
Powdery Mildew, Scab, and Other Disease Control on Almond

Project No.: 08-PATH7-Holtz

Project Leader: Brent A. Holtz
Pomology Farm Advisor
UCCE Madera County
328 S. Madera Avenue
Madera, CA 93637
(559) 675-7879 ext. 205
e-mail: baholtz@ucdavis.edu

Project Cooperators and Personnel:
James E. Adaskaveg, UC Riverside

Objectives:

There are several fungal diseases that can infect almond trees during bloom, infecting and killing blossoms and ultimately reducing yield. Fungicides are commonly sprayed on almond trees, and other stone fruits, during bloom to prevent disease. In some instances fungicide resistance has developed in pathogen populations. We would like to determine what registered fungicides provide the best control for Powdery Mildew on Almond and also the best application timing for disease control. Consideration should be given to develop a disease management program that avoids developing fungicide resistance not only with this species of powdery mildew but the other fungal diseases typically sprayed during the same timing period such as Anthracnose, Alternaria, and Scab. We would also like to evaluate both conventional, organic, and developmental unregistered fungicides for their efficacy to control brown rot, shot hole, anthracnose, and scab bloom time diseases of almond.

Interpretive Summary:

Information from fungicide trials are incorporated into the UC IPM publication "Efficacy and timing of fungicides, bactericides, and biologicals for deciduous tree fruit, nut, strawberry, and vine crops" <http://www.ipm.ucdavis.edu> that is published every year. Growers use this information to determine what particular fungicide has efficacy towards the specific disease(s) they have in their orchard(s), and the proper timing of a specific fungicide to control a specific disease. Growers are made aware that they should practice chemical rotation in order to avoid resistance development in fungal pathogen populations.

Recent Publications:

Holtz, B.A., and Martin-Duvall, T. 2008. Evaluation of fungicides for control of scab on almond, 2007. Plant Disease Management Reports 2:STF015, American Phytopathological Society, APSnet, St. Paul, MN, <http://www.plantmanagementnetwork.org/>.

Holtz, B.A., Martin-Duvall, T., and Adaskaveg, J.E. 2008. Evaluation of fungicides for control of powdery mildew on almond, 2007. Plant Disease Management Reports 2:STF018, American Phytopathological Society, APSnet, St. Paul, MN, <http://www.plantmanagementnetwork.org/>.

Evaluation of fungicides for control of powdery mildew on almond, 2007.

An almond orchard on a 22 x 24 ft spacing was divided into single tree plots of eighteen treatments with five replications in a randomized complete block design. Treatments were applied at shuck split, two weeks after and 4 weeks after shuck split, with a handgun delivering 4 gallons per tree through a 0.60 disk nozzle tip of a handgun applicator at 200 psi. All treatments were evaluated for powdery mildew incidence and severity (visual estimate of nut surface area infected) on 25 June and 9 July. The nuts were shaken and each plot was harvested for yield on 10 August. Samples were collected from each plot and dried. Evaluations were conducted on the nut meats to determine the effects of powdery mildew on yield and nut quality. Prior to analysis, incidence and severity data were arcsine transformed; visual count data and nut meat yields were log transformed. All data were back transformed for reporting purposes.

Two species of powdery mildew have been reported on almond, the apple powdery mildew fungus *Podosphaera leucotricha* and the peach powdery mildew fungus *Sphaerotheca pannosa*. We believe the apple powdery mildew fungus is responsible for causing disease symptoms on almond similar to those of peach rusty spot, but presence of both organisms has not been successfully disputed at this time. **Table 1** shows the results. Microthiol at 10 to 20 lb exhibited the least incidence and severity of powdery mildew as well as the least shrivels throughout the season. All treatments exhibited lower incidence and severity of powdery mildew at both in season evaluation dates than the control. Only Adament, A15909, Topsin M alone or tank mixed with Microthiol Disperss, and V10116 were statistically similar to Microthiol for shrivel. All other treatments were not significantly different from the control.

Table 1. Evaluation of fungicides for control of powdery mildew on almond, 2007.

Treatment and rate/A	App Time **	25 June 07 *		9 July 07 *		10 Aug 07 *	
		% Infected nuts	% Nut surface area infected	% Infected nuts	% Nut surface area infected	Yield per tree (lb)	Percent Shivel
Control		43.1 a	43.7 a	47.8 a	34.6 a	11.59	4.25 ab
Abound 2.08F 12.8 fl oz + Induce 1 qt	1,2,3	5.5 cd	9.3 cdef	6.3 bcd	5.5 cdefgh	15.60	3.44 abcd
Adament 50WDG 6 oz + BreakThru 1 qt	1,2,3	14.4 bc	12.5 bcd	10.9 bc	9.9 cdef	16.34	1.62 cde
A15909A SC 14 fl oz + Induce 1 qt	1,2,3	6.2 cd	5.8 cdef	2.3 bcd	1.9 efgh	16.15	1.64 cde
Enable 2F 6 fl oz + BreakThru 1 qt	1,2,3	6.8 cd	6.3 cdef	2.4 bcd	1.1 gh	15.67	2.58 abcde
Gem 4.17SC 3 fl oz + BreakThru 1 qt	1,2,3	15.0 bc	19.6 bc	5.0 bcd	7.8 cdefgh	11.22	2.97 abcd
Inspire 2.08EC 7 fl oz + Induce 1 qt	1,2,3	8.2 cd	6.1 cdef	5.0 bcd	8.2 cdefg	17.10	1.90 bcde
Laredo 1.67EW 12.8 fl oz + BreakThru 1 qt	1	3.9 cd	5.4 def	3.3 bcd	7.2 cdefgh	13.73	3.66 abc
Laredo 1.67EW 12.8 fl oz + BreakThru 1 qt	1,2	6.0 cd	3.1 def	10.9 bc	11.3 cde	20.00	2.82 abcd
Laredo 1.67EW 12.8 fl oz + BreakThru 1 qt	1,2,3	8.1 cd	8.7 cdef	5.2 bcd	4.7 cdefgh	17.91	4.84 a
Microthiol Disperss 80WG 10 lb	1,2,3	1.0 d	1.1 f	2.2 bcd	3.1 defgh	15.31	2.55 abcde
Microthiol Disperss 80WG 20 lb	1,2,3	2.9 d	1.6 ef	0.7 d	0.6 h	17.55	0.88 e
Pristine 38WDG 14.5 oz + BreakThru 1 qt	1,2,3	14.3 bc	7.8 cdef	9.6 bc	5.2 cdefgh	12.69	3.41 abcd
Quintec 2.08SC 8 fl oz + BreakThru 1 qt	1,2,3	10.8 bcd	6.3 cdef	12.1 bc	14.4 bc	21.95	2.99 abcd
Topsin M 70WDG 1 lb + BreakThru 1 qt	1,2,3	7.7 cd	10.6 bcdef	13.1 b	11.8 bc	16.19	1.94 bcde
Topsin M 70WDG 1 lb + Microthiol Disperss 80WG + BreakThru 1 qt	1,2,3	6.0 cd	2.9 def	2.0 cd	1.6 fgh	17.67	1.36 de
V10116 50WG 2.5 oz + BreakThru 1 qt	1,2,3	6.6 cd	2.8 def	10.0 bc	15.2 bc	21.53	2.10 bcde

* Means in the same column not followed by a common letter are significantly different according to Fisher's LSD ($\alpha = 0.05$)

** Timing 1 – Shuck split (26-28 Mar); Timing 2 – Shuck Split + 2wks (April 13); Timing 3 - Shuck split + 4 wks (date?)

Evaluation of fungicides for control of scab on almond, 2007.

The experiment was conducted in a Carmel variety mature orchard in Madera, CA with a 19 ft x 22 ft spacing. Treatments were applied to single-tree plots arranged in a randomized complete block design with 6 replicates. All materials were applied to run-off with a handgun sprayer with a 90 spray nozzle at 200 psi. Treatments were applied on 1-3 Mar (pink bud), 14-16 Mar (full bloom), 29-31 Mar (petal fall) and 24-25 Apr (four wks past petal fall). Treatments were applied as protectants based on tree phenology and weather. Each plot was evaluated on 23 Jul, and 1 Aug for number of nuts with lesions per 25 nuts and the number of lesions per nut. The final visual rating was conducted on 5 Sept. Rainfall was: Mar 0.44, Apr 0.40, and May 0.30 inches. Percent infestation was arcsine transformed and severity data was log transformed for mean separation and back transformed for reporting purposes. There was no significant rainfall prior to, during and after full bloom which provided poor conditions for brown rot and shothole. There was adequate rainfall for scab development. The recommended timing for scab control is at 2 - 5 weeks after petal fall. **Table 2** shows the results. The greatest control for the three evaluations was exhibited by Quash tank mixed with BreakThru applied at timing 1 and 3 at 2.5 ounces, 4 ounces at timing 4 with Rovral at 16 fl oz tank mixed with Hook at 32 fl oz at timing 2. This was not significantly different from Adament at 4 or 6 oz applied at all timings; Echo 720 at 4 pts or Echo Ultimate at 3.6 lb applied at timings 1,2, & 3 both followed by Pristine at 12 oz tank mixed with Latron B1956 at timing 4; Quash tank mixed with BreakThru applied at timing 1 and 3 at 2.5 ounces, 4 ounces at timing 4 with Abound at 12.8 fl oz tank mixed with Hook at 32 fl oz at timing 2, Topsin at 1 lb tank mixed with Dormant Oil at timing 2 followed by Topsin at 1 lb tank mixed with Maneb, TD2313, or Ziram at timing 3 and Maneb, TD2313 or Ziram alone at timing 4; or Gem at 4.17 lb applied at all timings.

Table 2.Evaluation of fungicides for control of scab on almond, 2007.

Treatment ^{zy}	% Incidence ^x					Number of Scab Lesions/nut ^x					Visual evaluation of lesions per tree ^x
	23 July 2007		1 Aug 2007		23 July 2007		1 Aug 2007		5 Sept 2007		
Quash 50WG 2.5 oz + BreakThru 1 qt ^{ac} Rovral 4F 1 pt + Hook 1 qt ^b Quash 50WG 4 oz + BreakThru 1 qt ^d	0.0	p	0.4	rst	0.0	1	0.00	i	0.8	m	
Rovral 4F 1 pt + Hook 1 qt ^a Pristine 38% 12 oz + BreakThru 2.5 pt ^{bcd}	0.0	p	8.2	mno	0.75	ghijkl	0.24	hi	2.0	defghi	
Inspire 2.08EC 5 fl oz + Vanguard 75WG 5 oz + Hook 1 qt ^{abcd}	0.1	op	7.6	mnop	0.0	1	0.75	ghi	0.9	lm	
Adament 50 WG 6 oz ^{abcd}	0.2	op	0.4	rst	0.04	1	0.08	i	1.2	klm	
Topsin M70WP 1 lb+oil 2 gal ^b Topsin M 70WDG 1 lb+ Maneb 75DF 6 lb ^c Maneb 75DF 8 lb ^d	0.2	op	3.5	opqr	0.06	1	0.30	hi	1.6	hijklm	
Echo 720 4 pt ^{abc} Pristine 12 oz + Latron B1956 2.5 pt ^d	0.4	op	2.3	pqrs	0.31	jkl	0.43	hi	1.0	lm	
Quash 50WG 2.5 oz + BreakThru 1qt ^{ac} Abound 2.08SC 12.8 fl oz + Hook 1 qt ^b Quash 50WG 4 oz + BreakThru 1 qt ^d	1.4	nop	0.9	qrst	0.12	1	0.07	i	0.90	lm	
Topsin M 70WP 1 lb + oil 2 gal ^b Topsin M 70WP 1 lb + TD2313 75DF 6 lb ^c TD-2313 75DF 8 lb ^d	1.6	mnop	1.3	qrst	0.12	1	0.07	i	1.1	klm	
Adament 50WG 4 oz ^{abcd}	1.7	lmnop	0.1	st	0.17	kl	0.06	i	0.8	m	
A15909A 14 fl oz + Inspire 1 qt ^{abcd}	1.7	lmnop	10.7	ijklmn	0.17	kl	1.00	fghi	1.3	ijklm	
Topsin M 70WP 1 lb + Ziram 75DF 6 lb ^{abcd}	1.8	lmnop	10.6	ijklmn	0.12	1	0.55	hi	2.5	cdef	
Echo Ultimate 82.5WDG 3.6 lb ^{abc} Pristine 38WDG 12 oz + Latron B1956 2.5 pt ^d	2.0	lmnop	0.0	t	0.22	jkl	0.00	i	1.6	hijklm	
Enable 2F 6 fl oz + BreakThru 1 qt ^a Enable 2F 6 fl oz + DithaneF45 6 lb +BreakThru 2.5 pt ^{bc}	2.2	mnop	7.5	mnop	0.95	ghijkl	0.70	ghi	1.4	ijklm	
Gem 4.17SC 3 fl oz ^{abcd}	2.2	lmnop	0.7	qrst	0.06	1	0.1	i	0.8	m	
Topsin M70WP 1 lb + oil 2 gal ^b Topsin M70WP 1 lb + Ziram76DF 6 lb ^c Ziram 76DF 8 lb ^d	2.3	lmnop	0.8	qrst	0.33	jkl	0.44	hi	1.3	ijklm	
Abound 2.08SC 12.8 fl oz + Inspire 1 qt ^{abcd}	3.7	klmno	4.3	nopq	0.35	ijkl	0.42	hi	1.7	ghijkl	
Adament 50WG 8 oz ^{abcd}	6.2	ijklmn	2.1	qrs	0.38	ijkl	0.80	ghi	1.2	ijklm	
Pristine 38WDG 12 oz +BreakThru 2.5 pt ^{bc} Captan 50WDG 9.07 lb ^d	6.9	klmnop	15.2	hijklm	0.57	hijkl	1.83	defgh	3.0	bc	
Distinguish 4SC 9 fl oz ^{abcd}	7.5	ijklmn	19.9	efghi	0.75	ghijkl	1.61	efgh	1.7	ghijkl	
Distinguish 4SC 12.8 fl oz ^{abcd}	7.7	ijklm	9.8	klmn	0.85	ghijkl	0.61	hi	1.8	efghijk	
DPX LEM 17 4.3 fl oz + Manex 4L 4qt ^{abcd}	8.1	hijkl	8.81	mno	0.65	hijkl	0.70	ghi	1.4	ijklm	

Enable 2F 6 fl oz + BreakThru 1 qt ^{abc}	9.9	ghijk	2.3	pqrs	1.01	ghijkl	0.89	fghi	1.4	ijklm
Rovral 4F 16 fl oz + Hook 1 qt ^{abcd}	15.4	fghij	23.6	defgh	1.62	efghij	3.28	cdef	2.7	bcd
Vanguard 75WG 5oz + Inspire 1qt ^{abcd}	18.1	fghi	18.0	fghijk	2.66	cdefg	4.15	bcde	2.5	cdef
Laredo 1.67EW 12.8 fl oz + BreakThru 1qt ^{abc}	19.0	efgh	27.9	cdef	4.39	bcde	5.36	abcd	1.8	fghijk
DPX LEM 17 ^{abcd}	21.1	defg	19.6	efghij	1.88	defghi	3.16	cdef	2.7	bcd
V-10135 50WG 8 oz + BreakThru 1 qt ^{abcd}	25.7	cdef	26.4	cdefg	2.11	defgh	3.80	bcde	1.3	ijklm
Captan 50WDG 9.07 lb ^{cd}	27.1	cdef	16.0	ghijkl	1.48	fghijk	2.71	cdefg	1.9	defghij
V-10135 4SC 12 fl oz + BreakThru 1 qt ^{abcd}	32.6	bcde	21.0	efgh	4.75	bcd	3.18	cdef	2.2	defgh
Scala 5SC 12.8 fl oz ^{abcd}	35.0	bcd	37.3	abc	4.10	bcdef	6.90	abc	2.4	cdefg
V-10135 4SC 5.98 fl oz + BreakThru 1 qt ^{abcd}	40.5	bc	23.4	defgh	4.38	bcde	5.50	abcd	1.9	defghij
V-10135 4SC 8 fl oz + BreakThru 1 qt ^{abcd}	43.9	b	33.6	bcd	4.86	bcd	4.26	bcde	3.3	b
V-10135 4SC 10 fl oz + BreakThru 1 qt ^{abcd}	46.2	b	37.0	abc	7.72	ab	6.40	abc	2.6	bcde
DPX LEM 17 3 fl oz ^{abcd}	47.2	b	28.4	cdef	5.96	bc	6.16	abc	2.5	cdef
UTC 1	66.2	a	45.2	ab	15.1	a	9.73	ab	4.4	a
lsd at 0.05	9.340		7.402		0.332		0.362		0.7693	

²Dates of fungicide applications were as follows: a = 1-3 March, b = 14-16 March, c = 29-31 March, and 24-25 April 2007.

³Products were applied in 200 gallons for the first application and 250 gallons of water per acre for applications 2, 3, & 4.

^xMeans not followed by a common letter are significantly different according to Fisher's LSD ($P \leq 0.05$).