Biology and Control of Red Leaf Blotch:

a new and invasive disease of almond in California

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ALMOND BOARD OF CALIFORNIA

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Red leaf blotch

- Red leaf blotch (RLB) caused by the fungal pathogen ***Polystigma amygdalinum*** is one of the most important leaf diseases currently affecting almond trees in the **Mediterranean basin**, particularly in **Spain**, and regions of the Middle East
- First described in **1843 in France** from almond leaves
- **First detected May 29, 2024, in Merced County**
- A new, **invasive** disease of almond for California
- It only affect **leaves** of almond

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Early symptoms

- Merced County, May 1st, 2025

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Early symptoms

(Early May)

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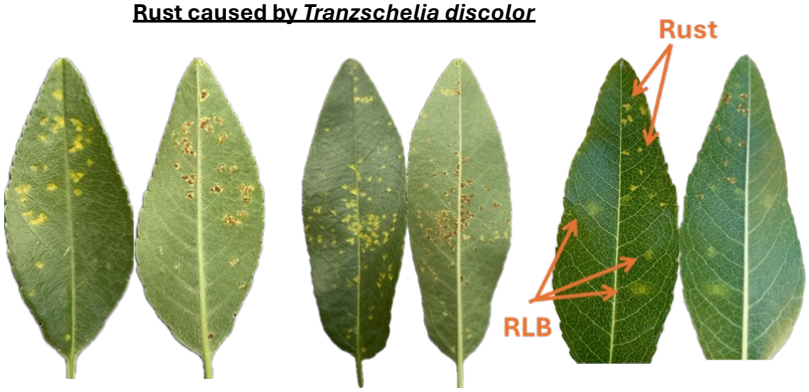
Early symptoms

- **Symptoms are quite unique** and easily distinguishable from other spring leaf diseases

Rust caused by *Tranzschelia discolor*



Bacterial blast caused by *Pseudomonas syringae*

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Advanced symptoms

(June – July)

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All leaves and trees may be infected in an orchard
ROOTED TOGETHER: ALMOND PRODUCTION RESEARCH SUMMIT 2025

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Current situation in an unsprayed orchard with RLB disease history

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Trees defoliate by the end of August

- ❑ **Early defoliation has high energy costs for trees** which might be prompted to produce new leaves before fall
- ❑ **Leaves on the ground (leaf litter) will serve as inoculum** for next growing season


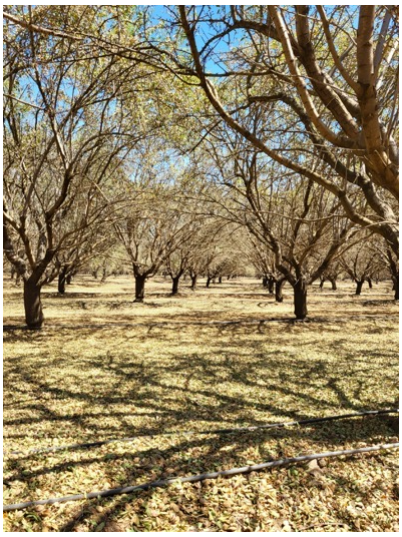


Photo credits Cameron Zuber

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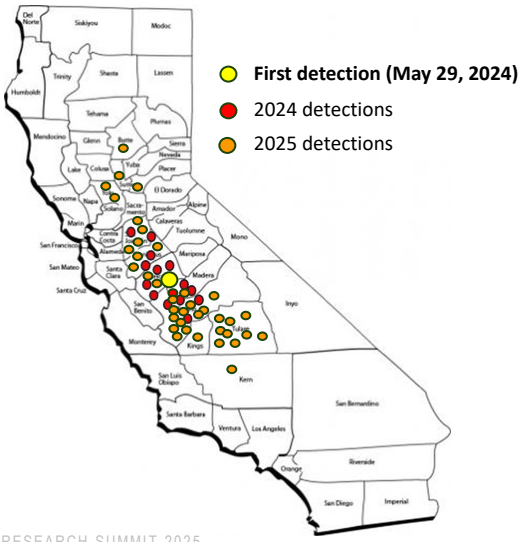
Current disease distribution

Epidemic – Disease outbreak

- ❑ First detection in May 2024 in Merced Co (CE advisor Cameron Zuber)
- ❑ Now detected in Butte, Kern, Kings, Madera, Merced, Fresno, San Joaquin, and Stanislaus, Sutter, Tulare and Yolo counties
- ❑ Cultivars affected included Aldrich, Butte, Carmel, Fritz, Independence, Monterey, Nonpareil, Padre, Shasta, and Wood Colony



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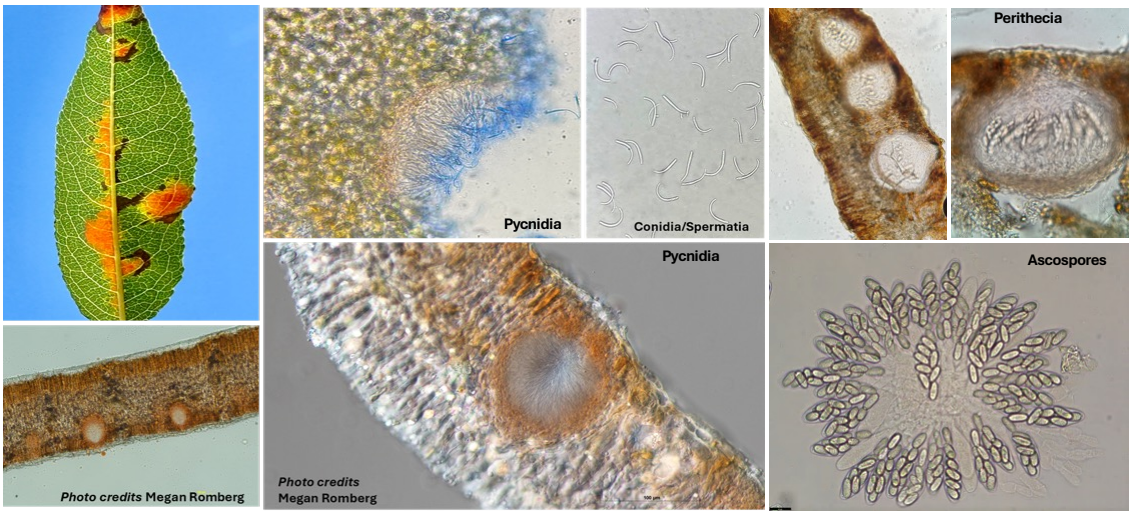
The pathogen: *Polystigma amygdalinum*

- *P. amygdalinum* (Ascomycota) is an **obligate biotrophic** fungal pathogen, and is dependent on living plant tissue for growth, reproduction, and feeding and cannot be grown on culture medium.



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Disease cycle

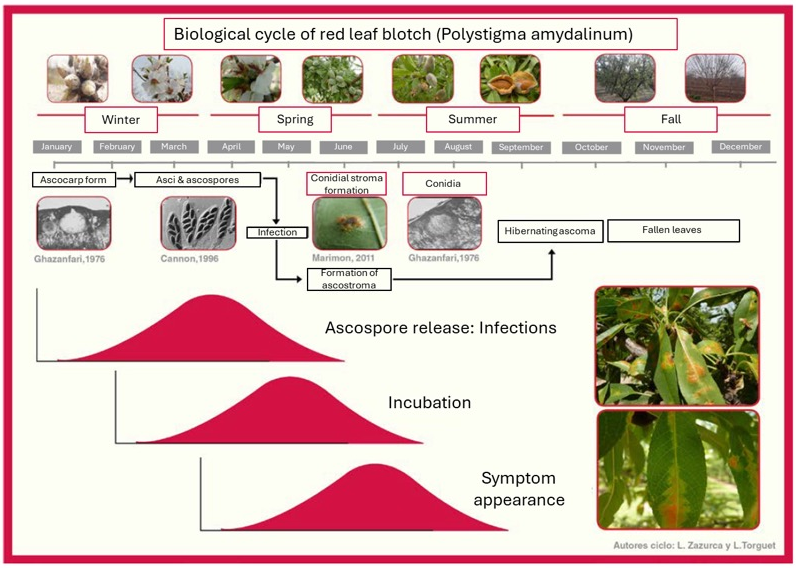

Figure credits: Gemma Pons-Solé, Xavier Miarnau, Laura Torguet, Lourdes Zazurca, Erick Zúñiga, Jordi Luque, IRTA Barcelona-Lleida.

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Pathogenicity studies

- ❑ We developed successful pathogenicity tests for *Polystigma amygdalinum*
- ❑ This assay will be critical next year to better determine the timing (leaf stage) of host susceptibility and ultimately confirm the number of fungicide applications required for optimal disease control



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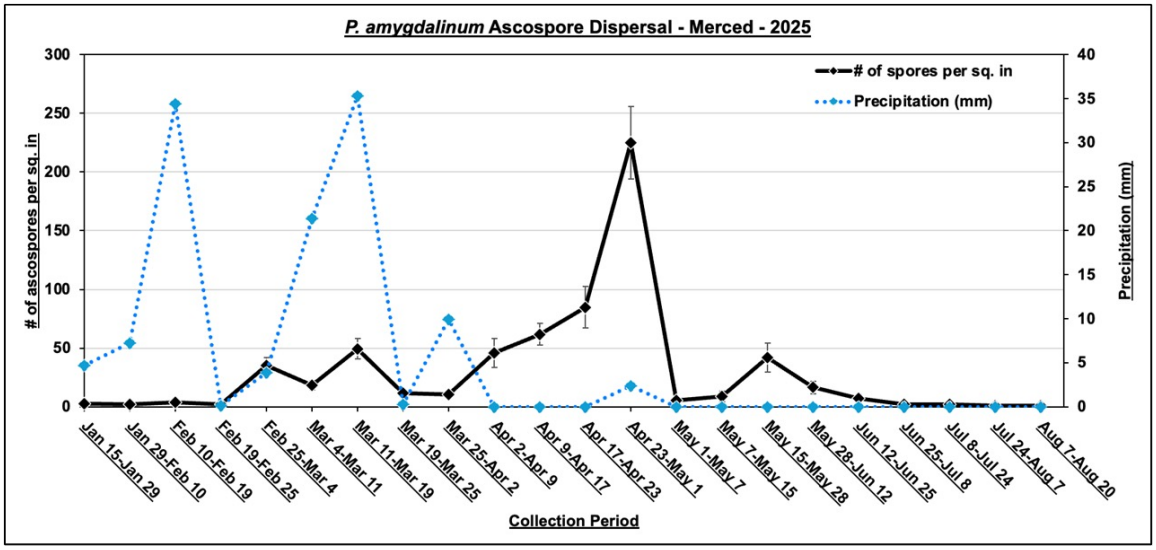
Disease biology

Dynamic of spore inoculum (Merced, California, 2025)



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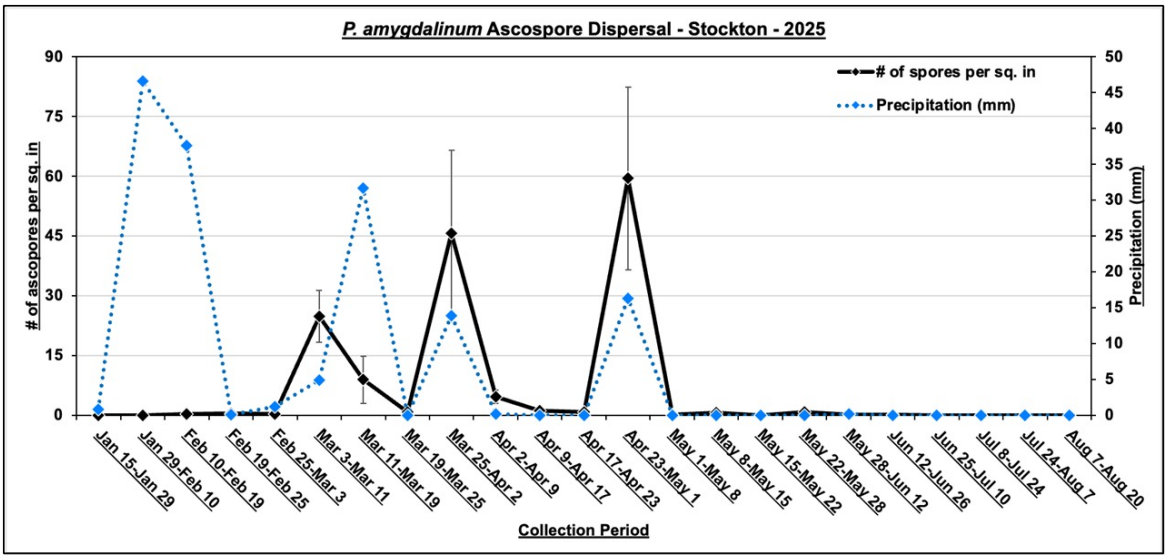
Disease biology

Dynamic of spore inoculum (Stockton, California, 2025)



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Disease biology

Period of infection/host susceptibility (Spain)

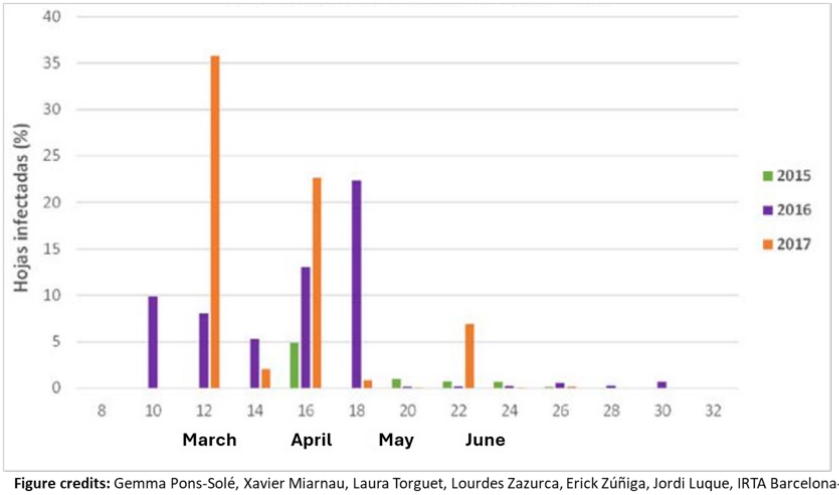

Figure credits: Gemma Pons-Solé, Xavier Miarnau, Laura Torguet, Lourdes Zazurca, Erick Zúñiga, Jordi Luque, IRTA Barcelona-Lleida.

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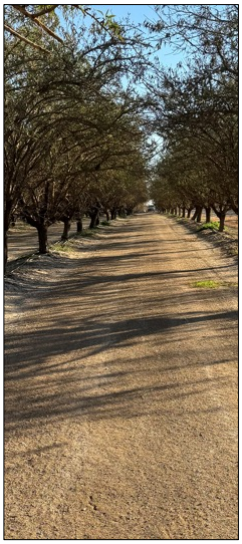
Disease control

Cultural practices:

- ❑ Cultural practices focused on **eliminating the primary inoculum of infected fallen leaves** can help mitigate the disease
- ❑ **Zinc sulfate** to hasten leaf fall, **removing leaf litter** or applying **urea** to accelerate leaf decomposition
- ❑ However, such strategies are only effective **when applied over a wide area**
- ❑ **Cleaning harvest and spray equipment** between orchards



Fungicide control: **Most effective,** although fungicides applied during bloom and after symptoms are visible in May are **not effective**

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Chemical control

Timing of fungicide applications

- ❑ **Fungicides applied during bloom and after symptoms are visible are NOT effective**

Disease	Dormant	Bloom			Spring[1]		Summer	
		Pink bud	Full bloom	Petal fall (March 10-15)	2 weeks (April 10-15)	5 weeks	May	June
Red leaf blotch	----	----	----	+++	+++	++	----	----
Anthracnose[2]	----	++	+++	+++	+++	+++	+++	++
Bacterial spot	+	----	++	+++	+++	++	+	----
Brown rot	----	++	+++	+	----	----	----	----
Green fruit rot	----	----	+++	++	----	----	----	----
Hull rot[7]	----	----	----	----	----	----	----	+++
Leaf blight	----	----	+++	++	+	----	----	----
Rust	----	----	----	----	----	+++	+++	+[6]
Scab[3]	++	---	---	++	+++	+++	+	---
Shot hole[4]	+[5]	+	++	+++	+++	++	----	----

Rating: +++ = most effective, ++ = moderately effective, + = least effective, and ---- = ineffective

Adaskaveg et al. 2017

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Chemical control

Best timing of fungicide applications and best products

- FRAC **groups 7 (SDHI: fluopyram, boscalid), 11 (QoI: trifloxistrobin, pyraclostrobin)** and some FRAC3 (DMI, **fenbuconazole**) are most effective (*Torguet et al. 2022*)
- Mixed fungicides (7/11, 7/3) (*Torguet et al. 2022*)
- Mixed fungicides (**FRAC groups 3+7; 3+11; 7+11) and FRAC 3-triazoles** were most effective (Trouillas Lab, 2025 trials)

Disease	Dormant	Bloom		Spring			Summer	
		Pink bud	Full bloom	Petal fall	2 weeks	5 weeks	May	June
Rust	----	----	----	----	----	3, 3/7, 3/11 3/33, 7, 7/11, 11, 19 M3	3, 3/7, 3/11 3/33, 7, 7/11, 11, 19	3, 3/7, 3/11 3/33, 7, 7/11, 11, 19
Scab[4]	M1+oil, M2[3], M5+oil	----	----	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11[2] 11[2] M3 M4, M5	1[2], 3/7, 3/9, 3/11, 3/33, 7, 7/11[2] 11[2] M3 M4, M5	3, 3/7, 3/9, 3/11 3/33, 7, 7/11[2], 11[2] M2[3] M3, M4	M2[3] M4	----
Shot hole	M1	2 3, 3/7, 3/9, 3/11, 7, 9, 11	2 3, 3/7, 3/9, 3/11 7, 7/11 9, 11, 19	2 3, 3/7, 3/9, 3/11 7, 7/11 9 11, 19	7, 7/11 11, 19 M3 M4 M5	7, 7/11 11, 19 M3 M4 M5	----	----

Adaskaveg et al. 2022

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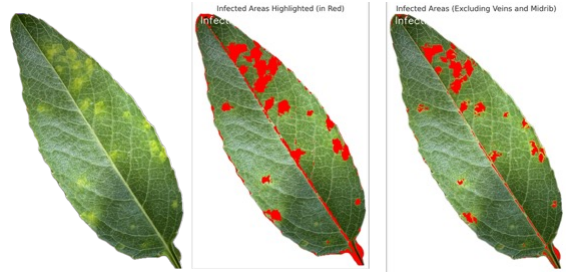
Brand	Product	FRAC Groups	A.I.	Rate/A	Color
	Water		Water		White
Bayer	Luna Sensation (2 applications)	FRAC 7 + 11	Fluopyram + Trifloxystrobin	7.6 fl oz	Green/black stripes
	Scala + DFO	FRAC 9 + 3	Pyrimethanil + Difenoconazole	23.84 fl oz	White/red stripes
	Adament (liquid formulation)	FRAC 3 + 11	Tebucnonazole + Trifloxystrobin	7.3 fl oz	Blue/black dots
	Serenade	BM02	Bacillus subtilis strain QST 713	4 qt	Yellow/black stripes
BASF	Merivon	FRAC 7 + 11	Fluxapyroxad + Pyraclostrobin	6.5 fl oz	Orange/black stripes
	Elisys	FRAC 3 + 7	Mefentrifluconazole + Fluxapyroxad	8.5 fl oz	Yellow/white stripes
	Pristine	FRAC 7 + 11	Pyraclostrobin + Boscalid	14.5 oz	Light blue
Corteva	Fontelis	FRAC 7	Penthiopyrad	20 fl oz	Pink/black stripes
Syngenta	Miravis Duo	FRAC 3 + 7	Difenoconazole + Pydiflumetofen	13.6 fl oz	Orange
	Miravis Prime	FRAC 7 + 12	Adepidyn + Fludioxonil	9.1 fl oz	White/blue dots
	Quadris Top	FRAC 3 + 11	Difenoconazole + Azoxystrobin	14 fl oz	Red/black stripes
FMC	Rhyme	FRAC 3	Flutriafol	7 fl oz	Dark blue
Heritage Crop Science	Gleam	P- unspecified	Chitosan 10% Vinegar 90%	20 fl oz	Blue/black Checkered
	Romeo	BM02	Cerevisane	0.5 lbs	Purple
UPL	AXIOS™ 20 SC	FRAC 52	Ipflufenoquin	5 fl oz	Red
Valent	Quash	FRAC 3	Metconazole	4 oz	White/yellow checkered
	Excalia	FRAC 7	Inpyrfluxam	4 fl oz	Neon yellow
	Intuity	FRAC 11	Mandestrobin	6 fl oz	White/blue stripes
Gowan	Ecoswing	BM01	Extract of Swinglea glutinosa	32 fl oz	White/orange dots
SAN Agrow	Gargoil	BM01	Cinnamon oil + Garlic	1% v/v	White/orange stripes
	Botector	NC	*Aureobasidium pullulans* strain DSM 14940 + *Aureobasidium pullulans* strain DSM 14941	10 oz	Green/black dots

Chemical control

Trouillas Lab – 2025 Fungicide Trial

- **Trial 1:** Stockton, Nonpareil (20 products) – backpack sprayer
- **Trial 2:** Stockton, Monterey (20 products) – backpack sprayer
- **Trial 3:** Merced, Lombardy Ave, Carmel (22 products) – spray bottle
- **Trial 4:** Merced, Childs Ave, Nonpareil (22 products) – spray bottle
- **Trial 5:** Merced, Lombardy Ave, Carmel (22 products) – single application



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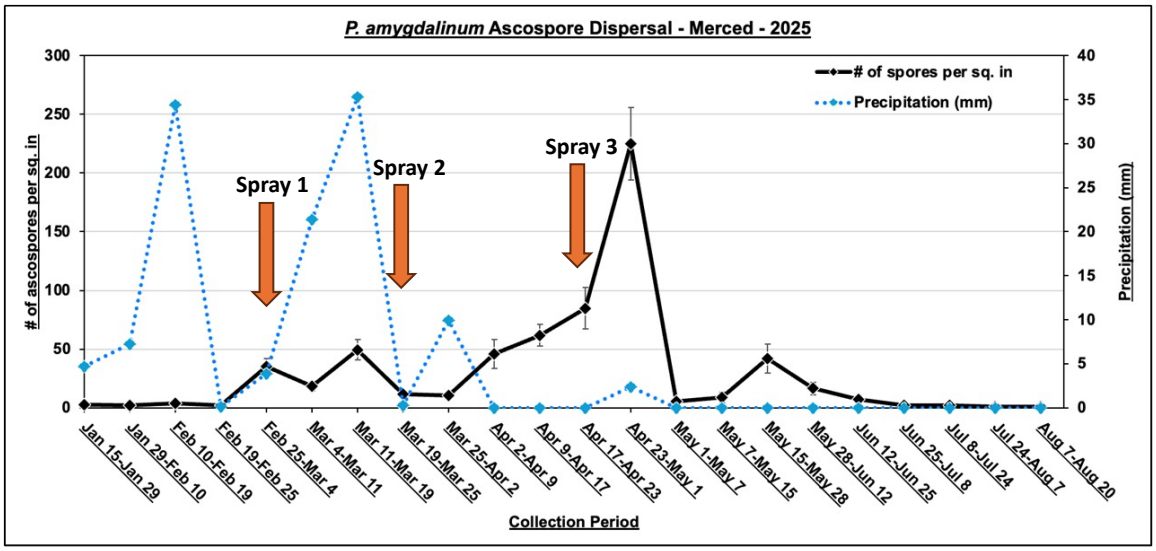
Disease biology

Dynamic of spore inoculum (Merced, California, 2025)



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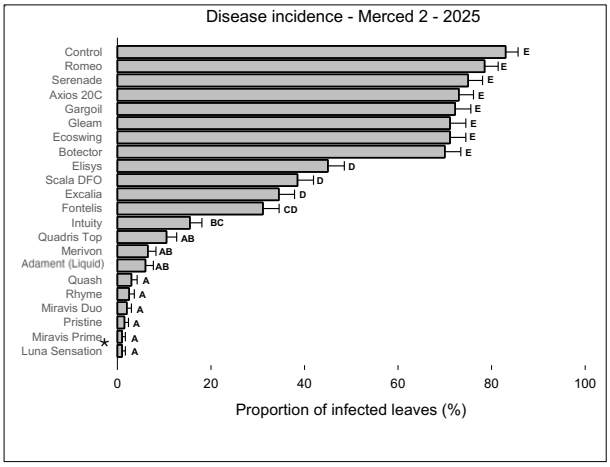
Chemical control

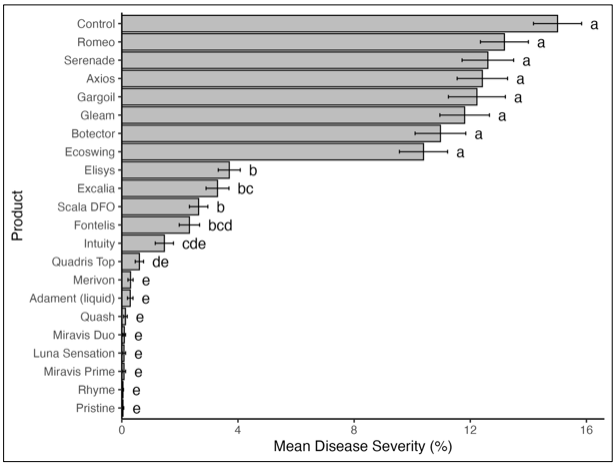
Trouillas Lab – 2025 Fungicide Trial – Merced Childs Ave

Application timings: @ 2/28/25 @ 3/18/25 @ 4/23/25

*Luna sensation @ 2/28/25 @ 3/18/25 only



Nonpareil



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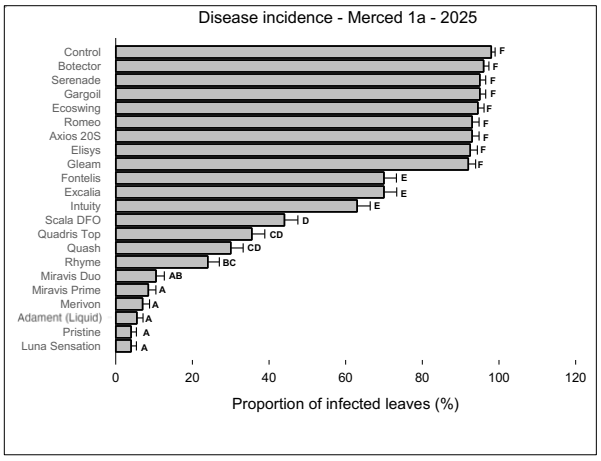
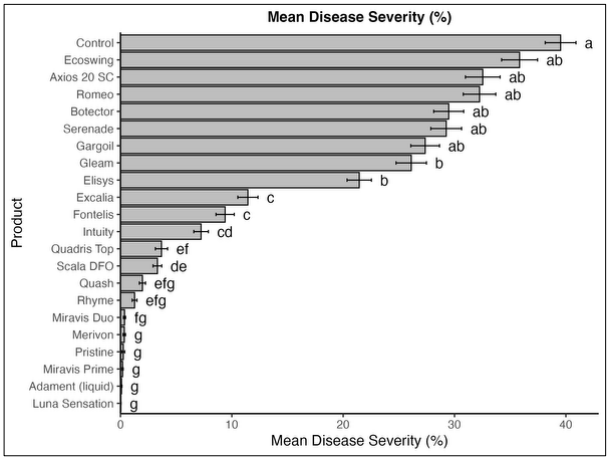
Chemical control

Trouillas Lab – 2025 Fungicide Trial – Merced 1a (Carmel)

Application timings: @ 2/28/25 @ 3/18/25 @ 4/23/25



Carmel



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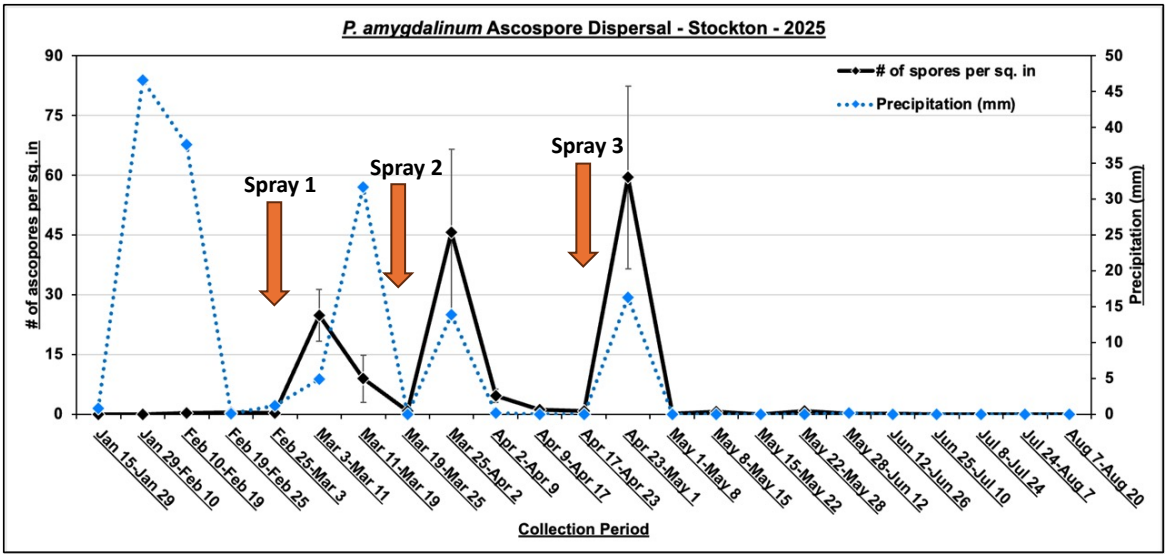
Disease biology

Dynamic of spore inoculum (Stockton, California, 2025)



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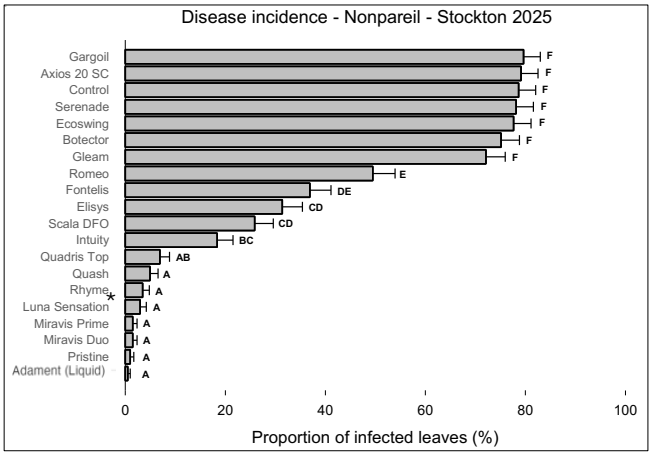
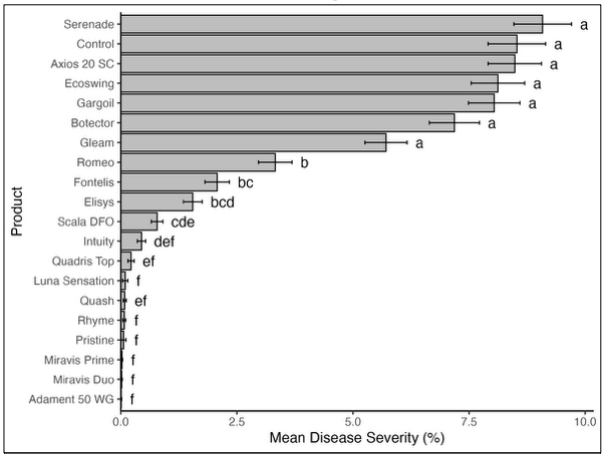
Chemical control

Trouillas Lab – 2025 Fungicide Trial – Stockton

Application timings: @ 3/3/25 @3/19/25 @ 4/23/25
*Luna sensation @ 3/3/25 @3/19/25 only
(Nu-Film-P was added to biocontrol products)



Nonpareil



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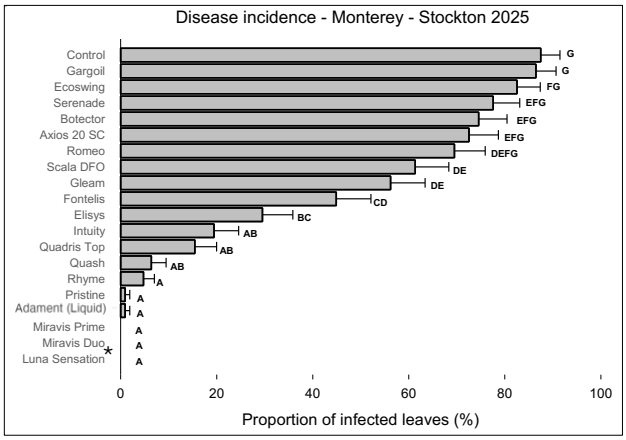
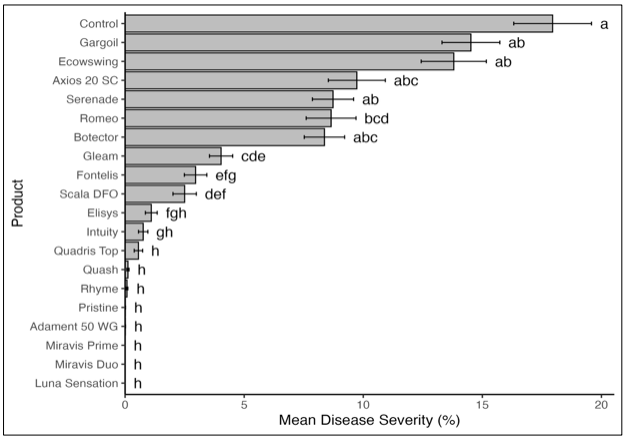
Chemical control

Trouillas Lab – 2025 Fungicide Trial – Stockton

Application timings: @ 3/3/25 @3/19/25 @ 4/23/25
*Luna sensation @ 3/3/25 @3/19/25 only
(Nu-Film-P was added to biocontrol products)



Monterey



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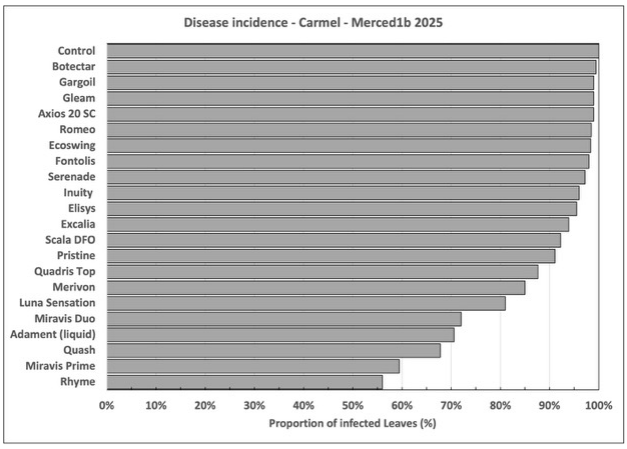
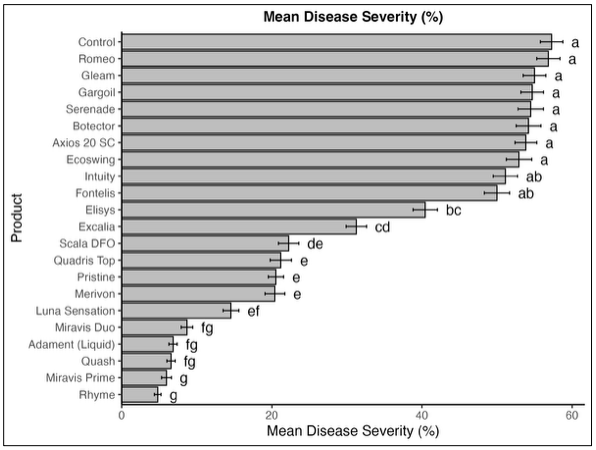
Single application

Trouillas Lab – 2025 Fungicide Trial – Merced 1b (Carmel)
Application timings: @ 2/28/25



Carmel



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Conclusion

- ❑ **New and serious disease outbreak** in California due to Red Leaf Blotch (RLB)
- ❑ It is here to stay – widespread now in CA
- ❑ **Paradigm shift in IPM strategies**, RLB will likely become the main focus in almond disease management strategies
- ❑ Integrate RLB management with management of rust, scab and shot hole
- ❑ Mixed fungicides (**FRAC groups 3+7; 3+11; 7+11**) and **FRAC 3-triazoles** are most effective at controlling RLB
- ❑ Use them smartly, **alternate active ingredients** to avoid development of fungicide resistance
- ❑ Research is on-going to determine the optimal number of fungicide applications, but at least **2 to 3 applications will be required between petal fall (early to mid-March) and 5-weeks post petal fall (mid- to late April) for effective management**
- ❑ Fungicides applied during bloom and after symptoms are visible are NOT effective

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Thank you!

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Trouillas Lab - UC Davis

Fruit & Nut Crop Pathology

Funding: Almond Board of California, Project Duration: **April 01, 2025 - July 31, 2028**

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Growers, farm advisors and PCA cooperators