New insights into the management of Colletotrichum dieback and Alternaria rot in California citrus

B. X. Camiletti, UC Davis,
bcamiletti@ucanr.edu
J. A. Paredes, UC Davis,
japaredes@ucanr.edu
V. M. Gabri, UC Davis,
vmgabri@ucanr.edu
T. J. Michailides, UC Davis,
tjmichailides@ucanr.edu

Year 1 of 1 (100% Complete)

Objectives

1. To test the efficacy of citrus registered fungicides against Colletotrichum dieback
2. Identify the best timing for single-spray programs against Alternaria rot
3. To evaluate the effect of grove sanitation on Alternaria rot
4. To assess *Alternaria* spp. and *Colletotrichum* spp. sensitivity to commercial fungicides

Problem and Significance

The Alternaria rot (AR) and Colletotrichum dieback (CD), caused respectively by *Alternaria* spp. and *Colletotrichum* spp., are two important fungal diseases affecting citrus production in California. In the groves, AR causes premature color change and fruit drop, whereas CD leads to tree defoliation, twig dieback, rind discoloration and fruit drop. Severe damage was reported by some growers and confirmed during visits to groves in the San Joaquin Valley (SJV). The development of a new management strategy that reduces pre-harvest losses caused by AR and CD is an important challenge.

Benefit to Industry

This project provides new insights into the best active ingredients against the pathogens that cause AR and CD, as well as the efficacy of different fungicide programs to control both diseases. This new information will help growers and pest control advisers to design efficient disease management programs aimed to mitigate the negative impact of AR and CD diseases. Growers will benefit from healthier orchards through the increased marketable yield and higher fruit quality.

Progress Summary

Laboratory experiments were performed to test the efficacy of commercial fungicide products to reduce *Colletotrichum* infections on citrus leaves. Mandarin leaves were collected from the experimental plot at the Kearney Agricultural Research and Extension Center planted with Kishu and Pixie cultivars. Leaves were disinfested and placed on mesh platforms resting in plastic boxes. All fungicide products were evaluated for their protective and curative effects. For the protective effect, fungicide suspensions were prepared as indicated on their respective labels. Leaves were sprayed with the suspensions and allowed to rest for 24 hours (h). After that, the leaves were inoculated with drops containing spores of the pathogen. To evaluate the curative effect, inoculations were performed 24 h prior to fungicide sprays. All treatments were placed at room temperature for 12 days. The evaluation was focused on the number of infected points generated by the pathogens on the leaves. The results indicated that Pristine® (BASF) showed the best protective effect, followed by Luna Sensation® (BAYER) and Quadris Top® (Syngenta). Ph-D® (UPL) resulted in the lowest efficacy, while K-Phite® (Plant Food Co.) showed an intermediate activity (Figure 1). Regarding the curative effect, Luna Sensation showed the best performance, followed by Pristine and Quadris Top (Figure 2).

The best timing to perform single-spray fungicide programs against AR was investigated. Field trials were performed during two consecutive years using three rows of a commercial Gold Nugget orchard in Strathmore, Tulare County, CA. The fungicide Quadris Top at full label rate was used due to its superior efficacy to control AR. Treatments consisted of single applications performed 15, 30, 45, 60, and 73 days before harvest (DBH) in 2020

and 2021. On harvest date, the number of dropped fruits on the ground with symptoms of AR was counted. Harvested fruit were boxed at the end of the fungicide trial and stored in a cold-room to simulate commercial conditions. After storage in the cold room, all boxes were placed at room temperature for 7 days to simulate the final step of commercialization. The number of fruits showing AR were recorded weekly, and finally removed from the boxes. The disease incidence observed in both years was relatively low due to non-conducive environmental conditions. However, the spray performed 15 DBH significantly reduced the number of dropped fruit compared to the control (no spray). The rest of the treatments did not differ from the control (Figure 3). The number of fruits lost during the storage period was not statistically influenced by the fungicide treatments. However, a trend indicating that fungicide applications performed 15 and 30 DBH reduce fruit loss was observed.

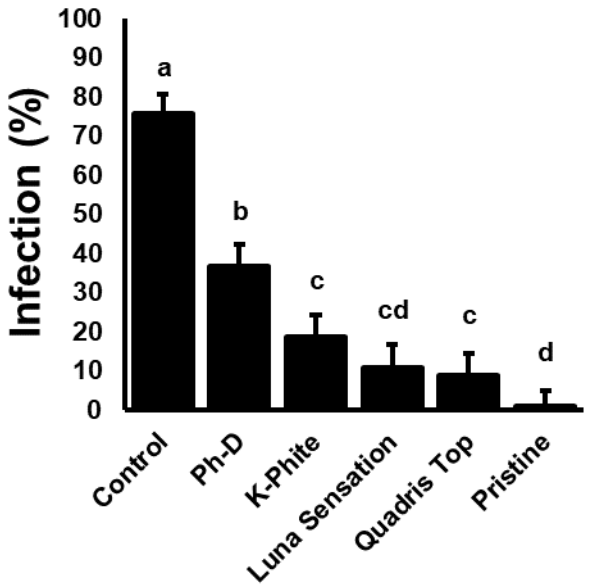

Figure 1. Protective activity of fungicide products against Colletotrichum *spp. infections on citrus leaves. Different letters indicate significant differences.*

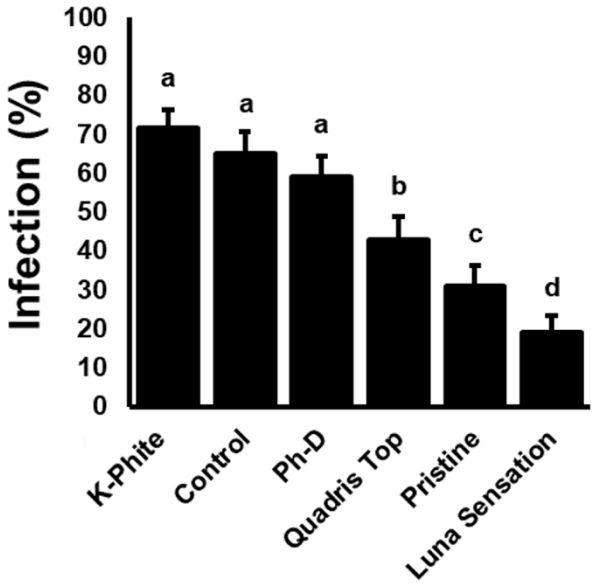

Figure 2. Curative activity of fungicide products against Colletotrichum *spp. infections on citrus leaves. Different letters indicate significant differences.*

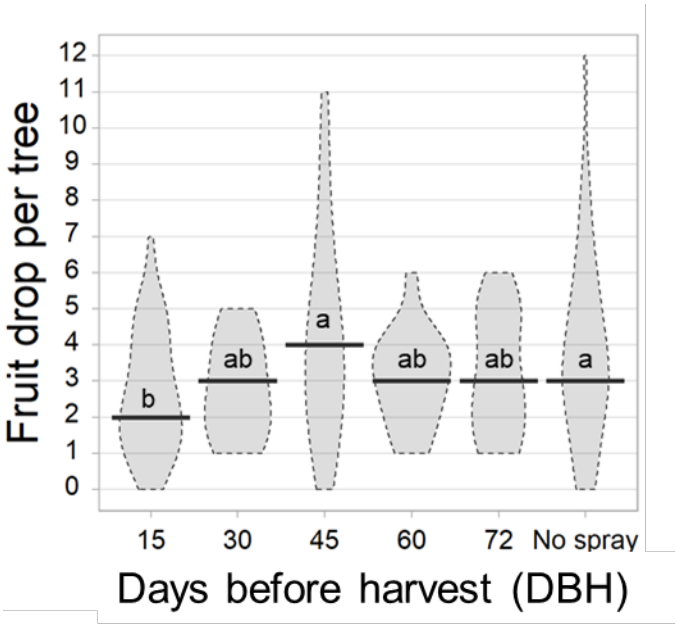

Figure 3. Violin plot describing the effect of single-spray fungicide treatments applied at different timing (DBH) on fruit drop caused by Alternaria rot. Crossbars represent median values for each treatment. Different letters indicate significant differences.

A field trial was conducted to determine whether sanitation measures reduce the amount of inoculum and consequently the AR. The effect of this cultural practice on fungicide programs was also investigated. The field trial was conducted using three rows of a commercial Sumo orchard in Ivanhoe, Tulare County, CA. The commercial fungicide Quadris Top at full label rate was selected

and used, and the programs evaluated are listed in Table 1. The AR epidemic was not severe on Sumo mandarins where non-conducive conditions were present during last season. However, a trend showing that treatments 5 and 6 reduced fruit drop was observed (Figure 4).

Several fungicides (Table 2) were screened by their activity against the growth of *Colletotrichum karstii*, *C. gloeosporioides* (CD pathogens), and *Alternaria* spp. (AR pathogen). The DMI group fungicides were highly effective against *Colletotrichum* populations (Figure 5). Overall, the fungicide penthiopyrad presented an intermediate activity. The remaining fungicides were less effective. Regarding *Alternaria* spp. (Figure 6), the DMI fungicides showed a strong activity. Fluopyram showed an intermediate activity, followed by penthiopyrad and chlorothalonil. Copper hydroxide showed scarcely any activity against this pathogen.

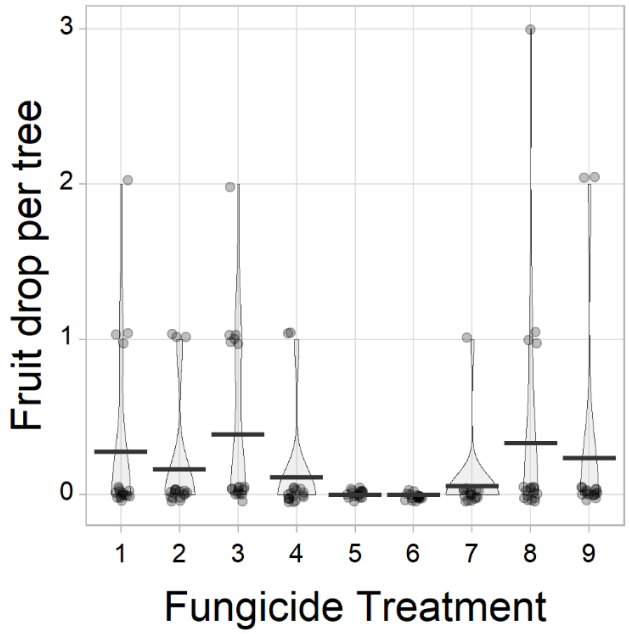

Figure 4. Violin plot describing the effect of fungicide treatments on fruit drop caused by Alternaria *spp. on Sumo mandarin orchard. Crossbars represent mean values for each treatment.*

Table 1. Description of the fungicide programs included in the field trial.

Treatment	Sanitation	Quadris Top (15.4 fl oz/A)				
		30 Nov	21 Dec	4 Jan	11 Jan	18 Jan
1	No	@				
2	No		@			
3	No				@	
4	Yes	@	@		@	
5	No	@	@		@	
6	Yes		@	@		@
7	No		@	@		@
8	No					

Table 2. Fungicides used in sensitivity assays.

Active ingredient (%)	**Manufacturer**	**Trade Name**	**Group Name**
Azoxystrobin (22.9)	Syngenta	Abound®	QoI
Trifloxystrobin (42.6)	Bayer	Gem 500®	QoI
Fluopyram (40.9)	Bayer	Luna Privilege®	SDHI
Penthiopyrad (20.4)	DuPont	Fontelis®	SDHI
Metconazole (50.0)	Valent	Quash®	DMI
Tebuconazole (38.7)	Bayer	Folicur®	DMI
Chlorothalonil (54.0)	Syngenta	Bravo®	M5
Copper hydroxide (46.1)	Certis	Kocide-3000®	M1

Conclusions

The commercial fungicide products registered for citrus in California present differences in their performances to control AR and CD. The most effective products reported in this study for each disease should be considered for fungicide efficacy field trials and further included in an integrated pest management program. A single spray closer to the end of the season can provide significant disease control in an epidemic year. Sanitation practices seem to reduce losses caused by AR and should always be implemented when economically feasible.

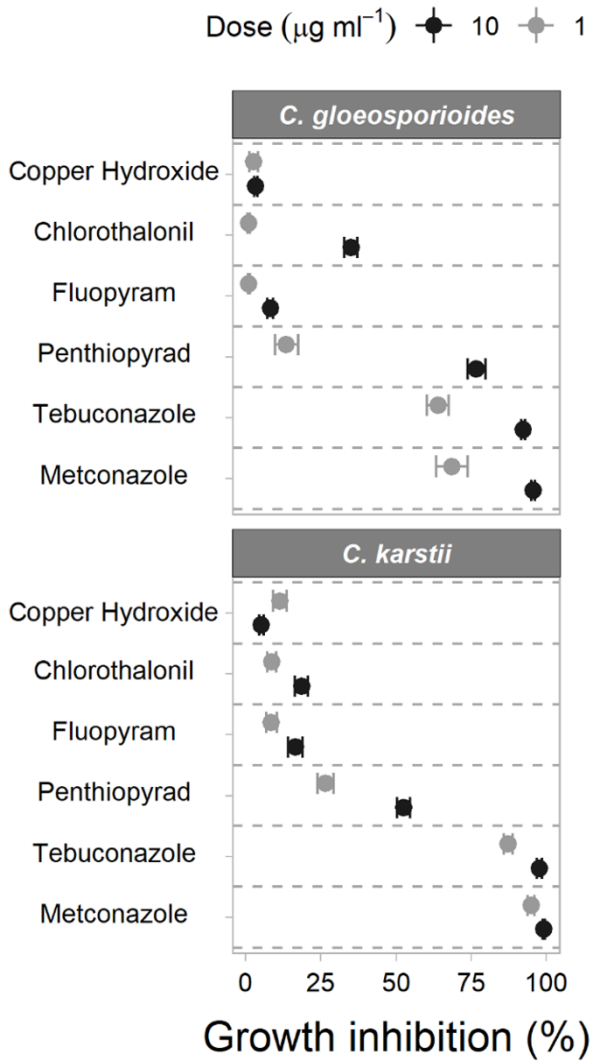

Figure 5. Relative growth inhibition (%) of C. gloeosporioides *and* C. karstii *on culture media mixed with fungicide at two concentrations (1 and 10 μg ml^{-1}).*

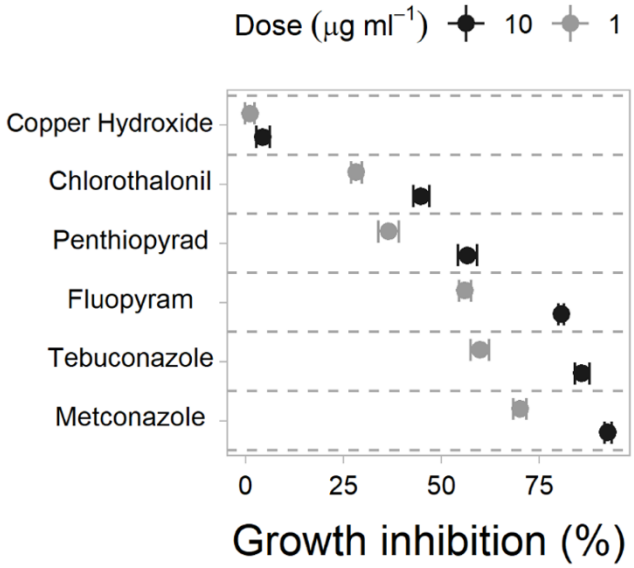

Figure 6. Relative growth inhibition (%) of Alternaria *spp. on culture media amended with chlorothalonil, fluopyram, metconazole, penthiopyrad, Copper hydroxide, and tebuconazole at two concentrations (1 and 10 μg ml^{-1}).*

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Publications and Presentations

Camiletti, B.X., Lichtemberg, P.S.F., Paredes, J.A., Michailides, T.J. 2021. Efficacy of fungicides against *Colletotrichum* species that cause Colletotrichum dieback of citrus. Presented at the California Citrus Conference. October 6, 2021, Visalia, CA.

Camiletti, B.X., Lichtemberg, P.S.F., Paredes, J.A., Michailides, T.J. 2021. Best timing to spray fungicides against Alternaria rot in mandarins using single-spray programs. Presented at the California Citrus Conference. October 6, 2021, Visalia, CA.