Climate change effects on agricultural pests

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USDA-ARS, Salinas CA

Adapting Vegetable, Berry, and Grapevine Production Practices
in the Central Coast to Changing and Variable Climate
03/06/2024

USDA Agricultural Research Service

Impact of climate change on insect pests

1. **Rising atmospheric CO_2 levels**
2. **Rising temperatures**
3. **Changing precipitation patterns**

Impact of rising temperatures on insect pests

Temperature is the most important environmental factor affecting insect biology

- Cold-blooded = body temperature depends on the temperature of their environment
- Minimum/maximum threshold temperatures for insect development and reproduction

  → *Optimal temperatures exist*

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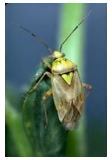
Key Central Coast pests

- Western flower thrips, *Frankliniella occidentalis*
  - Vector for impatiens necrotic spot virus (INSV)



- Lygus bug, *Lygus Hesperus*

- Vine mealybug, *Planococcus ficus*
  - Vector for Grapevine leafroll-associated viruses (GLRaV)

Optimal temperatures for all three pests = ~80-86°F

UC IPM (*L. hesperus*)
Daane et al., 2012 *(Pl. ficus*)

Impact of rising temperatures on insect pests

Rising temperatures will have a greater effect on insects that spend most of their time aboveground

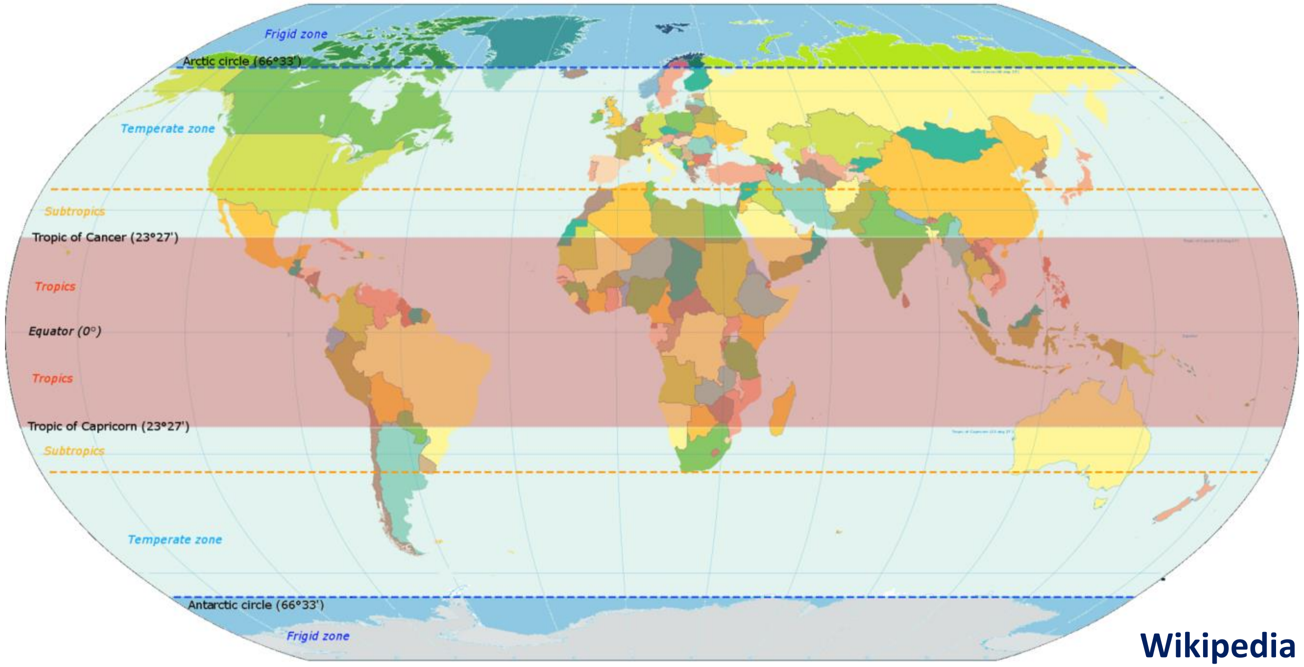
- Soil dwelling insects are thermally insulated

Pest populations expected to *increase* in temperate regions

- Most of the U.S., including Salinas Valley
- Optimal temperatures generally occur late in growing season

Pest populations expected to *decline* in lowland tropical regions

- Parts of Southeast Asia, Latin America, Caribbean
- Current temperatures are already near optimal

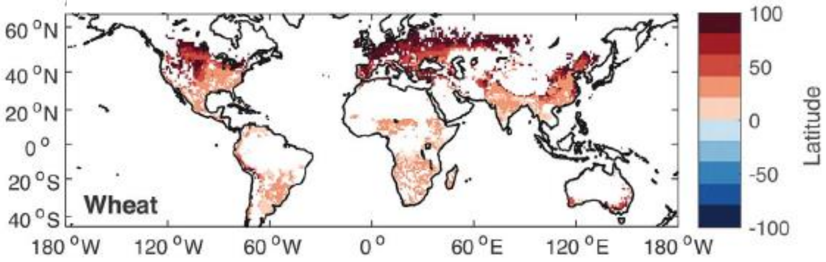


Wikipedia

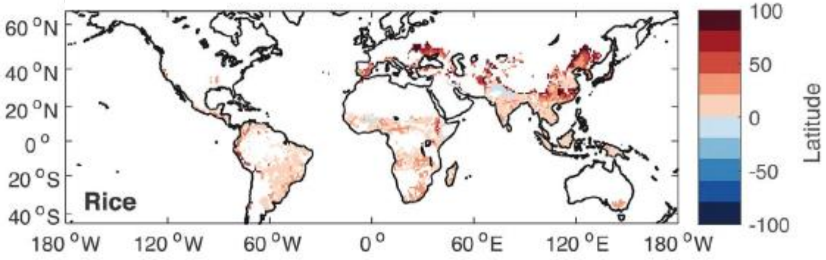
Impact of rising temperatures on insect pests

Pest survival during diapause (nongrowing season)

Temperate



Tropical



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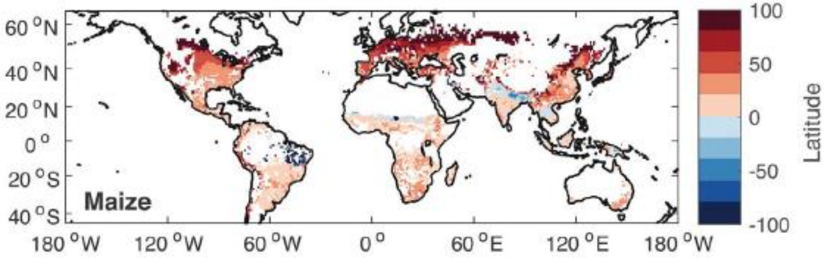

Deutsch et al., 2018

Impact of rising temperatures on insect pests

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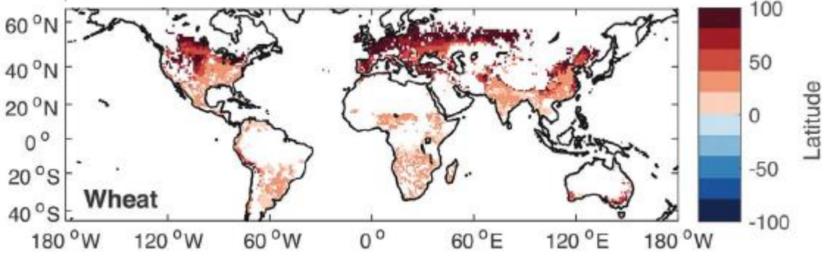

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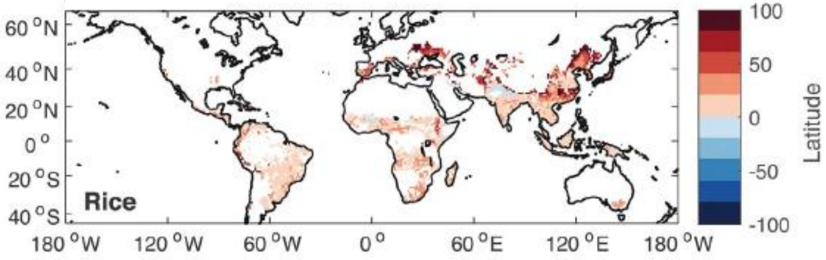

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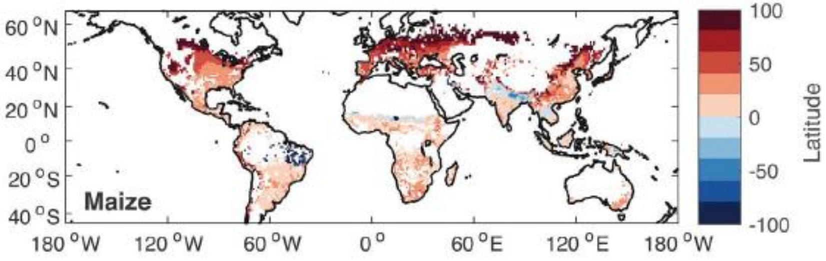

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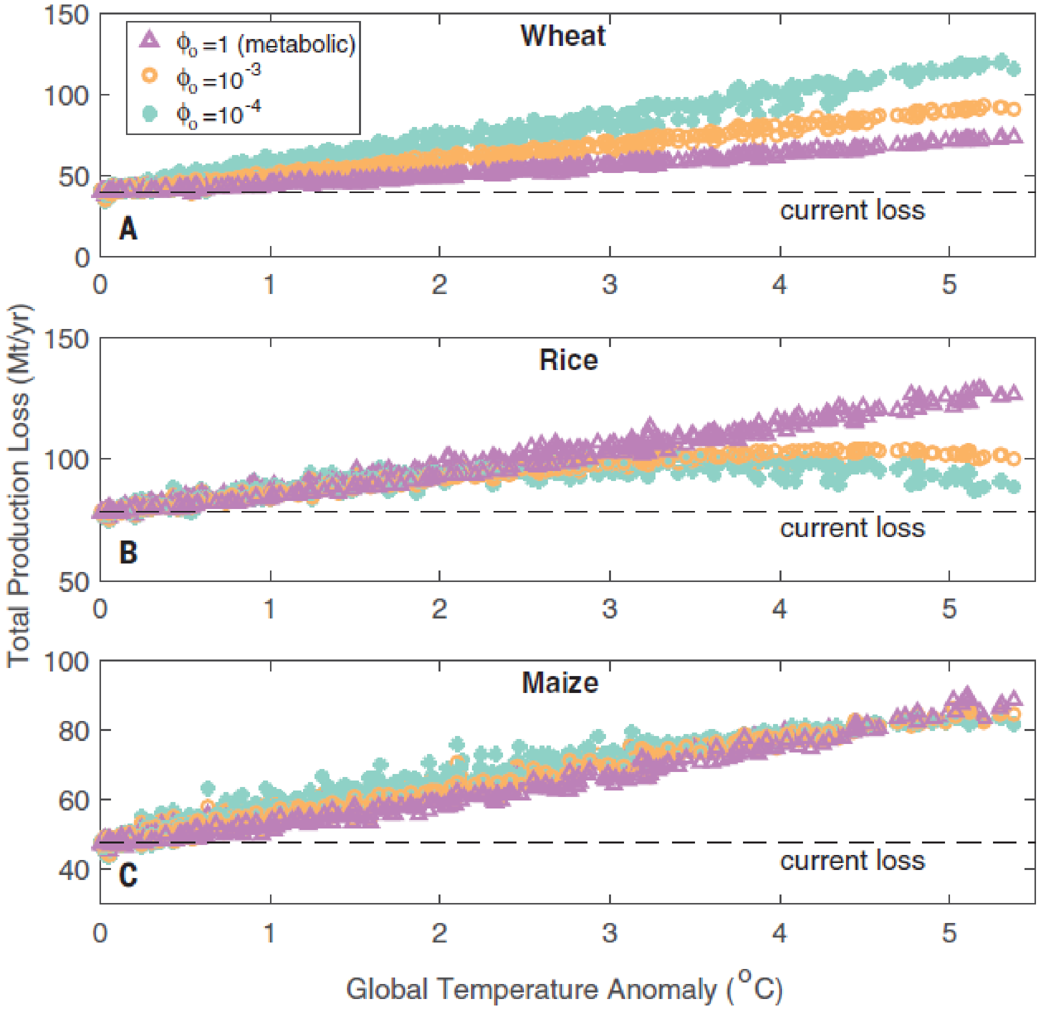

↑ pest population
↑ production loss

↓ pest population
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Impact of rising temperatures on insect pests

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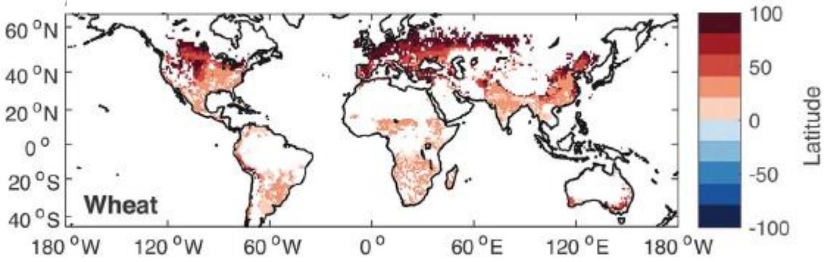

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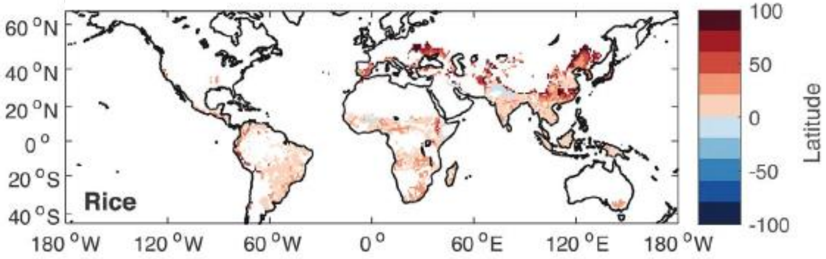

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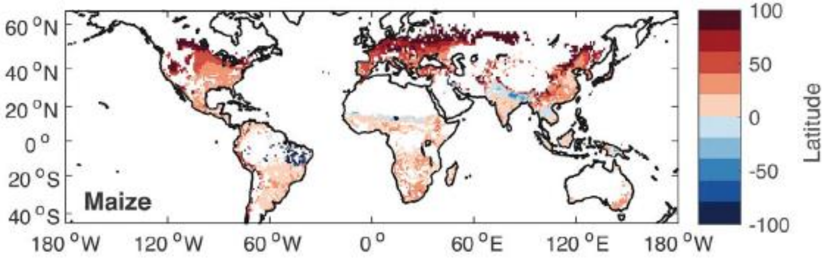
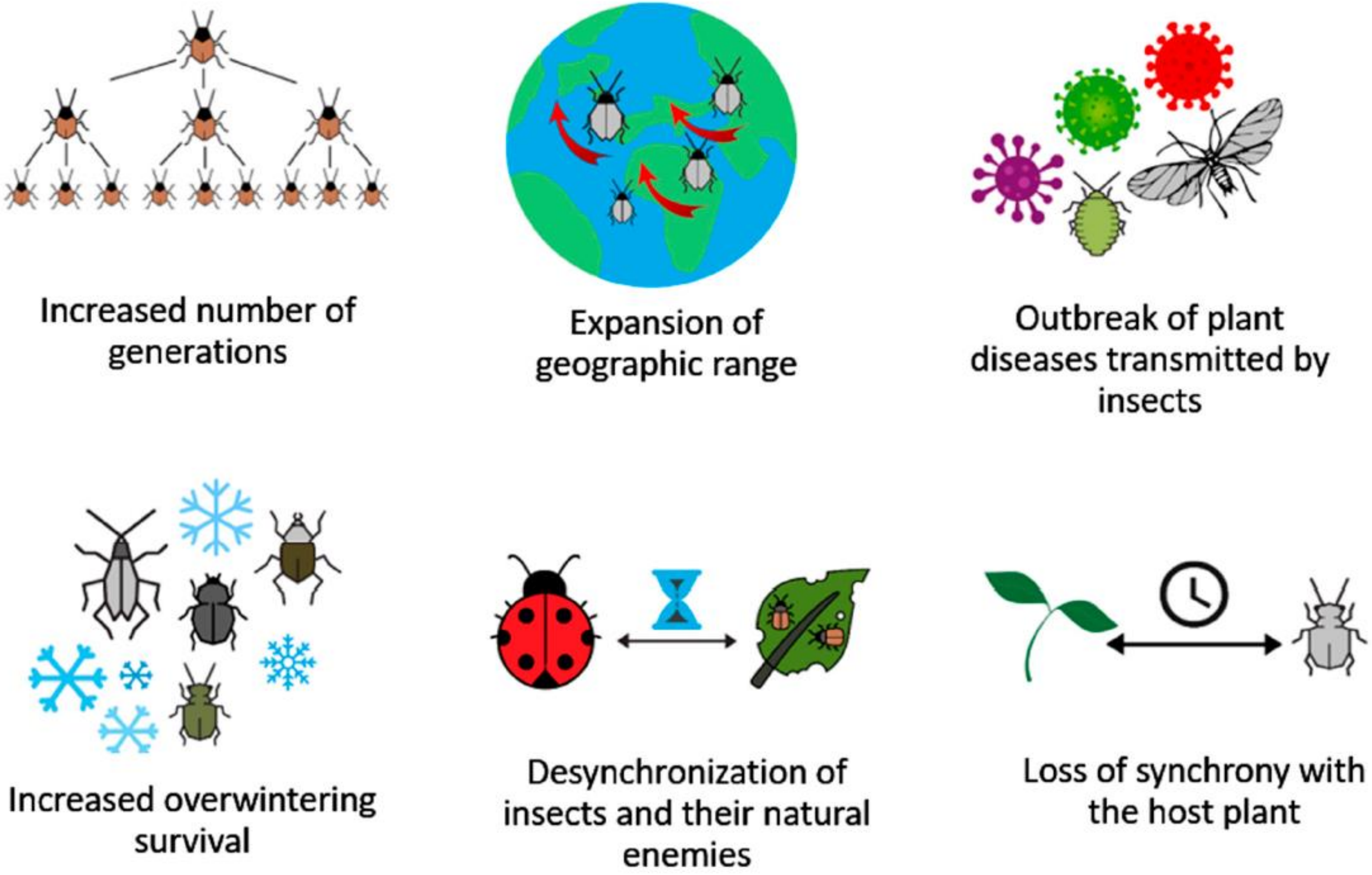


"Because temperate populations often reach carrying capacity only late in the growing season, if at all, they have the most potential for increases in population size as temperature rises. How much they increase depends on baseline survival rates during the nongrowing season..."

Deutsch et al., 2018

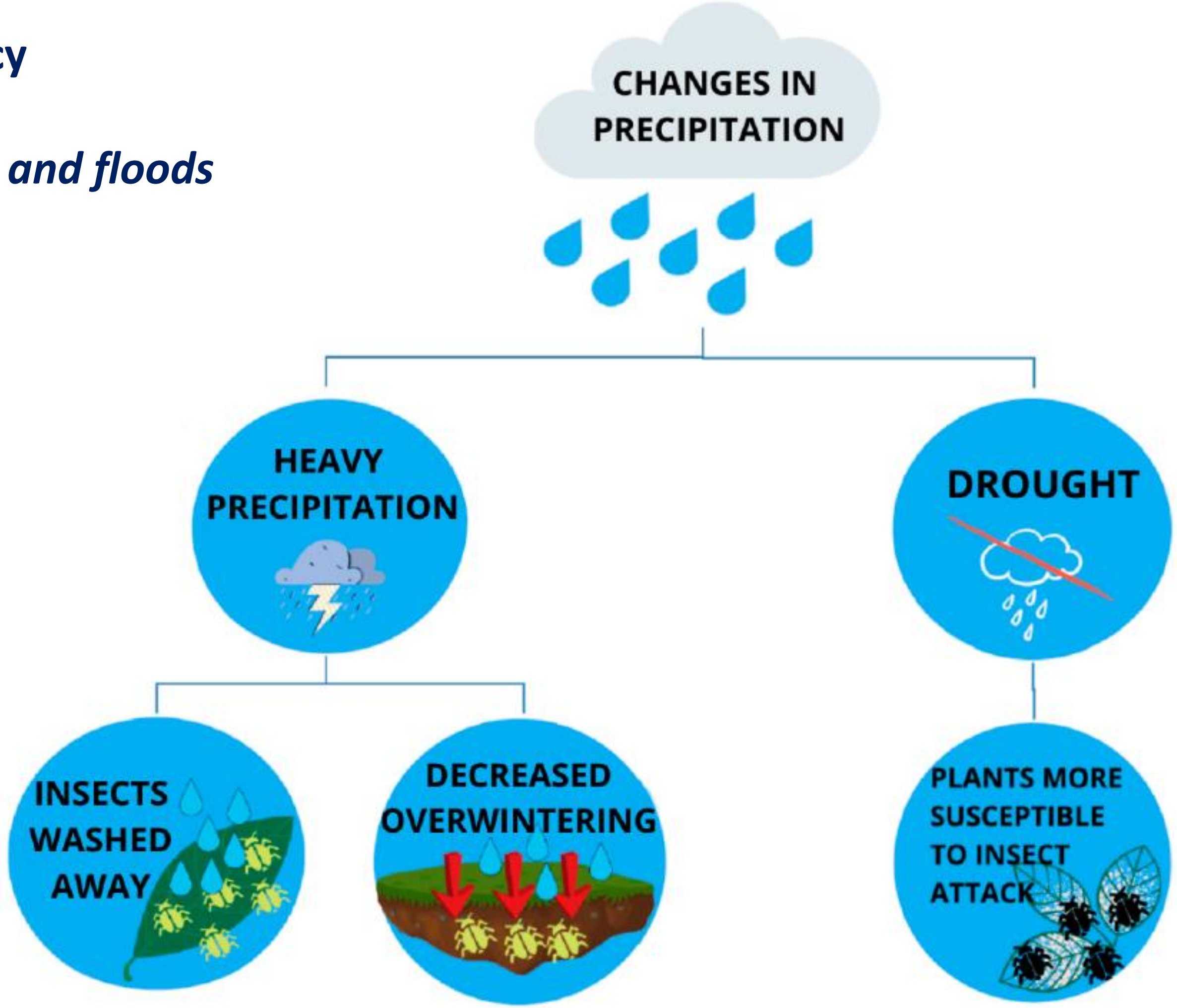
Impact of rising temperatures on insect pests



Skendzic et al., 2021

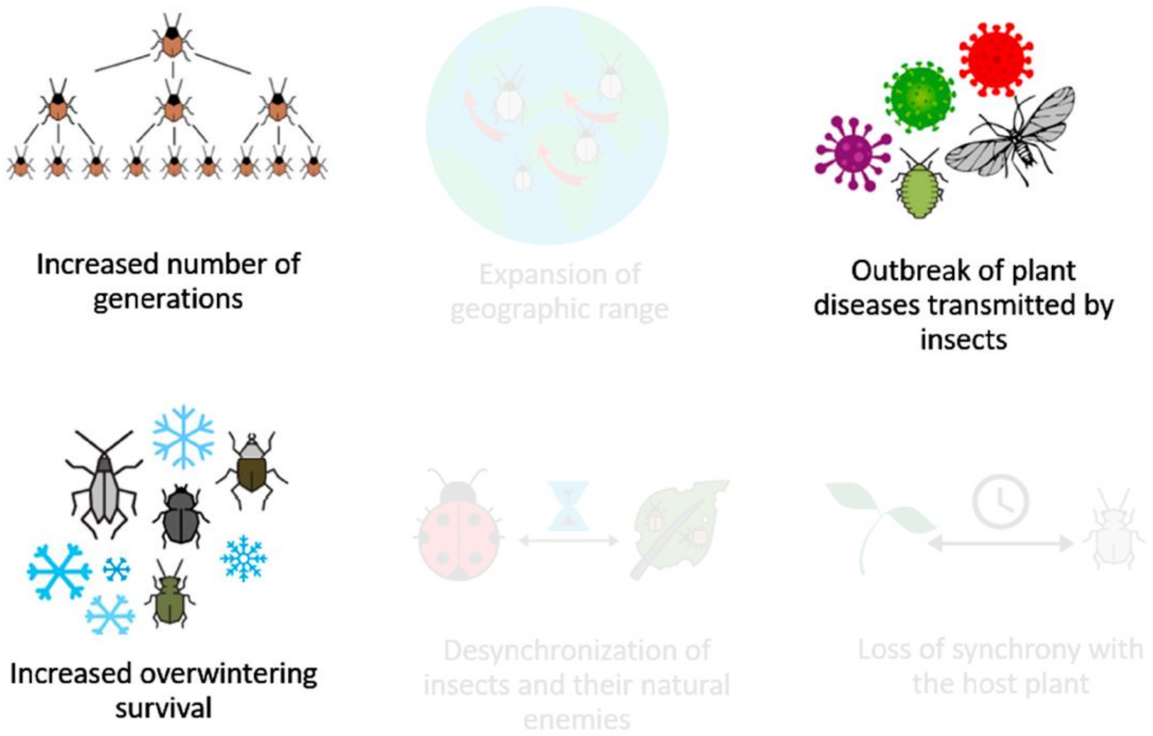
Impact of precipitation on insect pests

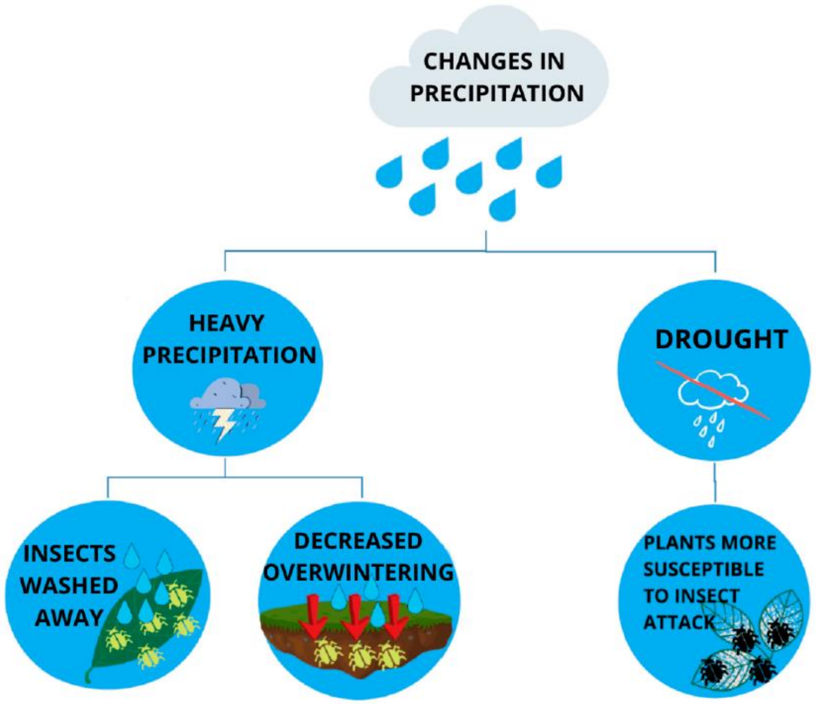
- Decrease in precipitation frequency
- Increase in precipitation intensity
- *Favors the occurrence of droughts and floods*



Skendzic et al., 2021

Impact of temperature and precipitation on insect pests





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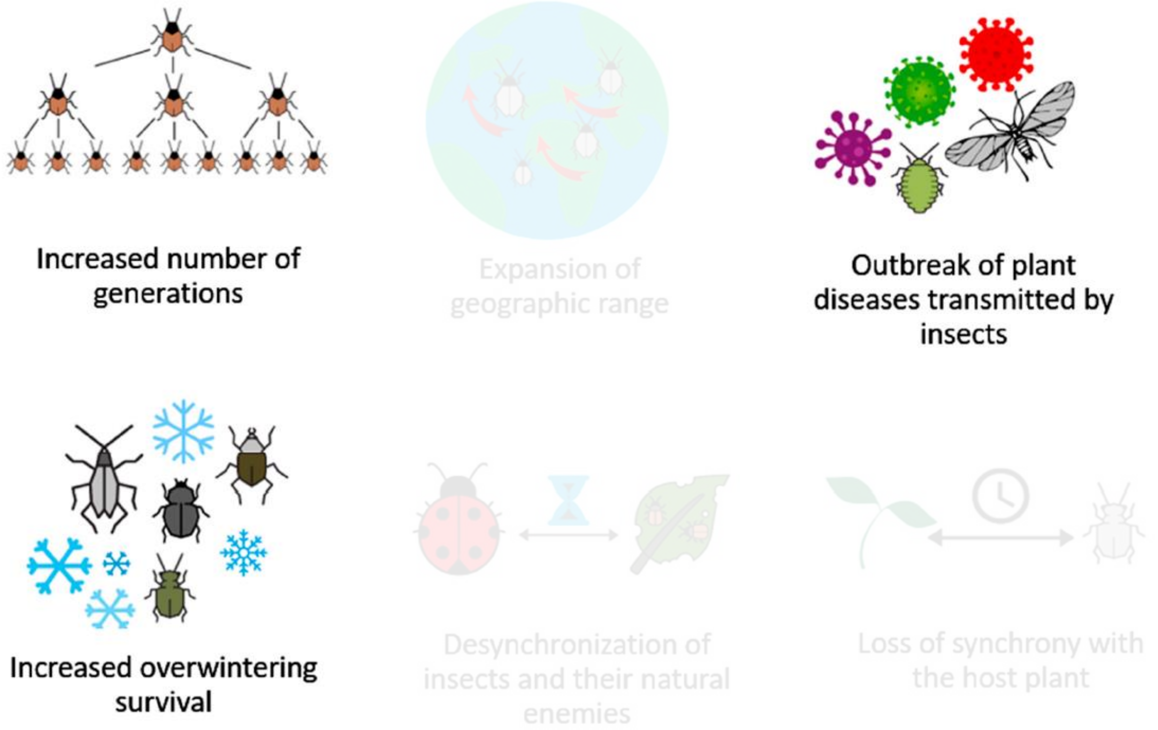

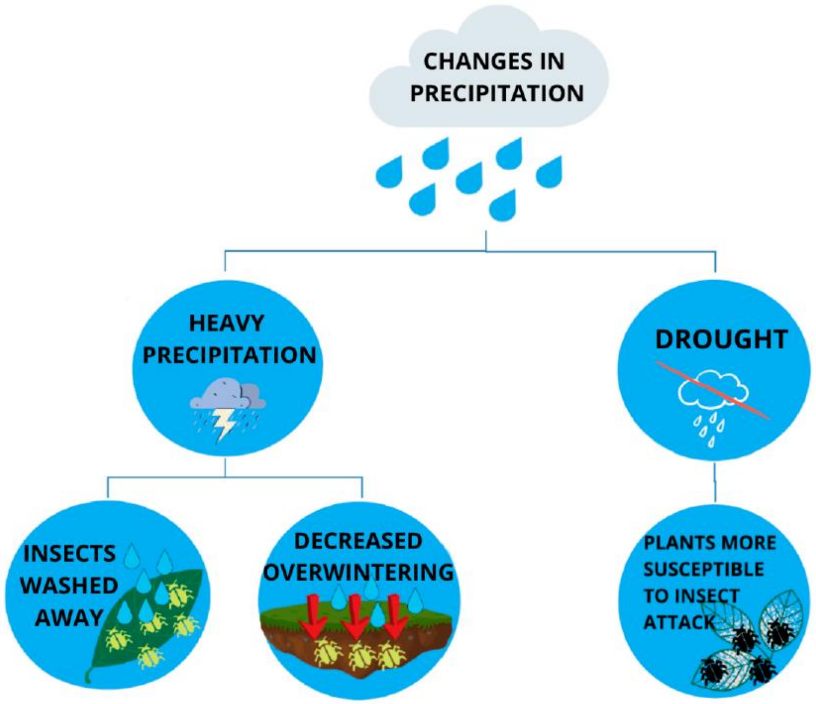

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Skendzic et al., 2021

Western flower thrips, *Frankliniella occidentalis*

Impatiens necrotic spot virus (INSV)

- Family *Tospoviridae*, genus *Orthotospovirus*
- Ambisense, segmented tripartite genome

2006: INSV first reported in lettuce in the Salinas Valley

2006 - 2012: Minor to isolated outbreaks of INSV in lettuce

2019 - current: Severe outbreaks in the Salinas Valley. Up to 100% crop losses, losses = millions US$

2022: 1,032 fields reported INSV incidence >1%
2023: 236 fields reported INSV incidence >1%

*INSV can infect a wide range of plants

GROWER-SHIPPER ASSOCIATION of Central California Since 1930

2023 observations: weather, weeds, thrips, INSV

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Weather → Weeds / Thrips → INSV 236 fields reported

2022

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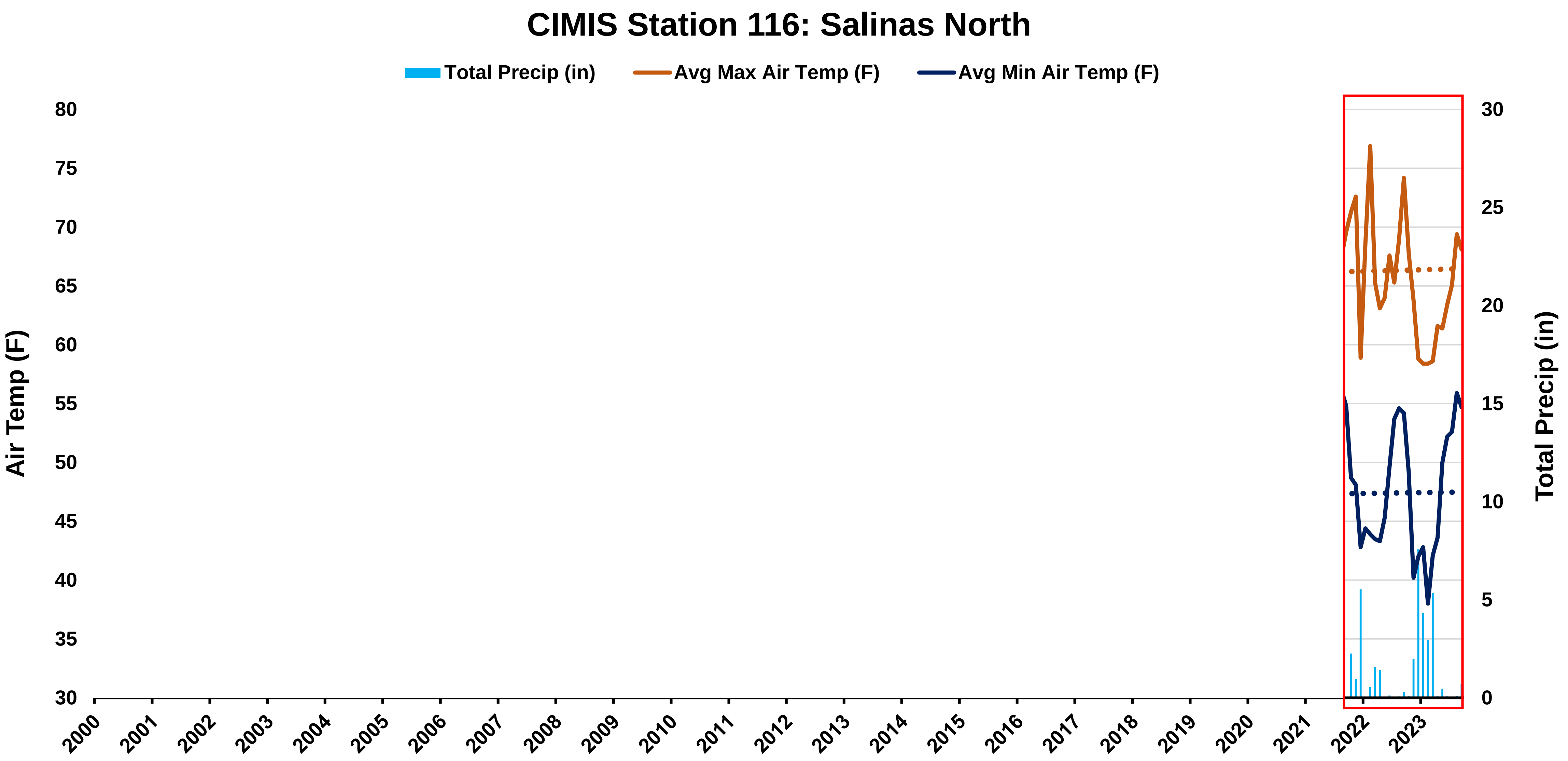
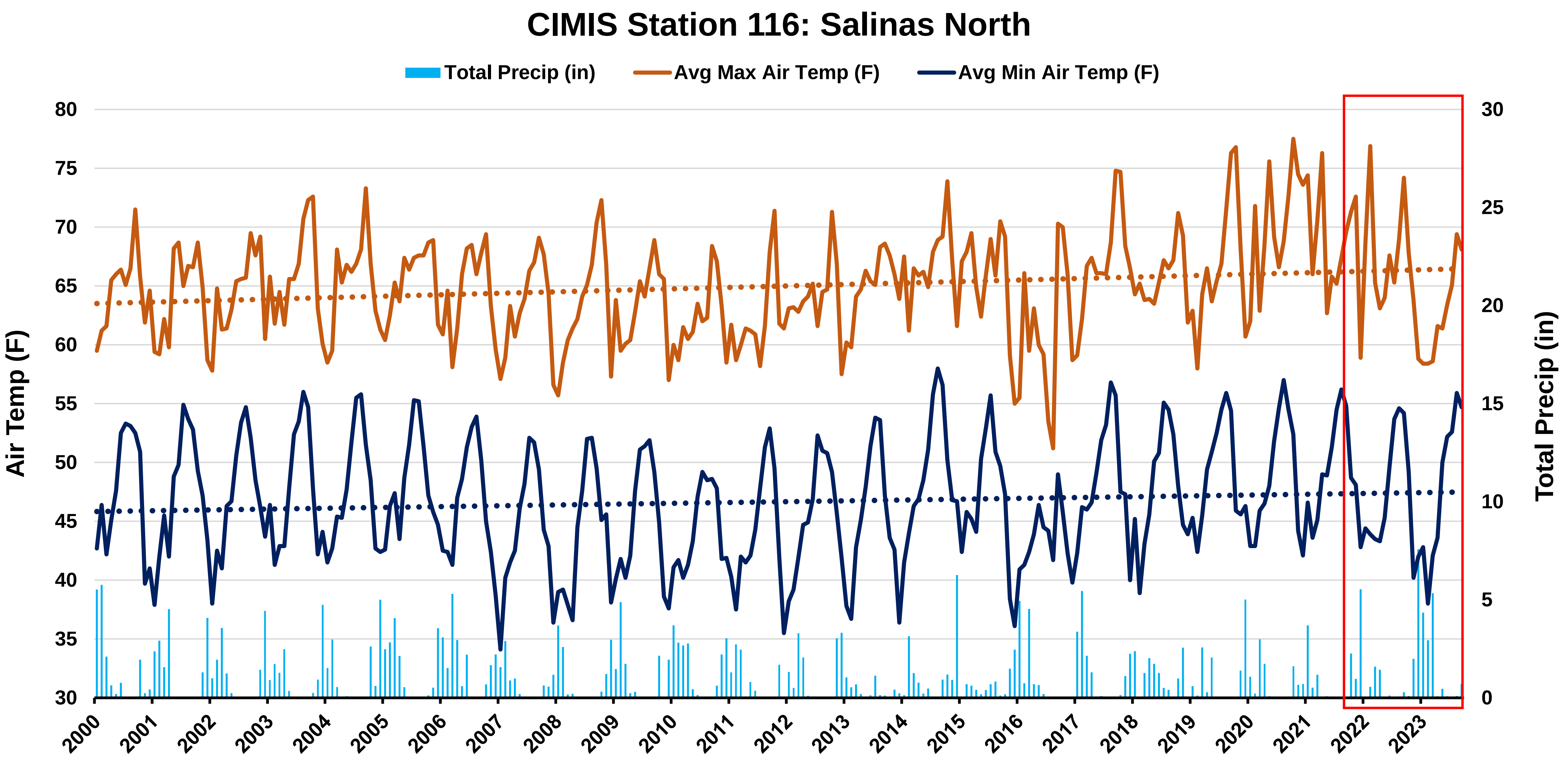
Temperature and precipitation: 2000-2023



INSV first documented in coastal lettuce

Severe INSV outbreaks started to occur

Temperature and precipitation: 2000-2023



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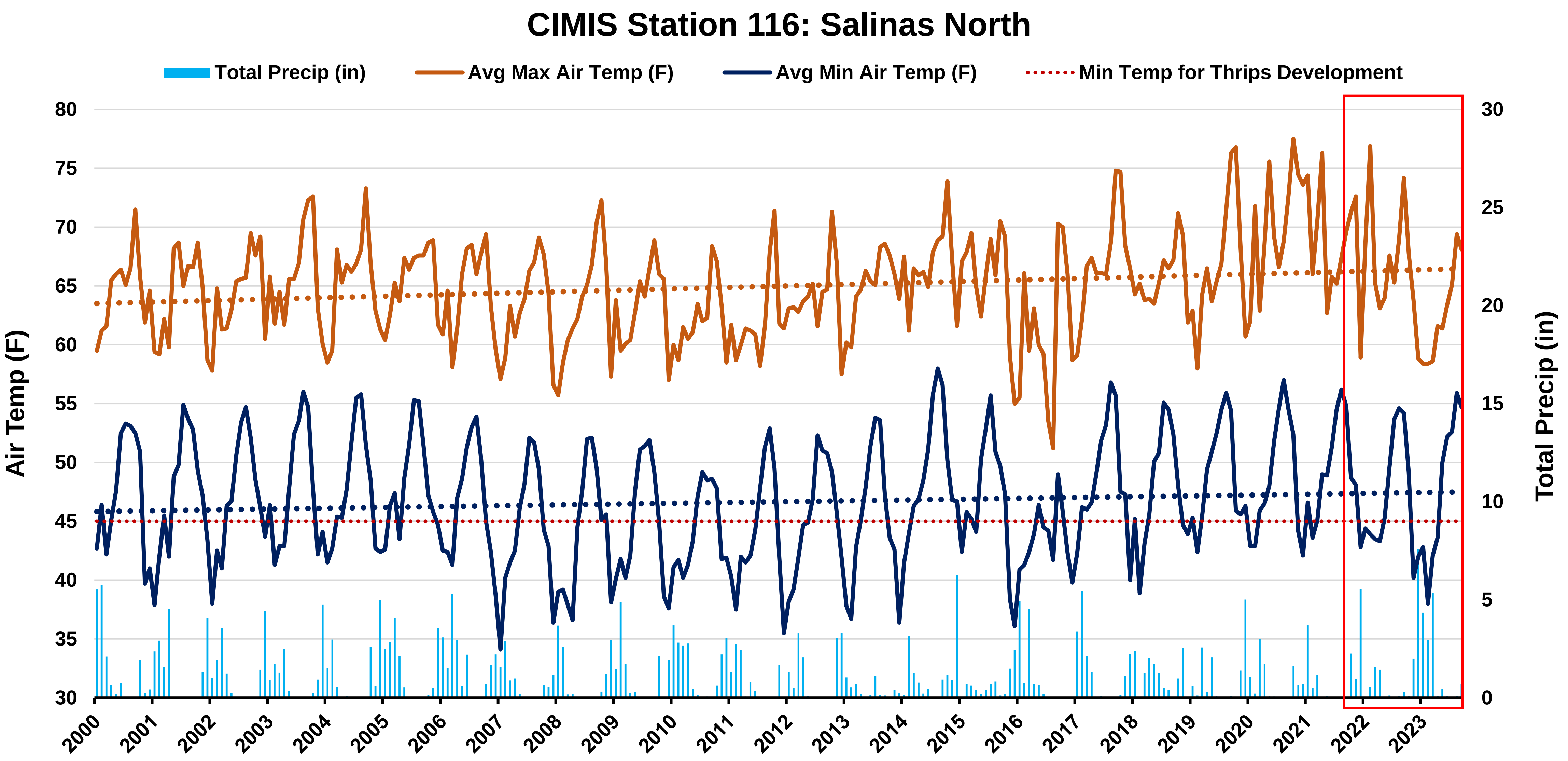

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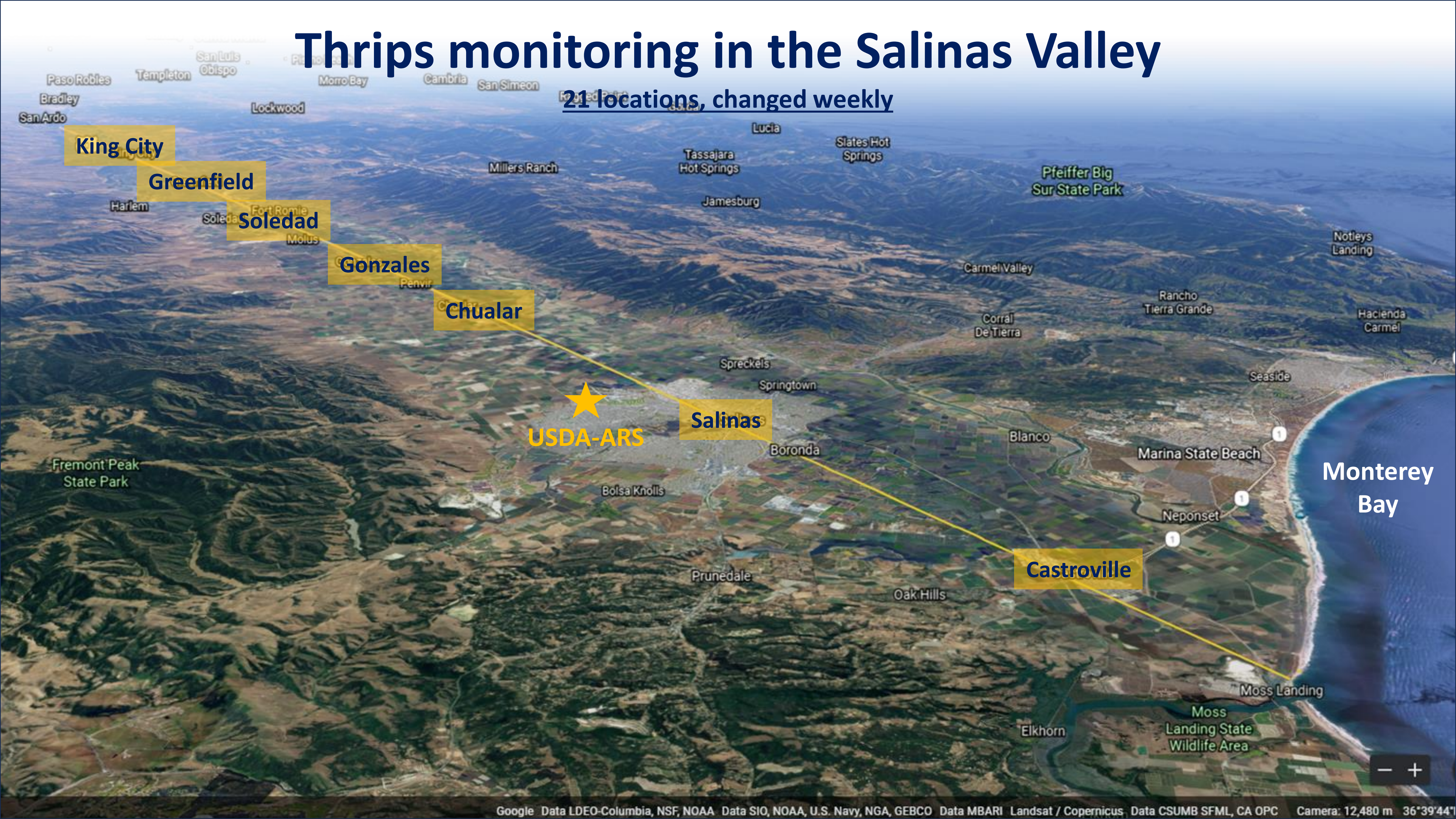
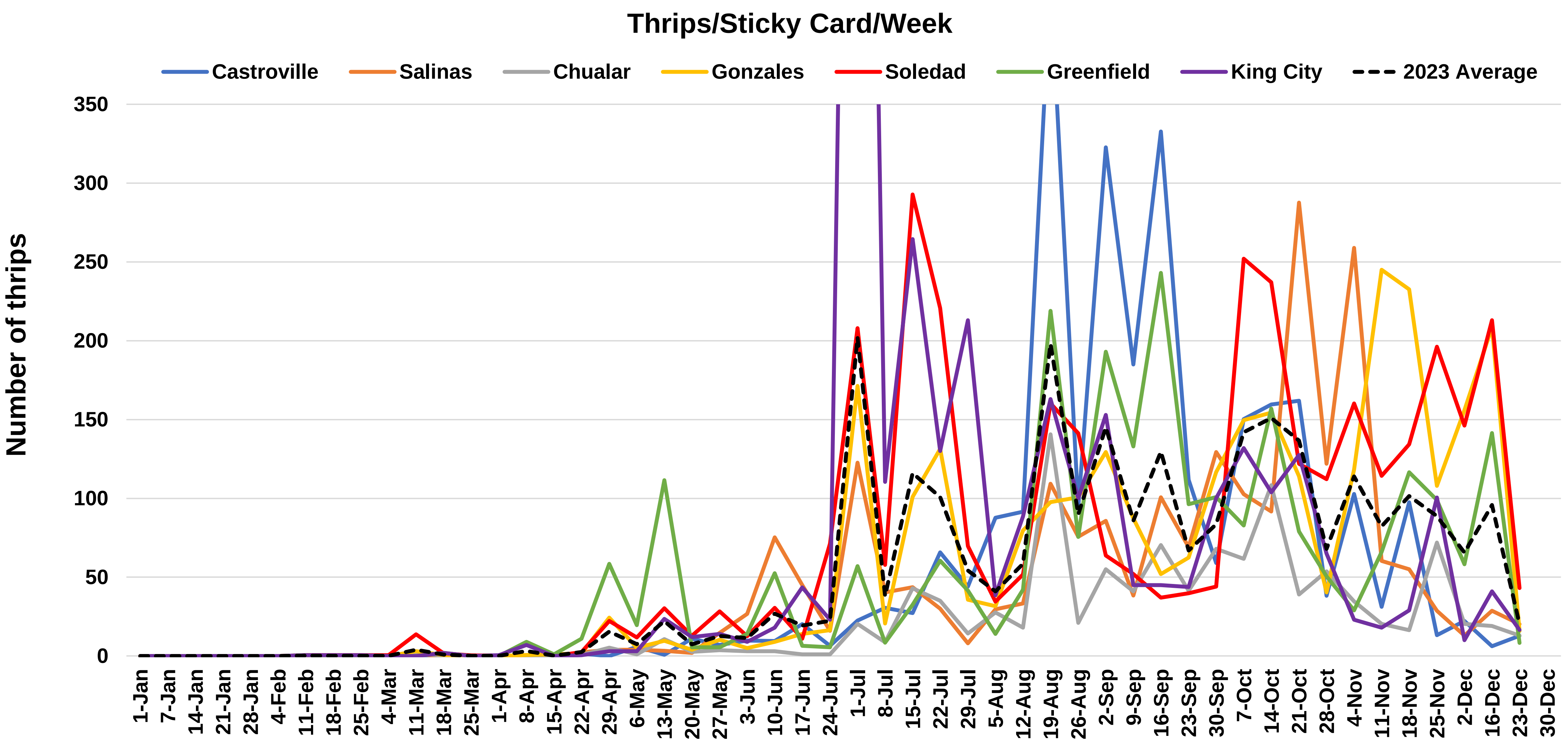
Thrips monitoring in the Salinas Valley

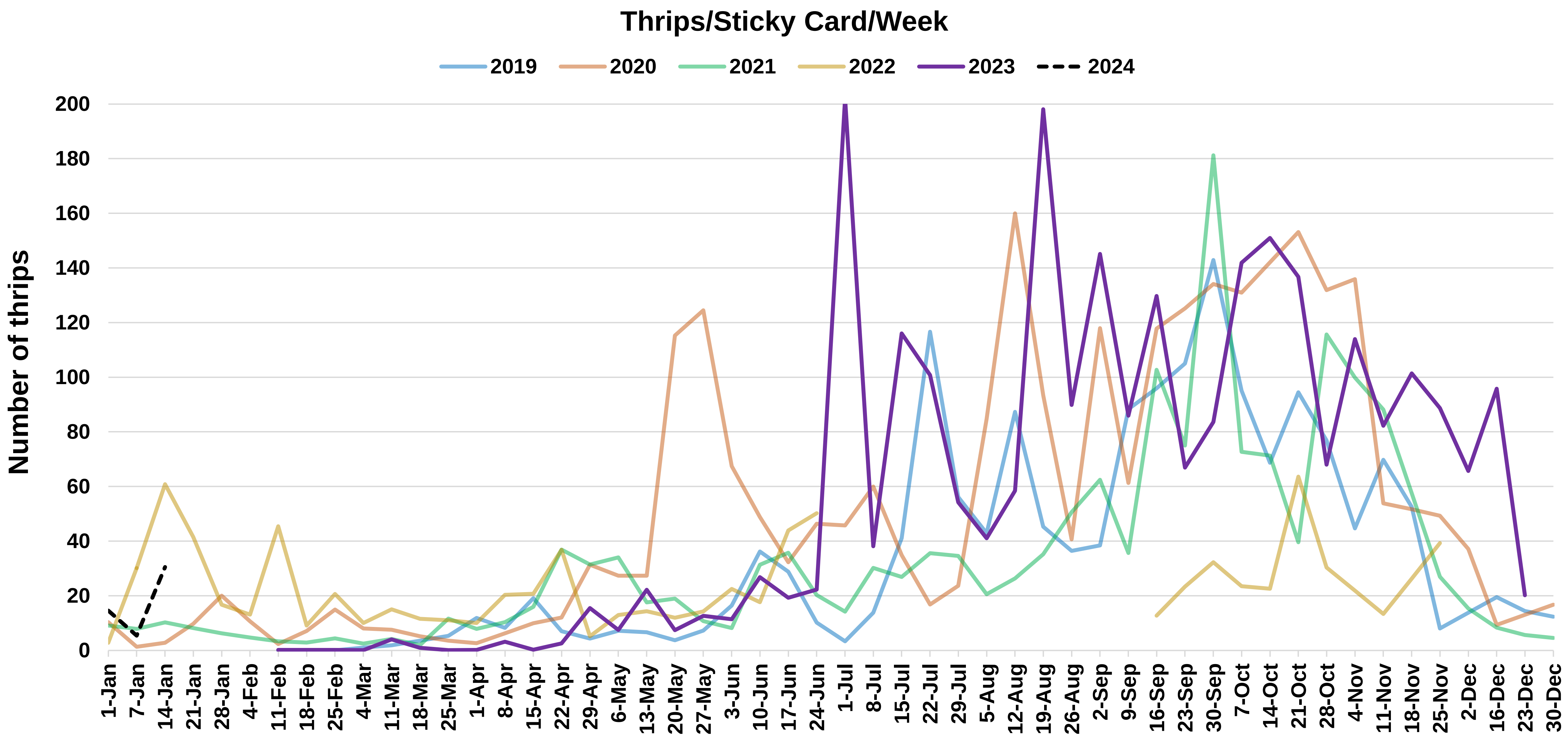
21 locations, changed weekly



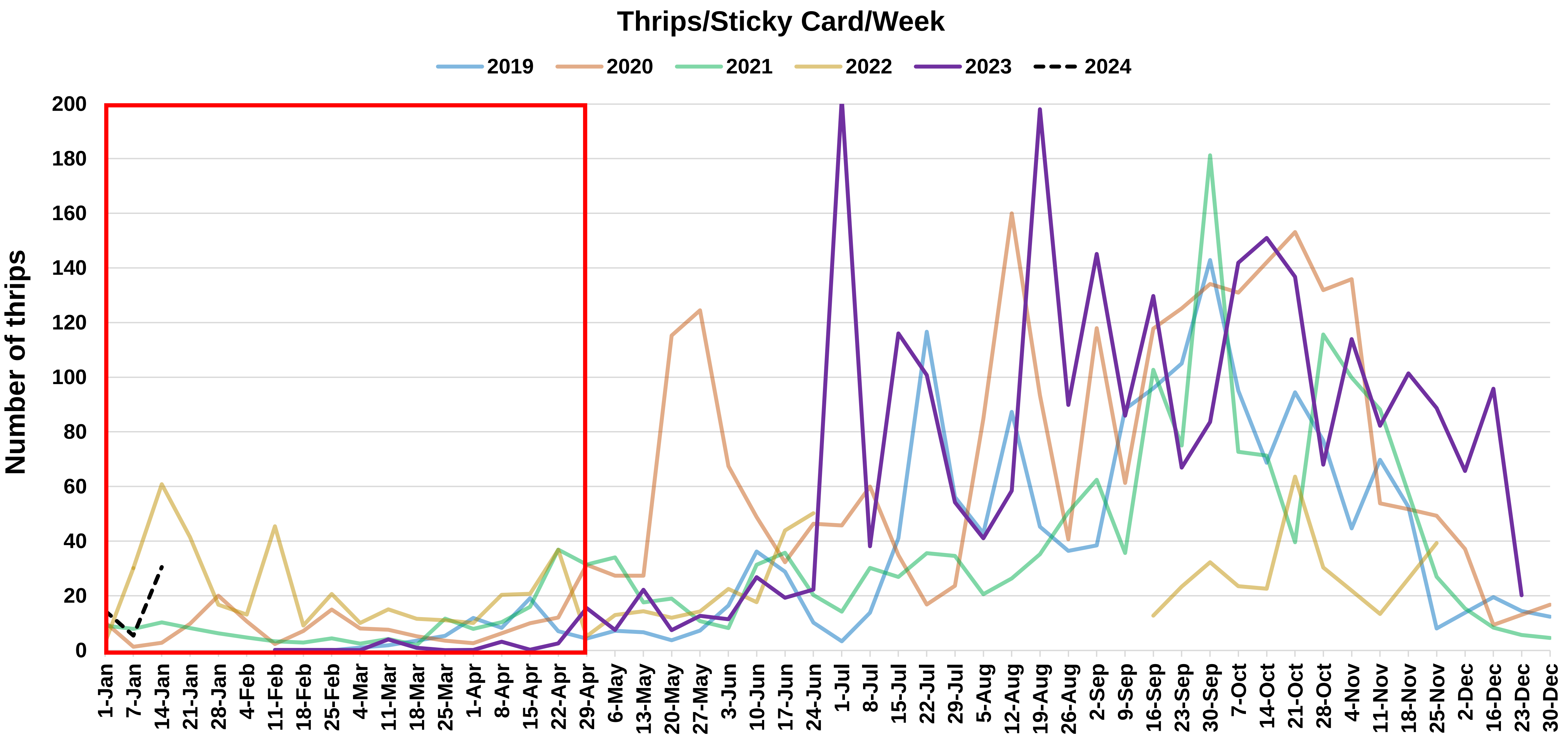
Thrips monitoring: 2023



Thrips monitoring: 2019 – 2024



Thrips monitoring: 2019 – 2024



Salinas Valley insect monitoring

Dr. Ian Grettenberger
UC Davis

About This App | Thrips | Diamondback Moth | Aphid | Temp. and City Counts | Compare Annual Counts

Salinas Valley Lettuce Pest Mapping Tool

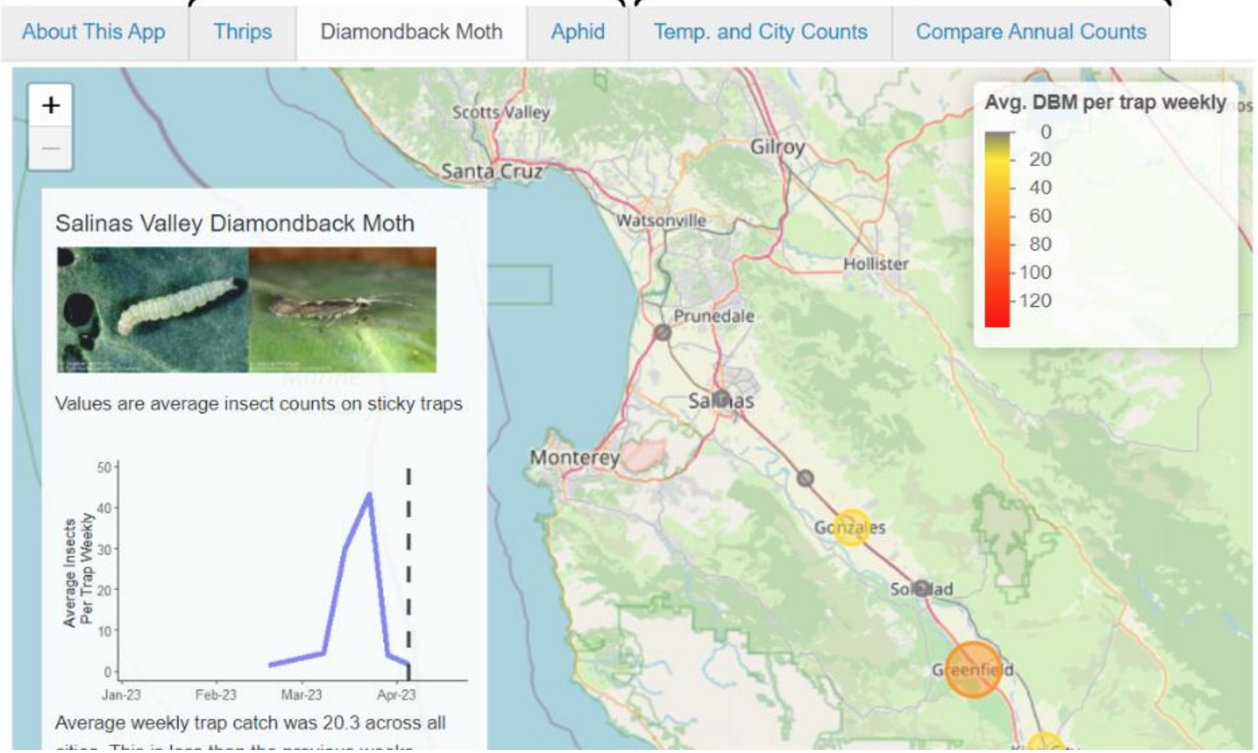
Desktop Version: If maps are scaled incorrectly, try the Mobile Version Here

How to use this tool

This app was designed to visualize up-to-date lettuce pest sampling data in the Salinas Valley. Select a pest above to view the current year's population trends. Use the slider to see how populations have shifted throughout the season and hover your mouse over circles to get average counts for each region. You can also select the 'Temp. and City' tab to see site-by-site breakdowns and how average temperatures affected pest populations, or the 'Compare Annual Counts' Tab to compare years.

Map this year's pest populations

Compare Locations, Temperature, and Years



Desktop version: https://salinaspestmap.shinyapps.io/salinas-pestmap/
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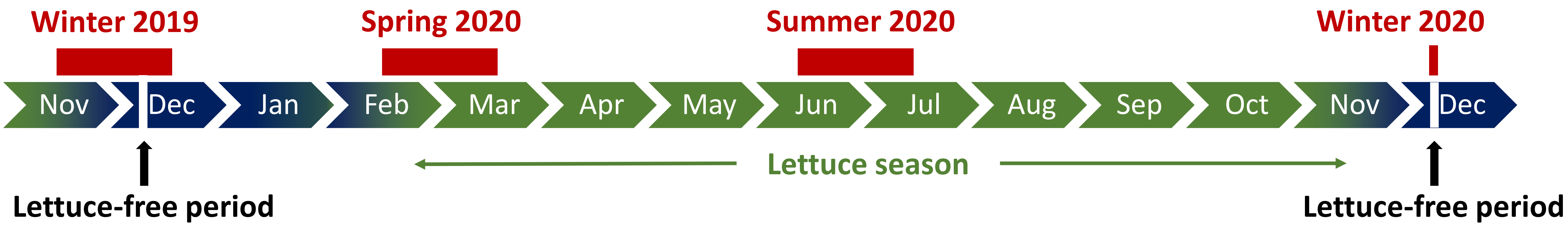
Field surveys to identify INSV hosts

Sampling summary:
~4,000 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

Hasegawa et al., in prep

Top 10 non-lettuce hosts for INSV in the Salinas Valley, CA

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


1


2


3


4


5


6


7


8

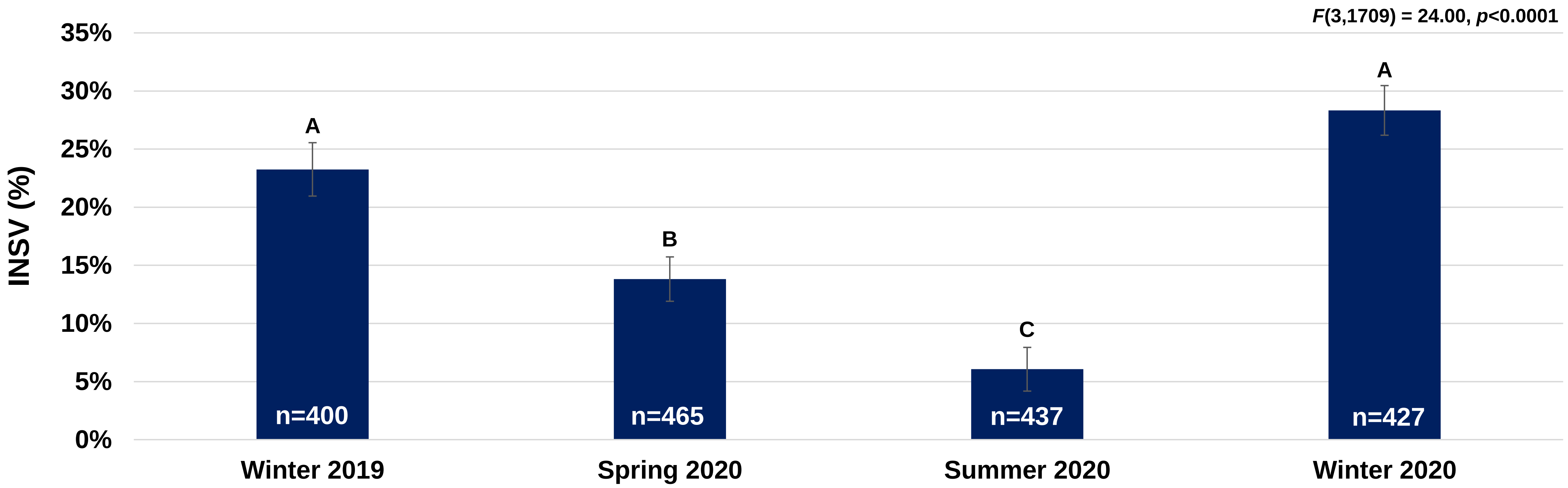

9

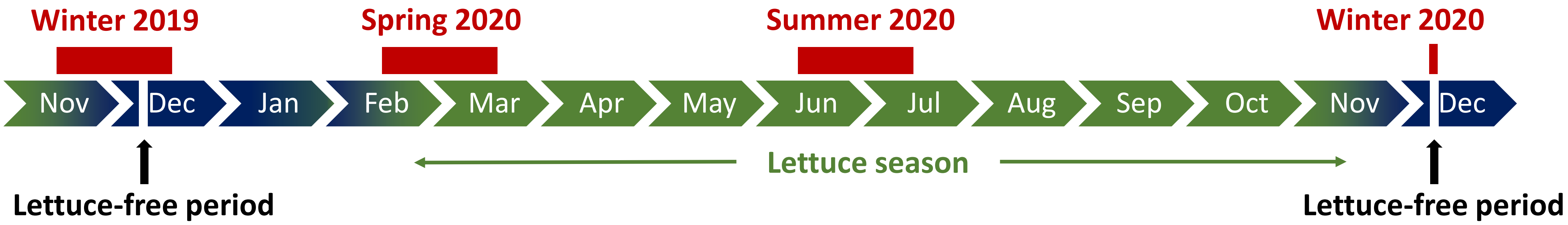

10

Richard Smith, UCCE
http://ipm.ucanr.edu/PMG/weeds_all.html

Hasegawa et al., in prep

INSV infection of top 10 hosts





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High thrips reproduction on INSV-infected weeds

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INSV infection of top 10 hosts

8 locations: Salinas and Chualar

GROWER-SHIPPER ASSOCIATION of Central California Since 1930

UC CE University of California Cooperative Extension

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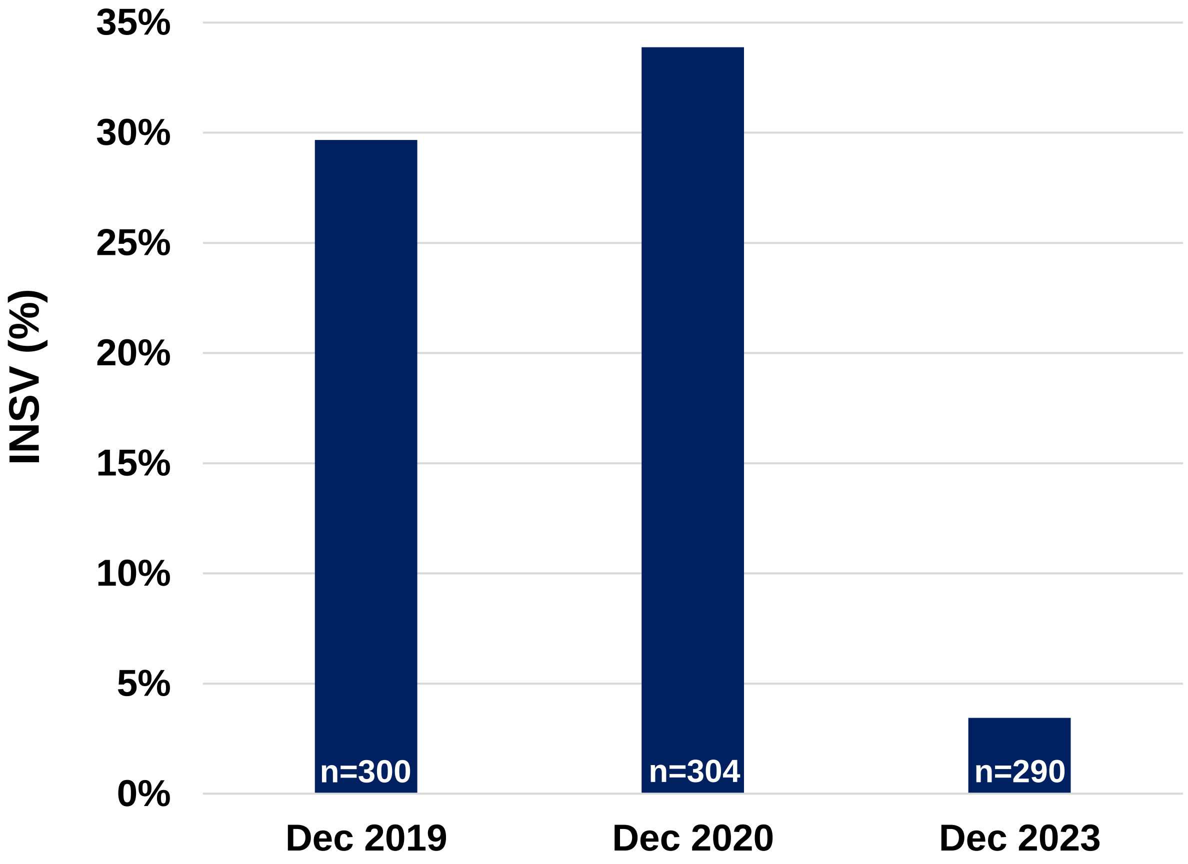

Adapting IPM practices to climate change

1. Pest thresholds – early season treatments
2. Crop varieties – tolerant/resistant types
3. Planting time and location – avoiding high pest pressure
4. On-farm biodiversity – increase abundance and diversity of natural enemies

Research

1. Pest monitoring – history informs the future
    - Abundance and distribution (regional and area-wide)
    - Existing and new invasive pests
    - Integrating climate data and pest forecasting
2. Insect behavior and dispersal
3. Efficacy
    - Biopesticides (e.g., entomopathogens)
    - Chemical volatility and residues

Journal of Applied Ecology 2008, **45**, 524–536 doi: 10.1111/j.1365-2664.2007.01356.x

Prospective evaluation of the biological control of vine mealybug: refuge effects and climate

Andrew Paul Gutierrez[1,2]*, Kent M. Daane[1], Luigi Ponti[1], Vaughn M. Walton[3] and C. Ken Ellis[1]

[1]Department of Environmental Science Policy and Management, College of Natural Resources, University of California, Berkeley, CA 94720–3114, USA; [2]Center for the Analysis of Sustainable Agricultural Systems (CASAS), Kensington, CA 94707, USA; and [3]Department of Horticultural Sciences, Oregon State University, Corvallis, OR 97331-7304, USA

- Western flower thrips, *Frankliniella occidentalis*
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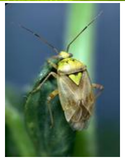

- Lygus bug, *Lygus Hesperus*

- Vine mealybug, *Planococcus ficus*
    - Vector for Grapevine leafroll-associated viruses (GLRaV)

Optimal temperatures for all three pests = ~80-86°F

Thank you

<u>Hasegawa Lab, USDA-ARS, Salinas, CA</u>

- <u>Lab Technician</u>: Laura Hladky
- <u>Postdocs</u>: Viviana Camelo, Shulu Zhang, Deena Husein
- <u>Biological Science Aids (CSUMB undergrads)</u>: Kiara Gable, Kai Larrieu, Jasmin Azad-Khan, Chaela Hicks, Juan Vargas, Grace Hardy, Lisette Godinez-Rivera, Suzette Segoviano-Quiroz, Ulisses Peralta-Diaz, Luis Ramirez-Espinoza

<u>University of California Cooperative Extension, Monterey County</u>
Richard Smith, Kirsten Pearsons, Alejandro Del-Pozo (Virginia Tech)

<u>University of California Davis</u>
Ian Grettenberger

Growers, PCAs, CCAs, other industry members

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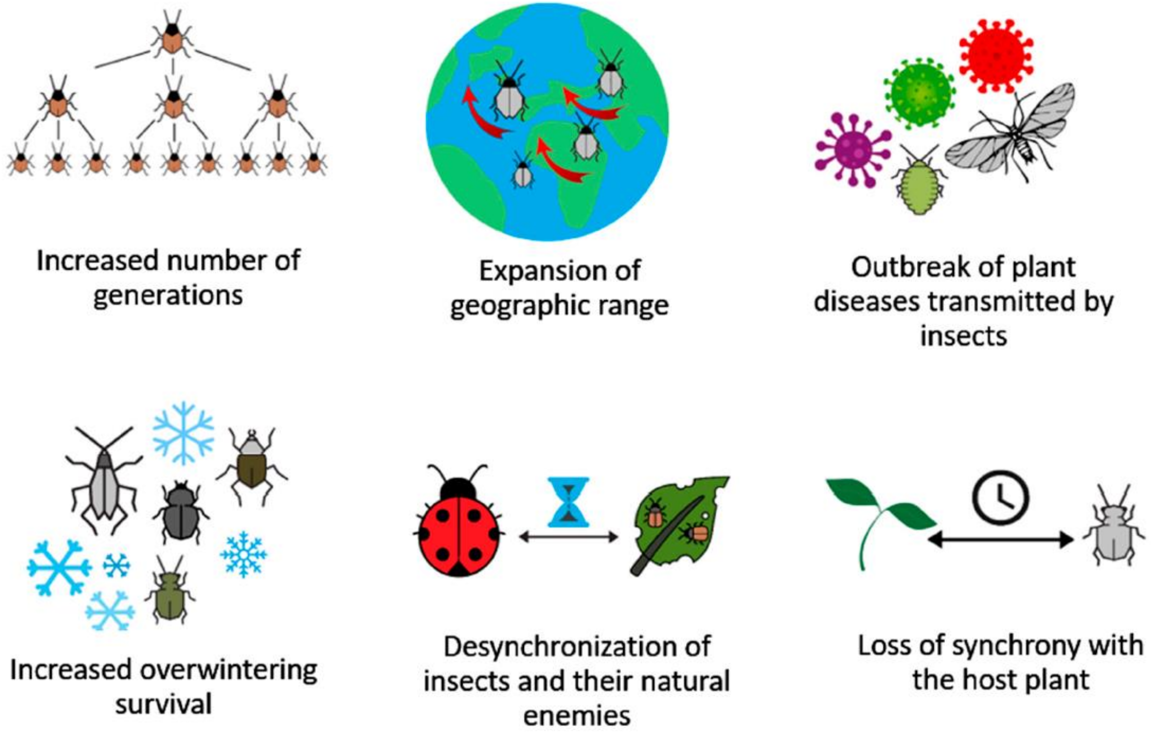
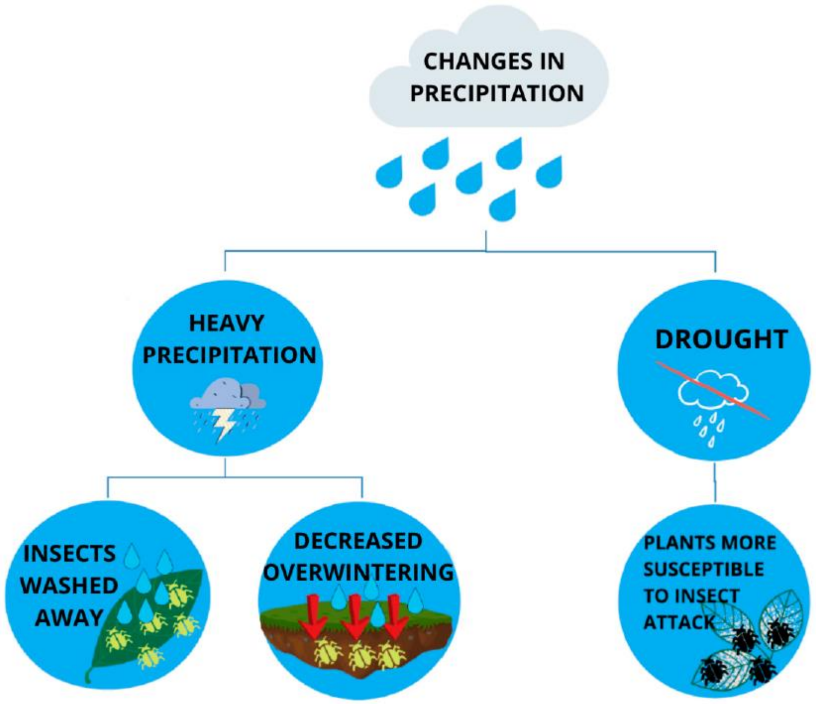
USDA Agricultural Research Service

CALIFORNIA LEAFY GREENS RESEARCH PROGRAM

Impact of temperature and precipitation on insect pests





Skendzic et al., 2021