Epidemiology and Management of Bacterial Spot of Almond

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

- Bacterial spot is common on peach in the eastern US (high moisture conditions)
- Found first in spring 2013 on almond, cherry, and possibly other stone fruit crops - Colusa, San Joaquin, Stanislaus, Merced and Madera Co. – Identification with specific PCR primers
- Fritz is one of most susceptible varieties, but isolations have also been made from Nonpareil, Butte, Carmel, and Price.
- Sprinkler irrigation is a factor for increased disease over the course of the season.
- Management strategies are being explored: dormant and springtime applications with bactericides.

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

Materials for Managing Bacterial Spot

Inorganics and Conventional Synthetics

Toxicants

- Inorganics: Copper (M1) 1960s
- Dithiocarbamates: Manzate, Dithane (M3) 1940s

Inhibitors

- Phosphonates: ProPhyt, K-Phite, Fungi-phite, *Aliette, Linebacker (non-bearing)* (33) 1980s

Natural Products and Biocontrols

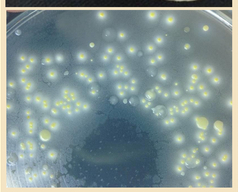
Actinovate, Serenade Opti — Natural products/biocontrols with antibacterial or SAR characteristics for organic almond production

Experimental Products under Evaluation

- Antibiotics: Kasumin (24-D3), Oxytetra-cycline (41-D5)
- Others: Ceragenin (?), Quintec (13), ATD (?)

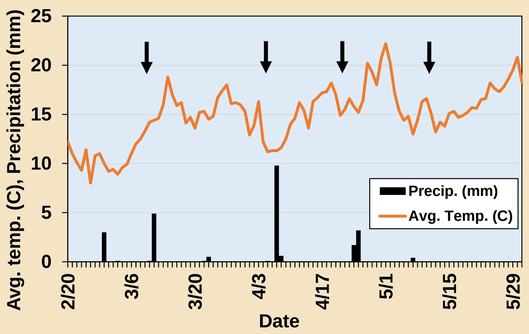
Multi-site mode of action; Single-site mode of action; Reduced-risk fungicides; FRAC group

X. arboricola pv. *pruni* overwinters in fruit mummies on the tree



Pathogen colonies on isolation plate with selective medium. The halos around the colonies are diagnostic for *Xanthomonas* spp.

Environmental conditions near field trial locations (Ripon, CA)



Environmental conditions near field trial locations in Ripon, CA in the spring of 2015. Arrows indicate bactericide timings in the two studies where applications were done based on rain events.

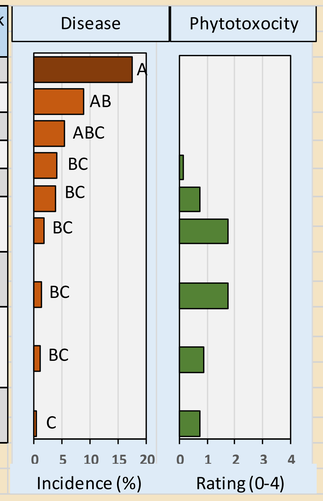
Field trials on management of bacterial spot of almond 2015

1. Evaluation of in-season treatments – timings based on

Trial 1: Evaluation of copper, and antibiotics

No.	Treatment*	Rate(/A)	PF 2/25	1-wk 3/6	3-wk 3/17	5-wk 3/26	7-wk 4/6
1	Control	---	---	---	---	---	---
2	Mycoshield	16 oz	@	@	@	@	@
3	ATD	13 oz	@	@	@	@	@
4	ATD + Kasumin	13 oz + 64 fl oz	@	@	@	@	@
5	Kasumin	64 fl oz	@	@	@	@	@
6	ChampION^{++}	3.3 to 0.8 lb	3.3	1.6	0.8	0.8	0.8
	Mycoshield	16 oz	@	@	@	@	@
7	ChampION^{++}	3.3 to 0.8 lb	3.3	1.6	0.8	0.8	0.8
	Kasumin	64 fl oz	@	@	@	@	@
8	ChampION^{++}	3.3 to 0.8 lb	3.3	---	1.6	---	0.8
	Mycoshield	16 oz	@	@	@	@	@
	Manzate	4 lbs/A	---	@	---	@	---
9	ChampION^{++}	3.3 to 0.8 lb	3.3	---	---	---	---
	Mycoshield	16 oz	@	@	@	@	@

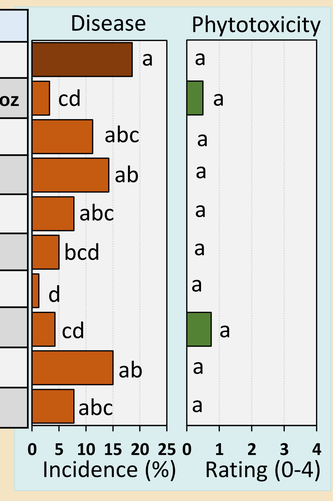
Cv. Fritz, Copper rates were reduced with each treatment. Evaluation on 7-1-15.



Trial 2: Evaluation of copper, and biologicals

Treatment	Rate(/A)
Control	---
Kocide 3000 + Serenade Opti + NF-P	3.3 to 0.8 lb + 8 oz + 8 fl oz
Serenade Opti + NF-P	8 oz + 8 fl oz
Serenade Opti + NF-P	16 oz + 8 fl oz
USF2018A	7 fl oz
USF2018A	5.3 fl oz
Badge X2	3.3 to 0.8 lb
Badge X2 + Vintre	3.3 to 0.8 lb + 64 fl oz
Actinovate	8 oz
Actinovate + Nutrient	8 oz + 2 lb

Cv. Fritz, Applications on 2-25, 3-6, 3-17, 3-26, 4-6-15. Evaluation on 7-1-15. Copper rates were 3.3, 1.6, 0.8, 0.4, and 0.8 lb/A for the five timings, respectively.



Trial 3: Evaluation of copper, antibiotics, mancozeb, and quinoxyfen

Treatment	Rate(/A)
Control	---
Kasumin	64 fl oz
Mycoshield	12 oz
Kocide 3000 + Kasumin	8 oz + 64 fl oz
Kocide 3000 + Mycoshield	12 oz + 12 oz
Quintec	12 fl oz
Quintec + Manzate Max	12 + 96 fl oz
Ceragenin	5 fl oz

Cv. Fritz, Applications on 2-25, 3-6, 3-16, 3-26, 4-6, 4-24-15. Evaluation on 7-1-15.

Trial 4: Evaluation of kasumin and mancozeb

Treatment	Rate(/A)
Control	---
Kasumin	64 fl oz
Kasumin + Manzate Max	64 +64 fl oz

Cv. Fritz, Applications based on rain events on 3-11, 4-6, 4-24, and 5-13-15. Evaluation on 7-1-15.

2. Evaluation of dormant and in-season treatments on the incidence of bacterial spot and phytotoxicity of cv. Fritz almond in San Joaquin Co. 2015

		Disease incidence (%)									
		Timing 1 D: 12/18/14 IS: 3/11/15		Timing 2 D: 12/18/14 IS: 4/6, 4/24		Timing 3 D: 12/18/14 IS: 3/11, 4/6, 4/24, 5/13		Timing 4 D: 12/18/14 IS: none		Treatment Avg	
Dormant treatment	In-season	Disease^	LSD^^	Disease	LSD	Disease	LSD	Disease	LSD	Disease	LSD
Control	ChampION^{++} + Manzate	2.0	B a	4.3	AB a	2.5	B a	10.3	A a	4.8	a
Kocide 3000 6 lb	ChampION^{++} + Manzate	2.3	A a	1.8	A a	1.0	A a	4.5	A a	2.4	a
Kocide 3000 6 lb + Manzate 6 lb	ChampION^{++} + Manzate	0.8	A a	2.0	A a	1.0	A a	3.3	A a	1.8	a
	Timing Avg	1.7	B	2.7	B	1.5	B	6.0	A		
		Copper phytotoxicity rating on leaves									
Dormant treatment	In-season	Phytotox.	LSD	Phytotox.	LSD	Phytotox.	LSD	Phytotox.	LSD	Phytotox.	LSD
Control	ChampION^{++} + Manzate	1.5	B a	0.8	C a	2.8	A a	0.0	C a	1.3	a
Kocide 3000 6 lb	ChampION^{++} + Manzate	1.0	B a	1.0	B a	2.5	A a	0.0	C a	1.2	a
Kocide 3000 6 lb + Manzate 6 lb	ChampION^{++} + Manzate	1.0	B a	0.8	B a	2.3	A a	0.0	D a	1.0	b
	Timing Avg	1.2	B	0.83	C	2.6	A	0	D		

*- D= dormant treatment. IS = in-season treatments with ChampION^{++} + 3.5 lb Manzate 75DF/A. Rates for ChampION^{++} and Manzate were: 3.3 lb + 96 fl

^- Fruit were evaluated for the presence of bacterial spot on 7-1-15. Disease values are the number of diseased fruit counted per tree. Phytotoxicity on leaves was evaluated using a rating scale from 0 (= no phytotoxicity) to 4 (= severe).

^^- Values followed by the same number are not significantly different based on an analysis of variance and LSD mean separation ($P > 0.05$). Statistical comparisons for values in the shaded area by column are with lower case letters, those by row are with upper case letters. Treatment averages are values for treatments over all timings and are statistically compared by column. Timing averages are values for each timing for all treatments and are statistically compared within the row.

Summary

- In 2015, the presence of the disease at previous and additional locations was confirmed and continued to be a problem on cv. Fritz and other cvs. planted with Fritz.
- The pathogen was found again to overwinter in fruit mummies on the tree indicating their role as the primary inoculum source. Twig cankers were not found.
- Due to drier weather conditions in the spring of 2015 the incidence of bacterial spot was generally lower.
- In contrast to 2014, none of the dormant treatments (applied either in mid-Dec. or in late Jan.) with copper or copper-mancozeb resulted in a significant reduction of bacterial spot. This was likely due to the very dry winter and low inoculum.
- In-season treatments that started at full bloom and petal fall significantly reduced the disease when timed around rain events and before warm springtime temperatures.
- Isolates evaluated to date were all rated as copper-sensitive. The most effective and consistent treatments included copper (Kocide 3000, Badge, ChampION++) and copper mixed with mancozeb or with kasugamycin (e.g., Kasumin).
- Experimentals: Kasumin, Fireline / Mycoshield, & USF2018A were also effective.
- Copper phytotoxicity was observed on leaves after 4 or 5 applications even when copper rates were successively reduced, and minor leaf tip necrosis was present after ≥4 successive Kasumin applications.
- Based on 2014 and 2015 data, the most effective management program will include a late dormant application to reduce inoculum and one to two in-season preventative applications starting at bloom and timed around rainfall events and warm temperatures.