

Epidemiology and Management of Bacterial Spot of Almond

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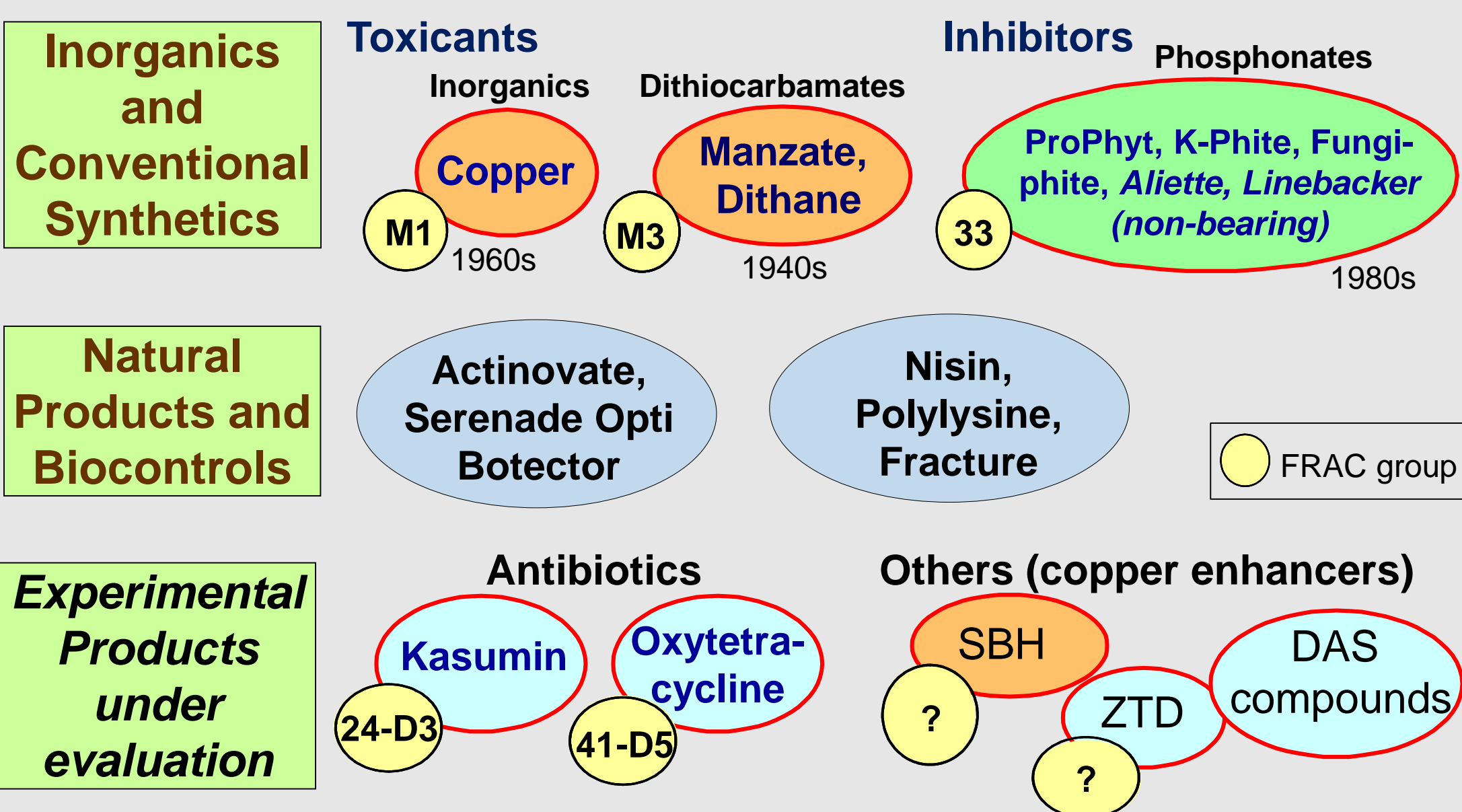
Bacterial spot of almond (*Xanthomonas arboricola* pv. *pruni*)

- Bacterial spot caused by *Xanthomonas arboricola* pv. *pruni* (Xap) is common on peach in the eastern US (high moisture conditions).
- Found in spring 2013 on almond - Colusa, San Joaquin, Stanislaus, Merced, and Madera Co. Current distribution: Butte to Kern Co.
- Fritz is most susceptible, but the disease has also been found on Nonpareil, Butte, Carmel, and Price.
- Rainfall and high-angle sprinkler irrigation contribute to disease increase.
- Management with dormant and springtime bactericide applications are being explored, and time of host susceptibility is evaluated.



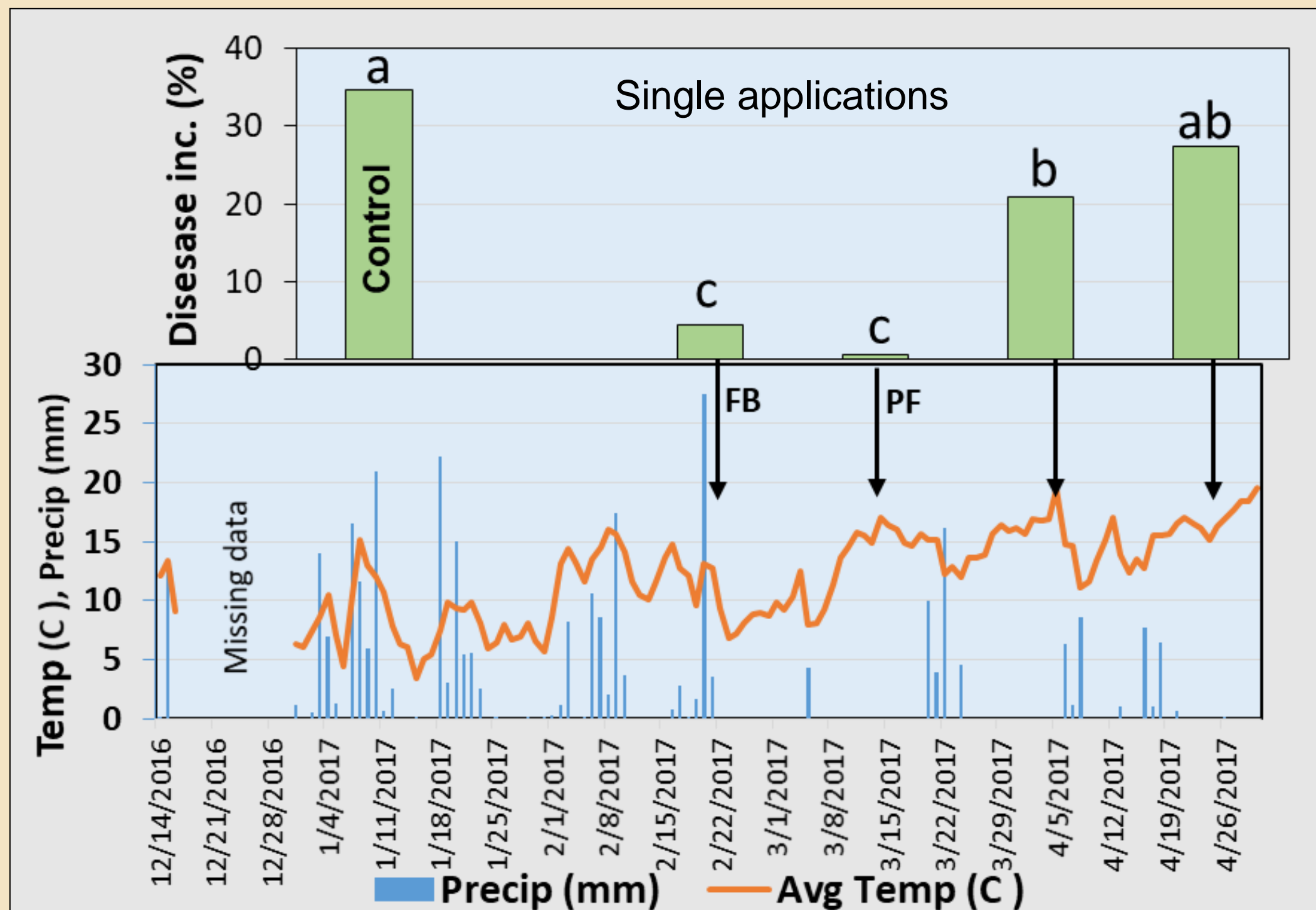
Overwintering fruit mummy and symptoms of bacterial spot on almond fruit and leaves.

Materials for Managing Bacterial Spot



Studies on bacterial spot of almond in 2017

1. Timing of in-season applications, 'Fritz' almond



Environmental conditions near field trial locations in Ripon, CA, in the spring of 2017, and timing and efficacy of single applications (arrows) with Badge 3.3 lb/A or Badge 3.3 lb/A + Manzate 4 lb/A (average presented). Significant differences in timing of applications are shown.

Single in-season treatments at full bloom or petal fall with copper or copper-mancozeb reduced the disease to very low levels.

2. Timing of dormant and in-season treatments with copper-mancozeb on 'Fritz' almond, San Joaquin Co. - 2017

Treatments*		Timing 1 IS: none		Timing 2 IS: 2/22 (FB)		Timing 3 IS: 3/15 (PF)		Timing 4 IS: FB + PF		Treatment Avg.	
Dormant	In-Season	Dis.**	LSD^A	Dis.	LSD	Dis.	LSD	Dis.	LSD	Dis.	LSD
Control	@	41.3	A a	16.3	B a	0.8	C a	3.0	BC a	13.6	a
Early (12/14/16)	@	10	A ab	4.3	A b	1.3	A a	3.3	A a	4.7	b
Delayed (1/25/17)	@	8.8	A b	9	A b	2.5	A a	1.8	A a	5.5	b
Timing Avg.		18.1	A	10.4	B	1.5	C	2.7	C		

Dormant applications: ChampION 6 lb/A + Manzate 6 lb/A. FB and PF alone applications, ChampION 3.3 lb/A; for FB+PF treatments, the PF application was done at 1.65 lb/A. Disease evaluation on 6-6-17.

- Early and delayed dormant copper-mancozeb treatments resulted in a high reduction of bacterial spot as compared to the untreated control probably by reducing inoculum levels and pathogen dispersal.
- Additional in-season treatments reduced the disease to very low levels.

3. New bactericides applied in-season to 'Fritz' almond, San Joaquin Co. - 2017

Conventional treatments

Treatment*	Rate(/A)	Incidence (%)
Control	---	a
Mycoshield	16 oz	ab
ZTD + Kasumin	34 fl oz + 64 fl oz	bc
Mycoshield + Manzate	16 oz + 64 oz	bc
Kasumin	64 fl oz	bcd
ZTD	500 ppm = 34 fl oz	bcde
Kasumin + Manzate	64 fl oz + 64 oz	bcde
DAS-1 + ChampION**	27 fl oz + 3.3-0.8 lb	cde
Kasumin + ChampION**	64 fl oz + 3.3-0.8 lb	de
ZTD + ChampION**	34 fl oz + 3.3-0.8 lb	de
Mycoshield + ChampION**	16 oz + 3.3-0.8 lb	e

Applications: 2-22, 3-16, 4-5, 4-26-2017

Biological treatments

Treatment*	Rate(/A)	Incidence (%)
Control	---	a
Serenade Opti + Nufilm-P	16 oz	ab
Serenade + Nufilm-P + Sugar	16 oz + 8 fl oz - 32 oz	bc
Botector	10 oz	a
Botector + Sugar	10 oz + 32 oz	a
Badge X2 + Manzate	3.7-0.93 lb + 64 oz	c

Applications: 2-22, 3-16, 4-5-2017

- Most effective and consistent: copper mixed with mancozeb, kasugamycin, copper-activity enhancers (ZTD, DAS-1), or Mycoshield.
- Biologicals: Serenade Opti mixed with sugar as a nutrient source for the biocontrol agent.

4. Epidemiology - Pathogen survival and time of host susceptibility - 2017

Survival:

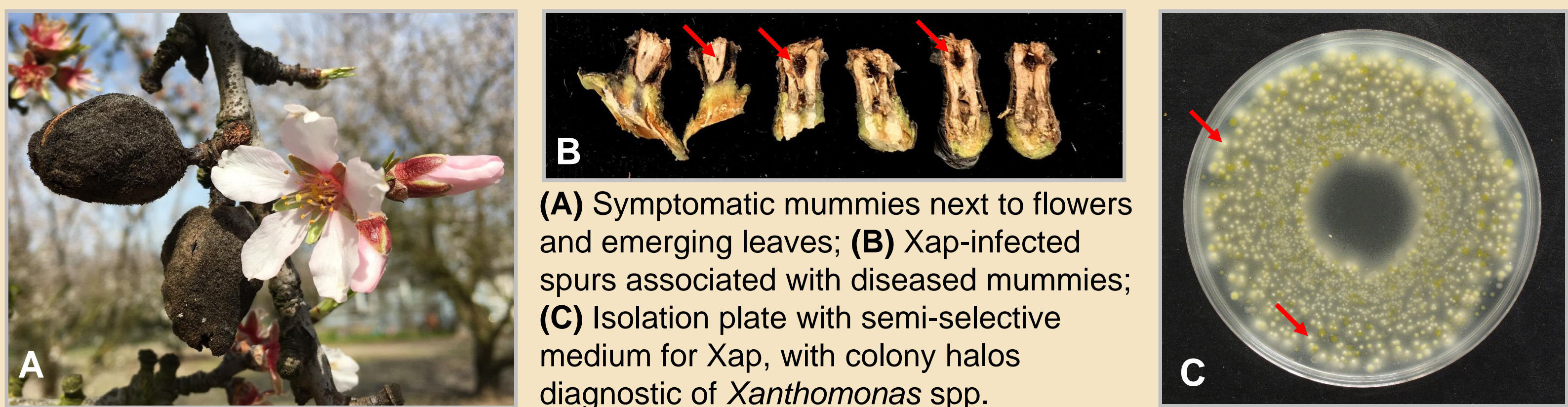
- The pathogen was detected in overwintering symptomatic fruit mummies and attached peduncles (spurs), but also in healthy flower buds and emerging leaves that were in close proximity to mummies in the tree.

Inoculation studies:

- Disease developed on 'Fritz' almond after inoculation from bloom to the mature fruit stage, indicating a long period of susceptibility.
- Still, possibly flower inoculations only contribute to inoculum built-up for later fruit infections.

Inoculation	Inoculum	Fruit incid. (%)	Leaf incid. (%)
Flowers Feb. 22, 2017	Water control	bcd	c
	Xap 2 x 10 ⁶ cfu/ml Xap 1 x 10 ⁷ cfu/ml	bcd a	c b
Immature fruit April 15, 2017	Water control	bcd	c
	Xap 2 x 10 ⁶ cfu/ml Xap 1 x 10 ⁷ cfu/ml	b a	c b
Mature fruit May 17, 2017	Water control	cd	c
	Surfactant control	d	c
	Xap 2 x 10 ⁶ cfu/ml Xap 1 x 10 ⁷ cfu/ml	bcd bcd	c c
	1 x 10 ⁷ cfu/ml + surf.	bcd	c

Surfactant = 0.1% Triton X-100. LSD mean separation is for the entire column.



Summary

- In 2017, a high incidence of bacterial spot was present at many locations due to high amounts of rainfall and wetness, especially on 'Fritz' almond.
- The pathogen was found to **overwinter** in fruit mummies and adjacent peduncle tissue on the tree indicating their role as the primary inoculum source. This is important because the peduncle (spur) remains on the tree following mummy removal. No twig cankers were found.
- Early (mid-Dec) and delayed (late Jan) **dormant treatments** with copper-mancozeb resulted in a significant reduction of bacterial spot, likely due to the wet winter and rapid increase in inoculum. Additional in-season treatments reduced the disease to very low levels.
- In-season treatments** at full bloom or petal fall alone also reduced the disease to low levels.
- The **most effective and consistent bactericides** included copper and copper mixed with mancozeb
- Experimentals** (by themselves): Kasumin, Fireline / Mycoshield, & ATD were also effective.
- Copper phytotoxicity** was low in 2017, probably due to high rainfall.
- The **most effective management program** will include a late dormant application to reduce inoculum and one (two) in-season preventative application at bloom or petal fall and timed around rainfall events and warm temperatures.