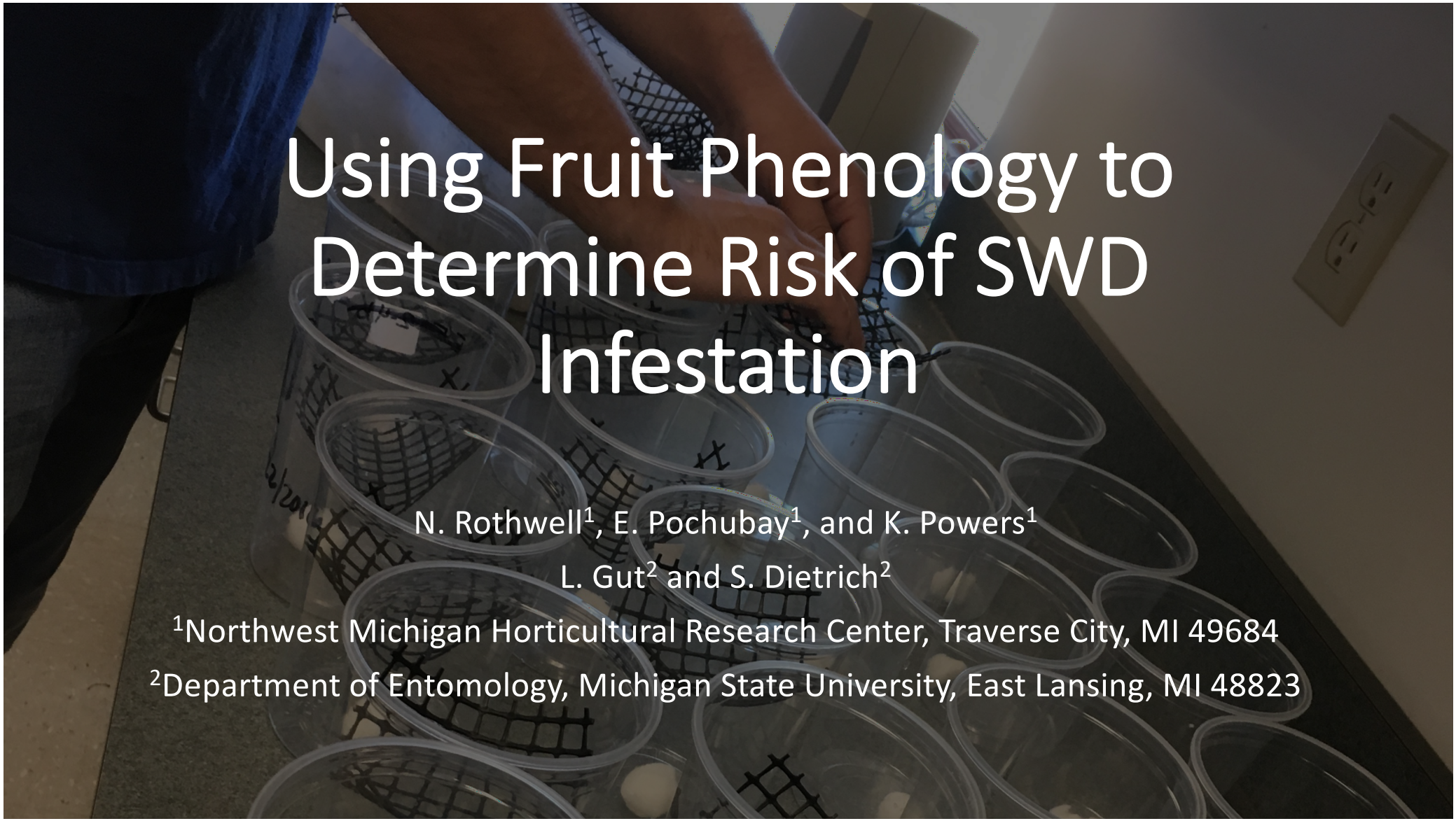

Using Fruit Phenology to Determine Risk of SWD Infestation

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Project Objectives

- Determine quantifiable fruit phenological stages that initiate SWD oviposition under different annual environmental conditions
- *Hypothesis*: SWD females lay eggs into tart cherry fruit at a quantifiable stage of ripeness
- *Goal*: Develop a degree-day based SWD risk model in Montmorency cherry to help growers manage SWD successfully

Anecdotal Rationale

- TNRC efficacy trial 2017
  - Tart cherries were red, mostly ripe
  - Adults were being trapped at low #s
  - Staff was checking for larvae regularly, but none found
  - Sprayed efficacy treatments on Tuesday following long weekend
  - Sampled fruit on Friday and all treatments were infested
    - Fruit was infested prior to insecticide applications
    - ~7 days orchard went from not infested to infested

- On-farm SWD traps begin to catch flies at varying times during season
  - No relationship on early vs. late catch on orchard infestation

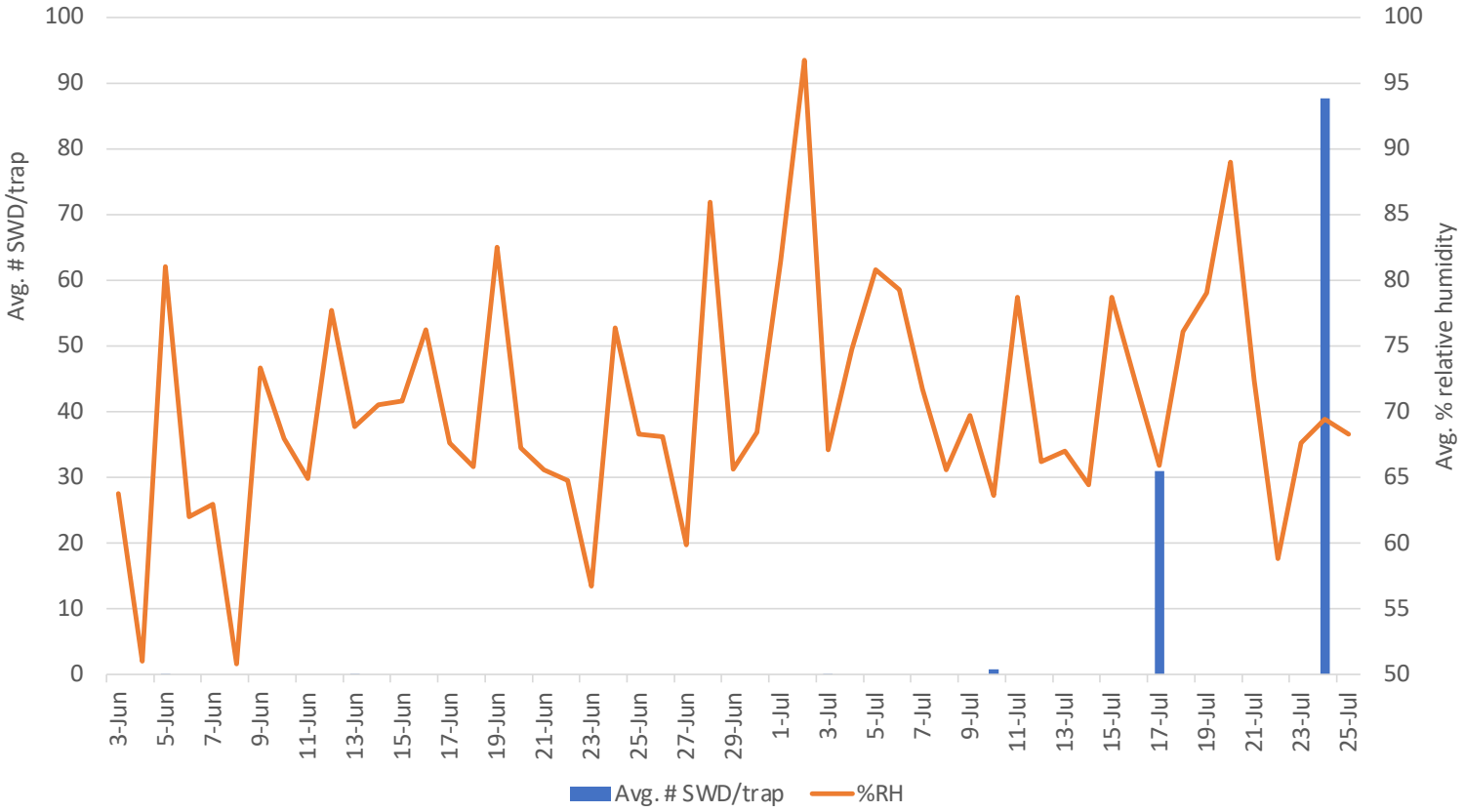
Region	1st Adult Catch		1st Detection of Larvae		Harvest Date	Larvae before harvest
	Date	# of flies	Date	# of larvae		
NW 1	12-Jun	2	26-Jul	2	28-Jul	Yes
NW 2	10-Jul	1	N/A	0	27-Jul	No
NW 3	12-Jun	3	19-Jul	1	23-Jul	Yes
NW 4	29-May	2	28-Jun	3	12-Jul	Yes
NW 5	12-Jun	1	19-Jul	2	20-Jul	Yes
NW 6	5-Jun	1	21-Jul	3	25-Jul	Yes
NW 7	19-Jun	2	19-Jul	7	26-Jul	Yes
NW 8	19-Jun	3	26-Jul	2	5-Aug	Yes
NW 9	5-Jun	1	27-Jul	16	6-Aug	Yes
NW 10	12-Jun	1	1-Aug	4	29-Jul	No

- First catch: 5/29-6/19
- 8 of 10 orchards were infested before harvest

Two examples show that SWD is present in orchards, but *some trigger* results in rapid infestation with no link to adult trap catch

Rationale, cont.

- In 2019, sweet cherry fruit were ‘clean’ ~July 15
  - Calls about SWD infestation in *sweet cherries* began to come in ~July 23
  - Relative humidity rises on July 17 for 5 days



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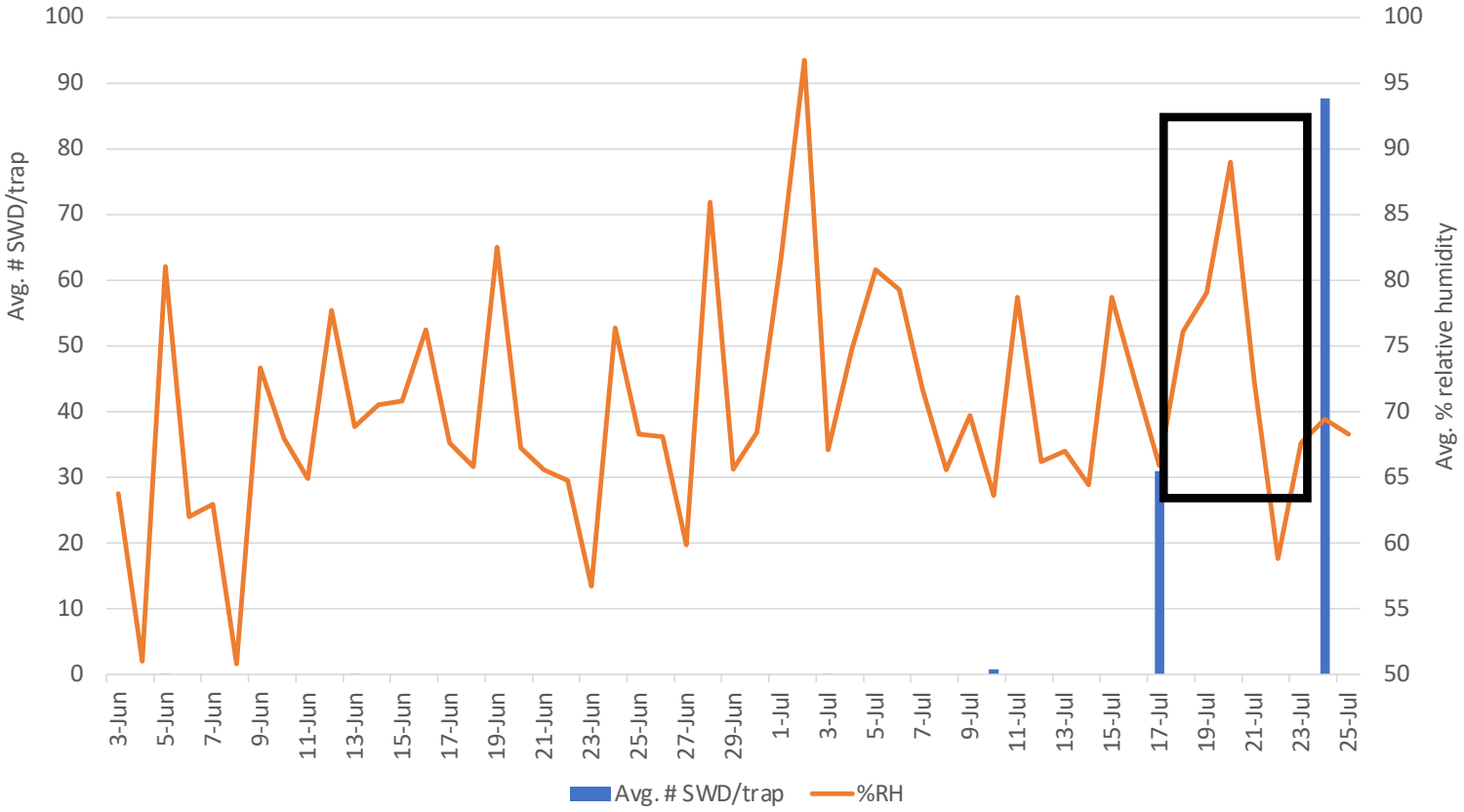
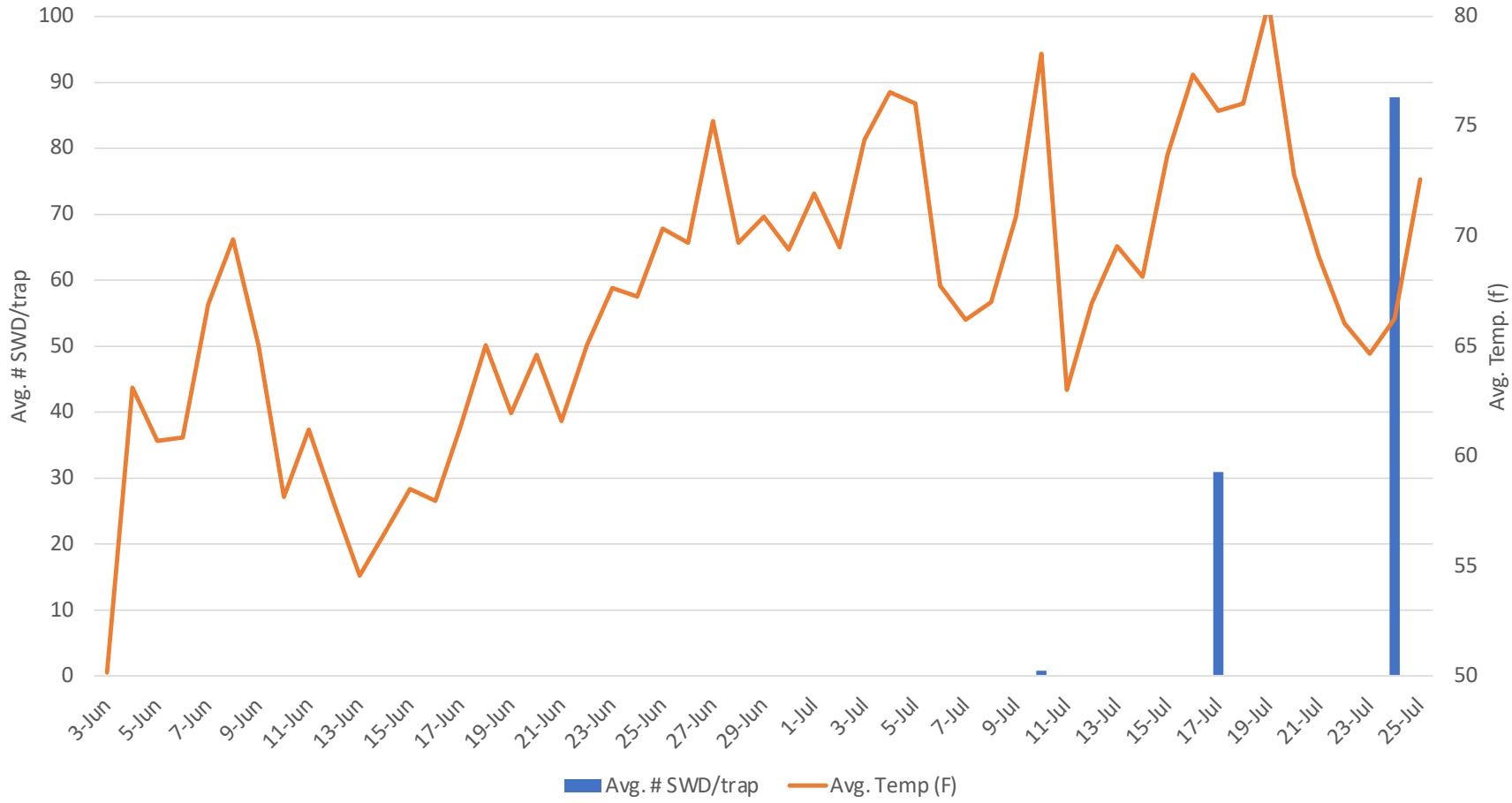


Temperature also rises ~July 15-July 21



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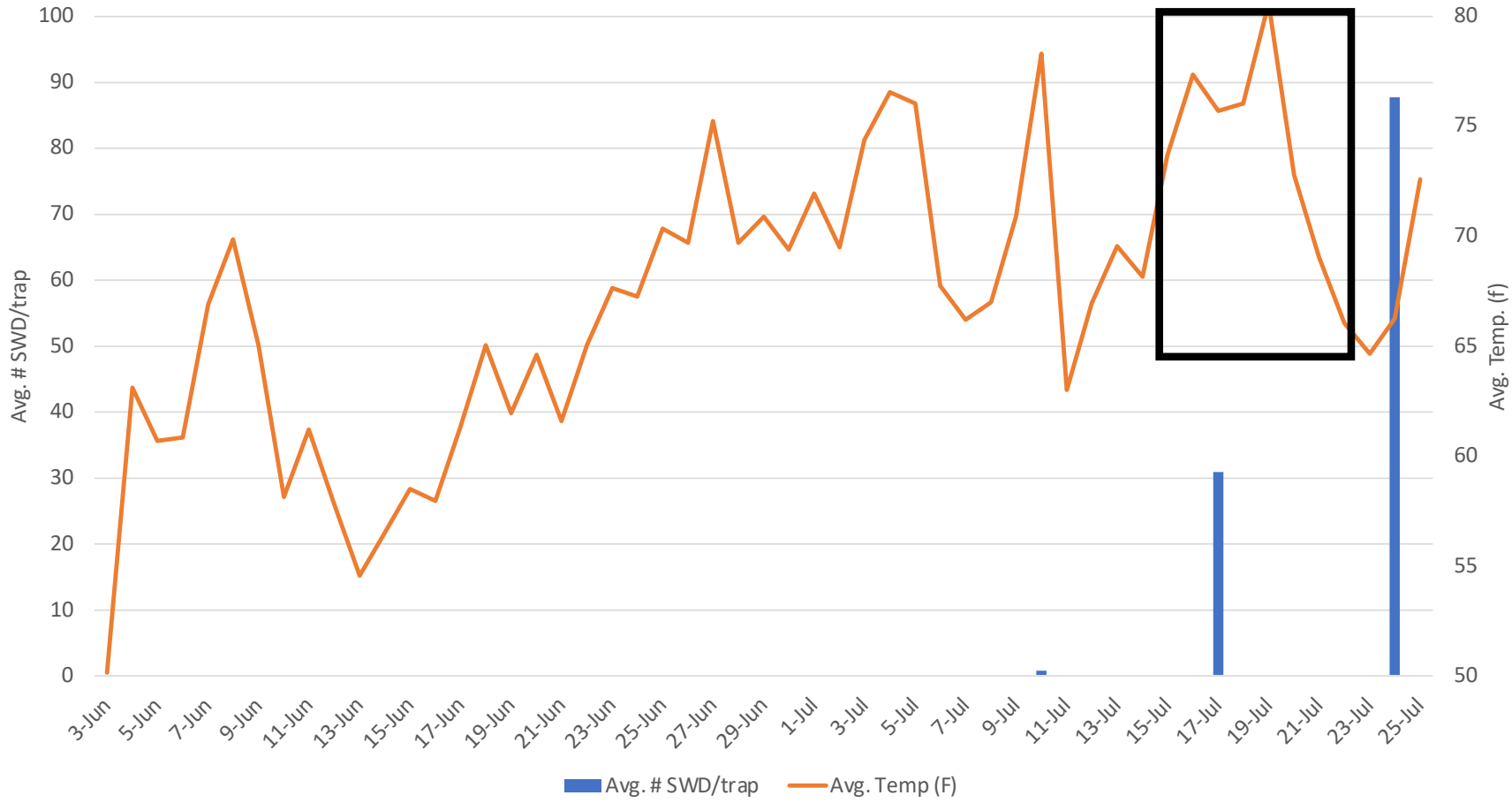


Changing Our Thinking

SWD is consistently present in environment

- Population size varies throughout the year

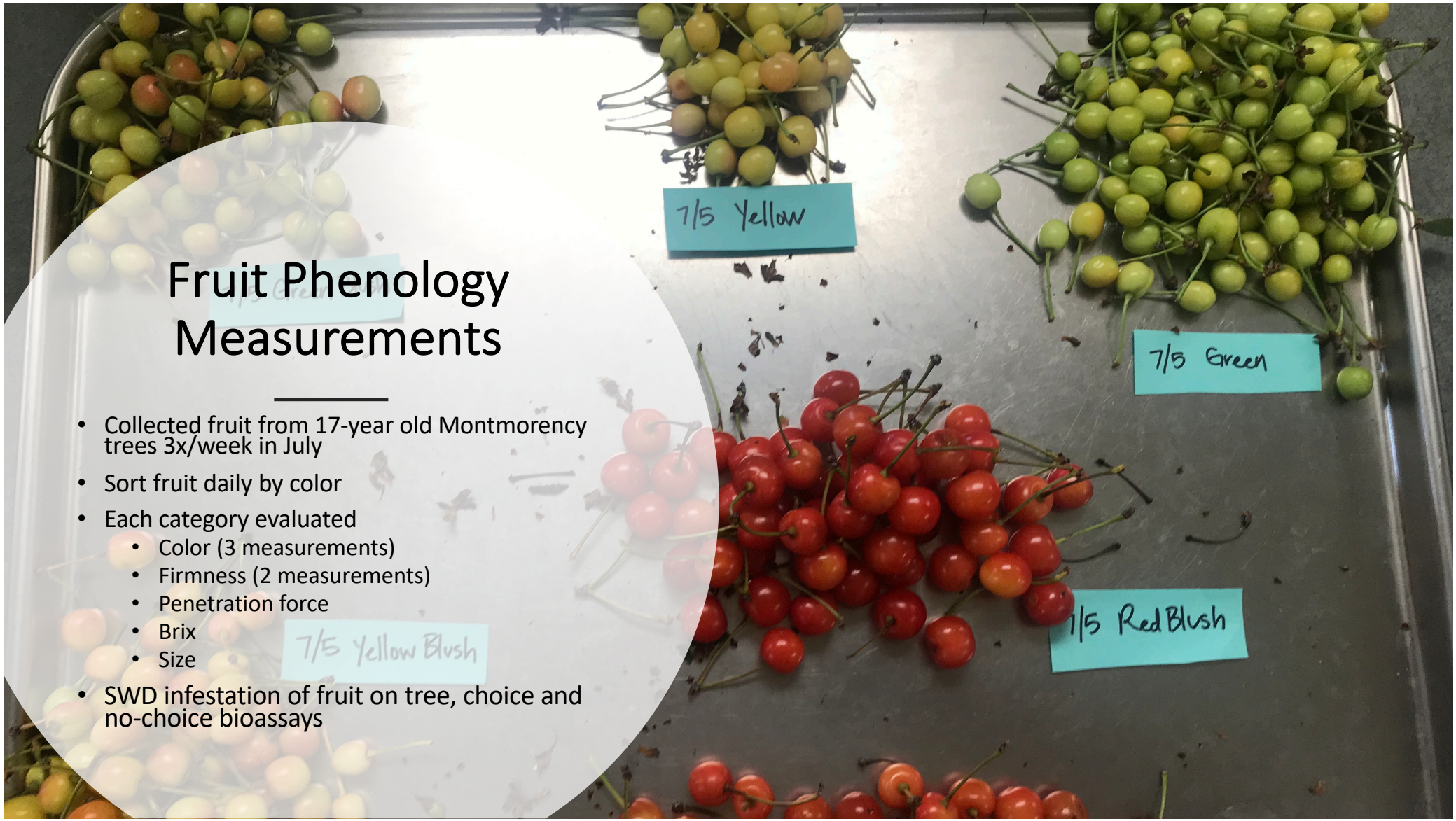
Other factors that result in rapid infestation of tree/block

- Do SWD cue in on fruit phenological stage(s) to initiate egg-laying?
  - Color, firmness, penetration force, brix, size
- Are there environmental factors that favor rapid increases in SWD activity/egg-laying?
  - Relative humidity, temperature, overnight temperatures

Shift research efforts to understand impacts of crop phenology and/or environmental factors on SWD

Fruit Phenology Measurements

- Collected fruit from 17-year old Montmorency trees 3x/week in July
- Sort fruit daily by color
- Each category evaluated
  - Color (3 measurements)
  - Firmness (2 measurements)
  - Penetration force
  - Brix
  - Size
- SWD infestation of fruit on tree, choice and no-choice bioassays



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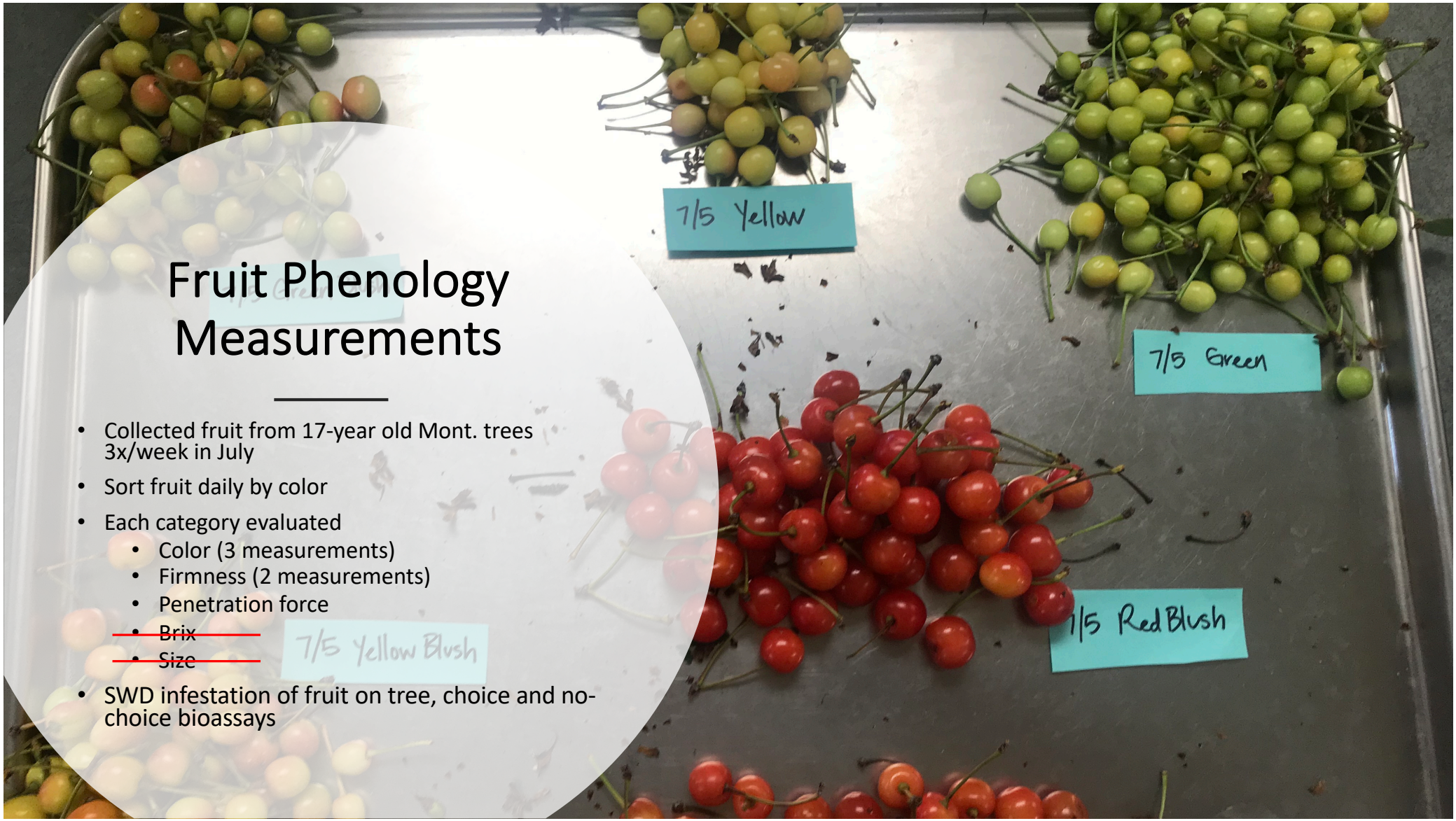
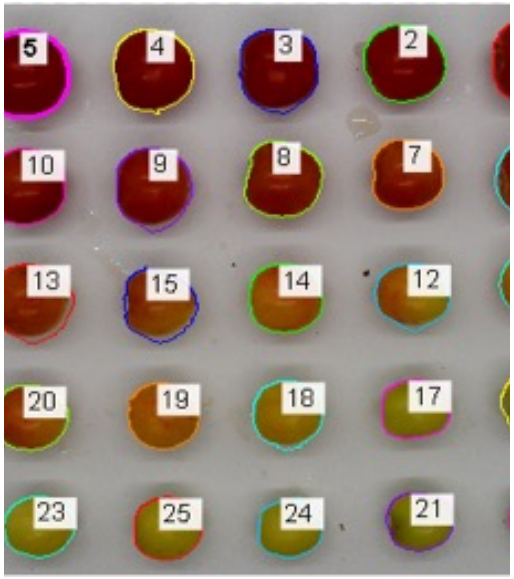
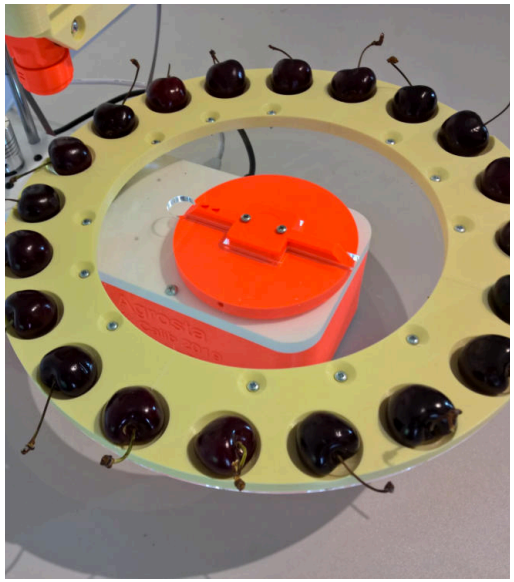
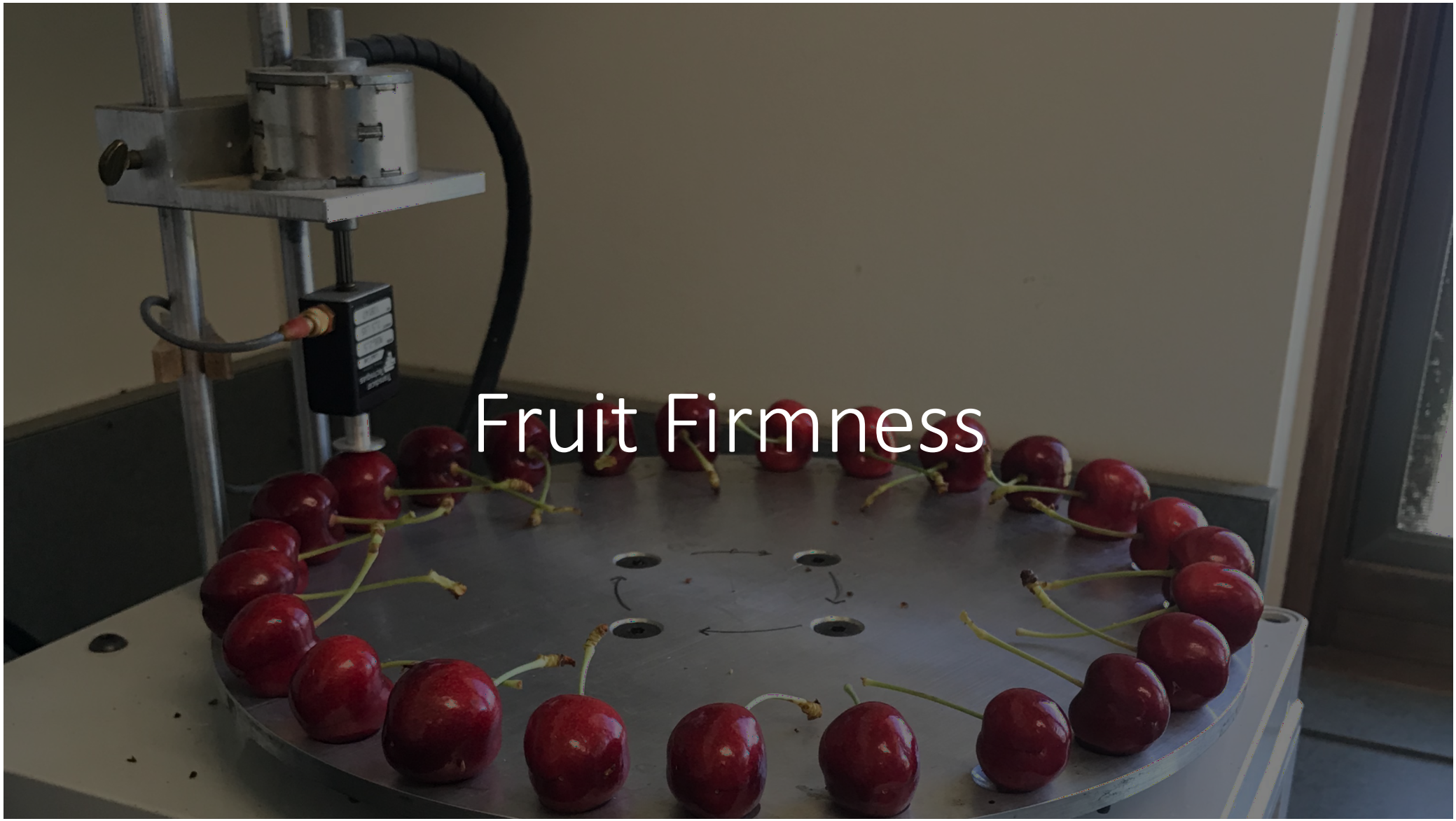






Fruit Color

- Measured three ways:
  - Traditional camera in light box
    - Able to generate RGB readings for each fruit
  - Colorimeter
  - Agrosta Winterwood
    - Spectrophotometer – provides light intensity on specific wavelengths

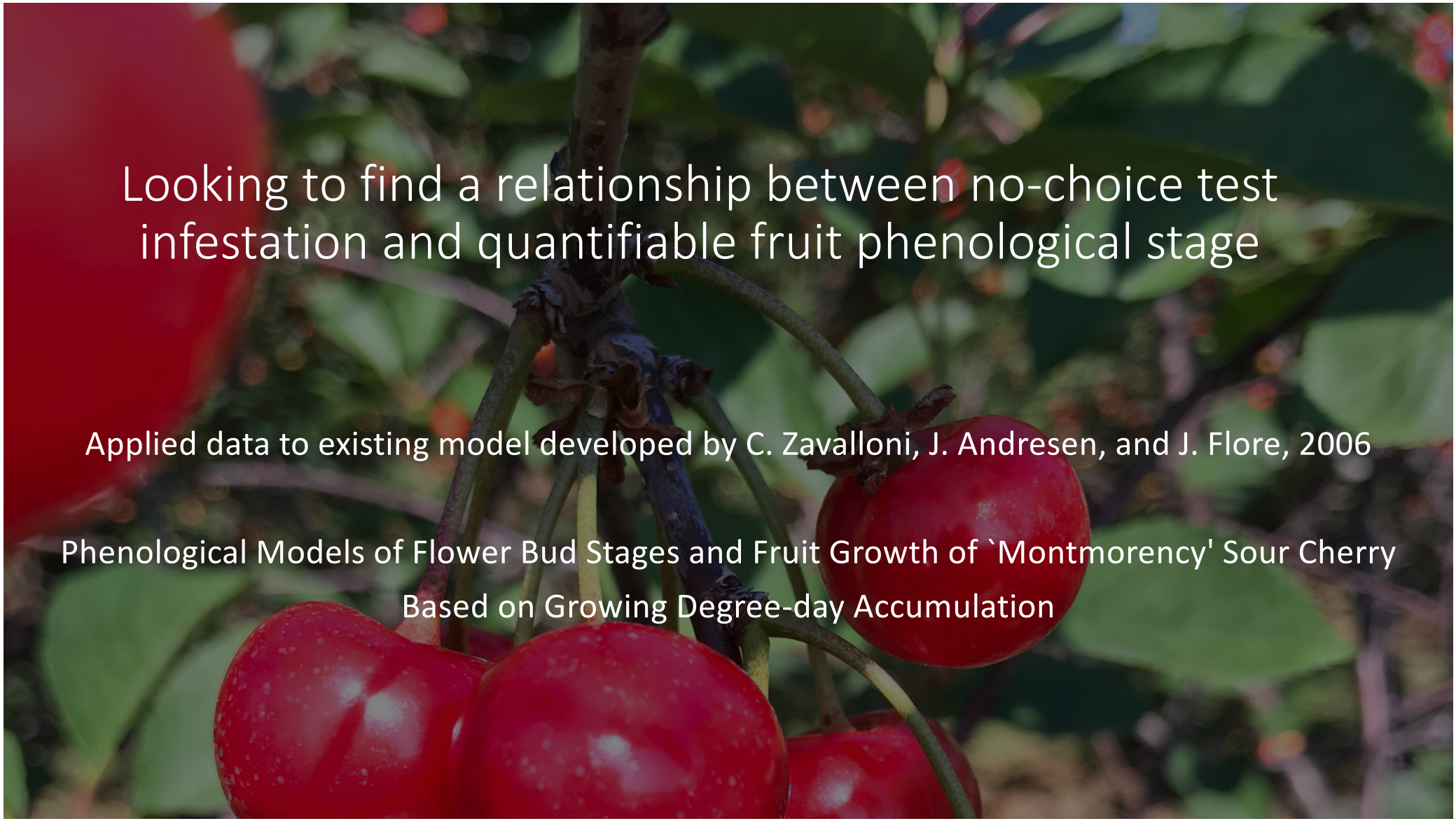

Fruit Firmness

Fruit Penetration Force

Measured 25 fruit in each color sample (‘18-’19) to determine level of force to pierce cherry skin

No-Choice Bioassays

- All fruit were used in no-choice bioassays 3x/week
- Male and female SWD added to cup with 5 fruit of each color category
- 6 replicates
- Adults removed after 48hrs
- Fruit tested for larvae after 7D using brown sugar method



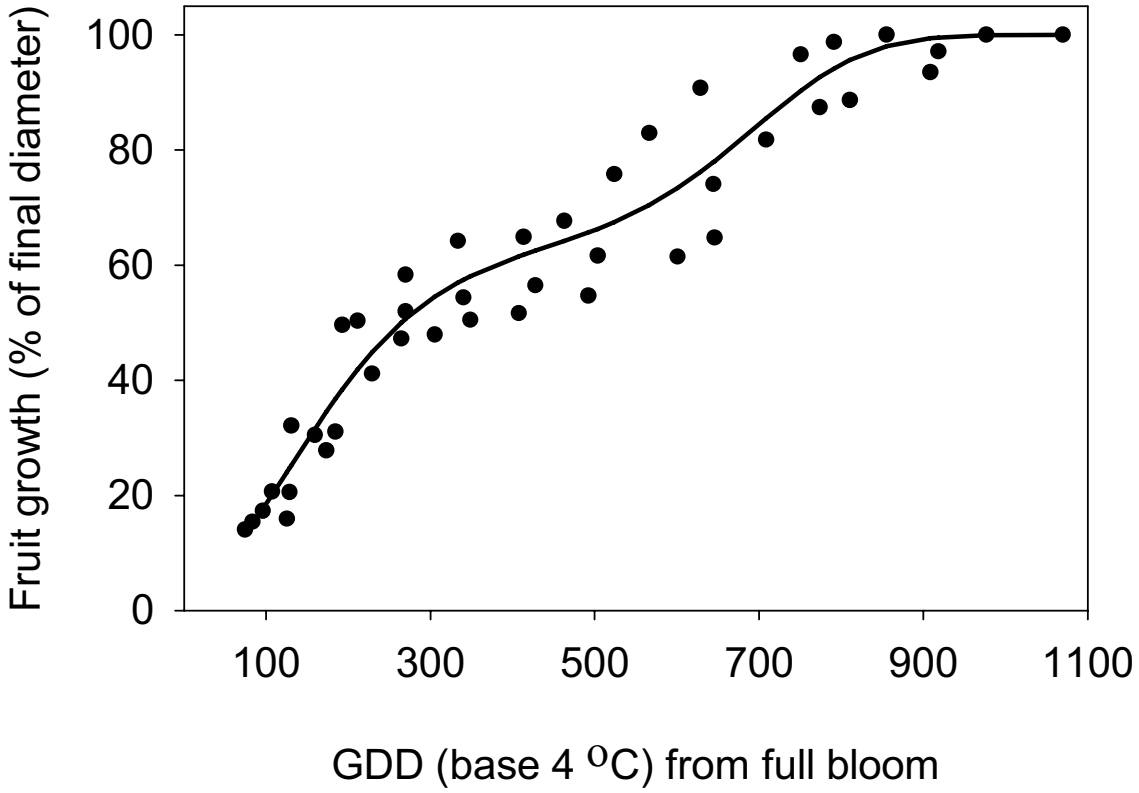
Looking to find a relationship between no-choice test infestation and quantifiable fruit phenological stage

Applied data to existing model developed by C. Zavalloni, J. Andresen, and J. Flore, 2006

Phenological Models of Flower Bud Stages and Fruit Growth of `Montmorency' Sour Cherry Based on Growing Degree-day Accumulation

Tart cherry fruit growth as a function of growing degree-day (GDD base 4◦C) accumulation from full bloom

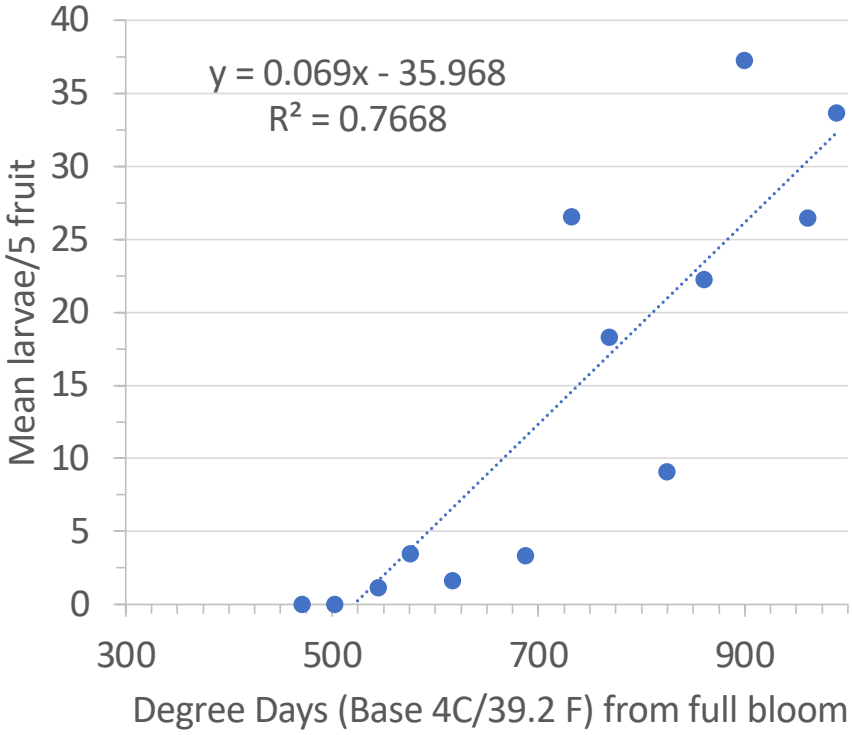
Zavalloni et al. 2006. J. Amer. Soc. Hort. Sci. 131: 601-607



Montmorency Model

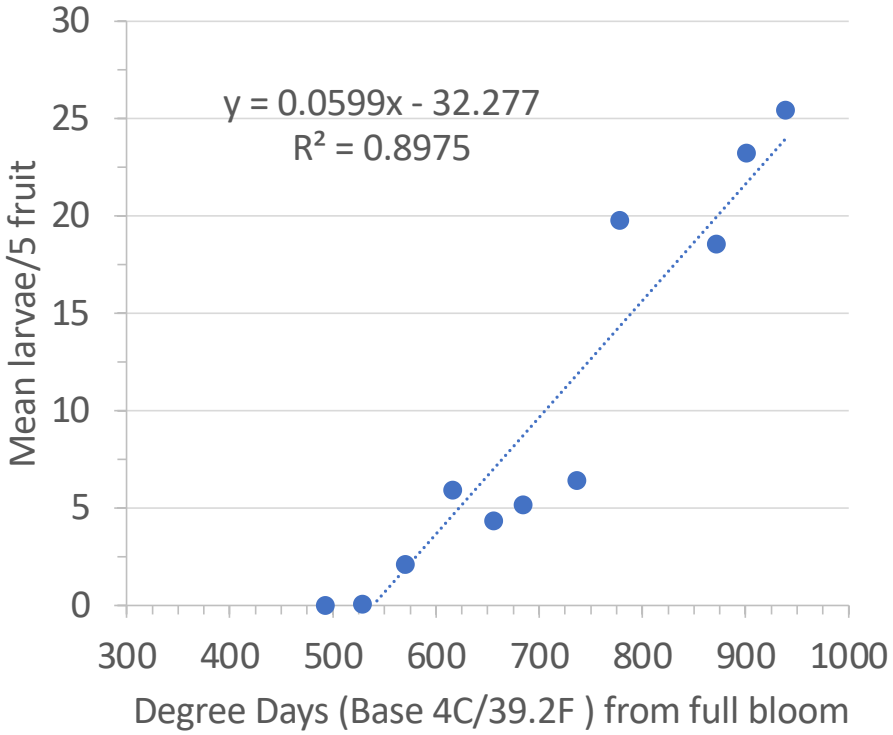
- Model determined flower bud phenological stages and fruit growth as function of daily temperatures
- Observed flower bud phenology and fruit diameter at 3- to 7-day intervals
- Used accumulation of GDDs (base 4C/39.2F) as an independent variable and fitted GDD to field observations
- Model agrees with in-orchard growth of fruit through season
    - We could use our SWD data in established model

2018



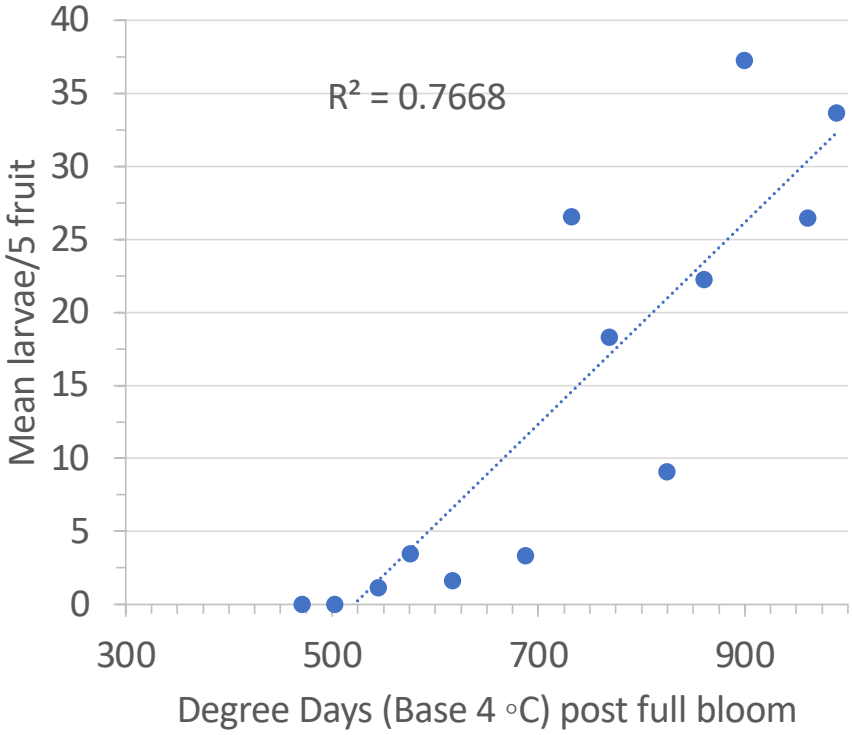
X intercept = 521

2019



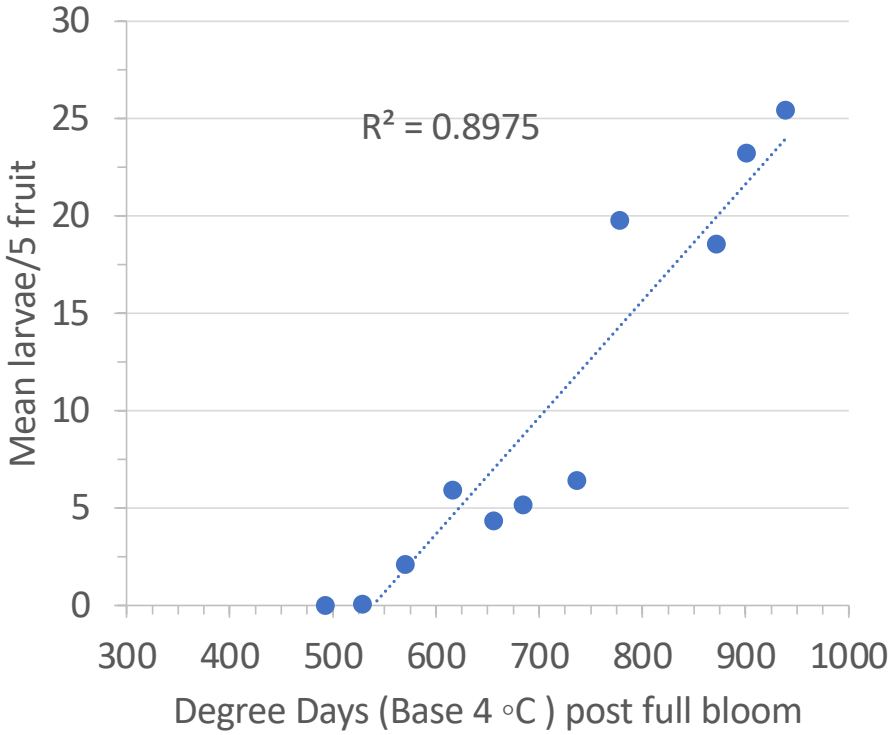
X intercept = 539

2018



X intercept = 521 DD
(zero infestation)

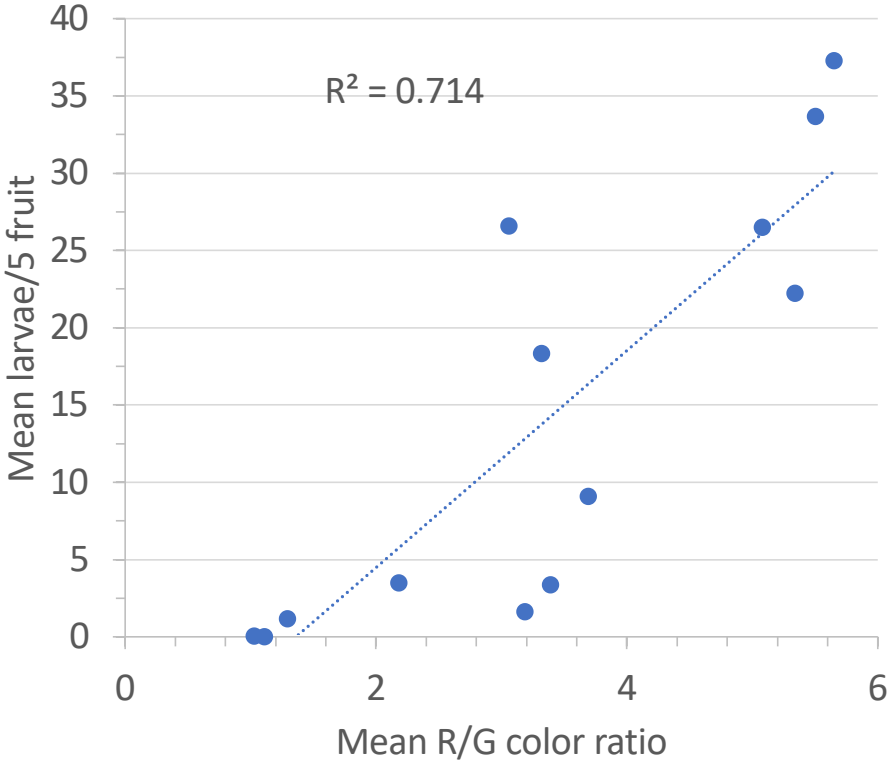
2019



X intercept = 539 DD
(zero infestation)

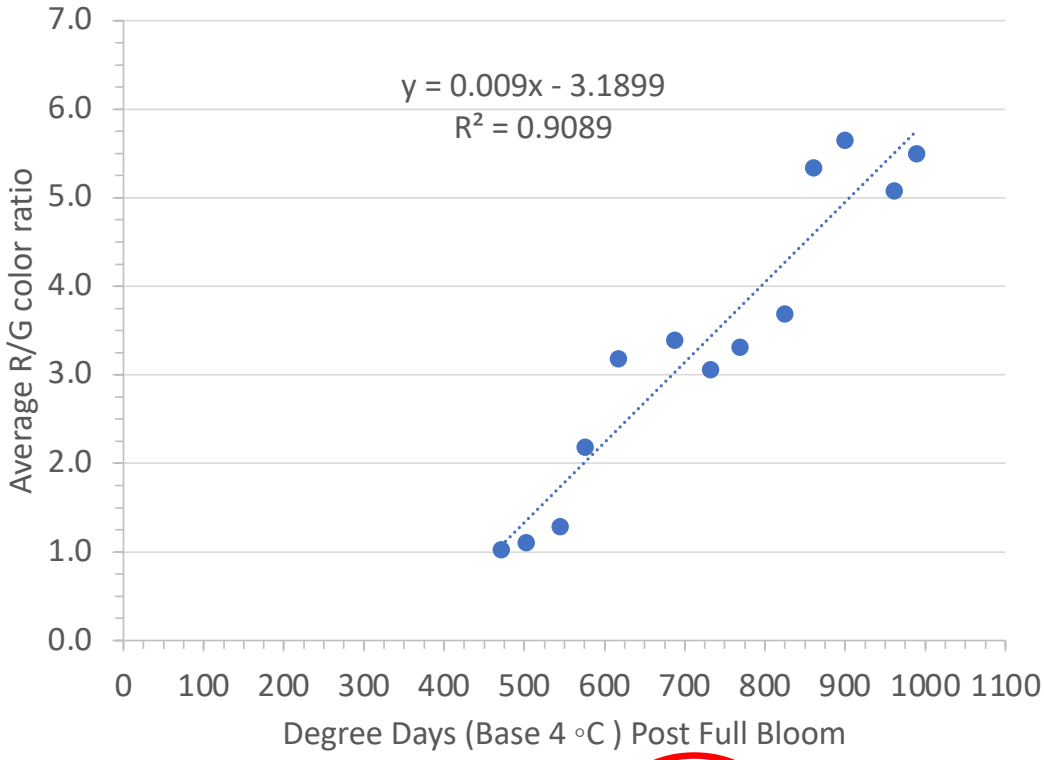
Color is the fruit development characteristic most closely associated with timing of infestation

2018 color-infestation relationship



X intercept = 1.36
(zero infestation)

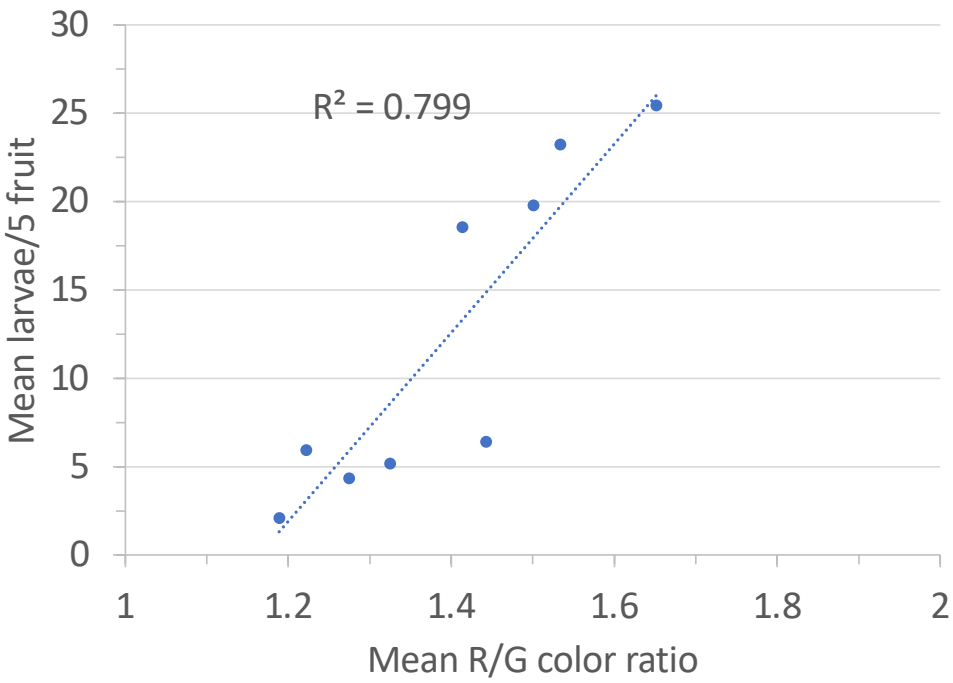
2018 color – DD Base 4 ◦C relationship



1.36 R/G = 506 DD

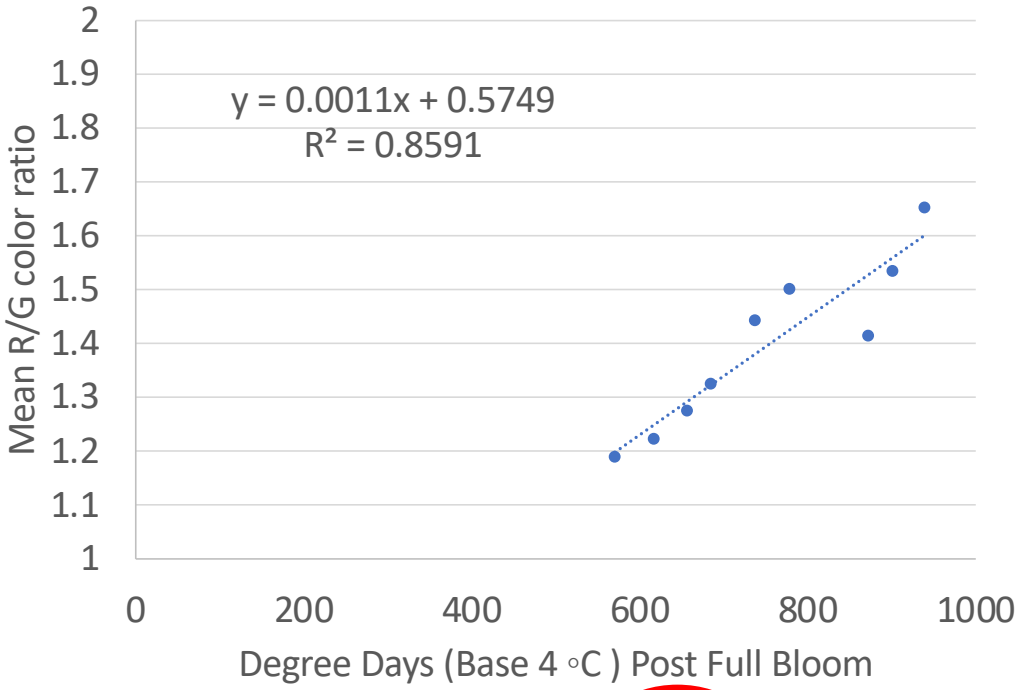
Color is the fruit development characteristic most closely associated with timing of infestation

2019 color-infestation relationship

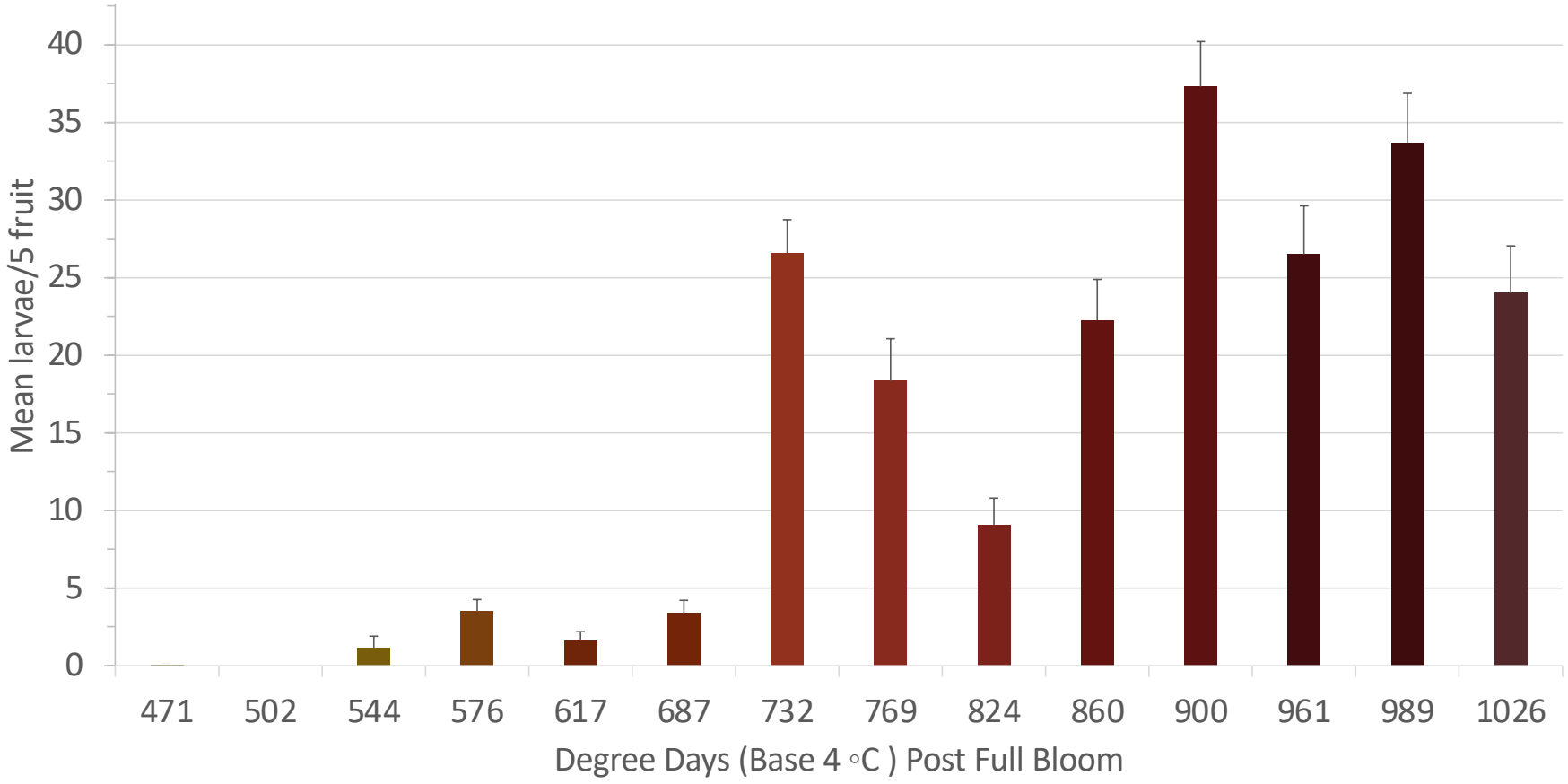


X intercept = 1.16
(zero infestation)

2019 color – DD Base 4 ◦C relationship



1.16 R/G = 532 DD


Mean larvae/5 fruit
40
35
30
25
20
15
10
5
0
471
502
544
576
617
687
732
769
824
860
900
961
989
1026
Degree Days (Base 4 ◦C) Post Full Bloom


Low risk
Mod risk
High risk
400
530
650
1000

Putting SWD Risk Model to Use in 2020

2019		Temperature(°F)			Degree Days Base 50°F		Biofix Date (first sust										
Day	Date	Max	Min	Avg	Today	Since 3/1	10/3	10/5	10/7	10/9	10/11	10/13	10/15	10/17	10/19	10/21	1
Tuesday	11/5	37.9	28.4	33.2	0	2299	58	53	46	35	18	13	13	13	13	5	1
Wednesday	11/6	30.9	27.1	29	0	2299	58	53	46	35	18	13	13	13	13	5	1
Thursday	11/7	31.3	25	28.1	0	2299	58	53	46	35	18	13	13	13	13	5	1
Friday	11/8	28.6	23.1	25.8	0	2299	58	53	46	35	18	13	13	13	13	5	1
Saturday	11/9	38.1	25.7	31.9	0	2299	58	53	46	35	18	13	13	13	13	5	1

- Set biofix at full bloom date
- Begin accumulating GDD base 39.2F from biofix
- Fruit are slightly susceptible to infestation at 530GDD base 39.2F
  - Few fruit are ‘red’ enough in orchard, so infestation would still be very low
  - Fruit that do become infested will likely drop
- Risk of infestation increases considerably at ~630GDD base 39.2F
  - 100GDD past 530GDD
- Goal: Bata SWD risk model on Enviroweather

Impacts of Environmental Conditions on SWD Risk Model

- Hypothesis: Tart cherry fruit can start to become susceptible to infestation at ~530GDD but this timing may be influenced by environmental conditions
  - i.e. If weather warms and relative humidity rises, risk of infestation may increase

- Research for 2020 is to determine how temperature and humidity influence trap count/egg-laying
  - Overlay environmental condition data in risk model to improve output

Thank You!

Gut lab

NWMHRC crew

Michigan State HORTICULTURAL Society

Project GREEEN

MONTMORENCY TART CHERRIES™