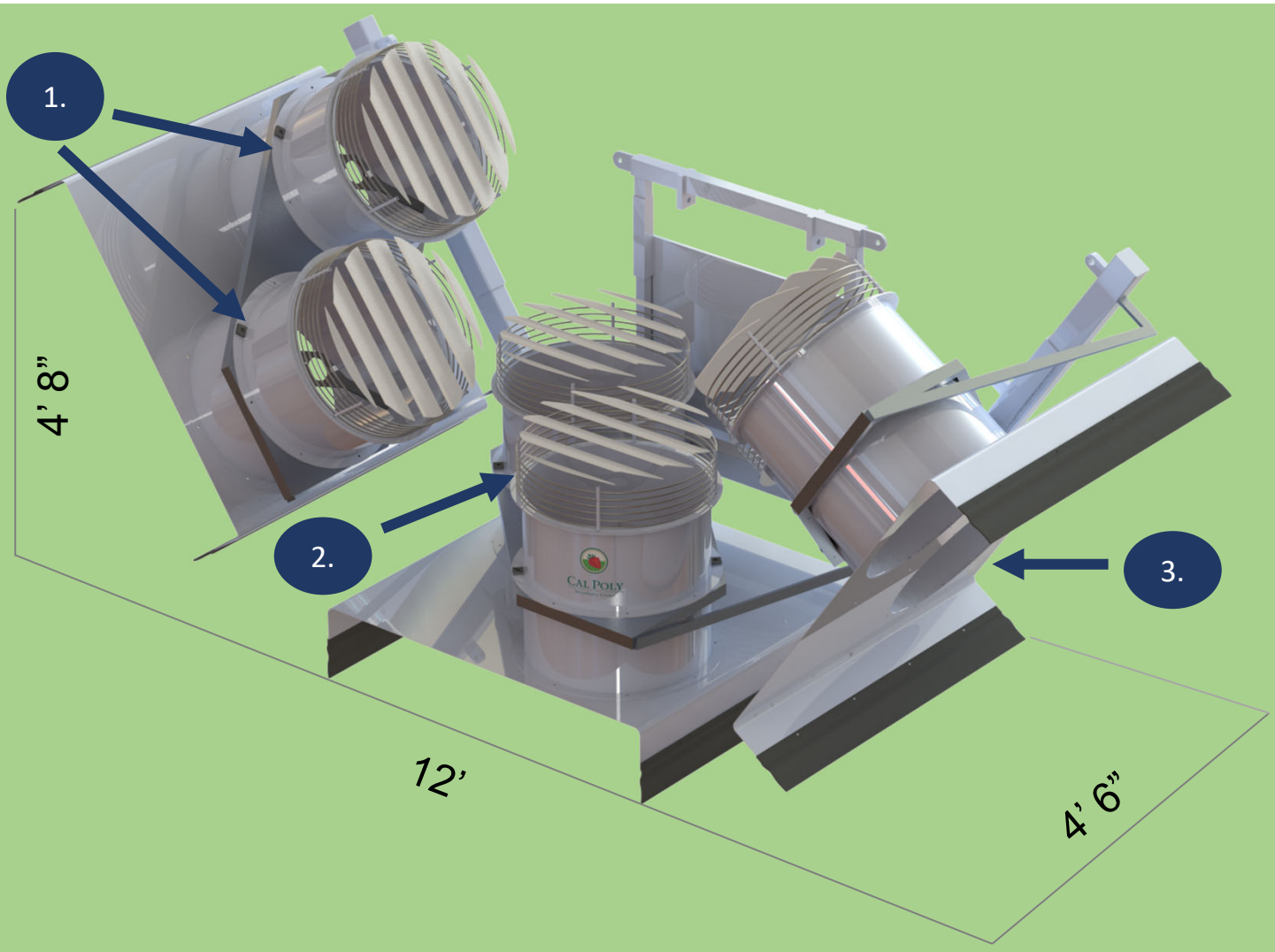
Double Barrel Bug Vacuum 2020

CAL POLY Strawberry Center



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

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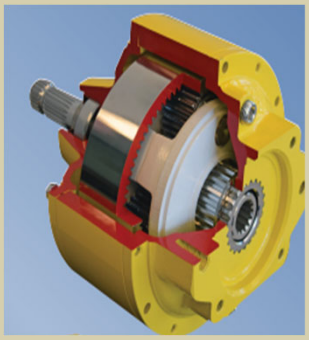
Proportion of *Lygus* spp. population removed (% +/- SEM)							
Bug Vacuum	10/16/18	10/17/18	10/24/18	10/25/18	10/30/18	10/31/18	10/14/19
Grower Standard	2% (+/- 0.4)	4% (+/- 0.7)	13% (+/-2.4)	6% (+/-2.1)	10% (+/-1.3)	13% (+/- 2.4)	10% (+/- 2.7)
Double Barrel	5% (+/- 1.1)	4% (+/-0.2)	33% (+/-1.9)	21% (+/-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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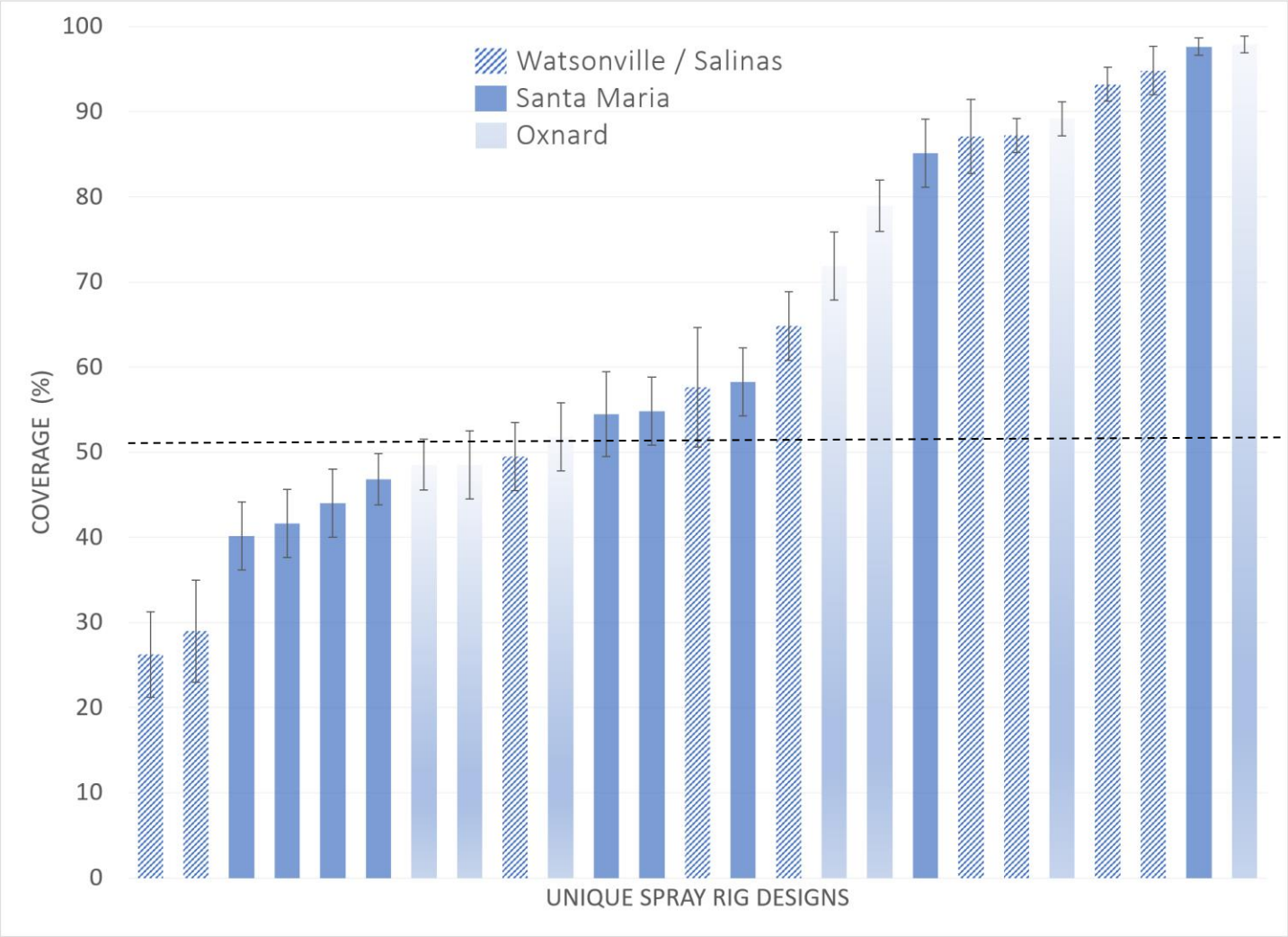
Example Spray Rig Yardstick: How does your rig compare?



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.

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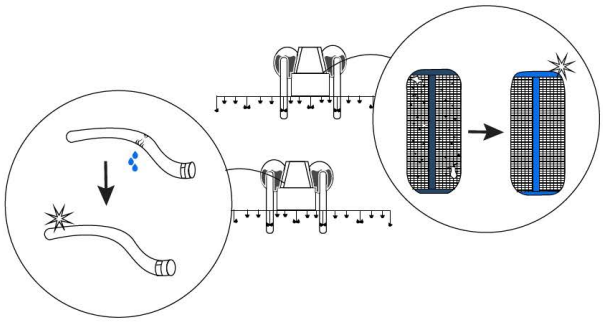
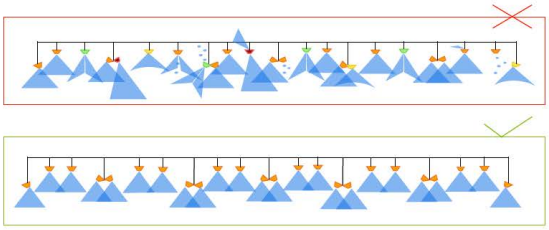
Calibration and Maintenance: It has been two years since your rig's last calibration and maintenance. It is recommended to complete the following procedures twice yearly.

Put on personal protective equipment

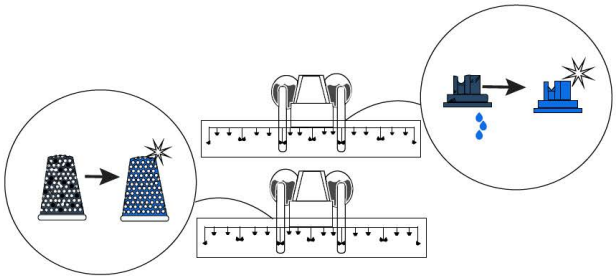


Clean, repair, or replace filters that are clogged or have holes

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

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The Effect of Pre-plant Fertilizer on Four Strawberry Cultivars

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[1]Horticulture and Crop Science Dep't, Cal Poly, San Luis Obispo, [2]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.[1] 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.

[1]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.

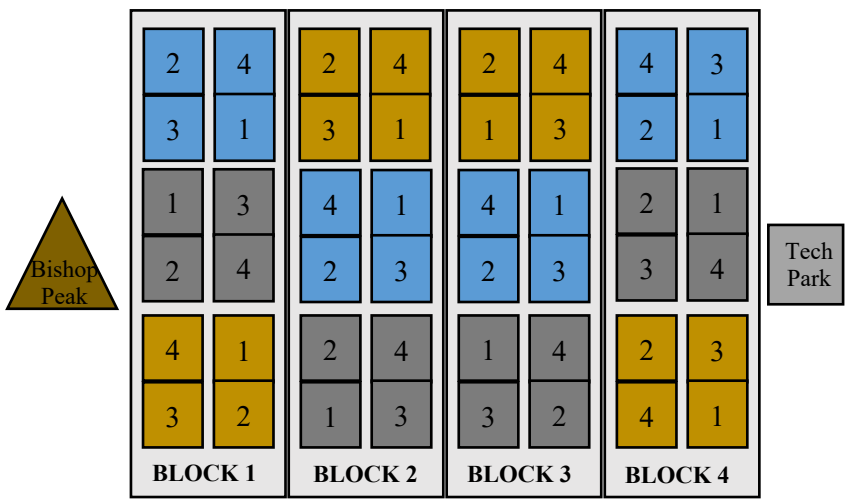
Fig. 1

Pre-plant Management (100 lb. N/acre)

- Compost
- Control
- Cont. Rel. Fert.

Cultivars

1. Monterey
2. San Andreas
3. Albion
4. Proprietary



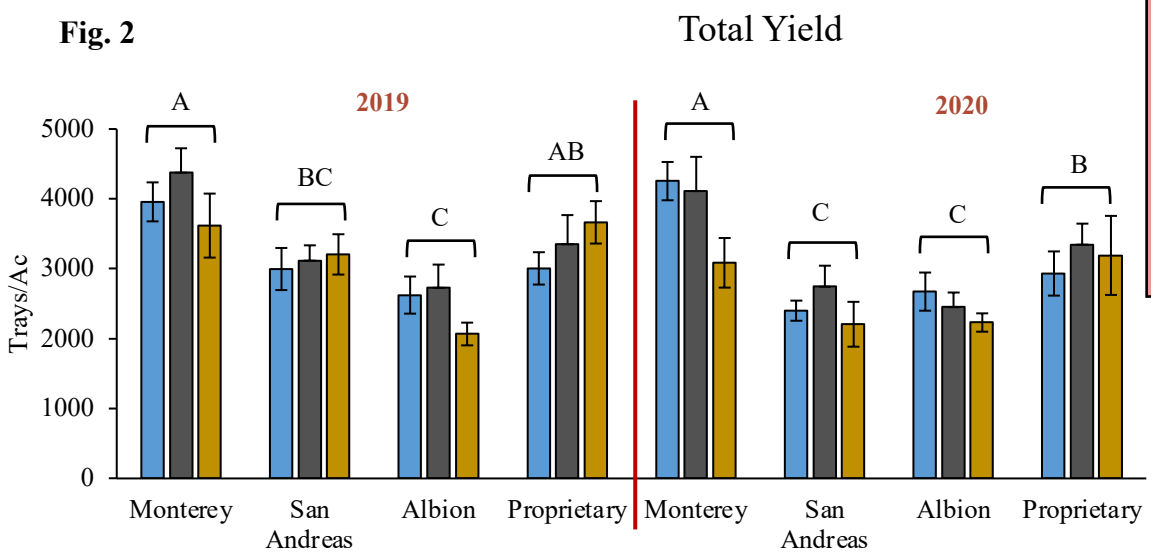
Measurements

- Soil N availability in/below root zone
- Plant N uptake
- Plant C:N
- Plant biomass
- Labile C (POxC)
- Microbial activity (Min C)
- Yield
- Disease incidence/mortality

Figure 1. Field experiment design.

Preliminary Results

Fig. 2

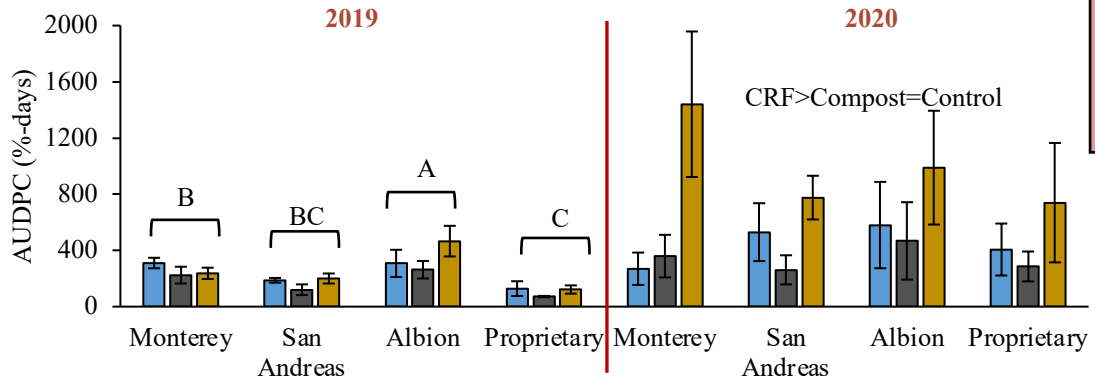


2019: Management: n.s. (p= 0.4120)
Cultivar: sig (p<0.0001)
Management x Cultivar: n.s (p= 0.3370)
2020: Management: n.s. (p=0.3384)
Cultivar: sig (p<0.0001)
Management x Cultivar: n.s. (p=0.2432)
*n.s.= not significant, sig= significant at p<0.05 level

Figure 2. Total yield data for 2019 and 2020 growing seasons. Total yield was divided by 9 lbs. to estimate yield in trays/Ac. Results show cultivar type has a strong effect on yield and pre-plant management does not.

Preliminary Results continued

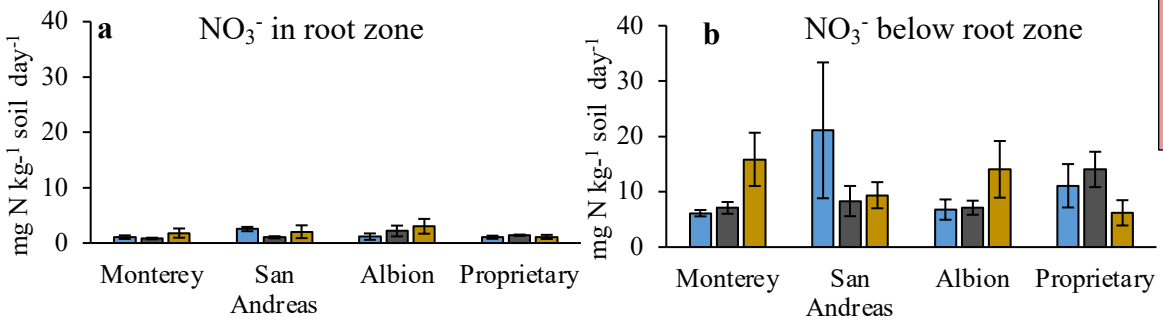
Fig. 3 *Macrophomina* Disease and Plant Mortality



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.

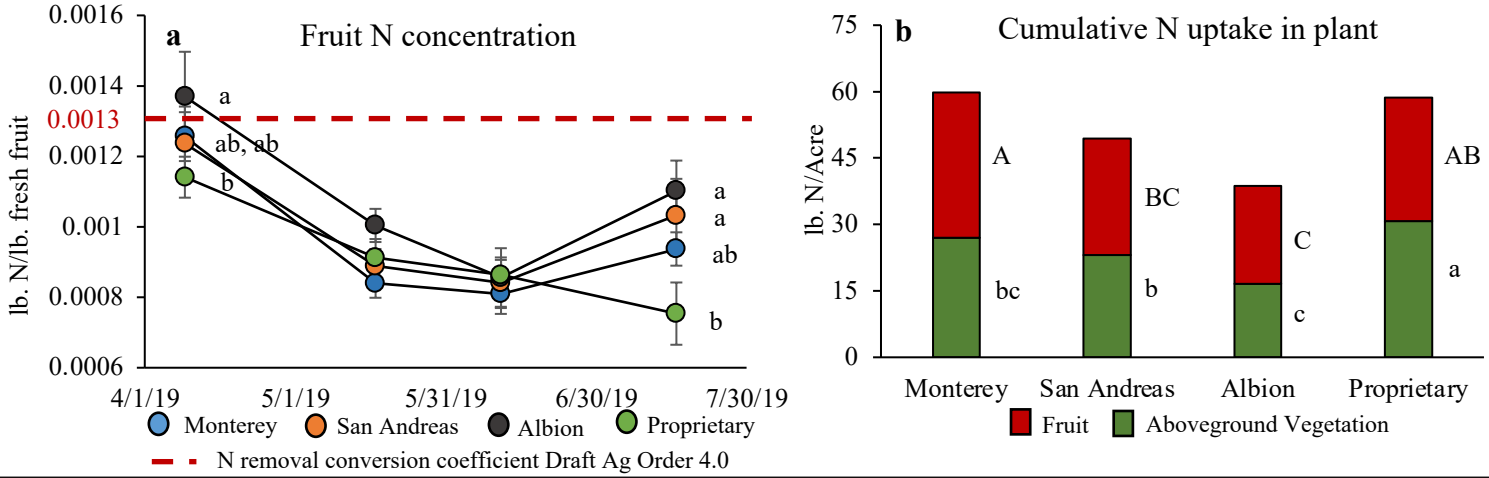
Fig. 4 Soil NO_3^- Dynamics (2019)



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_3^- exposure below the root zone (b) compared with in the root zone (a).

Fig. 5 Crop N Dynamics (2019)



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.cdfa.ca.gov/oefi/healthysoils. This research was supported the the California Statue University Agricultural Research Institute.

Evaluating Host Resistance to Macrophomina Crown Rot in Strawberry - 2020

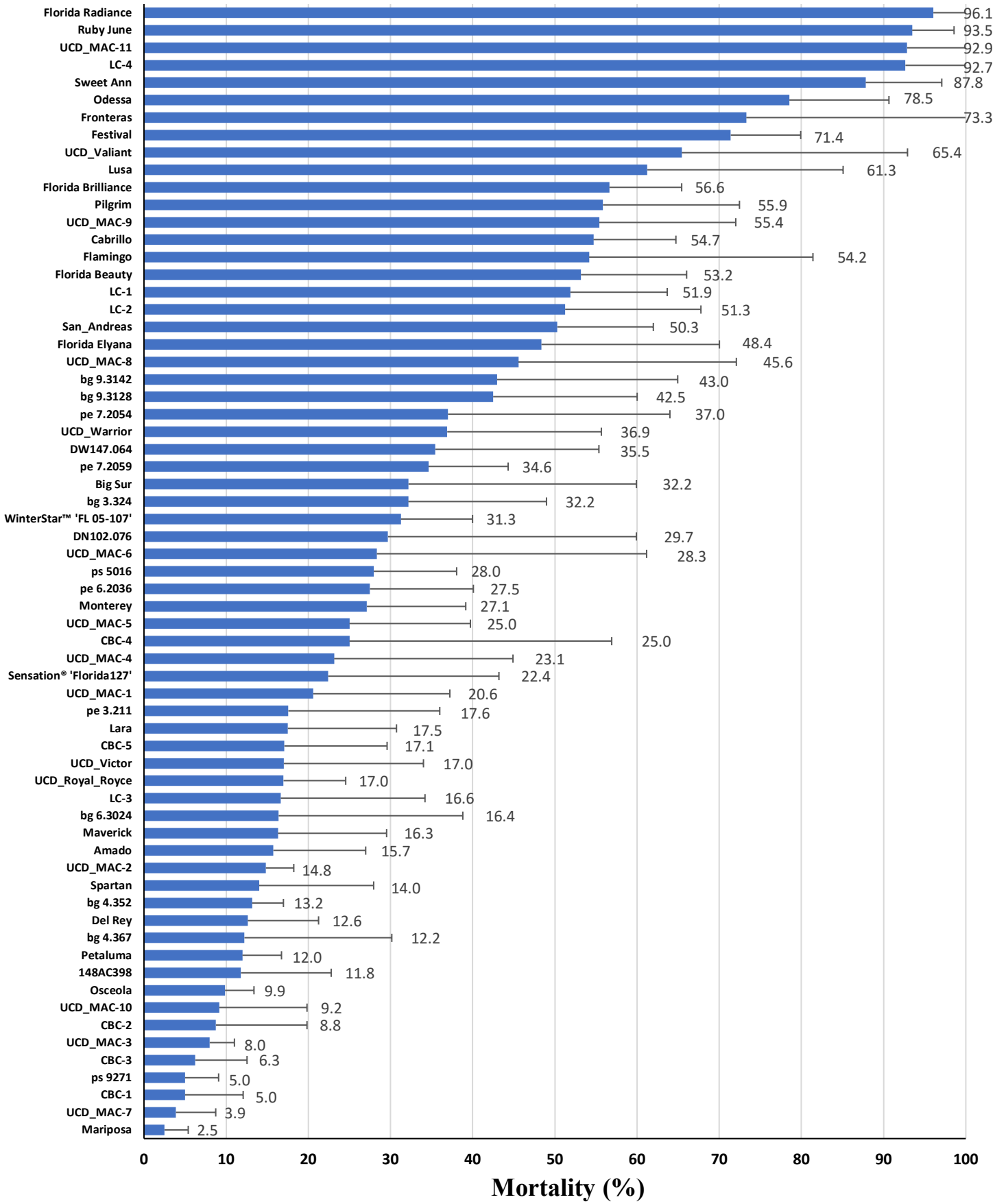
S. M. Mansouripour, K. A. Blauer & G. J. Holmes

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.

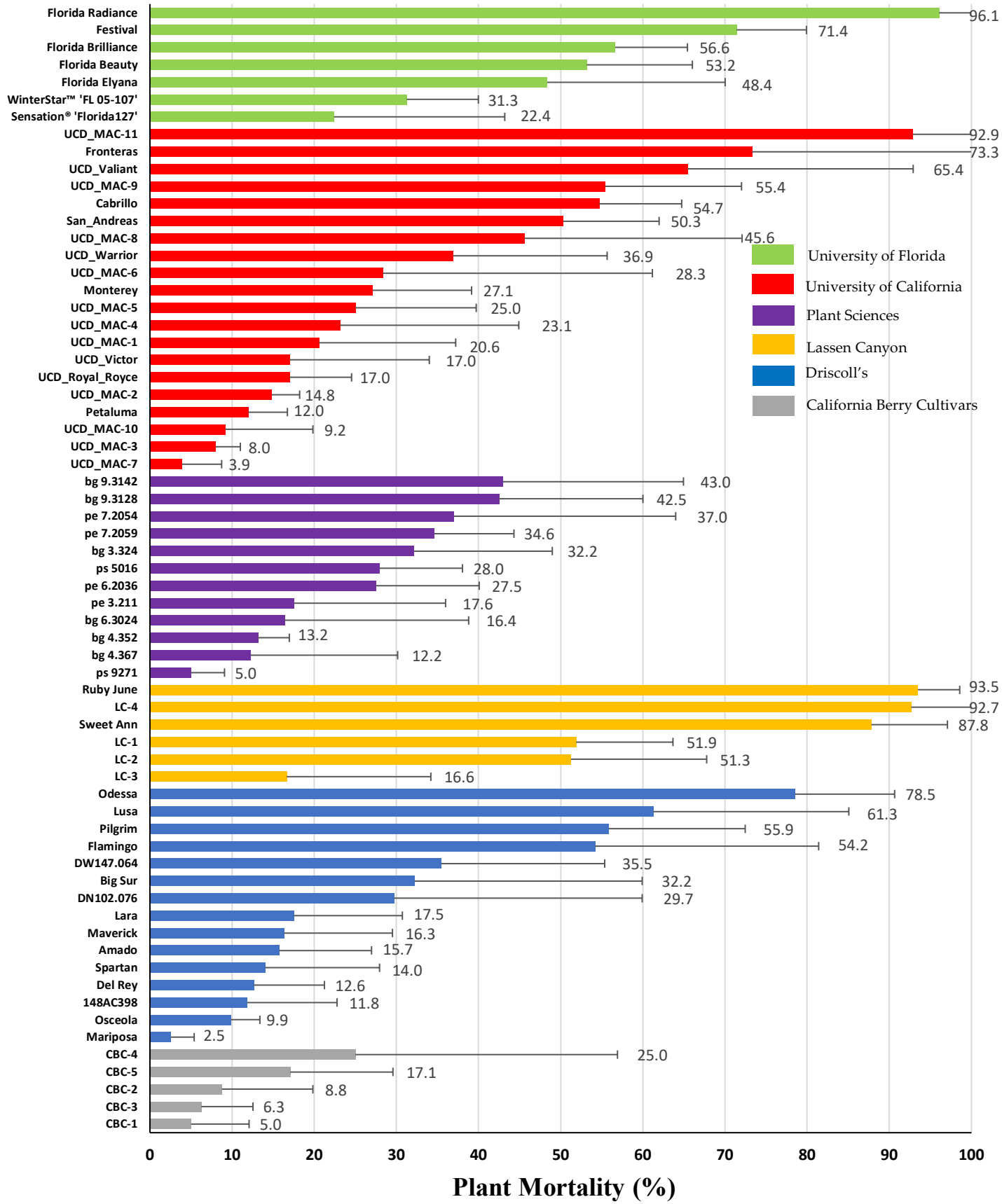
Figure 1. Aerial view of *Macrophomina* host resistance trial located in field 35b on Cal Poly San Luis Obispo farm. Plants in the area outlined in red were inoculated; plants in the area outlined in yellow were not inoculated (control). (Photo taken on 13 July 2020)

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 (1×10^6 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.

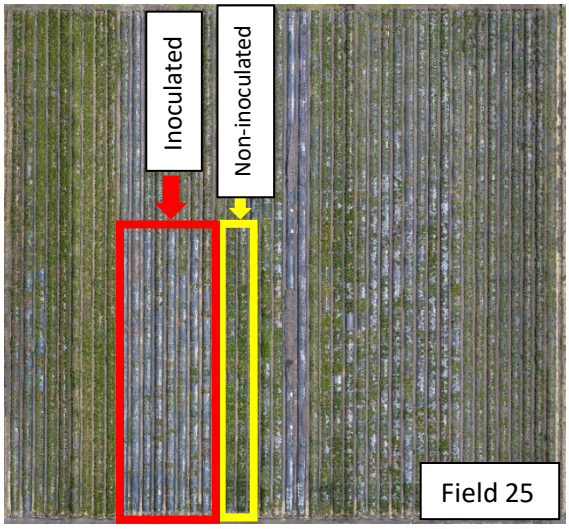
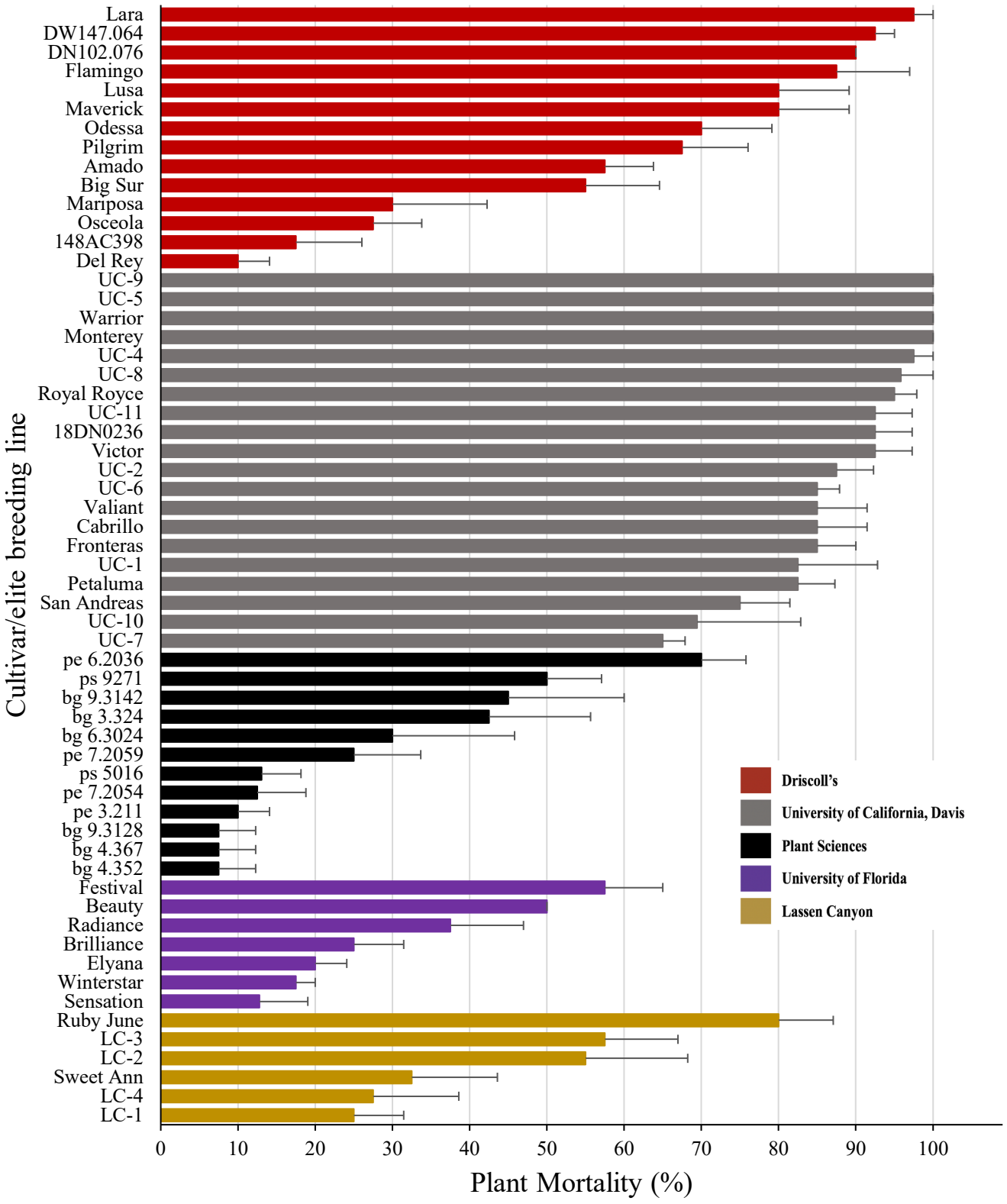


Figure 1. (Left) Aerial photo of the anthracnose host resistance trial located in field 25, block 8 on the Cal Poly San Luis Obispo farm. The area outlined in red is the inoculated reps. The area outlined in yellow is the non-inoculated control. A single buffer bed separated the inoculated from non-inoculated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

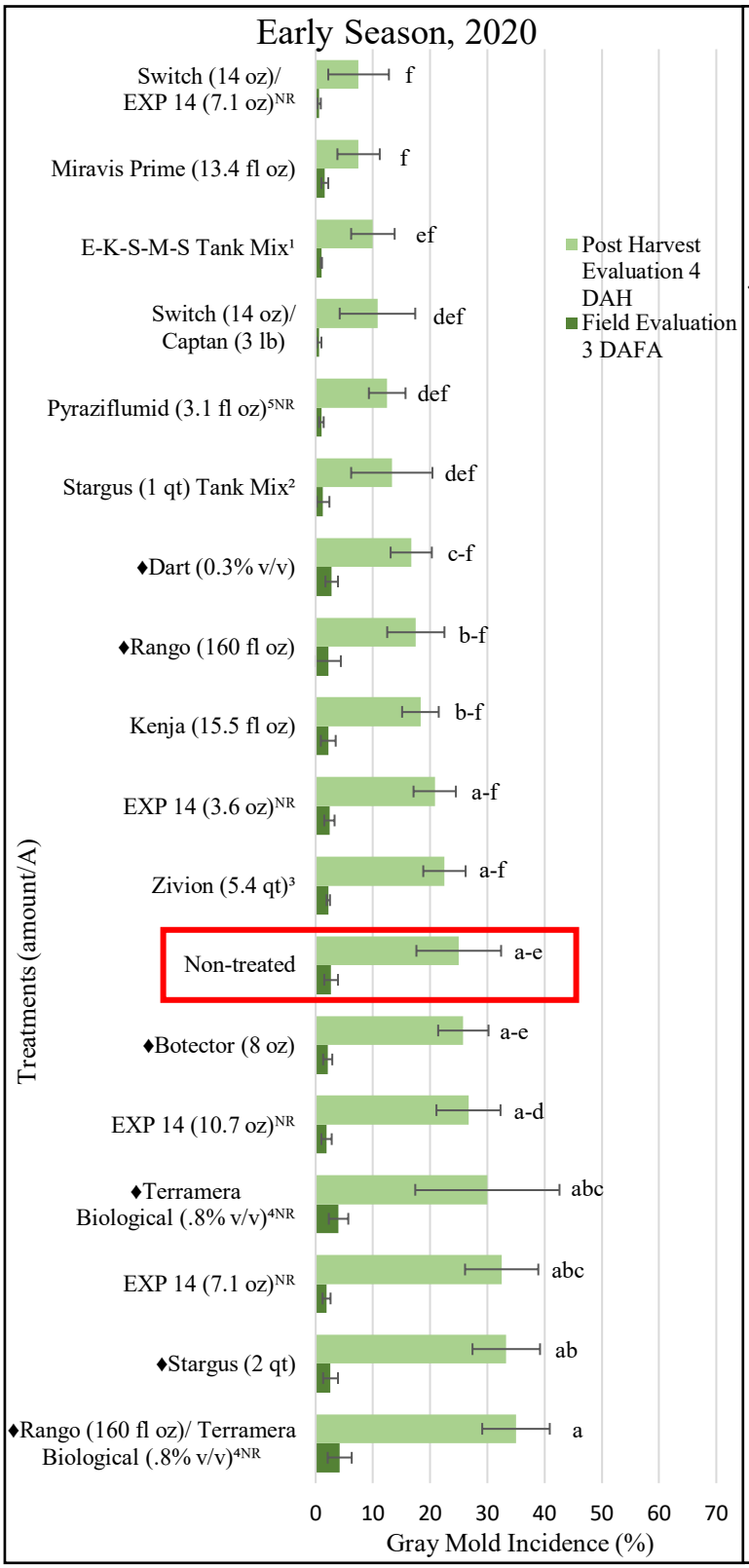
Figure 2. A) Petri dishes with strawberry plant petioles used for growth of *Colletotrichum acutatum* spores for inoculum; B) Bare-root transplants being inoculated on 25 October 2019 with *C. acutatum*; C) Strawberry plant showing symptoms of anthracnose on 15 April 2019; D) Strawberry fruit showing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

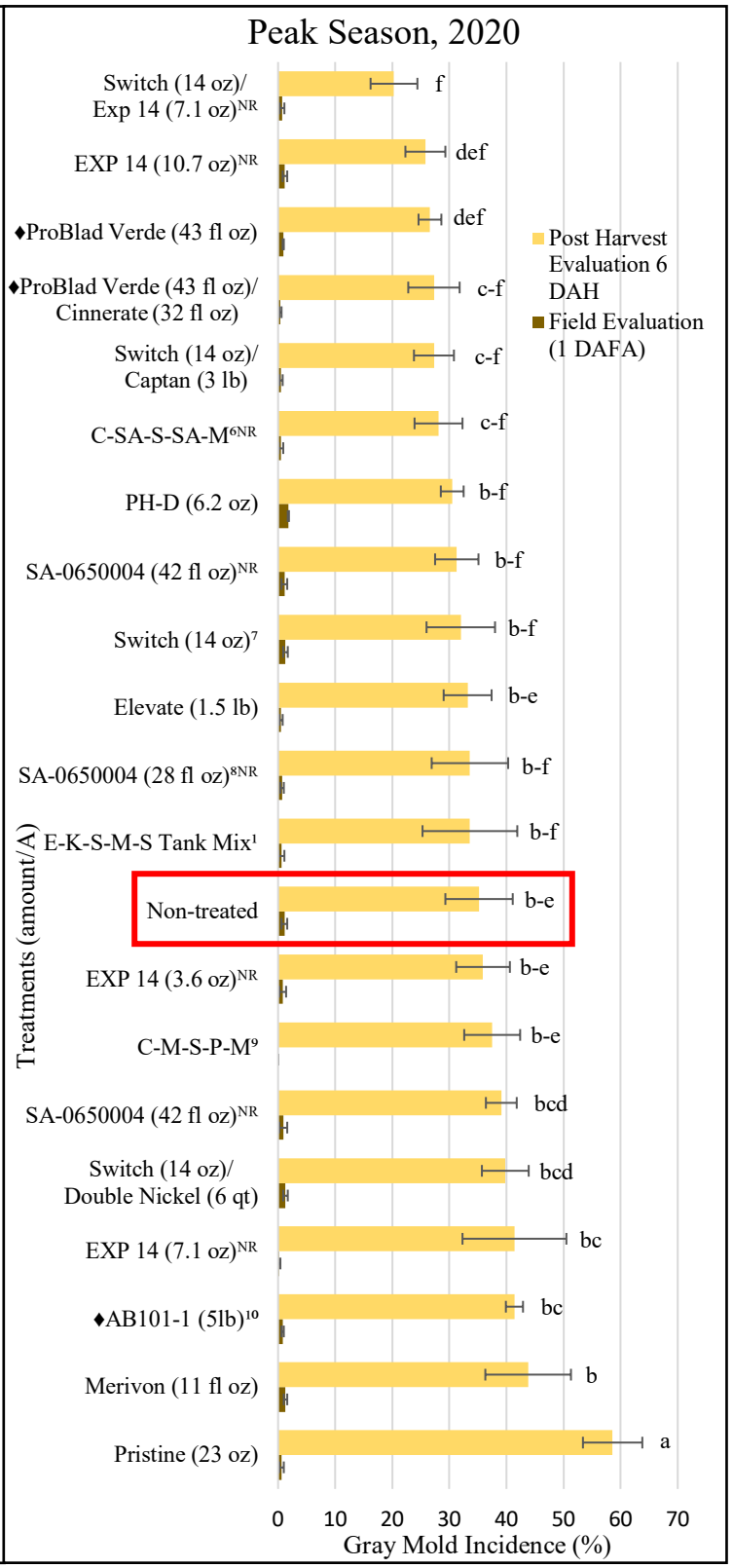
Average plant mortality (%) due to anthracnose as of 29 April 2020



Fungicide Efficacy Against Botrytis Gray Mold (cv. Monterey)

Kyle Blauer, Cal Poly Strawberry Center





♦ = Organic products; NR = Not registered; / = Weekly rotation; DAFA = Days after final application; DAH = Days after harvest. [1]Rotation sequence of Elevate, Kenja, Switch, Merivon, Switch (at max labeled rate); each tank mixed with Captan 80WDG (3 lb/A). [2] Tank Mixed with Switch rotated with Captan. [3]Night application and mixed with Brandt liquid zinc. [4] Mixed with Nu Film P @ 16 fl oz/A. [5] Mixed with Kinetic @ 12 fl oz/A. [6] Rotation sequence of Captan 80WDG (3 lb/A), SA-0650004, Switch, SA-0650004, Merivon (at max labeled rate). [7] Applied every other week. [8] Mixed with Kinetic @ 23 fl oz/A. [9] Rotation sequence of Captan 80WDG (3 lb/A), Merivon, Switch, Pristine, Merivon Switch (at max labeled rate). [10] 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 (α=0.05). If no letters are present, means were not significantly different.

STRAWBERRY FUNGICIDE EFFICACY

Fungicide	Resistance risk (FRAC)[1]	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)	++++	+++	+++[R]	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)	++++	++[R]	+++[R]	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)	+++	+++[R]	++	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, Azoxyzone, etc.	high (11)	++	+[R]	+++	NR	NR	NR	NR	ND	NR	NR
Cabrio	high (11)	++	+[R]	++	NR	----	NR	NR	NR	NR	NR
Evito	high (11)	++	+[R]	++	NR	NR	NR	NR	NR	NR	NR
Flint	high (11)	+++	+[R]	+	NR	NR	NR	NR	NR	NR	NR
Intuity	high (11)	+	++[R]	NR	NR	NR	NR	NR	NR	NR	NR
Fontelis	high (7)	+++	++++[R]	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)	+++	++++[R]	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)	+++	+++[R]	----	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	++++[R]	+(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
Captevate	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)	----	----[R]	----	----	----	----	----	+++	----	++
Rovral, Iprodione, Nevado	low (2)	NR	+++	----	NR	----	++		----	----	----
Scala	low (9)	NR	++	NR	NR	NR	NR	NR	NR	NR	NR
Switch	high (9/12)	----	++++[R]	+++	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; [R] = Resistant populations documented; and ND = no data.

[1] 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) [1]	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; [R] = Resistant populations documented; and ND = no data.

[1] 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[1], Gerald Holmes[1] and Dan Legard[2]
[1]Cal Poly Strawberry Center, [2]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.

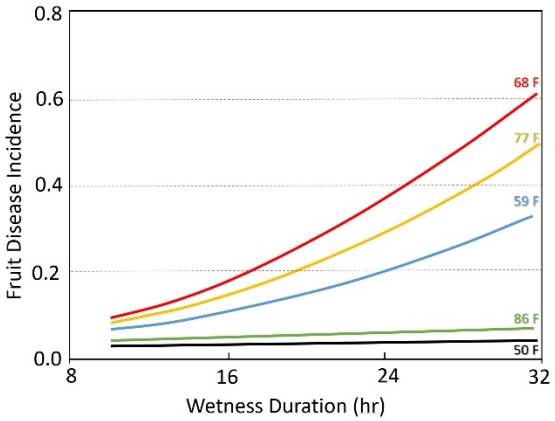
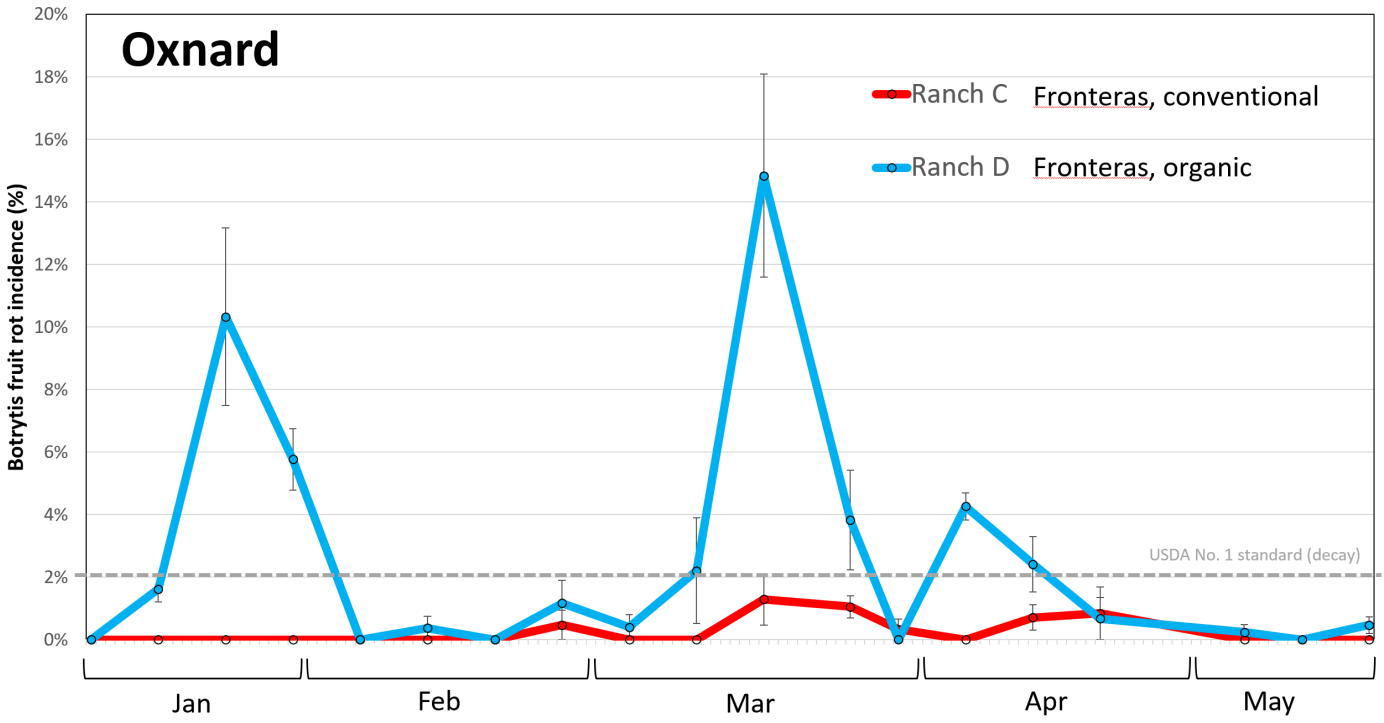


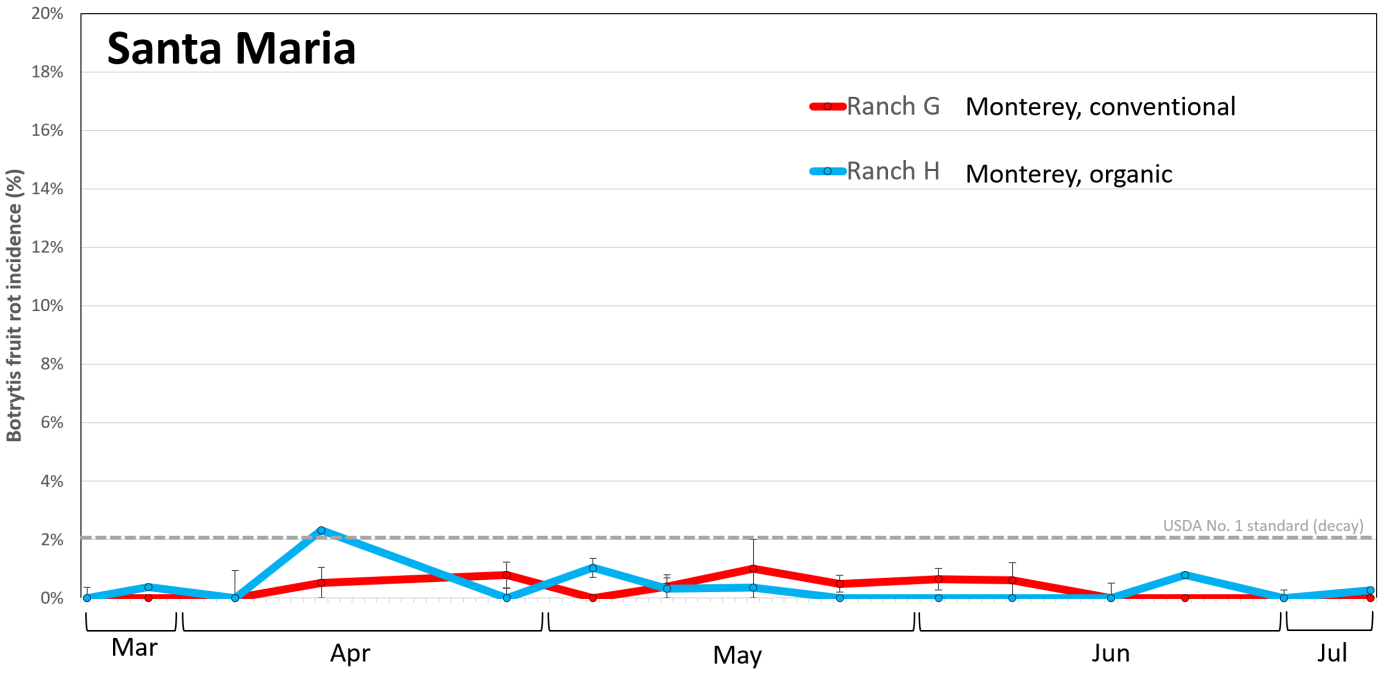
Figure 1. Effect of wetness duration and temperature at flower inoculation on the predicted proportion of ripe strawberry fruit infected by *Botrytis cinerea*. Modified from: Bulger, Ellis and Madden. 1987. Phytopathology 77:1225

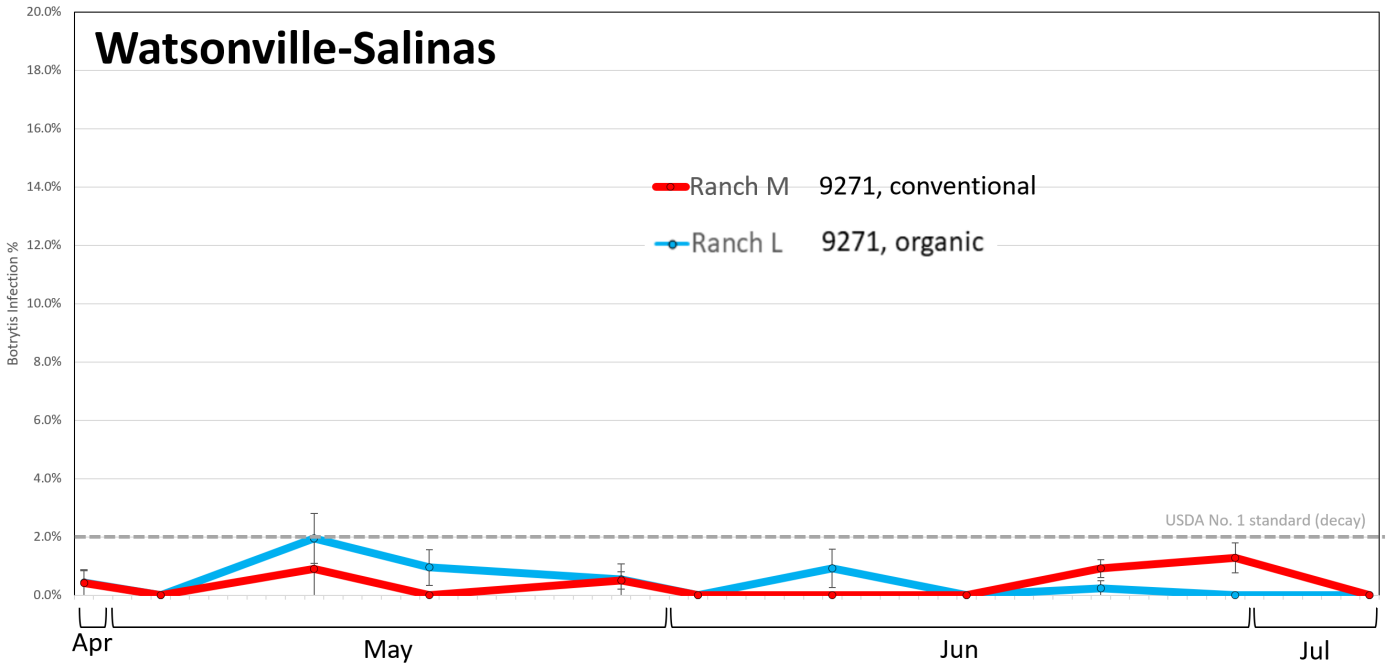
Objective. Determine the levels of BFR following commercial conditions of harvest, packing and storage at 34°F for 7 days.

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 BRF 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 + tryfloxystrobin	7 + 11	0.312 mL/L
Quintec	quinoxyfen	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.

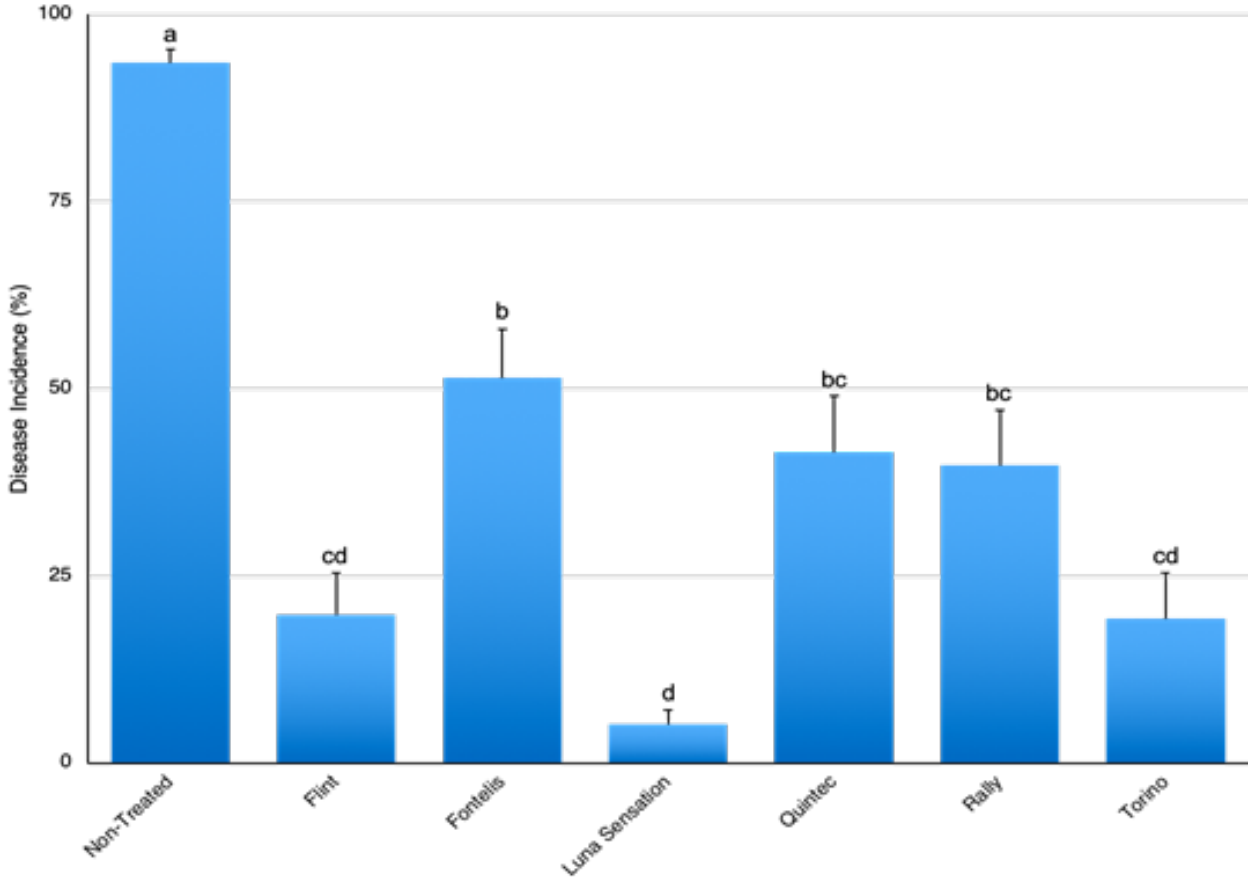


Fig 1. Powdery mildew disease incidence in response to each treatment across 19 isolates tested. Each treatment was applied at the minimum labeled rate. Treatments that do not share the same letter are significantly different according to Tukey HSD post-hoc testing.

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.

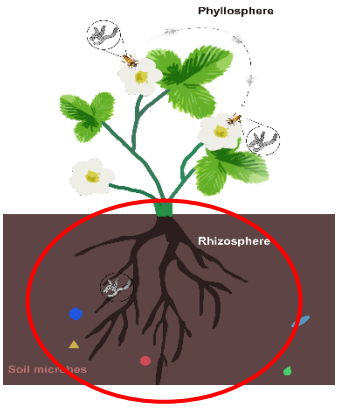


Figure 1. Rhizosphere of a strawberry plant. (Source: https:// naturemicrobiology community.nature.com)

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.

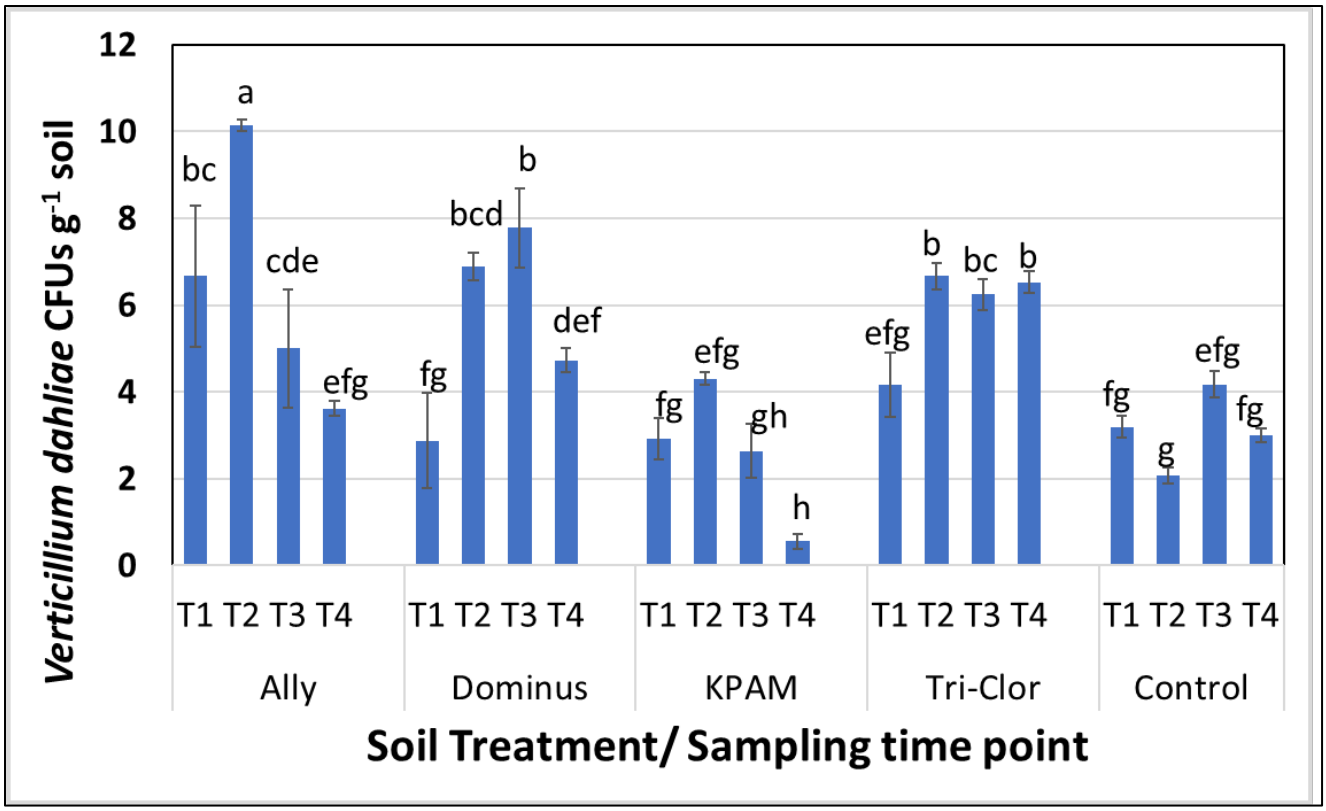


Figure 2. Soil *Verticillium* spp. population changes.

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

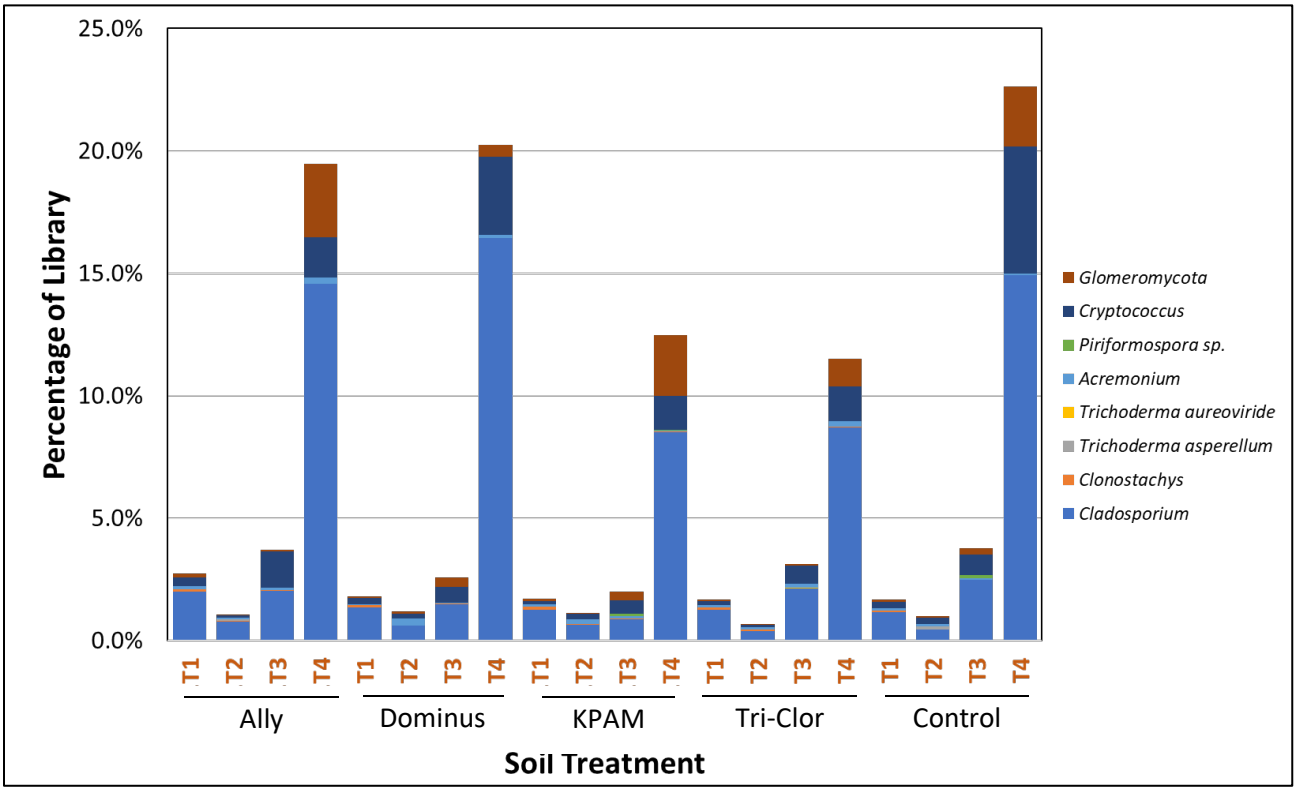


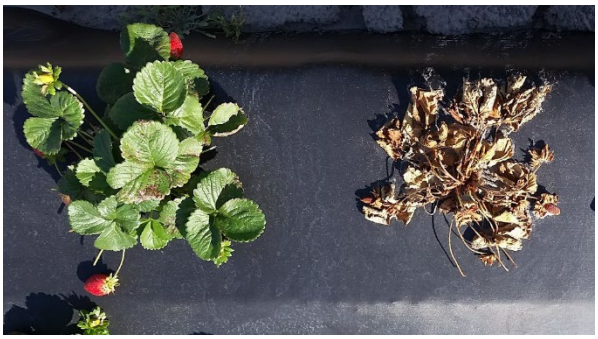
Figure 3. Changes in abundance of known biocontrol fungi in soil over the sampling period.

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**
- *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
Total number of samples	**86**	**122**

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.

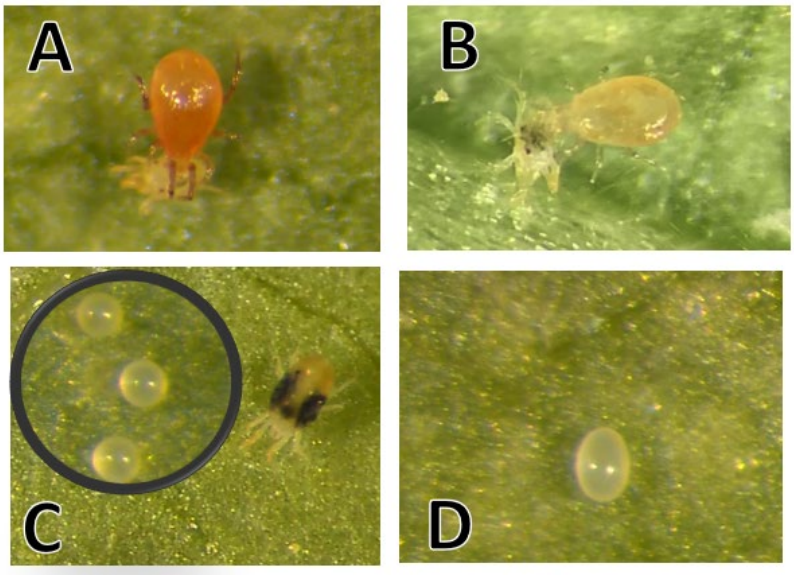


Figure 1. **(A)** *Phytoseiulus persimilis* and **(B)** *Neoseiulus californicus* are predators of **(C)** *Tetranychus urticae*, the twospotted spider mite (TSM). *P. persimilis* is larger than an adult TSM and is orange to red in coloration. *N. californicus* is smaller than an adult TSM and is translucent, 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

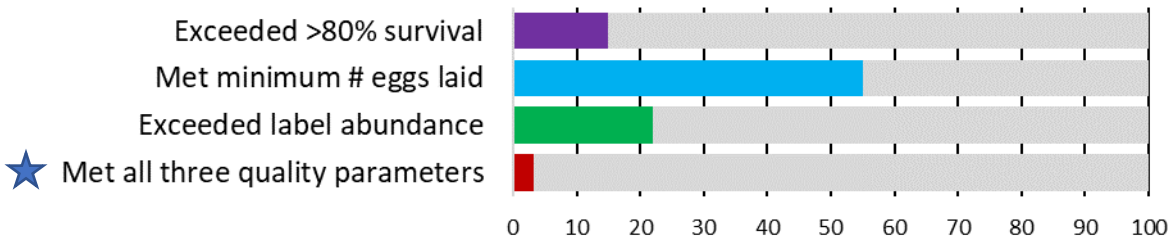


Fig. 2. Only one of thirty-two containers met all three standards. Less than one-quarter (22%) met their labeled abundance and 55% of the containers met the quality standards for the minimum number of eggs laid per female. The survivorship was the lowest overall with only 15% of the containers meeting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