites







CALIFORNIA LEAFY GREENS
RESEARCH PROGRAM

California Environmental Protection Agency
dpr Department of Pesticide Regulation

Enhancing Virus Control in Lettuce and Melons by Optimizing Immunity Priming Approaches

<u>2.5 years (2021 – 2024); Year 2: Field trial</u>

Dr. Kerry Mauck
Assistant Professor of
Entomology, UC Riverside

1. Actigard (AI = acibenzolar-*S*-methyl [ASM]).
2. Regalia (AI = extract of Giant Knotweed *Reynoutria sachalinensis*).
3. Lannate SC (AI = Methomyl)
4. Radiant SC (AI = Spinetoram)

- 9 total treatments, 4 replicated blocks
- 3 applications, 2 weeks apart
- INSV incidence and severity, number of thrips recorded
- Data being collected

CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

California Environmental Protection Agency dpr Department of Pesticide Regulation

Receptor interference: A novel IPM technology for managing key insect pests of vegetables in California

2.5 years: (2022 – 2025)

- **Phase 1 (Discovery)**: Identification and expression of receptors that are specific to western flower thrips (WFT) and diamondback moth (DBM),
- **Phase 2 (Synthesis)**: Screen, design, and synthesize bioactive peptides that selectively bind to and disrupt WFT and DBM GPCRs, and
- **Phase 3 (Efficacy)**: Evaluate the efficacy of bioactive peptides on WFT and DBM survival.


Morning AgClips America's #1 Daily Ag News Source

PEST MANAGEMENT · RESEARCH · TECHNOLOGY

PEST MANAGEMENT ...

New technology for environmentally safe pest control discovered

"Receptor interference" technology disrupts the vital processes needed for fire ants to survive

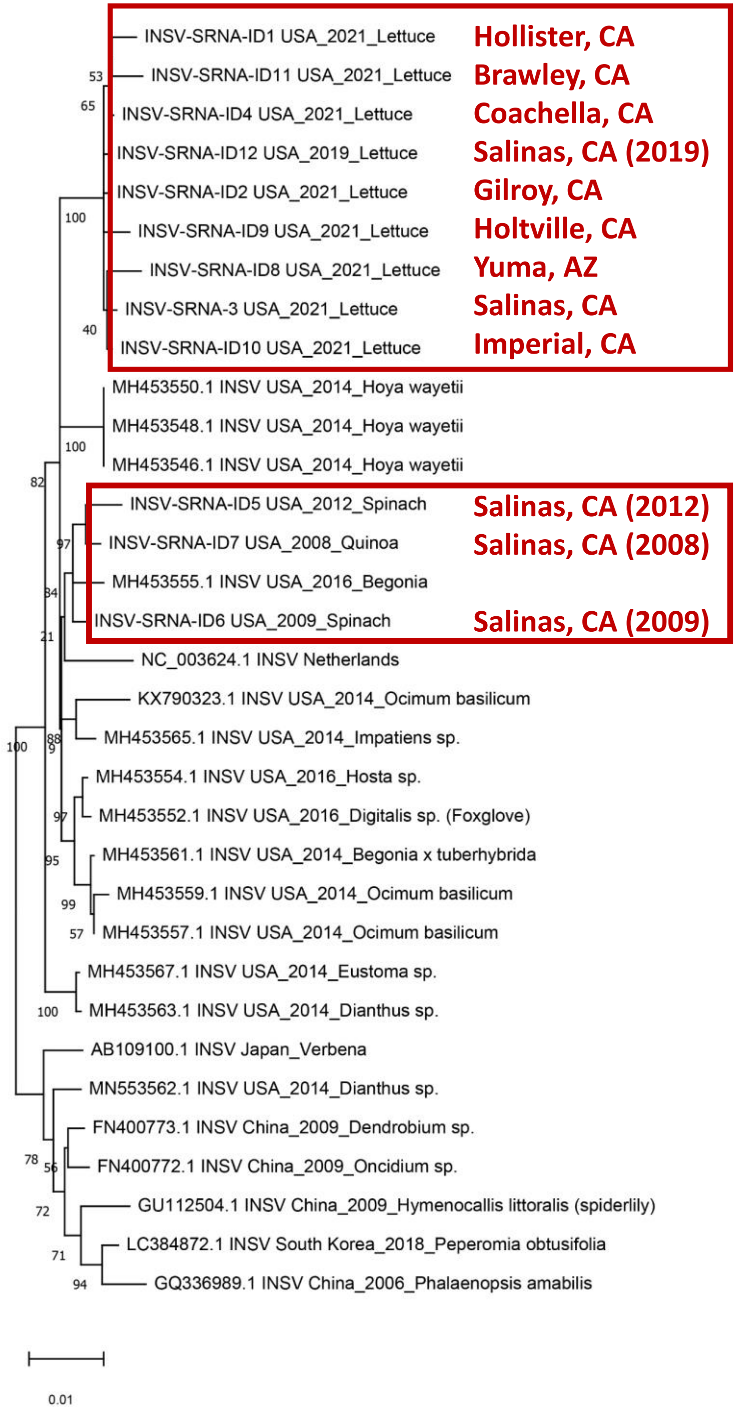
PUBLISHED ON **AUGUST 29, 2021**

Dr. Manny Choi
Research Entomologist,
USDA Corvallis, OR

Laura Hladky
USDA, Salinas
Lab Tech

Juan Vargas
USDA, Salinas
CSUMB undergrad

California Environmental Protection Agency
Department of Pesticide Regulation



2021 samples (n=9)
>99% similarity

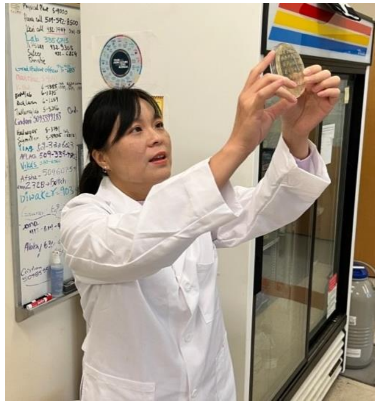
~98.5% similarity

Historical samples (n=3)
>99% similarity

INSV genome sequencing

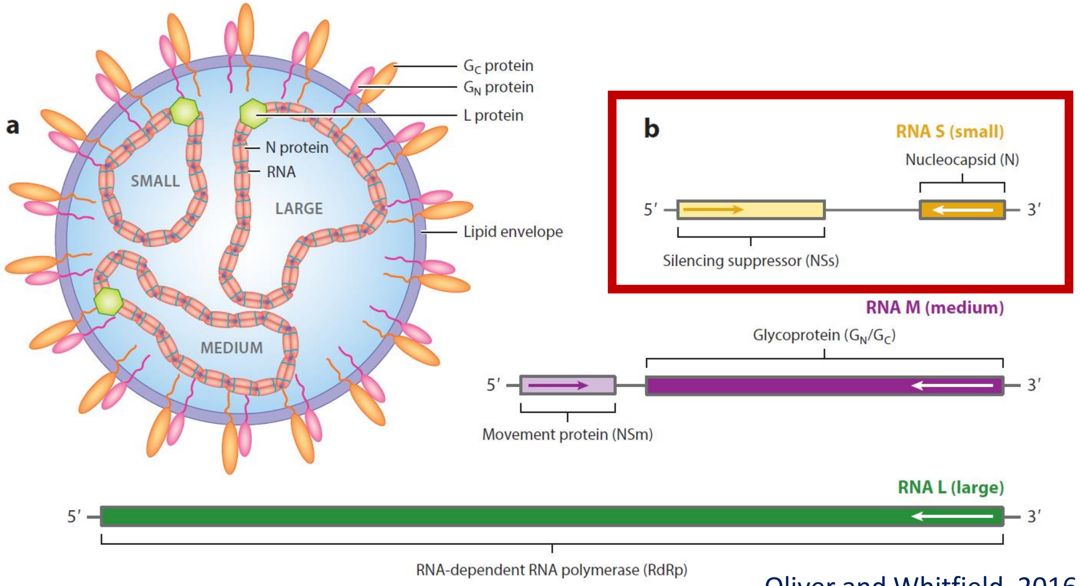
S RNA

Dr. Hanu Pappu
Distinguished Prof.
Plant Virology



Dr. Ying Zhai
Research
Associate

Washington State University



Oliver and Whitfield, 2016

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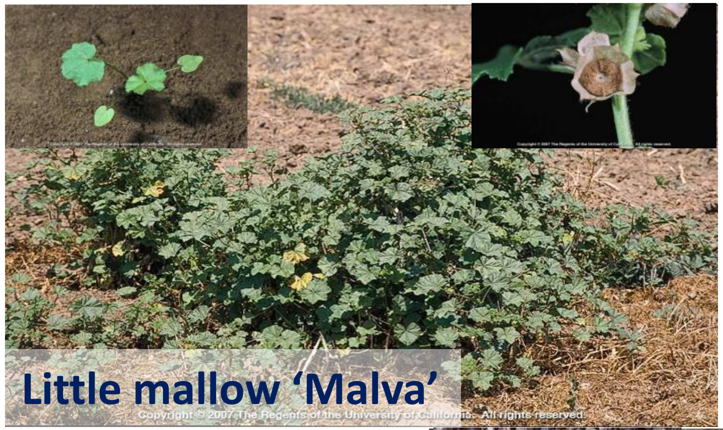
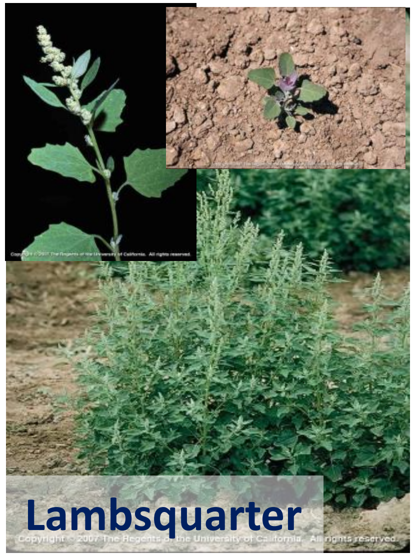
Top 10 hosts





Pictures courtesy of Richard Smith and UC ANR

Top 10 non-lettuce hosts for INSV on the Central Coast of CA

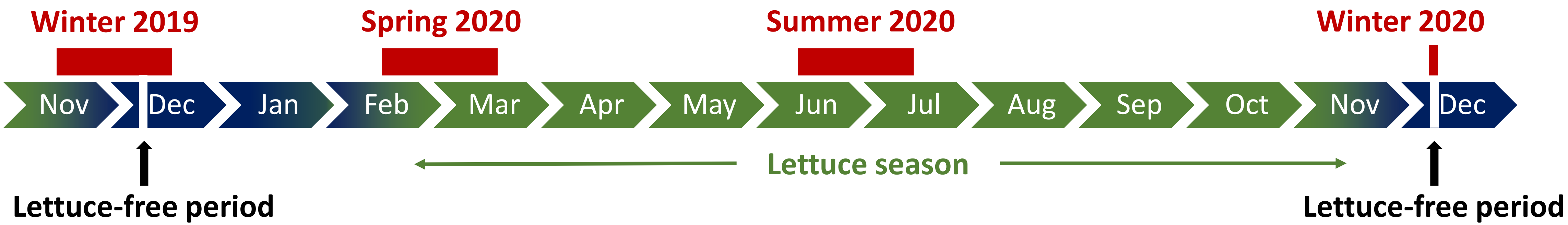
				Seasonal abundance			
Common name	**Scientific name**	**Family**	**Category**	**Winter**	**Spring**	**Summer**	**Fall**
Little Mallow	*Malva parviflora*	Malvaceae (Mallow Family)	Broadleaf	++	++	++	++
Annual Sowthistle	*Sonchus oleraceus*	Asteraceae (Sunflower Family)	Broadleaf	++	++	++	++
Nettleleaf goosefoot	*Chenopodium murale*	Chenopodiaceae (Goosefoot Family)	Broadleaf	+	++	++	++
Mare's Tail	*Conyza canadensis*	Asteraceae (Sunflower Family)	Broadleaf	+	++	++	++
Field Bindweed	*Convolvulus arvensis*	Convolvulaceae (Morning glory Family)	Broadleaf	0	++	++	++
Shepherds Purse	*Capsella bursa-pastoris*	Brassicaceae (Mustard Family)	Broadleaf	++	++	++	++
Common Purslane	*Portulaca oleracea*	Portulacaceae (Purslane Family)	Broadleaf	0	+	++	++
Hairy Fleabane	*Conyza bonariensis*	Asteraceae (Sunflower Family)	Broadleaf	+	++	++	++
Burning Nettle	*Urtica urens*	Urticaceae (Nettle Family)	Broadleaf	++	++	++	++
Common Lambsquarter	*Chenopodium album*	Chenopodiaceae (Goosefoot Family)	Broadleaf	0	++	++	++

Courtesy of Richard Smith

http://ipm.ucanr.edu/PMG/weeds_all.html

Field surveys to identify hosts for INSV: Salinas Valley

Sampling summary:
>3,000 plant samples tested for INSV
73 species: majority weeds, native plants, vegetable crops



Primary detection of INSV:
Serological: TAS-ELISA

Validation:
Serological: Lateral flow rapid strip tests
Genetic: RT-PCR

CALIFORNIA LEAFY GREENS
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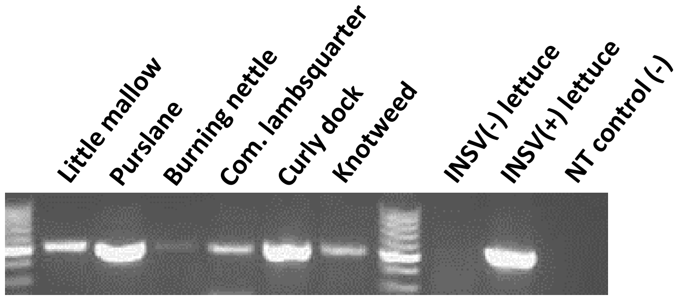
Ranking system for INSV hosts

Laura Hladky
USDA, Salinas
Lab Tech

Grace Hardy
USDA, Salinas
CSUMB undergrad

<u>Host INSV Index</u> = $\text{Avg ELISA}_{positive} \times (N_{positive}/N_{total})$

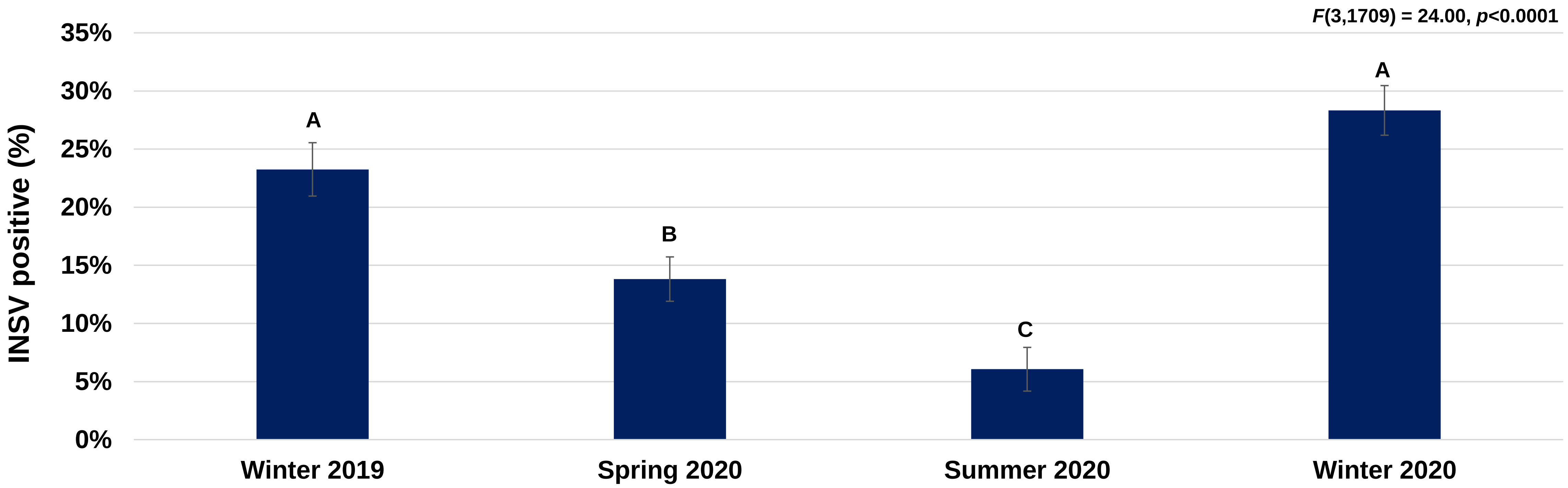
Common name	Avg. ELISA Abs.	INSV positive	Total samples	% INSV	Host INSV Index	Validation: Immunostrip	Validation: RT-PCR	Validation: Seq. (partial)
Lettuce*	3.061	100	100	100.0	3.061	✓	✓	✓
Chickweed*	3.210	26	50	52.0	1.669	✓		
Hairy fleabane	1.730	26	93	28.0	0.484	✓		
Annual sowthistle	1.721	64	295	21.7	0.373	✓	✓	✓
Common lambsquarter	1.211	15	54	27.8	0.336		✓	✓
Purslane	1.724	13	75	17.3	0.299	✓	✓	✓
Curly dock	1.508	9	46	19.6	0.295	✓	✓	✓
Field bindweed	1.137	26	118	22.0	0.251	✓	✓	✓
Shepherd's purse	2.557	11	116	9.5	0.242		✓	
Little mallow	1.066	101	544	18.6	0.198	✓	✓	✓
Mare’s tail	1.720	15	157	9.6	0.164			
Bristly oxtongue	1.073	8	54	14.8	0.159			
Burning nettle	1.020	9	59	15.3	0.156		✓	✓
Redroot pigweed	1.592	2	30	6.7	0.106		✓	
Nettleleaf goosefoot	0.605	34	214	15.9	0.096	✓	✓	
Prickly lettuce	0.705	3	48	6.3	0.044	✓	✓	✓
Shortpod mustard	1.594	10	406	2.5	0.039	✓	✓	
Swine cress	0.644	1	30	3.3	0.021			
Artichoke	0.261	1	30	3.3	0.009			
Wild arugula	0.291	1	39	2.6	0.007			
Bull mallow	0.946	1	131	0.8	0.007			
Alkali mallow	0.249	0	31	0.0	0.000			
Iceplant	0.249	0	91	0.0	0.000			
Field mustard	0.249	0	32	0.0	0.000			
Plantain	0.249	0	31	0.0	0.000			

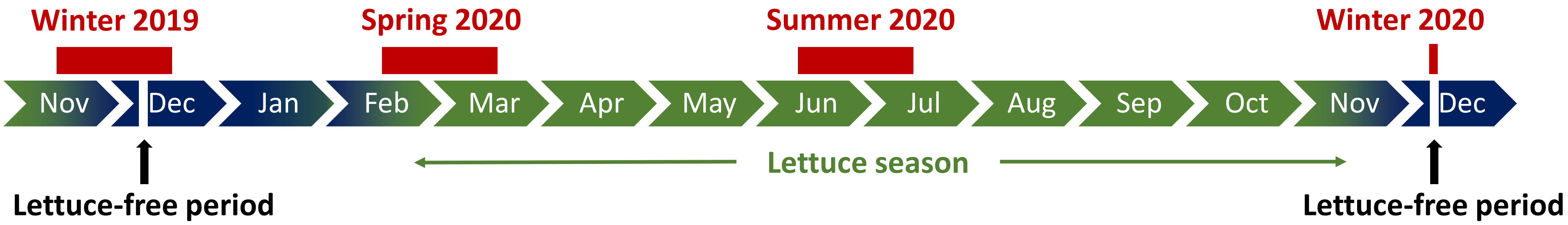


CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

Hasegawa et al., in prep

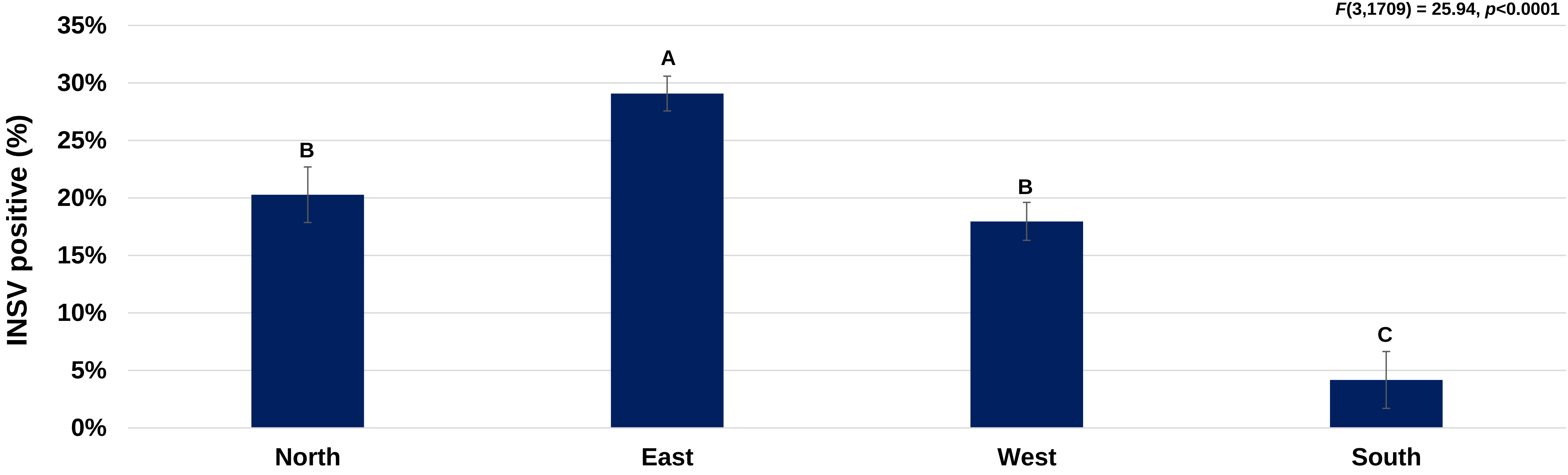
Top 10 hosts: Season

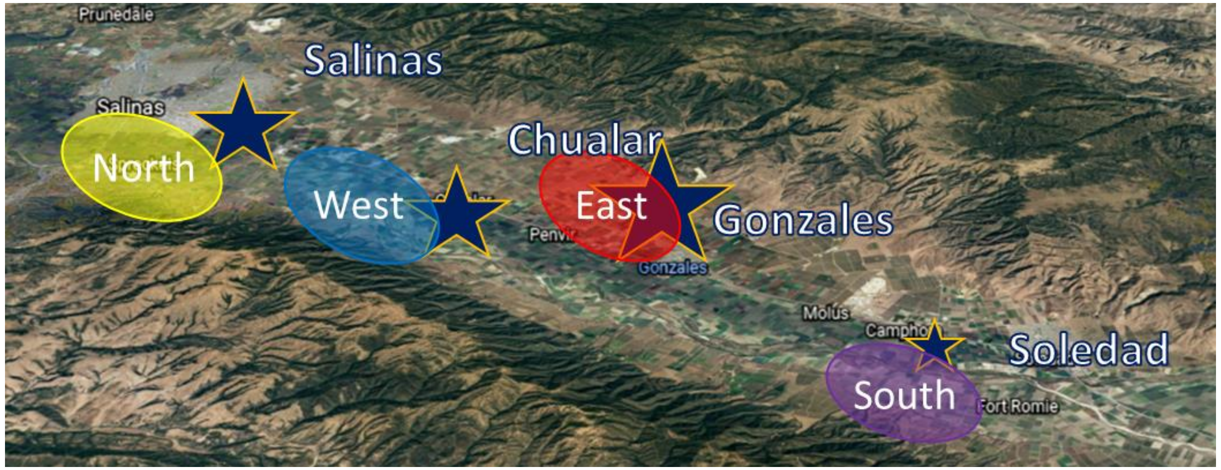




Hasegawa et al., in prep

Top 10 hosts: Location





CALIFORNIA LEAFY GREENS
RESEARCH PROGRAM

Hasegawa et al., in prep

Western flower thrips, *Frankliniella occidentalis*

<u>Vector management challenges:</u>

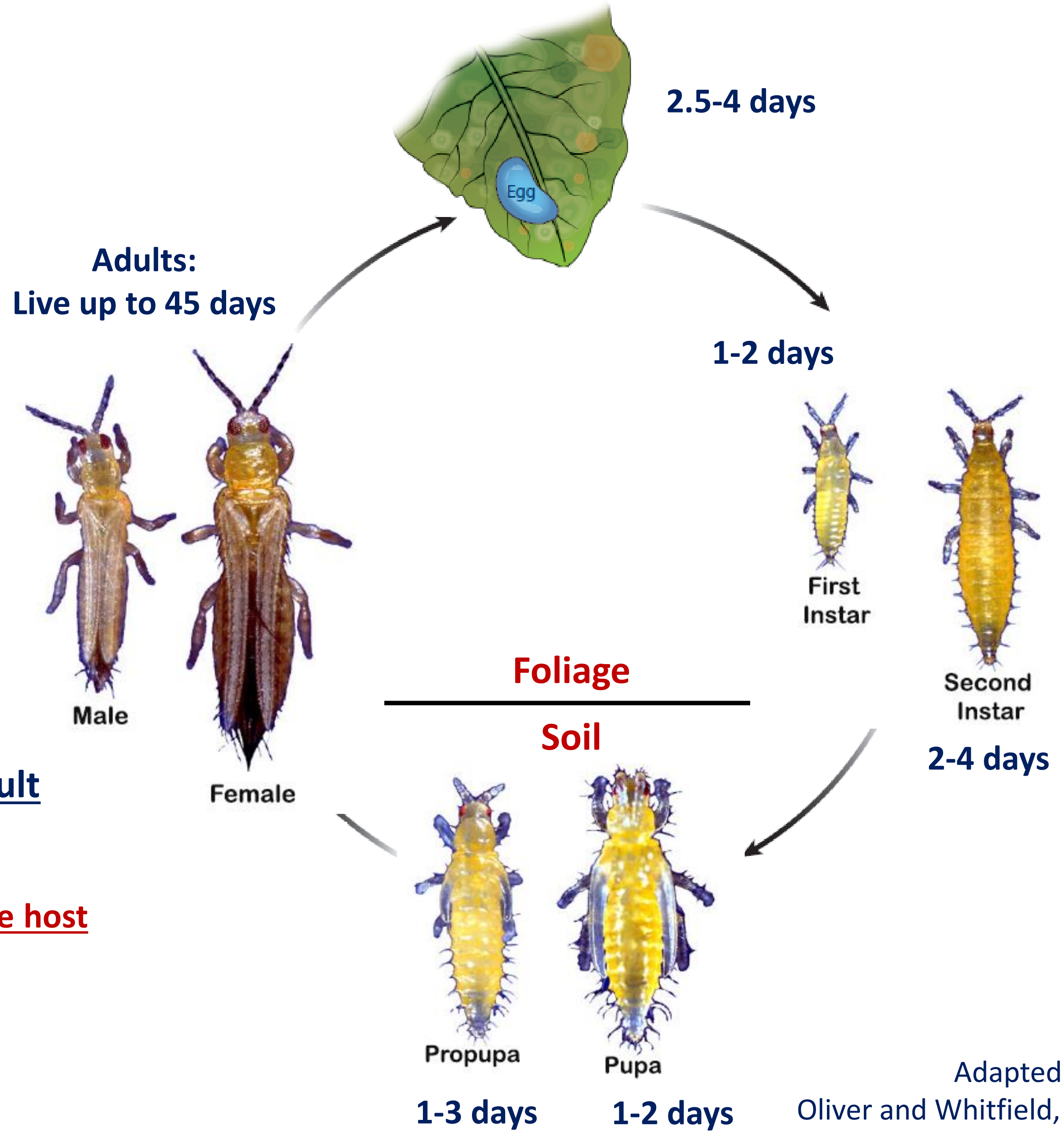
- Small (1-2 mm), cryptic, high fecundity
- Limited chemical options in CA lettuce
    - ~20% organic production in 2021
- Host range = 100s of plants

<u>Virus Management challenges:</u>

- Lack of genetic-based resistance to INSV in lettuce
- Host range = 100s of plants

<u>Virus must be acquired as larvae to transmit as an adult</u>

- Adults transmit the virus.
- Virus is not passed from adult to offspring.
- Plants that are infected with INSV must be a <u>reproductive host</u> for western flower thrips for virus acquisition to occur.

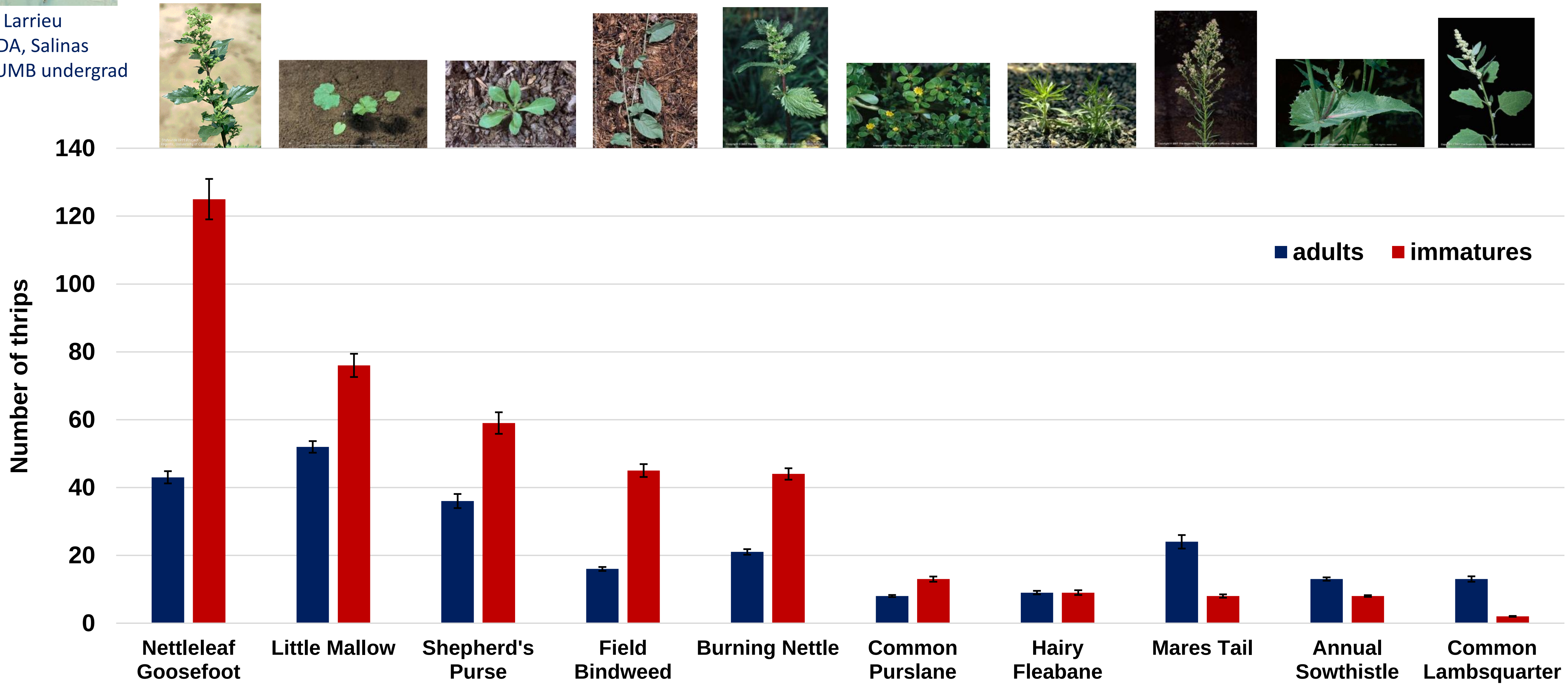


Adapted from
Oliver and Whitfield, 2016
Rotenberger et al., 2020

Kai Larrieu
USDA, Salinas
CSUMB undergrad

Thrips reproduction on top 10 hosts for INSV

Average number of thrips/plant; 10 plants per species



Focused weed management: Example

Field 1

2021 (Romaine):

2021: INSV Source

	INSV positive / Total	% INSV positive
Little mallow	17/44	38%
Annual sowthistle	23/37	62%
Nettleleaf goosefoot	32/42	76%
Common knotweed	8/36	22%

Field 2

2021 (Romaine):

Field 3

2021 (Romaine):

Focused weed management: Example

Field 1

2021 (Romaine):
7/22 (43d): 10.9% INSV
7/29 (50d): 11.5% INSV

2021: INSV Source

	INSV positive / Total	% INSV positive
Little mallow	17/44	38%
Annual sowthistle	23/37	62%
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Common knotweed	8/36	22%

Field 2

2021 (Romaine):
6/29 (49d): 6.0% INSV
7/6 (56d): 13.4% INSV

Field 3

2021 (Romaine):
6/16 (60d): 95.2% INSV

Focused weed management: Example

Field 1

2021 (Romaine):
7/22 (43d): 10.9% INSV
7/29 (50d): 11.5% INSV

2021: INSV Source

2022:
8/26: majority of the weeds were eliminated, but still some remaining

Field 2

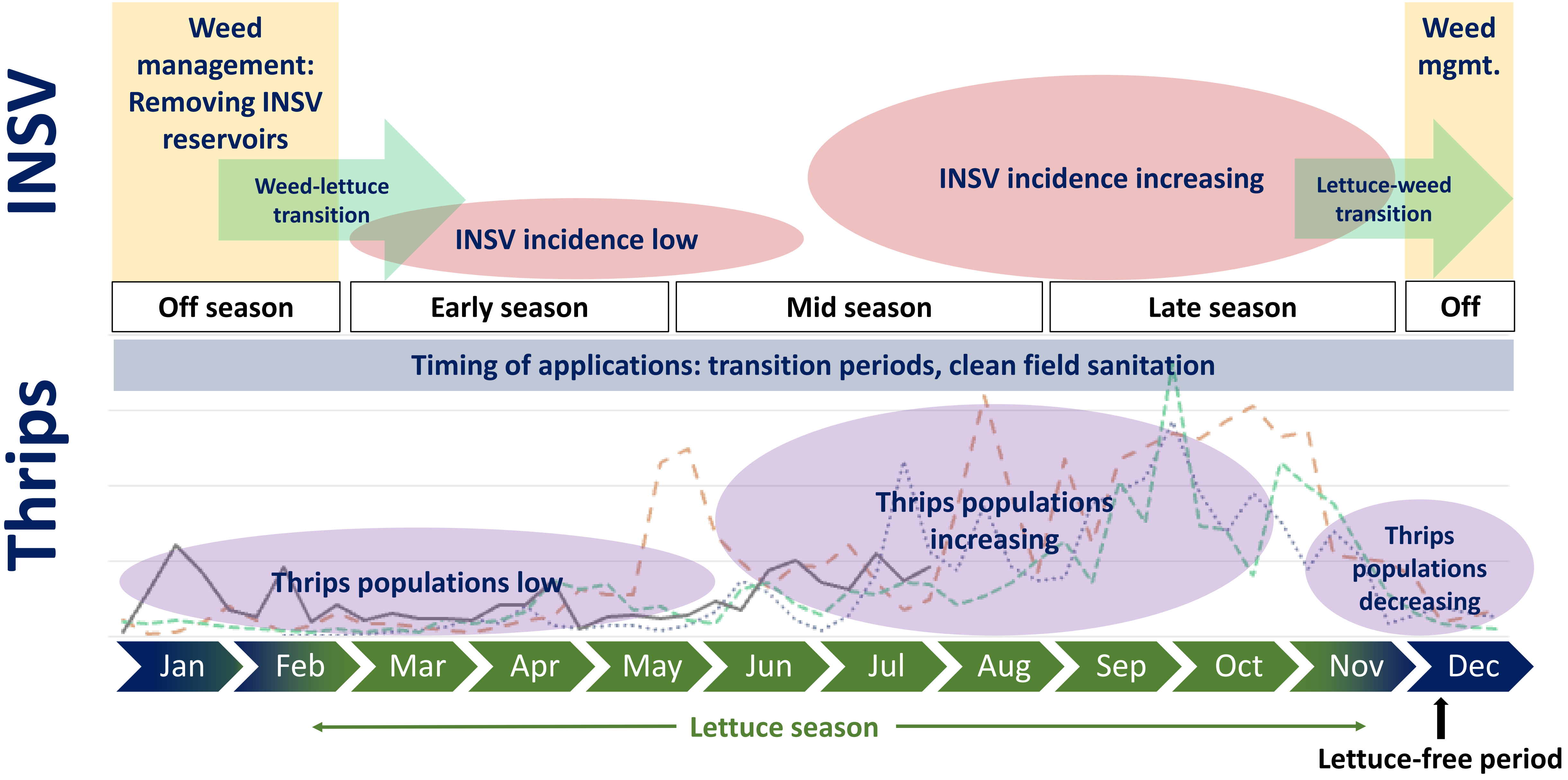
2021 (Romaine):
6/29 (49d): 6.0% INSV
7/6 (56d): 13.4% INSV

2022 (Romaine):
8/26 (47d): 1.7% INSV
9/2 (54d): 3.6% INSV

Field 3

2021 (Romaine):
6/16 (60d): 95.2% INSV

Thrips/INSV IPM model



Thank you

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Mary Zischke, INSV/Pythium Task Force leader

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