

PROGRAM BOOKLET

STRAWBERRY

FIELD DAY 2026



CAL POLY
Strawberry Center

Ensuring the sustainability of the California strawberry industry through research and education that addresses industry needs.

A MESSAGE FROM OUR CENTER DIRECTOR



Gerald Holmes, Ph.D.

Director

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Welcome to the 2026 Strawberry Center Field Day!

We're excited to celebrate our 10th Field Day with you as we continue our mission of supporting California's strawberry industry through applied research, innovation, and Cal Poly's Learn by Doing approach.

Today, you'll see the latest work from our faculty, staff, and students in automation, plant health, pest management, and production efficiency—all aimed at addressing real-world challenges facing growers. Thank you for joining us, and we hope you leave with valuable insights, new connections, and ideas you can put to work in your operations.

PROGRAM LEADERS



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AGENDA - STRAWBERRY FIELD DAY

Thursday, July 23, 2026, 7:30 AM - 12:00 PM

7:30 AM: Registration & networking • 8:20 AM: Welcome • 8:50 AM: Rotation through stations • 12:00 PM: Lunch

This program is approved by CDPR and CCA for 2.5 hours of continuing education units.

STOP 1

1. Sponsor showcase, product updates and refreshments

STOP 2

Topic	Speaker
2. Distinguishing between fruit rots caused by <i>Rhizopus</i> and <i>Mucor</i> spp.	Gabriela Torres (CP MS Student)
3. Evaluation of fungicides for control of Botrytis fruit rot and powdery mildew	Kyle Blauer (Field Research Manager, CPSC)
4. Cultivar resistance to strawberry powdery mildew	Shaelyn Spencer (CP PLSC Student)
5. Cal Poly strawberry disease diagnostic service activity - 2026	Shashika Hewavitharana (Plant Pathologist, CPSC)
6. Biodegradable mulch field demonstration	Lisa DeVetter (Professor, WSU)

STOP 3

Topic	Speaker
7. Effect of sanitizing agents on major soilborne pathogens and survey of sanitation practices in the Santa Maria district	Maria Alvarez Arredondo (CP MS Student) Elias Barriga-Hernandez (CP MS Student)
8. Interaction of root-knot nematode with Fusarium wilt and strawberry cultivar resistance	Elias Barriga-Hernandez (CP MS Student) Antoon Ploeg (Nematologist, UC Riverside)
9. Host plant resistance to Macrophomina root rot, Verticillium wilt and Fusarium wilt	Maria Alvarez Arredondo (CP MS Student) Marin Vargas (CP MS Student)
10. Autonomous Lygus vacuum and solar harvest aid	Juan Bravo (Founder, Agrobot)
11. Autonomous farming platforms	Linda McNair (VP of Marketing, Bonsai Robotics)

STOP 4

Topic	Speaker
12. Heated hole puncher	Tony Sandoval (Founder, Precision Ag)
13. Operating aid system	Rickey Ishida (Production Automation Manager, CSC) Brendan Holt (Agricultural Engineer, CSC) Aidan Fischer (Field Engineer, CSC)
14. Laser runner cutter	Brendan Holt (Agricultural Engineer, CSC)
15. Autonomous bareroot transplanter	Aidan Fischer (Field Engineer, CSC)
16. UV-C and Lygus vacuum services	Adam Stager (Founder, TRIC Robotics)

STOP 5

Topic	Speaker
17. Mite and insect spray efficacy trial data 2025	Mohammad Amir Aghaee (Entomologist, CPSC)
18. 2025 cultivar tolerances against <i>Tetranychus urticae</i>	Sophie Rodriguez (Cal Poly MS Student)
19. 2025 bug vacuum efficacy against <i>Lygus hesperus</i>	Emily Henry (Research Associate, CPSC)
20. Parabug drone demo	Taylor Hibino (Cal Poly MS Student)

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 Strawberry Center Staff at 805.756.2150).

AGENDA - DÍA DE CAMPO DE LA FRESA

Jueves, 23 de Julio de 2026, 7:30 AM - 12:00 PM

7:30 AM: Inscripción • 8:20 AM: Bienvenida • 8:50 AM: Rotación por presentaciones • 12:00 PM: Almuerzo

Este programa fue aprobado por CDPR y CCA para 2.5 horas de unidades de educación continua.

ESTACIÓN 1

1. Exhibición de patrocinadores, actualizaciones de productos y refrigerios

ESTACIÓN 2

Tema	Presentador
2. Diferenciación entre las podredumbres de los frutos causadas por <i>Rhizopus</i> y <i>Mucor</i> spp.	Gabriela Torres (Estudiante de Maestría, CP)
3. Evaluación de fungicidas para el control de la podredumbre del fruto por <i>Botrytis</i> y oídio	Kyle Blauer (Gerente de Investigación de Campo, CPSC)
4. Resistencia de los cultivares al oídio de la fresa	Shaelyn Spencer (Estudiante, CP)
5. Actividad del servicio de diagnóstico de enfermedades de la fresa de Cal Poly - 2026	Shashika Hewavitharana (Patóloga de plantas, CPSC)
6. Demostración en campo de acolchado biodegradable	Lisa DeVetter (Profesora, WSU)

ESTACIÓN 3

Tema	Presentador
7. Efecto de los agentes desinfectantes sobre los principales patógenos transmitidos por el suelo y estudios de las prácticas de saneamiento en el distrito de Santa María	Maria Alvarez Arredondo (Estudiante de Maestría, CP) Elias Barriga-Hernandez (Estudiante de Maestría, CP)
8. Interacción del nemátodo de las agallas de la raíz con la marchitez por <i>Fusarium</i> y resistencia de cultivares de fresa	Elias Barriga-Hernandez (Estudiante de Maestría, CP) Antoon Ploeg (Nematólogo, UCR)
9. Resistencia de la planta hospedante a la podredumbre radicular por <i>Macrophomina</i> y a la marchitez por <i>Verticillium</i> y a la marchitez por <i>Fusarium</i>	Maria Alvarez Arredondo (Estudiante de Maestría, CP) Marin Vargas (Estudiante de Maestría, CP)
10. Sistema autónomo de aspiración de <i>Lygus</i> y ayuda solar para la cosecha	Juan Bravo (Fundador, Agrobot)
11. Plataformas agrícolas autónomas	Linda McNair (Vicepresidenta de Marketing, Bonsai Robotics)

ESTACIÓN 4

Tema	Presentador
12. Perforadora térmica	Tony Sandoval (Fundador, Precision Ag)
13. Sistema de asistencia operativa	Rickey Ishida (Gerente de Automatización de la Producción, CSC) Brendan Holt (Ingeniero agrícola, CSC) Aidan Fischer (Ingeniero de campo, CSC)
14. Cortadora láser de tipo pórtico	Brendan Holt (Ingeniero agrícola, CSC)
15. Trasplantadora autónoma a raíz desnuda	Aidan Fischer (Ingeniero de campo, CSC)
16. Servicios de aspirado para <i>Lygus</i> y tratamiento con UV-C	Adam Stager (Fundador, TRIC Robotics)

ESTACIÓN 5

Tema	Presentador
17. Datos del ensayo de eficacia de aerosoles contra ácaros e insectos de 2025	Mohammad Amir Aghaee (Entomólogo, CPSC)
18. Tolerancias de cultivares de 2025 contra <i>Tetranychus urticae</i>	Sophie Rodriguez (Estudiante de Maestría, CP)
19. Eficacia de la aspiradora de insectos 2025 contra <i>Lygus hesperus</i>	Emily Henry (Investigadora Asociada, CPSC)
20. Parabug demostración de dron	Taylor Hibino (Estudiante de Maestría, CP)

Nota: Las ubicaciones de las presentaciones mencionadas están abiertas al público para participar en la reunión. Se harán acomodaciones especiales para personas con discapacidades físicas, visuales o auditivas si se solicita (por favor contacte al personal del Centro Strawberry al 805.756.2150)

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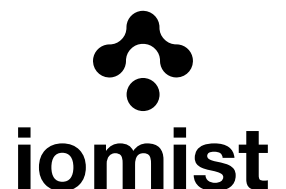


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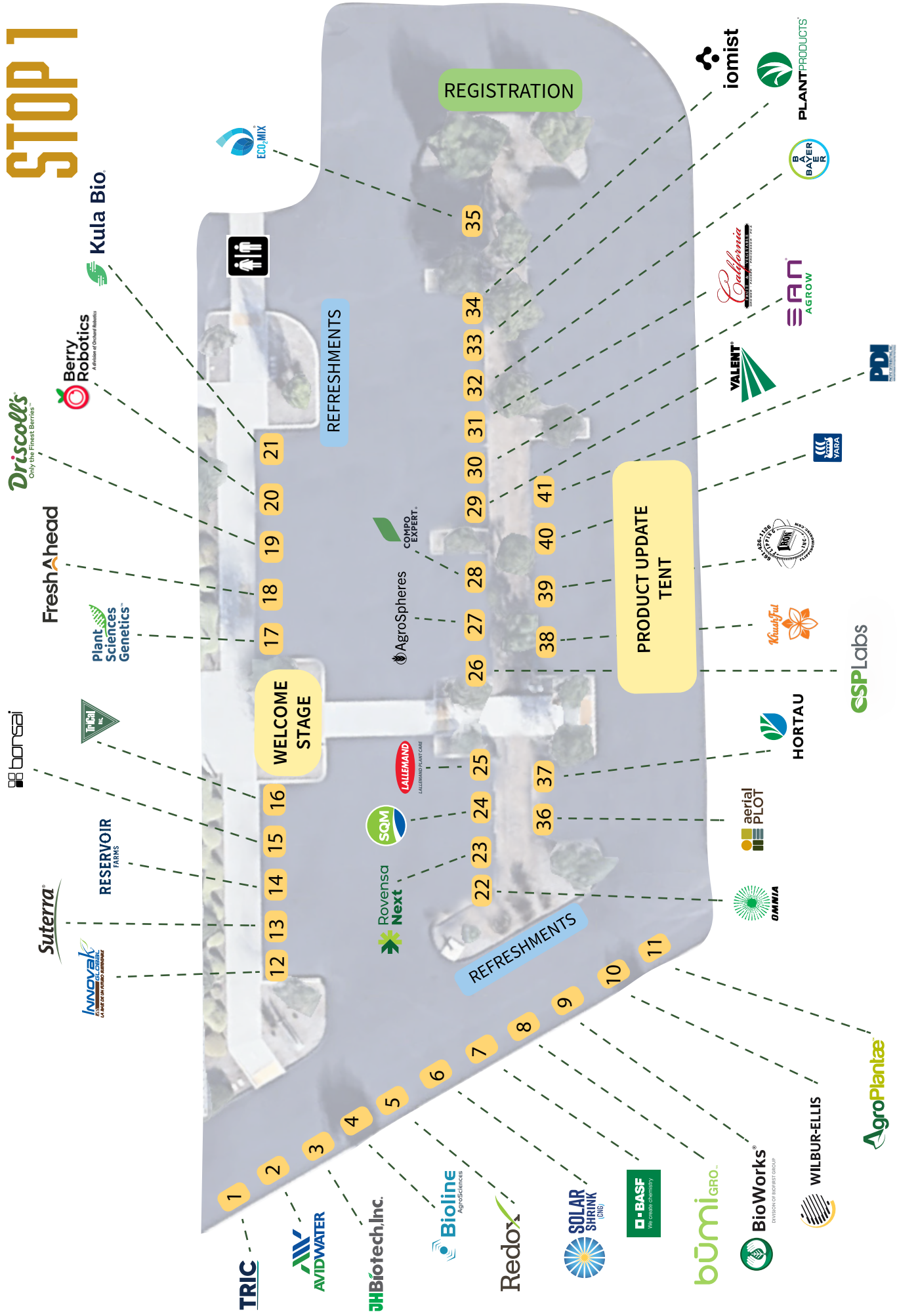
SILVER



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STOP 1



Characterization of two poorly understood strawberry fruit rots: *Rhizopus* and *Mucor*

G. Torres Gonzalez, S. S. Hewavitharana, and G. J. Holmes

Fruit rots cause major losses in California strawberry production, with *Botrytis* fruit rot predominating in colder, wetter months, and *Rhizopus* and *Mucor* fruit rots in warmer months. The causal agents, *Rhizopus* and *Mucor*, are difficult to differentiate due to overlapping symptoms and signs. Because of this, they are often grouped together, limiting research on management and species-specific information. To address these research gaps, this study aims to determine the prevalence, species composition, and management characteristics of these pathogens across California's three major strawberry-growing regions. To determine prevalence, isolates will be collected from each district. As of June 2026, 200 isolates have been collected from rotting fruit in strawberry production fields or from harvested fruit in clamshells using sterile cotton swabs. Each isolate was identified to species through culture isolation, DNA extraction, sequencing, and local sequence alignment analysis. Findings from 130 isolations resulted in 119 (90.8%) *Rhizopus stolonifer* isolates, 2 (1.5%) *R. arrhizus* isolates, 7 (5.3%) *Mucor piriformis* isolates, and 3 (2.3%) *Gilbertella persicaria* isolates. Observable differences in growth habits and spore appearance (Fig. 1) between *Rhizopus* and *Mucor* are evident. These features allow rapid and accurate field identification with the naked eye or aided by a 20× loupe. Identifying these differences is an important foundation for optimizing management practices. Future work on this project will include collection of another 100 isolates, identification of all remaining isolates, evaluations of optimum growth temperatures, fungicide efficacy, and their implications for disease management.

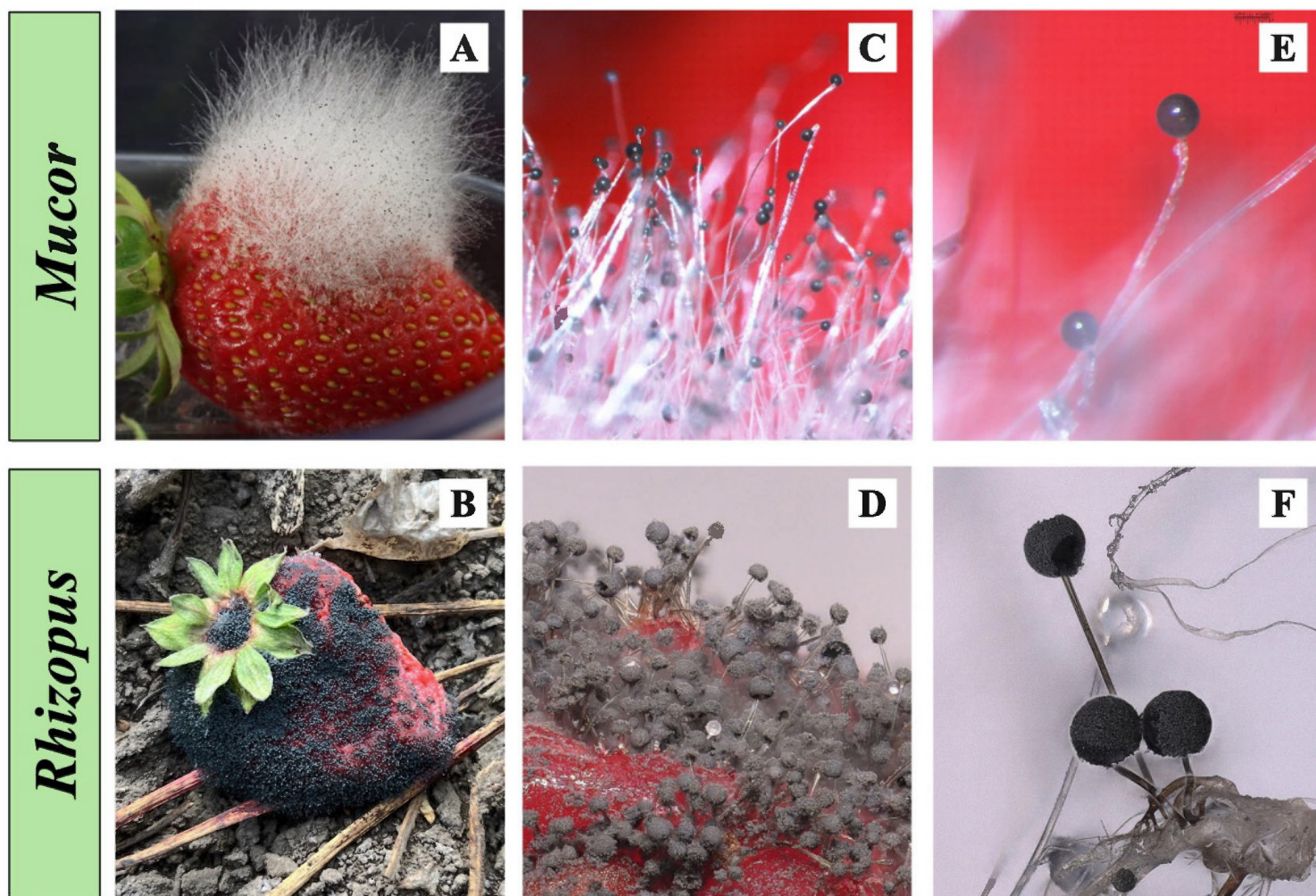


Figure 1. Comparison of the growth habit and sporangiophore morphology of *Mucor piriformis* and *Rhizopus stolonifer*. A) *M. piriformis* and B) *R. stolonifer* growth habit on diseased fruit. *Mucor* colonies form dense, white, wiry patches on the fruit. *Rhizopus* colonies appear darker and typically form closer to the fruit surface, except under high humidity. C) *Mucor piriformis* and D) *Rhizopus stolonifer* sporangiophores. E) *M. piriformis* sporangiophores and F) *R. stolonifer* sporangiophores at higher magnification. *M. piriformis* forms sporangial drops, making its sporangia glisten. *R. stolonifer* does not produce sporangial drops; its sporangia are dry and powdery.



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Evaluation of conventional, biological, and natural products for control of Botrytis fruit rot (BFR), 2026

K. A. Blauer and G. J. Holmes

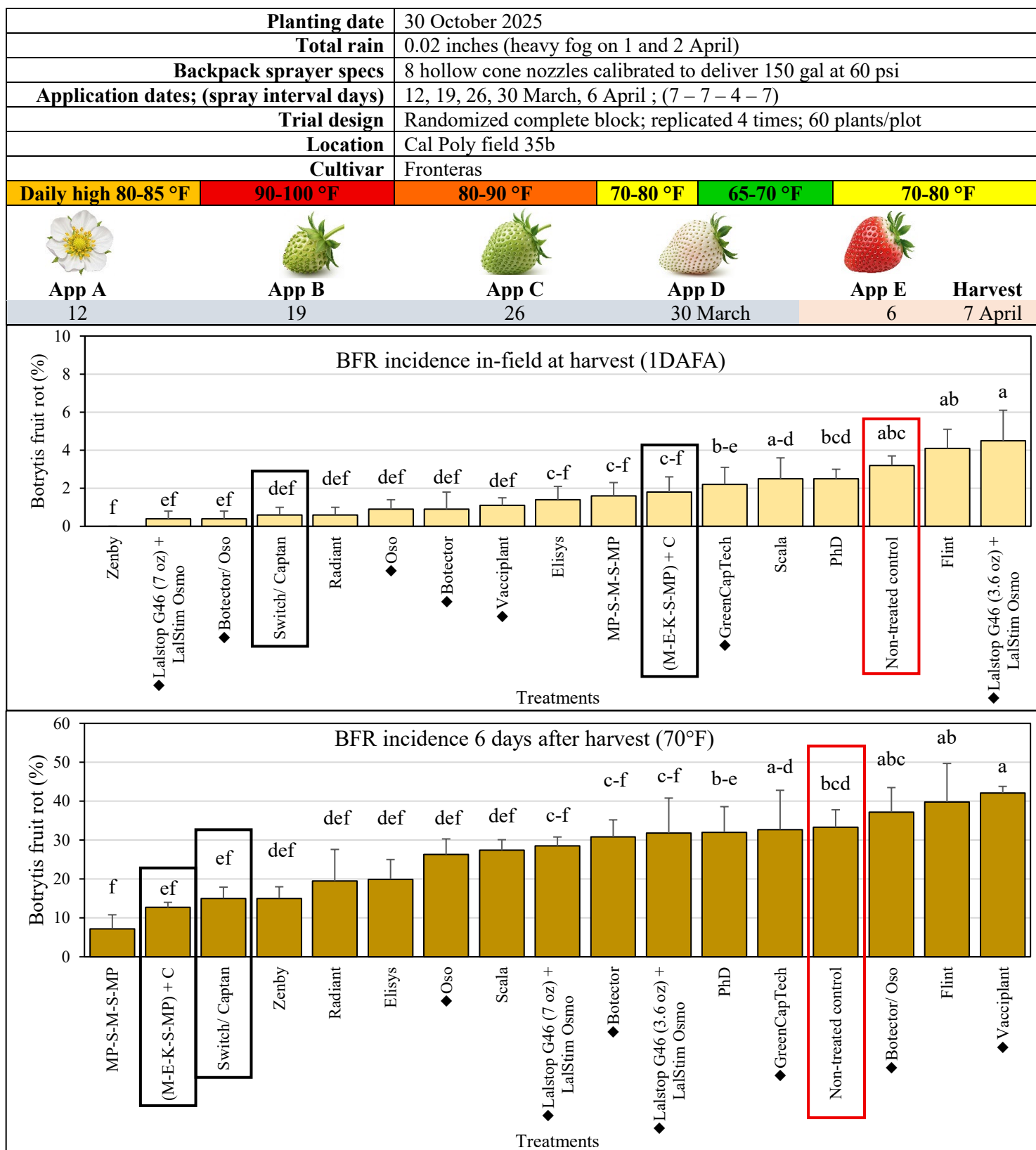


Figure 1. Key to abbreviations: DAFA= days after final application; = Non-treated control; = Strawberry Center standards; / =Weekly rotation; + =Tank mix; MP=Miravis Prime; S=Switch; M=Merivon; E=Elevate, K=Kenja; ◆ = biological or natural product. Silwet L-77 was applied at 3.2 fl oz/100 gal to all products except GreenCapTech and all other products were applied at max label rate unless otherwise stated. Lalstop G46 treatments were applied after sunset. 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 ($\alpha=0.05$).



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Evaluation of conventional, biological, and natural products for control of powdery mildew, 2026

M. J. Gutierrez, K. A. Blauer, and G. J. Holmes

Location	Cal Poly Greenhouse
Greenhouse temperature max/min	75° & 55°F
Cultivar	Monterey
Trial design	Randomized complete block; replicated 4 times; 4 plants/plot
Backpack sprayer specs	Single flat fan nozzle calibrated to deliver 100 gal/A at 25 psi
Planting date	4 May 2026
Inoculation date	22 May 2026
Application dates; (spray interval days)	5 weekly sprays (26 May, 2, 9, 16, 23 June)
First sign of disease	1 June 2026
Evaluation	1 day prior to each fungicide application



Figure 1. Visual comparison of disease severity. From left to right: 15% severity, 65% severity, 100% severity.

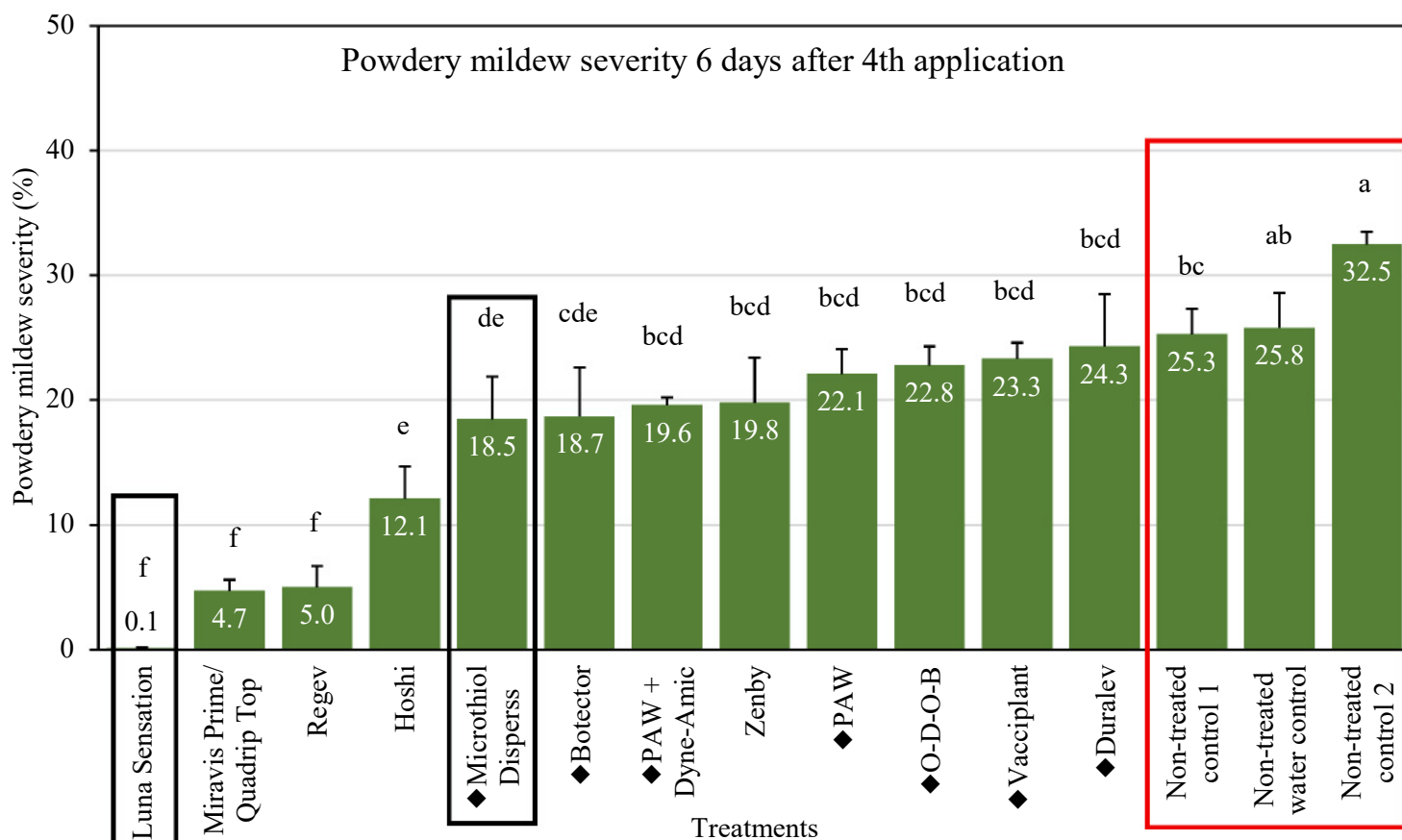


Figure 2. = Non-treated control; = Strawberry Center standards; / = Weekly rotation; + = Tank mix; O = Oso; D = Duralev; B = Botector; ◆ = biological or natural product. Data was subject to ANOVA and Fishers LSD mean separation. Error bars represent standard error of the mean. Means that do not share the same letter are significantly different ($\alpha=0.05$).



STRAWBERRY: FUNGICIDE EFFICACY - CONVENTIONAL

Fungicide ¹	Resistance risk (FRAC) ²	Gray mold	Powdery mildew	Anthrax - nose	Rhizopus/ Mucor rot	Phytophthora diseases ³	Common leaf spot	Angular leaf spot
Miravis Prime	medium (7/12)	5	5	3	NL (4)	NL	NL	NL
Merivon	medium (7/11)	5 ^R	5 ^R	ND	NL (4)	NL	0	NL
Kenja, Zenby	high (7)	5	3	ND	NL (2)	NL	ND	NL
Pristine	medium (7/11)	5 ^R	4 ^R	ND	NL	NL	0	NL
Switch ⁵	medium (9/12)	5 ^R	2	4	4	NL	NL	NL
Cannonball ⁵	high (12)	5 ^R	NL	4	4	NL	NL	NL
Elevate	high (17)	5 ^{RR}	NL (0)	NL (0)	NL	NL	NL (0)	NL
Inspire Super	medium (3/9)	5 ^R	5	4	5	NL	ND	NL
Protocol	medium (1/3)	4 ^R	4 ^R	3	NL	NL	4	NL
Captevat ^{**}	medium (M4/17)	4 ^R	NL	4	NL	NL	NL	NL
Rovral, Iprodione, Nevado, etc. ⁷	high (2)	4 ^R	NL (0)	0	NL	NL	0	NL
Thiram	low (M3)	4	NL (0)	3	NL	NL	0	NL
Captan	low (M4)	4	NL (0)	NL (2)	NL (2)	NL	NL (0)	NL
PH-D, Oso	high (19)	3	4	3	NL	NL	NL	NL
Regev	medium (3/BM 01)	3	5	4	5	NL	ND	NL
Scala	high (9)	3	NL (2)	NL	NL	NL	NL	NL
Fontelis	high (7)	2 ^R	4 ^R	NL	NL	NL	NL	NL
Luna Sensation	medium (7/11)	1 ^R	5	3 ^R	2	NL	ND	NL
Luna Privilege ^{**} (foliar)/ Velum One (soil) ⁴	high (7)	1/NL	5/3	NL	ND	ND	ND	NL
Luna Tranquility	medium (7/9)	1	5	NL	1	NL	ND	NL
Tesaris	high (7)	1	ND	NL	NL	NL	NL	NL
Topsin-M, T-Methyl, Incognito, etc. ⁶	high (1)	1 ^{RR}	4	0	NL	NL	NL (3)	NL
Intuity	high (11)	1 ^{RR}	2 ^R	NL	NL	NL	NL (0)	NL
Quadris, Abound, Acadia LFC, Arius, etc.	high (11)	1 ^{RR}	3 ^R	4 ^R	NL (2)	NL	NL	NL
Evito [*]	high (11)	1 ^{RR}	3 ^R	2 ^R	NL	NL	NL	NL
Flint Extra	high (11)	1 ^{RR}	4 ^R	2 ^R	NL	NL	NL	NL
Cabrio	high (11)	1 ^{RR}	2 ^R	3 ^R	NL (2)	NL	0	NL
Quilt Xcel, Avaris 2XS, etc.	medium (3/11)	NL (3) ^R	5 ^R	0 ^R	NL (0)	NL	NL	NL
Quintec	high (13)	NL (3)	5 ^R	NL (4 ^R)	NL (0)	NL	NL (0)	NL
Quadris Top, Acadia ESQ ^{*,8} , etc.	medium (3/11)	NL (2) ^R	5 ^R	4 ^R	NL	NL	3	NL
Bumper, Tilt, etc.	high (3)	NL (0)	5 ^R	NL (3)	NL (0)	NL	4	NL
Mettle, Perissim, etc.	high (3)	NL	5 ^R	NL	NL	NL	ND	NL
Procure	high (3)	NL	5 ^R	NL (2)	NL	NL	NL (0)	NL
Rally	high (3)	NL (0)	5 ^R	NL (3)	NL	NL	4	NL
Rhyme ⁹	high (3)	NL (0)	5 ^R	NL	NL	NL	NL	NL
Torino	high (U6)	NL	5 ^R	NL	NL	NL	NL	NL
Gatten [*]	high (U13)	NL	5	NL	NL	NL	NL	NL
Prolivo, Hoshi	High (50)	NL	4	NL	NL	NL	NL	NL
Sulfur	low (M2)	NL	4	NL	NL	NL	NL	NL
Cevya	high (3)	NL	3 ^R	NL	NL	NL	NL	NL
Zivion S ⁵	low (48)	NL (0)	NL	4	NL	NL	NL	NL
Fungi-Phite, K-Phite, ProPhyt, etc.	high (P07,33)	NL	0	0	NL	4	NL	NL (2)
Orondis Gold	high (4/49)	NL	NL	NL	NL	4	NL	NL
Aliette ^{3,9} , Legion ^{**}	high (P07,33)	NL	NL	NL	NL	4	NL	NL
Ridomil Gold SL, Ultra Flourish, etc. ⁹	high (4)	NL	NL	NL	NL	4	NL	NL
Copper, etc. ¹⁰	low (M1)	0	0	0	0	0	0	4 ¹⁰
Actigard	high (P01)	NL	NL	NL	NL	NL	NL	3

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, ND = no data. ^R=Resistance in this pathogen has been documented but performance is not fully compromised.

^{RR}=High level of resistance documented in this pathogen and performance is significantly compromised.

Footnotes continued on next page...



* Registration pending in California.

** Not registered, label withdrawn or inactive in California.

¹ To reduce the risk of resistance development, start fungicide treatment with a multi-site mode of action; rotate or mix fungicides with different mode of action FRAC numbers for subsequent applications, use labeled rates (preferably the upper range), and limit the total number of applications per season.⁷

² Code numbers are assigned by the Fungicide Resistance Action Committee (FRAC) according to different modes of actions (for more information, see <http://www.frac.info/>). To minimize resistance, make no more than one application of a fungicide with a “high” or “medium” resistance risk of the same FRAC code before rotating to a fungicide with a different FRAC code. Resistance risk determined based on single-site = high risk; premix = medium risk; multi-site = low risk.

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

⁴ Velum One is a fluopyram formulation for chemigation. Soil applications are designed for nematode management but may also suppress powdery mildew.

⁵ Apply as a transplant dip after digging/harvesting and prior to cold storage (nursery use) or prior to planting (field use).

⁶ Generic products may not be all listed and “etc.” indicates that other products may be available that have the same active ingredient.

⁷ Apply as preplant dip or foliar spray; do not apply after first fruiting flower.

⁸ Not for use in nurseries, on nursery transplants, or greenhouses (check label for details).

⁹ Foliar applications provide systemic treatment.

¹⁰ Apply at low rates since phytotoxicity (reddening of older leaves, slow growth and yield reduction) has been documented with repeated sprays.

STRAWBERRY - FUNGICIDE EFFICACY - BIOCONTROLS AND NATURAL PRODUCTS

Fungicide trade names	Active ingredient	Resistance risk (FRAC) ¹	Gray mold	Powdery mildew	Anthrac - nose	Rhizopus/ Mucor rot	Phytophthora diseases ²	Common leaf spot	Angular leaf spot
Oso	Polyoxin D zinc salt	medium (19)	3	4	3	NL	NL	ND	NL
Microthiol Disperss, etc. ³	sulfur	low/ (M2)	NL	4	NL	NL	NL	NL	NL
All Phase	potassium sorbate; sodium lauryl sulfate	low (NC)	ND	4	ND	NL	NL	ND	ND
Serenade ASO, etc. ³	<i>Bacillus subtilis</i> QST 713	low (BM 02)	0	3	0	NL (0)	NL (0)	NL (0)	NL
Sonata	<i>Bacillus pumilis</i> QST 2808	low (BM 02)	NL (0)	3	0	NL	NL	NL	NL
Timorex Act	tea tree oil	low (BM 01)	0	3	ND	0	ND	NL	ND
ProBlad Verde, Fracture ³	Banda de <i>Lupinus albus</i> doce	low/(NC)	0	3	ND	ND	NL	ND	NL
Aviv, BACIX, etc.	<i>Bacillus subtilis</i> IAB/BS03	low (BM 02)	0	3	ND	NL	ND	ND	NL
Kaligreen, MilStop, etc.	potassium bicarbonate	low (/NC)	0	3	NL	NL	NL	NL	NL
M-Pede, Des-X, etc. ³	potassium salts of fatty acids	medium (28)	NL	2	NL	NL	NL	NL	NL
Double Nickel	<i>Bacillus amylo-liquefaciens</i> D747	low (BM 02)	0	2	0	NL	0	NL	1
Actinovate	<i>Streptomyces lydicus</i> WYEC 108	low (BM 02)	0	2	NL	NL	0	NL	1
Serifel	<i>Bacillus amylo-liquefaciens</i> MBI 600	low (BM 02)	0	2	0	NL	0	ND	2
Taegro	<i>Bacillus amylo-liquefaciens</i> FZB24	low (BM 02)	0	2	0	NL	ND	NL	NL (2)
Theia	<i>Bacillus subtilis</i> AFS032321	low (BM 02)	0	2	0	NL	0	NL	ND
Regalia	<i>Reynoutria sachalinensis</i> extract	low (P5)	0	2	ND	NL	ND	NL	NL

Table continued on next page...



Fungicide trade names	Active ingredient	Resistance risk (FRAC) ¹	Gray mold	Powdery mildew	Anthrax - nose	Rhizopus/ Mucor rot	Phytophthora diseases ²	Common leaf spot	Angular leaf spot
Stargus	<i>Bacillus amylo-liquefaciens</i> F727	low (BM 02)	0	1	ND	NL	NL (1)	NL (1)	NL (1)
Copper, etc. ⁴	Copper	low (M 01)	0	0	0	0	0	0	4 ⁵
Cinnerate	cinnamon oil	low (BM 01)	0	ND	NL	ND	NL	NL	NL
Lalstop G46	<i>Clonostachys rosea</i> J1446	low (BM 02)	2	0	NL	NL	ND	ND	ND
Oxidate, Jet-Ag, etc.	Hydrogen peroxide; peroxyacetic acid	low (NC)	0	0	NL	NL	NL	NL	2
Julietta	<i>Saccharomyces cerevisiae</i> LAS02	low (BM 02)	0	NL	NL	NL	NL	NL	NL
Procidic, etc.	citric acid	low (NC)	0	NL	NL	NL	0	NL	NL
Rango	cold pressed neem oil	low (NC)	2	ND	ND	NL	0	0	NL
BotryStop	<i>Ulocladium oudemansii</i> U3	low (BM 02)	0	NL	NL	NL	NL	NL	NL
Botector	<i>Aureobasidium pullulans</i> DSM 14940; DSM 14941	low (BM 02)	0	NL	ND	NL (1)	NL	NL	NL
Howler	<i>Pseudomonas chlororaphis</i> AFS009	low (BM 02)	0	NL (2)	NL	NL	ND	ND	0
Veg'Lys	garlic oil	Unknown/ (NC)	0	NL	0	NL	0	0	ND
Vacciplant	Laminarin	Low (P04)	0	ND	ND	ND	ND	ND	ND

Rating: 5 = excellent and consistent, 4 = good and reliable, 3 = moderate and variable, 2 = limited and/or erratic, 1 = minimal and often ineffective, 0 = ineffective, NL = not on label, 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 for soil applied control of Phytophthora crown rot and leather rot of fruit.

³ Generic products may not be all listed and "etc." indicates that other products are available that have the same active ingredient.

⁴ Apply at low rates since phytotoxicity (reddening of older leaves, slow growth and yield reduction) has been documented with repeated sprays.





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A close-up photograph of strawberry plants growing in a field. The plants have green leaves and several ripe red strawberries. A large, semi-transparent blue graphic element, resembling a stylized leaf or a piece of mulch, is positioned on the right side of the image. The background is a dark, textured surface, likely the mulch film.

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Evaluation of strawberry host plant resistance to powdery mildew in 38 genotypes under greenhouse conditions, winter 2026

S. A. Spencer, K. A. Blauer, G. J. Holmes

Thirty-eight strawberry genotypes from seven breeding programs were evaluated for powdery mildew susceptibility in a greenhouse trial at the Cal Poly Strawberry Center. Bareroot transplants were planted directly in a greenhouse on 22 January 2026 where powdery mildew-infected strawberry plants were present with high levels of sporulation. Transplants were planted in 1-gal. plastic nursery pots and were replicated four times, with each replicate consisting of three plants (one plant/pot) arranged in a randomized complete block design on greenhouse benches. Disease severity was based on the percentage of the upper and lower leaf surfaces covered by visible mycelial growth of each fully emerged trifoliate leaf. First symptoms of powdery mildew were detected 16 days after exposure to diseased plants in the greenhouse.



Figure 1. Visual comparison of disease severity. From left to right: 100% severity, 60% severity, 30% severity, 5% severity.

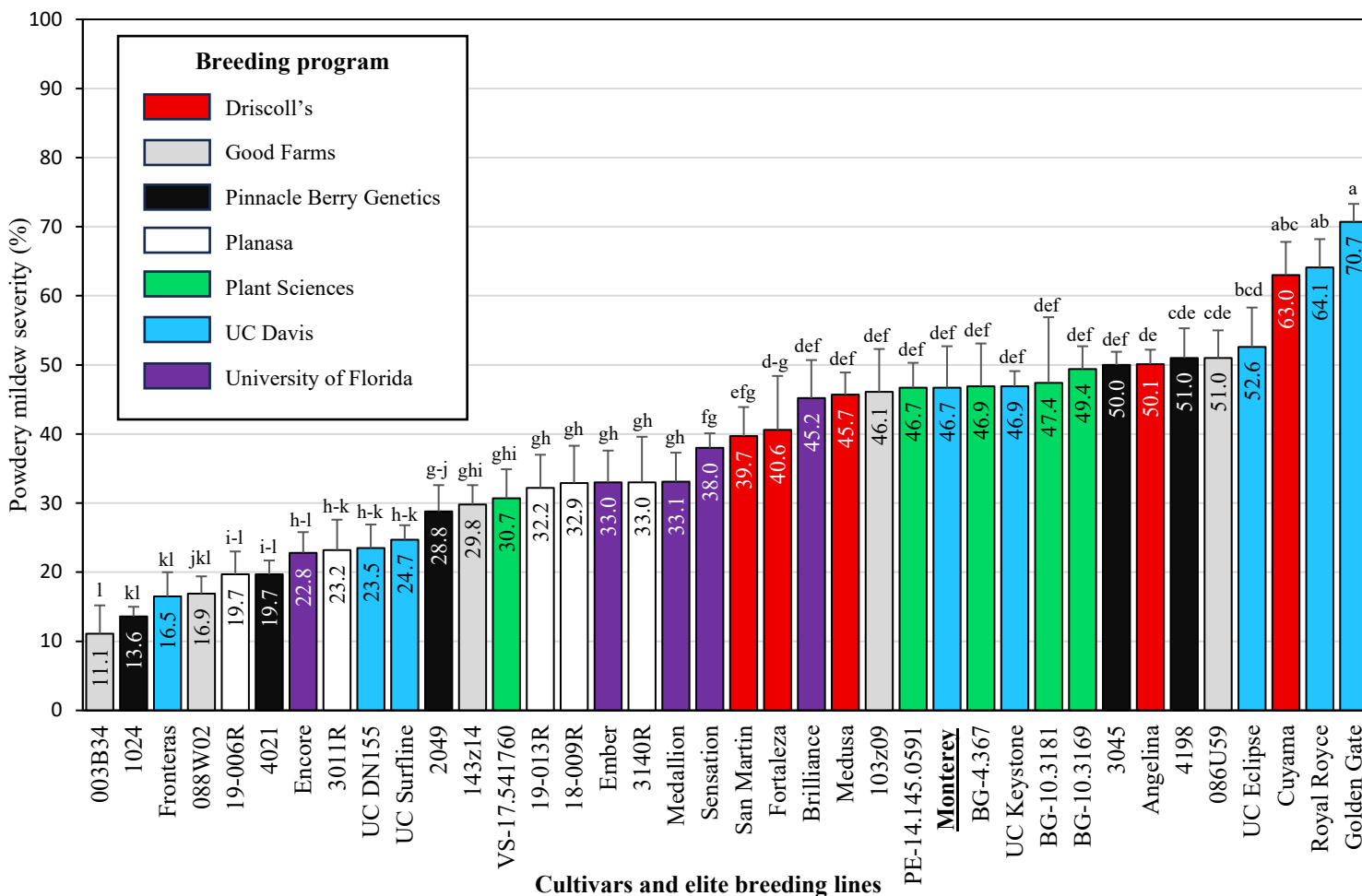


Figure 2. Average powdery mildew disease severity for each of 38 cultivars. Data were analyzed using ANOVA followed by Fisher's LSD mean separation test. Error bars represent the standard error of the mean. Means that do not share the same letter are significantly different ($\alpha = 0.05$).



Cal Poly strawberry disease diagnostic service activity - 2026

S. S. Hewavitharana and A. E. Richardson

The plant diagnostic service is funded by the California Strawberry Commission and is a free service for California strawberry growers. From Jan to Jun 2026, we received 258 samples from four strawberry growing regions (Fig. 1 and 2). Samples typically consist of 3-5 plants but can be more if they are fruit, leaf, or transplants. The samples were analyzed using microscopy, incubations, plating on selective media and molecular methods for fungal, oomycete, and bacterial pathogens and nematodes.

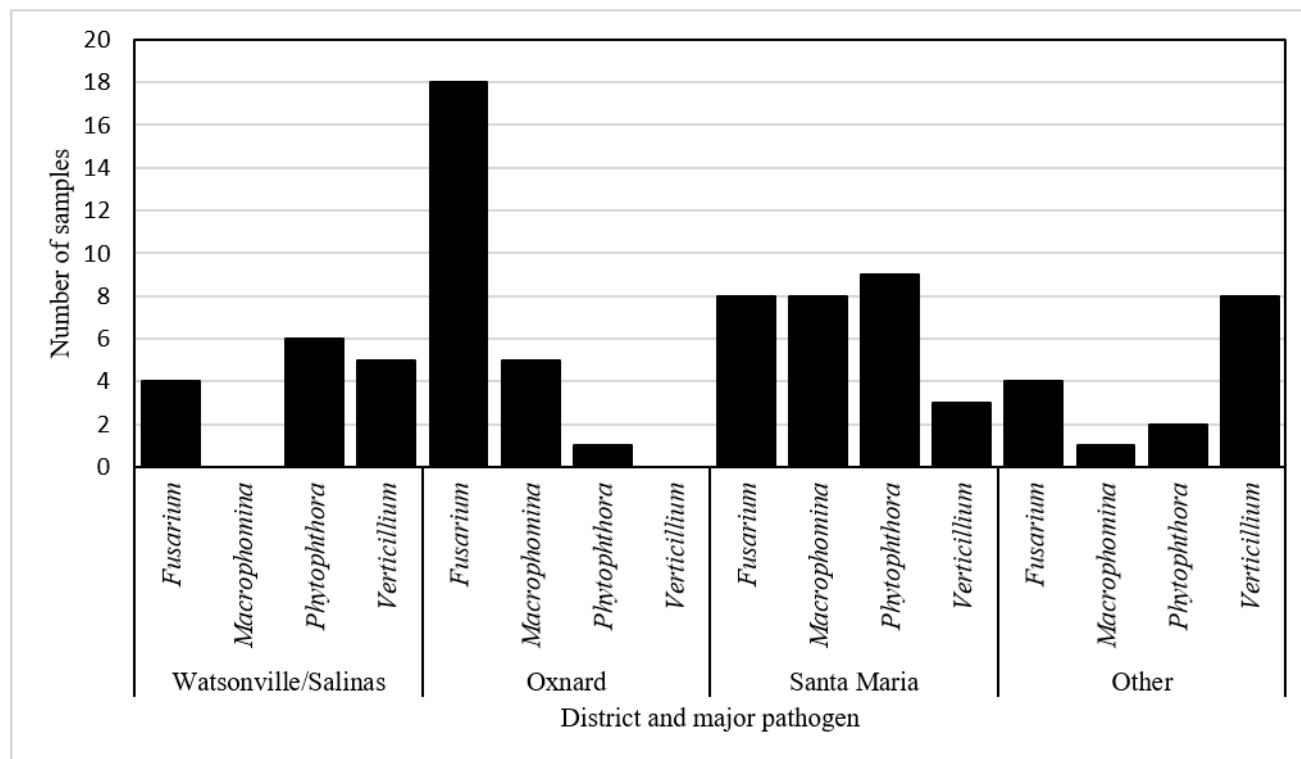


Figure 1. Diagnoses of diseases caused by major soilborne pathogens by district in 2026.

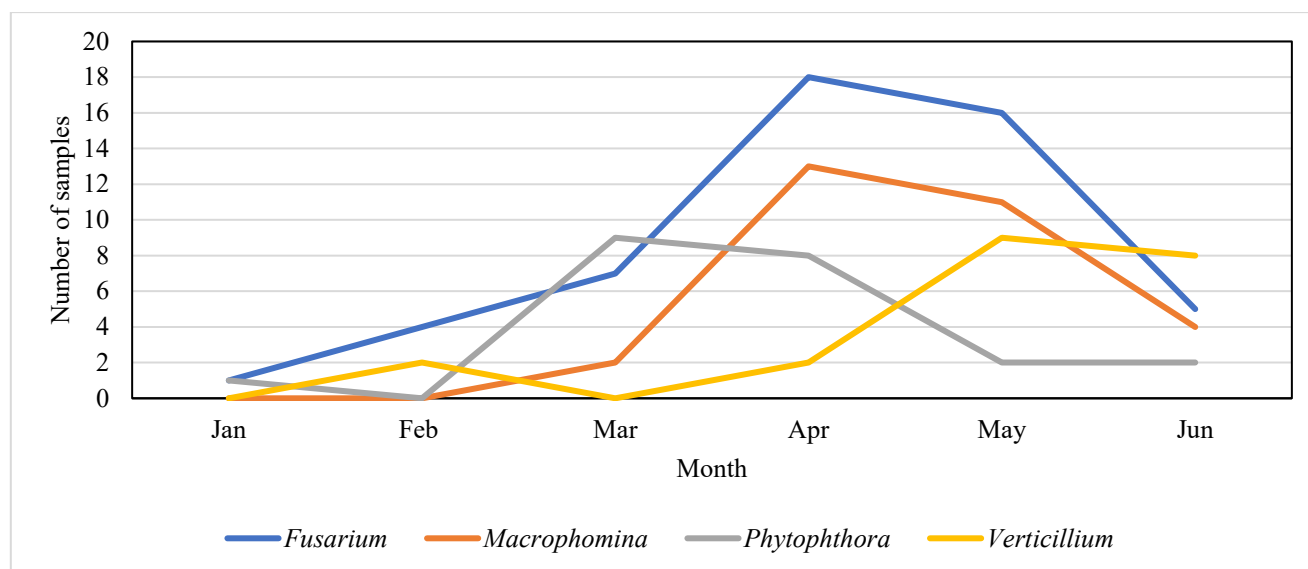


Figure 2. Diagnoses of diseases caused by major soilborne pathogens by month of 2026.



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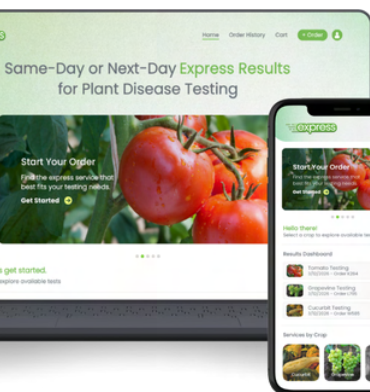
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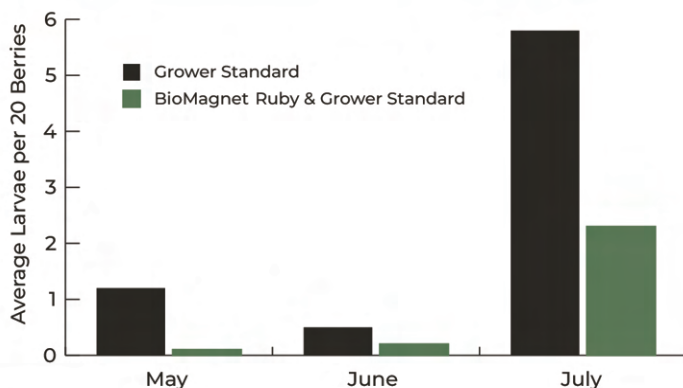
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Evaluation of sanitation practices and sanitizing agents for managing soilborne pathogens

M. G. Alvarez Arredondo, E. Barriga-Hernandez, S. S. Hewavitharana, and G. J. Holmes

Root diseases such as *Macrophomina* root rot, *Fusarium* wilt, *Verticillium* wilt, and *Phytophthora* crown/root rot are major threats to California strawberry production because they reduce plant vigor, decrease yield, and increase management costs. One important way they spread is through the movement of contaminated soil on tractors, equipment, vehicles, and workers' footwear. As a result, sanitation is an important management practice for limiting the movement of soilborne pathogens between fields. This project evaluated sanitation practices using three complementary approaches: an industry survey, field observations, and laboratory experiments. A survey of strawberry industry stakeholders in the Santa Maria district, representing approximately 93% of the district's strawberry acreage, found that most respondents considered sanitation to be an effective strategy for reducing pathogen spread. However, the time and cost required to implement sanitation consistently were identified as the primary barriers. Pressure washing was the most commonly reported method for removing soil from tractors and tillage equipment (Fig. 1). A field evaluation examined where soil accumulates on vehicles and the time required for cleaning under commercial conditions. Soil was most commonly retained in wheel wells, undercarriages, and bumpers (Fig. 2). High-pressure water with 15° angle effectively removed dried and compacted soil, and approximately 15 minutes were required to remove all visible soil from a heavily contaminated truck.

Laboratory assays evaluated the efficacy of the following labeled rates of sanitizing agents against pathogen isolates from different strawberry districts: Agrowlyte® (hypochlorous acid, 0.05%), bleach (sodium hypochlorite, 8.25%), ethanol (ethyl alcohol, 70%), Lysol® (o-Benzyl-p-chlorophenol, 5.5%), MG 4-Quat® (quaternary ammonia compounds, <5.0%), Oxidate® (hydrogen peroxide, 27.1%), Physan 20® (quaternary ammonia compounds, 20%), Virkon™ S® (potassium peroxydisulfate, 21.41%), and a control treatment using sterile DI water. Responses of *Macrophomina phaseolina* varied among isolates, although ethanol consistently provided the greatest reduction in pathogen growth, with bleach and Lysol also providing moderate suppression (Fig. 3). For *Fusarium oxysporum* f. sp. *fragariae* race 1, all treatments with the exception of Agrowlyte® showed complete inhibition. Growth inhibition of *Verticillium dahliae* was most consistent with bleach, ethanol, Lysol®, and Physan 20® treatments, although response varied across isolates (Fig. 4). A preliminary trial was also conducted to assess the efficacy of bleach and ethanol against oospores of *Phytophthora cactorum*, which demonstrated complete growth inhibition. Together, these findings demonstrate that thorough vehicle soil removal, combined with appropriate sanitizing agents, can provide a practical approach for reducing the spread of soilborne pathogens and improving disease management in strawberry production systems.

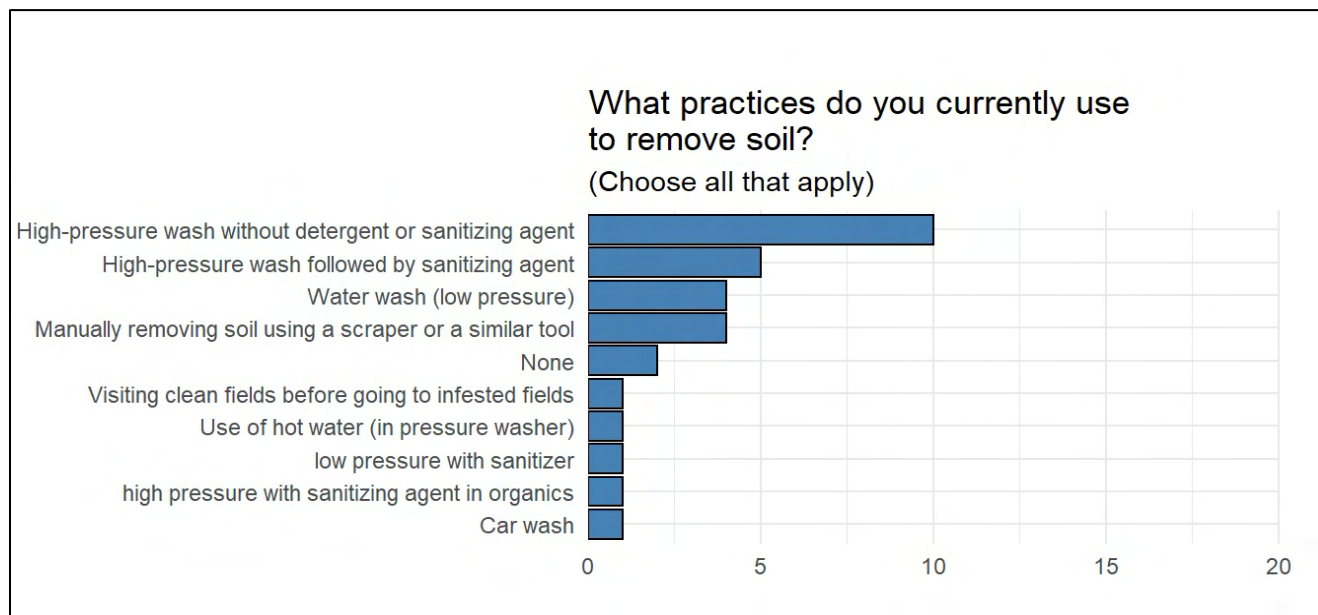


Figure 1. Current physical and chemical methods used by surveyed participants to remove soil from agricultural equipment and tools. Horizontal bars indicate the frequency of selection for each method.





Figure 2. Visual evidence of soil and mud accumulation on a Ford F-150 pickup truck following agricultural operations. Panels highlight key high-risk vectors for cross-ranch pathogen transport: front wheel well and tire tread (A), rear bumper and tire tread (B), interior liner of the rear wheel well (C), and rear bumper and exhaust (D).

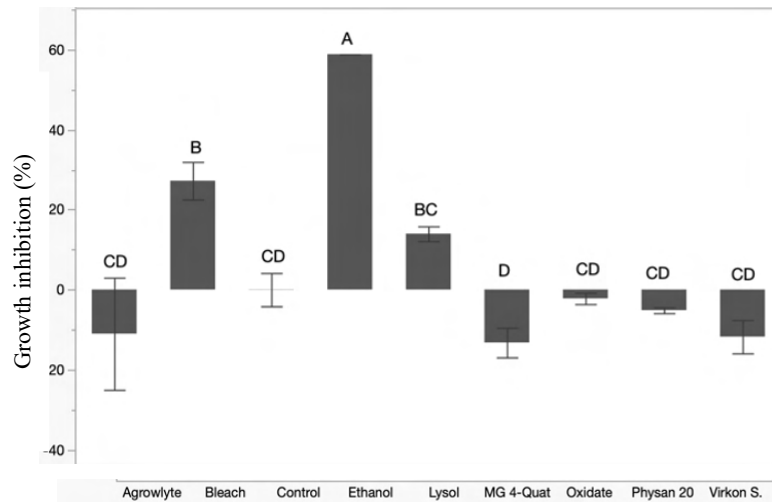


Figure 3. Mean percent inhibition of mycelial growth of *Macrophomina phaseolina* isolate Mp 96, following exposure to eight sanitizer and disinfectant treatments. Error bars represent $\pm$ SEM. Bars sharing the same letter are not significantly different (Tukey's HSD, $\alpha = 0.05$).

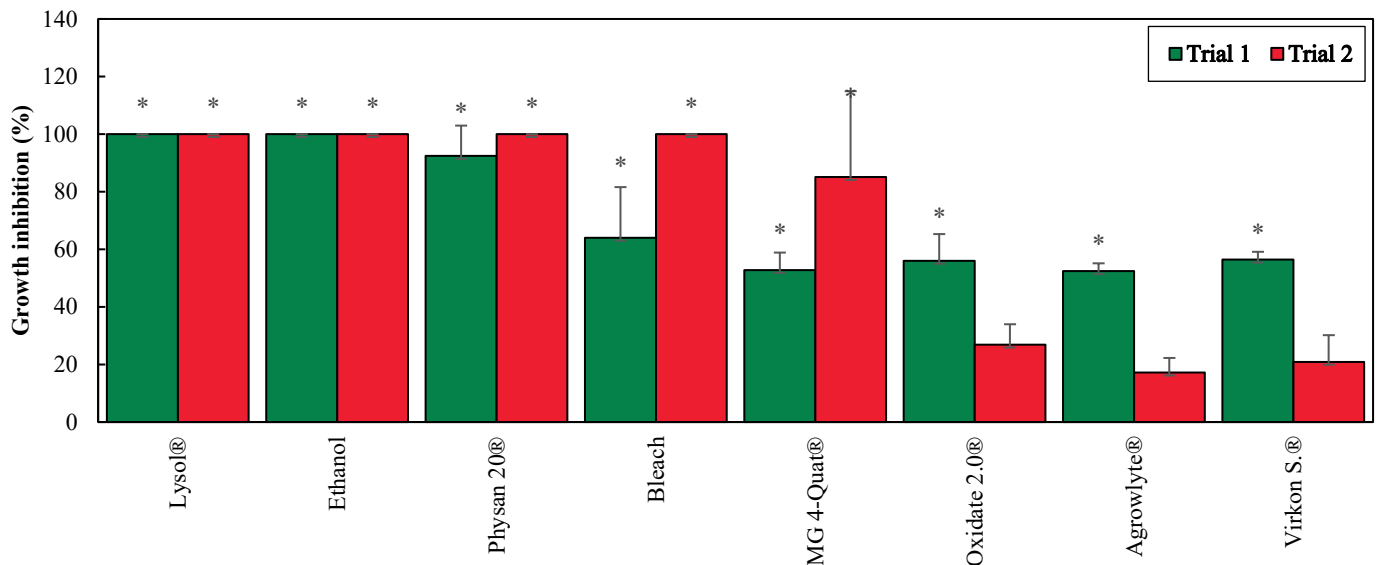


Figure 4. Percent growth inhibition of a *Verticillium dahliae* isolate from San Luis Obispo relative to the untreated control for each sanitizing treatment. Error bars represent the standard deviation. Asterisks indicate the mean colony diameter is statistically different from the control at $P < 0.05$ based on Dunnett's test.





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Evaluation of strawberry cultivars for susceptibility to northern root-knot nematode

E. Barriga-Hernandez, S. S. Hewavitharana, A. T. Ploeg and G. J. Holmes

The Cal Poly Strawberry Center diagnostic service has detected northern root-knot nematode (N-RKN; *Meloidogyne hapla*) every year since 2022 in samples from Santa Maria and Oxnard strawberry growing districts. Although N-RKN has not previously been considered a prevalent soilborne pathogen, its repeated detection raises concern since it is known to reduce plant vigor, damage roots, and contribute to plant stunting across its host range. The objective of this study is to evaluate the resistance level to N-RKN in ten public/private strawberry cultivars: ‘Adelanto’, BG 10.3169, ‘Cabrillo’, ‘Fortaleza’, ‘Fronteras’, ‘Golden Gate’, ‘Monterey’, ‘Royal Royce’, ‘San Andreas’, and ‘Surflin’. This project assessed plant weight and the number of N-RKN eggs per gram of root tissue in response to N-RKN inoculation under greenhouse conditions. Each cultivar was grown in 2-liter pots containing 90% sand:10% peat moss substrate and was randomly assigned to either a non-treated control or an inoculation treatment of 20 N-RKN eggs g⁻¹ of soil. After a 5-month growth period, plant weight between treated and untreated controls was compared within cultivars, and significant differences were observed for ‘Adelanto’ and ‘BG 10.3169’ (Fig. 1). N-RKN reproduction measured in eggs per gram of root tissue varied amongst cultivars, but differences were not statistically significant (Fig. 2). On average, nematode reproduction was highest in ‘San Andreas’ and lowest in ‘Surflin’ (seven-fold lower than ‘San Andreas’).

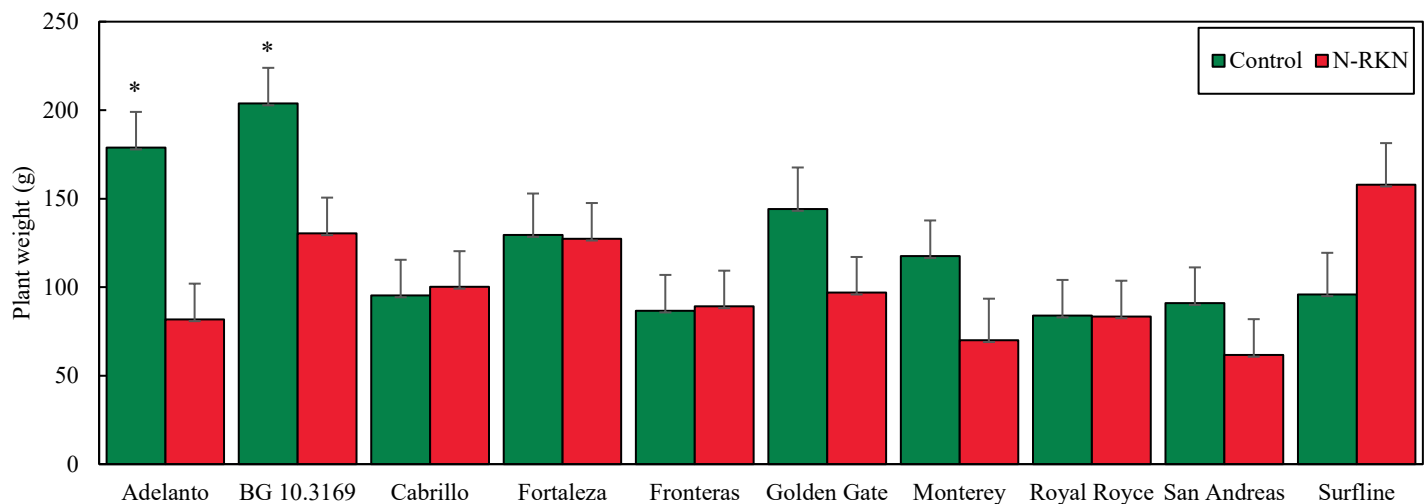


Figure 1. Plant weight response of ten public and private strawberry cultivars to *Meloidogyne hapla* inoculation and a non-inoculated control. Bars represent mean plant weight in grams $\pm$ standard error from a randomized complete block design. Asterisks indicate significant differences between non-inoculated control and *M. hapla* inoculated plants within a cultivar based on LS Means Student's *t* comparisons test. Interaction between cultivar and treatment was significant ($P = 0.0316$).

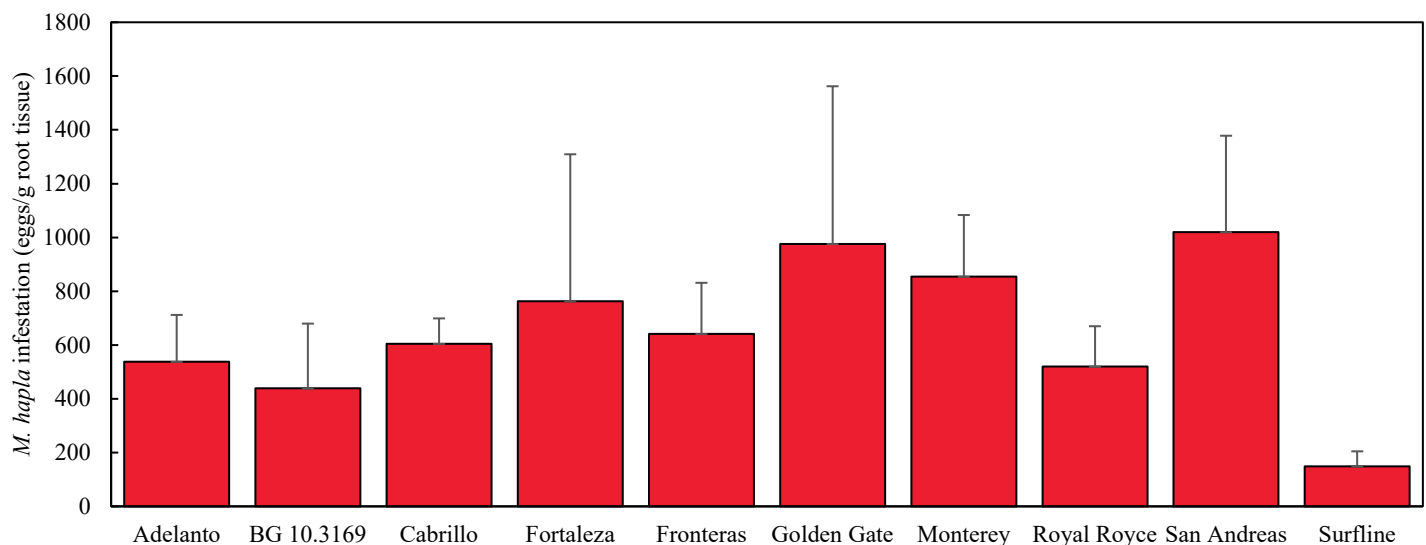


Figure 2. Reproduction of *Meloidogyne hapla* on strawberry (eggs/g root tissue) in ten strawberry cultivars five months after inoculation. Bars represent means $\pm$ standard error. No eggs were recovered from non-inoculated control plants. Cultivar differences were not statistically significant based on analysis of variance using log-transformed eggs per gram of root ($P = 0.1811$).



Interaction of northern root-knot nematode with *Fusarium oxysporum* f. sp. *fragariae* race 1

E. Gomez, A. T. Ploeg, E. Barriga-Hernandez, G. J. Holmes, and S. S. Hewavitharana

Fusarium wilt of strawberry is a widespread disease across all strawberry growing districts of California. *Fw1* major gene resistance has been integrated into many strawberry cultivars and is an important disease management tool for growers. Northern root-knot nematode (*Meloidogyne hapla*; N-RKN) has been detected in Cal Poly Strawberry Center's diagnostic service since 2022 (n = 4, 8, 6, 10, and 8 in 2022, 2023, 2024, 2025, and 2026, respectively) and in our district-wide root disease surveys. In other crops, soilborne pathogens have shown to interact with *Meloidogyne* spp. and exacerbate the disease or break resistance to fungal pathogens including *Fusarium* and *Verticillium*. The objective of this study was to assess the interaction between *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) and *M. hapla* in a resistant (San Andreas) and a susceptible (Monterey) cultivar to *Fof* in a greenhouse experiment. For three months, N-RKN was reared on 'Large Red' cherry tomato planted in infested soil collected from strawberry ranches in the Santa Maria district. N-RKN eggs were extracted from infected tomato plants. *Fof* inoculum was prepared in Kerr's broth and adjusted to 5×10^6 /spores mL⁻¹. The experiment was set up as a randomized complete block design with four treatments: (1) an untreated control (UTC), (2) soil inoculated with 20 N-RKN eggs/g soil (N-RKN), (3) inoculated soil with 5×10^6 spores/ml of *Fof* race 1 (*Fof*; root-dip inoculation), and (4) co-inoculated soil with 5×10^6 /spores mL⁻¹ *Fof* spores and 20 N-RKN eggs/g soil (N-RKN+ *Fof*) with six replicates. After three months of plant growth, the experiment was harvested, plant weight, *Fof* DNA quantity in crown tissue, and N-RKN eggs in root tissue were assessed.

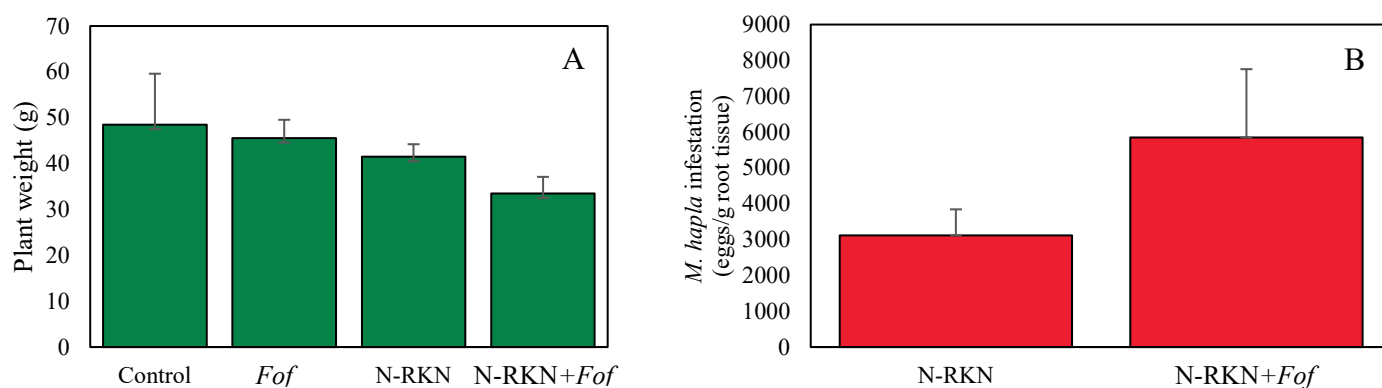


Figure 1. A) Mean plant weight of 'San Andreas' strawberry plants three months after inoculation in trial 1. Mean plant weight of treatments did not differ significantly based on one-way ANOVA ($P = 0.5947$). **B)** Mean N-RKN eggs/g root tissue three months after inoculation in trial 1. Mean *M. hapla* eggs/g root tissue between treatments did not differ significantly based on one-way ANOVA ($P = 0.1061$). Control = non-inoculated control; *Fof* = *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) spores root dip; N-RKN = northern root-knot nematode inoculation at 20 eggs/g soil; N-RKN+*Fof* = combined treatments (N-RKN+*Fof*). Error bars represent $\pm$ SE with n = 6.

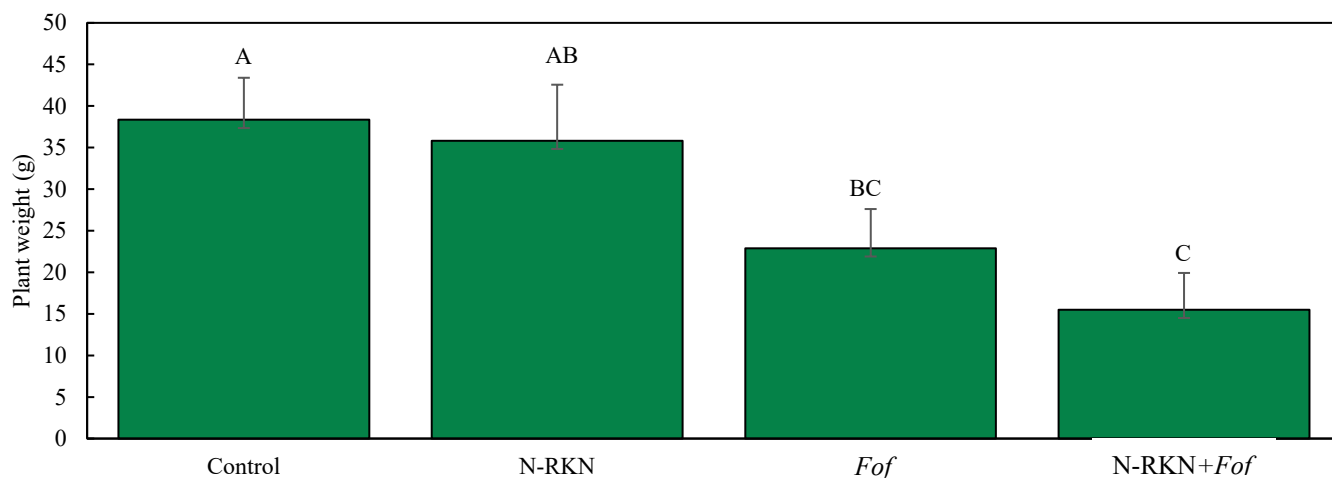


Figure 2. Mean plant weight three months after inoculation in trial 2 across 'Monterey and 'San Andreas' (no significant interaction between cultivar and treatment ($P = 0.418$). Treatment had a significant effect on plant weight based on two-way ANOVA performed on log-transformed data ($P = 0.0005$). Different letters indicate significant differences among treatments based on Tukey HSD post hoc test. Control = non-inoculated control; *Fof* = *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*) spores root dip; N-RKN = northern root-knot nematode inoculation at 20 eggs/g soil; N-RKN+*Fof* = combined treatments (N-RKN+*Fof*). Error bars represent $\pm$ SE with n = 6.





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Evaluating host resistance to *Macrophomina* root rot in strawberry

M. G. Alvarez Arredondo, S. S. Hewavitharana, and G. J. Holmes

This fall growing season (2025-26) marks the 10th consecutive year of an ongoing field trial evaluating strawberry cultivar resistance to *Macrophomina* root rot. The trial is conducted in Field 35b on the California Polytechnic State University, San Luis Obispo campus (Fig. 1). This year's trial included 92 cultivar entries from six breeding programs: Driscoll's, Good Farms, Pinnacle Berry Genetics, Planasa, Plant Sciences, and UC Davis. Plots consisted of 20 bare-root transplants per genotype, with slight variation in some plots due to plant availability. Each genotype was replicated across four randomized blocks. Standard 64-inch beds were used, with four rows of plants per bed and two lines of drip tape for irrigation and fertigation. All genotypes were transplanted on 30 October 2025 except for the 11 genotypes from Good Farms which were planted on 4 November. On 24 November each plant was inoculated with 5 g of cornmeal-sand inoculum containing *Macrophomina phaseolina* at 3,840 CFU/g, applied around the crown and upper root zone (Fig. 2A). Plant mortality was assessed weekly and plants were recorded as dead when all above ground foliage was necrotic (Fig. 2B). *M. phaseolina* was confirmed in host tissue using standard plating techniques (Fig. 2C). Disease expression increased gradually throughout the 2025-26 growing season, especially beginning in June when irrigation was reduced by 25%. Plant mortality as of 23 June is shown in Figures 3 and 4.



Figure 1. Experimental plot layout for the strawberry cultivar field trial located in Field 35b at the Cal Poly Strawberry Center.

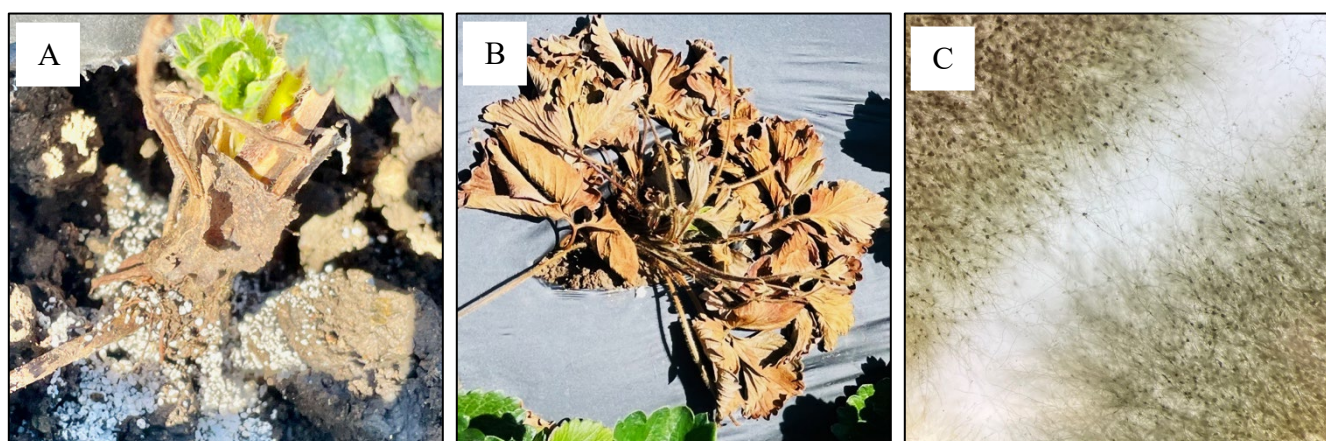


Figure 2. A) Transplant inoculation with *Macrophomina phaseolina*. B) Symptoms of *Macrophomina* root rot. C) Fungal identification of *Macrophomina phaseolina* on agar medium.



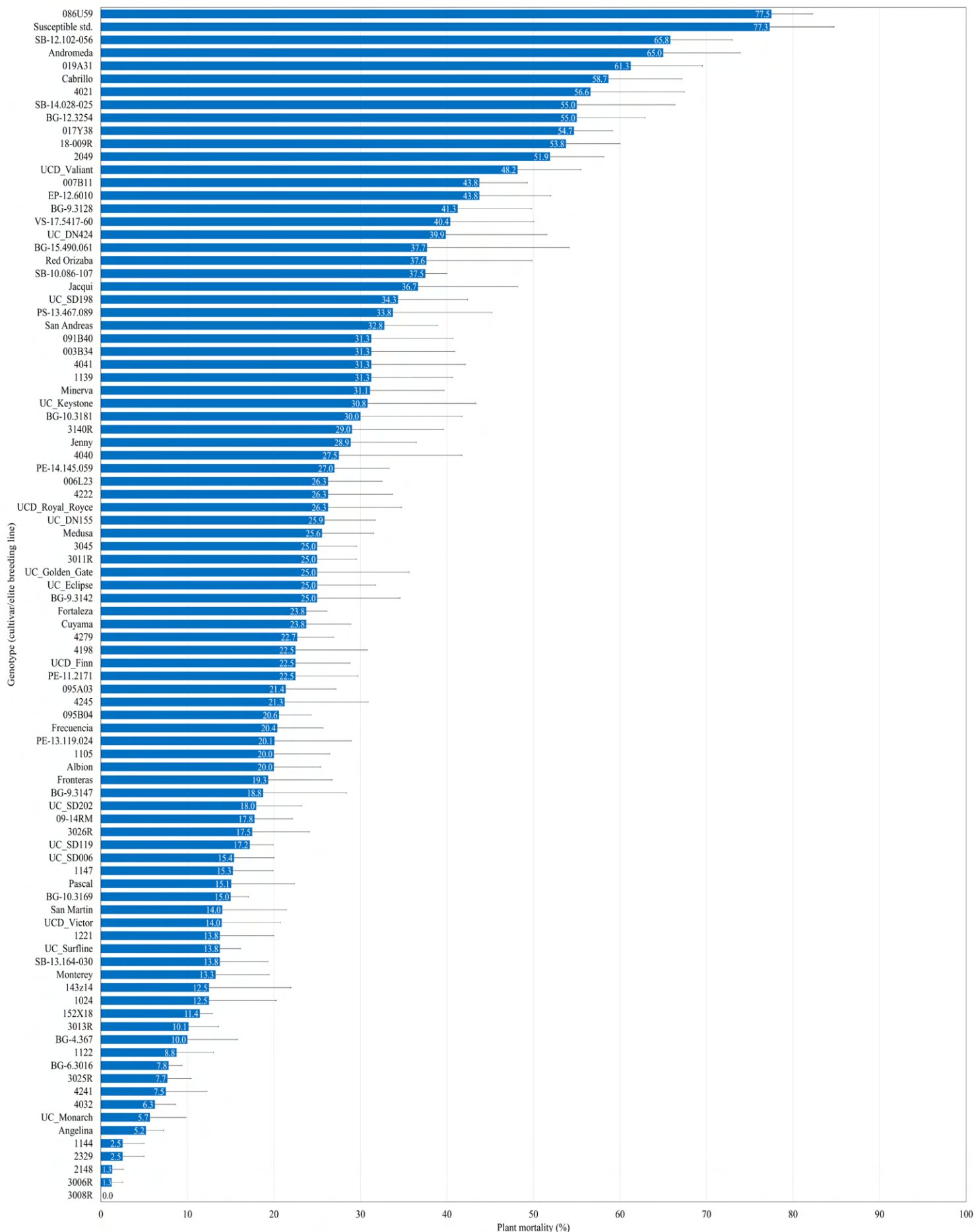


Figure 3. Average percent plant mortality due to *Macrophomina* root rot as of 23 June 2026. Error bars represent standard error from four replicates per genotype (n=4).



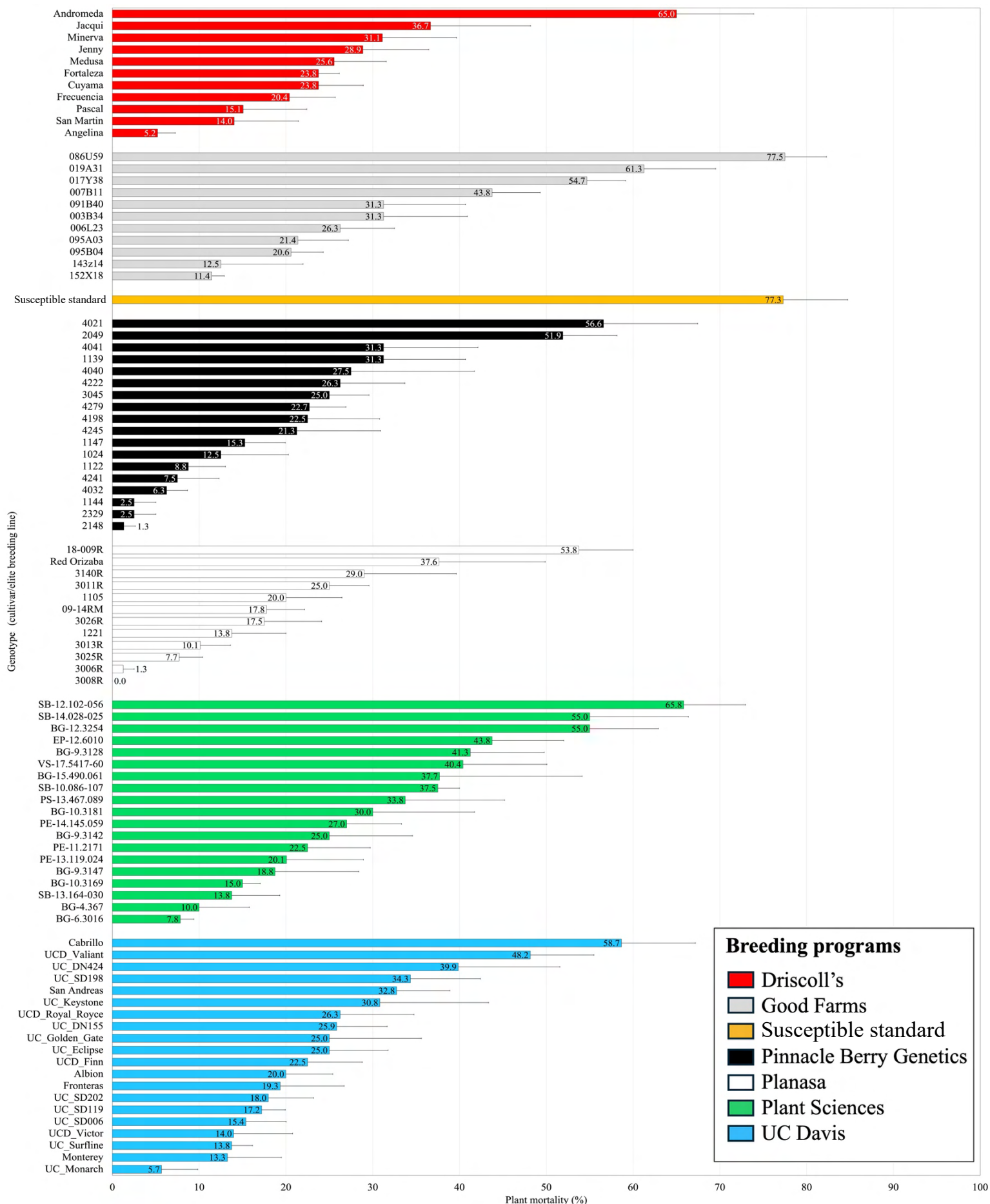


Figure 4. Average percent plant mortality due to *Macrophomina* root rot (sorted by breeding program) as of 23 June 2026. Error bars represent standard error from four replicates per genotype (n=4).





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Evaluating host resistance to *Verticillium* wilt in strawberry

M. G. Alvarez Arredondo, S. S. Hewavitharana, and G. J. Holmes

The 2025–26 season marks the tenth consecutive year of a long-term field trial evaluating strawberry genotypes for resistance to *Verticillium* wilt caused by *Verticillium dahliae*. This year's trial included 92 cultivar entries from six breeding programs. Driscoll's, Good Farms, Pinnacle Berry Genetics, Planasa, Plant Sciences, and UC Davis. Plots consisted of 20 plants per genotype, with slight variation in some plots due to plant availability. Bareroot transplants were planted in Cal Poly's Field 25, block 3, a field with a well-documented history of *Verticillium* wilt (Fig. 1). All genotypes were transplanted on 30 October 2025 except for 11 genotypes from Good Farms which were planted on 4 November. The field was not fumigated prior to planting and the soil is naturally infested with *V. dahliae* (8.0 CFU/g soil). Plant mortality was assessed weekly throughout the growing season, with plants classified as dead once 50% or more of the foliage exhibited necrosis (Fig. 2A). Disease symptoms developed gradually, likely reflecting the unusually warm and dry conditions early in the season, which may have been less favorable for *Verticillium* wilt development. Consequently, symptom progression was delayed, and plant mortality accumulated much more slowly than in previous years.



Figure 1. Experimental plot layout for the strawberry cultivar field trial located within Field 25, block 3 at the Cal Poly research field.

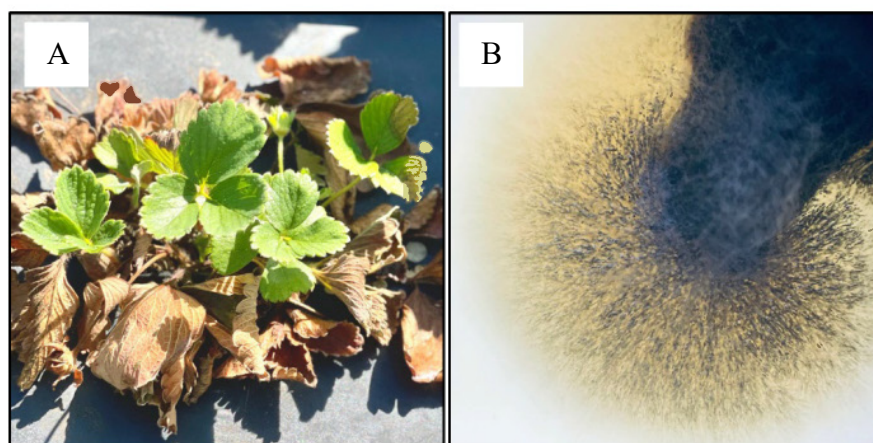


Figure 2. A) Symptoms of *Verticillium* wilt B) *Verticillium dahliae* growing out from one end of an infected strawberry petiole plated on a semi-selective medium (NP-10).

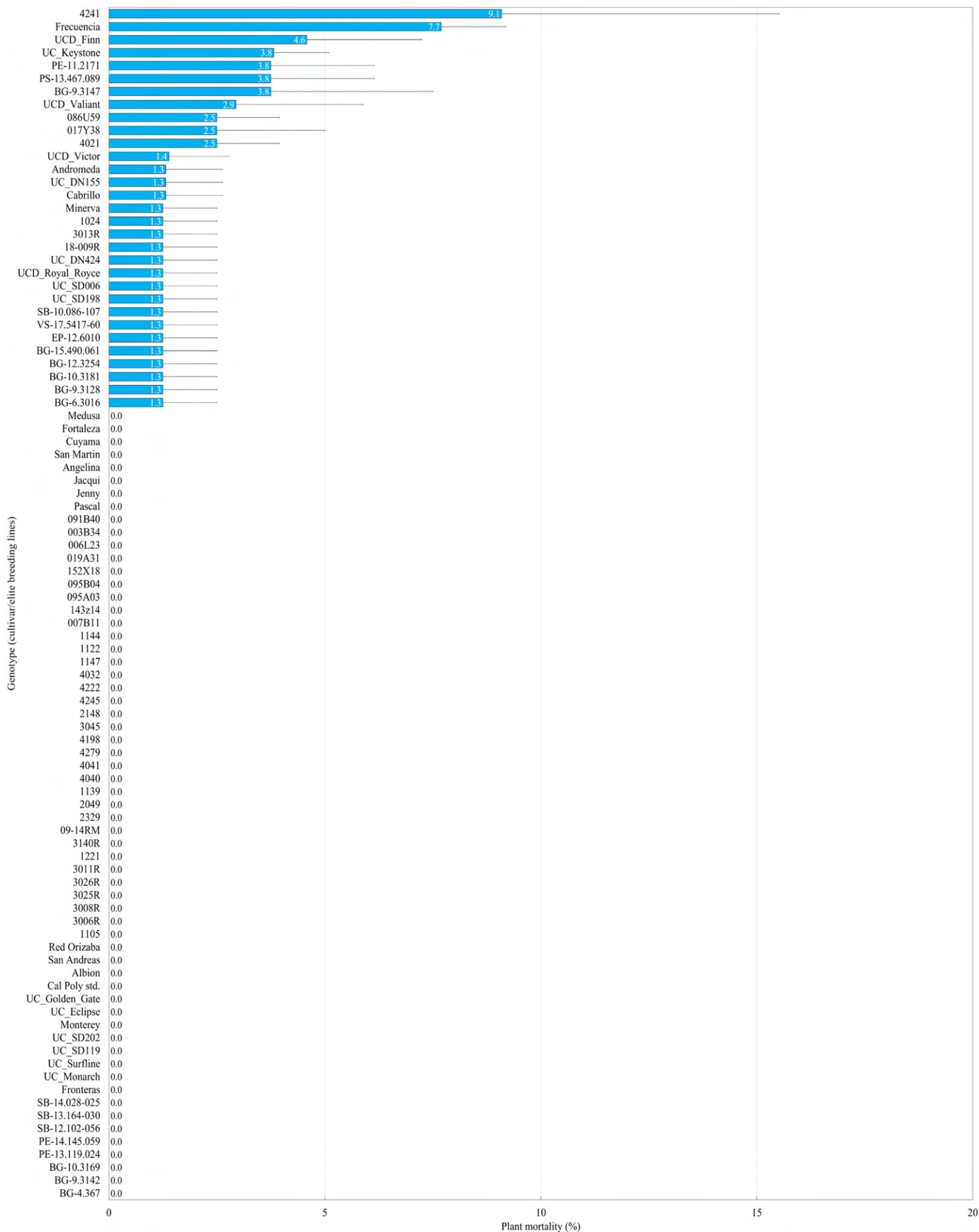


Figure 3. Average percent plant mortality due to Verticillium wilt as of 23 June 2026. Error bars represent standard error from four replicates per genotype (n=4).



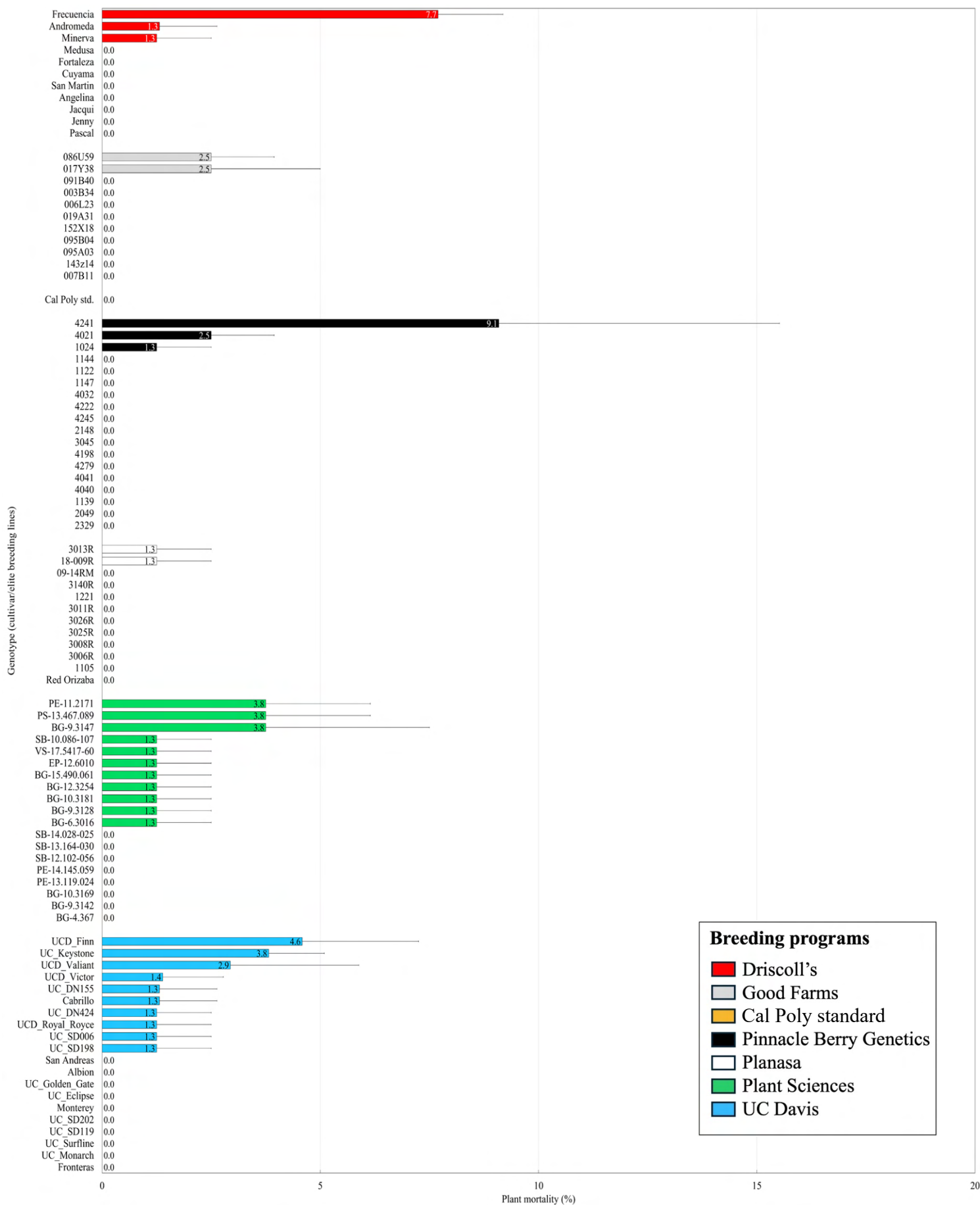


Figure 4. Average percent plant mortality due to *Verticillium* wilt (sorted by breeding program) as of 23 June 2026. Error bars represent standard error from four replicates per genotype (n=4).



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Evaluation of strawberry host resistance to *Fusarium* wilt, Guadalupe, CA, summer 2025

M. A. Vargas, S. Z. Simard, K. A. Blauer, S. S. Hewavitharana and G. J. Holmes

The trial was conducted in Guadalupe, CA, in an organically farmed commercial strawberry field. It was conducted as a pilot study to determine the feasibility of evaluating host plant resistance to *Fusarium oxysporum* f. sp. *fragariae* race 1 (*Fof*), the causal agent of Fusarium wilt. The field consists of naturally infested sandy soil with a history of Fusarium wilt. The field was managed by the grower using standard industry-growing practices for the Santa Maria growing district. Bare-root transplants were planted in raised beds on 31 May 2025. A limited number of cultivars with known levels of resistance to Fusarium wilt were included: five cultivars considered to be Fusarium wilt-resistant (Portola, Eclipse, San Andreas, Artesia, and Alturas) and three Fusarium wilt-susceptible cultivars (Monterey, Cabrillo, and Sweet Ann). Plants were arranged in 65-ft sections across eleven beds. Within each 65-ft section, a 17-ft section, containing 50 plants, was selected to assess plant mortality and disease severity. Beds were 64 in. between row centers with four lines of plants and three lines of drip tape per bed. Plots were replicated four times in a randomized complete block design. Disease severity and plant mortality were recorded every two weeks, from 11 June to 12 November. In September, 10 plants were collected and diagnosed using molecular methods, confirming *Fof* as the causal pathogen. For plant mortality counts, plants were considered “dead” once 100% of the foliage was necrotic. For disease severity, a 1 to 5 scale (1=healthy and 5=dead) was used (data not shown). Data were analyzed using Fisher's LSD mean separation test and analysis of variance using ARM version 2026.0.

Differences in susceptibility to Fusarium wilt were observed among cultivars and were consistent whether measured as disease severity or final plant mortality. ‘Eclipse’, ‘Artesia’, ‘San Andreas’, and ‘Alturas’ displayed the lowest disease severity and mortality (Fig. 1). ‘Portola’ and ‘Cabrillo’ showed intermediate mortality percentages. Portola is often considered a resistant cultivar, and Cabrillo is considered susceptible. In this trial, they performed similarly in mortality, but differed significantly in disease severity, with Portola showing lower susceptibility (1.4/5) to Fusarium wilt than Cabrillo (2.1/5).

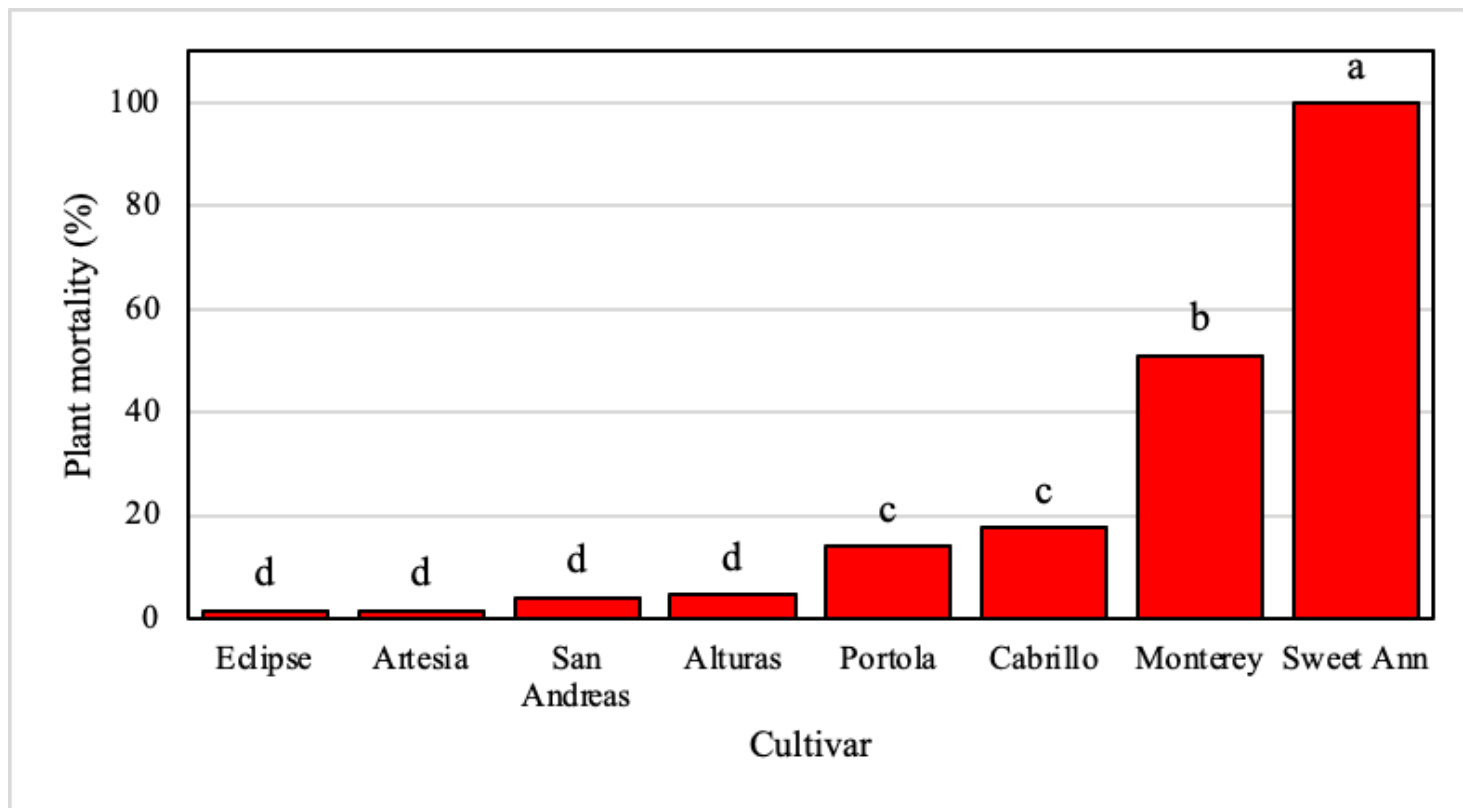


Figure 1. Mean plant mortality for each cultivar as of 12 November 2025. Cultivars with different letters are statistically significant according to Fisher's least significant difference (LSD) mean separation test ($\alpha = 0.05$, $n=4$).



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FIELD TRIAL

A field ProDem was conducted at RVS Ranch on California's Central Coast to evaluate the effects of a foliar application program on strawberry fruit quality. The treatment consisted of Kresko® (16 fl oz) combined with Packhard® (0.5 gallon), applied four times throughout the production cycle at three-week intervals. Fruit quality assessments were performed two weeks after the final application by collecting samples from 10 plants per treatment, with measurements based on the average of five representative fruits from each sampling unit, including ion meter evaluations.

TREATMENT	BRIX	POTASSIUM (K)	WEIGHT	NUMBER FRUITS PER PLANT	REJECTED FRUIT PER PLANT
Innovak Global	9.47%	1016.67 ppm	30.44 g	2.23	1.00
Growers Standard	8.17%	940 ppm	27.97 g	1.5	1.67

Table 1. Fruit Quality measurement

The Innovak Global treatment improved key fruit quality parameters compared to the grower standard, increasing °Brix, potassium concentration, fruit weight, and fruits per plant while reducing fruit rejection (table 1.). These improvements were accompanied by a slight increase in total flats harvested during the evaluation period (Figure 1).



Grower Ignacio Mendoza from Mendoza Growers, INC said, "The ease of use when mixing and applying Kresko with Packhard in the field gave my plants the 1- 2 punch they needed to thrive in peak production last season. I will continue to incorporate these products in my foliar program for years to come."

— Ignacio Mendoza 2026

Packhard
Packhard Fruit Quality &
Post-Harvest Life

Kresko
Fruit Set and Sizing

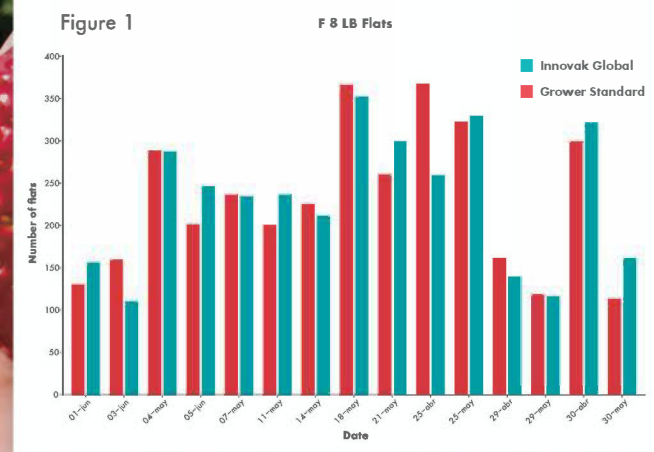
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Arroyo Grande: 16 fl oz/ac in rotation significantly improved marketable yields and cut Botrytis infections at harvest and post-harvest.

Nipomo: Strong gray mold reduction after just 2 sprays early in the program. Excellent crop safety with uniform vigor.

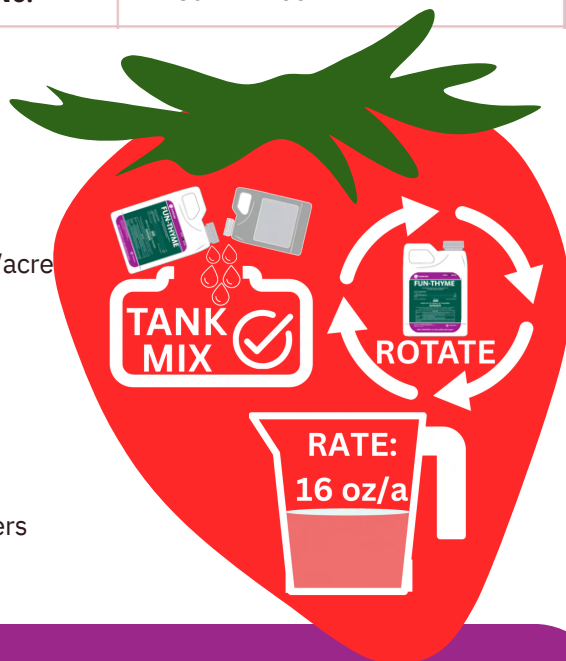
PRODUCT PROFILE QUICK-VIEW

Active Ingredient	26% Thyme Oil
REI / Signal	48 Hours / DANGER
EPA Reg. No.	99869-2-2935

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Standard Application Rate: Apply at a rate of **16 fl oz/acre** (up to 32 fl oz/acre under extreme pressure). Start applications early at bloom or first visible symptoms on 7-day intervals, or in rotation.

Resistance Management Callout: FUN-THYME™ serves as an excellent rotational or tank-mix partner in your current spray program. Its unique multi-site mode of action helps proactively manage and improve resistance populations, making it an ideal tool for both conventional and organic growers alike.



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Establishing pathogenicity of *Colletotrichum gloeosporioides* in California strawberry

K. R. Higgins, G. J. Holmes, and S. S. Hewavitharana

Anthrachnose, caused by *Colletotrichum* spp., is a disease that can cause whole plant collapse and localized lesions on a wide variety of hosts. Historically, the main causal agent of anthrachnose in California strawberry has been the *C. acutatum* species complex. The *C. gloeosporioides* species complex is the main causal agent in the southeastern United States and was previously undocumented in California. In 2024, the Cal Poly Strawberry Center's Disease Diagnostic Service began receiving samples testing positive for *C. gloeosporioides*. The objectives of this project, including a greenhouse trial and detached leaf and fruit assays, are to establish pathogenicity of *C. gloeosporioides* complex isolates in common strawberry cultivars and to compare severity to the established *C. acutatum* complex isolates.

Greenhouse trial

The experiment consisted of a greenhouse trial examining cultivar susceptibility to *C. gloeosporioides* and *C. acutatum*. The trial included cultivars Monterey and Albion inoculated with four *C. gloeosporioides* complex isolates and one *C. acutatum* complex isolate compared against an uninoculated control group. Plants were observed weekly and sampled at mortality. Diseased plant tissue was plated onto ½ strength potato dextrose agar, and disease incidence for both species complexes was evaluated.

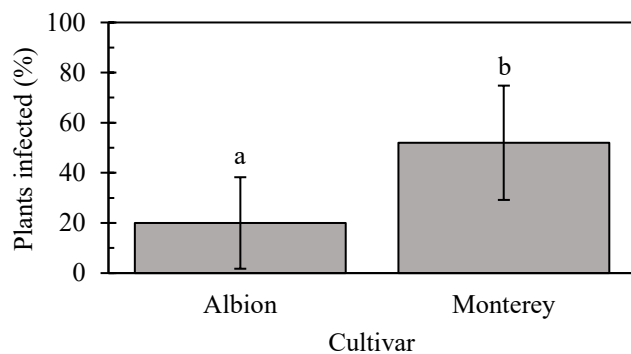


Figure 1. Percentage of plants infected with a *Colletotrichum* spp. by cultivar. Data without connecting letters were statistically significant ($P < 0.05$). Error bars represent standard error ($n = 5$).

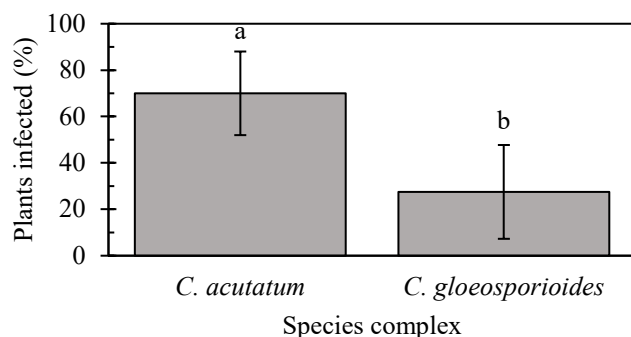


Figure 2. Percentage of plants infected with a *Colletotrichum* spp. by species complex. Data without connecting letters were statistically significant ($P < 0.05$). Error bars represent standard error ($n = 5$).

Leaf and fruit assays

The experiments consisted of two detached leaf and fruit assays examining cultivar susceptibility to *C. gloeosporioides* and *C. acutatum*. The trials included cultivars Monterey, Monarch, and San Andreas inoculated with two *C. gloeosporioides* complex isolates and two *C. acutatum* complex isolates compared against an uninoculated control group. Fruit and leaves were incubated for six days, after which lesion diameter was measured.

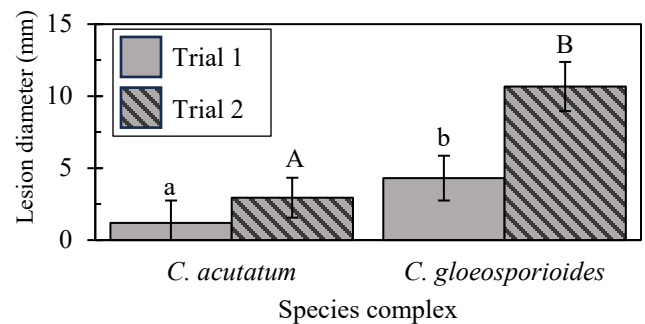


Figure 3. Mean lesion diameter on strawberry leaves after six days of incubation. Data without connecting letters were statistically significant ($P < 0.05$). Error bars represent standard error ($n = 3$).

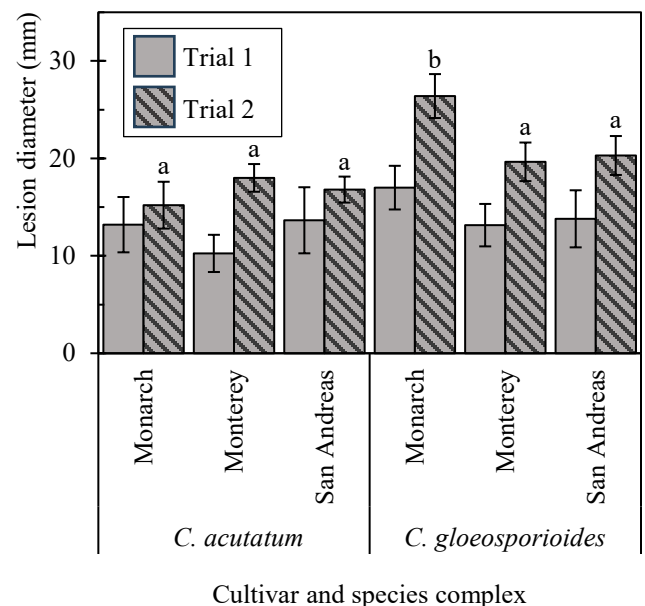


Figure 4. Mean lesion diameter on strawberry fruit after six days of incubation by species complex and cultivar. Data without connecting letters were statistically significant ($P < 0.05$). Error bars represent standard error ($n = 5$).





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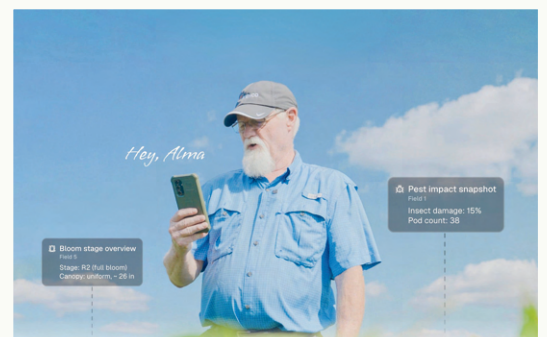


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Operator Aid System (OAS)

G. Kondo, B. Holt, A. Fischer, A. Herman and J. Lin

The operator aid system was developed to improve the performance of spray rigs and bug vacuum systems by monitoring various performance factors and communicating real-time information to both the operators and the managers. Each OAS unit can monitor equipment speed, location, travel path, implement height, air speed in a bug vacuum barrel, nozzle pressure in a spray rig, estimated cost per operation, and other operational factors of interest. The system communicates to operators with gauges and LED lights to indicate the real-time performance of their operation and when to make changes. All measured factors are communicated with managers via a web-accessible dashboard that allows them to see real-time information on the current operation and compare previous operations of all tracked equipment. A demonstration of the OAS dashboard is shown below (Fig. 1). Preliminary results indicate that this system can be beneficial in enhancing the efficacy of the bug vacuum for reducing Lygus bugs and increasing spray rig coverage and uniformity.

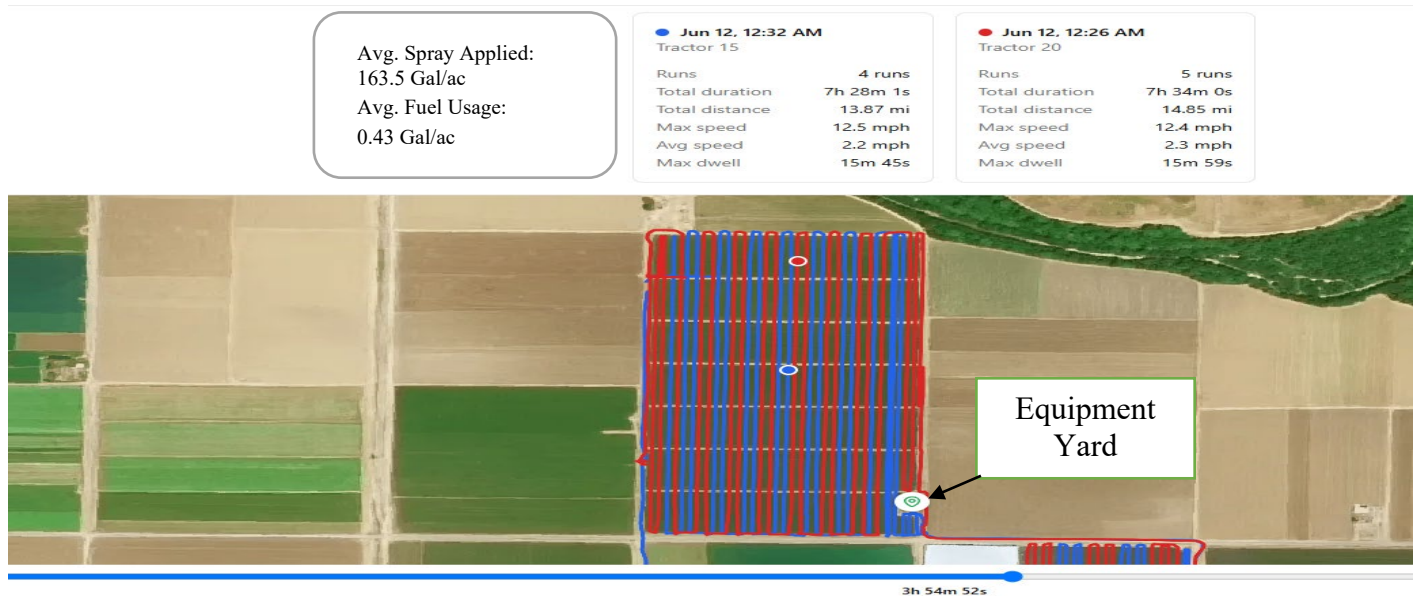


Figure 1. The web-accessible OAS dashboard demonstrates the comparison of two spray rigs operating together on a commercial field. Operational factors are displayed such as tractor idle time, speed, and location, all referenced on a satellite image of the ranch. Managers can scrub through each operation to follow equipment routes and view data by the minute.



Figure 2. A spray rig on a commercial field that is equipped with an OAS monitoring the performance of the operation and communicating relevant data to the operator and manager to help increase spray efficiency.



Autonomous laser runner cutter

G. Kondo, B. Holt, A. Fischer, and J. Lin

The goal of this project is to produce a low-cost autonomous runner cutting machine that identifies strawberry runners and cuts/wounds them by precision burning using a laser as it moves through the field without disrupting fruit production. The system uses off-the-shelf hardware and focuses specifically on California strawberries. This lets us tune the design and machine-learning training for better performance while keeping overall cost down.

To detect runners, we used an RGBD camera to acquire a 3,500-image dataset and benchmarked leading real-time image segmentation models. These included the YOLO family of models, RF-DETR, Mask R-CNN with PointRend, and RTMDet. YOLOv8 performed best for both speed and detection accuracy. It identifies runner boundaries in real time at 30 frames per second and tracks them across the camera's field of view. The software uses these runner detections to aim a high-power laser at its center and fire a controlled burst at a USDA-validated wavelength and power level shown to stop future runner growth.

A web-based app allows remote control and monitoring from any internet-connected device. The system is also designed to adapt quickly to a new field. As little as one day of imaging is enough to calibrate it to local conditions. Initial field tests successfully demonstrated real-time runner detection and laser cutting under production conditions. Testing is ongoing.

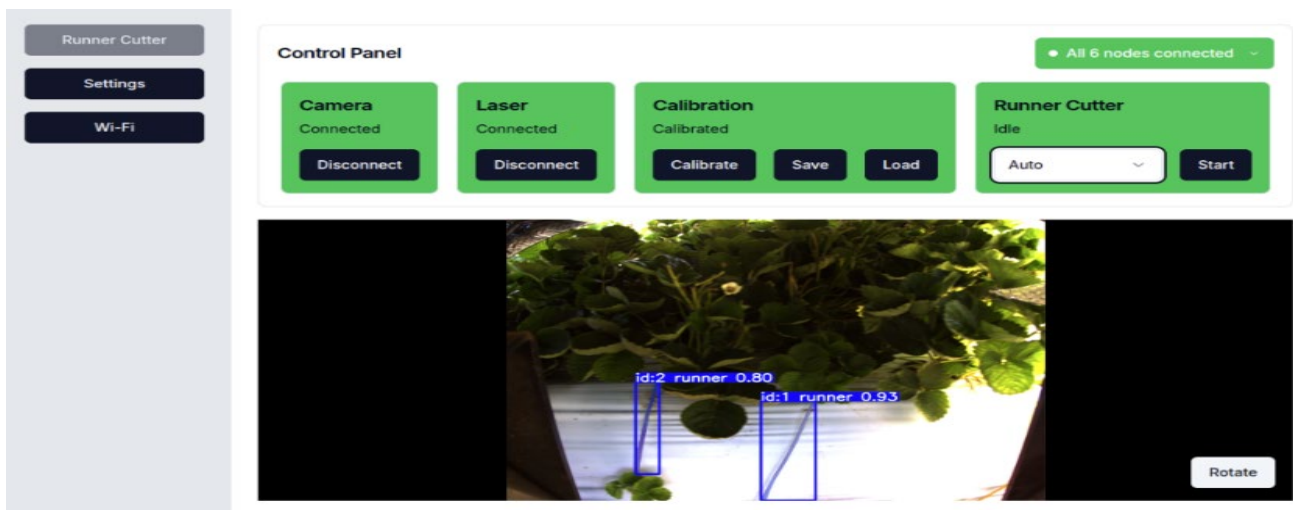


Figure 1. Web-based interface for real-time system control and monitoring.



Figure 2. Laser runner cutter mounted on a Farm-NG Amiga during field testing.



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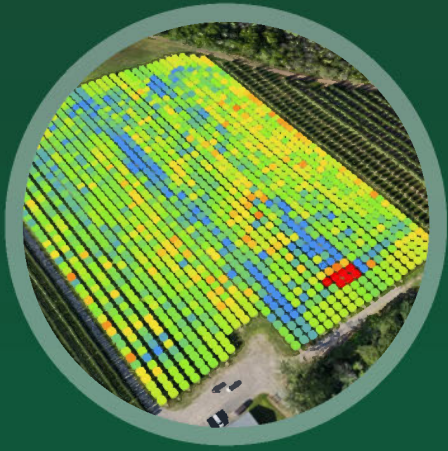
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Mechanical bareroot transplanter

A. Fischer, W. Kraemer, and J. Lin

According to the 2026 acreage report conducted by the CSC, California has 43,726 acres of strawberries planted. Assuming that it costs ~\$1,000 per acre to plant strawberries (UC ANR 2024), the total labor cost associated with planting is \$43 million. This project first timed each subtask required in a manual planting operation to achieve a 5% replant threshold. It was found that 36% of the time associated with planting was spent on repetitive, non-precision tasks such as waiting on boxes, walking to get more plants from boxes, and separating bareroot transplants from each other. This data was collected across 5 days of planting with laborers being paid piece rate. Second, we experimented with various designs and materials (Figs. 1, 2, and 3) to develop a material handling system that can retain the benefits of a transplant plug without increasing the cost of a traditional bareroot transplant. Lastly, we analyzed and reengineered current mechanical planters outside of the strawberry industry (Fig. 4) to design one that would work for our industry (Fig. 5). A mechanical transplanter system could reduce replanting rate and j-rooting by increasing plant depth consistency. Furthermore, it provides a platform to introduce treatments (e.g., fungicidal dips) to each bareroot transplant.



Figure 1. Prototype 1 of a bareroot wrapping mechanism. The tension in the PVA material while wrapping was found to be desirable, however, the loading mechanism was too slow.



Figure 2. Prototype 2 of a bareroot wrapping mechanism. This design included both loading and manufacturability improvements, however, it lowered the tension consistency as the PVA material was wrapped around bareroots.



Figure 3. Commercial field testing of a custom PVA/glycerol material. This material retains all beneficial qualities of commercially produced PVA thread, while allowing flexibility and control of components and material characteristics.



Figure 4. A modified sweet potato transplanter that was used to test planting concepts such as conveyance methods, material handling, and a plant insertion systems.

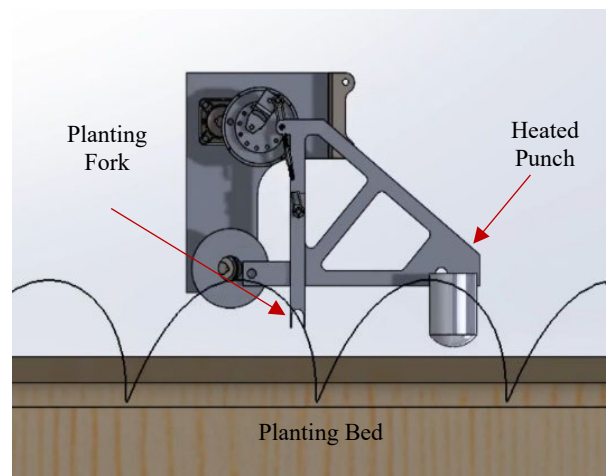


Figure 5. A model of the current development of a California strawberry-specific bareroot transplant planting implement. The idea is to punch holes in the mulch ahead of a planting fork that is attached to the same timing and driving mechanism as the heated punch. The fork will pick up individual plants and insert them into the next punched hole while the tractor is in motion.



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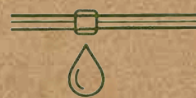
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Evaluation of Kanemite 30 SC® against twospotted spider mite

K. I. Rodriguez Diaz, C. T. Koubek, and M. A. Aghaee

Spray dates	6 March
Sampling dates	9, 13, 18 and 25 March 2025
Backpack sprayer specs	8 hollow cone Teejet nozzles calibrated to deliver 150 GPA at 60 psi
Trial design	Randomized complete block; replicated 4 times; 4 × 10 ft plot area
Location	Cal Poly Strawberry Center Field 35A
Cultivar	Albion
Data Collection	10 randomly selected leaves were collected as sample leaves.

A new formulation of acequinocyl, Kanemite 30 SC®, was tested for control of twospotted spider mite (TSSM) in strawberries. The study was conducted at Field 35A at Cal Poly. Enervate 4 SC® and Kanemite 15 SC® were used as standards along with an untreated control. Dyne-Amic® was used as an adjuvant in all treatments at a rate of 0.25% v/v. Adult and nymph counts were analyzed separately at each sampling data using a generalized linear mixed model with a Poisson distribution in JMP version 19.0 (SAS Institute Inc., Cary, NC) to analyze differences between treatments.

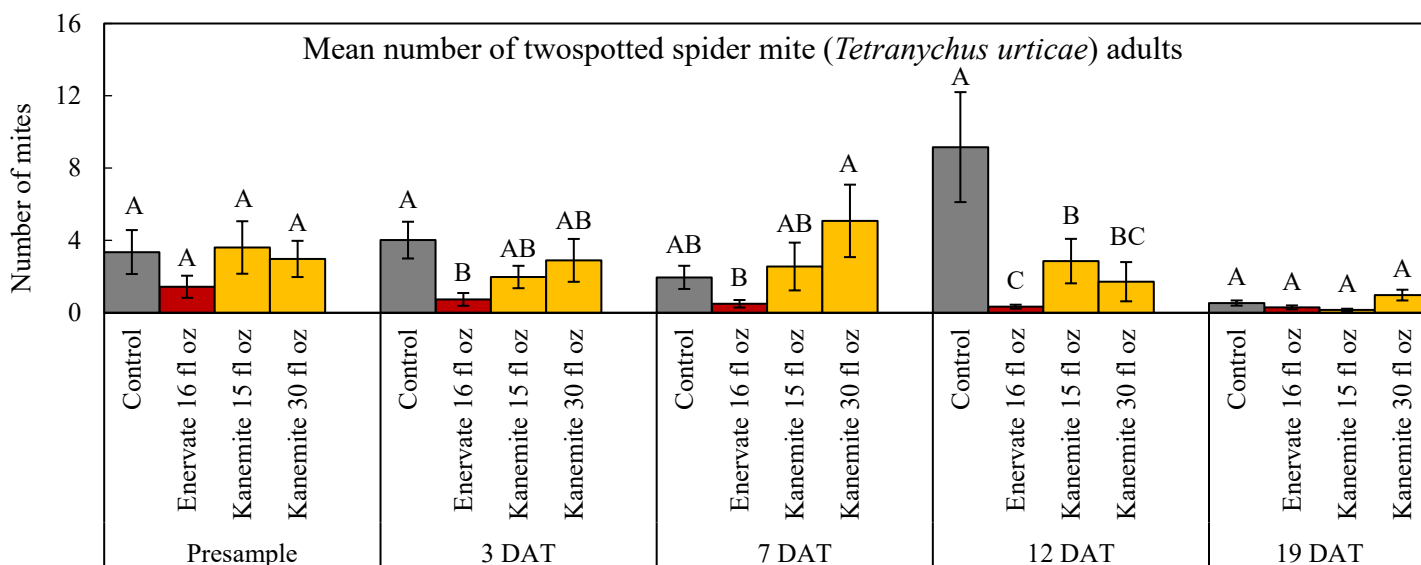


Figure 1. Twospotted spider mite (*Tetranychus urticae*) untransformed adult counts at the following sample times: Presample, 3, 7, 12, and 19 days after treatment (DAT). Dyne-Amic® was mixed with all products at 0.25% v/v and carrier volume of 150 GPA. Means that do not share the same letter are significantly different ($\alpha=0.05$).

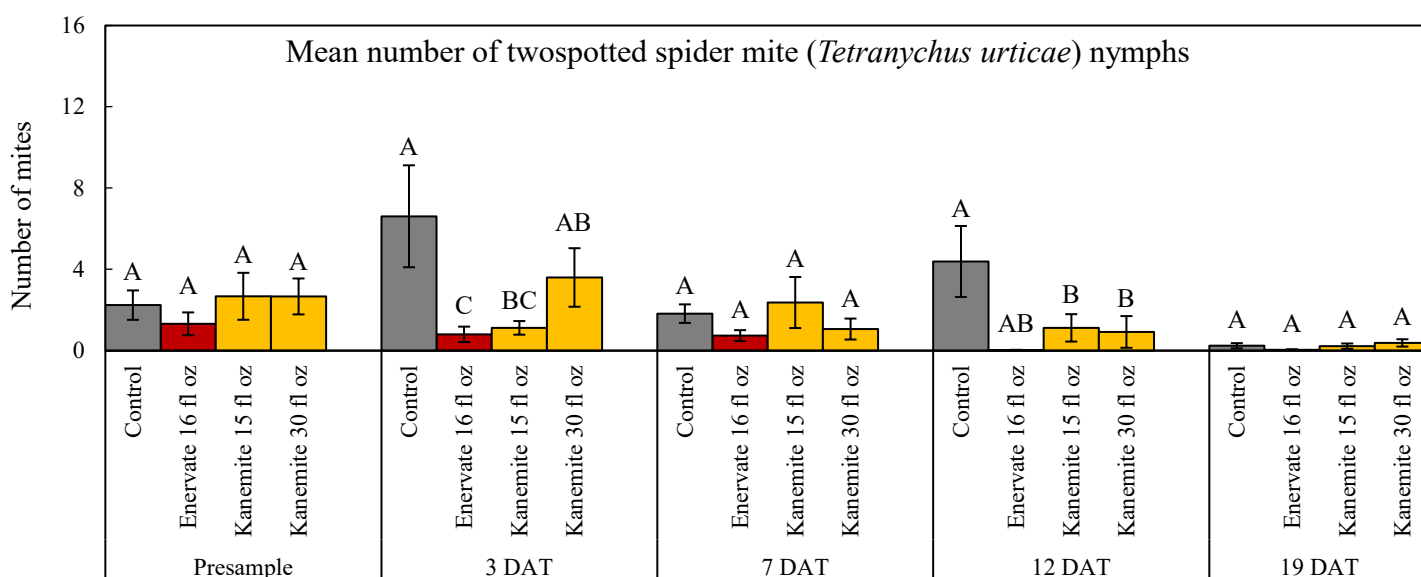


Figure 2. Twospotted spider mite (*Tetranychus urticae*) untransformed nymph counts at the following sample times: Presample, 3, 7, 12, and 19 days after treatment (DAT). Dyne-Amic® was mixed with all products at 0.25% v/v and a carrier volume of 150 GPA. Means that do not share the same letter are significantly different ($\alpha=0.05$).



Efficacy of Sefina ® against western flower thrips

M. A. Aghaee, E. E. Henry, C. T. Koubek

Spray dates	4, 11, 18 May
Sampling dates	4, 5, 7, 11, 14, 18, 19, 21, 25 May
Backpack sprayer specs	8 hollow cone Teejet nozzles calibrated to deliver 150 GPA at 60 psi
Trial design	Randomized complete block; replicated 5 times; 4 × 15 ft plot area
Location	Cal Poly Strawberry Center Field 35A
Cultivar	Albion
Data Collection	10 of either 1-day old flowers, 3- to 4-day old flowers, early fruit in 20 ml ethanol (95%)

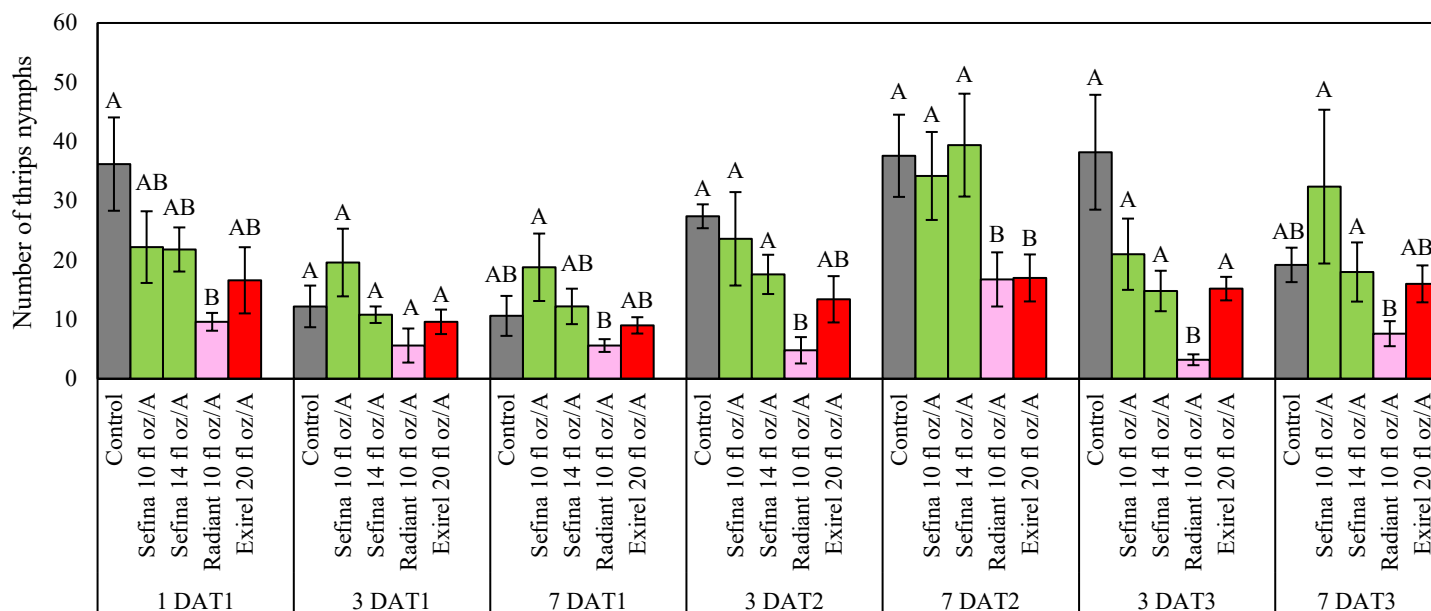


Figure 1. Comparing western flower thrips nymphs from across multiple days after treatment. Dyne-Amic® was added at a rate of 18 fl oz/A to all products. Data was analyzed using ANOVA and Tukey means separation using PROC GLIMMIX with a negative binomial distribution at each sampling date in SAS 9.4®. Means that do not share the same letter are significantly different ($\alpha=0.05$). *1DAT white flowers, 3 DAT 3- to 4-day old flowers, and 7 DAT early fruit were collected on those dates.

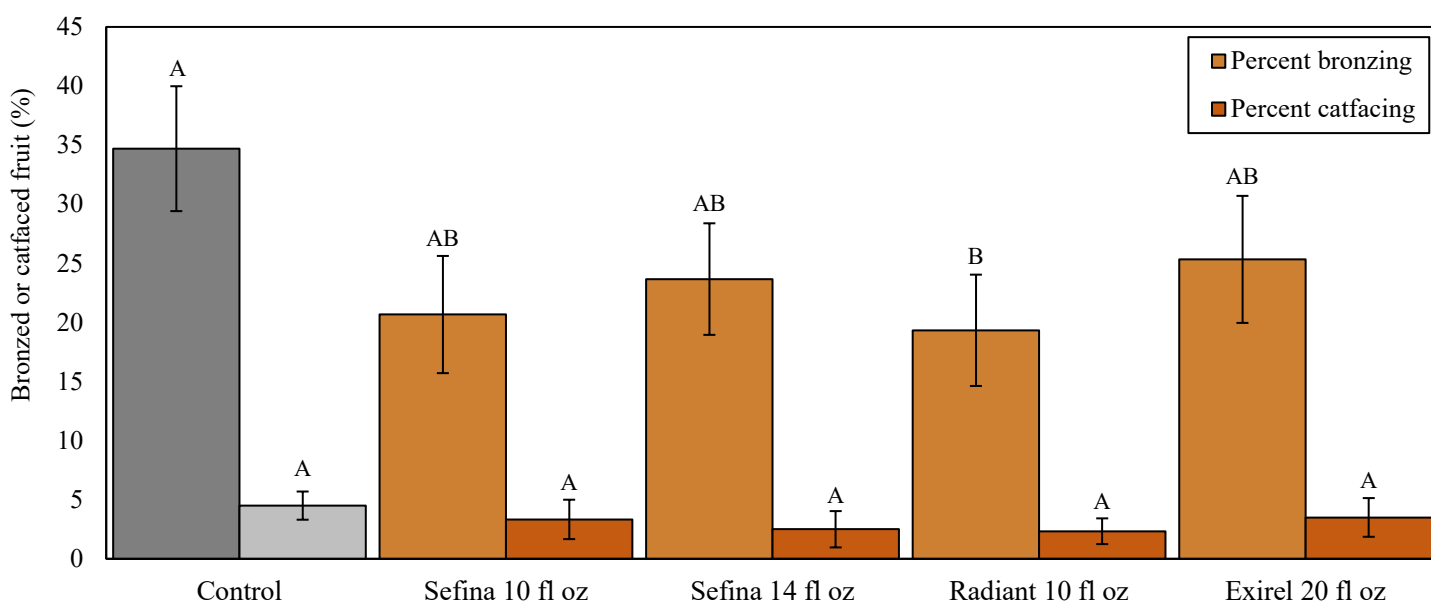


Figure 2. Percent bronzed and catfaced white fruit over two weeks of collection. In the first week twenty fruit were collected per plot, and 40 fruit were collected in the second week. Means that do not share the same letter are significantly different ($\alpha=0.05$). Bronzing was analyzed with an ANOVA and Tukey means separation using PROC GLM on arcsine transformed data. Catfacing was analyzed with an ANOVA and Tukey means separation using PROC GLIMMIX with a binomial distribution in SAS 9.4®.





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Mite cultivar evaluation for host plant resistance to twospotted spider mite, 2026

S. E. Rodriguez, C. T. Koubek and M. A. Aghaee

The experiment was conducted in Field 35A at Cal Poly. Bare root strawberry transplants were planted into raised beds on 31 October 2025. Beds were covered with 1.1 mil black TIF (totally impermeable film) polyethylene mulch (TriCal Inc., Hollister, CA). The experimental area consisted of eleven beds, 120 ft long. Each strawberry bed was 64 in. center to center with four rows of plants spaced 12 in between rows and 15.5 in between plants within a row. Plants were irrigated and fertilized via three lines of drip tape per bed. Each cultivar was planted in a plot that was 5 ft long, replicated four times, and arranged in a randomized complete block design. Each plot was hand infested with twospotted spider mites (*Tetranychus urticae*) once in February and again in April. Five leaflets were collected every two weeks beginning 10 February and ending 20 May 2026 with a total of 8 sampling dates. All adults, nymphs, and eggs were counted.

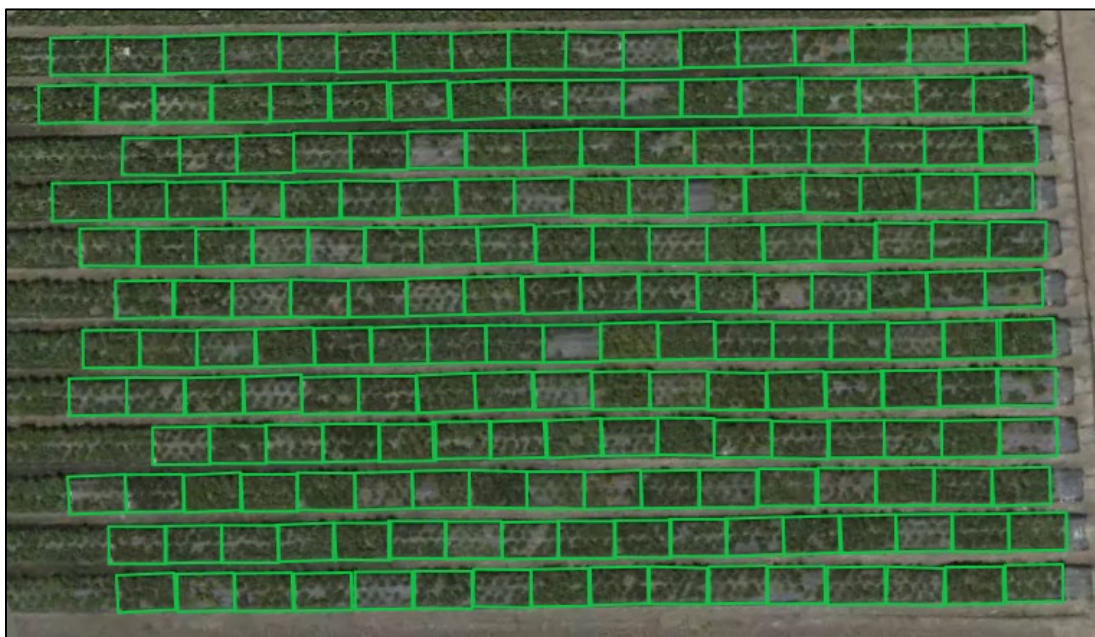


Figure 1. Aerial image of the mite cultivar field trial on 24 April 2026, located in field 35A on the Cal Poly SLO farm taken by AerialPlot. Plants in the area outlined in green were infested with twospotted spider mites in February and April 2026.



Figure 2. Image of early season twospotted spider mites (winter form) feeding on the underside of a strawberry leaflet. Note the size of the trichomes (plant hairs) relative to the mites.

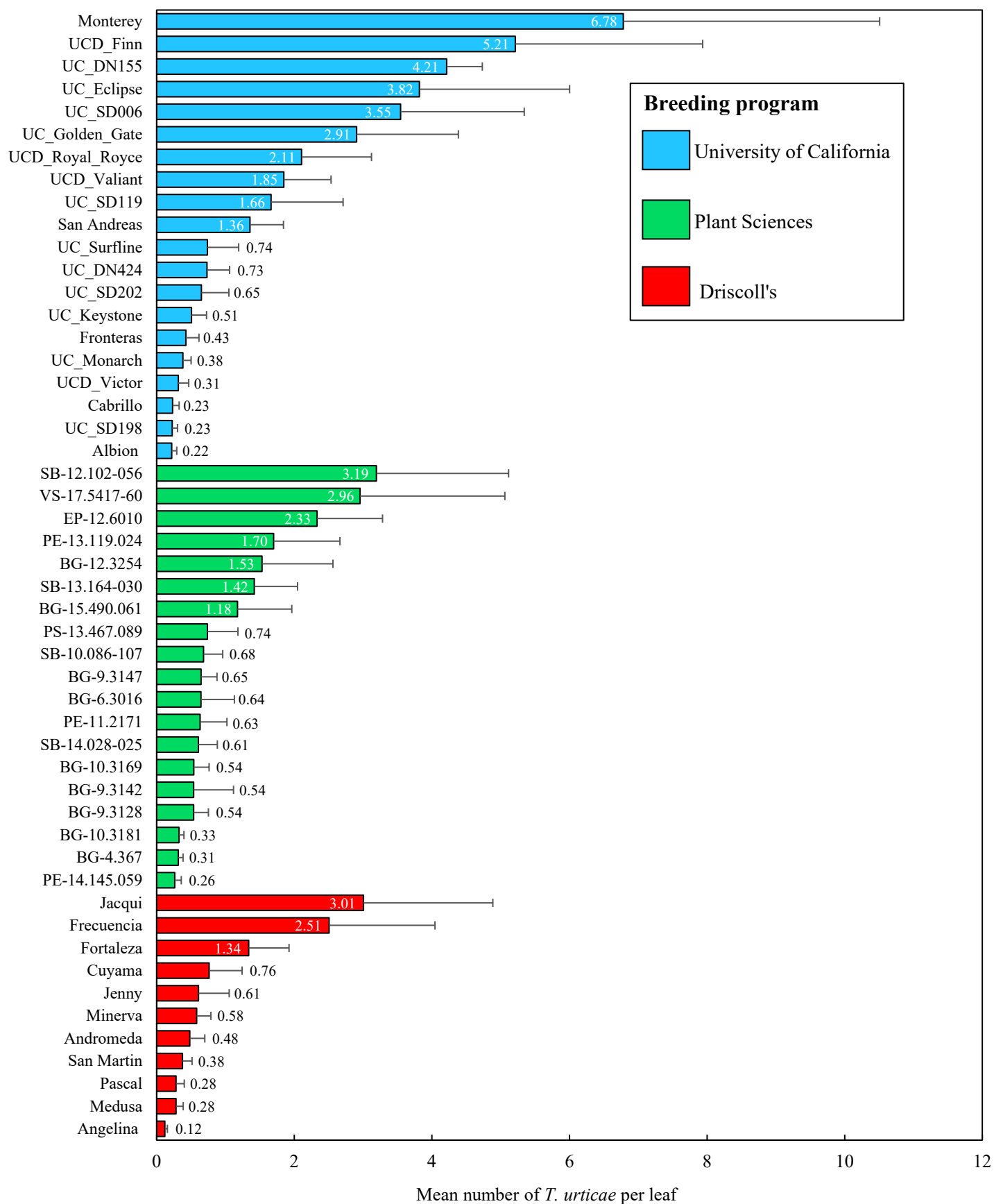


Figure 3. Twospotted spider mite (*Tetranychus urticae*) nymph and adult combined counts on genotypes/cultivars averaged across the seasonal sampling collections for ease of presentation.



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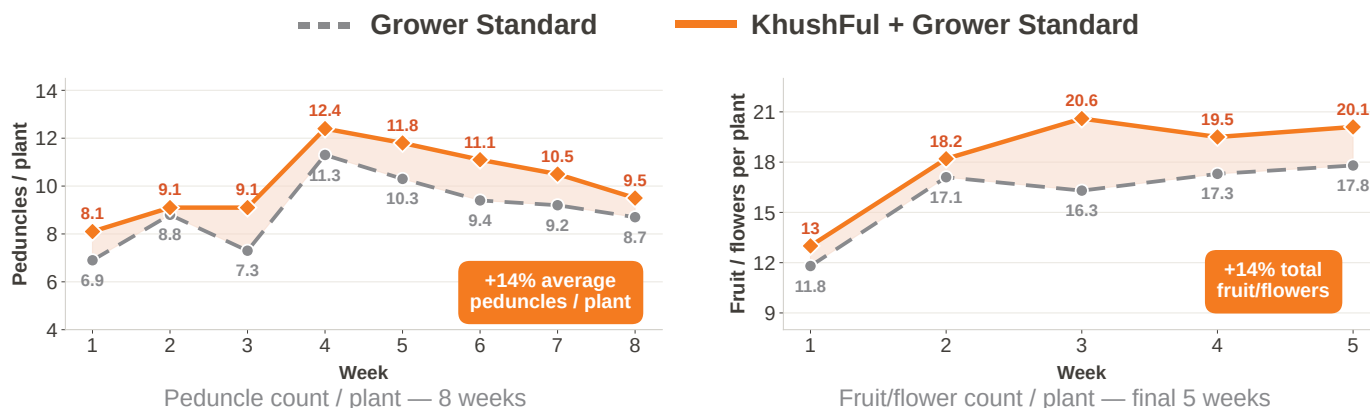
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Evaluation of bug-vacuum efficacy on *Lygus hesperus* in organic and conventional strawberry production

M. A. Aghaee, C. T. Koubek, and E. E. Henry

A multi-season evaluation of TRIC robotics bug-vacuum was conducted. In both years, the vacuum was tested in both organic and conventional fields. In 2025, the experimental design contained five replicates but was not randomized. In 2026, the experimental design was a randomized complete block design, with 5 replicates in the conventional field, and 4 replicates in the organic field. *Lygus hesperus* were sampled weekly with a handheld vacuum before being transported to the lab and counted. The organic and conventional trial area was approximately 43 and 29 acres, respectively in 2025. In 2026, the organic and conventional trial area was approximately 15 and 25 acres, respectively. Data collection in 2026 is not yet completed. Data will be analyzed alongside catfacing and commodity prices to determine the value of bug vacuuming. Data suggests that the bug vacuum provides an additive effect in reducing the *Lygus* field population.

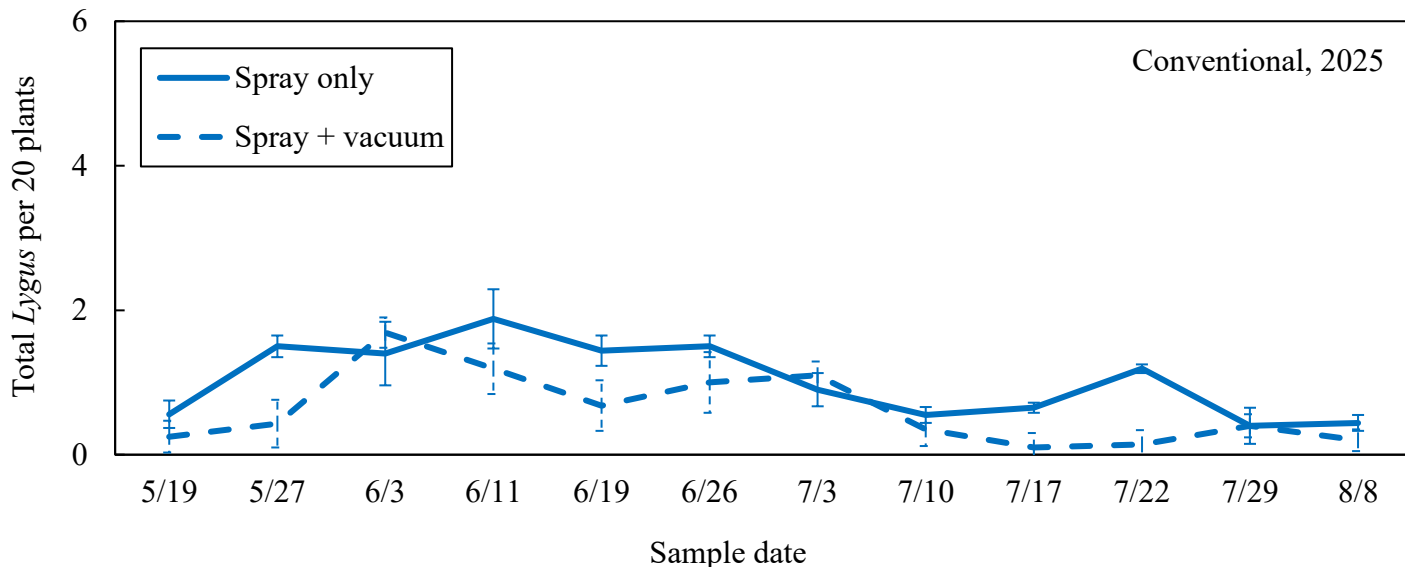


Figure 1. Average combined counts of *Lygus hesperus* (nymphs + adults) in a conventional ranch with standard errors across 12 weeks in 2025. Study was conducted in a conventional strawberry field.

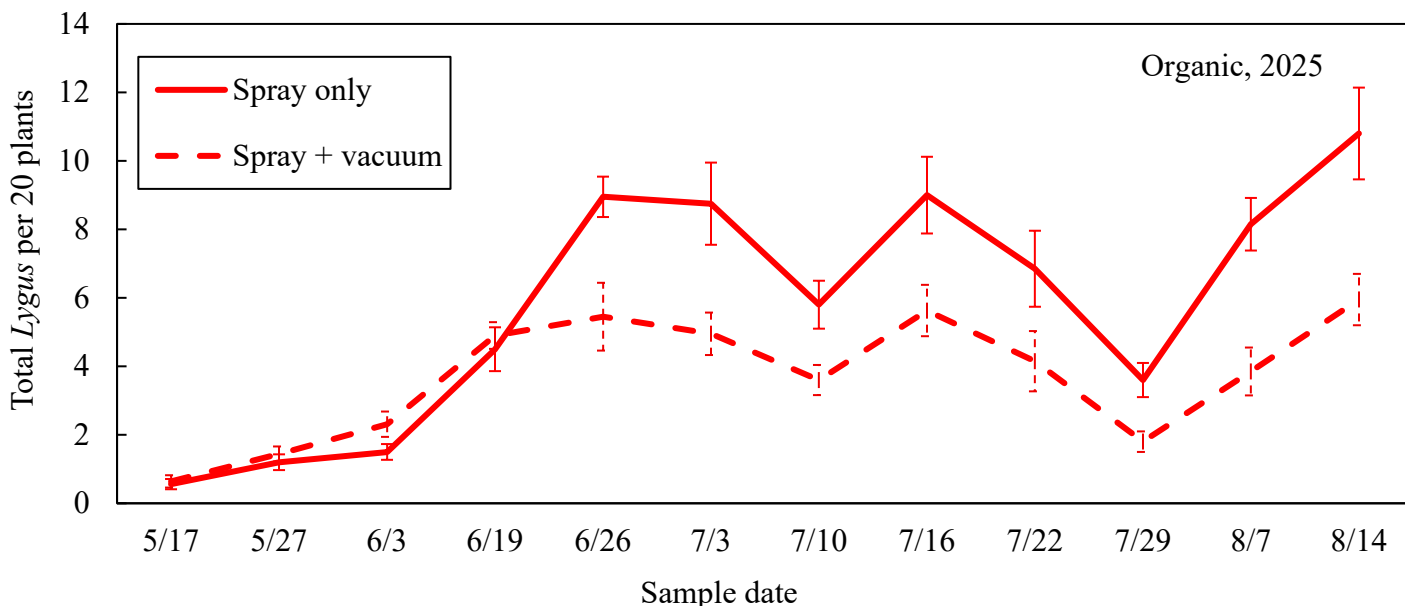


Figure 2. Average combined counts of *Lygus hesperus* (nymphs + adults) in an organic ranch with standard errors across 12 weeks in 2025. Study was conducted in an organic strawberry field.



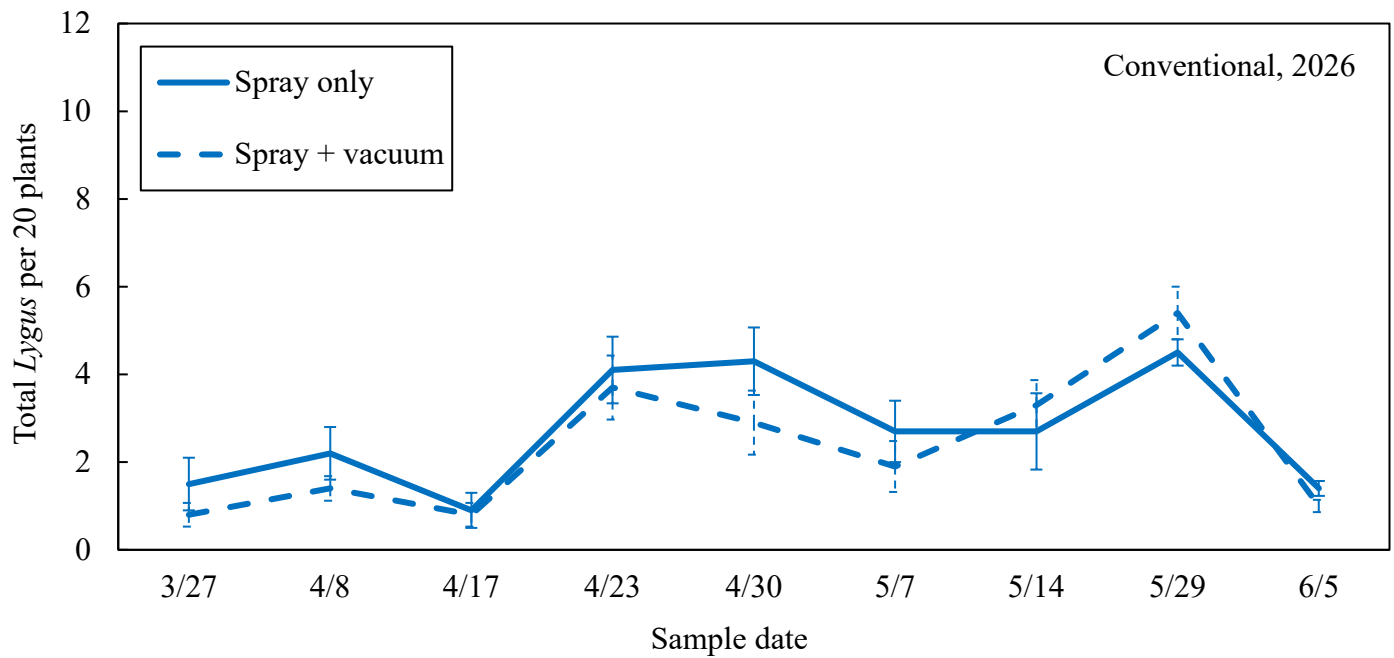


Figure 3. Average combined counts of *Lygus hesperus* (nymphs + adults) in a conventional ranch with standard errors across 9 weeks in 2026. Further data collection remains. Study was conducted in a conventional strawberry field.

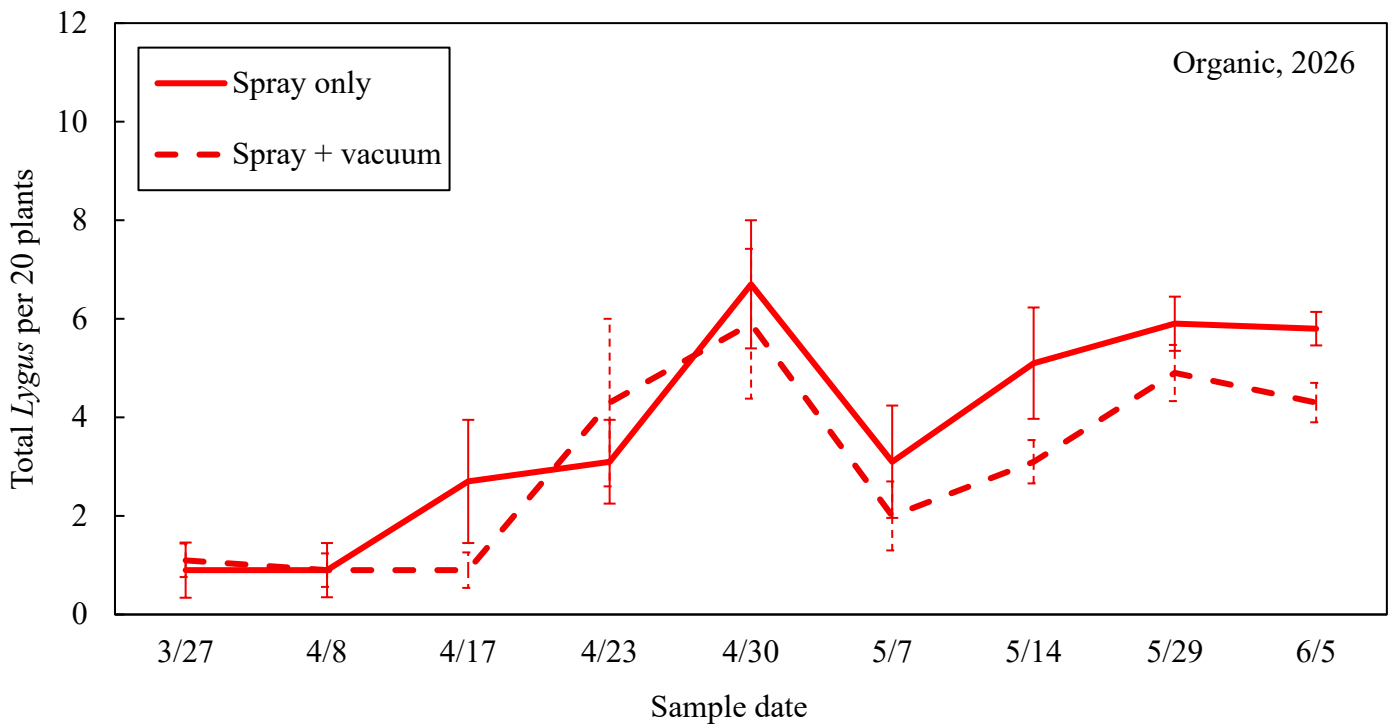


Figure 4. Average combined counts of *Lygus hesperus* (nymphs + adults) in an organic ranch with standard errors across 9 weeks in 2026. Further data collection remains. Study was conducted in an organic strawberry field.





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Key Results

- **61% flowering by week 11** with Iodine treatment
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The result: higher marketable yield and nearly \$500 per acre in additional returns.



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Miticide tolerance in field populations of twospotted spider mite, 2025

M. A. Aghaee, C. T. Koubek, and E. E Henry

Adult twospotted spider mites (TSSM; *Tetranychus urticae*) were sampled from strawberry fields across all three strawberry production districts. For ease of analysis all fields were grouped by county: Monterey, San Luis Obispo, Santa Barbara, Santa Cruz, and Ventura County. The miticides Nealta® (a.i. cyflumetofen; IRAC 25), Enervate 4 SC® (a.i. bifenazate; IRAC 20D), Agri-mek SC® (a.i. abamectin; IRAC 6) Fujimite 20 SC (a.i. fenpyroximate; IRAC 21A), and Kanemite 15 SC (a.i. acequinocyl; IRAC 20B) were evaluated. Compounds were sprayed at the maximum labeled rate. A susceptible colony was used as a comparison for each sample population.

Negative controls were not sprayed. For each location and chemical treatment, five adults were placed on a green bean leaf disc, with five replications per treatment and location combination. All leaf discs were then sprayed using a Potter's tower at each chemical's maximum field rate, at a volume equal to 150 gallons per acre, and mite mortality was recorded 48 hours post-application.

Raw mortality proportions were rank transformed using PROC RANK in SAS (SAS Institute, Cary, NC) to account for the non-normal distribution of the data, and the resulting ranks were analyzed using a generalized linear mixed model (PROC GLM) by each chemical to detect differences between counties. Mean separation was performed using Dunnett's test at $\alpha = 0.05$. Untransformed percent mortality means and standard errors are reported in the figure below for ease of interpretation.

Data suggests that location/county had a significant effect on the performance of all miticides. Ventura had instances of high tolerance to all miticides tested. All other counties had only moderate instances of high tolerance to miticides detected in 2025. Further testing is warranted to confirm if this is a long-term trend. Our data points to the importance of maintaining chemical rotations and integration of biological control to avoid reductions in efficacy of our chemical tools.

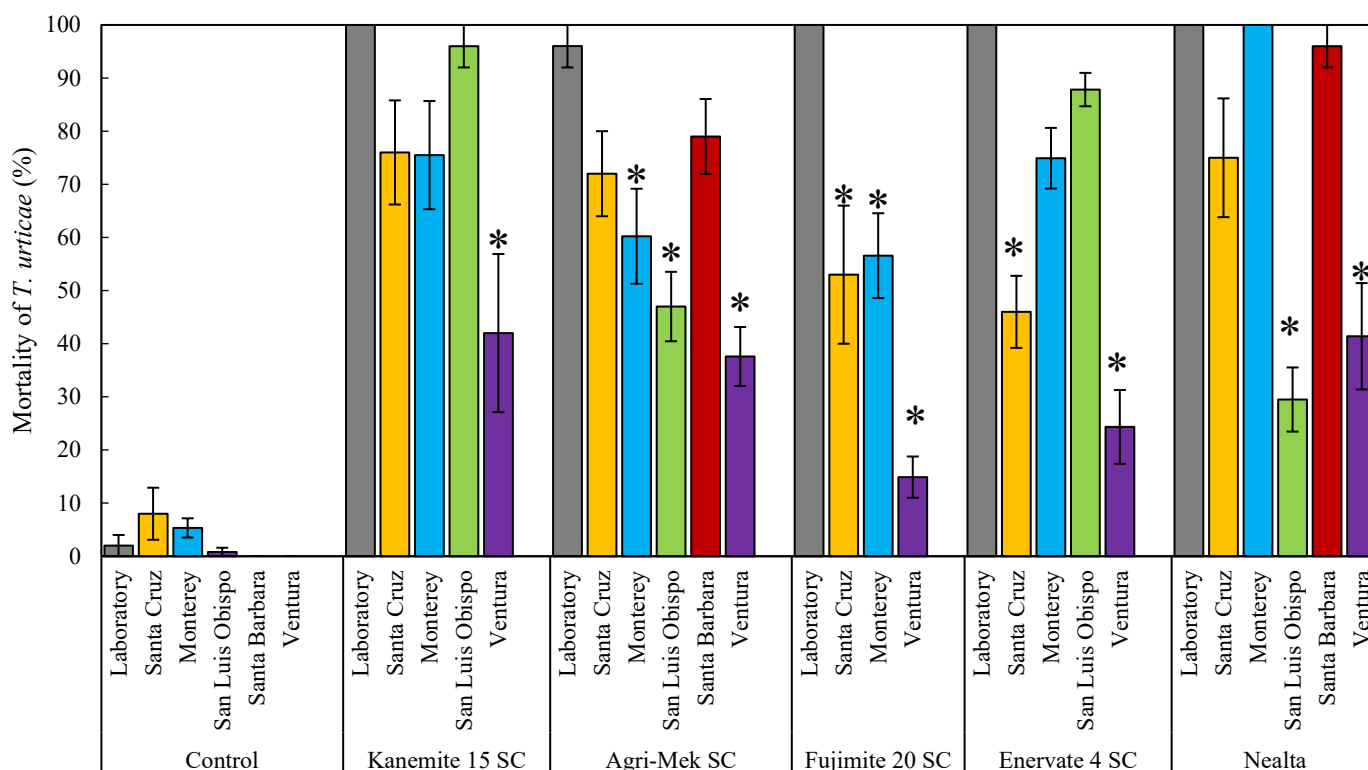


Figure 1. Comparison of acaricide mortality by county. Mean mortality ($\pm$ SE) of adult twospotted spider mites (TSSM) 48 hours after application of maximum field rate of Kanemite 15 SC (31 fl oz/A), Agri-mek SC (3.5 fl oz/A), Fujimite 20 SC (7.45 fl oz/A), Enervate 4 SC (16 fl oz/A), and Nealta (13.7 fl oz/A). Bars with an asterisk are significantly different to the Laboratory mortality ($\alpha = 0.05$).



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Evaluating sterile male to wild type ratios of *Drosophila suzukii* for population suppression in a confined environment

E. E. Henry and M. A. Aghaee

In 2026, we began to investigate sterile insect technique (SIT) as a management tool for spotted wing drosophila (SWD; *Drosophila suzukii*) in California strawberry production. SWD is an invasive vinegar fly that lays eggs into ripening fruit using their serrated ovipositor. Infested fruit is unrecognizable to the naked eye and mistakenly harvested, leading to rejections for the fresh and processing markets and increased preventative monitoring costs. Chemical management is the main tool used due to quick efficacy and residual effects on adult flies. However, there is significant need for nonchemical alternatives as current reliance on chemical management poses challenges for the future in California. SIT is a nonchemical approach for suppressing SWD populations that involves releasing large amounts of sterile males to mate with wild females, resulting in unfertilized eggs and lower reproductive capacity. There is limited information about the effectiveness for SIT use as a management tool in California strawberry production. This project aims to address this knowledge gap through generating data that will show the ratios of sterile males to wildtype males necessary for optimal use. This experiment is currently being conducted under USDA containment and permitting. Treatments consist of 5 ratios of sterile male to wildtype males (0:1 Control, 1:1, 10:1, 20:1, and 40:1) on blueberries, strawberries, and standard SWD diet. Temperature and humidity are consistent across all treatments and chosen to simulate California strawberry production climates. After exposure to sterile males for one week, the first generation of emerging SWD are collected, sexed, and counted for comparison among treatments. In strawberries, a 10:1 ratio reduces the population by nearly 40% compared to the control. In standard SWD diet, a 40:1 ratio reduces the population 60% compared to the control. In blueberries, a 40:1 appears to be the most effective compared to the other treatments. This experiment is in progress and will run until the end of 2026.



Figure 1. Arenas used to test the ability of the sterile insects to suppress oviposition. Left: the strawberry arena. Right: the diet arena. Both had foam plugs and mesh on the lid.

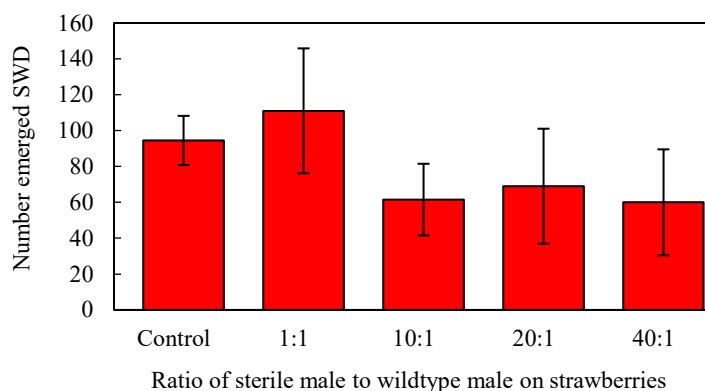


Figure 2. Emerged spotted wing drosophila adults from strawberries normalized by weight. Error bars represent the standard error of the mean.

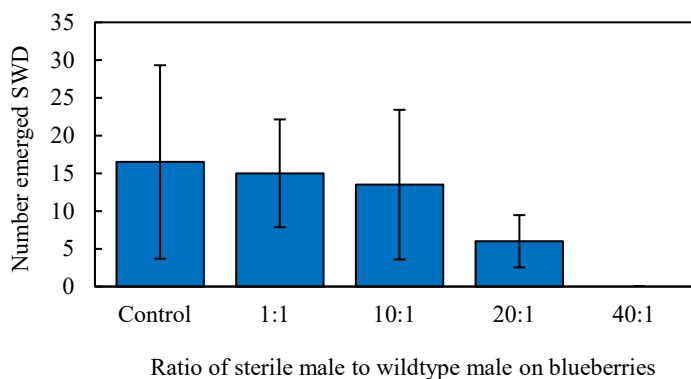


Figure 3. Emerged spotted wing drosophila adults from blueberries normalized by weight. Error bars represent the standard error of the mean.

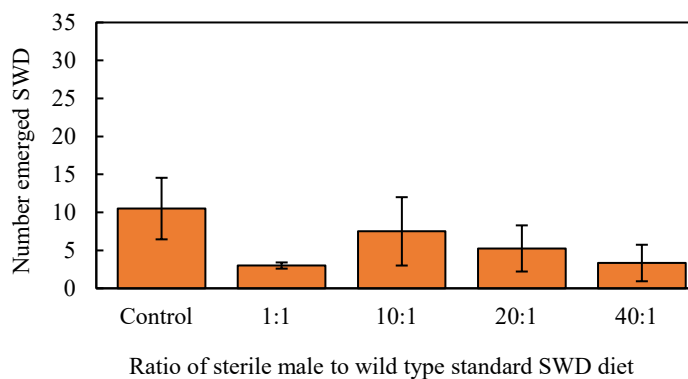


Figure 4. Emerged spotted wing drosophila adults from diet normalized by weight. Error bars represent the standard error of the mean.





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Assessing quality control methods of commercially reared *Phytoseiulus persimilis* for biological control

T. K. Hibino and M. A. Aghaee

From 2024-2026, we evaluated the quality of commercial *Phytoseiulus persimilis*, a key predatory mite used to manage twospotted spider mites (*Tetranychus urticae*) in California strawberries. Three evaluation methods were tested: the lab's original "Old Method," which uses a heated lamp to drive mites down onto sticky cards through a sieve; the International Organization for Biological Control's (IOBC) subsampling method to estimate live and dead mites; and a reverse Berlese method that uses light to draw mites upward (Fig. 1). Eighty bottles were assessed to compare mite recovery rates of the counting methods. In bottles labeled as containing 2,000 mites (2k bottles), IOBC and reverse Berlese both recovered approximately 102% of the labeled mite count, compared to 76% for the Old Method. In 4k bottles, IOBC estimated 94% of the labeled count, reverse Berlese recovered 83%, and the Old Method recovered 74% (Fig. 2). For both bottle sizes, reverse Berlese recovered more mites than the Old Method and produced estimates comparable to the industry-standard IOBC method. In addition to providing a quantitative estimate, reverse Berlese allows for qualitative assessment of mite condition and quality, making it a promising tool for predatory mite quality control. Additional testing and statistical analyses are ongoing.

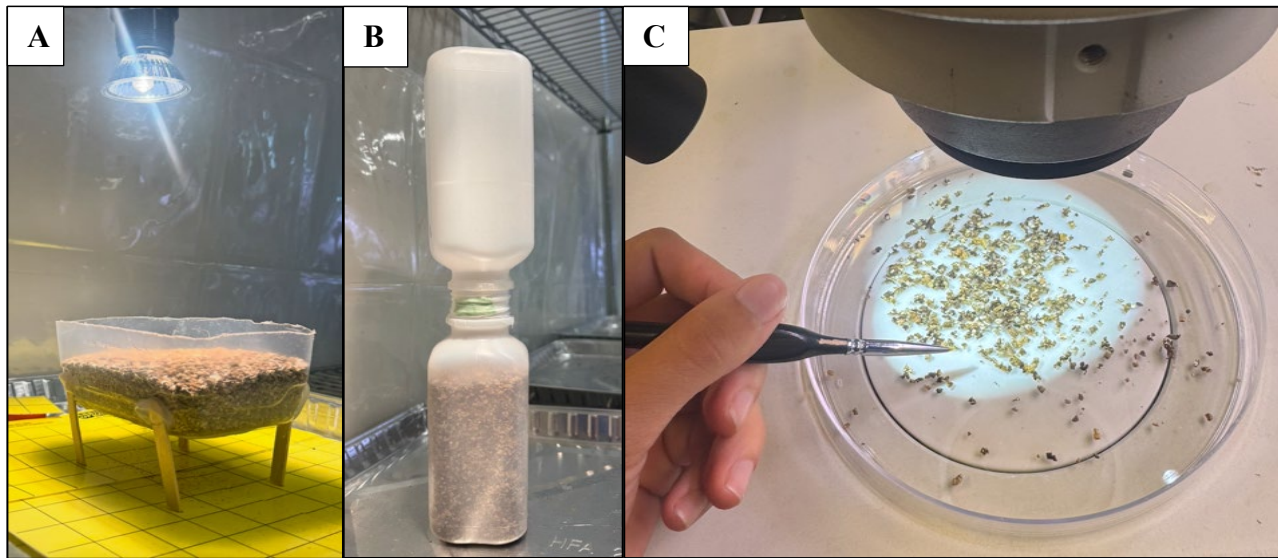


Figure 1. Methods used to assess the quality and quantity of *Phytoseiulus persimilis*: the "Old Method" (A), the reverse Berlese method (B), and the IOBC subsampling method (C).

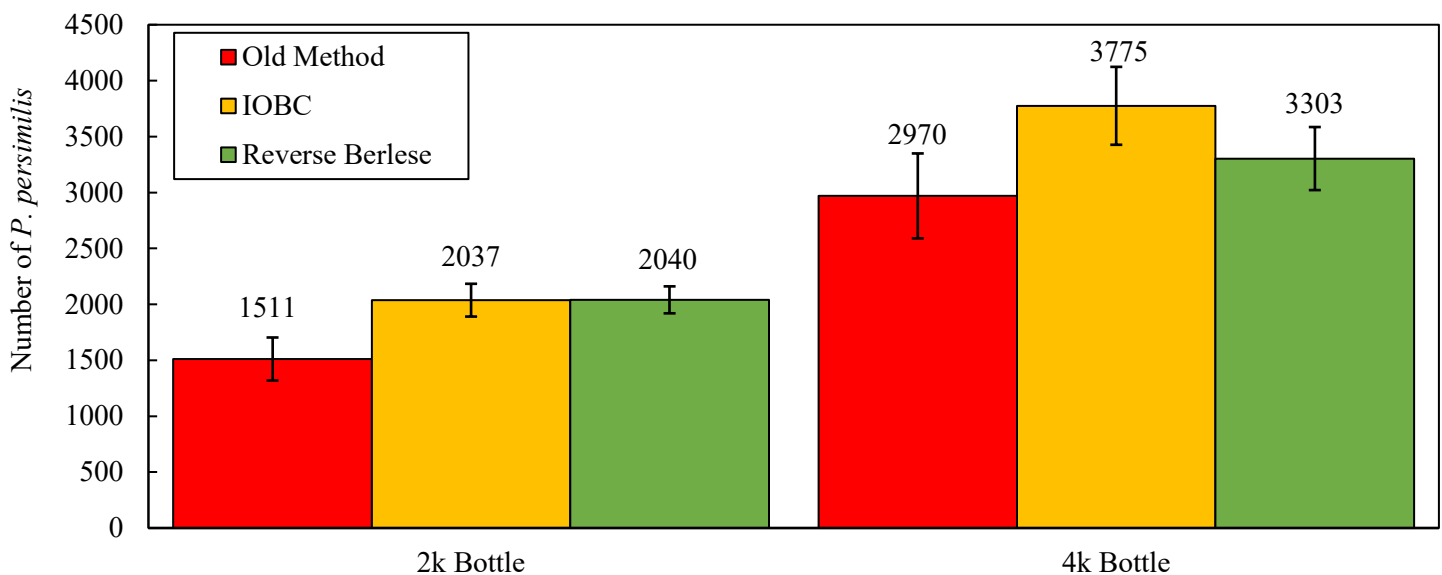


Figure 2. Comparison between the labeled number of mites (2k or 4k) and the average number of mites recovered using the Old Method, IOBC, and reverse Berlese methods. Eighty bottles were sampled for this study from 2024-2026. Error bars represent the standard error.



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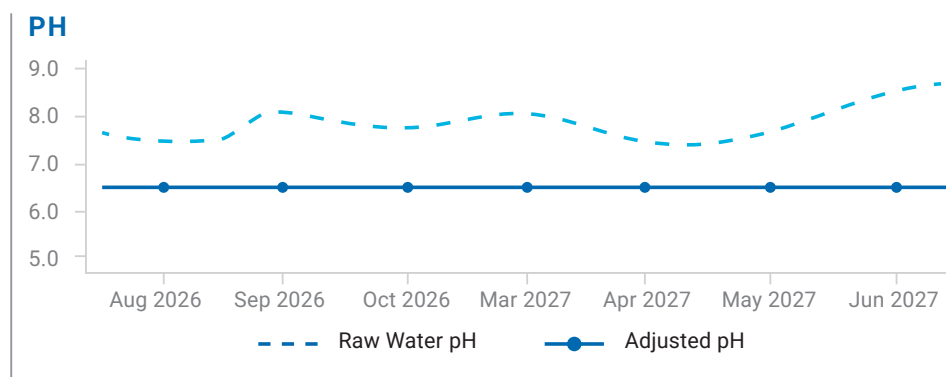
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Residual effects of Incipio® insecticide (isocycloseram) on the survival of the predatory mites
Neoseiulus californicus and *Phytoseiulus persimilis*
T. K. Hibino and M. A. Aghaee

Spider mites are important pests of California strawberries and can cause significant yield losses when populations reach damaging levels. Plinazolin® (isocycloceram) is a Group 30 insecticide with a novel mode of action that selectively targets invertebrate GABA-gated chloride channels. Although it provides a new option for mite management, information regarding its compatibility with predatory mites remains limited. This study evaluated the residual activity of Plinazolin in the federally registered formulation Incipio® on two predatory mite species commonly used in strawberry production, *Neoseiulus californicus* and *Phytoseiulus persimilis*. Strawberry leaflets were collected from field-treated plots at 5, 12, 20, 27, 34, and 41 days after treatment (DAT), and leaf-disc bioassays were conducted under laboratory conditions (Fig. 1). Predatory mites were exposed to field-aged residues for 48 hours, and mortality was recorded. Both predator species experienced elevated mortality shortly after application of Incipio. Mortality of *N. californicus* reached 79% and 59% at 5 DAT for the 2.1 and 3.1 fl oz rates, respectively (Fig. 2), while *P. persimilis* mortality reached 74% and 56% (Fig. 3). Residual toxicity generally declined as residues aged, although mortality remained higher in the Incipio treatments than in the untreated control and comparison treatments at several evaluation dates. Mortality in the Enervate 4 SC®, Agri-mek SC®, and untreated control treatments remained comparatively low throughout the study. These results indicate that Incipio residues may negatively affect predatory mites shortly after application, but toxicity generally decreases as residues age. Differences in susceptibility between predator species suggest that predator selection and application timing should be considered when integrating Incipio into strawberry IPM programs.



Figure 1. Representative leaf-disc bioassay arenas used to evaluate the residual toxicity of field-aged pesticide residues to predatory mites. Strawberry leaf discs collected from treated field plots were used to assess 48-h mortality of *N. californicus* and *P. persimilis*.



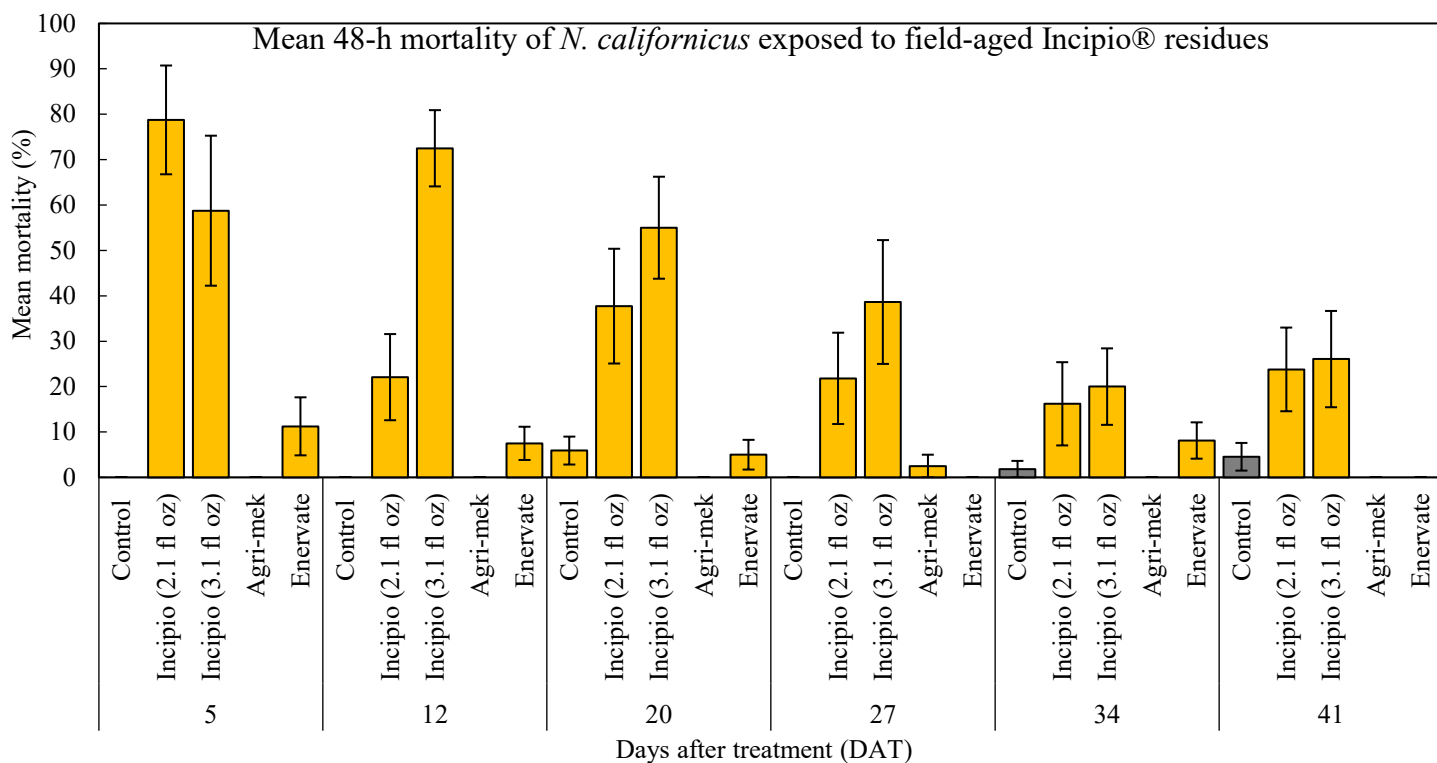


Figure 2. Mean ($\pm$ SE) 48-h mortality of *Neoseiulus californicus* following exposure to leaf discs collected from strawberry plants treated with Incipio® (2.1 and 3.1 fl oz), Agri-mek®, Enervate®, or left untreated (Control). Leaf discs were collected at 5, 12, 20, 27, 34, and 41 days after treatment (DAT).

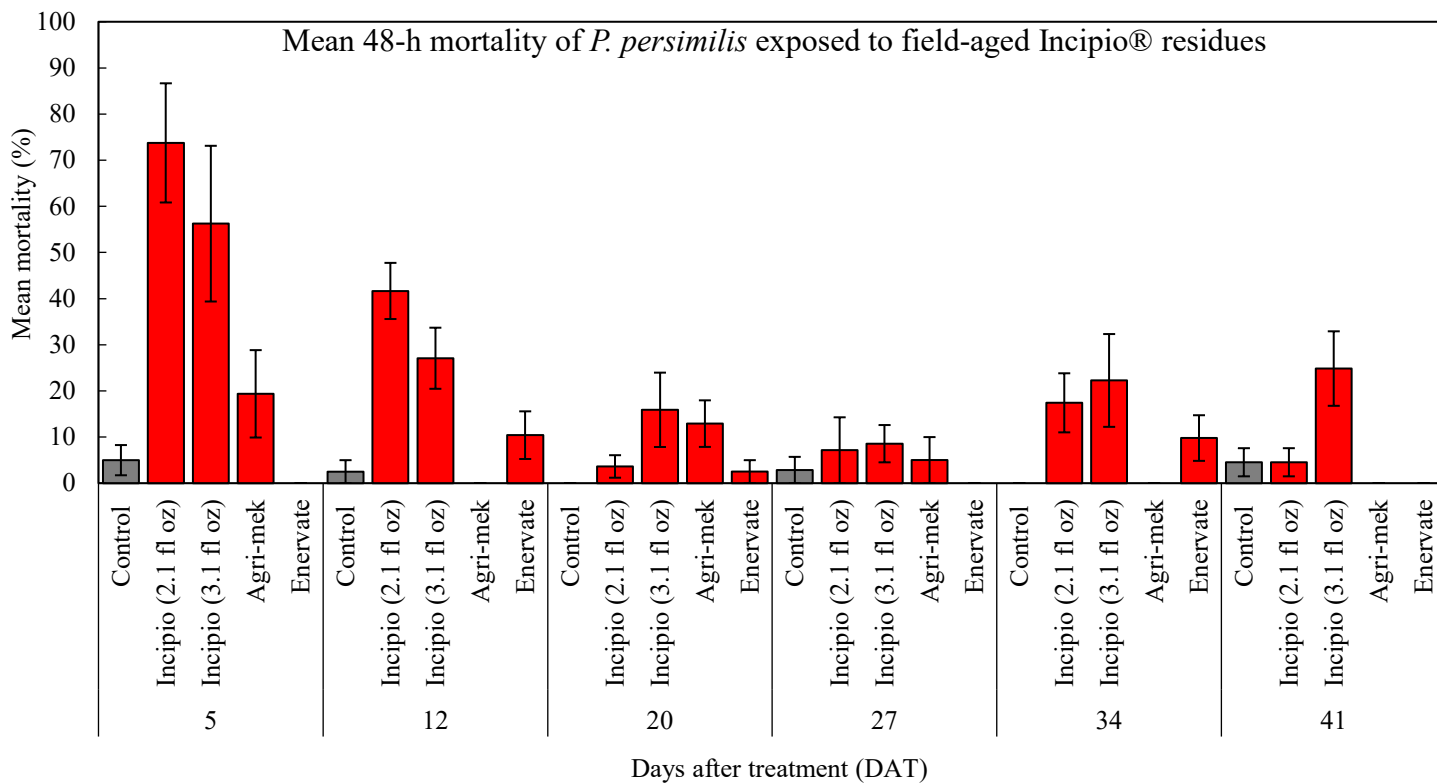


Figure 3. Mean ($\pm$ SE) 48-h mortality of *Phytoseiulus persimilis* following exposure to leaf discs collected from strawberry plants treated with Incipio® (2.1 and 3.1 fl oz), Agri-mek®, Enervate®, or left untreated (Control). Leaf discs were collected at 5, 12, 20, 27, 34, and 41 days after treatment (DAT).





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