Studies on Biology and Management of Almond Brown Rot, Jacket Rot, Shot Hole, Rust, and Hull Rot

Project No.: **11-PATH4-Adaskaveg**

Project Leader: J. E. Adaskaveg
Department of Plant Pathology
University of California, Riverside
Riverside, CA 92521
951.827.7577
jim.adaskaveg@ucr.edu

Project Cooperators and Personnel:
D. Thompson, H. Förster, D. Felts, D. Cary, and Y. Luo, UC Riverside
T. Gradziel, UC Davis
J. Connell, UCCE - Butte County
R. Duncan, UCCE - Stanislaus County
B. Holtz, UCCE - San Joaquin County

Objective:

I. Disease management strategies: Evaluate new fungicides and develop efficacy data based on spectrum of activity, systemic action, and persistence.

a. Continue evaluations of new products against brown rot, jacket rot, and shot hole, in experimental orchards at UC Davis and KAC (as well as rust if the disease occurs during the season).
   - Evaluate new fungicides, fungicide pre-mixtures, and adjuvant - fluxapyroxad - Xemium, penthiopyrad (Fontelis), metconazole - Quash, difenoconazole - Inspire, polyoxin-D - Ph-D and organic formulations of the active ingredient, dodine - Syllit, Adament, Luna Sensation, Quadris Top, Quilt Xcel, Inspire Super, Inspire XT, Merivon, Q8Y78.
   - Evaluate persistence and post-infection activity of selected fungicides in laboratory studies for management of brown rot.

b. For hull rot management, evaluate timing and new fungicides.
   - Susceptibility of almond fruit to *M. fructicola* at different stages of development.
   - QoIs, DMIs, and experimental fungicides, as well as selected pre-mixtures and adjuvant as above.

II. Develop baseline sensitivities of fungal pathogen populations against new fungicides and determine potential shifts in fungicide sensitivity.

a. Characterize baseline sensitivities of *Monilinia, Cladosporium,* and other fungal species against SDHI (penthiopyrad, fluxapyroxad), and other fungicides

b. Determine fungicide sensitivities in locations where disease was not satisfactorily managed after fungicide treatments

c. 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.

III. Studies on the etiology of a powdery mildew-like disease of almond fruit.

a. Inoculate almond fruit with *Acremonium* sp. and observe symptoms (Koch's postulates).

b. Evaluate symptomatic fruit from different locations for the presence of *Acremonium* sp.

Interpretive Summary:

In 2011-12, we again conducted field and laboratory studies on the evaluation of new treatments against major foliar and fruit diseases of almond in California. New fungicides evaluated all belong to existing classes (e.g., DMIs – FRAC 3, SDHIs – FRAC 7, anilinopyrimidines – FRAC 9, QoIs –FRAC 11, polyoxins – FRAC 19, phosphonates – FRAC 33, EBDCs – FRAC M3, isophthalonitriles – FRAC M5, and guanidines – U12). New pre-mixtures evaluated (Merivon, Luna Sensation, and Q8Y78) all belong to FRAC 7/11. FRAC 7 fungicides are assigned to three sub-groups within this class that differ in their anti-fungal activity. Differences in the target binding sites reduce cross-resistance among some of the sub-groups; however, cross resistance is still possible. Studies are ongoing to characterize this cross-resistance in some of the main almond pathogens. With awareness and fungicide stewardship, the arsenal of available fungicide treatments will help prevent the selection and build-up of resistant pathogen populations when applied in rotation or mixture programs. The use of pre-mixtures is a resistance management strategy, but additionally, the spectrum of activity of the treatment is generally expanded so that several diseases can be targeted by a single treatment. In our research, highly effective single-fungicides and pre-mixtures were identified for the management of brown rot blossom blight, gray mold, shot hole, and rust. At the time of preparing this annual report, we can only include 2012 data for the springtime diseases brown rot, shot hole, and gray mold. Trials on summer diseases including rust and hull rot are ongoing, and thus, we are presenting our 2011 data for these objectives (the poster will have the 2012 results for studies on for these diseases). Research on scab and Alternaria leaf spot is presented in a separate report.

For brown rot management, multiple fungicides belonging to several classes, as well as pre-mixtures and rotation programs provided excellent disease control. Still, isolates resistant to anilinopyrimidine (FRAC Group 9) were detected in almond in northern California in orchards where aircraft applications were done. For management of shot hole, programs with treatments containing QoIs or Syllit resulted in superior control. We also conducted studies on the management of hull rot, a disease with an increased occurrence in recent years due to changes in horticultural practices. Hull rot caused by *R. stolonifer* can be managed with a single application of either one of several fungicide classes during early hull split. Hull rot caused by *Monilinia* species, however, was generally not reduced using the same treatments and timings and we are currently exploring if different application timings can to be used. Additionally, we determined that a powdery mildew-like disease of almond fruit is most likely not caused by a powdery mildew fungus, but by a species of *Acremonium*.

Materials and Methods:

Fungicide evaluations for management of brown rot, gray mold, and shot hole in experimental orchards – 2012 Research**.** Treatment evaluations focused on fungicides; no new biological or natural products were made available in 2012. Field trials were conducted at UC Davis on cvs. Drake, Butte, and Sonora, and at the Kearney Ag Center on cvs. Wood Colony and Sonora. Treatments were done as single-fungicide, pre-mixture, or rotation programs. In timing trials, the efficacy of selected fungicides was compared using single sprays at early or full bloom or in a two-spray program at both blossom stages. 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 for each of four or five single-tree replications. All fungicides were also evaluated in laboratory studies on detached blossoms that were inoculated with conidia of *M. laxa* (20,000 conidia/ml) either 24 h before or after treatment. The incidence of stamen infections was then determined after 5 days of incubation at 20C. For efficacy against gray mold, field-treated flower petals were collected and incubated on moist vermiculite for 5 days at 20C for the development of natural incidence of the disease. For shot evaluation, a random sample of 25-30 fruit was collected from each of four single-tree replications in mid-April. Disease incidence was based on the number of fruit with shot hole lesions of the total number of fruit collected and disease severity is the average number of lesions per fruit.

Brown rot blossom blight and spurs infections were sampled in commercial orchards where aircraft applications provided poor management. Over 150 isolations were done and sensitivity of isolates was tested to AP (e.g., cyprodonil, pyrimethanil) and DMI (e.g., propiconazole) fungicides using the spiral gradient dilution assay.

***Fungicide evaluations for management of hull rot - 2011 Research*.** Field trials were conducted on cv. Nonpareil in Stanislaus Co. where hull rot was mostly caused by *Monilinia* spp., and in Colusa Co. where the disease was mostly caused by *Rhizopus stolonifer*. Two sub-plots were treated at each location. Treatments were done as single treatments at early hull split, at 20% hull split, or in two-treatment programs at early and 20% hull split. Hull rot was evaluated at the time of harvest by counting the number of shoot infections per tree.

***Fungicide efficacy in the management of almond rust - 2011 Research*.** The efficacy of fungicides against leaf rust was evaluated on cv. Nonpareil at Kearney Ag Center. Treatments were done in late July and early August when first symptoms started to appear. For evaluations of disease on 8-26-11, 50 leaves from each of the 4 single-tree replications were evaluated using a rating scale from 0-4.

***Statistical analysis of data*.** All data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures ($P > 0.05$) of SAS version 9.2.

Results and Discussion:

***A. Brown rot blossom blight and gray mold management– 2012 Research*.** With high spring rainfall, a high level of disease was present in the UC Davis trial on the highly susceptible cultivar Drake with an average of 84.8 brown rot strikes per tree on untreated control trees. Two bloom spray applications of all treatments significantly reduced the incidence of disease. Among the single-fungicide treatments, the new SDHI (FRAC 7) fungicide penthiopyrad (Fontelis) and the experimental QoI (FRAC 11) picoxystrobin (YT669) had the lowest amount of disease with an average of 6.8 to 8.9 strikes per tree (**Table 1**). A new experimental pre-mixture of these two fungicides also gave excellent disease control. Among the eight rotation programs evaluated, the LBG-61 (FRAC 3+33, tebuconazole+phosphite) – Catamaran (FRAC M5+33, chlorothalonil – phosphite) rotation and rotations of Quash (FRAC3), Vangard (FRAC 9), and Syllit (FRAC U12) had numerically the lowest disease (**Table 1**).

Table 1: Efficacy of fungicide programs for management of brown rot, shot hole, and gray mold of Drake almonds at UC Davis 2012.

			Application*				Average number of									
			P	F	P	P	Brown rot strikes/tree**		Shot hole on fruit***				Gray mold****			
Progra	Fungicide*	Rate	2-17	2-	3-	3-	No	LSD^	Inc.	LSD	Severit	LSD	Inc.	LSD	Severit	LSD
	Contro	--	--	--	--	--	84.8	a	80.	a	4.	a	97.	a	3.	a
Single	Topguar	7 fl oz	@	@	@	@	34.0	b	57.	a	2.	b	38.	d	0.	d
	Topguar	14 fl	@	@	@	@	15.3	cdef	30.	cd	1.	d	23.	f	0.	ef
	Fontelis 1.67SC + Breakthru	14 fl oz + 8 oz	@	@	@	@	6.	f	55.	b	2.	b	59.	c	1.	c
	Fontelis 1.67SC + Breakthru	20 oz + 8 oz	@	@	@	@	7.	f	22.	defg	0.	d	40.	d	0.	de
	YT669 2.08SC	8 fl oz	@	@	@	@	19.5	cdef	18.	de	0.	d	77.	b	2.	b
	YT669 2.08SC	12 fl	@	@	@	@	8.	e	4.9	fghij	0.	d	75.	b	2.	b
	CHA-1310	7 fl oz	@	@	@	@	12.3	de	46.	b	1.	d	31.	e	0.	d
	CHA-1310	14 fl	@	@	@	@	21.8	bcde	37.	bc	0.	d	32.	e	0.	de
	IKF-5411 400SC	15.8 fl	@	@	@	@	14.0	cdef	34.	bc	1.	c	60.	c	1.	c
	IKF-5411 400SC	18.9 fl	@	@	@	@	19.3	cdef	35.	bc	0.	d	45.	d	0.	d
Pre-	Q8Y78 240SC	18 fl	@	@	@	@	6.	f	5.	fghij	0.	d	69.3	b	1.	c
Rotation	LBG-	32 fl	@	@			11.	de	13.0	efghi	0.	d	18.0	g	0.	fg
	Catamaran	64 fl			@	@										
	Meteor	1 pt=16 fl oz	@	@			22.	bcde	10.3	efgh	0.	d	24.4	f	0.	ef
	Ziram 76 DF	8			@	@										
	Meteor	16 fl	@	@			25.	bc	3.	ghi	0.	d		not		
	Manzate ProStick	6			@	@										
	Meteor 2L (Tazz)	32 fl	@	@			27.	b	8.	fghij	0.	d	2.	i	0.	h
	Ziram 76DF	8			@	@										
	Rovral 4L	16 fl	@	@			27.	b	3.	ghi	0.	d	13.3	h	0.	g
	Ziram	8			@	@										
	Quas	3.5 oz	@				14.	cdef	1.	i	0.	d	25.0	f	0.	defg
	Vangar	5 oz		@												
	Syllit	1.5 lb			@	@										
	Quas	3.5 oz	@				18.	cdef	0.	j	0.	d				
	Vangar	5 oz		@										not		
	Syllit + Bumper	1.5 lb + 4 fl oz			@	@										
	Quas	3.5 oz	@				12.	de	2.	hi	0.	d				
	Vangar	5 oz		@										not		
	Syllit	2			@	@										

* Treatments were applied using an air-blast sprayer at a rate of 100 gal/A. Q8Y78 240SC is a pre-mix of picoxystrobin and penthiopyrad.

** For brown rot evaluation, the number of brown rot strikes per tree was counted on 4-3-12for each of four single-tree replications.

*** Shot hole was evaluated on 4-17-12. Disease incidence was based on the number of fruit with shot hole lesions of a total of 25-30 fruit evaluated for each of four single-tree replications. Disease severity is the number of shot hole lesions per fruit.

**** Gray mold was evaluated on flower petals that were collected on '3-7-12 and incubated on moist vermiculite in the laboratory. Incidence of gray mold was based on ca. 50 petals for each treatment replication. Severity was evaluated using a rating scale: 0=0, 1=<25%, 2=26-50%, 3= 51-75%, 4=76-100% petal-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).

In the trial on cv. Sonora at UC Davis with a lower disease pressure, an average of 18 brown rot strikes per tree were observed in the untreated control. Two bloom spray applications of all treatments including two DMIs, a new experimental (i.e., S-2200) and several pre-mixtures were mostly similarly highly effective (**Table 2**). No disease was observed in the 3.5-oz Quash treatment. In the trial at Kearney Ag Center, disease incidence was very low with the untreated control having less than 3% disease. In these trials, all fungicides applied as a single, delayed-bloom treatment, effectively reduced brown rot blossom blight to nearly non-detectable levels.

Most of the field treatments (single-fungicides, mixtures, and pre-mixtures) were also evaluated in laboratory studies on detached blossoms. Most of these treatments showed high pre-and post-infection activity (treatments done 24 h before or after inoculation, respectively). Overall, S-2200 was the least effective treatment.

Table 2: Efficacy of fungicide programs for management of brown rot, shot hole, and gray mold of cv. Sonora almonds at UC Davis 2012**.**

			Application*				Number of Brown rot strikes/tree**		Shot hole on fruit***				Gray			
			PB	FB	PF	PF										
Program	Fungicide*	Rate (/A)	2-23	2-28	3-8	3-23	No.	LSD^	Inc. (%)	LSD	Severity	LSD	Inc. (%)	LSD	Severity	LSD
	Control	---	---	---	---	---	18.0	a	85.5	a	5.8	a	64.0	bc	1.8	ab
Single	Indar 2F+NIS	4 fl oz	@	@	@	@	4.8	b	72.0	ab	3.7	bc	76.7	ab	1.9	a
	Indar 2F+NIS	6 fl oz	@	@	@	@	1.3	bc	70.1	ab	3.4	bc	62.5	bcd	1.3	bcd
	Quash	2.5 oz	@	@	@	@	1.8	bc	33.8	d	1.3	de	24.6	fg	0.3	gh
	Quash	3.5 oz	@	@	@	@	0.0	c	20.8	def	0.5	de	18.3	g	0.2	h
	S-2200 50WG	2 oz	@	@	@	@	4.3	b	77.8	ab	4.7	ab	52.6	cde	1.5	abc
	S-2200 50WG	3 oz	@	@	@	@	1.5	bc	63.3	bc	2.3	cd	66.3	abc	2.0	a
Mixtures	S-2200 + Quash 50WG	2 oz + 2 oz	@	@	@	@	1.5	bc	37.3	cd	1.0	de	not done			
	S-2200 + Quash	3 oz + 3 oz	@	@	@	@	0.8	bc	17.2	def	0.4	de	32.5	fg	0.6	fgh
Pre-mixes	Luna Sensation SC	5 fl oz	@	@	@	@	1.0	bc	22.5	de	0.4	de	39.0	ef	0.8	defg
	Inspire Super+NIS	20 fl oz + 8 fl oz	@	@	@	@	1.0	bc	13.0	def	0.2	e	60.9	bcd	1.2	cdef
	Quadris Top	14 fl oz	@	@	@	@	2.0	bc	18.0	def	0.3	de	82.4	a	2.1	a
	Pristine 38WG	14 oz	@	@	@	@	1.5	bc	5.7	ef	0.1	e	42.6	def	1.2	cde
	Merivon	4 fl oz	@	@	@	@	1.5	bc	6.0	f	0.1	e	29.4	fg	0.7	efgh
	Merivon	6.5 fl oz	@	@	@	@	1.5	bc	8.0	ef	0.2	e	34.6	efg	0.7	efgh
Rotation	Indar 2F + Breakthru	6 fl oz + 8 fl oz	@	---	---	---	2.3	bc	16.8	def	0.3	de	not done			
	Indar 2F + Breakthru + Dithane	6 fl oz + 8 fl oz + 6 lb	---	@	@	@										

* 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 4-10-12 for each of four single-tree replications.

*** Shot hole was evaluated on 4-18-12. Disease incidence was based on the number of fruit with shot hole lesions of a total of 25-30 fruit evaluated for each of four sing-tree replications. Disease severity is the number of shot hole lesions per fruit.

**** Gray mold was evaluated on flower petals that were collected on 3-0-12 and incubated on moist vermiculite in the laboratory. Incidence of gray mold was based on ca. 50 petals for each treatment replication. Severity was evaluated used a rating scale: 0=0, 1=<25%, 2=26-50%, 3=51-75%, 4=76-100% petal 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).

Registration efforts are being continued with two registrants for an organic formulation of polyoxin-D. The goal is to have an effective fungicide for the almond industry that meets OMRI standards. Fungicide application timing studies using selected compounds on cv. Butte almond at UC Davis showed that pink bud applications alone were effective for Quash+S2200, Luna Sensation, and Merivon, indicating that these fungicides have some locally systemic activity and can penetrate into closed blossoms (**Table 3**). For Quash + S2200 and Merivon, single applications at pink bud or full bloom were similarly highly effective as two applications at pink bud and full bloom. For Luna Sensation, two applications were more effective than either of the single applications. For Quadris Top, the pink bud application alone was least effective, whereas the full bloom application and the two-spray program were very effective and resulted in a similar low disease level as for the other fungicides. Thus, in the absence of high rainfall (precipitation during bloom only occurred at full bloom on Feb 29 and March 1; see **Figure 1**), optimum treatment timing depended on the fungicide used and it's potential for systemic movement into the flower. Treatment performance, however, will also depend on the stage of bloom (i.e., timing) and environmental conditions. In previous studies we showed that under high rainfall conditions as during the spring of 2011, full bloom applications were more effective than pink bud applications and two applications resulted in the lowest disease incidence. Thus, improved fungicide coverage with functional residues on the internal blossom parts (e.g., stamens and pistils) provided the highest level of protection of blossoms from brown rot blossom blight.

Table 3: Evaluation of application timings of selected fungicides for management of brown rot of Butte almonds at UC Davis 2012

		Application		Average number of Brown rot strikes/tree**	
		PB	FB		
Treatment	Rate/A	23-Feb	28-Feb	No.	LSD^
Control	---	---	---	30.3	a
Quash +S2200	2 oz +2 oz	@	---	7.0	b
Quash +S2200	2 oz +2 oz	---	@	5.7	b
Quash +S2200	2 oz +2 oz	@	@	3.0	b
Control	---	---	---	30.3	a
Quadris Top	14 fl oz	@	---	16.7	b
Quadris Top	14 fl oz	---	@	10.0	bc
Quadris Top	14 fl oz	@	@	3.3	c
Control	---	---	---	30.3	a
Luna Sensation SC	5 fl oz	@	---	6.7	b
Luna Sensation SC	5 fl oz	---	@	5.7	b
Luna Sensation SC	5 fl oz	@	@	0.0	c
Control	---	---	---	30.3	a
Merivon	5.5 fl oz	@	---	7.7	b
Merivon	5.5 fl oz	---	@	3.0	b
Merivon	5.5 fl oz	@	@	1.7	b

* 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 4-18-12 for each of five single-tree replications

^ Values followed by the same letter are not significantly different based on an analysis of variance and LSD mean separation ($P > 0.05$)

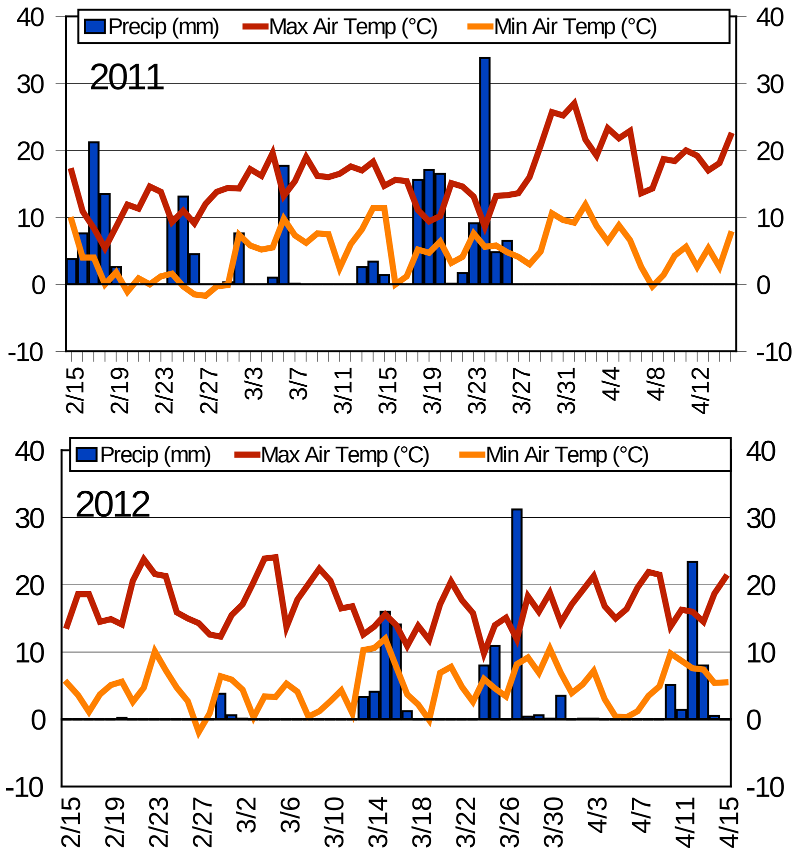

Figure 1. Precipitation and temperature at the UC Davis Trial site during almond bloom in 2011 and 2012

In surveys of several orchards where AP fungicides were applied by air and disease levels were high, we isolated from over 150 blossom blight spurs. Results indicated that in one location approximately 20% of the isolates were resistant to this FRAC Group of fungicides (e.g., Group 9 including cyprodonil and pyrimethanil). Thus, the reduced disease control was in part due to the detection of resistant isolates of the pathogen. Resistance of *Monilinia* spp. to AP fungicides has been reported on other *Prunus* spp. in northern California in the last three years. A high potential for resistance occurs with over usage of this mode of action (group of fungicides) and therefore, resistance management approaches should be strictly followed and include rotation, mixtures, and application that does not compromise coverage and ultimately residues.

The efficacy of field fungicide treatments against gray mold was evaluated in a blossom petal assay on cvs. Drake and Sonora. The lowest levels of disease occurred on cv. Drake using a high rate of Topguard, LBG-61-Catamaran, Meteor-Ziram, Rovral-Ziram, and on cv. Sonora using the high rate of Quash (**Tables 1 and 2**). Still, many other treatments also reduced gray mold significantly from that of the control.

B. Shot Hole management – 2012 Research. With additional precipitation occurring at the UC Davis trial site between mid-March and mid-April (**Figure 1**), the incidence of shot hole on fruit of cvs. Drake and Sonora in mid-April was over 80% in the untreated controls. On cv.

Drake, the incidence among the single-fungicide treatments ranged from 4.9% (i.e., the QoI YT669) to 57.5% (i.e., the low rate of the DMI Topguard) (**Table 1**). The new pre-mixture Q8Y78 had 5% incidence. All rotation programs performed with very high efficacy (0 to 13% incidence). Programs that used Syllit resulted in 0 to 2% disease incidence. On cv. Sonora, disease incidence among treatments ranged from 5.7% (i.e., Pristine) and 6% (i.e., Merivon) to 77.8% (S-2200) (**Table 2**). At the rates used, the DMI Quash was more effective than the DMI Indar. Overall, all pre-mixtures (all except Inspire Super containing a QoI fungicide) performed well.

***C. Hull Rot management – 2011 Research*.** Field studies were conducted in Colusa Co. and Stanislaus Co. on cv. Nonpareil. In Colusa Co. where the disease was mainly caused by *R. stolonifer*, an application at 20% hull split by most treatments was effective. Disease incidence was reduced from 60.5% in the control to between 14.8% (i.e., Merivon) and 41.3% (i.e., Ph-D) (**Table 4**). In a timing study using selected fungicides, Luna Sensation and Quash showed efficacy, whereas Quadris Top and Q8Y78 did not reduce the disease from that in the control (**Table 4B**). For Luna Sensation and Quash, applications at early hull split, 20% split, or at both timings were similarly effective and thus, there was no significant difference among the timings (similar to previous years' findings). Because there was no increase in disease after a single early-split application as compared to two applications, this may indicate that inoculum is targeted by the fungicide *before* infection of the open split occurs. Alternatively, in the absence of rain and host tissue expansion, the early application may persist long enough to protect the opening split from infection.

Table 4: Efficacy of fungicide treatments for management of hull rot of cv. Nonpareil almond caused mostly by *Rhizopus stolonifer - Colusa Co. 2011*

Plot A - Timing comparison

			Hull rot incidence	
No.	Treatment	Rate/A	%	LSD
1	Control	-----	60.5	a
2	Ph-D 11.2DF org + NIS	6.2 oz	41.3	ab
3	YT669 2.08SC (picoxystrobin)	12 fl oz	28.5	bc
4	Quash 50WG	3.5 oz	28.3	bc
5	Adament 50WG	6 fl oz	33.5	bc
6	Luna Experience	6 fl oz	23.0	bc
7	Luna Sensation	5 fl oz	32.5	bc
8	Inspire Super + NIS	20 fl oz	31.5	bc
9	Quadris Top	14 fl oz	19.5	bc
10	Pristine 38WG	14.5 oz	36.5	bc
11	Merivon	6.8 fl oz	14.8	c
12	Q8Y78 + NIS	24 fl oz	32.8	bc

* Treatments were applied at early and/or 20% hull split using an air-blast sprayer at 100 gal/A.

** Evaluations for disease were done on 9-13-11 and the number of hull rot twig strikes per 100 spurs was counted on each of the 4 single-tree replications.

*** Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation (P > 0.05)

Plot B - Timing comparison

			Timing		Hull rot incidence	
No.	Treatment	Rate	Early suture	20% split	%	LSD
1	Control	-----	-----	-----	16.8	a
	Quash 50WG	3.5 oz	@	---	9.25	b
			---	@	10.5	ab
			@	@	6.5	b
2	Control	-----	-----	-----	16.8	a
	Luna Sensation	5 fl oz	@	---	4.5	b
			---	@	4.75	b
			@	@	5.5	b
3	Control	-----	-----	-----	16.8	a
	Ph-D+NuFilm	6.2 fl oz	@	---	17.75	a
			---	@	13.75	a
			@	@	10	a

* Treatments were applied at early and/or 20% hull split using an air-blast sprayer at 100 gal/A.

** Evaluations for disease were done on 9-13-11 and the number of hull rot twig strikes per 100 spurs was counted on each of the 4 single-tree replications.

*** Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation (P > 0.05) procedures

At the Stanislaus Co. site where hull rot was mostly caused by *Monilinia* spp., applications were made similar to our experience in managing hull rot caused by *R. stolonifer*. None of the treatments reduced the disease in the first plot (**Table 5A**) and only Luna Sensation had some effect in the second plot (**Table 5B**). Because the fungicides used have high efficacy against the brown rot pathogens, the application timing used may be inappropriate and treatments may have to be done earlier for this type of hull rot. These studies are ongoing for 2012. Thus, hull rot caused by *R. stolonifer* can be managed with fungicide applications, but for the most effective integrated management, hull split should be induced simultaneously with proper water management (i.e., deficit irrigation) and should proceed as quickly as possible to shorten the highly susceptible period.

D. Rust management – 2011 Research**.** Fungicides were evaluated at Kearney Ag Center where a low level of rust started to develop in late July of 2011. At evaluation time in late August, the disease rating in the untreated control was 1.3 (of a maximum rating of 4) (**Table 6**). The rating after two applications of Luna Sensation or Quadris Top was 0.3. Merivon had an intermediate efficacy. Additionally, fungicide efficacy data for rust were also obtained in our Alternaria trials. At the Kern Co. location with low to moderate disease pressure, the disease was reduced to low levels by all treatments, including Inspire Super (**Table 7**). Ph-D had an intermediate activity. Studies on rust management will be continued but they are difficult to do because of the sporadic occurrence of the disease.

E. Studies on the etiology of a powdery mildew-like disease of almond fruit - 2011 and 2012 research. Powdery mildew-like symptoms on almond fruit have been observed at numerous locations in recent years but the economic importance of this pathogen is currently not known. The disease has been attributed to an undetermined powdery mildew species. A high incidence of the disease occurred at one location in 2011 and samples were collected. The fungus *Acremonium* sp. was consistently isolated from sampled fruit and identified by morphology and DNA sequence analysis. In microscopic observations, the fungus was found growing and sometimes coiling around fruit trichomes. In 2012 inoculations with two isolates of this fungus were done to verify its pathogenicity, and results are pending. Although Koch's postulates have not yet been fulfilled, the disease is most likely not caused by a powdery mildew fungus, but by a species of *Acremonium*.

Table 5: Efficacy of fungicide treatments for management of hull rot of cv**.** Nonpareil almond caused mostly by *Monilinia fructicola* - Stanislaus Co. 2011

Plot A

			Hull rot incidence	
No.	Treatment	Rate/A	%	LSD
1	Control		72.9	a
2	Ph-D org. 11.2DF + NuFilm	6.2 oz	64.8	a
3	YT669 2.08SC (picoxystrobin)	12 fl oz	61.5	a
4	Quash 50WG	3.5 oz	60.5	a
5	Adament 50WG	6 fl oz	62.8	a
6	Luna	6 fl oz	59.5	a
7	Luna Sensation	5 fl oz	58.0	a
8	Inspire Super + NIS	20 fl oz	63.0	a
9	Quadris Top	14 fl oz	68.5	a
10	Pristine	14.5 oz	66.8	a
11	Merivon	6.8 fl oz	65.0	a
12	Q8Y78 + NIS	24 fl oz	64.3	a

Plot B

			Hull rot incidence	
No.	Treatment	Rate/A	%	LSD
1	Control		72.9	a
2	Ph-D org. 11.2DF + NuFilm	6.2 oz	67.0	a
3	Quash 50WG	3.5 oz	60.3	a
4	Inspire Super + NIS	20 fl oz	70.0	a
5	Luna Sensation	5 fl oz	42.8	b

* Treatments were applied at early and 20% hull split using an air-blast sprayer at 100 gal/A. NIS=non-ionic surfactant. Q8Y78 240SC is a pre-mix of picoxystrobin and penthiopyrad

** Evaluations for disease were done on 9-7-11 and the number of hull rot twig strikes was counted for 100 spurs on each of the 4 single-tree replications

*** Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation.

Table 6: Efficacy of fungicide treatments for management of almond leaf rust on cv. Nonpareil - Fresno Co. 2011

No	Treatment	Rat	Dis. rating on leaves (%)	LSD^
1	Contro	---	1.3	a
2	Ph-D 11.2DF	6.2 oz	0.9	ab
3	Inspire Super + Breakthru	20 fl oz + 5 fl oz	0.8	abc
4	BAS703 (Merivon)	6.8 fl oz	0.5	bc
5	Luna Sensation	5 fl oz	0.3	c
6	Quadris Top	14 fl	0.3	c

* Treatments were applied on 7-20 and 8-6-11 using an air-blast sprayer at a rate of 100 gal/A

** For evaluations of disease on 8-26-11, 50 leaves from each of the 4 single-tree replications were evaluated using a rating scale from 0-4

^ Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference (LSD) mean separation (*P* > 0.05) procedures

Table 7: Efficacy of fungicide treatments for management of almond leaf rust on cvs. Monterey and Fritz - Kern Co. 2011

1

				Timings			cv. Monterey		cv. Fritz	
							Dis. Sev. on leaves		Dis. Sev. on leaves	
No.	Program	Treatment	Rate	5/13/11	6/2/11	6/23/11	Rating	LSD	Rating	LSD
1	---	Control	---	---	---	---	1.3	a	2.6	a
2	Single fungicides	PW38DD	96 oz	@	@	@	0.0	b	0.2	gh
3		CX10440	3.75 fl oz	@	@	@	0.0	b	1.8	b
4		CX10440	7.5 fl oz	@	@	@	0.1	b	1.3	bcd
5		Ph-D 11.2DF org. form.	6.2 oz	@	@	@	0.2	b	1.2	cde
6		BAS700 (Xemium)	4.5 fl oz	@	@	@	0.2	b	0.0	h
7		Quash 50WG	3 oz	@	@	@	0.0	b	0.8	def
8		IKF-5411 400SC	10.5 fl oz	@	@	@	0.0	b	1.7	bc
9		IKF-5411 400SC	17 fl oz	@	@	@	0.3	b	1.3	bcd
10	Pre-mixtures	Luna Experience	6 oz	@	@	@	0.0	b	0.3	fgh
11		Luna Sensation	5 fl oz	@	@	@	0.0	b	0.0	h
12		Inspire Super SC	20 fl oz	@	@	@	0.2	b	0.7	efg
13		Quadris Top	14 fl oz	@	@	@	0.2	b	0.0	h
14		Pristine 38WG	14 oz	@	@	@	0.2	b	0.0	h
15		BAS703 (Merivon)	6.8 fl oz	@	@	@	0.0	b	0.0	h
16	Mixture	Ph-D org. 11.2DF + Quash 50WG	6.2 oz + 3 oz	@	@	@	0.0	b	0.2	gh
17	Rotations	PW38DD	96 oz	@	---	---	0.0	b	0.0	h
		Pristine 38WG	14 oz	---	@	---				
		PW38DD	96 oz	---	---	@				
18		Luna Experience	6 fl oz	@	---	---	0.0	b	0.0	h
		Gem 500SC	3.8 fl oz	---	@	---				
		Adament 50WG	6 oz	---	---	@				
19		Ph-D 11.2DF org. form.	6.2 oz	@	---	---	0.2	b	0.0	h
		Quash 50WG	3 oz	---	@	---				
		Ph-D 11.2DF+ Quash 50WG	6.2 oz + 3 oz	---	---	@				
20		Ph-D 11.2DF org. form.	6.2 oz	@	---	---	0.2	b	0.7	efg
		BAS700 (Xemium)	4.5 fl oz	---	@	---				
		Inspire Super SC	20 fl oz	---	---	@				
21		Ph-D 11.2DF org. form.	6.2 oz	@	---	---	0.0	b	0.0	h
		Inspire Super SC	20 fl oz	---	@	---				
		BAS700 (Xemium)	4.5 fl oz	---	---	@				

* Treatments were applied using an air-blast sprayer at a rate of 100 gal/A and there were 3 single-tree replications for each treatment.

** For evaluation of leaf rust a severity rating was used with 0=healthy, 1= < 25% of leaves diseased, 2= 25-50%, (LSD)

^ Values followed by the same letter are not significantly different based on an analysis of variance and least significant difference 3= 50-75%, 4= >75 of leaves diseased mean separation (*P* > 0.05) procedures).