



**Virtual Field Day Agenda**

<b>Handout No.</b>	<b>Topic</b>	<b>Speaker</b>	<b>Time (PST)</b>
	Welcome and Introductory Remarks	<b>Dr. Gerald Holmes</b> Director, Cal Poly Strawberry Center	9:00 AM
<b>1</b>	Lygus Bug Vacuuming for an Integrated Pest Management Program	<b>Jack Wells</b> Production Automation Engineer, California Strawberry Commission	9:12 AM
<b>2</b>	Importance of Sprayer Calibration for an Effective Pesticide Application	<b>Caleb Fink</b> Production Automation Engineer, California Strawberry Commission	9:18 AM
<b>—</b>	Update on Plastic Mulch Cross Hole Puncher	<b>Jack Wells</b> Production Automation Engineer, California Strawberry Commission	9:24 AM
<b>—</b>	Recent Advances in Robotic Harvesting	<b>Kyle Cobb,</b> Co-Founder, Advanced.Farm <b>Lewis Anderson,</b> Co-Founder & CEO, Traptic <b>Gary Wishnaski,</b> Exec Chairman & CEO, CROO Robotics	9:30 AM
<b>3</b>	The Effect of Pre-plant Fertilizer Management on Four Strawberry Cultivars	<b>Kamille Garcia Brucher</b> Cal Poly MS Student	9:45 AM
<b>4</b>	Susceptibility to Macrophomina Crown Rot in 65 Cultivars and Advanced Breeding Lines	<b>Dr. Mojtaba Mansouripour</b> Grower Services Research Manager, Plant Sciences	9:57 AM
<b>5</b>	A Two-year Summary Evaluating Host Resistance to Anthracnose in 105 Cultivars and Elite Breeding Lines of Strawberry	<b>Omar Gonzalez Benitez</b> Staff Research Associate II, UC Davis	10:09 AM
<b>6</b>	Fungicide Performance Against Botrytis Gray Mold	<b>Kyle Blauer</b> Field Research Manager, Cal Poly Strawberry Center	10:21 AM
<b>7</b>	Prevalence of Postharvest Botrytis Gray Mold After Simulated Shipment and Cold Storage	<b>Dr. Gerald Holmes</b> Director, Cal Poly Strawberry Center	10:31 AM
<b>8</b>	Fungicide Resistance in Strawberry Powdery Mildew and Powdery Mildew Host Susceptibility	<b>Michael Palmer</b> Cal Poly MS Student	10:43 AM
<b>9</b>	Soil Microbiome Changes in Response to Soil Fumigation	<b>Dr. Shashika Hewavitharana</b> Plant Pathologist, Cal Poly Strawberry Center	11:00 AM
<b>10</b>	Cal Poly Strawberry Disease Diagnostic Service Updates	<b>Dr. Shashika Hewavitharana</b> Plant Pathologist, Cal Poly Strawberry Center	11:12 AM
<b>11</b>	Assessing the Quality of Predatory Mites for Augmentative Biological Controlling in CA Strawberries	Speaker to be revealed	11:17 AM
	<b>Program Concludes</b>		<b>11:30 AM</b>

This program was approved by CDPR and CCA for 2 hours of continuing education units



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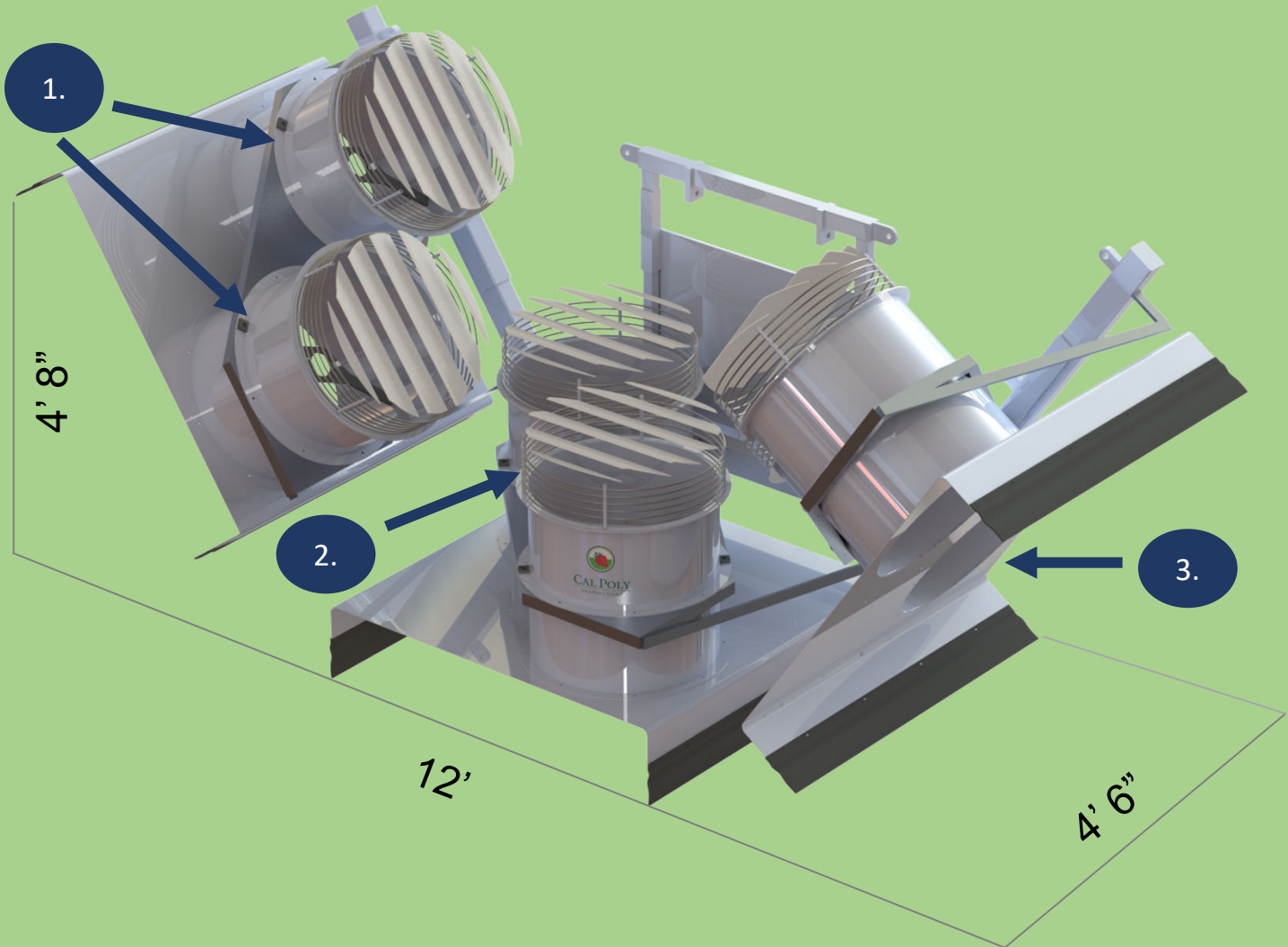
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1.

### Two-tube design

Overlapping 24-inch fans cover the entire strawberry bed with high-speed air

2.

### Raised baffle system

High-porosity perforated plate six-inches above the outlet improves system efficiency and increases inlet air speed

3.

### Circular ducting

24.5-inch tubes yield improved fan efficiency and increased *Lygus* spp. removal

## Equipment operation

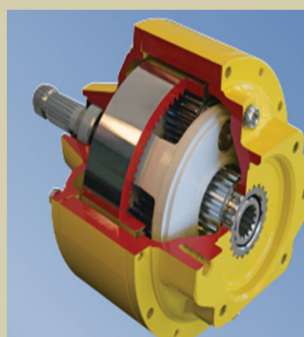
- ❖ 2600 PSI pump pressure
- ❖ 90 horsepower tractor
- ❖ 500 PTO RPM
- ❖ 2 mile/hour travel speed

Proportion of <i>Lygus</i> spp. population removed (% +/- SEM)							
Bug Vacuum	10/16/18	10/17/18	10/24/18	10/25/18	10/30/18	10/31/18	10/14/19
Grower Standard	2% (+/- 0.4)	4% (+/- 0.7)	13% (+/-2.4)	6% (+/-2.1)	10% (+/-1.3)	13% (+/- 2.4)	10% (+/- 2.7)
Double Barrel	5% (+/- 1.1)	4% (+/-0.2)	33% (+/-1.9)	21% (+/-5.1)	22% (+/-1.6)	24% (+/-1.4)	25% (+/- 4.9)

❖ 2.3-fold increase in *Lygus* spp. removal when compared to grower standard across all trials

## Field tested components

- ❖ **Fan** – Multi-wing 24/5-5/28.5/PAG/2ZR
- ❖ **Motor** – Danfoss SNM2/17
- ❖ **Pump** – Eaton 420 series ADU080L
- ❖ **Gearbox** – AuburnGear Model 8 PTO Drive



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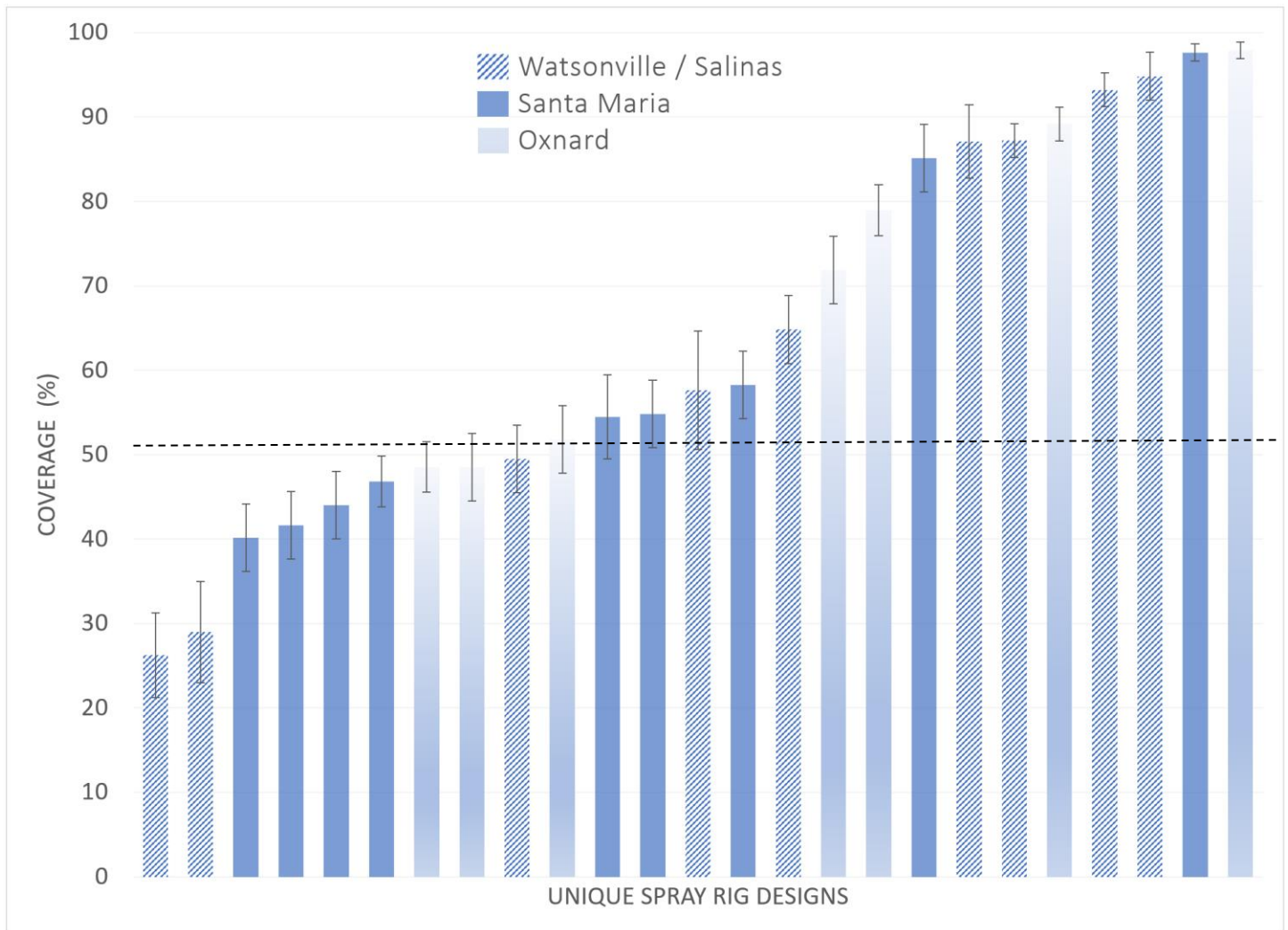
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**Example Spray Rig Yardstick: How does your rig compare?**



**Example Recommendation:**

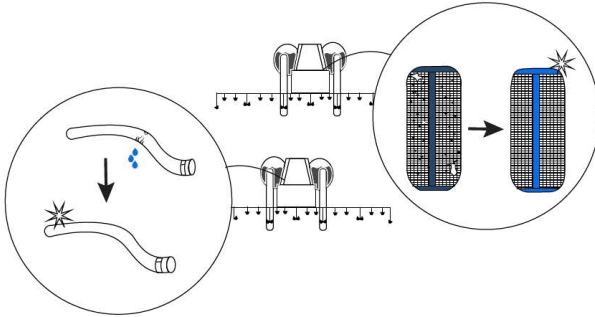
- Spray at or below the canopy height. Currently your rig sprays 6 inches above the plant canopy. By spraying at or below the canopy level you are ensuring that the spray particles are in the canopy.
- Change Tips: Currently your rig uses 15 hollow cone D2-DC45 disc core nozzles per bed. It is recommended to use 8 ConeJet TXR80036VK nozzles or 8 Albuz ATR80 Green nozzles per bed. These nozzles are easier to maintain, easier to replace, and potentially less expensive and more durable than disc core nozzles.



Calibration and Maintenance: It has been two years since your rig's last calibration and maintenance. It is recommended to complete the following procedures twice yearly.

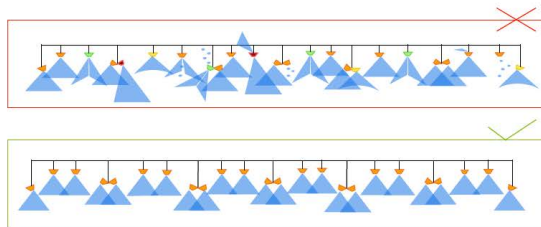


Put on personal protective equipment

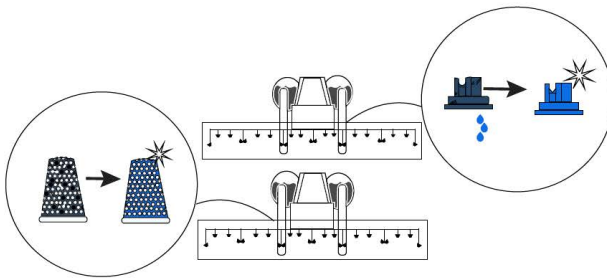


Clean, repair, or replace filters that are clogged or have holes

Verify that hoses are intact and unobstructed, clean, repair, or replace as necessary



Verify that nozzles match or are arranged in a pattern and that the output appears visually uniform



Correct mismatched nozzles  
Clean or replace nozzles and/or nozzle filters that are clogged, worn, or damaged

Contact us:

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# The Effect of Pre-plant Fertilizer on Four Strawberry Cultivars

3

Kamille Garcia-Brucher<sup>1</sup> and Charlotte Decock<sup>2</sup>

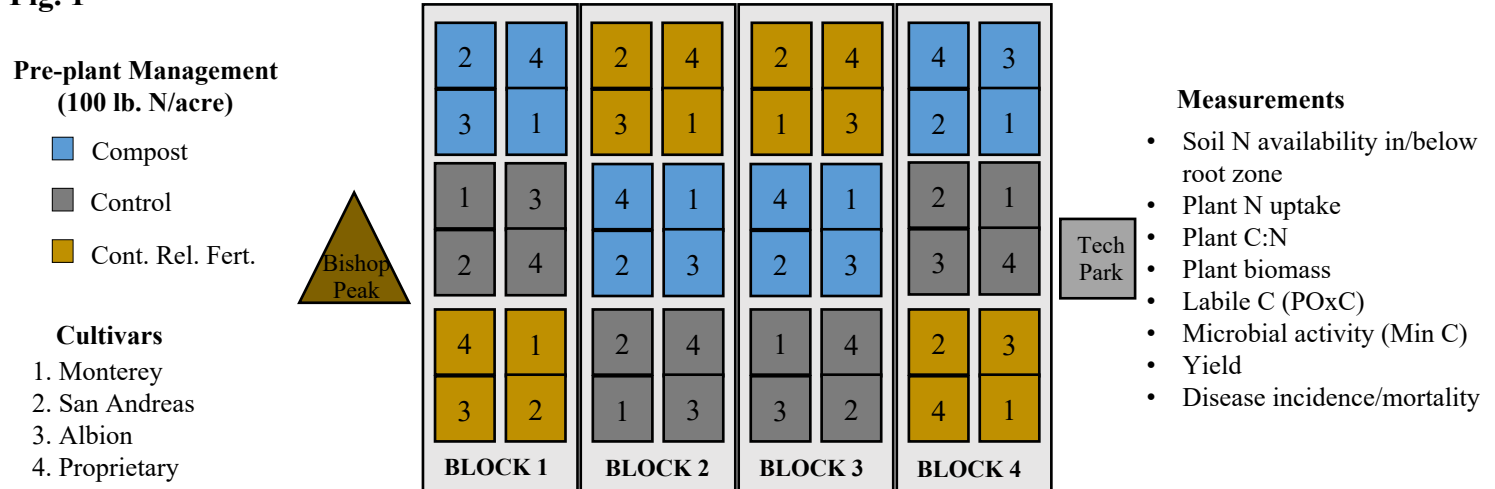
<sup>1</sup>Horticulture and Crop Science Dep't, Cal Poly, San Luis Obispo, <sup>2</sup>Environmental Science Dep't, Cal Poly, San Luis Obispo

## Background

Rising environmental concerns and legislative restrictions on nitrogen (N) use in crop production have spurred research in quantifying crop N requirements and assessing the fate of fertilizer N in cropping systems. Controlled release fertilizers (CRFs) are commonly applied in the fall before planting with the expectation of long-term release of nutrients during winter plant establishment. A recent study from the UC Cooperative Extension shows that CRF N is released before plant N uptake, suggesting that CRF is an ineffective source of nutrients for the crop.<sup>1</sup> Compost might be a viable substitute for early season nutrient delivery to strawberry crops because composts tend to have slow nutrient release patterns. However, compost also holds the risk of competing with the plant by temporarily immobilizing nitrogen. Besides effects of compost on nitrogen dynamics, they have been shown to build soil organic matter and suppress disease by soil borne pathogens in certain cases, but have no effect or even increase disease incidence in other cases. Given incentives by the State of California to increase compost application to agricultural land to protect soil fertility and decrease greenhouse gas emissions, further research is needed to assess the suitability of the use of compost in strawberry production. A field experiment at California Polytechnic State University's Strawberry Center began in Sep 2018 to observe soil and plant N dynamics and disease incidence of *Macrophomina phaseolina* by comparing three pre-plant fertilizer strategies among four strawberry cultivars.

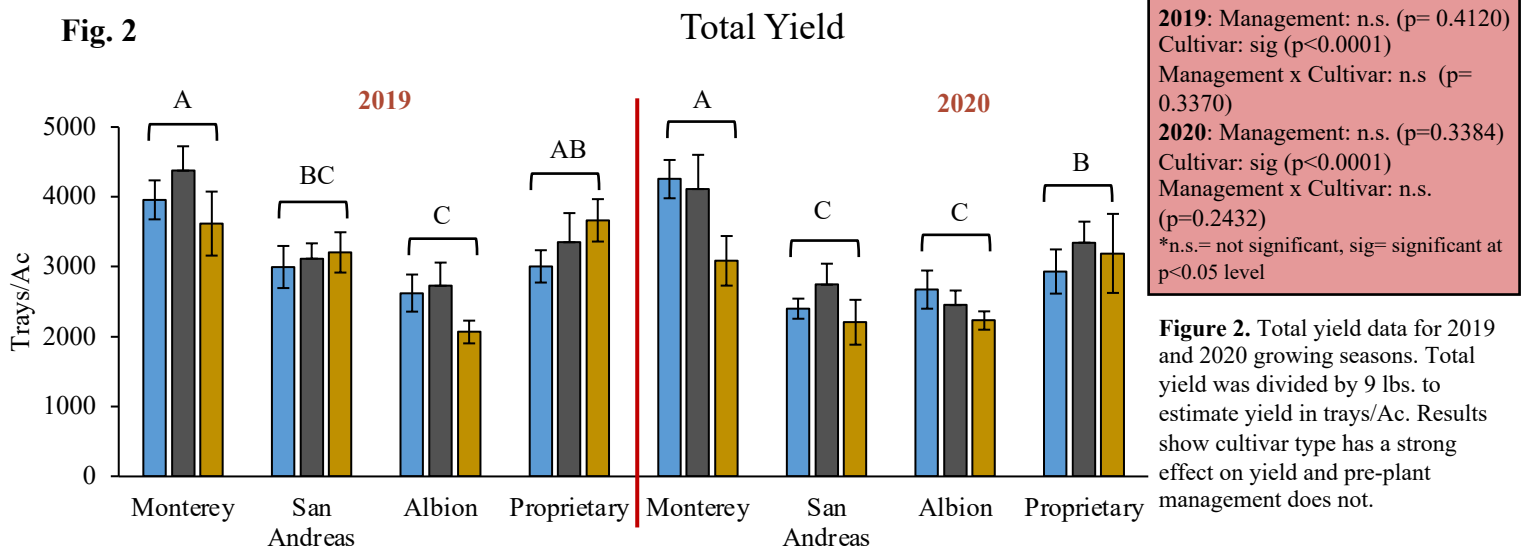
<sup>1</sup>Bottoms, T.G., T.K. Hartz, M.D. Cahn, and B.F. Farrara. 2013. Crop and soil nitrogen dynamics in annual strawberry production in California. HortScience. 48: 1034-1039.

Fig. 1



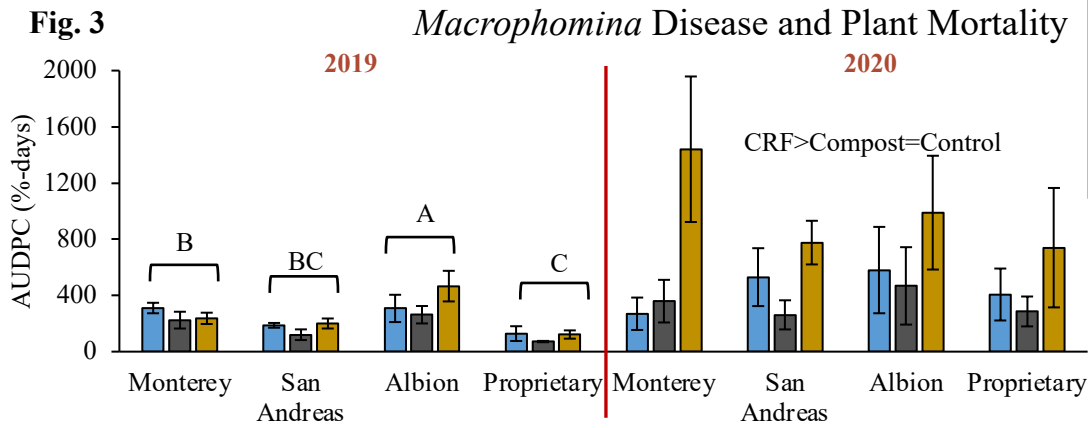
## Preliminary Results

Fig. 2



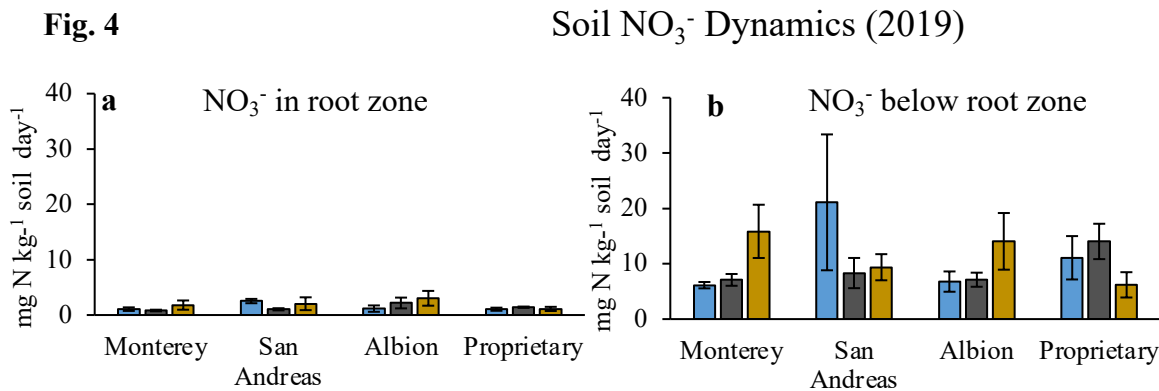
## Preliminary Results continued

### Macrophomina Disease and Plant Mortality



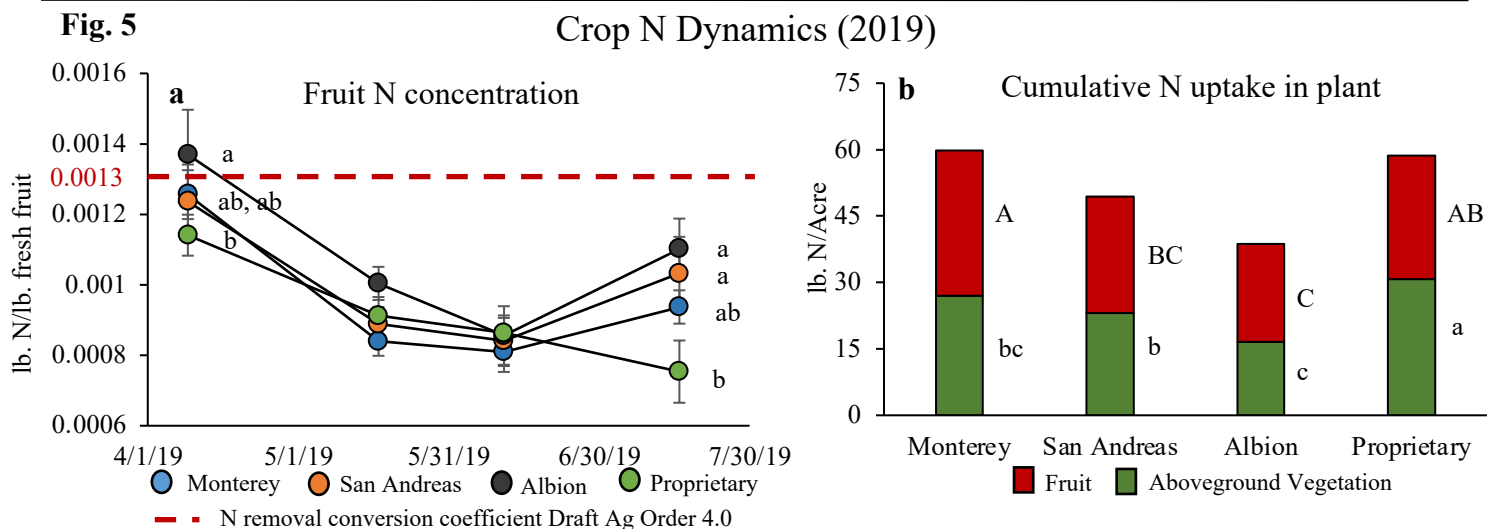
2019: Management: n.s. (p= 0.1630)  
Cultivar: sig (p<0.0001)  
Management x Cultivar: n.s. (p= 0.4323)  
2020: Management: sig (p<0.001)  
Cultivar: n.s. (p=0.5612)  
Management x Cultivar: n.s. (p=0.6519)  
\*n.s.= not significant, sig= significant at p<0.05 level

**Figure 3.** Area under disease progress curve (AUDPC) results for the 2019 growing season show cultivar has a strong effect on disease incidence and pre-plant management does not. AUDPC results for the 2020 growing season show a significant effect by pre-plant management and cultivar does not.



Management: n.s. (p= 0.4106)  
Cultivar: n.s. (p=0.7424)  
Depth: sig (p<0.001)  
Management x Cultivar x Depth: n.s. (p=0.6098)  
\*n.s.= not significant, sig= significant at p<0.05 level

**Figure 4.** Soil N data for the 2019 growing season show there is significantly greater NO<sub>3</sub><sup>-</sup> exposure below the root zone (b) compared with in the root zone (a).



**5a.** Management: n.s. (p=0.1174), Cultivar: sig. (p=0.003); **5b** Fruit N- Management: n.s. (p=0.3556); Cultivar: sig. (p<0.001); Vegetation N- Management: sig. (p=0.00344) Control>CRF; Cultivar: sig. (p<0.001). Different uppercase letters indicate differences in fruit N removal. Different lowercase indicate differences in aboveground N uptake.

**Figure 5.** Fruit N concentration changed over the course of the 2019 growing season and shows a significant effect of cultivar in the first and last months of harvest (April and July, respectively). There is a significant effect of cultivar on cumulative N removal in fruit and N uptake in aboveground vegetation. In addition, aboveground N uptake was significantly greater in the control treatment compared to the CRF Treatment. Note, fruit N removal and aboveground N uptake in this experiment are low due to disease pressure.

## Conclusion

- Long-term compost application is known to build soil health but there are also some risks to compost application. In this experiment, we applied Certified Organic compost and did so safely without negative effects on yield or plant mortality.
- In fertile, fine textured soils (such as in Field 35 at the CP Strawberry Center), synthetic CRF applications may not show any benefits.
- Strawberry N requirements are affected by yield, vegetative growth, N concentration in fruit, and N concentration in vegetative biomass. Our results show these factors were affected differently by cultivar and pre-plant fertilizer treatment. This has implications for optimizing rate and timing of fertilizer applications.

Compost application rates were based on the financial incentives program established by the CDFA and former Gov. Brown's Healthy Soils Initiative. To learn more about the initiative, visit: <https://www.cdca.ca.gov/oefi/healthysouls>. This research was supported by the California State University Agricultural Research Institute.



## Evaluating Host Resistance to *Macrophomina* Crown Rot in Strawberry - 2020

S. M. Mansouripour, K. A. Blauer & G. J. Holmes

In the fall of 2019, our fourth consecutive field trial was established to evaluate 65 strawberry cultivars and elite selections for resistance to crown rot caused by *Macrophomina phaseolina*. Strawberry germplasm was selected from six breeding programs: University California Davis (UC), University of Florida (FL), Driscoll's (DR), Plant Sciences (PSI/PE/BG), California Berry Cultivar (CBC) and Lassen Canyon (LC). The trial consisted of 20-plant plots replicated four times, with a fifth non-inoculated replicate. The non-inoculated area was bed-fumigated with Ally 33 at 534 lb/A in the fall of 2019. On 23 Oct 2019, bare-root strawberry transplants were set in field 35b on the Cal Poly San Luis Obispo farm (Fig. 1). Two weeks later each plant in the inoculated replicates received 5 grams of cornmeal-sand-*Macrophomina* inoculum placed around the crown and root zone (Fig. 2A). Plants were drought stressed by withholding irrigation for 3 consecutive days per week starting 1 Jun. Presence of the pathogen in plants was confirmed by standard plating techniques. Disease assessments were conducted every two weeks. Plants were considered dead when all foliage was necrotic.

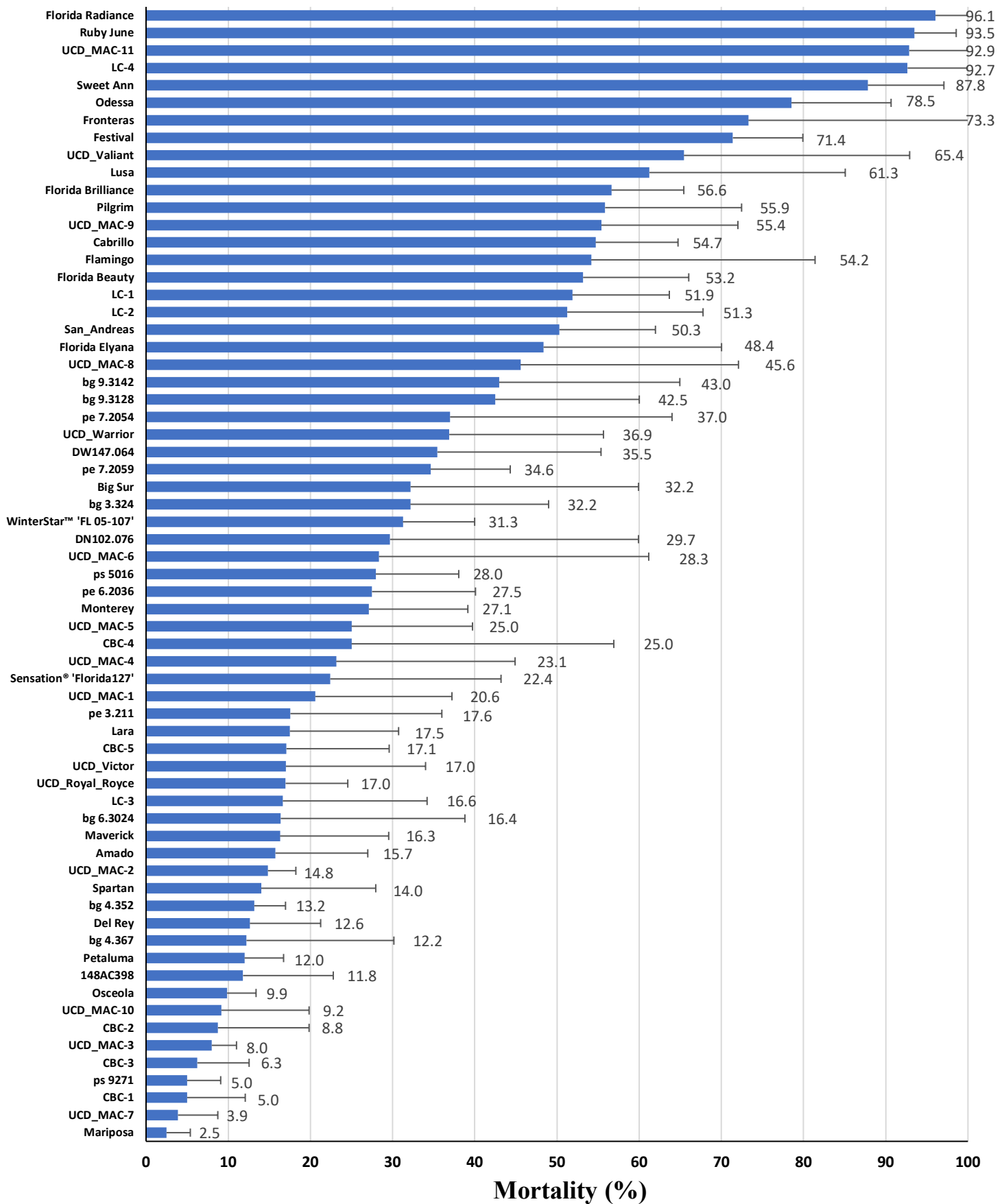


**Figure 1.** Aerial view of *Macrophomina* host resistance trial located in field 35b on Cal Poly San Luis Obispo farm. Plants in the area outlined in red were inoculated; plants in the area outlined in yellow were not inoculated (control). (Photo taken on 13 July 2020)

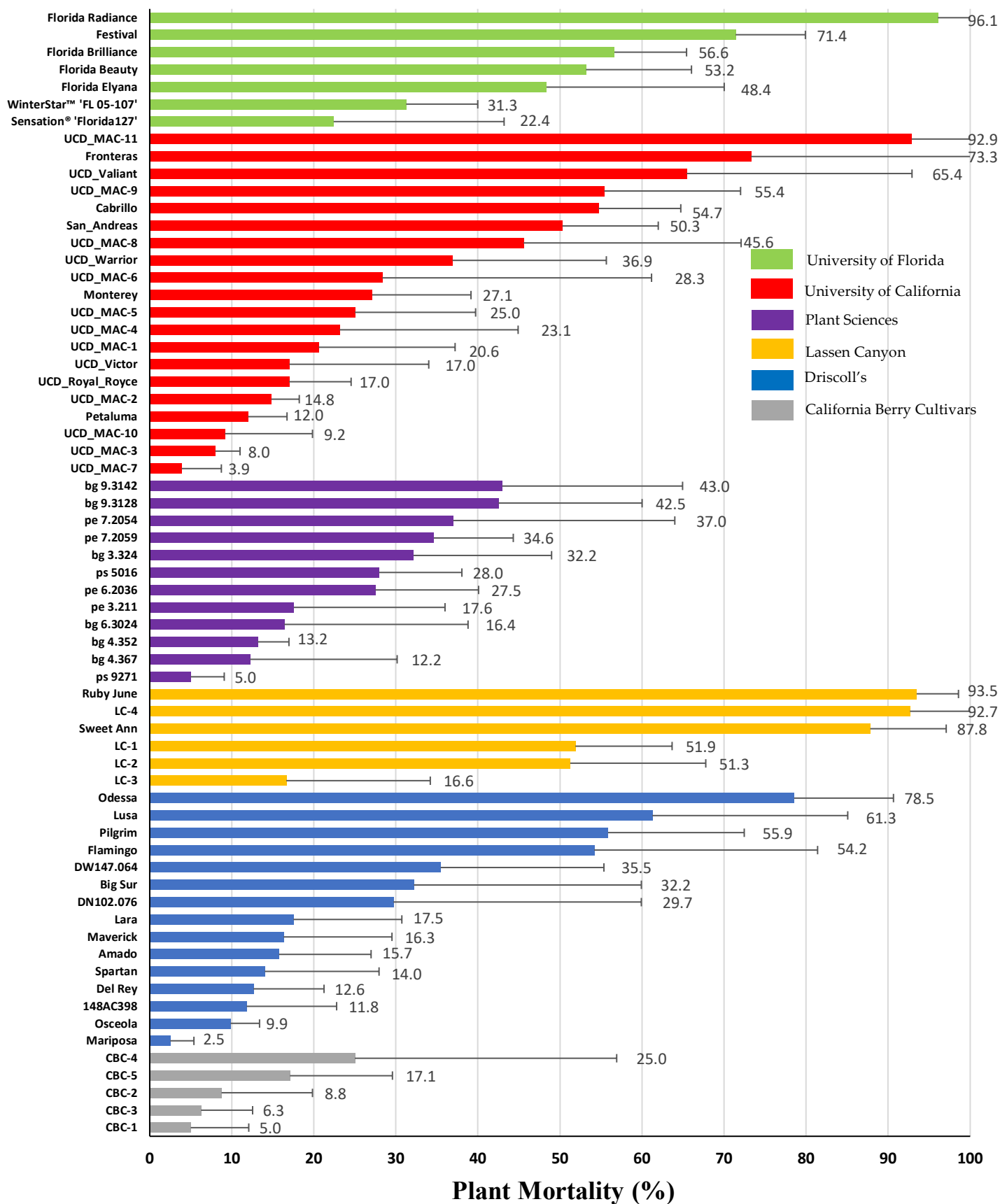


**Figure 2.** A) Inoculating a transplant with *M. phaseolina* inoculum. B) Early wilt symptoms of crown rot (plant circled in yellow). C) Cross section of a necrotic crown showing brown discoloration of the tissue due to *M. phaseolina*.

## Average % mortality due to *Macrophomina* crown rot on 3 August 2020



## Average % mortality due to *Macrophomina* crown rot (By breeding program) on 3 August 2020

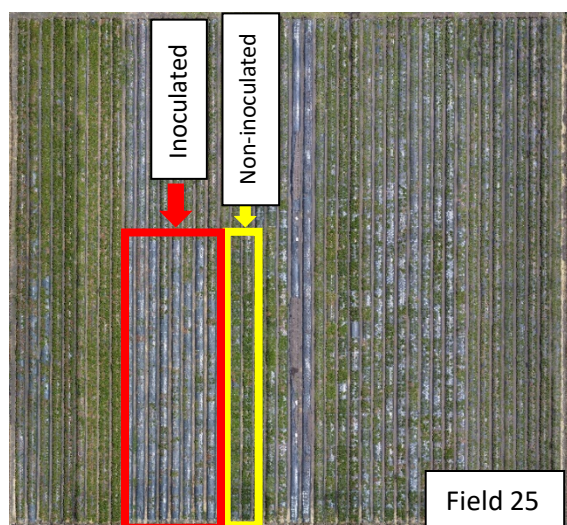




## Evaluation of Host Resistance to Anthracnose in Strawberry - 2020

O. Gonzalez-Benitez, D. Summerfield, K. Blauer, S. Hewavitharana & G. Holmes

During the fall of 2019, we evaluated 59 strawberry cultivars and elite breeding lines for resistance to anthracnose caused by *Colletotrichum acutatum*. Strawberry germplasm was selected from five breeding programs: University of California, Davis (UC), University of Florida, Driscoll's, Plant Sciences (BG/PS/PE) and Lassen Canyon (LC). On 23 Oct 2019, bare-root strawberry transplants were transplanted in field 25, block 8 on the Cal Poly San Luis Obispo farm. The trial consisted of 10-plant inoculated plots replicated four times, with a fifth, non-inoculated control. The field was drip line fumigated with Ally 33 (67% AITC + 33% chloropicrin at 55 gal/A) prior to planting. Bare-root strawberry transplants were placed in a 1-gal plastic bag, mixed with 100 ml of *C. acutatum* inoculum ( $1 \times 10^6$  spores/ml) and shaken for one minute prior to planting. The first anthracnose symptoms were observed three weeks after planting. Presence of the pathogen on diseased plants was confirmed using Petri dish assays. Disease assessments were conducted weekly starting three weeks after planting (13 Nov 2019). Plants were considered dead when all foliage was necrotic.



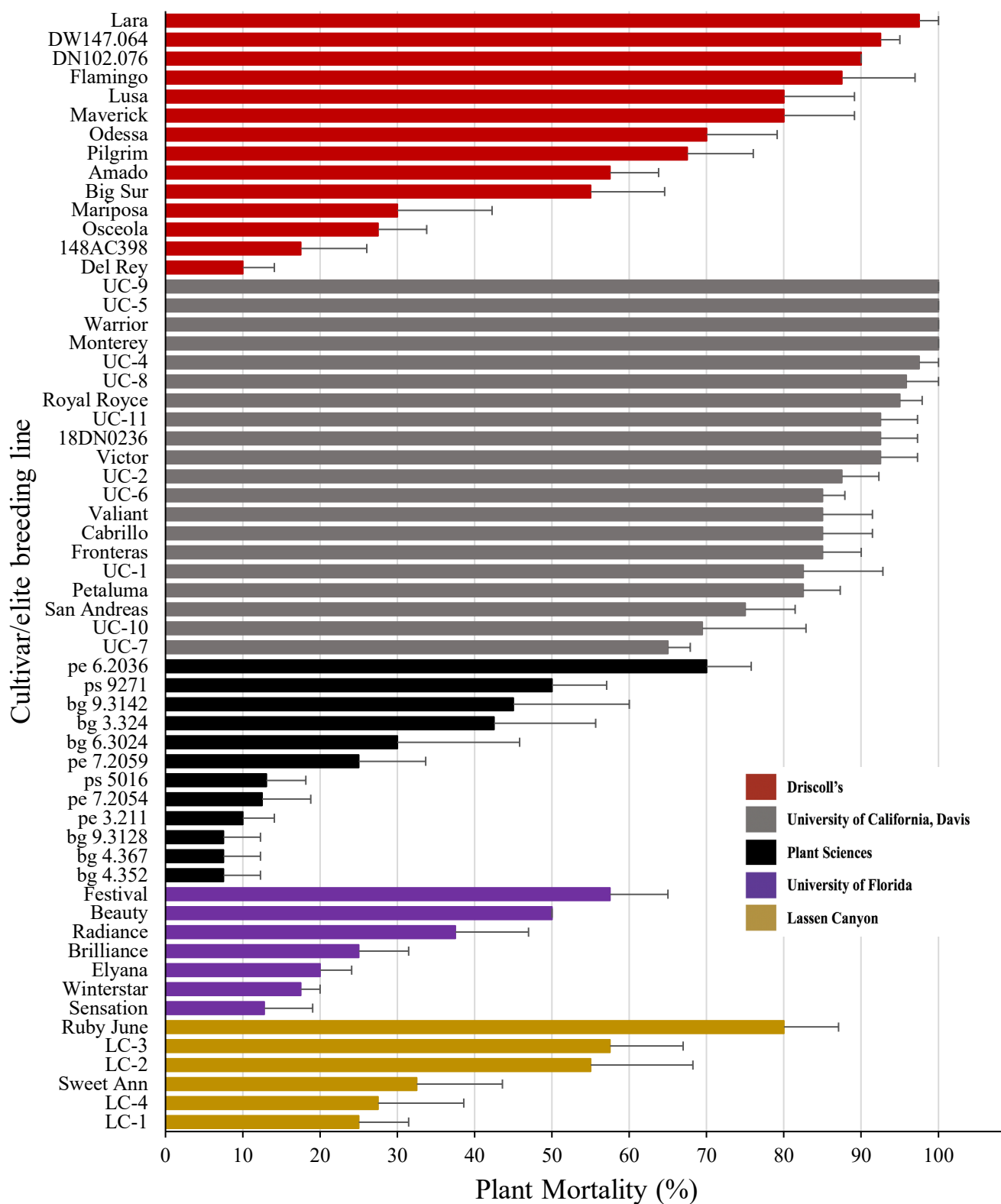
**Figure 1. (Left)** Aerial photo of the anthracnose host resistance trial located in field 25, block 8 on the Cal Poly San Luis Obispo farm. The area outlined in red is the inoculated reps. The area outlined in yellow is the non-inoculated control. A single buffer bed separated the inoculated from non-inoculated plots. Both the red and yellow areas were fumigated with Ally 33 (67% AITC + 33% chloropicrin at 55 gal/A).



**Figure 2.** A) Petri dishes with strawberry plant petioles used for growth of *Colletotrichum acutatum* spores for inoculum; B) Bare-root transplants being inoculated on 25 October 2019 with *C. acutatum*; C) Strawberry plant showing symptoms of anthracnose on 15 April 2019; D) Strawberry fruit showing anthracnose lesion.



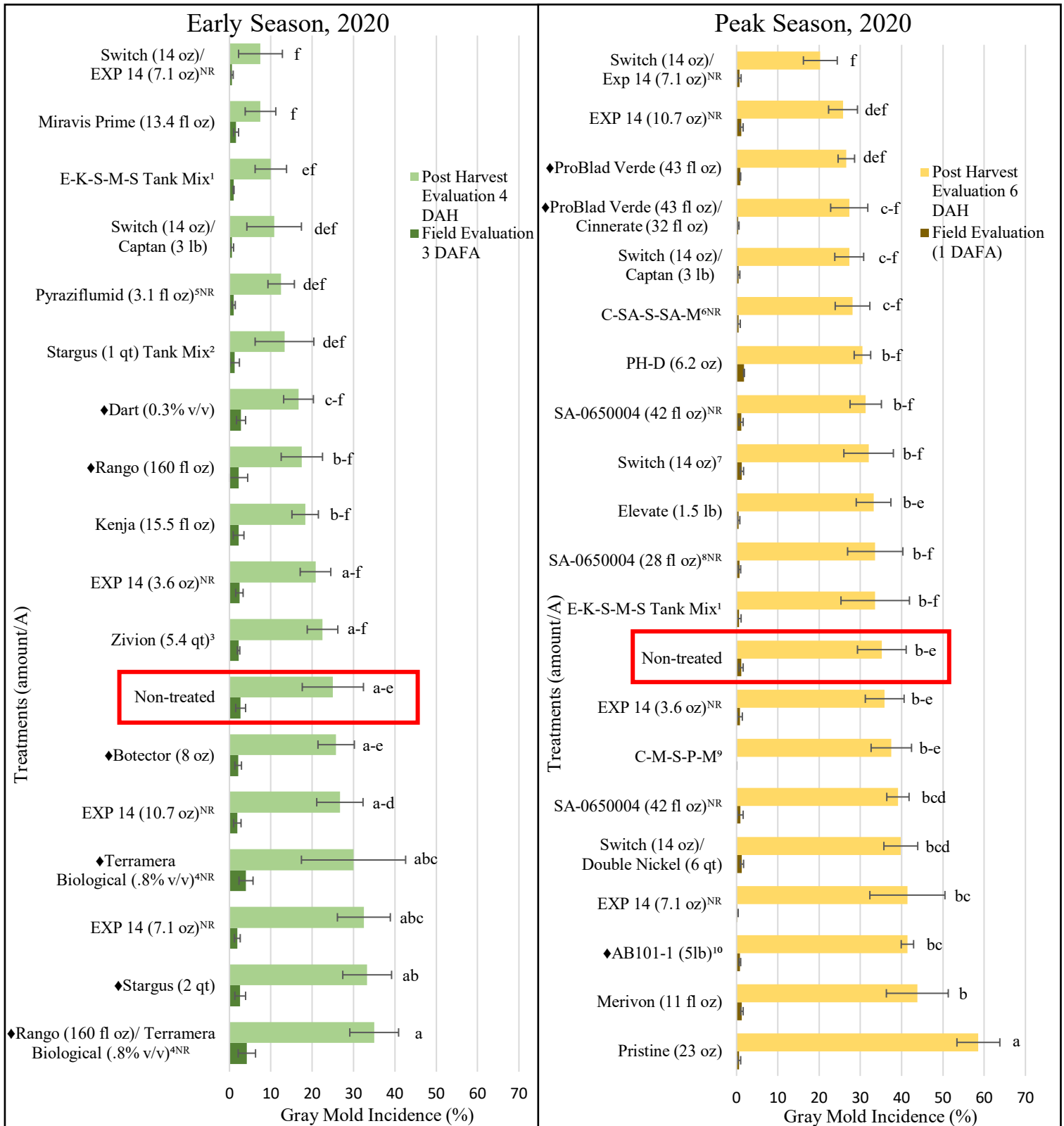
## Average plant mortality (%) due to anthracnose as of 29 April 2020



# Fungicide Efficacy Against Botrytis Gray Mold (cv. Monterey)

Kyle Blauer, Cal Poly Strawberry Center

6



♦ = Organic products; <sup>NR</sup> = Not registered; / = Weekly rotation; DAFA = Days after final application; DAH = Days after harvest. <sup>1</sup>Rotation sequence of Elevate, Kenja, Switch, Merivon, Switch (at max labeled rate); each tank mixed with Captan 80WDG (3 lb/A). <sup>2</sup> Tank Mixed with Switch rotated with Captan. <sup>3</sup>Night application and mixed with Brandt liquid zinc. <sup>4</sup> Mixed with Nu Film P @ 16 fl oz/A. <sup>5</sup> Mixed with Kinetic @ 12 fl oz/A. <sup>6</sup> Rotation sequence of Captan 80WDG (3 lb/A), SA-0650004, Switch, SA-0650004, Merivon (at max labeled rate). <sup>7</sup> Applied every other week. <sup>8</sup> Mixed with Kinetic @ 23 fl oz/A. <sup>9</sup> Rotation sequence of Captan 80WDG (3 lb/A), Merivon, Switch, Pristine, Merivon Switch (at max labeled rate). <sup>10</sup> Mixed with Induce @ 18 fl oz/A.

Sorted by level of gray mold present at postharvest evaluation. Data was subject to ANOVA and Fishers LSD mean separation. Error bars represent standard error of the mean. Means that do not share the same letter are significantly different ( $\alpha=0.05$ ). If no letters are present, means were not significantly different.

## STRAWBERRY FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC) <sup>1</sup>	Powdery mildew	Gray mold	Anthracnose	Angular leaf spot	Common leaf spot	Mucor rot	Rhizopus rot	Leather rot	Crown rot	Red stele
Bumper, Tilt	high (3)	++++	NR	++(NR)	NR	+++	NR	NR	NR	NR	NR
Luna Sensation	medium (7/11)	++++	+++	+++ <sup>R</sup>	NR	ND	NR	ND	NR	NR	NR
Luna Tranquility	medium (7/9)	++++	++	NR	NR	ND	NR	ND	NR	NR	NR
Mettle	high (3)	++++	NR	NR	NR	ND	NR	NR	NR	NR	NR
Procure	high (3)	++++	NR	+(NR)	----	----	----	----	----	----	----
Quadris Top	medium (3/11)	++++	++ <sup>R</sup>	+++ <sup>R</sup>	NR	NR	NR	NR	NR	NR	NR
Quilt Xcel, Avaris 2XS	medium (3/11)	++++	NR	+++	NR	NR	NR	NR	NR	NR	NR
Protocol	high (1/3)	+++	+++ <sup>R</sup>	++	NR	NR	NR	NR	NR	NR	NR
Quintec	high (13)	++++	NR	NR	NR	NR	NR	NR	NR	NR	NR
Rally	high (3)	++++	NR	++(NR)	NR	+++	NR	NR	NR	NR	NR
Rhyme	high (3)	++++	NR	NR	NR	NR	NR	NR	NR	NR	NR
Torino	high (U6)	++++	NR	NR	NR	NR	NR	NR	NR	NR	NR
Abound, Avaris, Azoxystrobin, etc.	high (11)	++	+ <sup>R</sup>	+++	NR	NR	NR	NR	ND	NR	NR
Cabrio	high (11)	++	+ <sup>R</sup>	++	NR	----	NR	NR	NR	NR	NR
Evito	high (11)	++	+ <sup>R</sup>	++	NR	NR	NR	NR	NR	NR	NR
Flint	high (11)	+++	+ <sup>R</sup>	+	NR	NR	NR	NR	NR	NR	NR
Intuity	high (11)	+	++ <sup>R</sup>	NR	NR	NR	NR	NR	NR	NR	NR
Fontelis	high (7)	+++	++++ <sup>R</sup>	NR	NR	NR	NR	NR	NR	NR	NR
Kenja	high (7)	+++	++++	ND	NR	NR	NR	NR	NR	NR	NR
Merivon	medium (7/11)	+++	++++	ND	NR	----	NR	NR	NR	NR	NR
Ph-D, Oso	medium (19)	+++	++	++	NR	NR	NR	NR	NR	NR	NR
Pristine	medium (7/11)	+++	++++ <sup>R</sup>	ND	NR	----	NR	NR	NR	NR	NR
Sulfur	low (M2)	+++	NR	NR	NR	NR	NR	NR	NR	NR	NR
Topsin-M, T-Methyl, Incognito	very high (1)	+++	+++ <sup>R</sup>	----	NR	++	NR	NR	NR	NR	NR
Velum One	high (7)	++	+(NR)	NR	NR	NR	NR	NR	NR	NR	NR
Captan	very low (M4)	NR	+	+++ (NR)	NR	NR	+(NR)	+(NR)	NR	NR	NR
Elevate	high (17)	NR	++++ <sup>R</sup>	+(NR)	NR	NR	NR	NR	NR	NR	NR
Aliette	low (33)	NR	NR	NR	NR	NR	NR	NR	+++	++	++
Equus	low (M5)	NR	NR	NR	NR	+++	NR	NR	NR	NR	NR
Captevatate	medium (M4/17)	NR	+++	+++	NR	NR	+(NR)	+(NR)	NR	NR	NR
Copper	low (M1)	NR	NR	NR	+++	NR	NR	NR	NR	NR	NR
Fungi-Phite, K-Phite, Prophyt, etc.	low (33)	----	NR	----	NR	NR	----	----	+++	++	++
Ridomil Gold SL	high (4)	NR	NR	NR	NR	NR	NR	NR	+++	++	++
MetaStar	high (4)	----	---- <sup>R</sup>	----	----	----	----	----	+++	----	++
Rovral, Iprodione, Nevada	low (2)	NR	+++	----	NR	----	++	----	----	----	----
Scala	low (9)	NR	++	NR	NR	NR	NR	NR	NR	NR	NR
Switch	high (9/12)	----	++++ <sup>R</sup>	+++	NR	NR	+(NR)	+++ (NR)	NR	NR	NR
Thiram	low (M3)	NR	+	++	NR	----	NR	NR	NR	NR	NR
Zivion	low (48)	ND	ND	+++	----	----	----	----	----	----	----

**Rating:** ++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; ---- = ineffective; NR = not registered; <sup>R</sup> = Resistant populations documented; and ND = no data.

<sup>1</sup> Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see <http://www.frac.info/>).

Modified from: Adaskaveg et al., 2017. *Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops*.



## BIOLOGICALS/ NATURAL PRODUCTS

Fungicide	Resistance risk (FRAC) <sup>1</sup>	Powdery mildew	Gray mold	Anthracnose	Angular leaf spot	Common leaf spot	Mucor rot	Rhizopus rot	Leather rot	Crown rot	Red stele
Actigard	low (P01)	NR	NR	NR	+ / ++	NR	NR	NR	NR	NR	NR
Actinovate	low	+	----	NR	----	NR	NR	NR	NR	----	ND
Aleo	low (NC)	ND	----	----	----	----	----	----	----	----	----
Double Nickel	low	+	----	----	----	NR	NR	NR	NR	----	----
Fracture	low	++	+	NR	NR	NR	NR	NR	NR	NR	NR
Kaligreen	low (NC)	++	----	----	----	----	----	----	----	----	----
M-Pede	low	+	NR	NR	NR	NR	NR	NR	NR	NR	NR
Procidic	low (NC)	NR	----	NR	NR	NR	NR	NR	NR	NR	NR
Rango	low (NC)	ND	+	ND	----	----	ND	ND	----	----	----
Regalia	low (P05)	ND	----	ND	ND	ND	----	----	----	ND	ND
Serenade ASO, Serenade Opti	low	++	+	----	----	----	----	----	----	----	----
Stargus	low (NC)	NR	----	NR	NR	NR	NR	NR	NR	ND	ND

**Rating:** +++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; ---- = ineffective; NR = not registered; <sup>R</sup> = Resistant populations documented; and ND = no data.

<sup>1</sup> Group numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see <http://www.frac.info/>).

Modified from: Adaskaveg et al., 2017. *Efficacy and Timing of Fungicides, Bactericides, and Biologicals for Deciduous Tree Fruit, Nut, Strawberry, and Vine Crops*.

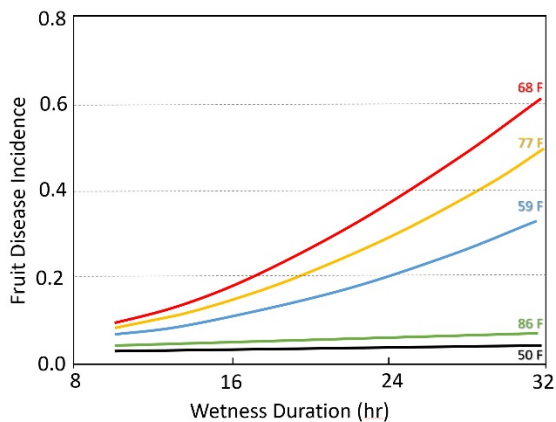




## Prevalence of Botrytis fruit rot after simulated shipment and cold storage

Shashika Hewavitharana<sup>1</sup>, Gerald Holmes<sup>1</sup> and Dan Legard<sup>2</sup>  
<sup>1</sup>Cal Poly Strawberry Center, <sup>2</sup>California Strawberry Commission

Botrytis fruit rot (BFR) is the most economically important fruit disease of strawberries worldwide. The disease is favored by moderate temperatures (60-75°F) and long periods (≥16 hr) of high relative humidity or surface wetness during flowering (Fig. 1). The incidence of fruit rot is highly correlated with the amount of rainfall 11-30 days prior to fruit maturity.

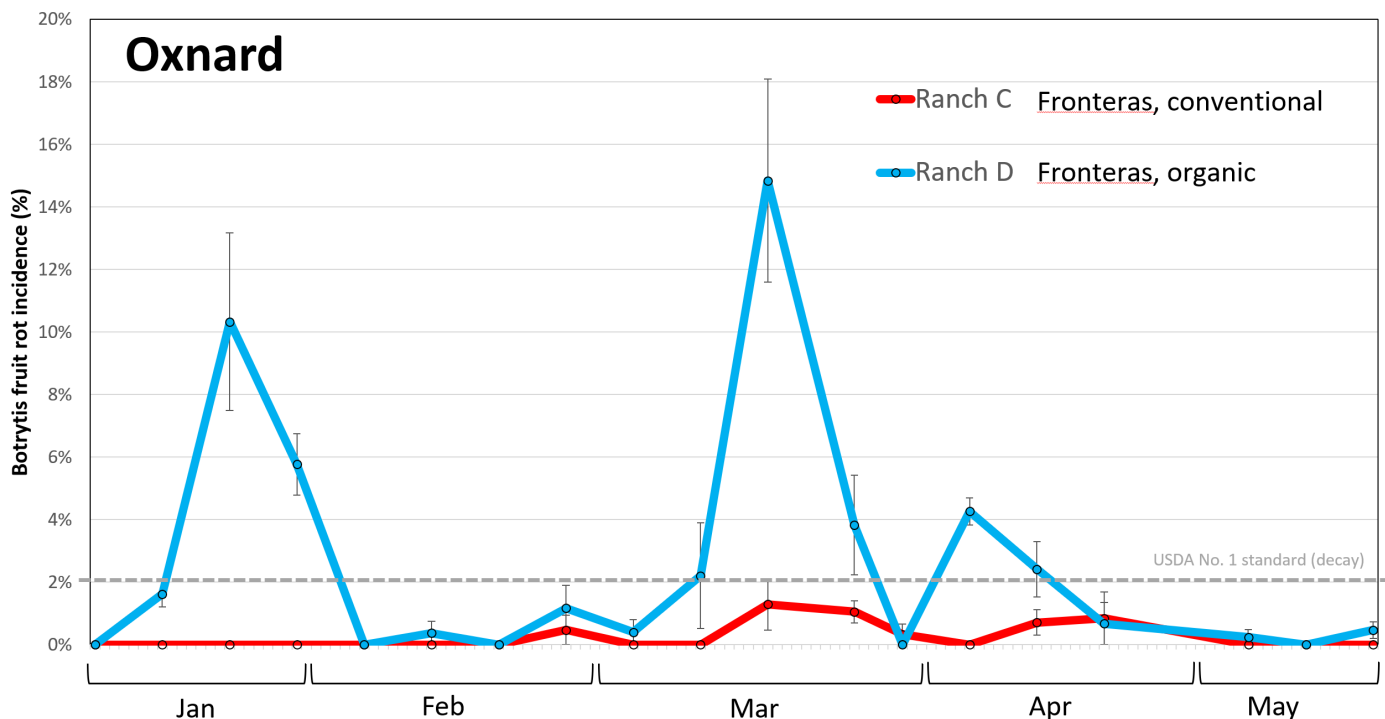


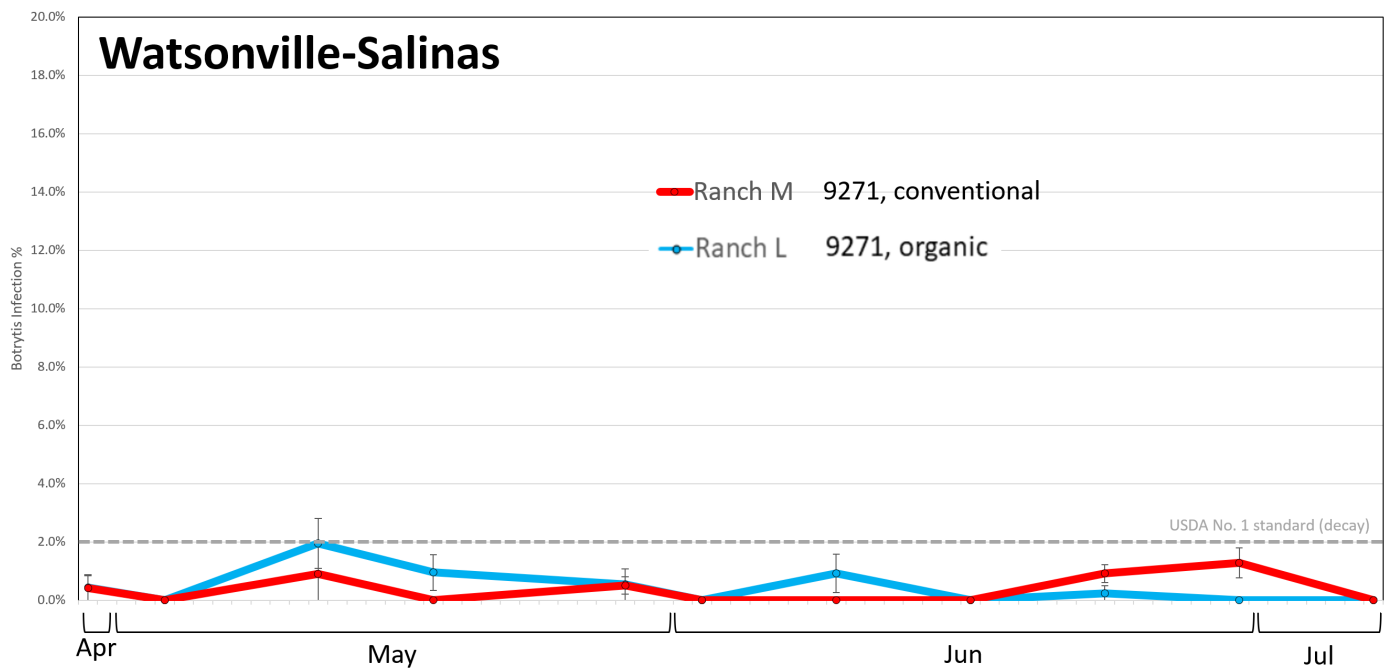
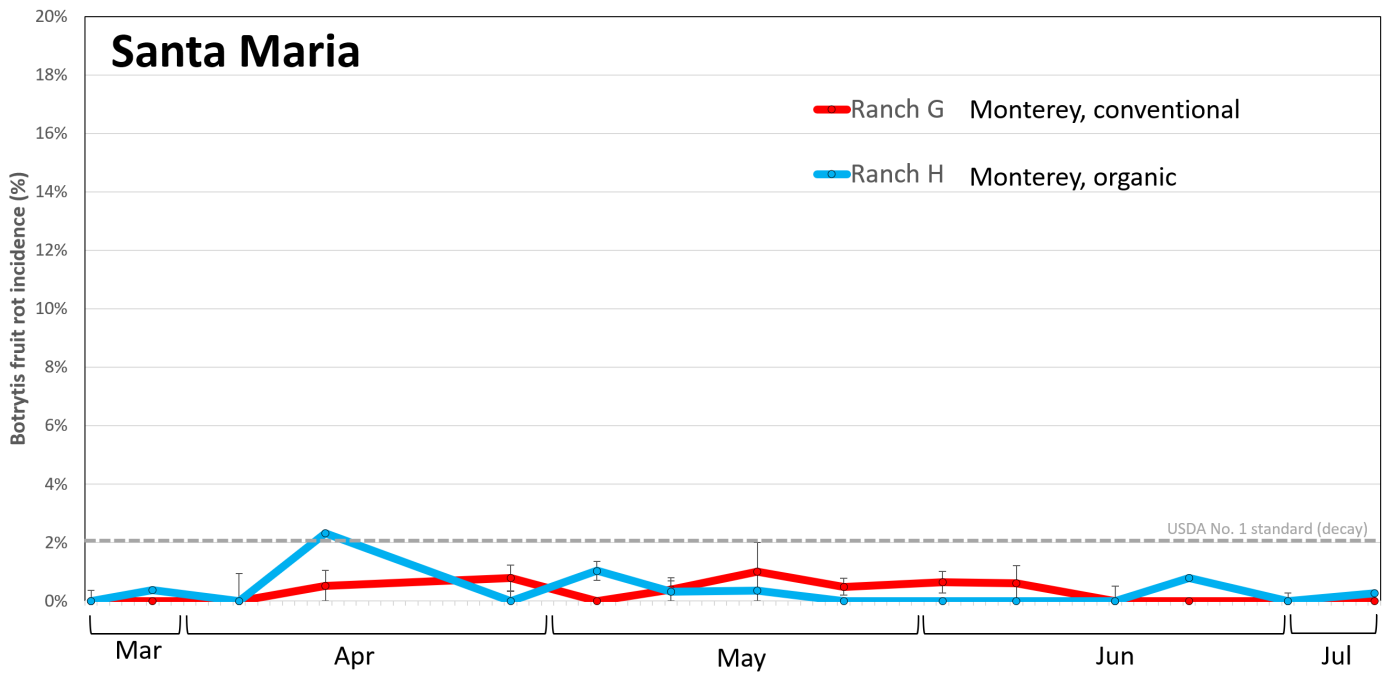
**Figure 1.** Effect of wetness duration and temperature at flower inoculation on the predicted proportion of ripe strawberry fruit infected by *Botrytis cinerea*. Modified from: Bulger, Ellis and Madden. 1987. Phytopathology 77:1225

**Objective.** Determine the levels of BFR following commercial conditions of harvest, packing and storage at 34°F for 7 days.

**Materials & Methods.** Select 4 fields in each District (Oxnard, Santa Maria and Watsonville-Salinas). For direct comparison, select two fields with the same variety, but one farmed organically and the other conventionally. Collect weekly fruit samples directly from each field after commercial picking and packing. Transport to Cal Poly for storage at 34F for 7 days. Evaluate fruit for incidence of BFR.

### Results.





#### Results (cont'd).

The vast majority of samples showed less than 2% BFR incidence (USDA No. 1 standard for decay) after storage at 34°F for 7 days.

The highest levels of BFR were associated with rainfall timing.

BFR incidence was generally low (<2%) during periods of no rainfall.

Fungicide application was not associated with BFR levels during periods of little to no rainfall.

#### Conclusions.

There appears to be significant opportunities to reduce fungicide applications in the summer without reducing BFR control.

## Fungicide Sensitivity in Strawberry Powdery Mildew caused by *Podosphaera aphanis* in California

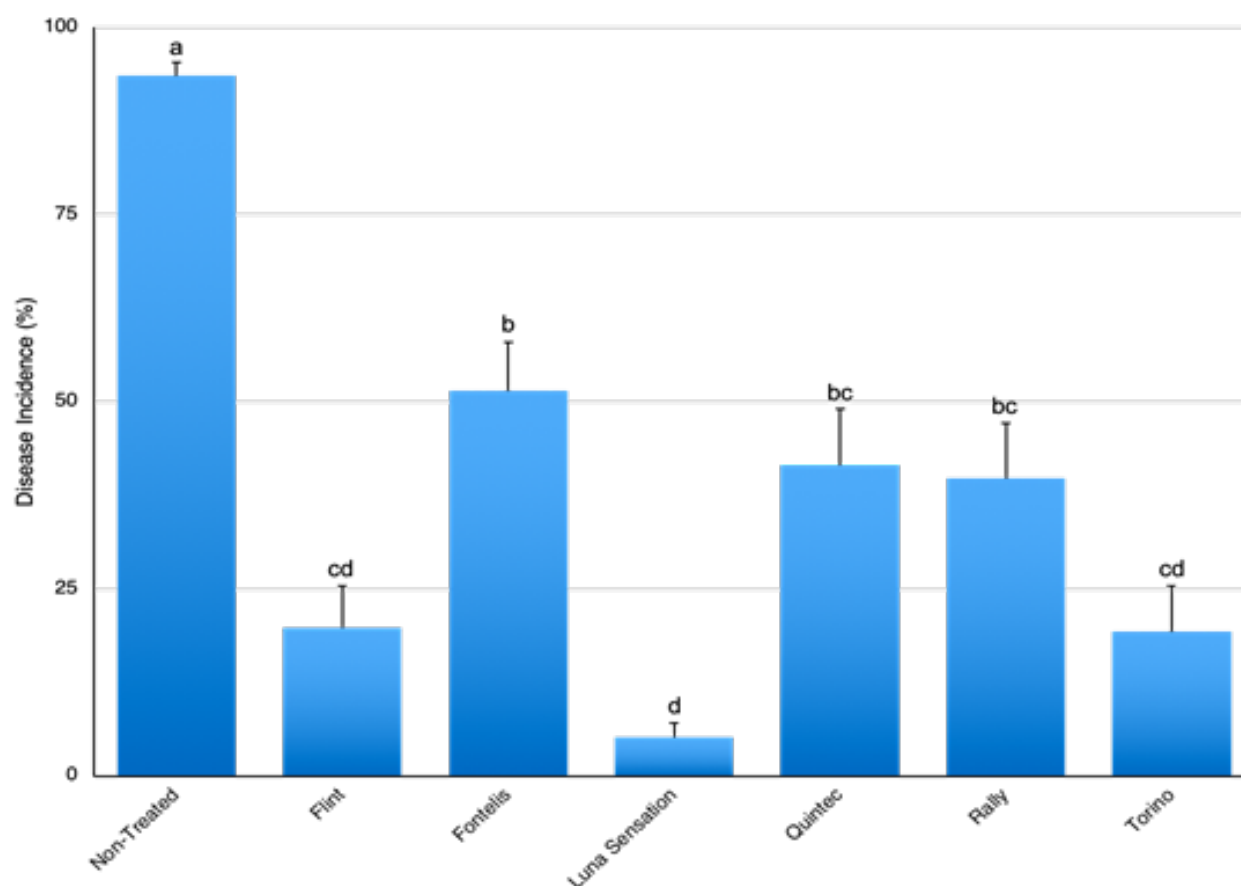
M. G. Palmer and G. J. Holmes

This study characterizes the sensitivity of 19 *Podosphaera aphanis* isolates to the most common fungicides used against strawberry powdery mildew in California. Isolates were collected from Santa Maria, Oxnard, and Turlock, California. Clean, unfurled strawberry leaves (cv. Monterey) were treated with one of 6 fungicides using the minimum labeled rate and inoculated with conidia of *P. aphanis* using the aid of the Andersen Spore Cascader and camelhair brush. Each treatment consisted of three detached leaflets on water agar, replicated three times. Inoculated leaves were incubated at 20°C under 16/8 hours of day/night lighting and assessed for disease incidence (presence of a sporulating lesion) at 14 days.

**Table 1.** Fungicides evaluated and their rates.

Trade Name	Active Ingredient(s)	FRAC Code(s)	Rate*
Flint	trifloxystrobin	11	0.15 g/L
Fontelis	penthiopyrad	7	1.25 mL/L
Luna Sensation	fluopyram + trifloxystrobin	7 + 11	0.312 mL/L
Quintec	quinoxifen	13	0.312 mL/L
Rally	myclobutanil	3	0.187 g/L
Torino	cyflufenamid	U6	0.265 mL/L

\*equivalent to the minimum labeled rate.



**Fig 1.** Powdery mildew disease incidence in response to each treatment across 19 isolates tested. Each treatment was applied at the minimum labeled rate. Treatments that do not share the same letter are significantly different according to Tukey HSD post-hoc testing.

## Characterization of Host Resistance in Strawberry to Powdery Mildew caused by *Podosphaera aphanis*

M. G. Palmer, K. A. Blauer & G. J. Holmes

Two studies were conducted in February (winter) and June (summer) at the Cal Poly Strawberry center to evaluate host resistance of 12 and 16 cultivars, respectively, to powdery mildew (PM). PM-free plants were established in 6-inch pots under high plastic tunnels and moved after five weeks into a greenhouse where an active powdery mildew epidemic was present. These plants were at the 4- to 5-leaf stage and showed no visible symptoms or signs of PM. Plants were evaluated at 40 and 41 days after transfer in the winter and summer trials, respectively, for disease incidence (% infected leaves per plot) and severity (% leaf area showing symptoms). Field ratings were also done on 3 July 2020 of the ten cultivars used in both winter and summer trials. Five leaves were selected from each plot (ten plots per cultivar) with a preference toward symptomatic leaves and rated for disease severity.

**Table 2.** Disease index values from winter and summer greenhouse trials. Disease index is calculated by multiplying disease incidence and average severity for each plot. Field values are reported as the average disease severity for each cultivar. Cultivars that do not share the same letter within a trial are significantly different according to Tukey HSD post-hoc testing.

Cultivar	Breeding Program	Winter Disease Index		Summer Disease Index		Field Severity (%)	
Albion	UC	6.0	bc	4.1	bcd	3.5	abcd
BG 3.324	Plant Sciences	19.4	a	10.0	a	7.2	a
BG 4.367	Plant Sciences	6.6	bc	6.5	abcd	5.3	abc
Cabrillo	UC	4.8	bc	5.3	abcd	6.2	ab
Driscolls 1	Driscolls	4.6	bc	--		--	
Driscolls 2	Driscolls	2.6	bc	--		--	
Fronteras	UC	--		1.4	d	--	
Monterey	UC	5.2	bc	3.8	bcd	3	bcd
Petaluma	UC	4.9	bc	3.9	bcd	3.7	abcd
R858	Lassen Canyon	--		3.6	bcd	--	
Royal Royce	UC	12.2	ab	6.2	abcd	5.3	abc
Ruby June	Lassen Canyon	5.6	bc	4.8	abcd	5.2	abc
San Andreas	UC	1.9	c	2.8	cd	2.1	cd
Sangria	Lassen Canyon	--		3.5	cd	--	
Sweet Ann	Lassen Canyon	1.5	c	3.1	bcd	1.1	d
Valiant	UC	--		2.2	cd	--	
Victor	UC	--		7.0	abc	--	
Warrior	UC	--		8.9	ab	--	

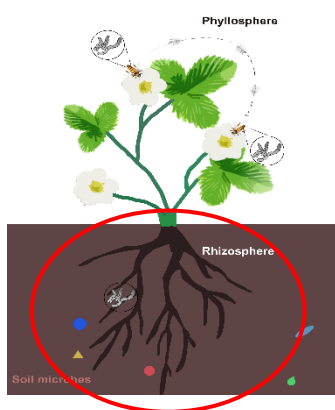


## Soil Microbiome Changes in Response to Soil Fumigation

Shashika S. Hewavitharana and Gerald J. Holmes

### What is the soil microbiome?

- *Soil microbiome* is a community of soil microorganisms interact with each other in a given habitat. Rhizosphere microbiome refers to the microbial community that is most closely associated with plant roots (Fig. 1). Changes to the soil microbiome may result in changes to plant health.
- *Soil-borne pathogens* cause significant crop losses and yield reductions. *Verticillium dahliae* is the pathogen that causes Verticillium wilt, one of the main soilborne diseases in California strawberries.
- *Soil fumigation* is an important part of integrated pest management of soilborne diseases of strawberry. However, there's a knowledge gap about the effect of various soil fumigants on the soil microbiome.
- *Objective* of this study was to find out if soil fumigation affects the soil microbiome and identify specific microorganisms that may potentially be enriched by other practices.



- *Methods*. A summer planting trial was initiated at Cal Poly field 25 block 4 in June 2019. The experiment design was a randomized complete block with 6 blocks. Soil treatments are described in Table 1. The beds were planted with cv. Portola in July 2019. Four yield analyses and disease assessments were conducted in October and November 2019 and twice in April 2020.

**Figure 1.** Rhizosphere of a strawberry plant. (Source: <https://naturemicrobiologycommunity.nature.com>)

**Table 1.** Soil fumigation treatments

Treatment	Active ingredient	Rate (lb/treated acre)
Dominus®	96.3 % allyl isothiocyanate	340
Tri-Clor EC	94% chloropicrin	300
Ally 33®	63.5% allyl isothiocyanate: 31.26% chloropicrin	55
K-Pam HL ®	54.0% potassium N-methyldithiocarbamate	62
Control	NA	NA

- Plants were stressed by mowing and limiting water in January 2020. The trial was ended in May 2020. Soil samples were taken at the following timepoints (Table 2). Soil samples were used to identify and quantify fungal and bacterial species in the soil microbiome.
- Fumigation treatments did not affect yield or disease levels.

**Table 2.** Soil sampling time points

Time point	Event
T1	Pre-treatment
T2	Post-treatment
T3	One month after planting
T4	Peak fruit production
T5	End of the season
T6	After disking

- Fig. 2 shows changes in the population of *Verticillium* spp. determined by soil plating method.

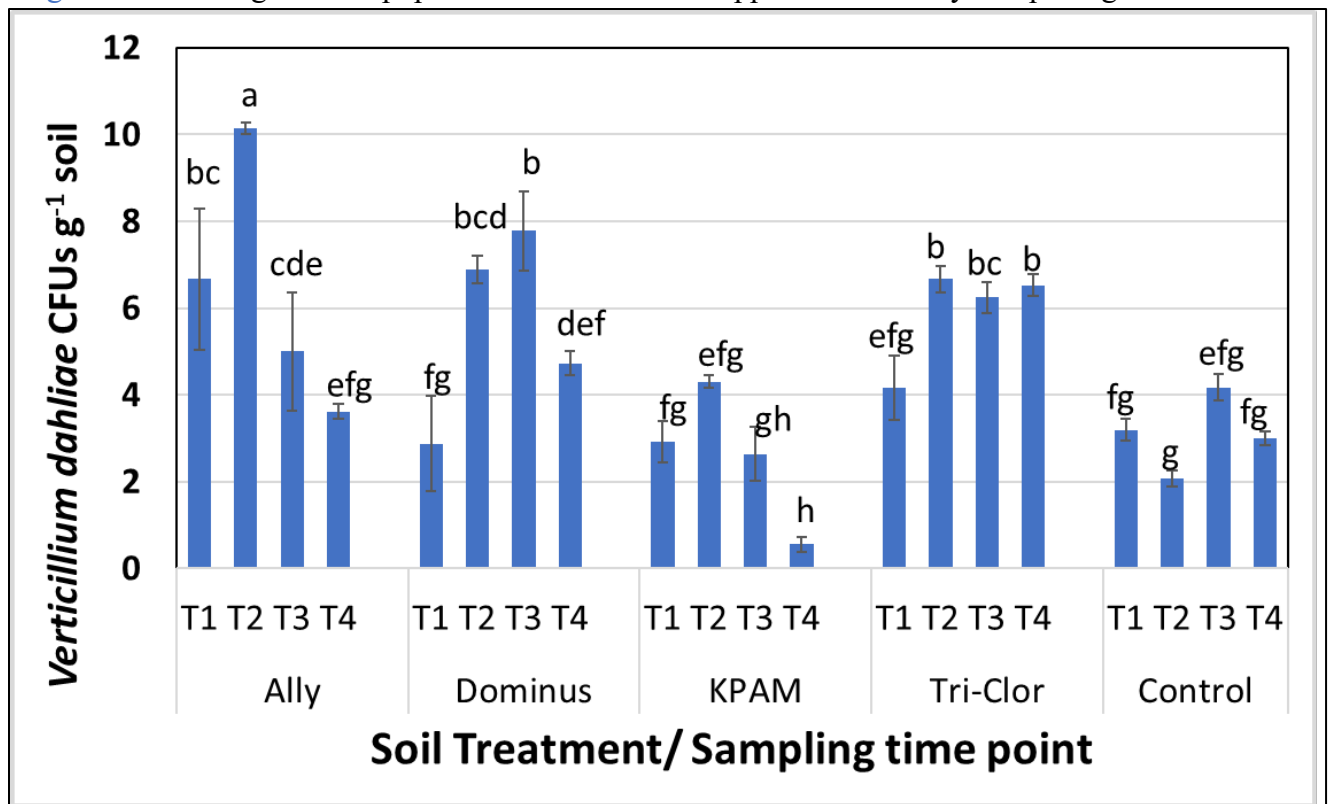


Figure 2. Soil *Verticillium* spp. population changes.

- Fungi associated with biological control increased over time in the rhizosphere in fumigated and non-fumigated soil over the soil sampling period (Fig. 3).

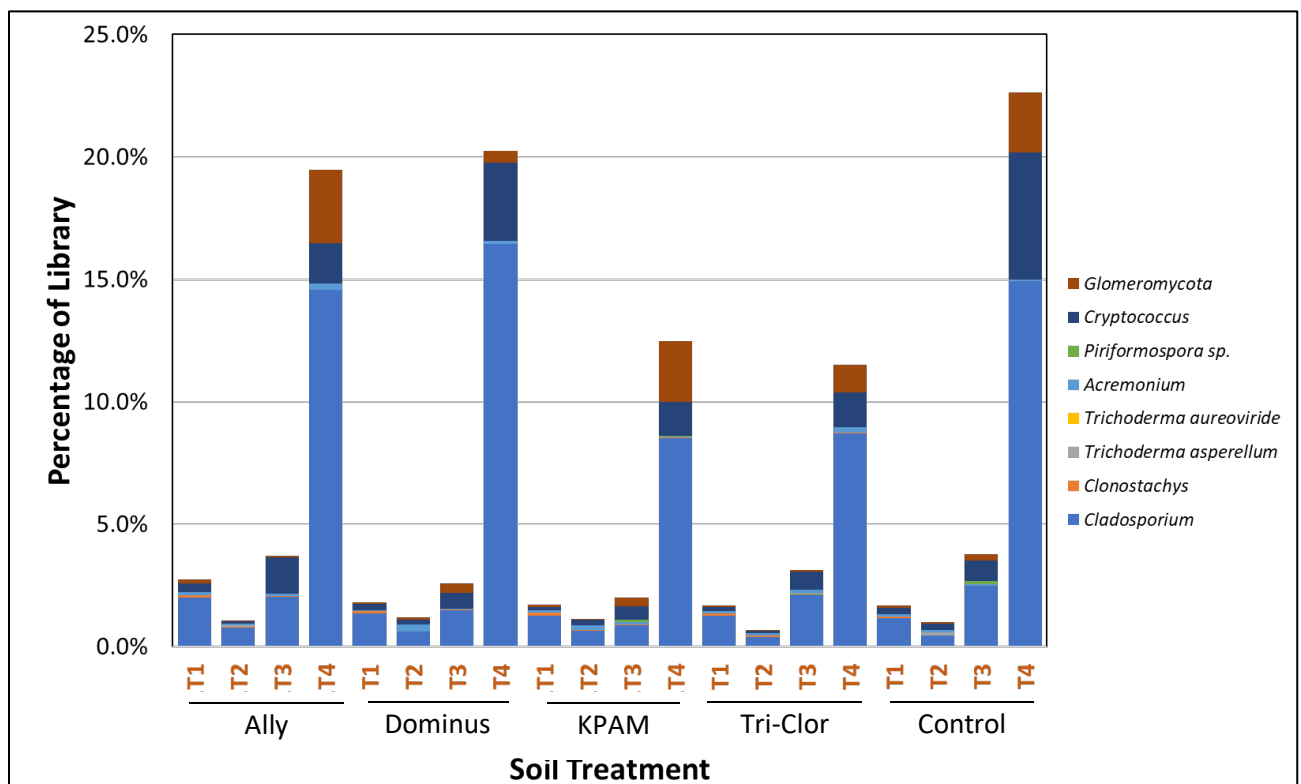


Figure 3. Changes in abundance of known biocontrol fungi in soil over the sampling period.

## How to Submit a Sample and Diagnostic Updates

Shashika S. Hewavitharana and Gerald Holmes

### Instructions on how to properly collect, package, and deliver a strawberry plant sample

- *Sample plants that show symptoms.* It is harder to find the pathogens in dead plant material because of all the other secondary organisms present. Include 2-3 plants that show different stages of the disease (mild to severe).



Too healthy



Too decayed



Just right

- *Send the entire plant.* Even if you see symptoms in leaves, the pathogen can be infecting the roots or crown. Please **don't** send a large amount of soil.
- *Soil samples.* Due to limitations of time and resources, we are unable to process soil samples at this time. We can direct you to other diagnostic labs upon request.
- *Take photos.* It is helpful for us to diagnose the disease if you can send us photos of the symptoms in the field that show the distribution of the problem in the field. You can take photos with your phones and email those to us at [shewavit@calpoly.edu](mailto:shewavit@calpoly.edu)
- *Fill out the submission form.* The plant disease problem submission form is now available online at <https://strawberry.calpoly.edu/>
  - Each sample that has a different problem needs a separate form.
  - Provide as much information as you can. Information you provide helps us diagnose the problem.
- *Submit your sample.*
  - Package your sample properly in a plastic bag. Do not use paper bags for leaf samples as these dry out quickly.
  - Local samples: Drop off at the address below.

- *Ship your sample:*
  - Please ship the sample on the same day it was collected.
  - If you are unable to ship the sample on the same day, store the bagged sample in the refrigerator. Fresh samples are better for diagnosis.
  - If possible, use a cooler with ice packs during transit. Avoid direct sunlight on the sample during transit.
  - It is better to send us the samples early in the week. Please avoid shipping on Fridays or before holidays.
  - Label your package ‘perishable plants’.
  - Shipping address:

**Cal Poly Strawberry Center  
1 Grand Ave,  
Technology Park,  
building 83, STE 1B  
San Luis Obispo, CA 93407**

**Monday-Friday 8.00 am-4.30 pm**

- *Diagnostic summary 2019 and 2020 (Jan-August):*

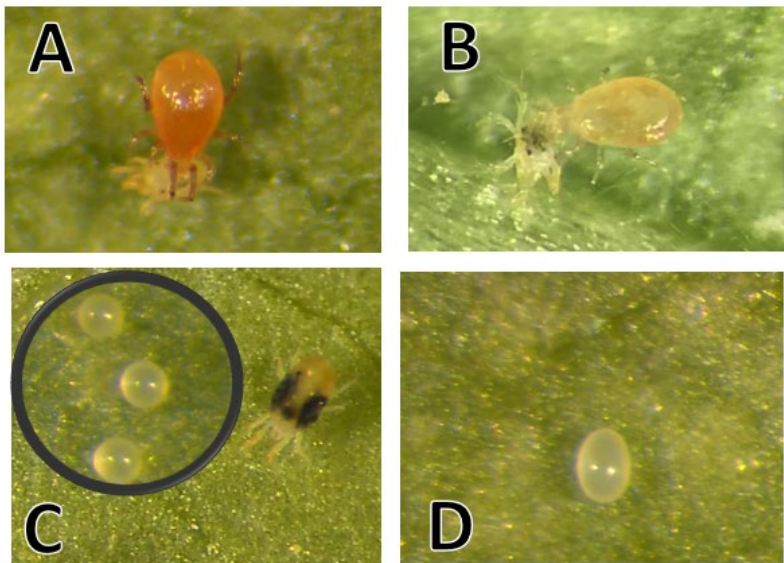
Disease/pest/disorder	Year	
	2019	2020
Abiotic/pest problems	38	35
Macrophomina crown rot	22	29
Phytophthora crown rot	16	9
Fusarium wilt	9	22
Verticillium wilt	5	17
Zythia dry calyx, leaf blotch, crown infection	4	9
Powdery mildew	1	0
Anthracnose	1	2
<b>Total number of samples</b>	<b>86</b>	<b>122</b>

## Assessing quality of predatory mites for augmentative biological control

Jose Alvarado Rojas, Dr. Sarah Zukoff

Strawberry Center, California Polytechnic State University

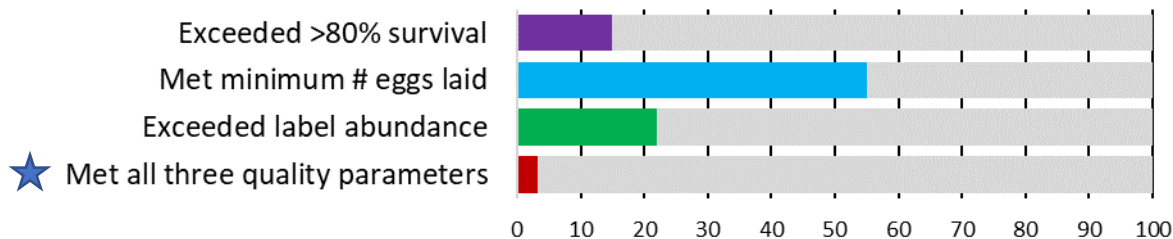
Releasing predatory mites to control spider mites in strawberry fields is a relatively common practice, thus, it is important that these predatory mites arrive in amounts specified on the package label, are in good condition, survive and are capable of reproducing. The overall goal of this study was to assess the quantity and quality of commercially produced predatory mites that California growers purchase and apply to their strawberry fields.



**Figure 1.** (A) *Phytoseiulus persimilis* and (B) *Neoseiulus californicus* are predators of (C) *Tetranychus urticae*, the twospotted spider mite (TSM). *P. persimilis* is larger than an adult TSM and is orange to red in coloration. *N. californicus* is smaller than an adult TSM and is translucent, pale orange, pink or peach. The easiest way to distinguish predatory mite eggs apart from TSM eggs is by looking at the shape of the eggs. (C) Twospotted spider mite eggs are round. (D) while the eggs of *P. persimilis* and *N. californicus* are oval or football shaped.

Containers (32) of predatory mites containing either *Phytoseiulus persimilis* or *Neoseiulus californicus* were obtained from commercial sources. **Three factors were used to assess the quality of mites** 1) **number of mites in each container compared to its label**, 2) **survival (longevity)**, and 3) **number of eggs laid per female (fecundity)**. The number of mites in each container was assessed by counting the number of mites in each container and comparing it to the number of mites stated on the label. Five one-gram samples from each container were taken to estimate container abundance. If the number of mites exceeded the label it was considered to meet expectations of quality. Fecundity and survivorship was examined by placing 20-30 gravid females on leaf disk arenas. These arenas were loaded with twospotted spider mites (the food source) and examined for survivorship every twenty-four hours for up to 6 days. If 80% of the predatory mites were found alive then it met, in part, the quality standards. Predatory mite eggs laid in these areas were counted during the same time period. To meet quality standards, *Phytoseiulus persimilis* must lay a minimum of 10 eggs per female and *Neoseiulus californicus* must lay a minimum of 7 eggs per female.

### Results



**Fig. 2.** Only one of thirty-two containers met all three standards. Less than one-quarter (22%) met their labeled abundance and 55% of the containers met the quality standards for the minimum number of eggs laid per female. The survivorship was the lowest overall with only 15% of the containers meeting the criteria for good quality mites. **Overall, the study indicates that most suppliers may currently not be meeting the standardized quality parameters.**





**CAL POLY**  
Strawberry Center

CALIFORNIA  
**STRAWBERRY**  
COMMISSION

The Cal Poly Strawberry Center was established in 2014 as a partnership between Cal Poly and the California Strawberry Commission. This one-of-a-kind Center is rooted in the hands-on learning approach that defines Cal Poly. The Center focuses on applied research that integrates both teaching and learning experiences for Cal Poly undergraduate and graduate students, faculty and California strawberry farmers. Outlined below are the Center's programs.

## PLANT PATHOLOGY



- Strawberry disease diagnostics
- Screening strawberry cultivars for disease resistance
- Disease management product evaluation
- Development of strawberry disease management tool box
- Training students for careers in plant pathology and crop protection



## AUTOMATION



- Labor saving areas of planting, pruning, pest management, picking and processing
- Engineering services available for growers through the **Automation Help Desk**
- Technology incubator available for researchers and entrepreneurs
- Annual showcase of technology at the Strawberry Automation Summit
- Validating field research through collaboration with the California Strawberry Commission



## ENTOMOLOGY



- Provide students with pest management experience and training
- Research to reduce lygus bug damage to strawberry
- Research to reduce damage from spider mites
- Produce sound, science-based solutions for arthropod pests that attack strawberries



## WORKFORCE READINESS



- Opportunity for industry to sponsor student internships
- **Earn-by-doing** opportunities in all aspects of strawberry production
- Research opportunities through senior projects and summer internships
- Recruitment opportunity at Cal Poly's annual **Ag Showcase** job fair
- We advertise positions online through Mustang Jobs and the Center's website



805-756-2150



[www.strawberry.calpoly.edu](http://www.strawberry.calpoly.edu)




@cpstrawberrycenter

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## FUNGICIDES



The active ingredient in AVIV® microbial fungicide is a powerful strain of *Bacillus subtilis* IAB/BS03, providing strong activity against bacterial and fungal diseases. OMRI-listing along with a 0-day PHI and 4-hour REI make it a great fit for conventional, sustainable or organic crop production models. 



FERVENT® 475SC fungicide combines the preventative disease fighting ability, rainfast staying power and translaminar movement of KENJA® together with the proven curative activity of tebuconazole for grapes and almonds. **FRAC 3** **FRAC 7**



KENJA 400SC is a Group 7 fungicide that offers outstanding control of *Botrytis* (Gray mold) plus broad spectrum activity on Powdery Mildew and Anthracnose on strawberries, as well as control of *Sclerotinia* drop on lettuce. **FRAC 7**



A recently introduced fungicide, PROLIVO® 300SC provides excellent preventative control of Powdery Mildew in grapes and cucurbits, with additional disease protection of untreated leaf and fruit surfaces through redistribution on the leaf surface and vapor activity. **FRAC 50**




RANMAN® 400SC, the only fungicide with a Group 21 designation, provides outstanding disease protection against Downy Mildew and other Oomycete diseases. **FRAC 21**



The next generation of plant disease control. REGEV fungicide is the first hybrid product that combines the disease control activity of botanical and chemical ingredients. REGEV combines Tea Tree Oil (TTO) and difenoconazole, giving growers a very effective disease control product, while reducing chemical usage and providing effective resistance management control. **FRAC 3** **FRAC 46**



Advanced Natural Plant Disease Control. TIMOREX® ACT is a preventative and curative natural fungicide controlling a broad spectrum of fungal and bacterial plant diseases. With multiple modes of action, TIMOREX® ACT is effective on an extensive range of crops. OMRI-listed. **FRAC 46** 




TIMOREX GOLD® fungicide is a natural botanical broad-spectrum fungicide for control of common fungal and bacterial diseases in a wide variety of fruit and vegetable crops. With multiple modes of action, TIMOREX GOLD provides effective activity against a broad spectrum of ascomycete and bacterial plant diseases. **FRAC 46**

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With its active ingredient, CYCLAPRYN®, HARVANTA® 50SL insecticide brings vegetable and strawberry growers a strong tool for effective insect control, with a control spectrum that is equal to or, in most cases, superior to all currently available diamide insecticides.\* **IRAC 28**



Fast-acting SEICAN™ is a biopesticide providing effective mite and insecticide control at low concentrations. Its OMRI-certified active ingredient, cinnamic aldehyde, is formulated as an emulsifiable concentrate, making it a reliable mite and insect control tool in organic and conventional crop production. 



A broad-spectrum diamide insecticide, VERDEPRYN™ 100SL offers pome, stone, citrus, grape, berry and tree nut producers an unmatched range of performance benefits. Driven by CYCLAPRYN®, VERDEPRYN is a compelling first choice for maximizing crop yield and quality.\* **IRAC 28**

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The active ingredient in ACIFIN provides a selective and highly effective post-emergent capability for controlling broadleaf weeds and certain annual grasses. **HRAC 14**



MISSION® herbicide provides both pre-emergence activity and long-lasting residual control to quickly and safely manage difficult weeds and grasses. **HRAC B2**



Growers need a variety of herbicide tools that allow them to tackle both difficult-to-control and resistant weeds. REFER® 280SL herbicide provides growers a safe and cost-effective non-selective herbicide option. **HRAC 10**



SHIELDEX® 400SC herbicide is a new post-emergent contact herbicide designed to provide corn growers with the power and flexibility to manage their nagging weed and grass problems.\*\* **HRAC 27**



SULFIN® 4SC herbicide provides growers a herbicide for use in pre-emergent and burndown timings that is highly effective on waterhemp, pigweed, morningglories, kochia and many other broadleaf weeds, grasses and sedges. **HRAC 14**



TRAJECT® 4SC herbicide is Summit Agro USA's novel cloransulam product that comes in a convenient liquid formulation. **HRAC 2**

**Always read and follow label directions.** Some products may not be registered for sale or use in all states or counties. Please check with your local extension service to ensure registration status.

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To learn more, visit us at [www.summitagro-usa.com](http://www.summitagro-usa.com) or call us at 984-260-0407.

\* Crop import tolerances for these insecticides are being established. Confirm that tolerances required for the export of your crop have been obtained prior to use.

\*\* SHIELDEX® 400SC herbicide performance is enhanced when combined with at least 0.5 lbs per acre of atrazine. See label for complete details and application information.

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**Cal Poly Strawberry Center Botrytis  
(Gray Mold) Trial 2019 & 2020**

See back for Field Trial Data ➡

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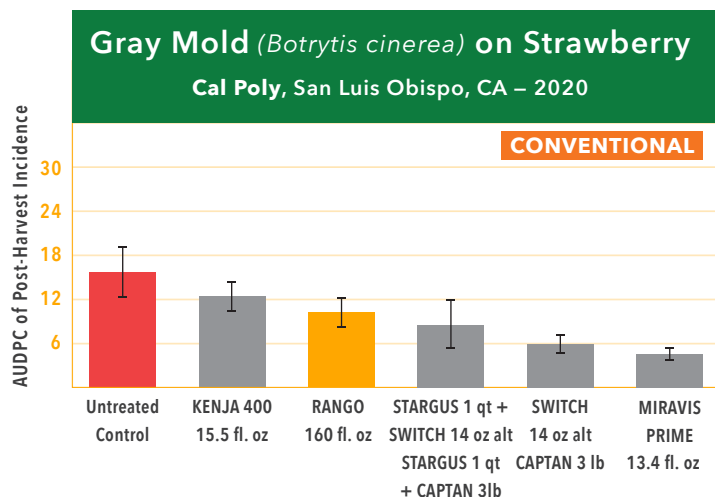
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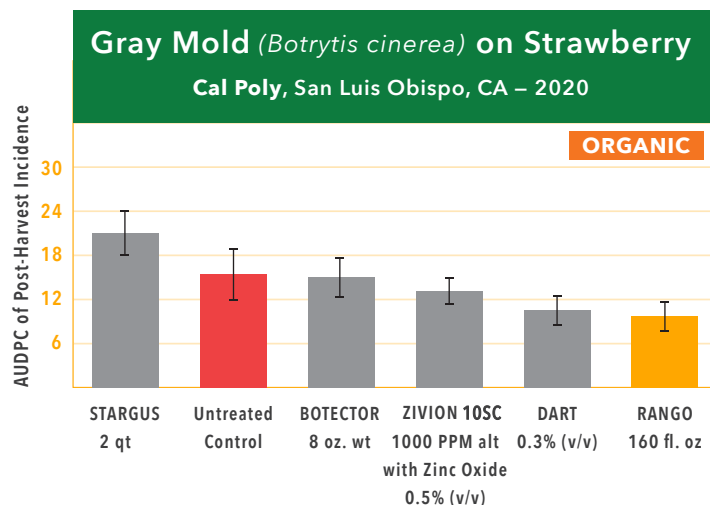




## 2020 Cal Poly Strawberry Center Botrytis Efficacy Trial

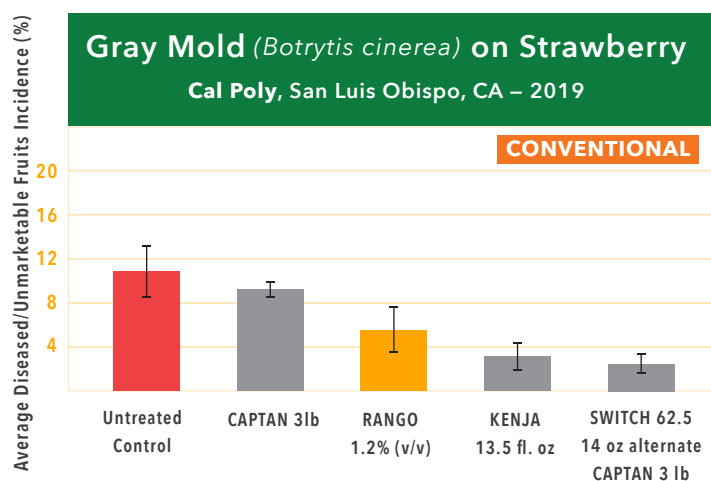


- Application timing:
  - Harvest was on Apr 27 (2 DAFA)
  - Mar 26, Apr 2, 10, 17, and 24
- Strawberry variety "Monterey"
- CO<sub>2</sub>-assisted spray: 150 GPA
- Area Under the Disease Progress Curve (AUDPC) from 0 to 7 DAH

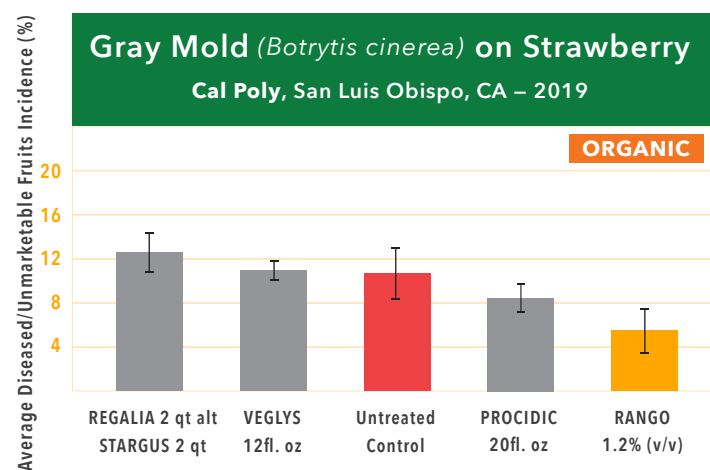


- Application timing:
  - Harvest was on Apr 27 (2 DAFA)
  - Mar 26, Apr 2, 10, 17, and 24
- Strawberry variety "Monterey"
- CO<sub>2</sub>-assisted spray: 150 GPA
- Area Under the Disease Progress Curve (AUDPC) from 0 to 7 DAH

## 2019 Cal Poly Strawberry Center Botrytis Efficacy Trial



- 5 applications made at 7-day intervals (12 Mar to 11 Apr). Harvest was on Apr 12
  - Mar 12, 19, 26, Apr 2 and 11
- In field evaluation on Apr 12. 1 DAFA.
- Strawberry variety "Monterey"
- CO<sub>2</sub>-assisted spray: 150 GPA



- 5 applications made at 7-day intervals (12 Mar to 11 Apr). Harvest was on Apr 12
  - Mar 12, 19, 26, Apr 2 and 11
- In field evaluation on Apr 12. 1 DAFA.
- Strawberry variety "Monterey"
- CO<sub>2</sub>-assisted spray: 150 GPA

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## GROWER SERVICES – FRUIT

**SunOpta** has an extensive grower and processing network that allows us to freeze and ship fresh fruit worldwide. Our goal is to be best in class and the processor of choice for our growers!

Because fresh fruit is perishable and highly vulnerable to weather events and transportation delays, we've developed relationships with partner processors and shippers to ensure access to freezing facilities within a few hours of all growing regions. We've also created regional crop redundancies within our network to maintain an uninterrupted supply of fresh fruit.

In addition to providing our customers with a **wide variety of frozen products** year-round, our network also opens up new opportunities for growers who traditionally have access to only local markets or regions. The establishment of bigger, stronger and more reliable markets for our growers is a huge source of pride for our organization.

Our global grower network partners are held to the highest standards. All growers and operating facilities are required to undergo strict third-party audits. We also perform our own on-site inspections and safety checks to independently verify documentation and audit results.



The Grower Services team key functions are:

- 🕒 Develop & strengthen relationships with strawberry growers across California and Mexico
- 🕒 Seek out quality strawberries – organic and conventional – for our four processing facilities
- 🕒 Support the communities our grower partners and processing plants are located in
- 🕒 Understand market trends as it relates to climate and pricing dynamics
- 🕒 Forecast crop timing for processing
- 🕒 Provide inventory management of processing trays for the growers
- 🕒 Provide optional outlets for grower partners for: Freezer processing berries, Fresh Rejects, 1WC, B-grade, and Juice berries
- 🕒 Seek out industry educational contacts and expertise
- 🕒 Develop and participate in agricultural sustainability programs
- 🕒 Manage full freezer fruit procurement process: Field management, harvesting, transportation, cooling, inspection, quality traceability, processing, tray sanitation, and return
- 🕒 Sourcing of other berry and fruit commodities