Epidemiology and Management of Almond Anthracnose and Brown Rot in California

Project No.: 06-PATH2-Adaskaveg

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Interpretive Summary:

Our research in 2006 and in the spring of 2007 focused on the evaluation of new fungicides against major foliar and fruit diseases of almond in California, i.e. brown rot blossom blight, anthracnose, shot hole, and scab as well as on the etiology of a new russeting disorder of fruit considered to be a powdery mildew. Due to low rainfall, incidence of these diseases throughout the state was generally high in the spring of 2006. Highly effective fungicides were identified that will help to prevent the selection and build-up of resistant pathogen populations when applied in rotation or mixture programs. In a Solano Co. field trial with a high disease pressure of brown rot blossom blight, all single-fungicide, mixture, pre-mixture, or rotation programs evaluated significantly reduced the incidence of disease. The lowest incidences were found with some of the pre-mixes (i.e., Pristine, USF2010, and newly registered DMI fungicides-Elite, Indar, and Orbit) and rotation programs (i.e., V-10116 rotated with Pristine or Rovral). The incidence of shot hole was most effectively controlled by Gem in the single-fungicide programs and Pristine in the pre-mix programs. In a field trial in Butte Co., the incidence of anthracnose was low in the untreated control, but all treatments significantly reduced the incidence. Anthracnose levels were low, because most rainy periods occurred with low temperatures (<63 F avg. daily) or 2007 low rainfall during the entire spring season. In trials in Kern Co. and Butte Co., the new SBI fungicide difenoconazole (Inspire) and a pre-mix of an SBI with a strobilurin (i.e., USF2010) were most effective in reducing the incidence of scab, whereas other strobilurin fungicides (i.e., Pristine, Abound) as well as the hydroxyanilides were ineffective. Field resistance to strobilurin fungicides was commonly found in *Cladosporium carpophilum* populations in multiple orchards in Northern California and in a Kern Co. orchard, emphasizing the importance of having several fungicide classes available that are active against a specific pathogen and the need to employ resistance management strategies whenever

several alternatives to manage a disease are available. In studies on the etiology of a new russeting, powdery mildew-like disease, fungicide treatments indicated that a fungal organism causes the disorder. Probably, the putative pathogen is a powdery mildew fungus because powdery mildew-specific fungicides (e.g., Quintec, V-10118) also effectively reduced the incidence of this disorder. In host-pathogen interaction studies in almond anthracnose, confocal microscopy studies directly demonstrated that pH shifts occur at the infection sites allowing the pathogen to go into its necrotrophic phase and cause disease. Studies on environmental stress factors and host variety determinants that allow this increase in pH are ongoing.

Objectives:

I. **Epidemiology**

A. Host-pathogen interactions: Effect of pH modulation as a pathogenicity factor for development of almond anthracnose.
B. Evaluate constitutive vs. adaptive processes of ammonia production in *Colletotrichum acutatum.*
C. Evaluate pH changes in resistant (e.g., Nonpareil) and susceptible (e.g., NePlus Ultra) genotypes.
D. Develop wetness-temperature models for predicting anthracnose.
E. Continue to evaluate inoculum viability under different environmental conditions and rate of re-activation of spore production on infected host tissues.
F. Evaluate fungi associated with kernel discolorations in collaboration with T. Gradziel.
G. Characterize the etiology of the newly described almond fruit russeting disorder.
H. Apply powdery mildew-specific fungicides (no activity against other fungi) (e.g., quinoxyfen, V-10118) and broad-spectrum fungicides (wettable sulfur, myclobutanil, azoxystrobin, pyraclostrobin/boscalid) in affected orchards.
I. From fungicide efficacy data deduce putative cause of disorder (fungal, specific fungi, non-fungal).
J. Greenhouse inoculation studies using infected almond fruit from the field as inoculum sources.

II. **Disease management strategies**

A. Evaluate new fungicides and develop efficacy data based on spectrum of activity, systemic action, and persistence.
   a. Continue evaluations on brown rot, shot hole, scab, and anthracnose.
   b. Evaluate new fungicides against almond leaf rust.
   c. Use information on the characteristics of fungicides to develop effective rotation programs for anthracnose and brown rot management, as well as other diseases of almond.
B. Evaluate persistence and post-infection activity of selected fungicides in field/laboratory studies for management of brown rot and anthracnose.
   a. Continue to develop a minimum application fungicide program for maximum disease control of major foliar diseases.

    b. Compare the single-application delayed bloom spray program with a two-application program.

C. Develop baseline sensitivities and characterize *Monilinia* and *Colletotrichum* spp. for their resistance potential to new fungicides. Monitor exposed populations for shifts in sensitivity.

D. Evaluate almond genotype susceptibility to foliar diseases including brown rot and other diseases that develop naturally in the almond variety orchard at UC Davis under simulated rainfall as part of an ongoing collaboration with T. Gradziel.

Materials and Methods:

Studies on host-pathogen interactions: Effect of pH modulation as a pathogenicity factor for development of almond anthracnose. Modulation of the pH within host cells by the pathogen and a subsequent increase in fungal enzyme activity have been demonstrated by others and by us in several diseases caused by *Colletotrichum* and *Alternaria* species. These shifts in pH that are caused by the pathogen are thought to increase the activity of the pathogen's pathogenicity factors. Previously, we demonstrated that pH shifts also occur in almond tissue infected by *C. acutatum* with an increase in pH values from ca. 4.2 in healthy fruit tissue to ca. 8 in diseased tissue. These increases in pH were correlated with an increase in the ammonia concentration.

Fungicide evaluations for management of brown rot and shot hole. For blossom blight control, field trials were conducted in Solano Co. (UC Davis). Treatments were done as single-fungicide, mixture or pre-mixture, and rotation programs shown in Table 1. Treatments were applied using an air-blast sprayer at a rate of 100 gal/A. For brown rot evaluation, the number of brown rot strikes per tree was counted on 5-5-06 for each of five single-tree replications. Incidence and severity of shot hole on determined on 5-17-06 and are based on 50 leaves or 25 fruit from each of five single-tree replications from each treatment. Data were evaluated using an analysis of variance and LSD mean separation ($P > 0.05$). Trials were repeated in the spring of 2007.

Fungicide evaluations for management of anthracnose and scab. For anthracnose management, field trials were conducted in Butte Co. Treatments were done as single-fungicide, mixture or pre-mixture, and rotation programs shown in Table 2A. Treatments were applied using an air-blast sprayer at a rate of 100 gal/A at pink bud (PB), full bloom (FB) and shuck split (SS). Incidence of disease based on 100 fruit from each of four single-tree replications from each treatment. Data were evaluated using an analysis of variance and LSD mean separation ($P > 0.05$). Trials were repeated in the spring of 2007.

For scab management, the efficacy of fungicide treatments was evaluated on almond cv. Carmel in Kern Co. Treatments were applied using an air-blast sprayer at a rate of 100 gal/A on three dates 5/19, 6/1, and 6/13) in late spring. Evaluations were done on 8-11-06. 25 fruit were collected from each single-tree replication. Incidence of disease was based on the number of diseased fruit of the total number of fruit evaluated.

Severity of disease was based on a rating scale from 0 = no disease, 1 = <10%, 2 = 10-25%, and 3 = >25% of fruit area diseased. Data were evaluated using an analysis of variance and LSD mean separation ($P > 0.05$). Trials were repeated in the spring of 2007.

Etiology of a new putative powdery mildew-like fruit russeting disease of almond. In mid- to late spring of 2005, unusual russetting of almond fruit was observed by J. Edstrom on the Nickels Estate. In the spring of 2006, this disorder was more widely found throughout the central valley. Although no crop losses have been reported due to this disorder, an investigation on the etiology of this problem was warranted. A fungicide trial was established using powdery mildew-specific fungicides (no activity against other fungi) (e.g., quinoxyfen - Quintec, V-10118) and broad-spectrum fungicides (wettable sulfur, pyraclostrobin/boscalid – Pristine, myclobutanil - Laredo, trifloxystrobin - Gem) in affected orchards. The goal was to deduce the putative cause of the disorder (fungal, specific fungi, or non-fungal) from efficacy data. Treatments were applied on almond cv. Padre in Colusa Co. using an air-blast sprayer at a rate of 100 gal/A.Dates of application were 4/6 and 4/19. These dates were based on fruit infection periods of peach and cherry. Incidence of disease was evaluated on 6-13-06 and was based on 200 fruit from each of four single-tree replications for each treatment. Data were evaluated using an analysis of variance and LSD mean separation ($P > 0.05$). Trials were repeated in the spring of 2007.

Results and Discussion:

Studies on host-pathogen interactions: Effect of pH modulation as a pathogenicity factor for development of almond anthracnose. In this year's studies - for the first time in any fungal-plant interaction - we directly demonstrated these pH shifts in the host tissue at the infection sites by using pH-sensitive stains in investigations using confocal microscopy (Fig. 1A,B). Increases in pH were visualized around the appressorium during host penetration and around invading fungal hyphae. Thus, pH modulation appears to be a mechanism in the infection of almond by *C. acutatum* that allows the pathogen to transform from the biotrophic to the disease-causing necrotrophic phase. Environmental stress factors and varietal determinants that prevent the host from maintaining its internal pH, however, are still unknown and these studies are ongoing. Perhaps an accumulation of infections overcomes pH stabilization within almond leaf and fruit tissue.

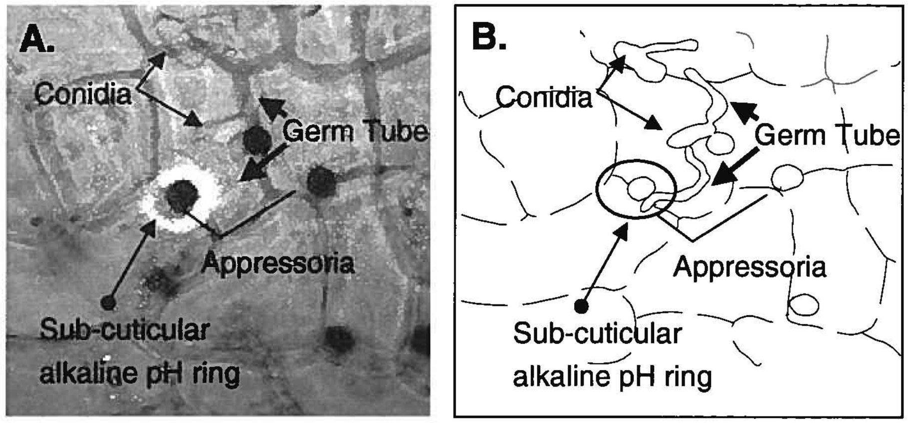

Fig. 1. Confocal micrograph and diagrammatic drawing of almond leaf epidermis colonized by *Colletotrichum acutatum* showing conidia, germ tubes, appressoria and sub-cuticular alkaline pH ring beneath an appressorium demonstrating pH-modulation pathogenesis at an individual infection point.

Fungicide evaluations for management of brown rot and shot hole. Blossom blight in the Solano Co. trial, as evaluated by the number of infected spurs (twig strikes) per tree, was significantly reduced under high disease pressure conditions by all treatments (Table 1). Disease was reduced from 53.4 strikes per tree in the control to 3.2 to 27.6 strikes in the treatments. Among the single-fungicide programs there was no significant difference between treatments. Numerically, however, the high rate of the anilinopyrimidine Scala was the best treatment with 9.4 strikes per tree. All pre-mixtures were highly effective, including Pristine, USF2010, and USF2014. There were 3.4 to 5.8 strikes per tree when using the higher application rates. Among the rotation programs, the two programs where the new SBI fungicide V-10116 was rotated with either Pristine or Rovral were very effective and 3.2 to 3.4 brown rot strikes per tree were observed.

Table 1. Efficacy of fungicide programs for management of brown rot and shothole of Drake almonds in field evaluations at the UC Davis experimental orchard in 2006.

							Brown rot**		Shothole on leaves***				Shothole on fruit***			
			Product Rate (100 gal/A)	2-14	2-22	3-15	Strikes per		Incidence		Severity Les./		Incidence		Severity Les./	
Prog.	No.	Treatments		PB	FB	SS	tree	LSD	(%)	LSD	leaf	LSD	(%)	LSD	fruit	LSD
	1	Control	---	---	---	---	53.4	a	84.3	a	4.2	a	96.8	a	6.8	a
SF	2	Vangard 75WG	5 oz	@	@	@	15.0	bcdef	46.2	bcde	0.9	bcd	79.0	bcd	4.4	bcd
	3	Scala 600SC	9 fl oz	@	@	@	19.6	bcd	61.8	bcde	1.5	b	86.0	ab	5.3	ab
	4	Scala 600SC	12.8 fl oz	@	@	@	9.4	cdef	47.2	bcd	1.1	bc	79.0	bc	4.0	bcde
	5	Evito 480SC	3.5 fl oz	@	@	@	20.8	bcd	46.4	bcde	0.9	bcd	62.5	cde	2.9	cdef
	6	Enable 2F	6 fl oz	@	@	@	18.2	bcdef	53.2	bc	1.0	bc	83.5	abc	4.8	bc
	7	Gem 500SC	3 fl oz	@	@	@	13.2	cdef	30.4	ef	0.5	cd	43.1	e	1.1	fg
P&M	8	Pristine 38WG	0.92 lb	@	@	@	4.2	ef	20.8	f	0.3	d	8.0	f	0.2	g
	9	USF2010 50WG	4 oz	@	@	@	6.8	cdef	41.6	cde	0.8	cd	75.4	bcd	3.8	bcde
	10	USF2010 50WG	6 oz	@	@	@	3.4	f	40.4	cde	0.9	bcd	69.0	bcd	3.1	cdef
	11	USF 2014 480SC	12.8 fl oz	@	@	@	9.2	cdef	46.4	bcde	1.1	bc	78.3	abc	4.2	bcd
	12	USF 2014 480SC	18 fl oz	@	@	@	5.8	def	38.8	cde	0.7	cd	57.7	de	2.5	def
	13	Scala-Evito	9 f oz/2 fl oz	@	@	@	15.0	bcdef	46.8	bcde	1.1	bc	71.8	bcd	3.6	bcde
R M	14	Laredo EW	12.8/10 fl oz	@	@	---	27.6	b	37.9	cde	0.7	cd	71.0	bcd	3.6	bcde
		Ziram 75WSP	8 lb	---	@	@										
	15	Vangard 75WG	5 oz	@	@	---	18.6	bcd	34.3	def	0.6	cd	55.5	de	2.2	ef
		Abound 2F	12.8 fl oz	---	@	---										
		Bravo 720F	4 pts	---	---	@										
	16	V-10116 50WDG	2.5 oz	@	---	@	3.2	f	38.4	cde	0.7	cd	61.4	cde	2.8	def
		Pristine 38WG	0.92 lb	---	@	---										
	17	V-10116 + NIS	2.5 oz	@	---	@	3.4	f	35.2	def	0.7	cd	58.2	de	2.3	ef
		Rovral 4F	1 qt	---	@	---										

* - Treatments were applied using an air-blast sprayer at a rate of 100 gal/A. Programs: SF = single fungicide, P = pre-mixture, M = tank mixture, and R = rotation.

** - For brown rot evaluation, the number of brown rot strikes per tree was counted on 5-5-06 for each of five single-tree replications.

***- Incidence and severity of shot hole on 5-17-06 are based on 50 leaves or 25 fruit from each of five single-tree replications from each treatment. Values followed by the same letter are not significantly different based on an analysis of variance and LSD mean separation ($P > 0.05$).

These results show that growers can effectively use fungicide pre-mixes or rotate fungicides for resistance management and not sacrifice performance of the fungicide program. Data for 2007 is currently being summarized but the newly registered DMI fungicides alone or in rotation provided excellent brown rot control.

A limited number of these fungicide field treatments were also evaluated for efficacy in laboratory experiments. Blossoms were collected in the field after a single full bloom application, inoculated with *Monilinia laxa*, and evaluated for stamen infection. Among the single-fungicide programs, Scala was again the most effective treatment with 2.2% of the stamens infected as compared to 76.9% in the control (Table 2). Enable (fenbuconazole) was the least effective, and the anilinopyrimidine Vangard, the strobilurin Gem, and the SBIs Laredo and V-10116 had intermediate efficacy. Among the pre-mixtures, numerically USF2014 and Pristine were was the most effective treatments. The fungicides in this latter study were also evaluated for their activity against blossom gray mold. Treated blossom petals were collected in the field, incubated in the laboratory, and evaluated for development of natural incidence of gray mold. Pristine, USF2010, USF2014, Vangard, and Scala were found to reduce gray mold the most among the treatments (Table 2). These studies were repeated in 2007 and data are currently being summarized.

Table 2. Efficacy of fungicide programs for management of brown rot and shothole of Drake almonds in laboratory evaluations of blossoms treated at the UC Davis experimental orchard.

				Brown rot on stamens**		Gray mold on petals***			
			Product Rate	Incidence		Incidence		Severity	
	No.	Treatments*	(100 gal/A)	(%)	LSD	(%)	LSD	Rating	LSD
	1	Control	---	76.9	a	82.1	a	2.1	a
Single fungicide programs	2	Vangard 75WG	5 oz	11.2	cde	25.4	bc	0.3	cd
	3	Scala 600SC	9 fl oz	2.2	e	19.5	cd	0.3	cd
	4	Enable 2F	6 fl oz	40.8	b	42.0	b	0.7	bc
	5	Gem 500SC	3 fl oz	23.8	bc	46.5	b	0.9	b
	6	Laredo EW	12.8 fl oz	28.1	bc	38.6	b	0.6	bcd
	7	V-10116 50WDG + NIS	2.5 oz	27.7	bc	15.7	bc	0.3	bcd
Pre-mixes	8	Pristine 38WG	0.92 lb	9.5	cde	15.7	de	0.2	d
	9	USF2010 50WG	6 oz	22.3	bcd	7.6	d	0.1	d
	10	USF 2014 480SC	18	4.5	de	27.6	bc	0.3	cd

* - Treatments were applied on 2-14-06 using an air-blast sprayer at a rate of 100 gal/A.

**- For brown rot evaluation, 7 blossoms from each of 4 single-tree replications were collected on 2-15-06 and inoculated with conidia of *M. laxa* (10,000 conidia/ml). Stamens were evaluated after 5 days of incubation at 20C.

***- Incidence of gray mold was based on the number of petals infected of the total number of petals, whereas the severity was based on the percent petal area diseased.

The incidence of shot hole disease was high in 2006 in our Solano Co. trial with 84.3% of the leaves and 96.8% of the fruit infected in the untreated control. The most effective treatments among the single-fungicides and pre-mixes in a three-spray program included the strobilurin Gem (30.4% disease on leaves, 43.1% disease on fruit) and Pristine (20.8% disease on leaves, 8% disease on fruit), respectively (Table 1). The four rotation-mixture programs had a similar efficacy with each other, but none was as effective as Pristine. Overall, fungicides were less effective against shot hole in 2006 as compared to 2005, most likely because of the extremely conducive environmental conditions in the spring of 2006 with 5 to 7 in of rainfall in March in northern California (CIMIS Stations 6, 12) where the trials were conducted. In 2007, the strobilurin fungicides were again very effective against shot hole and data are currently being summarized.

Fungicide evaluations for management of anthracnose and scab. In our field trial in Butte Co., 3.44% of the developing nuts of untreated trees had anthracnose symptoms (Table 3). Thus, although precipitation was very high in the spring of 2006, disease levels were low due to the cool avg. daily temperatures (48 and 57 F) in March and April (CIMIS Station 12). On treated trees, disease incidence was 0.75% or less (Table 3). No disease was found after treatment with the single-fungicide programs using Pristine or USF2010 and in rotation-mixture programs with: Laredo-Ziram; Scala-USF2014-Gem; Vangard-Abound-Bravo; or V-10116-Vangard.

Table 3. Efficacy of fungicide programs for management of anthracnose of Peerless almonds in Butte Co.

			Application Dates and Timings				Anthracnose Incidence**	
			14-Feb	23-Feb	17-Mar	13-Apr		
No.	Product*	Rate	PB	FB	PF/SS	4 wk-PF	(%)	LSD
1	Control	---	---	---	---	---	3.44	a
2	Gem 500SC	3 fl oz	@	@	@	@	0.5	b
3	Evito 480SC + NuFilm 17	3.5 fl oz/0.5 ml	@	@	@	@	0.75	b
4	Enable 2F	6 fl oz	@	@	@	@	0.28	b
5	USF2010 50WG	6 fl oz	@	@	@	@	0	b
6	Pristine 38WG	0.92 lb	@	@	@	@	0	b
7	Laredo EW	15.3/12.8 fl oz	@ 15.3	@ 12.8	---	---	0	b
	Ziram 75WSP	8 lb	---	@	@	@		
8	Enable 2F	6 fl oz	@	@	---	---	0.25	b
	Ziram 75WSP	8 lb	---	@	@	@		
9	Scala 600SC	12.8 fl oz	@	---	---	---	0	b
	USF 2014	18 fl oz	---	@	---	---		
	Gem 500SC	3 fl oz	---	---	@	@		
10	Vangard 75WG	5 oz	@	@	---	---	0	b
	Abound 2F	12.8 fl oz	---	@	---	---		
	Bravo 720F	4 pts	---	---	@	@		
11	V-10116 50WG	2.5 oz	@	---	@	@	0	b
	Vangard 75WG	5 oz	---	@	---	---		
12	Vangard 75WG	5 oz	@	@	---	---	0.25	b
	Evito 480SC	3.5 oz	---	@	---	---		
	Echo 720SC	6 qts	---	---	@	@		

* - Treatments were applied using an air-blast sprayer at a rate of 100 gal/A. Phenology: PB - Pink Bud; FB - Full Bloom; PF = petal fall; SS = Shuck Split.

** - Incidence of disease based on 100 fruit from each of four single-tree replications from each treatment. Values followed by the same letter are not significantly different based on an analysis of variance and LSD mean separation ($P > 0.05$).

In additional scab trials in 2007, strobilurin fungicides were effective in orchards without resistance and were ineffective in orchards where resistance developed. Fortunately, we were able to integrate the use of delayed dormant treatments (i.e., liquid lime sulfur) and multi-site mode of action fungicides (maneb, ziram, captan, etc.) during petal fall to effectively manage the disease. These fungicides were used less in previous years because the strobilurin fungicides were less expensive, less toxic to the environment, and safer for workers using the fungicides. One of our new findings was that pre-bloom, copper-oil mixtures were also very effective in suppressing fungal sporulation by the scab pathogen.

Late-spring applications with selected fungicides were evaluated for scab control in a trial in Kern Co. on cv. Carmel. At evaluation in August, there was no significant difference in the incidence or severity of disease after treatment with the antibiotic Endorse (i.e., polyoxin), the anilinopyrimidines Scala and Vangard, the strobilurin Abound, and the strobilurin-carboxyanilide mixture Pristine as compared to the control where 46.8% of the fruit were affected (Table 4). Disease incidence, however, was significantly reduced after applications with Inspire (difenconazole a SBI fungicide; 7.2% disease incidence) and the pre-mix USF2010, a mixture of a SBI with a strobilurin (13.2% disease incidence). One reason for the ineffectiveness of most treatments could be that the spray programs were initiated late in the spring season and due to the contact activity of the fungicides, the infection could not be inhibited. The reason for the ineffectiveness of the strobilurin fungicides (e.g., Abound, Pristine), however, is that the pathogen *Cladosporium carpophilum* has become resistant to this class of fungicide. Data on fungicide sensitivity of pathogen isolates from this field plot and a majority of isolates from four field sites (2006) and multiple sites (2007) in Butte Co. were found to be cross resistant to azoxystrobin, trifloxystrobin, and pyraclostrobin with EC_{50} values >25 ppm. Apparently the strobilurin fungicides have been over used and this emphasizes the importance of our fungicide evaluation program to identify multiple fungicide classes that are active against a specific pathogen and the need to employ resistance management strategies whenever several alternatives to manage a disease are available.

Etiology of a new putative powdery mildew-like fruit russeting disease of almond. After two treatment applications in April, trees were evaluated for symptoms in mid-June. In the untreated control 17.7% of the fruit had russeting symptoms (Table 5). The incidence of the disorder was significantly reduced by all treatments, including the powdery-mildew specific fungicides Quintec and V-10118, to between 0.2 and 5.4%. These results indicate that the russeting of almond fruit is caused by a fungal organism. Furthermore, based on the activity of the powdery mildew- specific fungicides, it is likely that a type of powdery mildew fungus is involved. Previously, powdery mildew fungi reported from almond in California and other locations in the world include *Podosphaera leucotricha, P. tridactyla, and Sphaerotheca pannosa.* The atypical powdery mildew symptoms are probably due to a non-specific host response from a mildew species that typically occurs on another Rosaceous host and is now also infecting almond. This situation is similar to rusty spot of peach where the apple-mildew fungus, *P. leucotricha*, is thought to develop on peach. In both, the almond fruit russeting and peach fruit rusty spot, infections can occur with apparently no obvious leaf infections. Additional studies

Table 4. Efficacy of fungicide treatments for management of scab on almond cv. Carmel - Kern Co.

No.	Product*	Rate	Application Dates 5-19	6-1	6-13	Scab Inc. (%)**	LSD	Severity	LSD
1	Control		---	---	---	46.8	a	15.5	a
2	Inspire 250EC	7 fl oz	@	@	@	7.2	b	3.6	b
3	USF2010 50WG	6 oz	@	@	@	13.2	b	3.9	b
4	Endorse 11.2WG	25 g ai	@	@	@	52.1	a	16.3	a
5	Endorse 11.2WG	20 g ai	@	@	@	49.6	a	16.3	a
6	Pristine 38WG	0.92 lb	@	@	@	36.6	a	12.2	a
7	Scala 600SC	18 fl oz	@	@	@	46.2	a	13.3	a
8	Abound 2F	12.8 fl oz	@	@	@	53.8	a	15.4	a
9	Vangard 75WG	10 oz	@	@	@	58.1	a	17.2	a

* - Treatments were applied using an air-blast sprayer at a rate of 100 gal/A.

** - Evaluations were done on 8-11-06. 25 fruit were collected from each single-tree replication. Incidence of disease was based on the number of diseased fruit of the total number of fruit evaluated. Severity of disease was based on a rating scale from 0 = no disease, 1 = <10%, 2 = 10-25%, and 3 = >25% of fruit area diseased. Values followed by the same letter are not significantly different based on an analysis of variance and LSD mean separation (*P* > 0.05).

Table 5. Efficacy of fungicide treatments for management of a new powdery mildew-like disease of almond cv. Padre in Colusa Co. in 2006

No.	Product	Rate	Application Dates 4-6-06	4-19-06	Incidence** (%)	LSD
1	Control	---	---	---	17.7	a
2	Evito 480SC	3.5 fl oz	@	@	2.6	bc
3	Gem 500SC	3 fl oz	@	@	0.4	cd
4	Pristine 38WG	14.5 oz	@	@	0.2	d
5	Laredo 1.67EW	12 fl oz	@	@	0.8	cd
6	Thiolux	20 lb	@	@	0.9	cd
7	Quintec 2L	8 fl oz	@	@	5.4	b
8	V-10118 0.41EC	9.5 fl oz	@	@	3.2	bc

* - Treatments were applied using an air-blast sprayer at a rate of 100 gal/A.

** - Incidence of disease was evaluated on 6-13-06 and was based on 200 fruit from each of four single-tree replications for each treatment. Values followed by the same letter are not significantly different based on an analysis of variance and LSD mean separation (*P* > 0.05).

were on efficacy and on the etiology of this disease were conducted in 2007 (results pending) and are planned in the coming seasons.