Vinegar flies in CA strawberries: Species Identification & insecticide resistance monitoring

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Current: California Department of Food & Agriculture

BACKGROUND – SPOTTED WING DROSOPHILA

- SWD is an invasive vinegar fly, arrived in CA in 2008 from SE Asia
- First found in strawberry & caneberry fields in Watsonville
- Severe economic pest of raspberries, blackberries, blueberries & cherries
- Females have serrated ovipositor used to lay eggs into firm, still-ripening fruit

BACKGROUND – STRAWBERRY SUSCEPTIBILITY

- Fresh market strawberries may be protected from SWD by cultural practices & chemical controls
  - Short harvest intervals
  - spinosad & malathion
- Strawberries for processing are allowed to ripen in the field & insecticide applications stop
- Can lead to vinegar fly infestation & rejected shipments if detected
  - Impact of SWD unknown

RESEARCH GOALS

1) Assess ripe & overripe processing fruit for larval infestation
2) Determine the relative abundance of species causing infestation at each developmental stage

Studies to be replicated in 3 main CA growing regions: Oxnard, Santa Maria & Watsonville

METHODS

- Collect at least 40 ripe and 20 overripe strawberries from 3-4 field sites per region

Oxnard
May/ June

Oleg Daugovish

Santa Maria
August

Peter Shearer

Watsonville
TBD

Mark Bolda

METHODS

- Sampled at least 40 ripe and 20 overripe strawberries from 3-4 field sites per region

Ripe

Overripe

METHODS

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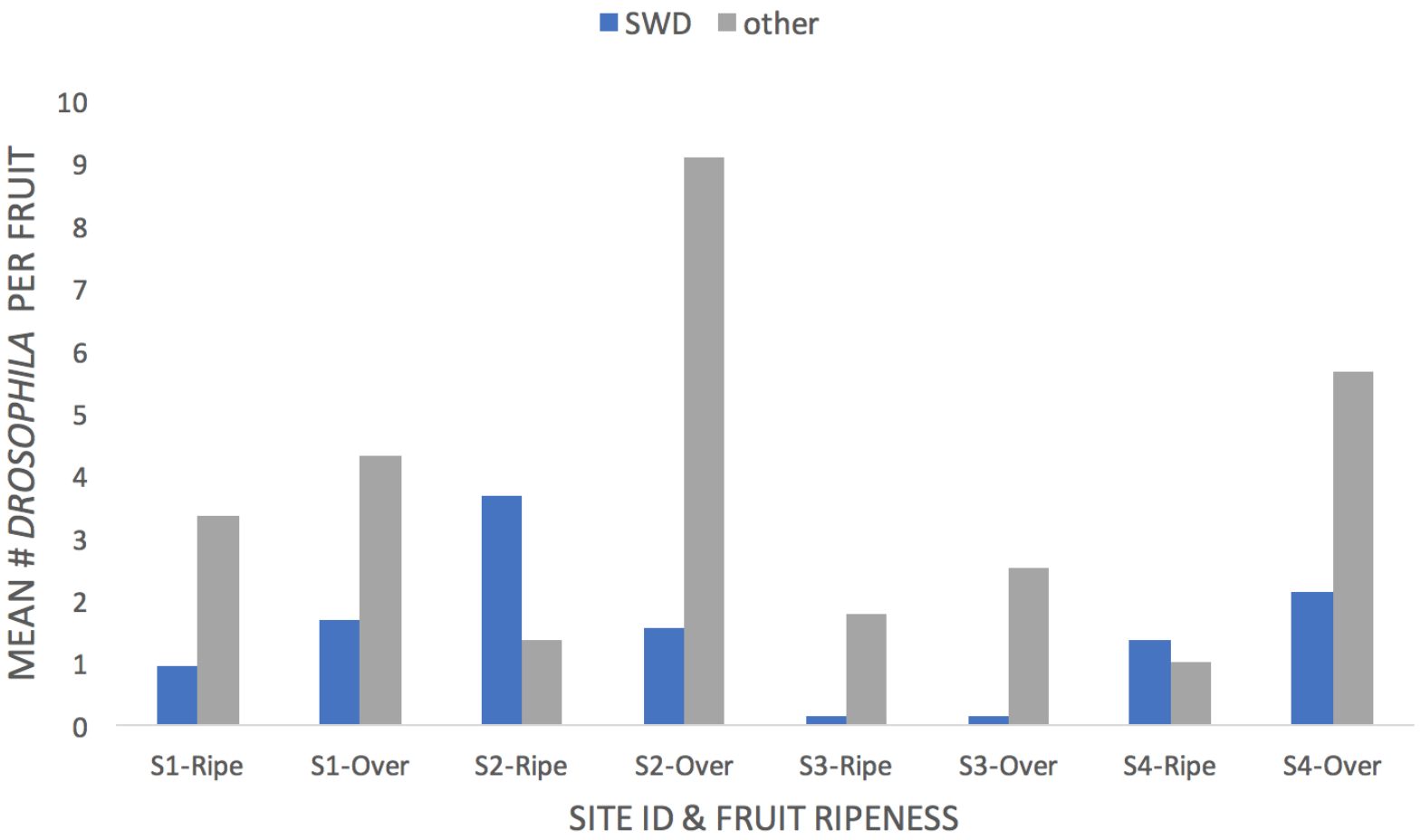
- Used morphological characteristics to ID to species

RESULTS – OXNARD



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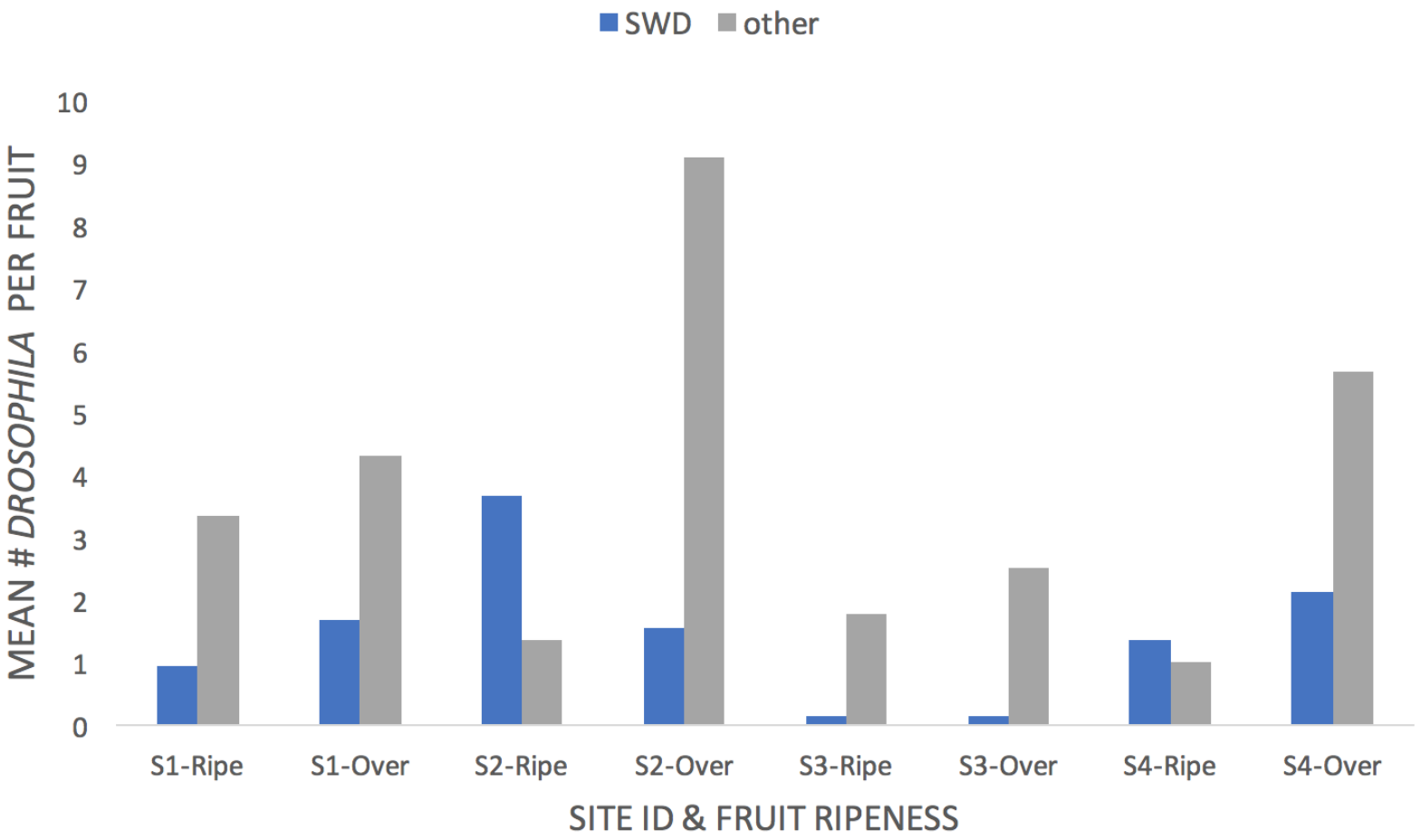

Average number vinegar fly larvae per fruit

Ripe: 3.4 (1.9 – 5)
Overripe: 6.8 (2.7 – 10.7)

$X^2 = 128.1$, $p = 0.0001$***

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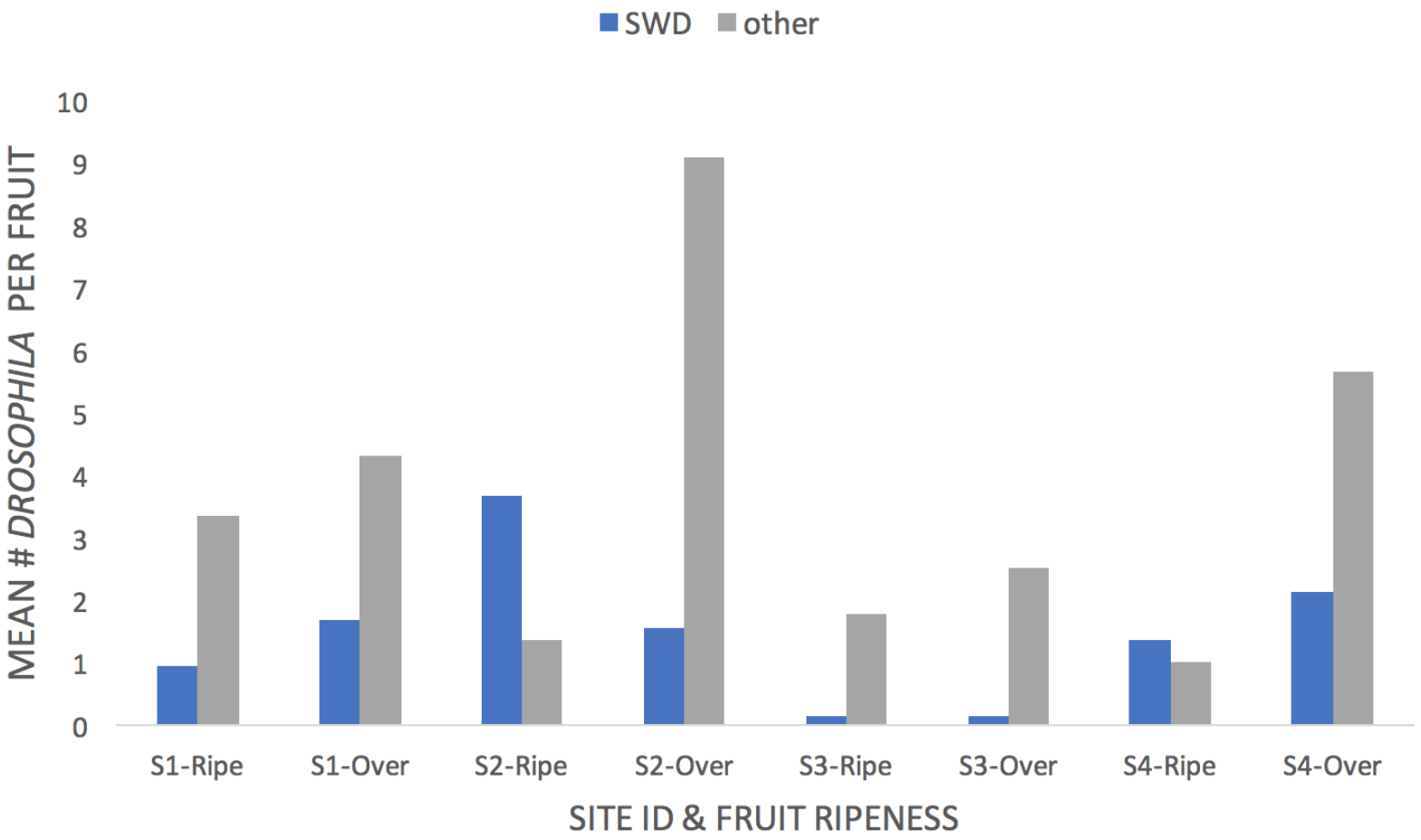

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Percent of total sample represented by SWD

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Overripe: 19% (4.9% - 28%)

z = 4.813, p = 0.0002**

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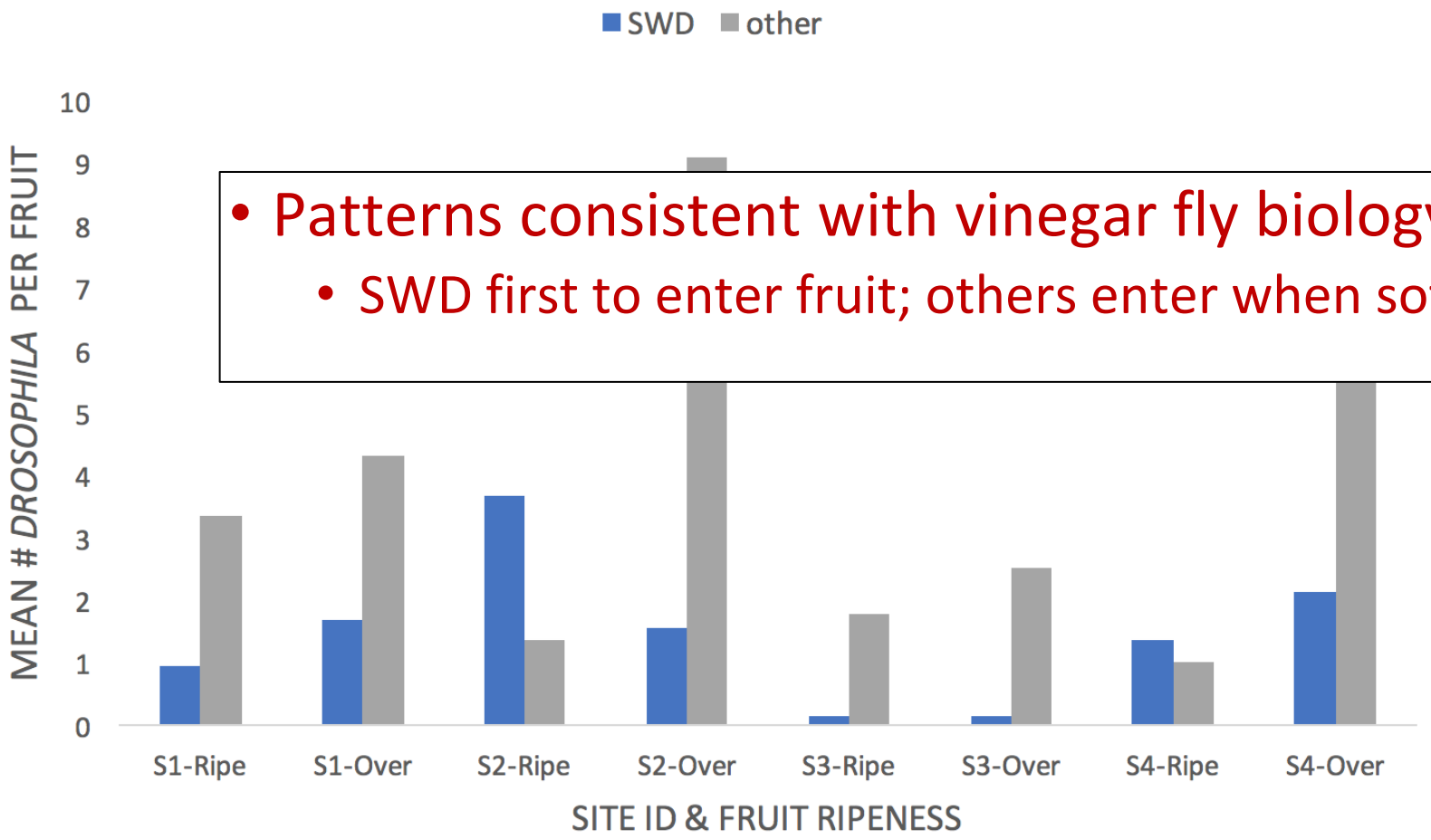

- Patterns consistent with vinegar fly biology
  - SWD first to enter fruit; others enter when soft / damaged

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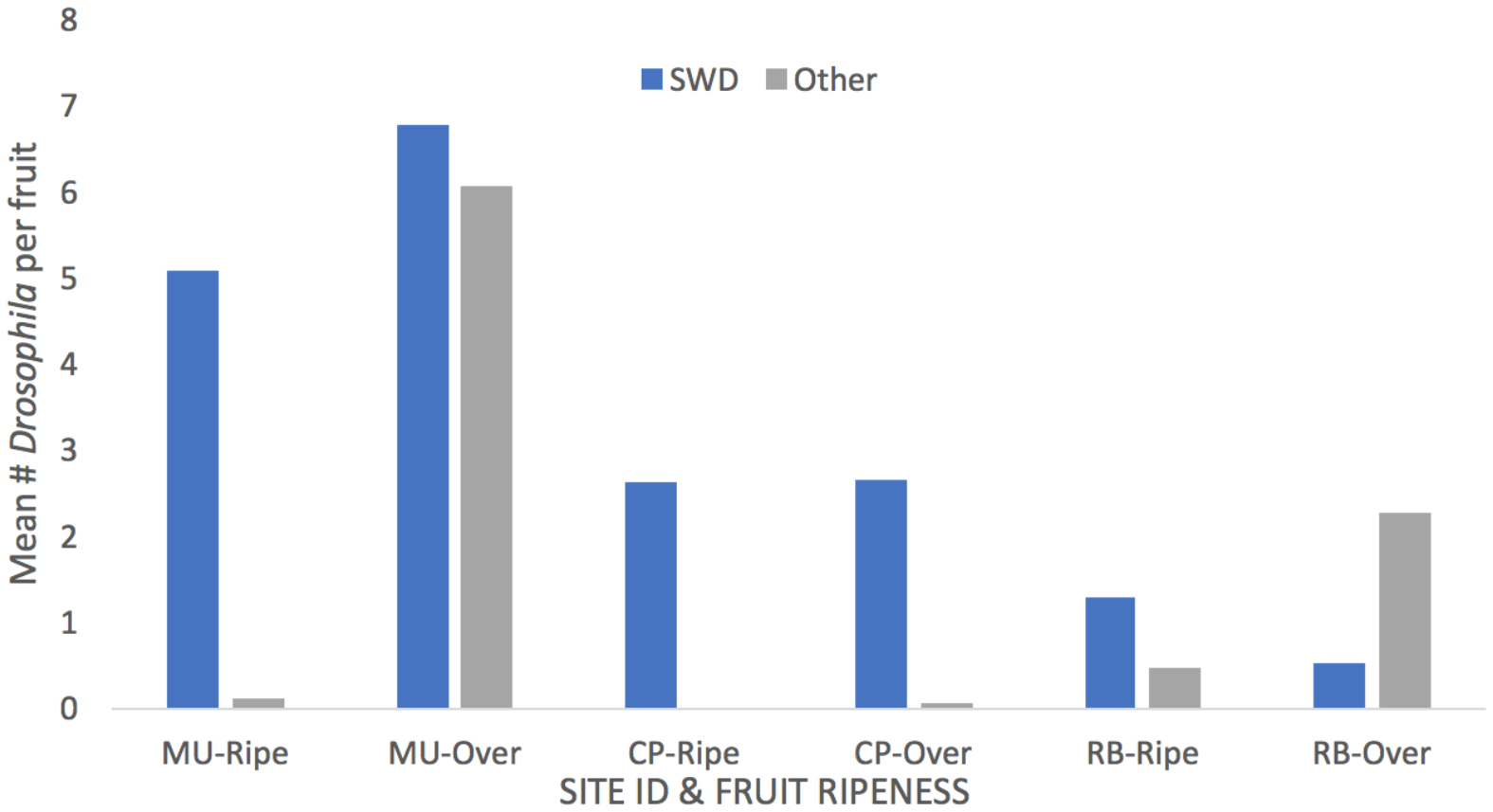

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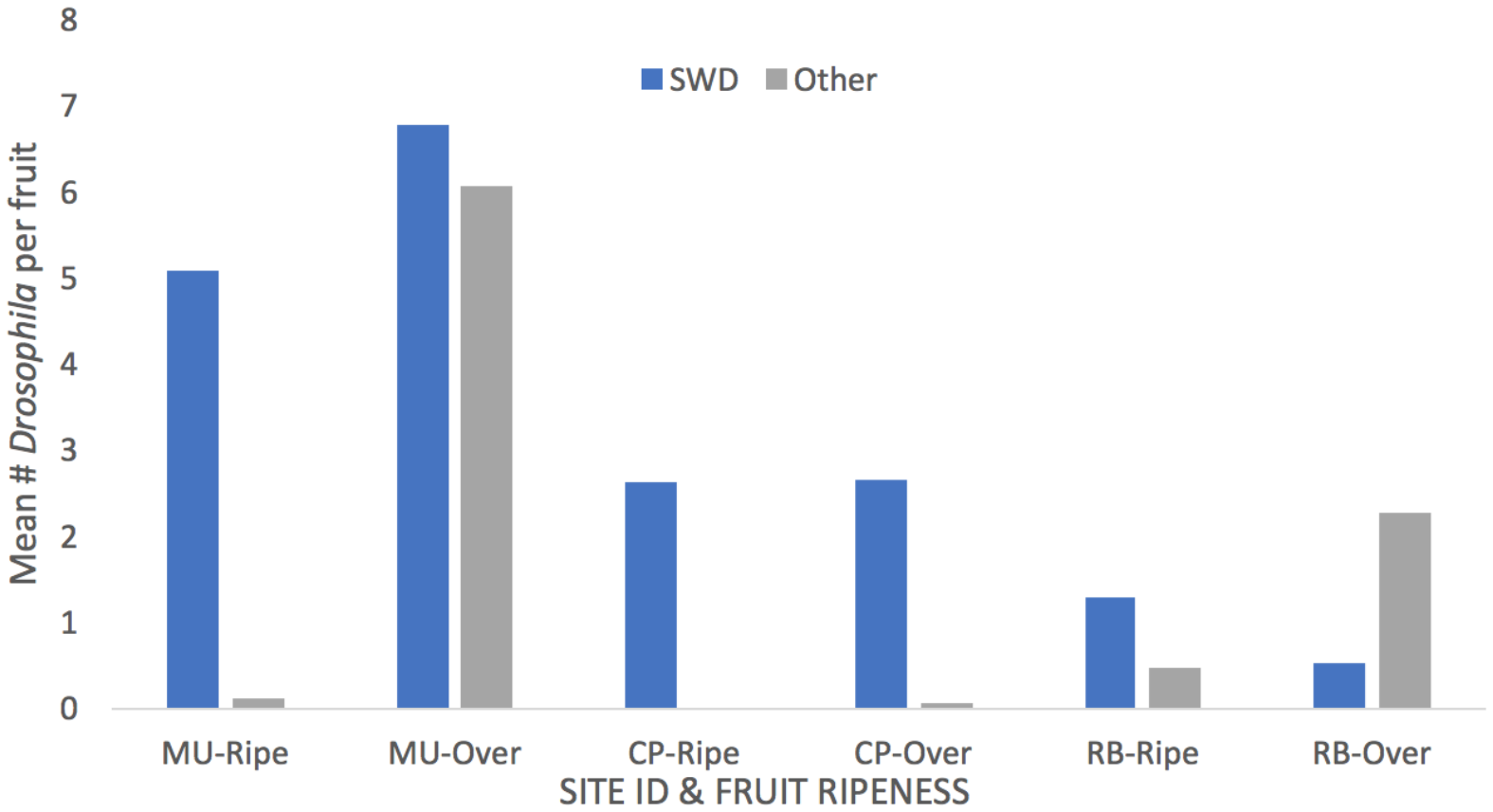

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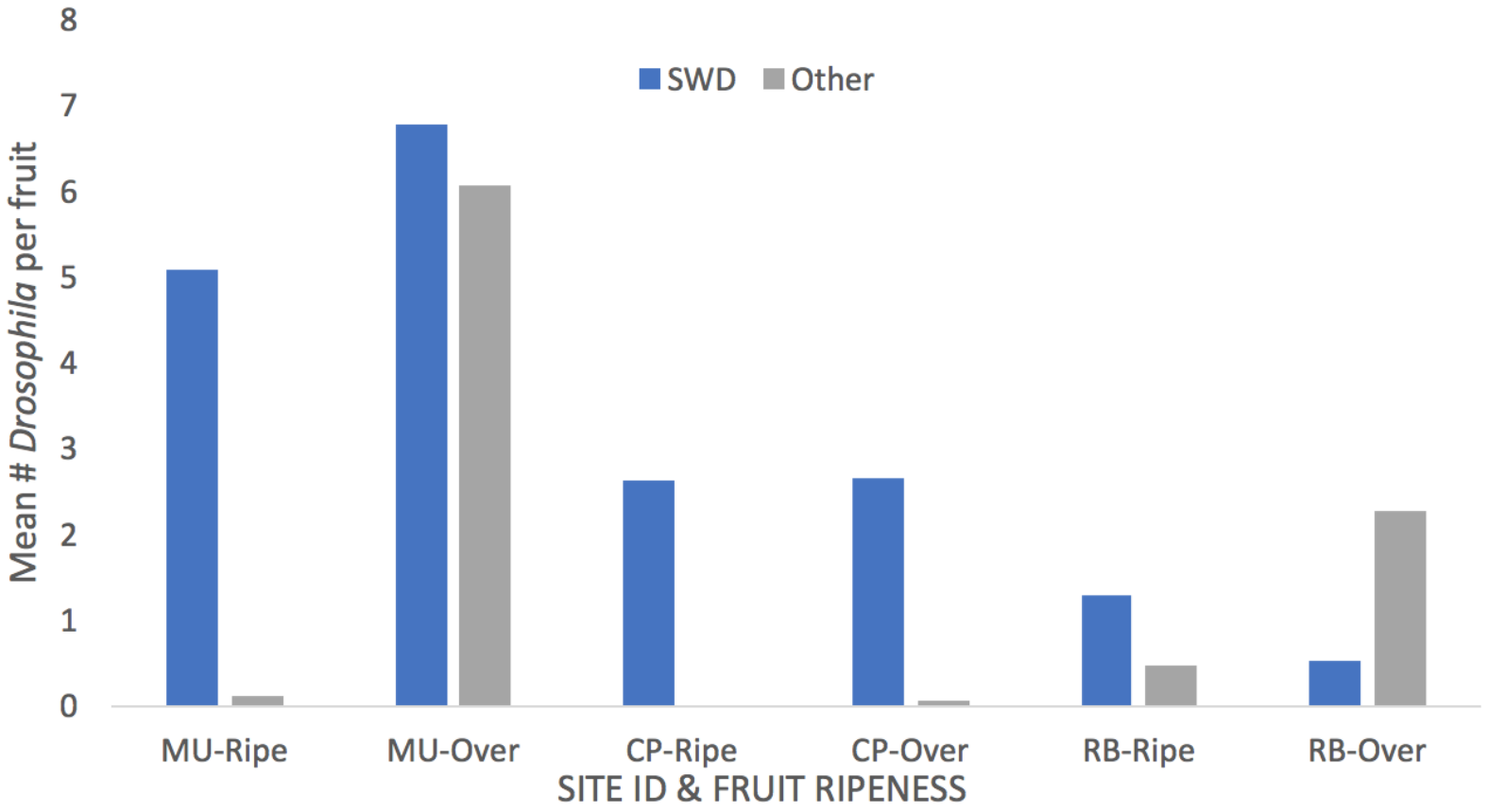

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Percent of total sample represented by SWD

Ripe: 94% (74% – 100%)
Overripe: 55% (19% - 98%)

$Z = 9.139$, $p < 0.0001$

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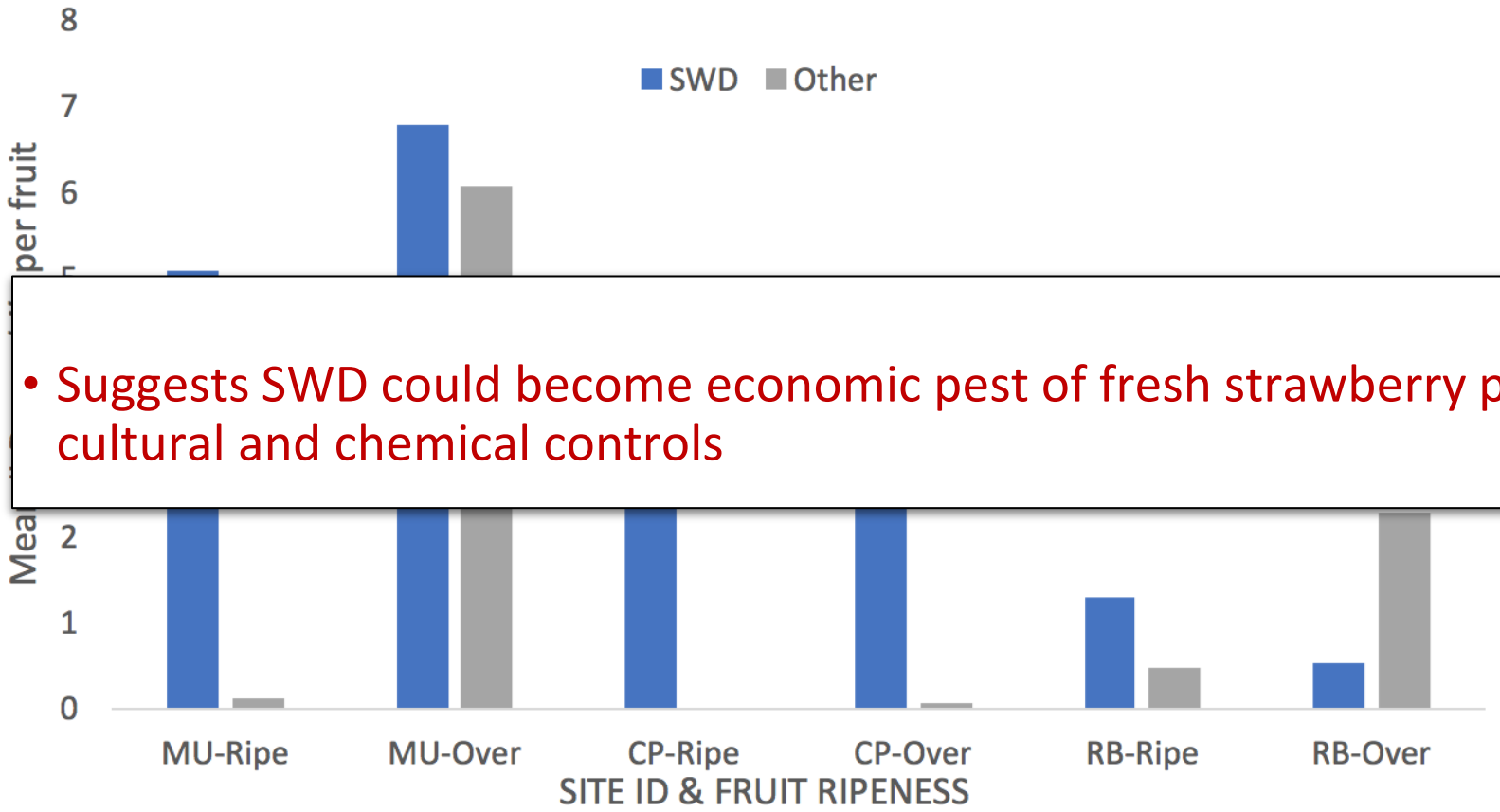

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- Suggests SWD could become economic pest of fresh strawberry production in absence of cultural and chemical controls

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INSECTICIDE RESISTANCE IN CA SWD

- Low to moderate levels of spinosad resistance emerging in Watsonville region
- Able to tolerate 5-12 x higher concentrations than susceptible SWD
- Significant increase in resistance observed after 5 generations of laboratory selection (~8-17 x)

Strain	LC50	SE	RR_W	RR_S
Susceptible (MI)	13.1	5.3	0.44	1
Wolfskill (untreated)	29.4	7.2	1	2.2
Watsonville	152.6	40.6	5.2	11.6
Watsonville-select	227.6	46.0	7.8	17.4

Gress & Zalom (2018) Pest Management Science

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Is resistance to malathion beginning to emerge in CA SWD populations?

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METHODS – MALATHION LARVAL BIOASSAYS

- Sampled SWD from two locations in CA
  - Commercial caneberry fields in Watsonville
  - USDA Wolfskill Germplasm repository (untreated)

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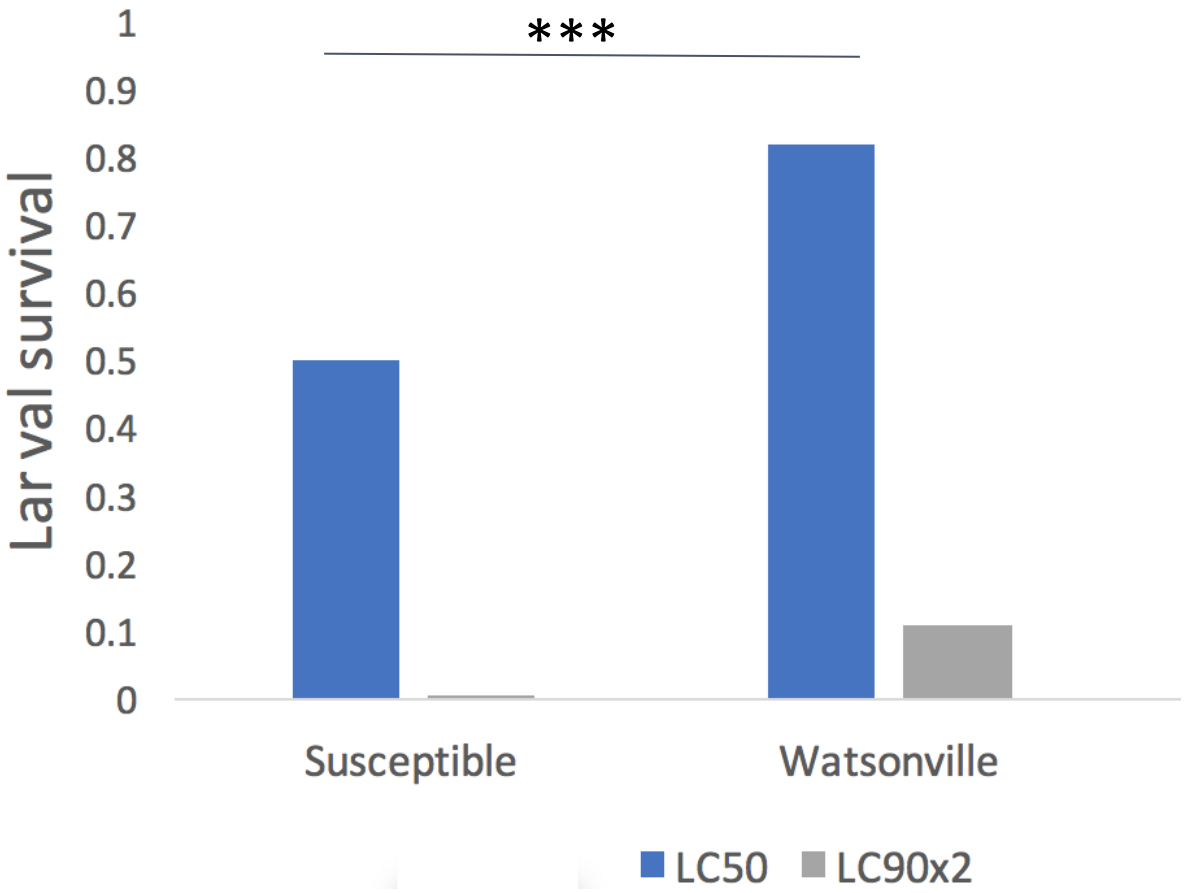
- Sampled SWD from two locations in CA
  - Commercial caneberry fields in Watsonville
  - USDA Wolfskill Germplasm repository (untreated)
- Allowed females to lay eggs in food bottles & treated larvae with malathion 4 days later
  - LC50, LC90x2 & water (control)
- Counted SWD that emerged as adults

RESULTS – WATSONVILLE LARVAE (MALATHION)



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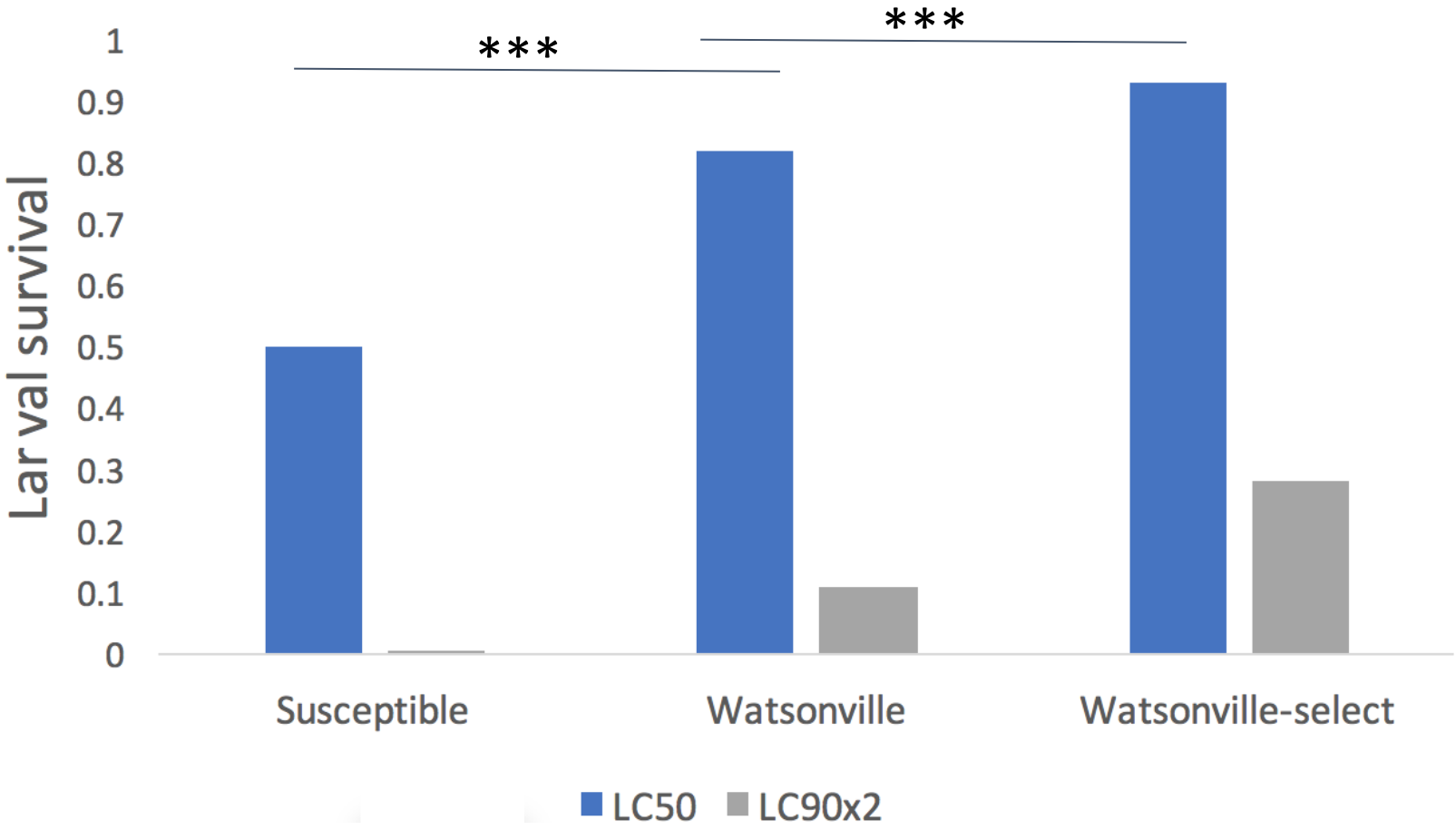

CONCLUSIONS

- Vinegar fly larvae were present in fruit from all stages and locations
  - SWD comprise between 5% and 100% of total larval load
  - Likely enter fruit first & create opportunities for other species (*D. simulans*)
- Spinosad & malathion resistance could create problems in fresh market crop
  - Cultural practices may help prevent
- Tolerance to both insecticides already present in commercial CA fields
- Susceptibility will likely further decline with continued field exposure

ACKNOWLEDGEMENTS


Frank Zalom


Oleg Daugovish


Mark Bolda


Peter Shearer


Joanna Chiu

CALIFORNIA STRAWBERRY COMMISSION

Undergraduate researcher
Chase Matterson

cdfa
CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

USDA
United States Department of Agriculture

UCDAVIS
UNIVERSITY OF CALIFORNIA

THE OFFICE OF ENVIRONMENTAL FARMING & INNOVATION
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pesticide consultation & analysis