CAL POLY
Strawberry Center

2021 Strawberry Field Day

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CAL POLY Strawberry Center

Agenda - Strawberry Field Day

Thursday, July 29, 2021, 8:30 AM - 12:30 PM
Cal Poly State University, Technology Park - Building 83

7:30 - 8:30 AM	Registration
8:30 - 8:45 AM	Welcome & Introductions
8:55 AM - 12:30 PM	Rotation of Topics & Breaks
12:30 PM	Lunch provided by YARA

Field 35b

Topic	Speaker
Machines and IPM, find out if heat, UV-C and vacuums may help combat your strawberry pests	Dr. Sarah Zukoff (Entomologist, Cal Poly Strawberry Center), Jose Alvarado Rojas (Cal Poly MS Student)
Fungicide Performance Against Botrytis Fruit Rot and Powdery Mildew	Kyle Blauer (Research Associate, Cal Poly Strawberry Center)
Best Practices for Submitting a Plant Sample	Dr. Shashika Hewavitharana (Plant Pathologist, Cal Poly Strawberry Center)
Disease Diagnostic Service Updates and Research on *Neopestalotiopsis* spp.	Dr. Shashika Hewavitharana (Plant Pathologist, Cal Poly Strawberry Center)
Resistance to Macrophomina Crown Rot in 51 Cultivars and Advanced Breeding Lines	Yu-Chen Wang (Cal Poly MS Student), Omar Gonzalez (Research Associate, UC Davis Breeding Program)
Susceptibility to Verticillium wilt in 51 Cultivars and Advanced Breeding Lines	Jack Koster (Cal Poly MS Student)

Parking Lot

Topic	Speaker
Optimized Lygus Bug Vacuuming for an Integrated Pest Management Program	Nigel Mallinson (Owner, C&N Tractors)
Infield Lygus Bug Monitoring for an Integrated Pest Management Program	Dr. Abbas Atefi (Senior Production Automation Engineer, California Strawberry Commission)
Autonomous UV-C	Dr. Daniel James Sargent (Principal Scientist, Saga Robotics)
Autonomous Runner Cutting	Dr. Ruijie He (CEO, Strio AI)
Field 4D – Promoting Runner Cutter Automation	Dr. Mojtaba Ahmadi (Senior Production Automation Engineer, California Strawberry Commission)
Autonomous UV-C	Dr. Adam Stager (Founder, TRIC Robotics)
Plastic Mulch Cross Hole Puncher	Will Kraemer (Lab Technician, Cal Poly BioResource & Agricultural Engineering Department)
Optimized 4-Row Spray Rig Design	Caleb Fink (Production Automation Engineer, California Strawberry Commission)

Note: The presentation locations listed above are accessible to the public for purposes of participating in the meeting. Special accommodations will be made for physically handicapped, vision or hearing impaired persons upon request. Please contact Center Staff at 805.756.2150 or strawberrycenter@calpoly.edu for accommodations.

This program was approved by CDPR and CCA for 3.5 hours of continuing education units

CAL POLY
Strawberry Center

Agenda - Día de Campo de la Fresa

Jueves, 29 de julio de 2021, 8:30 AM - 12:30 PM
Cal Poly State University, Technology Park - Edificio 83
Las presentaciones están en inglés con traducción en español

7:30 - 8:30 AM	Registración
8:30 - 8:45 AM	Bienvenidos e introducciones
8:55 AM - 12:30 PM	Sesiones rotativas
12:30 PM	Almuerzo proporcionado por YARA

Campo 35b

Tema	Orador
Máquinas y manejo integrado de plagas (MIP), averiguase si el empleo de calor, la luz ultravioleta y las aspiradoras de Lygus pueden ayudar a combatir las plagas en sus fresas	Dra. Sarah Zukoff (Entomóloga, El Centro de la Fresa de Cal Poly) y Jose Alvarado Rojas (Estudiante de Maestría, Cal Poly)
Rendimiento de fungicidas para el control de Moho Gris y el Mildiu Polvoriento	Kyle Blauer (Socio de Investigaciones, El Centro de la Fresa de Cal Poly)
Procedimiento recomendado para enviar una muestra de planta	Dra. Shashika Hewavitharana (Fitopatóloga, El Centro de la Fresa de Cal Poly)
Actualizaciones del servicio de diagnóstico de enfermedades y estudios de *Neopestalotiopsis* spp.	Dra. Shashika Hewavitharana (Fitopatóloga, El Centro de la Fresa de Cal Poly)
Resistencia a la pudrición carbonosa en 51 cultivares y líneas avanzadas de cría	Yu-Chen Wang (Estudiante de Maestría, Cal Poly) y Omar Gonzalez (Socio de Investigaciones, Universidad de California, Davis, programa de cría)
Susceptibilidad a la marchitez de Verticillium en 51 cultivares y líneas avanzadas de cría	Jack Koster (Estudiante de Maestría, Cal Poly)

Playa de estacionamiento

Tema	Orador
Aspiración de Lygus optimizada para uso en un programa de manejo integrado de plagas (MIP)	Nigel Mallinson (Dueno, Tractores C&N)
Monitoreo de insectos en el campo para uso en un programa de manejo integrado de plagas (MIP)	Dr. Abbas Atefi (Ingeniero superior de automatización de producción, Comisión de la Fresa de California)
Luz ultravioleta en plataforma autónomo	Dr. Daniel James Sargent (Científico principal, Róbotica Saga)
Corte de estolones con plataforma autónomo	Dr. Ruijie He (Director ejecutivo, Strio AI)
Campo 4D - promoviendo la automatización del corte de estolones	Dr. Mojtaba Ahmadi (Ingeniero superior de automatización de producción, Comisión de la Fresa de California)
Luz ultravioleta en plataforma autónomo	Dr. Adam Stager (Fundador, Robótica TRIC)
Perforadora de orificios cruzados de mantillo de plástico	Will Kraemer (Técnico de laboratorio, Departamento de Ingeniería Agrícola y recursos biológicos de Cal Poly)
Diseño optimizado del equipo de pulverización para 4 hileras	Caleb Fink (Ingeniero de automatización de producción, Comisión de la Fresa de California)

Nota: La ubicación de la presentación mencionada anteriormente es accesible al público para participar en la reunión. Se realizarán adaptaciones especiales para personas con discapacidades físicas, con discapacidad visual o auditiva que lo soliciten. Si se requiere alojamiento, comuníquese con el personal del Centro al 805.756.2150 o strawberrycenter@calpoly.edu. Este programa fue aprobado por CDPR para 3.5 horas de unidades de educación continua.

Cal Poly Strawberry Center

California Strawberry Commission

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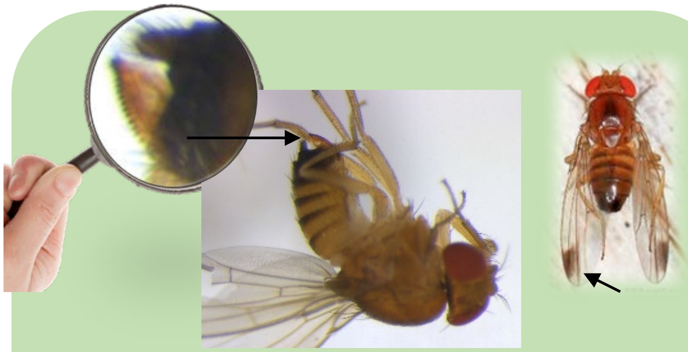
Assessing the effect of the bug vacuum on spotted wing drosophila

Dr. Sarah Zukoff and Jose Alvarado Rojas
Strawberry Center, California Polytechnic State University - SLO



Recognizing SWD females in the field can only be done with a 15x hand lens to see the saw-like ovipositor. Males can be distinguished by the spots on their wings.

Vinegar fly maggots look the same as SWD however a soft spot on a firm berry may indicate SWD maggots are lurking just beneath the surface.

The tractor-mounted lygus bug vacuum has been used to remove lygus bugs from strawberry fields but can it work on more than just lygus bugs? We tested spotted wing drosophila (SWD) adult flies to see if they get sucked into the vacuum and if any mortality occurs. There are 3 types of barrels currently available for lygus bug vacuums, C&N plastic barrel, the Cal Poly aluminum barrel, and the classic standard barrel, and we tested all 3 types mounted to a standard tractor. Flies were released in the bottom at canopy level and a large net was placed over each barrel to capture the flies as they exited the top. All three vacuum types killed over 70% of the flies released and the wind speed at which they were sucked up measured 45-50 mph. Since these flies are very mobile and can move between fields daily, and the vacuums typically run only 1-2x weekly, this will likely not act solely to control SWD, but will add to other practices growers are doing.

Grower standard	C&N new yellow plastic barrel style	Cal Poly new aluminum barrel style
71% SWD mortality 45 mph wind speed	71% SWD mortality 50 mph wind speed	73% SWD mortality 46 mph wind speed

The dead flies after they exited the barrels were often missing legs, wings or their heads but were otherwise intact.

Assessing the effect of heat on strawberry pests

Dr. Sarah Zukoff and Jose Alvarado Rojas
Strawberry Center, California Polytechnic State University

Propane gas-powered flameless heat has been shown to be effective at managing some diseases and pests in crops like grapes and tomatoes, and for weed control, but is it effective in strawberries? We evaluated insect and mite pests using Agrothermals' heat unit prototype developed specifically for strawberries. There was no difference in the average number of thrips or aphids with heat or without heat. However, there were more mobile two-spotted spider mites (TSSM) in the heat treatment but their egg numbers were greatly reduced. (Fig.1). Overall, more marketable fruit was collected from the rows not treated with the heat unit. The low canopy coupled with the deep furrows may make strawberries a poor candidate for the heat unit.

Fig.1. Agrothermal heat unit prototype

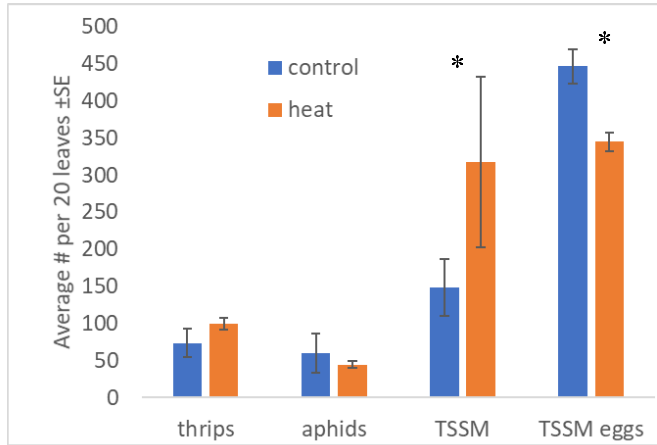


Fig. 2. Averagre number of insects and mites found per 20 leaves in with heat and without heat.

The heat coming out of the unit was set to 350°F initially but the unit had trouble with the depth of the furrows. The temp was raised in week 2 to its max temp of 400°F and the blowers were raised higher over the beds to traverse the furrows. The temperature hitting the plastic read an increase of 20 degrees higher than the ambient air temperature immediately after the unit passed over. The force of the hot wind blew the plants around and was able to hit the bottom leaves of the plants where the spider mites were heaviest.

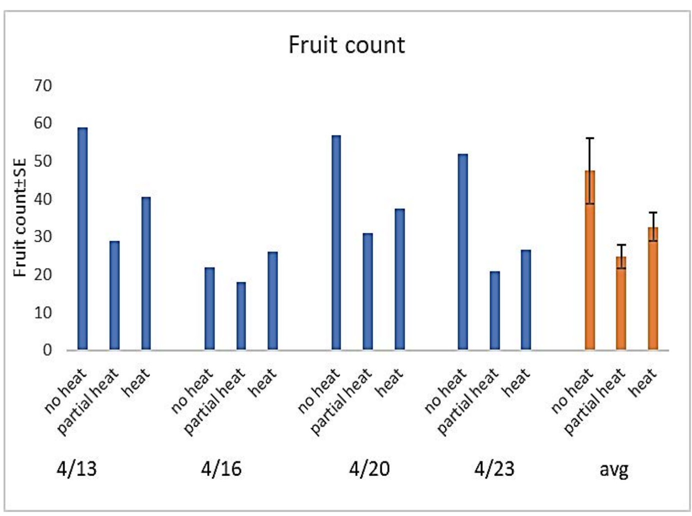


Fig. 3. Fruit collected per date per 130 ft of row.

We were able to test full heat as well as partial heat compared to no heat, and the fruit counts over the 10 days showed higher yield in the no heat treatment consistently. Therefore it would seem that Agrothermal heat unit is not a good fit for our strawberries in its current form.

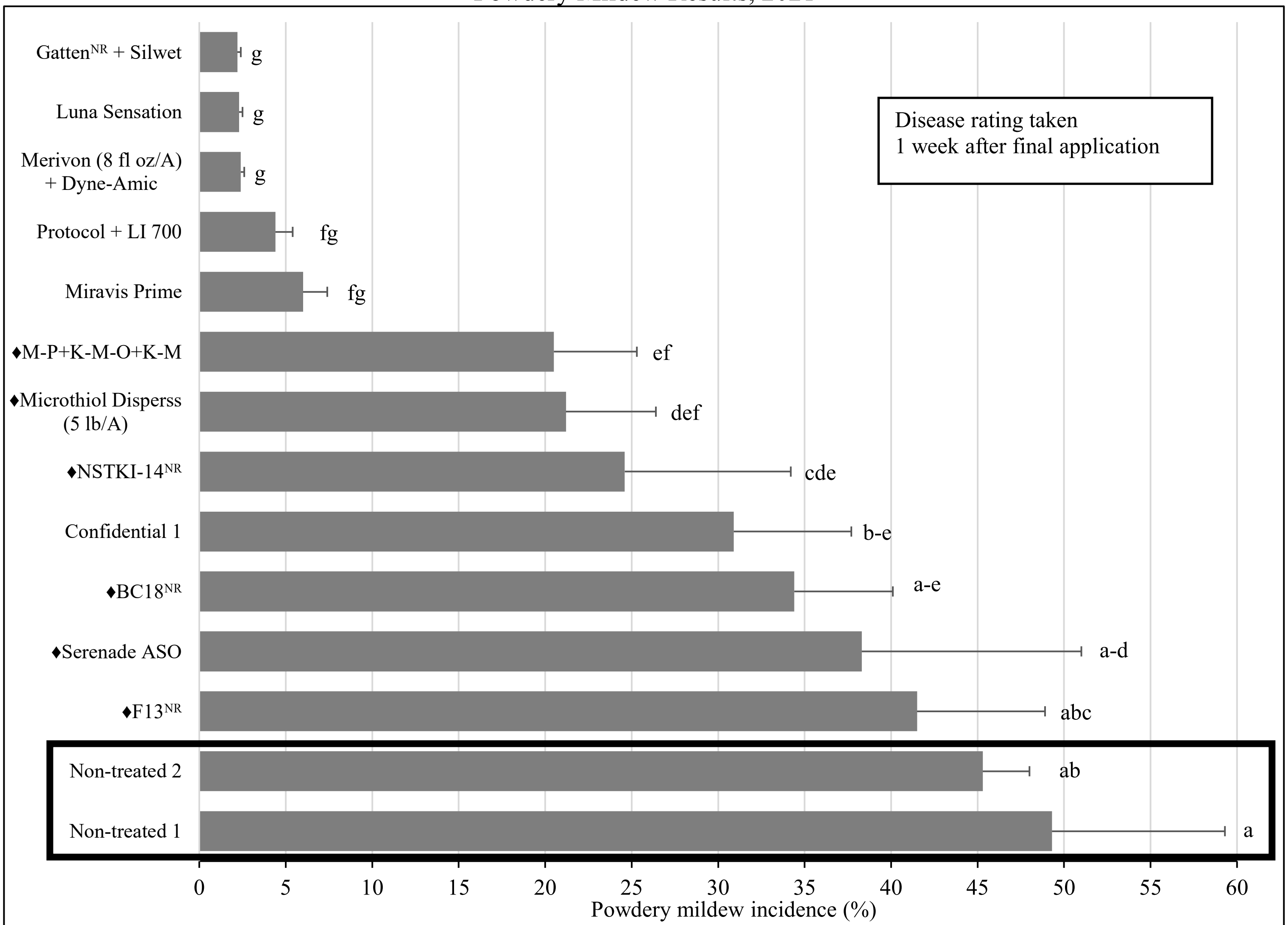
Fig. 4. The unit had to stop in place to exit the furrow and this overheated the plants directly under the blower.

Fungicide Evaluation Against Botrytis Fruit Rot and Powdery Mildew

Kyle Blauer, Cal Poly Strawberry Center

	Powdery Mildew Trial	Botrytis Trial 1	Botrytis Trial 2
Location	Green House	Field 35	Field 25 B6
Cultivar	Monterey	Monterey	Monterey
Planting Date	14 Apr, 2021	2 Nov, 2020	2 Nov, 2020
Application Start/ End Date	18 May 2021/ 15 Jun 2021	25 Mar 2021/ 26 Apr 2021	20 Apr 2021/ 20 May 2021
Total Rainfall	N/A	0.0 inches	0.0 inches
Average Daily Max Temperature	78.6 °F (inside GH)	66.4 °F	68.3 °F
Plot Size	4 plants (1 plant/pot)	17.5 ft by 5.3 ft	17.5 ft by 5.3 ft
Replications	4	4	4
Number of Applications	5	5	5
Application Interval & Sequence (Days)	7-7-7-7	7-7-9-9	7-7-7-8
Nozzle Type	1-flat fan (DG8002VS yellow)	8-hollow cone (ATR blue)	8-hollow cone (ATR blue)
Pressure (psi)	35	50	50
Carrier Volume (gal/A)	100	150	150

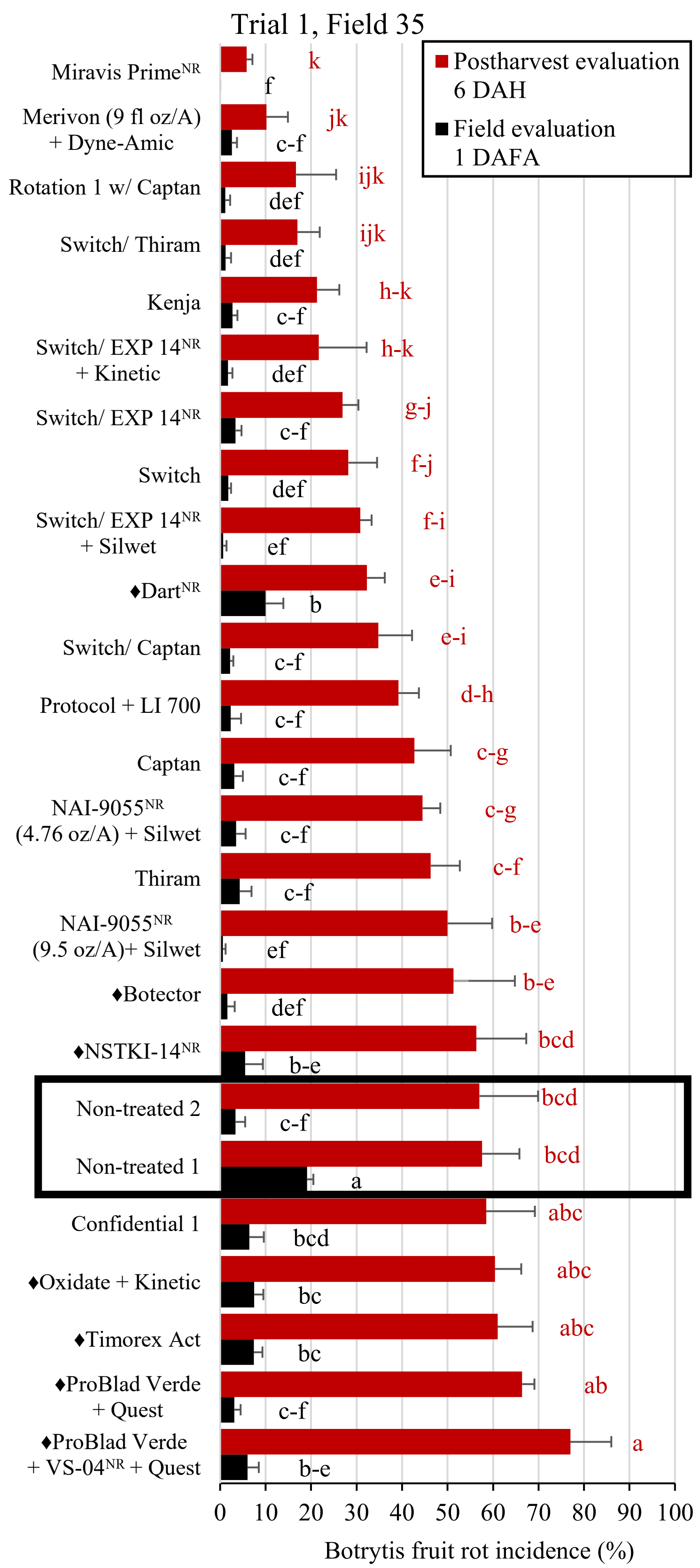
Powdery Mildew Results, 2021

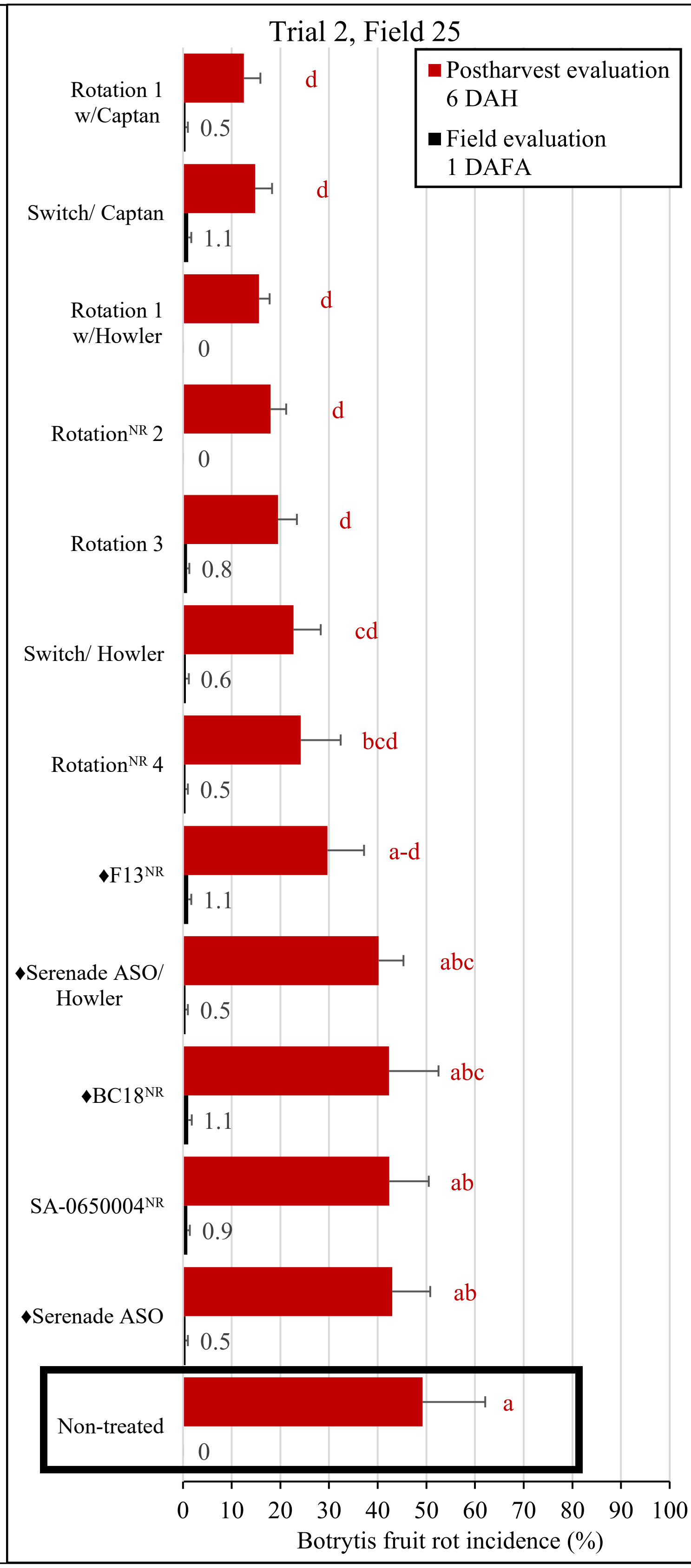


/ = Weekly rotation; + = tank mix; ♦ = Biological; NR = Not registered

M-P+K-M-O+K-M =Microthiol Disperss (5 lb/A) - PerCarb+Kinetic - Microthiol Disperss (5 lb/A) - Oxidate+Kinetic - Microthiol Disperss (5 lb/A)

Treatments were applied at max label rate unless stated otherwise. Sorted by level of powdery mildew incidence at 1 week after final application. 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).





/ =Weekly rotation; + =Tank mix; ♦ =Biological; NR =Not registered; **DAFA** =Days after final application; **DAH** =Days after harvest

Rotation 1: Elevate-Kenja-Switch-Merivon-Switch

Rotation 2: Captan-SA0650004-Switch-SA0650004-Merivon

Rotation 3: Captan-Merivon-Switch-Pristine-Merivon

Rotation 4: SA060004-Captan-SA060004-Captan-Switch

Treatments were applied at max label rate unless stated otherwise. Sorted by level of gray mold present at postharvest evaluation 6 DAH. 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 TABLE

CONVENTIONAL PRODUCTS

Fungicide trade names	Active ingredient	Resistance risk (FRAC)[1]	Gray mold[2]	Powdery mildew	Anthrac-nose	Common leaf spot	Rhizopus rot	Phytoph-thora[3]
Abound, etc. [4]	Azoxystrobin	high (11)	++[R]	++	+++	NR	NR	ND
Bumper, etc.	Propiconazole	medium (3)	NR	++++	++(NR)	+++	NR	NR
Cabrio	Pyraclostrobin	high (11)	+[R]	++	++	----	NR	NR
Captan	Captan	low (M4)	+	NR	+++(NR)	NR	+(NR)	NR
Elevate	Fenhexamid	medium (17)	++++[R]	NR	+(NR)	NR	NR	NR
Evito	Fluoxastrobin	high (11)	+[R]	++	++	NR	NR	NR
Flint	Trifloxystrobin	high (11)	+[R]	+++	+	NR	NR	NR
Fontelis	Penthiopyrad	high (7)	++++[R]	+++	NR	NR	NR	NR
Fosphite, etc.	Mono- and di-potassium salts of phosphorous acid	low (33)	NR	----	----	NR	----	++
Intuity	Mandestrobin	high (11)	++[R]	+	NR	NR	NR	NR
Kenja	Isofetamid	high (7)	++++	+++	ND	NR	NR	NR
Luna Sensation	Trifloxystrobin; Fluopyram	medium (11/7)	+++	++++	+++[R]	ND	----	NR
Luna Tranquility	Pyrimethanil; Fluopyram	medium (9/7)	++	++++	NR	ND	----	NR
Merivon	Pyraclostrobin; Fluxapyroxad	high (7/11)	++++	++++	ND	----	+++(NR)	NR
MetaStar, etc.	Metalaxyl	high (4)	NR	NR	NR	NR	NR	++
Nevado, etc.	Iprodione	high (2)	+++	NR	----	----	NR	NR
Mettle, etc.	Tetraconazole	medium (3)	NR	++++	NR	ND	NR	NR
Ph-D, etc.	Polyoxin D zinc salt	medium (19)	++	+++	++	NR	NR	NR
Pristine	Boscalid; Pyraclostrobin	high (7/11)	++++[R]	+++	ND	----	NR	NR
Procure, etc.	Triflumizole	medium (3)	NR	++++	+(NR)	NR	NR	NR
Protocol	Propiconazole; Thiophanate-methyl	medium (3/1)	+++[R]	+++	++	NR	NR	NR
Quadris Top	Azoxystrobin; Difenoconazole	medium (11/3)	(++[R])NR	++++	+++[R]	ND	NR	NR
Quintec	quinoxyfen	medium (13)	NR	++++	NR	NR	NR	NR
Rally, etc.	myclobutanil	medium (3)	NR	++++	++(NR)	+++	NR	NR
Rhyme	Flutriafol	medium (3)	NR	++++	NR	NR	NR	NR
Ridomil, etc.	Mefenoxam	high (4)	NR	NR	NR	NR	NR	++
Scala	Pyrimethanil	medium (9)	++	NR	NR	NR	NR	NR
Switch	Cyprodinil; Fludioxonil	medium (9/12)	++++[R]	----	+++	NR	+++(NR)	NR
Thiram	Thiram	low (M3)	+	NR	++	----	NR	NR
Topsin-M, etc.	Thiophanate-methyl	high (1)	+++[R]	+++	----	++(NR)	NR	NR
Torino	Cyflufenamid	unknown (U6)	NR	++++	NR	NR	NR	NR
Velum One	Fluopyram	high (7)	+(NR)	++	NR	NR	NR	NR
Zivion	Natamycin	unknown (48)	NR	ND	+++	NR	NR	NR

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/).

[2] Efficacy rating based on the absence of a fungicide resistant population of the pathogen.

[3] Efficacy rating for soil-application for control of Phytophthora crown rot.

[4] “etc.” following trade names indicates that other trade names exist for the same active ingredient

BIOLOGICALS/ NATURAL PRODUCTS

Fungicide trade names	Active ingredient	Resistance risk (FRAC) [1]	Gray mold[2]	Powdery mildew	Anthrac-nose	Common leaf spot	Rhizopus rot	Phytoph-thora
Actinovate	*Streptomyces lydicus*	unknown (BM2)	----	+	NR	NR	NR	----
Aleo, etc.	garlic oil	unknown (NC)	----	ND	----	----	----	----
Aviv, etc.	*Bacillus subtilis* strain IAB/BS03	unknown (NC)	ND	++	ND	ND	NR	ND
Botector	*Aureobasidium pullulans* strain DSM 14940; DSM 14941	unknown (NC)	----	ND	ND	NR	----	NR
Cinnerate	cinnamon oil	unknown (NC)	----	ND	NR	NR	NR	NR
Double Nickel	*Bacillus amyloliquefaciens* strain D747	unknown (BM2)	----	+	----	NR	NR	----
Fracture, etc.	Banda de Lupinus albus doce	unknown (NC)	+	++	NR	NR	NR	NR
Howler	*Pseudomonas chlororaphis* strain AFS009	unknown (BM2)	----	NR	ND	ND	NR	ND
Kaligreen, etc.	potassium bicarbonate	unknown (NC)	NR	++	NR	NR	NR	NR
Microthiol Disperss, etc.	Sulfur	low (M2)	NR	+++	NR	NR	NR	NR
M-Pede, etc.	potassium salts of fatty acids	medium (28)	NR	+	NR	NR	NR	NR
Oso, etc.	Polyoxin D zinc salt	medium (19)	++	+++	++	NR	NR	NR
Oxidate, etc.	Hydrogen peroxide; peroxyacetic acid	unknown (NC)	----	ND	NR	NR	NR	NR
Procidic, etc.	citric acid	unknown (NC)	----	NR	NR	NR	NR	NR
Rango	cold pressed neem oil	unknown (NC)	+	ND	ND	----	NR	----
Regalia	extract of *Reynoutria sachalinensis*	unknown (P5)	----	ND	ND	ND	NR	ND
Serenade ASO, etc.	QST 713 strain of *Bacillus subtilis*	unknown (NC)	+	++	----	----	----	----
Stargus	*Bacillus amyloliquefac-iens*	unknown (BM2)	----	NR	ND	NR	NR	NR
Timorex Act	tea tree oil	unknown (BM1)	----	++	ND	NR	----	ND

Rating:++++ = excellent and consistent; +++ = good and reliable; ++ = moderate and variable; + = limited and/or erratic; ---- = ineffective; NC = mode of action not classified; 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/).

2 Efficacy rating determined with fungicide susceptible populations of pathogen.

3 Efficacy rating for soil applied control of Phytophthora crown rot.

4 "etc." following trade names indicates that other trade names exist for the same active ingredient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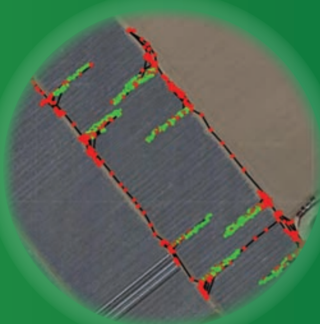



nathan.dorn@food-origins.com

Best Practices for Submitting a Plant Sample

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 organisms present. Include 3-5 plants that show different stages of the disease (mild to severe).

Too healthy Too decayed Just right

- *Check crown symptoms of similar plants before sending.* The chance of finding the pathogen increases when there's discoloration in the crown tissue.

Great variation of crown discoloration→

more *likely to find a pathogen*

Less variation of crown discoloration→

less *likely to find a pathogen*

- *Send the entire plant.* Even if you see symptoms in leaves, the pathogen can be infecting the roots or crown. Please **do not** send a large amount of soil.
- *Soil samples.* We are developing a service to assay soil for pathogen levels. Stay tuned!
- *Take photos*. It is helpful for us to diagnose the disease if you send photos of the symptoms in the field prior to sampling showing the distribution of the problem in the field. You can take photos with your phones and email those to **shewavit@calpoly.edu**

- *Fill out the submission form.* The plant sample 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.
    - Please include the city where the field is located in the top information section.
    - Make sure the label on the bag and the form match.
- *Submit your sample.*
    - Package your sample 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'.
  - Samples are accepted Monday through Friday 8:00 am-4:30 pm
  - Shipping address:

Attn: Shashika Hewavitharana

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

Cal Poly Strawberry Disease Diagnostic Service
Research Update on *Neopestalotiopsis* spp.

Shashika S. Hewavitharana, Elias Barriga-Hernandez, and Gerald Holmes

Background

Pestalotiopsis is a fungus common to many environments, but not generally considered a serious pathogen of strawberry. *Pestalotiopsis longesetula* was first reported causing fruit rot in Florida in 1972. A *Pestalotiopsis* species was isolated again in the 2012-2013 Florida strawberry season but considered a secondary pathogen. In 2017, 2018, and 2019-2020 seasons, another leaf spot and fruit rot outbreak caused serious losses in FL which is now attributed to a *Neopestalotiopsis* species. Due to this situation, our diagnostic service has been vigilant on this pathogen.

Detection of *Neopestalotiopsis* spp. in California

Since 2020, the Cal Poly Strawberry Center disease diagnostic service also isolated several *Pestalotiopsis*-like fungi from strawberry plant crowns. This is not unusual, but given the situation in FL we wanted to determine if these fungi were capable of causing disease. By sequencing DNA and high-resolution melt analysis molecular technique, all these isolates were identified as *Neopestalotiopsis rosae* which is **not** the virulent *Neopestalotiopsis* sp. identified in Florida.

Figure 1. Leaf symptoms and signs of *Neopestalotiopsis* sp. infection from Florida

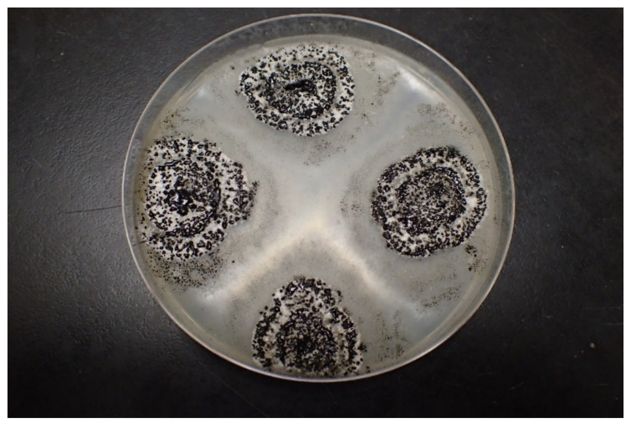


Figure 2. Culture of *Neopestalotiopis* sp. from Florida

Figure 3. Culture of *Neopestalotiopis rosae*

Figure 4. *Neopestalotiopsis rosae* conidia

Pathogenicity of *Pestalotiopsis*-like isolates from California

In trial 1 strawberry cvs. Monterey, BG-4367, BG-3324 and Sweet Ann were used. In a second trial, cvs. Monterey and Albion were used. In both trials, little to no disease was detected in plants inoculated with the fungus.

Cal Poly Strawberry Disease Diagnostic Service
Summary of Diagnostic Service Activity 2021

Between January and July 2021, 60 strawberry sample submissions were received. Each submission typically consisted of 3-5 plant samples but was greater when new transplants, leaf, or fruit samples were submitted. Plant samples were tested using plating on selective media and molecular methods.

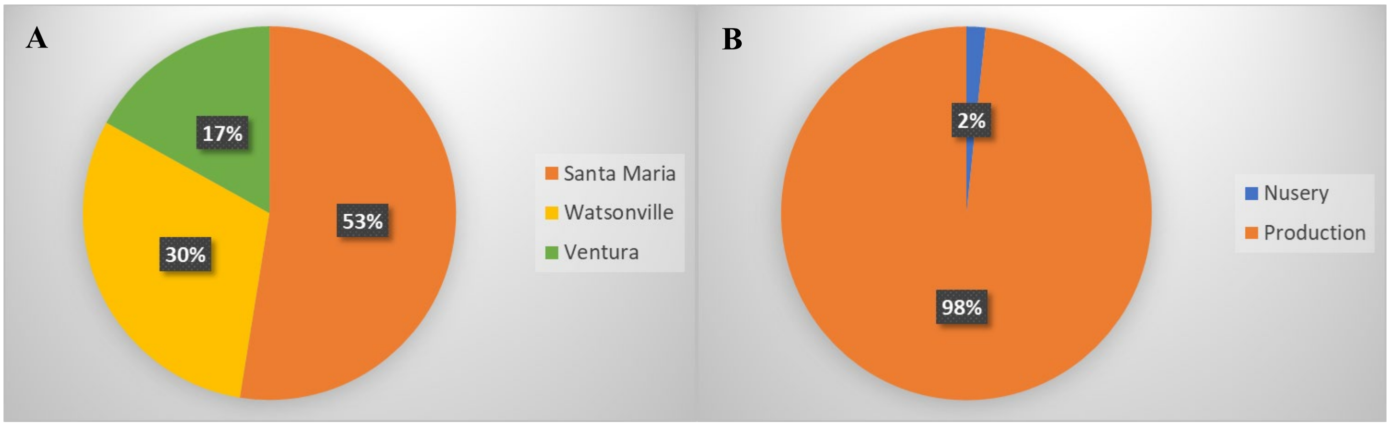


Figure 1. A) Diagnostic samples by district and B) by production type.

Table 1. Comparison of disease identification up to July 2021 with the past years.

Disease/pest/disorder	Number of samples			
	2018	2019	2020	Up to July 2021
Abiotic/pest problems	18	38	39	11
Macrophomina crown rot	2	22	37	14
Phytophthora crown rot	14	16	10	6
Fusarium wilt	2	9	31	8
Verticillium wilt	1	5	17	2
Zythia dry calyx, leaf blotch, crown infection	0	4	9	0
Rhizoctonia spp.	NA	NA	5	4
Pythium spp.	NA	NA	NA	18
Botrytis spp. (box rot)*	NA	NA	NA	1
Ilyonectria spp. **	NA	NA	NA	2
Total number of samples	**33**	**86**	**164**	**60**

NA: Not available

* Box rot is 'Frigo' or frozen strawberry transplants dying in the boxes that can be caused by many fungi including *Botrytis cinerea*.

** *Ilyonectria* spp. (synonymous *Cylindrocarpon* spp.) is part of the strawberry black root rot pathogen complex with *Pythium* spp., *Rhizoctonia fragariae,* and *Fusarium* spp.)

Evaluating Host Resistance to Macrophomina Crown Rot in Strawberry - 2021

Y. Wang, S. S. Hewavitharana, and G. J. Holmes

The fifth consecutive field trial to evaluate the host resistance to Macrophomina crown rot was conducted at field 35b at Cal Poly, San Luis Obispo in 2020. A total of 51 strawberry genotypes from four breeding programs (University of California Davis, Plant Sciences, Driscoll's, and Lassen Canyon) were included. The trial consisted of 20-plant plots replicated in four blocks, with a fifth non-inoculated block. Standard 64-inch beds with 4 rows of plants per bed and 3 lines of drip tape were used. In the four inoculated blocks, each plant received 5 grams of cornmeal-sand-*Macrophomina* inoculum (6,470 CFU/g) placed around the crown and root zone two weeks after planting. The non-inoculated block was bed-fumigated with Tri-Clor EC (Chloropicrin 94%) at 240 lb/acre in fall 2020. Bare-root strawberry transplants were planted on 2 November 2020. Plants were irrigated and fertilized through drip tape. Drought stress was created by withholding irrigation for 3 consecutive days per week starting 1 June 2021. Presence of the pathogen in plants was confirmed by standard plating techniques. Plant mortality assessment was conducted every two weeks. Plants were considered dead when all foliage was necrotic.

Fig. 1. Aerial view of the 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 14 July 2021)

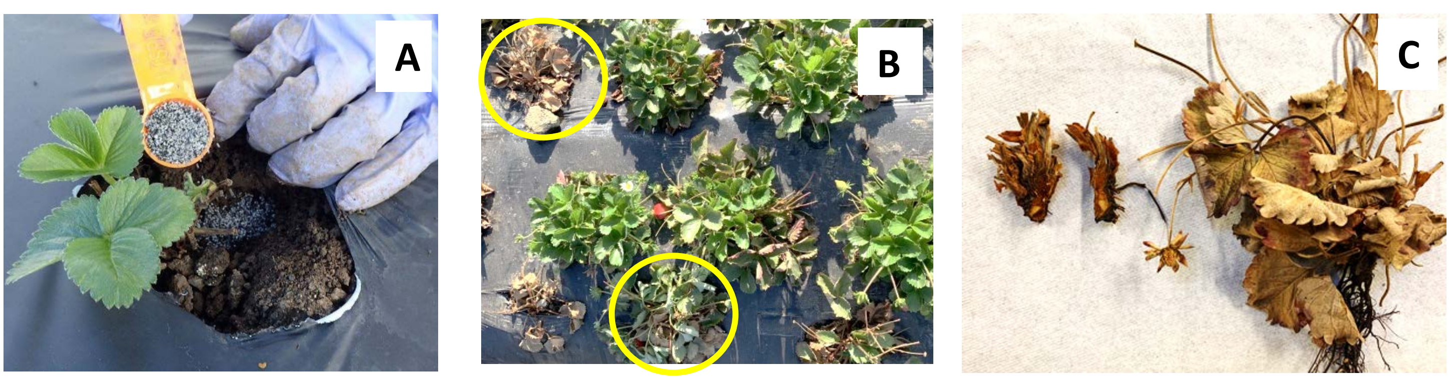


Fig. 2. A) Inoculating a transplant with *M. phaseolina* inoculum. B) Symptoms of Macrophomina crown rot: plant wilt and collapse (plant circled in yellow). C) A necrotic plant and cross section of a necrotic crown showing brown discoloration of the tissue due to *M. phaseolina*.

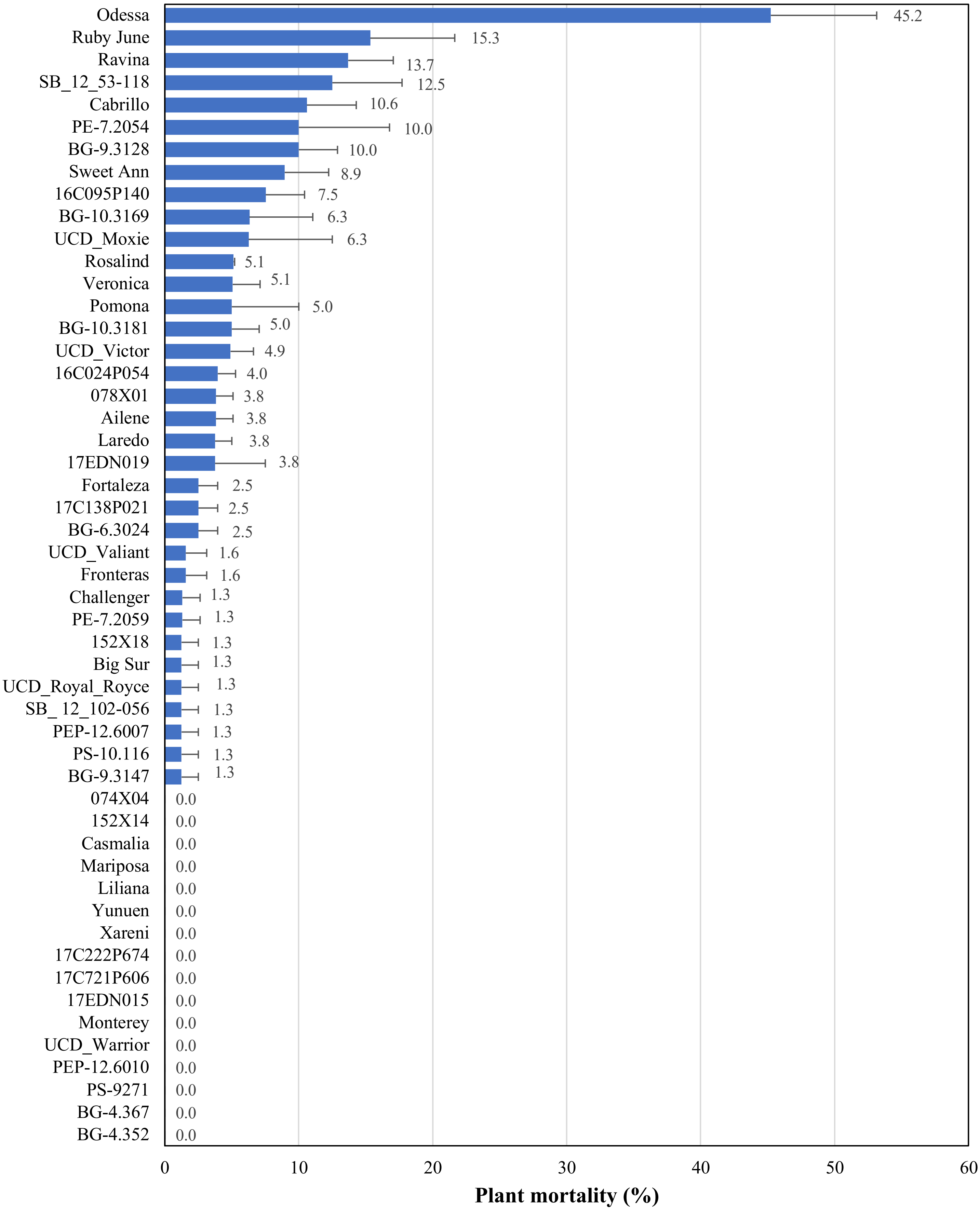


Fig. 3. Average percent of mortality due to Macrophomina crown rot on 12 July 2021.

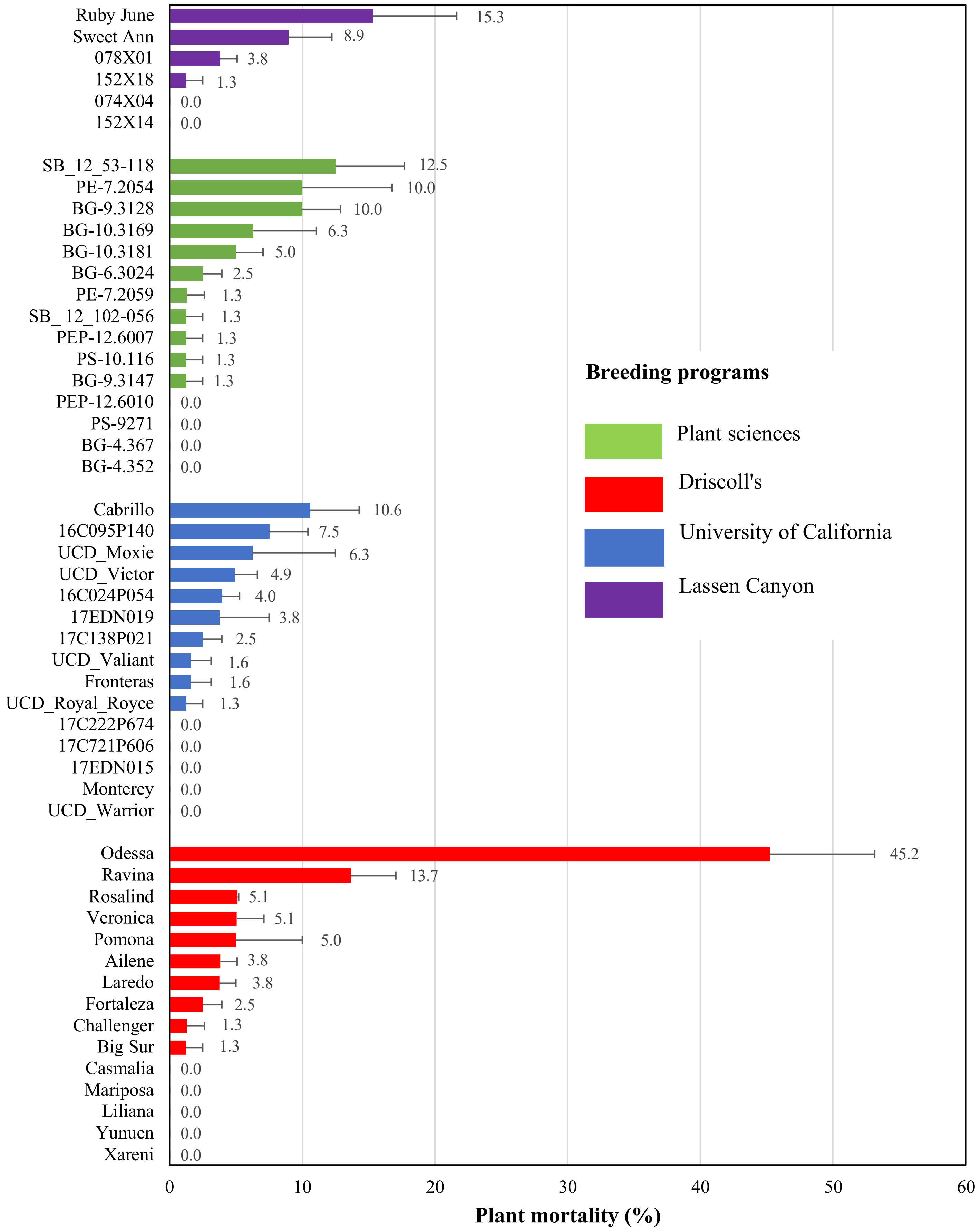


Fig.4. Average percent mortality due to Macrophomina crown rot (sorted by breeding program) on 12 July 2021.

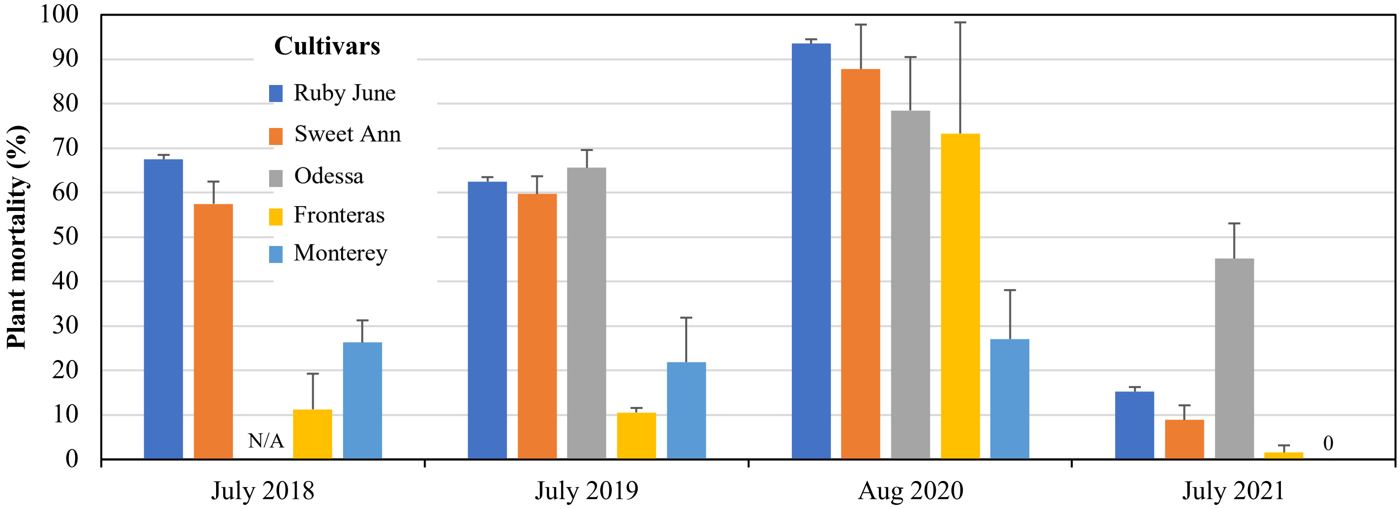


Fig. 5. Macrophomina crown rot percent mortality of 'Ruby June', 'Sweet Ann', 'Odessa', 'Fronteras', and 'Monterey' in 2018-2021.

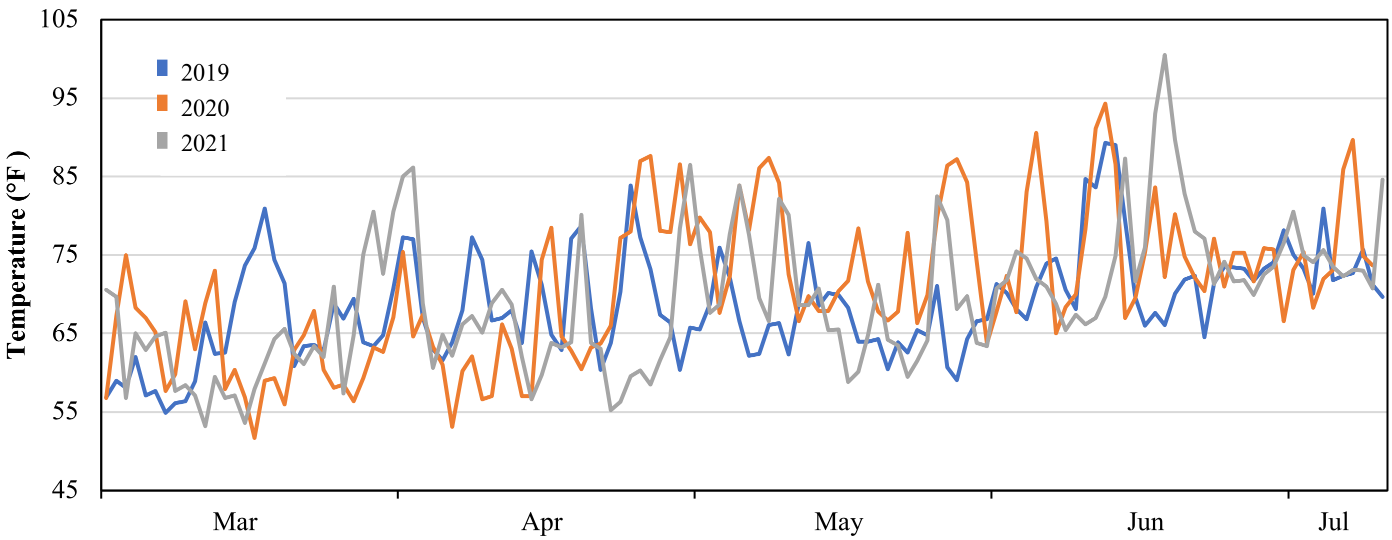


Fig. 6. Daily maximum temperature (°F) for March to July in 2019, 2020 and 2021.

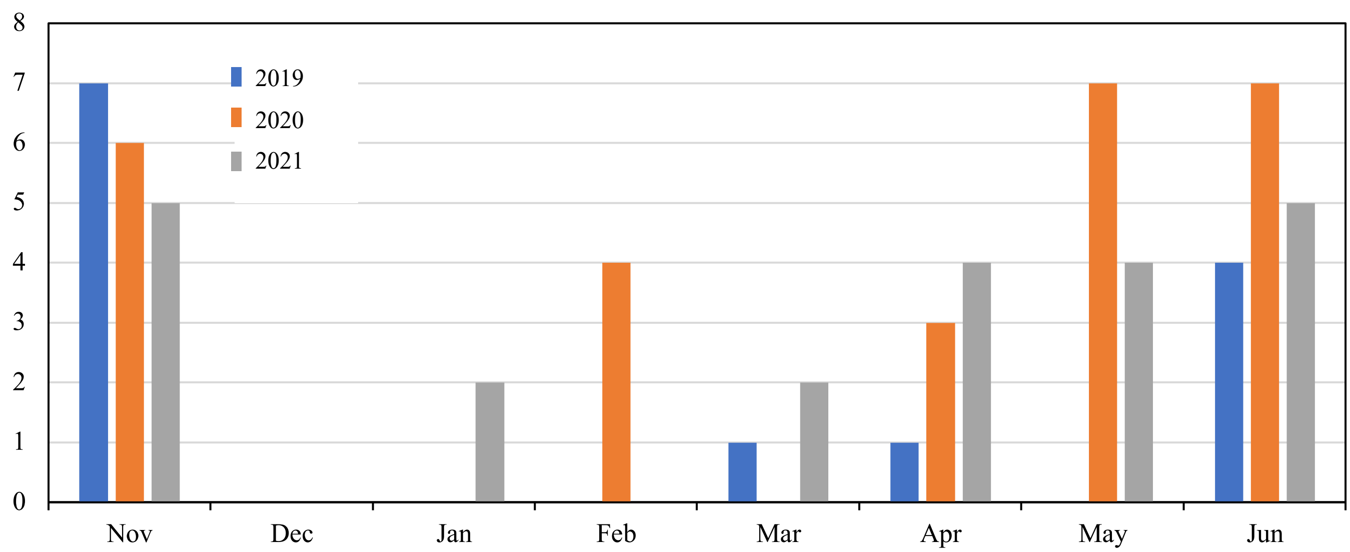


Fig. 7. Number of days above 80°F November to June in three years.

Evaluating Host Resistance to Verticillium Wilt in Strawberry - 2021

J.T. Koster, G. J. Holmes & S.S. Hewavitharana

In the fall of 2020, our fifth replicated field trial was established to evaluate 51 strawberry cultivars and elite selections for resistance to Verticillium wilt caused by *Verticillium dahliae*. Strawberry germplasms were selected from four breeding programs: University California, Davis (UCD), Driscoll's (D), Plant Sciences (PEP, PS, BG), and Lassen Canyon (LC). On 2 Nov 2020, bare-root strawberry transplants were set in field 25 on the Cal Poly San Luis Obispo farm; this field has a history of Verticillium wilt due to decades of vegetable cropping. Strawberries have never been cultivated in this field. Lettuce 'Black Seeded Simpson' was planted on 5 June 2020 and disked in order to increase the *Verticillium dahliae* population. Approximately 9 colony forming units of *Verticillium* spp. per gram of soil was measured prior to transplanting. The trial consisted of 20-plant plots replicated four times, with a fifth block bed fumigated with Tri-Clor EC (94% chloropicrin at 240 lb/A). The first Verticillium wilt symptoms were observed in early March 2021 and presence of the pathogen in plants was confirmed using standard plating and molecular techniques. Disease assessments were conducted every two weeks. Plants were considered dead when 50% of all foliage was necrotic.

Fig 1. Aerial photo of the Verticillium wilt host resistance trial located in field 25, block 6, on the Cal Poly San Luis Obispo farm. The area outlined in red was not fumigated and naturally infested; the area outlined in yellow was fumigated in October of 2020. (Photo taken 4 July 2021)

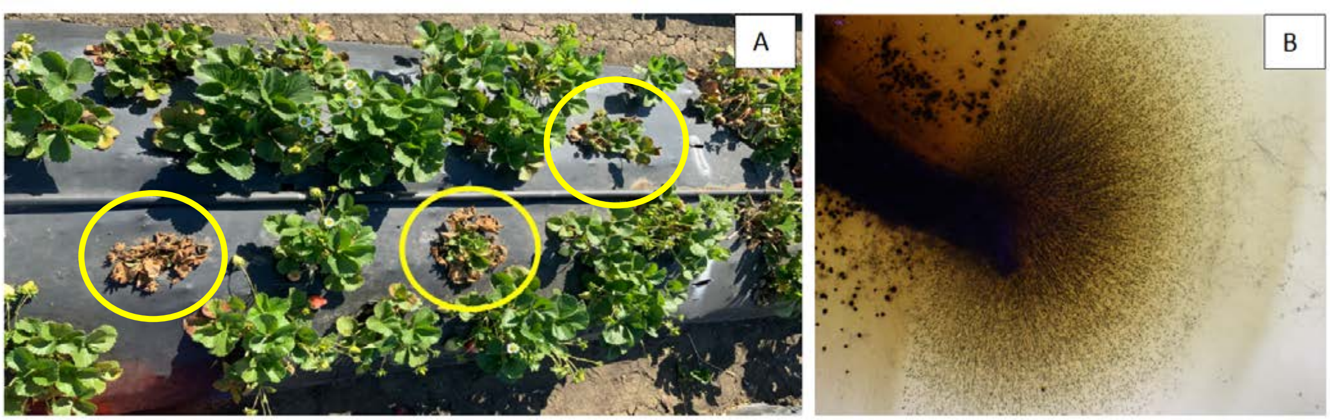


Fig 2. A) The first symptoms of Verticillium wilt (plants circled in yellow) appeared in early March; B) *Verticillium dahliae* growing out from one end of an infected strawberry petiole plated on a semi-selective medium, NP-10.

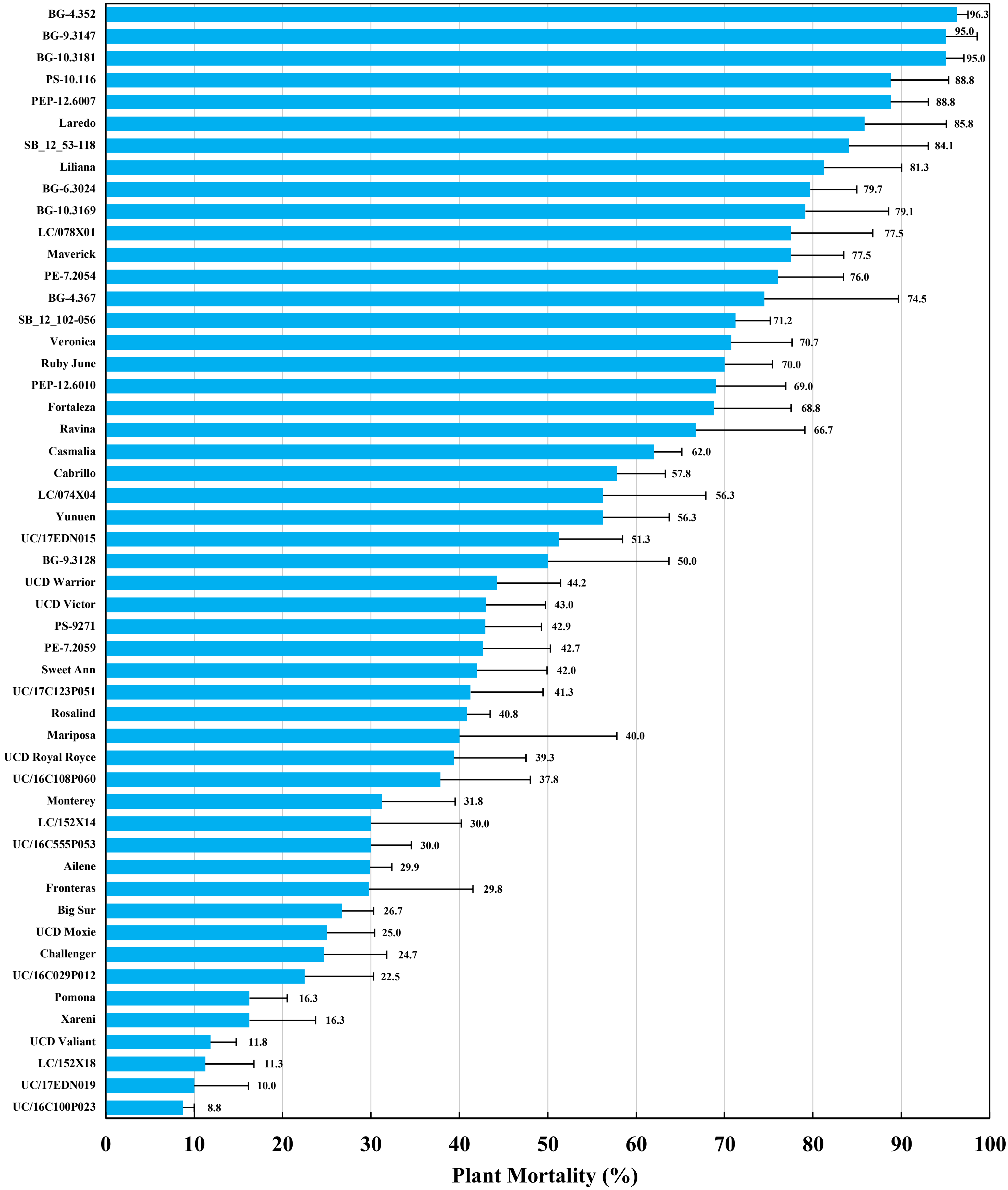


Fig 3. Average percent mortality due to Verticillium wilt on 12 July 2021.

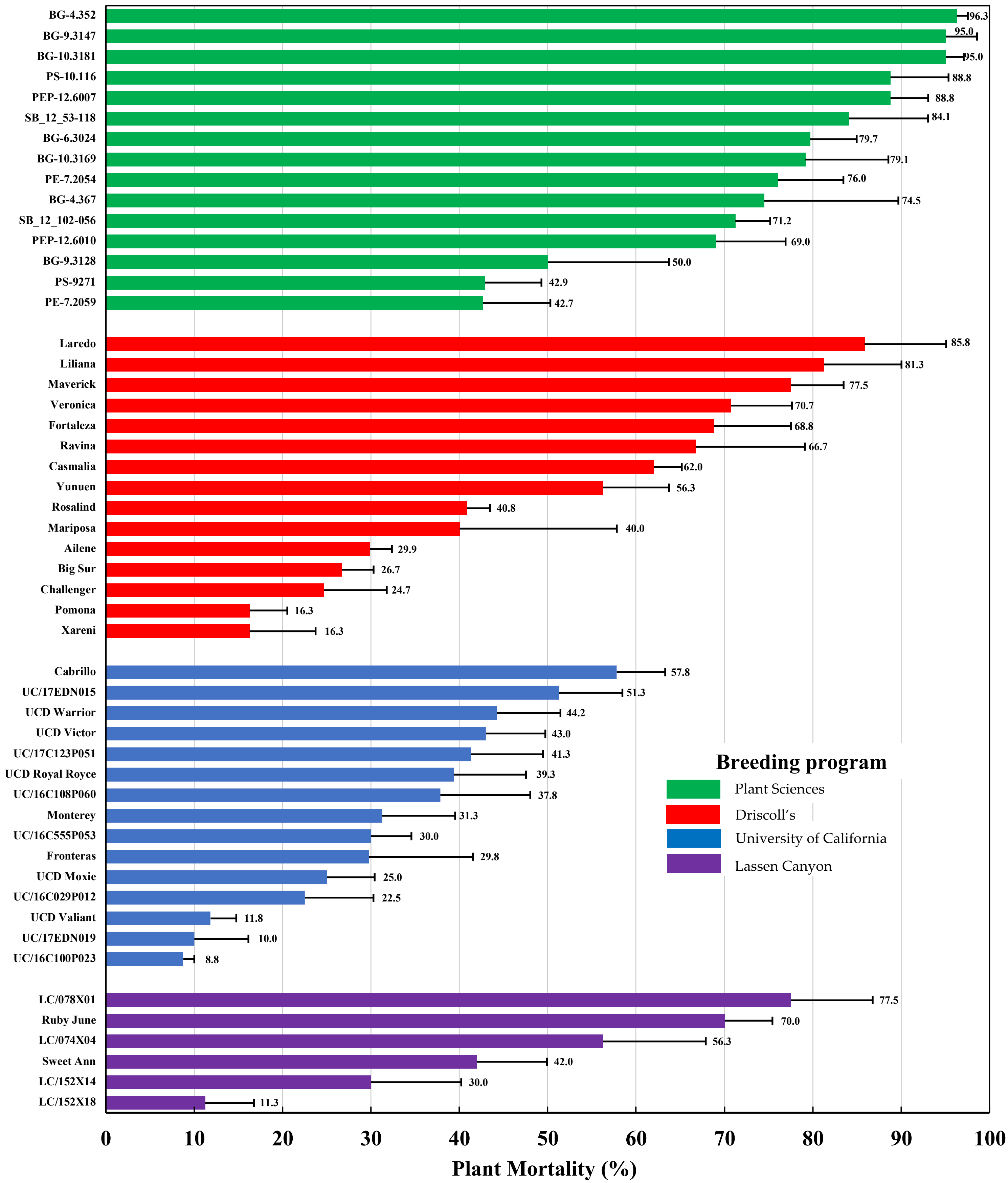


Fig 4. Average percent mortality due to Verticillium wilt (by breeding program) on 12 July 2021.

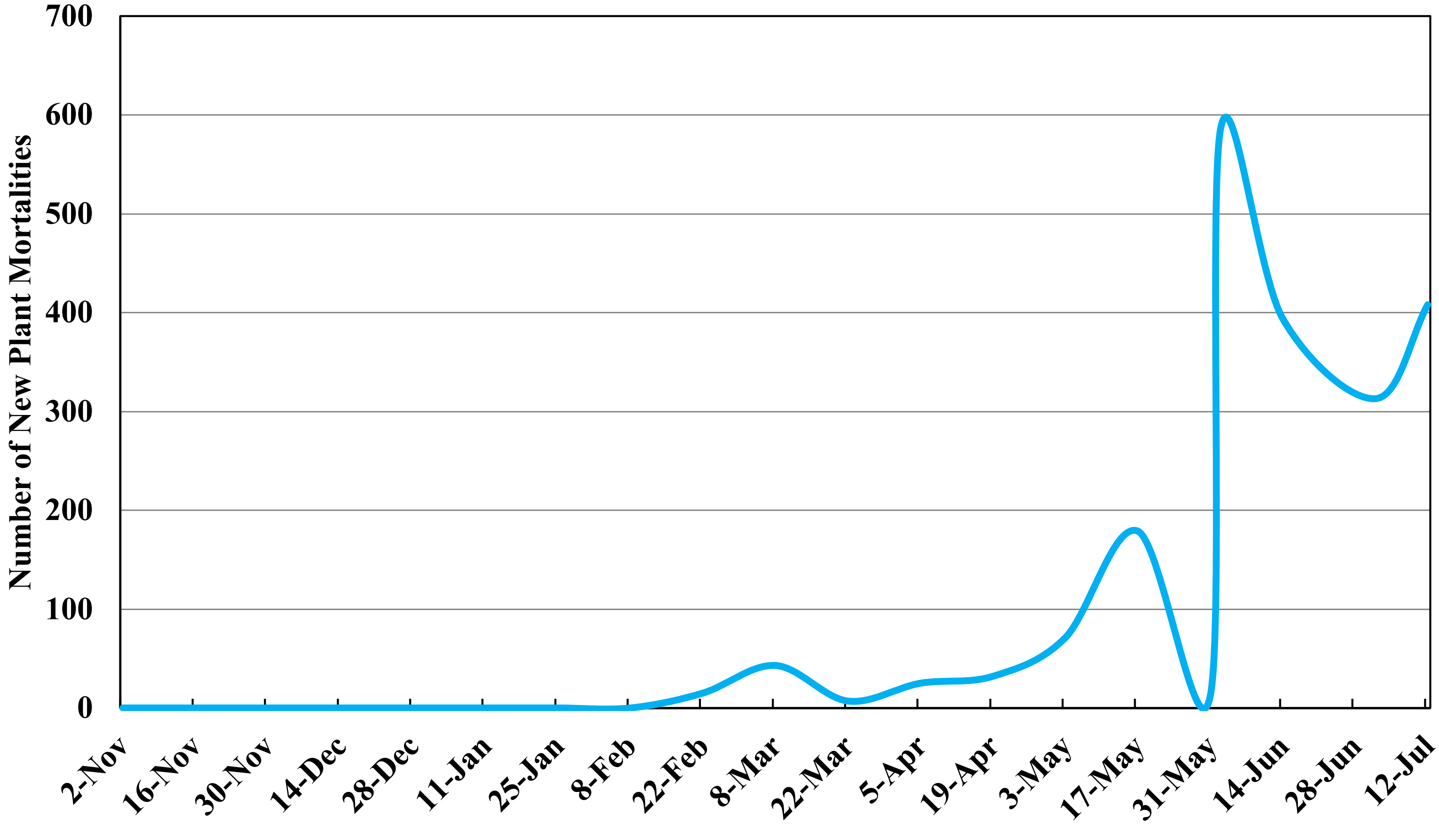


Fig 5. Number of new mortalities across all genotypes due to Verticillium Wilt.

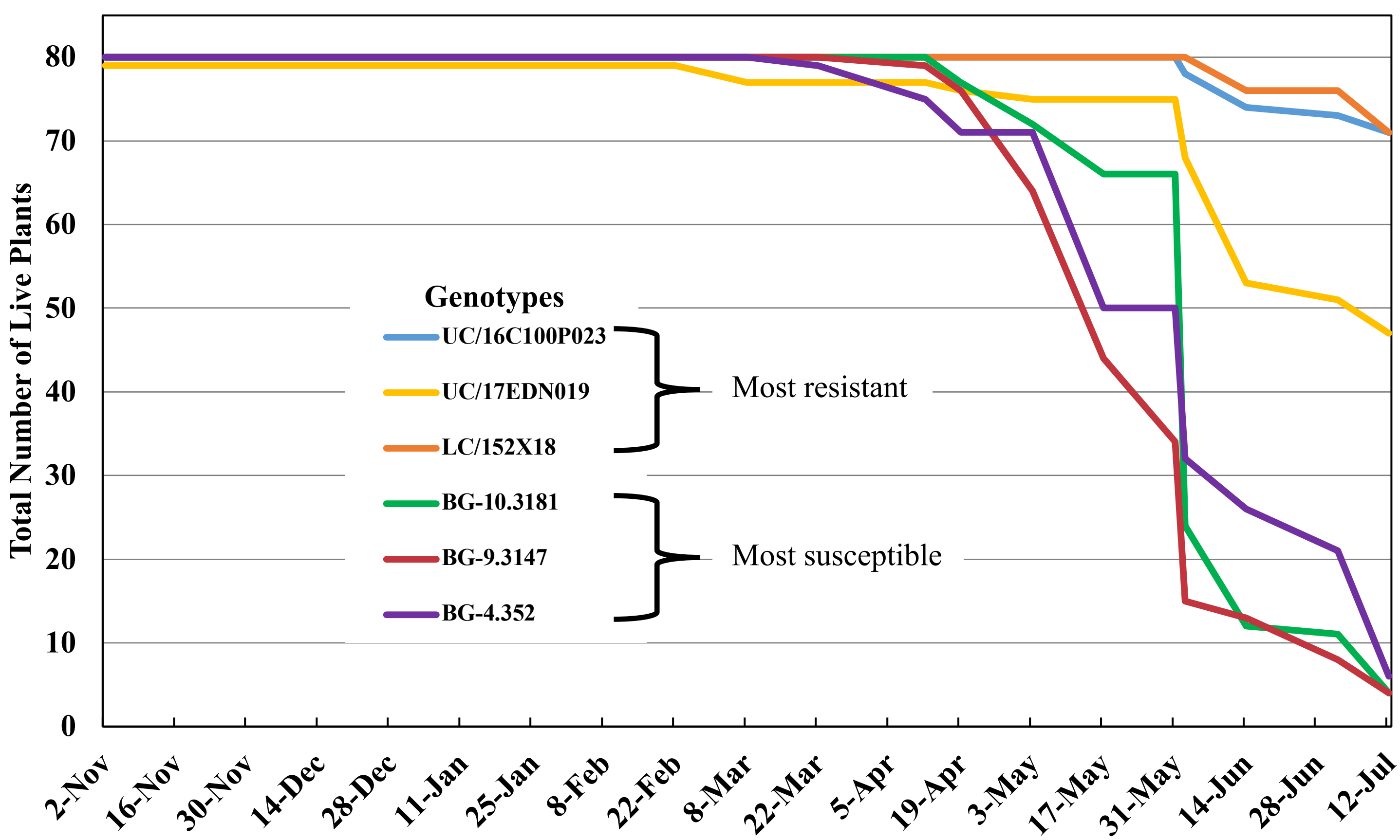


Fig 6. Survivability of 3 most susceptible and 3 most resistant genotypes to Verticillium Wilt.

Adjuvants

Liberate®

LECI-TECH INSIDE

Penetrant, Deposition Aid, Drift Control Agent

LIBERATE® is an uptake enhancing surfactant blend. Liberate is designed for use with pesticides that recommend a non-ionic surfactant, and works especially well with systemic chemistry, reducing driftable fines.

PRODUCT BENEFITS:

- **TO:** Drift reduction with performance-sized droplets
- **ON:** Droplet retention by adhesion and spreading
- **IN:** Increased penetration without cuticle disruption
- Neutral pH - ideally used with sulfonyl urea herbicides and other pesticides that require a pH 7 (neutral) or higher
- Contains an antifoam/defoam component and will not cause foaming problems in the spray tank

TARGET CHEMISTRIES:

- Sulfonyl urea (SU) herbicides, fungicides and those chemistries requiring a neutral pH

RATES

Apply 1 to 4 pints per 100 gallons when used with **Herbicides, Defoliants, Dessicants**

Apply 0.5 to 2 pints per 100 gallons when used with **Insecticides, Fungicides, Acaracides, Plant Growth Regulators, Foliar Nutrients**

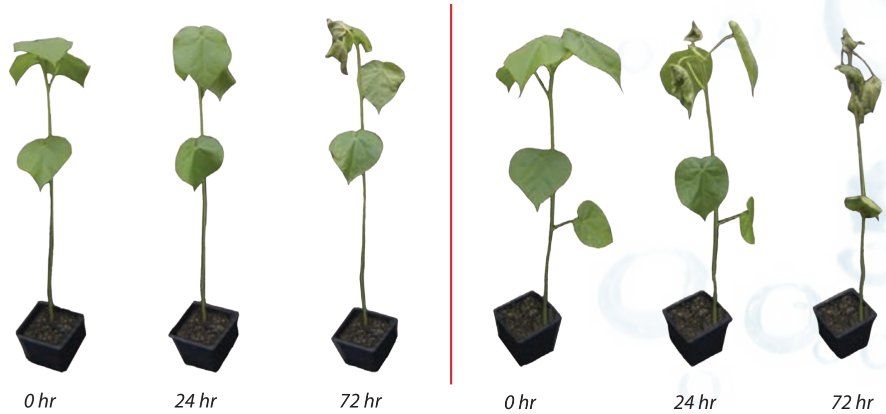
Apply 1 to 2 quarts per 100 gallons when used for **Drift Reduction**

NOTE: Do not use on pear or grape foliage

ALWAYS READ AND FOLLOW LABEL DIRECTIONS.

In the Plant —
Increased Penetration without Cuticle Disruption

IN

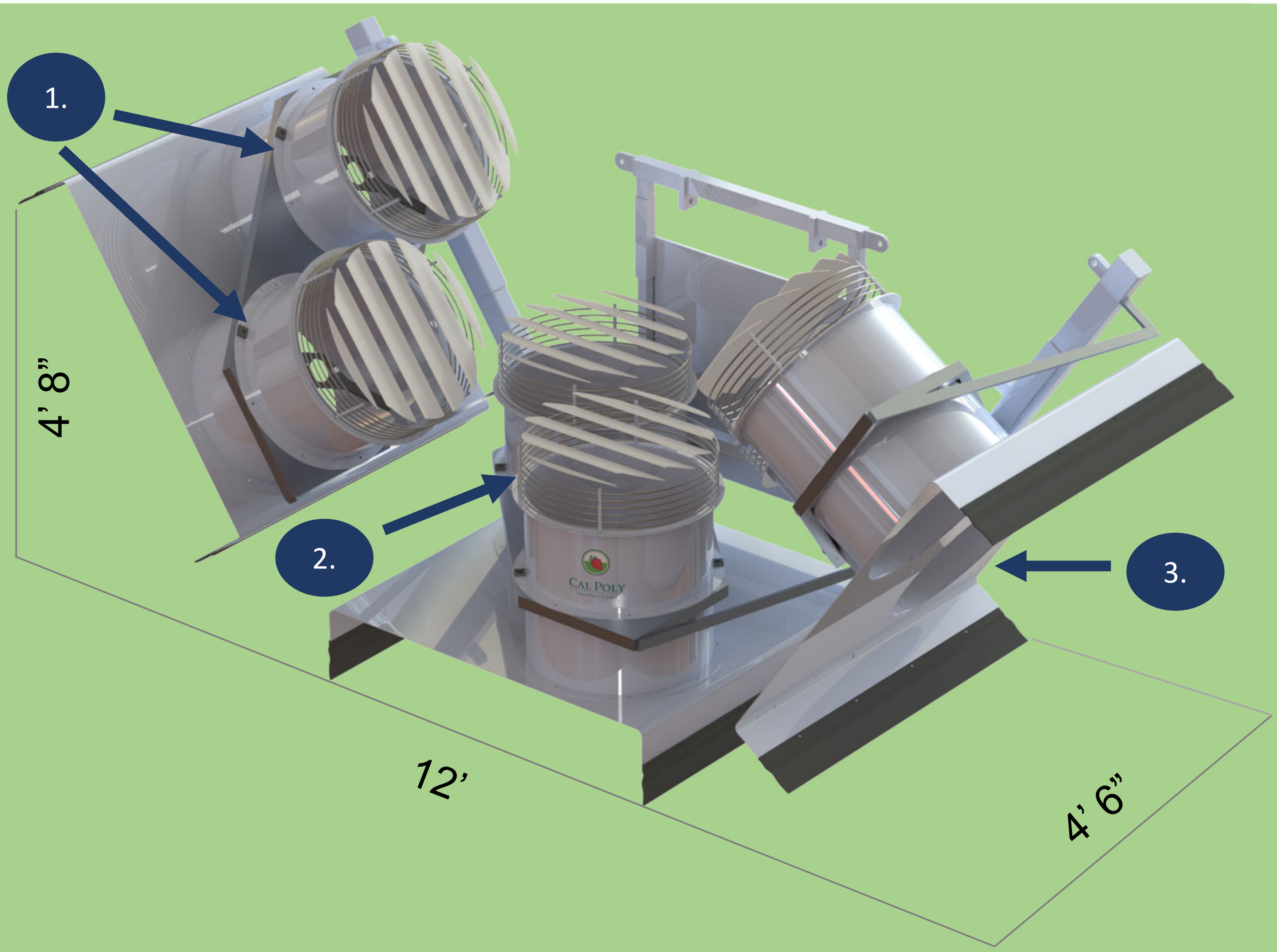


Demonstrates herbicide on velvetleaf up to 72 hours after treatment (HAT). The first 3 pictures are herbicide alone. The last 3 pictures have a Leci-Tech adjuvant added.

Loveland PRODUCTS – Get Growing

Double-Barrel Bug Vacuum 2019

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

Double-Barrel Bug Vacuum 2019

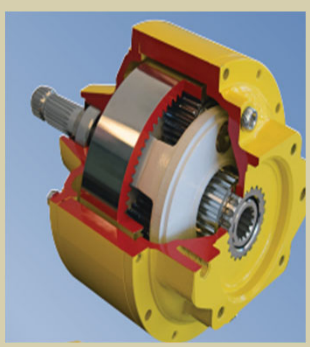
Proportion of *Lygus* spp. population removed (% +/- SEM)							
Bug Vacuum	10/16/18	10/17/18	10/24/18	10/25/18	10/30/18	10/31/18	10/14/19
Grower Standard	2% (+/- 0.4)	4% (+/- 0.7)	13% (+/-2.4)	6% (+/-2.1)	10% (+/-1.3)	13% (+/- 2.4)	10% (+/- 2.7)
Double Barrel	5% (+/- 1.1)	4% (+/-0.2)	33% (+/-1.9)	21% (+/-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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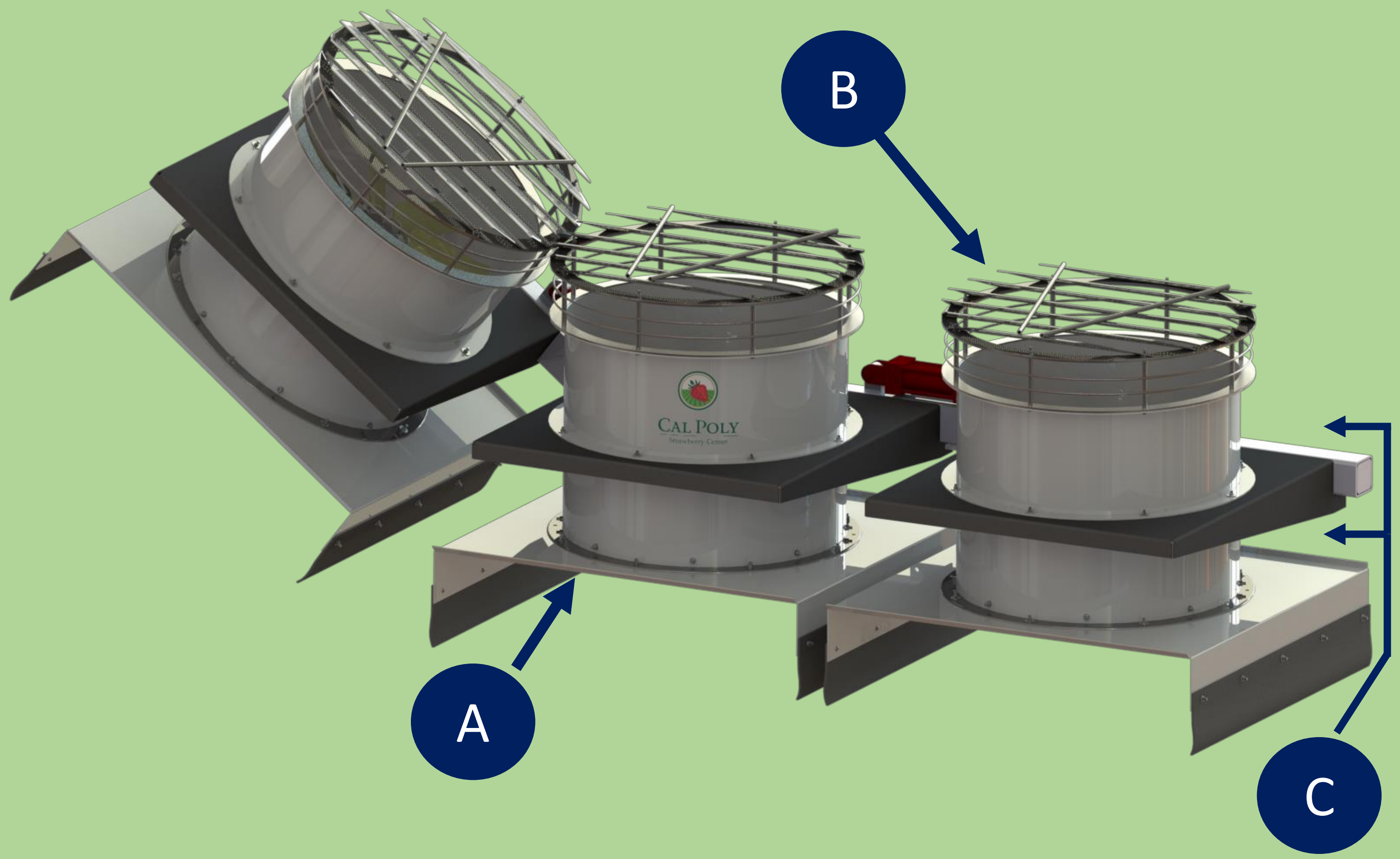
Single Barrel Bug Vacuum 2020

Cal Poly Strawberry Center



A

Large straight-tube
30-inch fan covers the entire strawberry bed with powerful suction

B

Raised baffle system
High-porosity perforated plate six-inches above the vacuum outlet improves efficiency while matching efficacy of existing baffles

C

Circular ducting
Tubular design improves airflow efficiency which leads to increased *Lygus* spp. removal

Equipment operation

- 2500 PSI pump pressure
- 70 horsepower tractor
- 500 RPM @ PTO
- 2 mile/hour travel speed

The CP30 Bug Vacuum has been designed to increase rates of *Lygus* spp. removal in California strawberry fields in comparison to conventional vacuums. It has been evaluated with the components and operating parameters listed above. Users should consult with the California Strawberry Commission's Automation Team if alternative components are to be used.

Single Barrel Bug Vacuum 2020

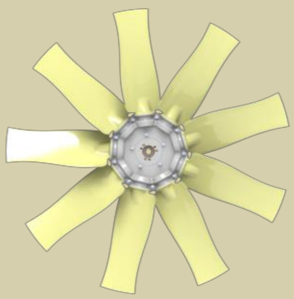
Cal Poly Strawberry Center

Proportion of *Lygus* spp. population removed (% +/- SEM)		
Bug Vacuum	**9/25/20**	**9/30/20**
Grower Standard	15% (+/- 4.5)	19% (+/- 4.2)
Single Barrel	55% (+/- 8.5)	47% (+/-5.7)

*CP30 removed significantly more *Lygus* spp. per pass (N=4) than a conventional vacuum (p<.001)

Evaluated components

- **Fan – Multi-wing 30/9-9/41.5/PAG/EMAX4**
- **Motor – Danfoss SNM2 19cc**
- **Pump – Eaton 420 series ADU062L**
- **Gearbox – AuburnGear Model 5 PTO Drive**

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Infield Lygus bug monitoring

The performance of the widely used bug vacuum depends on three parameters: tractor speed, vacuum air flow, and distance between the vacuum to plant. This project monitors those parameters and the amount of Lygus removed in real time. The data is used to create a bug vacuum performance map (Figure 1). This level of Lygus bug monitoring allows for a more targeted pest management strategy.

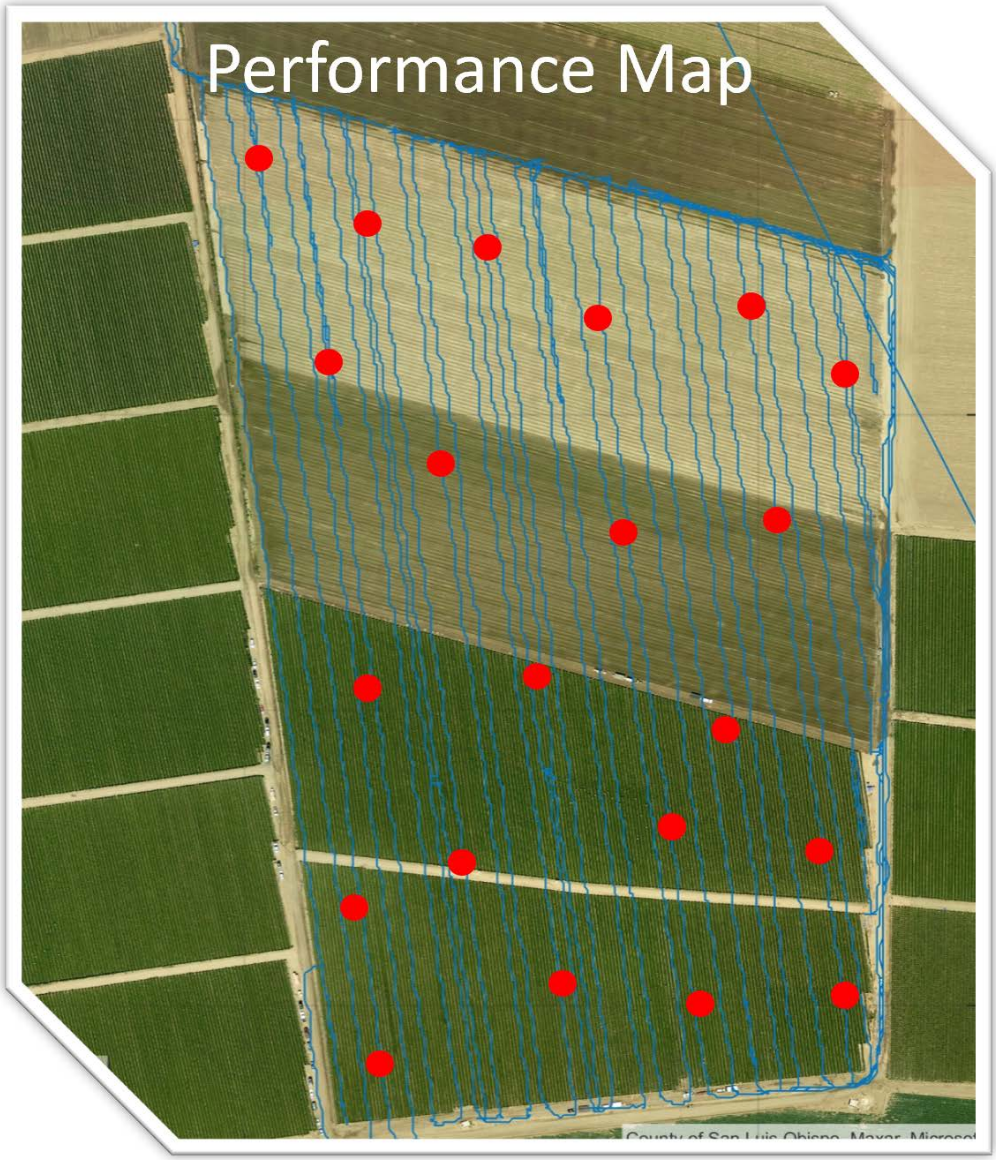


Figure 1. The amount of Lygus removed, tractor speed, vacuum air flow, and vacuum height above canopy are measured. The tractor path is shown as blue lines and measured parameters that exceed recommended thresholds are shown as red dots.

Field 4D – Promoting Runner Cutter Automation

Robotic runner cutting solutions must work side-by-side with existing farm labor and field infrastructure. Minimal, low-cost field changes can be considered, but robotic solutions should avoid costly changes as much as possible to promote rapid adoption. The goal of this project is to promote runner cutter automation by providing a database of runner-related videos, images, and point clouds gathered from regular scanning of fruiting fields throughout the year. This "4D" characterization of the runner cutter problem should help private-sector robotics developers gain a deeper and more comprehensive understanding of field operations and needs.

Example use case:

Berry Machine Corporation (BMC – a fictional company) is considering developing a runner cutting robot for California strawberry farms but is based in Cambridge, Massachusetts, and has no experience working with California strawberries. The head of R&D finds our database and is able to view video of the current manual runner cutting practice (see figure 1).

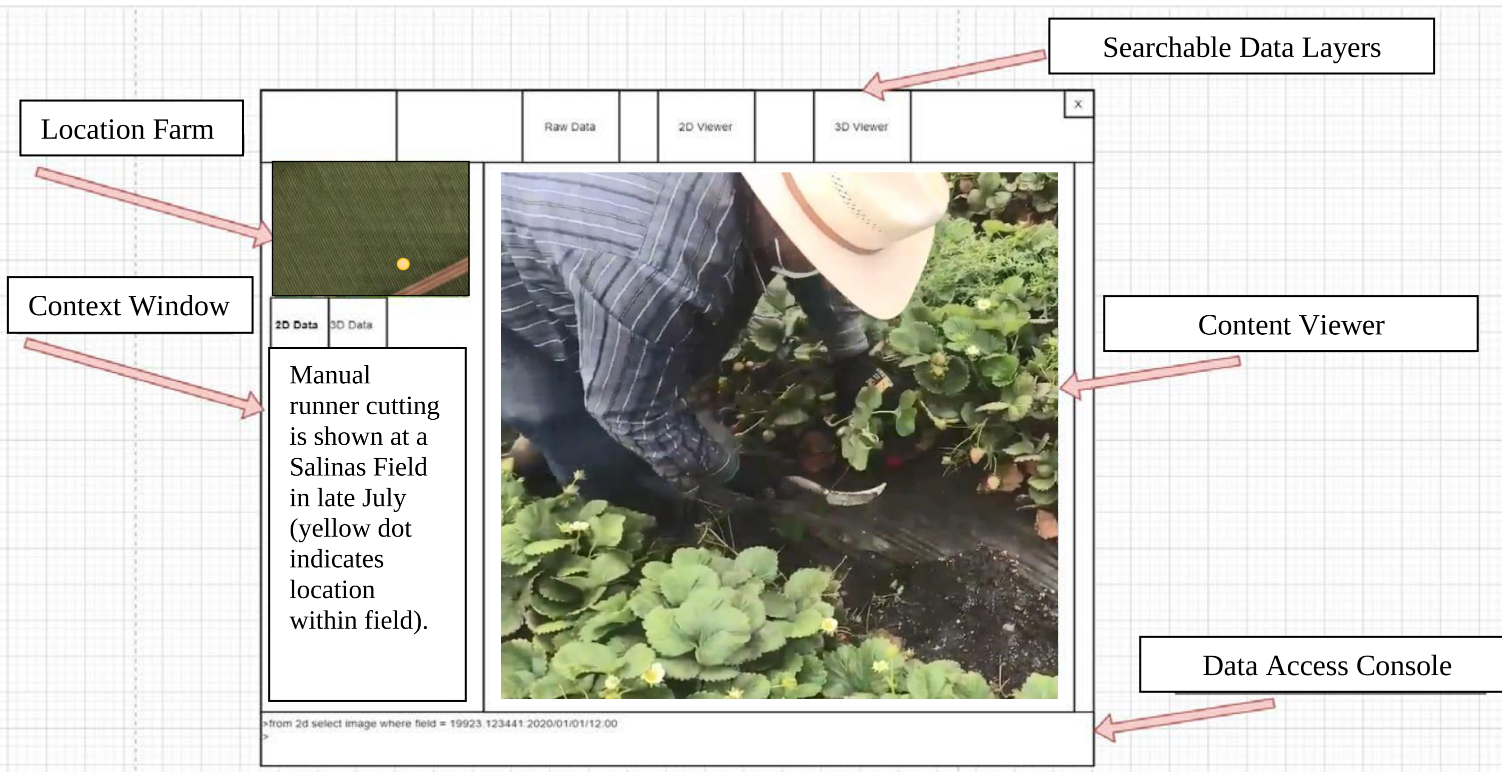
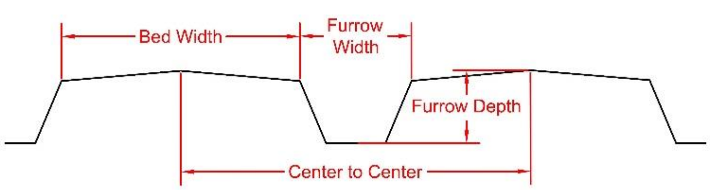


Figure 1. An example of a searchable database of runner cutting related practices and infrastructure.

BMC decides it will invest in an autonomous runner cutter project but needs to know common strawberry bed profiles to fit its system to. The company searches our database and finds detailed bed dimensions depending on growing district (see figure 2).



Dimension	Max	Min	Ave
Center to Center (in)	65.70	62.96	63.99
Bed Width (in)	43.34	39.37	41.07
Furrow Width (in)	26.69	20.37	22.92
Furrow Depth (in)	19.56	0.72	13.83

Figure 2. Example output for a Santa Maria bed profile query.

BMC now needs precise plant spacing and plant architecture to see if its existing robots have the precision required to cut runners. The R&D department searches our database and finds plant counts, centers, and diameters labeled by growing district and calendar month. In addition, they find images of plant varieties with runners labeled (see Fig. 3).

Figure 3. Image of plant on left and labeled runners on right.

Finally, after a hard six months of research and development, the BMC California division deploys a state-of-the-art robotic runner cutter to a farm in Salinas. The system can autonomously enter and exit the field without tearing surrounding plastic mulch, and runners are being precision-trimmed without damage to plant architecture.

Plastic Mulch Cross Hole Puncher

Conventional hole punchers leave narrow slices in the plastic which can prevent adequate water and sunlight from reaching a young strawberry plant. In some cases, this leads to plant death and increased replanting rates. To combat this, some growers utilize hand labor to make a cut perpendicular to the existing slice, opening the hole and allowing more water and sunlight to reach the plant (Fig 1). This process is estimated to cost $100/acre.

Figure 1. Manual cross hole cutting

The Cross Hole Puncher is a direct replacement for the conventional hole puncher. It consists of a linkage wheel system that always keeps the spikes in a vertical position (Fig. 2). The spikes can be customized to produce the required cut pattern and depth, and plant spacing is easily adjusted. Tests on growers' fields have shown promising results for sandy soils. However, additional work is needed for heavy clay soils due to soil buildup on the spikes.

Figure 2. Cross Hole Puncher (left) and example of punched hole (right).

Figure 3. Experimental center fin modification

We have also had promising results by utilizing a small fin placed in the center of conventional hole puncher blades. It produces a good cut with little buildup in moderately heavy soil. This approach would be a simple modification to conventional hole punchers.

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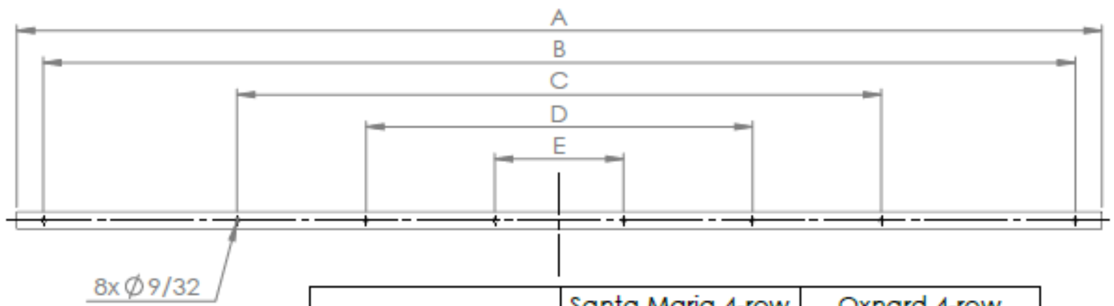
Locations in Oxnard, Santa Maria, and Salinas, California

4-Row Spray Rig Recommendation

Our recommended manifold design is ***8 nozzles*** per bed, spraying at a pressure of ***108 psi***. The recommended nozzle is ***Teejet Conejet Green TXR80036VK*** or an ***Albuz ATR80 Green*** with a hollowcone spray pattern**.** We tested this manifold design at a rate of ***150 gpa*** and tractor speed of ***2.9 mph.*** Please note, proper maintenance, calibration and spraying at canopy level ensures improved distribution uniformity and overall spray coverage.

4-Row Manifold Design



	Santa Maria 4-row	Oxnard 4-row
Bed Center - Center	64"	68"
A	58	64
B	56-7/8	60-7/8
C	33-7/8	38
D	20-1/4	22-3/4
E	6-3/4	7-1/2

Spray Rigs with Recommended 4-Row Manifold Design

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