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

Project No.: **12-PATH4-Adaskaveg**

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Objectives:

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.
      - Evaluate new fungicides, fungicide pre-mixtures, and adjuvants - fluxapyroxad - Xemium, penthiopyrad (Fontelis), metconazole - Quash, polyoxin-D - Ph-D or Oso, dodine - Syllit, Luna Experience, Luna Sensation, Quadris Top, Quilt Xcel, Inspire Super, Merivon, and others.
      - 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, SDHIs, polyoxin-D, and experimental fungicides, as well as selected pre-mixtures 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* and other species against SDHIs (penthiopyrad, fluxapyroxad, fluopyram, boscalid).
   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 new diseases.
   a. Etiology of a powdery mildew-like disease of almond fruit.
   b. Etiology of a new bacterial disease.

Interpretive Summary:

In 2012-13, we 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). Additionally, several pre-mixtures and rotation programs, as well as a natural product, were evaluated. 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. In vitro studies were conducted 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 2013 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, 2012 data are presented for these objectives. Research on scab and Alternaria leaf spot is presented in a separate report.

Brown rot, shot hole, and gray mold incidence was generally low in the spring of 2013, and shot hole was observed on leaves only, but not on fruit. For management, single-fungicides of several classes, and especially several pre-mixtures and rotation programs provided excellent disease control. Studies on the management of hull rot were conducted in orchards with *Rhizopus stolonifer, Monilinia fructicola,* or both pathogens as the causal agents. Hull rot caused by *R. stolonifer* could 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 less effectively reduced using the same treatments and timings. In a trial where different application timings were evaluated, we found that the early-June timing was critical, indicating that *M. fructicola* infects the developing almond fruit at an earlier stage than does *R. stolonifer*. Occurrences of the new powdery mildew-like disease of almond were not reported in 2012 and 2013. However, in the spring of 2013 in the central growing areas of the state serious outbreaks of a new disease of developing fruit, characterized by lesions penetrating into the mesocarp and profuse gumming, was identified as bacterial spot caused by *Xanthomonas arboricola* pv. *pruni*.

Materials and Methods:

Fungicide evaluations for management of brown rot, gray mold, and shot hole in experimental orchards – 2013 Research. Field trials were conducted at UC Davis on cultivars (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. Additionally, the new natural product Fracture (a seed storage protein from *Lupinus albus*) and the biocontrol Serenade Optimum (*Bacillus subtilis*) were available for evaluation. Applications were done at pink bud, full bloom, and petal fall 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 six 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 hours before or after treatment. The incidence of stamen infections was then determined after 5 days of incubation at 20 °C. For efficacy against gray mold, field-treated flower petals were collected after the full bloom spray and incubated on moist vermiculite for 5 days at 20 °C for the development of natural incidence of the disease. For shot hole evaluation, a random sample of 15-25 terminal leaf clusters was collected in mid-April and examined for shot hole lesions. Disease incidence was based on the number of leaf clusters with lesions of the total number of clusters collected and disease severity was based on the number of lesions and using a rating scale.

Fungicide evaluations for management of hull rot - 2012 Research. Field trials were conducted on cv. Nonpareil in Colusa County where hull rot was mostly caused by *R. stolonifer,* in Fresno County where *M. fructicola* was the main pathogen, and in Stanislaus County where both pathogens were present. Treatments were done as single treatments between early suture split and 10-20% hull split. In a timing study in Stanislaus County, treatments were applied on April 4, April 24, June 6, or July 13. One set of trees received the first three treatments. Hull rot was evaluated at the time of harvest by counting the number of shoot infections per tree.

Develop baseline sensitivities of fungal pathogen populations against new fungicides and determine potential shifts in fungicide sensitivity - 2012/2013 Research. Isolates of *M. fructicola* and *M. laxa* were obtained from diseased plant tissues between the early 1990s and 2005. In vitro fungicide sensitivities were determined using the spiral gradient dilution method as described previously (Forster et al., Phytopathology 94:163-170).

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:

Brown rot blossom blight and gray mold management – 2012 Research*.* Disease levels at all trial sites were low in the spring of 2013. Still, on the highly susceptible cv. Drake at UC Davis, an average of 36.8 brown rot strikes per tree were observed on untreated control trees. The pre-mixtures Luna Experience (FRAC 3+7), Luna Sensation (FRAC 7+11), Quadris Top (FRAC 3+11), A13703N (a new formulation of Quadris Top), Inspire Super (FRAC 3+9), and Merivon (FRAC 7+11) reduced disease incidence to 1.3 to 6.3 strikes per tree and thus, were highly effective (**Table 1**). Three rotation programs that included Scala, Luna Sensation, Ziram, and Serenade Optimum were similarly effective. The biocontrol Serenade Optimum can therefore be a component in a management program under less favorable disease conditions. Its performance under high disease pressure needs to be evaluated. Two DMI fungicides, Indar and Topguard, that were applied as single-fungicide programs showed intermediate control of brown rot. The addition of a surfactant to Indar improved efficacy. For Topguard, both rates resulted in the same level of disease control. On cv. Sonora where only 5.3 brown rot strikes per tree developed on the untreated control, most treatments reduced the disease to less than 1 strike per tree (**Table 2**). The natural product Fracture had an intermediate efficacy with 1.8 strikes per tree.

Table 1. Efficacy of fungicide programs for management of brown rot, shot hole, and gray mold of cv. Drake almonds at UC Davis 2013.

			Application*				Average Brown rot		Shot hole on leaves***				Gray mold****			
Program	Fungicide*	Product Rate	PB 2-22	FB 3-1	PF 3-11	PF 3-25	No.	LSD^	Inc. (%)	LSD	Severity	LSD	Inc. (%)	LSD	Severity	LSD
--	Control	--	--	--	--	--	36.8	a	66.7	a	1.2	a	63.3	b	1.8	b
Single	Indar	6 fl oz	@	@	@	@	18.7	b	53.9	ab	0.9	ab	31.8	def	0.8	defg
	Indar 2F + surf	6 fl oz + 0.125%	@	@	@	@	10.5	bcde	43.3	bc	0.6	bc	85.9	a	2.6	a
	CHA-1323 RHYME	3.5 fl oz	@	@	@	@	13.0	bc	43.1	bc	0.6	bc	46.8	b	1.4	c
	CHA-1323 RHYME	7 fl oz	@	@	@	@	14.5	bc	39.3	bc	0.6	bc	34.1	de	0.9	def
Pre-mix	Luna Experience	6 fl oz	@	@	@	@	4.7	cde	42.8	bc	0.6	bc	21.6	fg	0.4	gh
	Luna Sensation	5 fl oz	@	@	@	@	1.3	e	46.1	bc	0.7	bc	44.7	b	1.0	de
	Quadris Top + Dyne-Amic	14 fl oz + 16 fl oz	@	@	@	@	8.2	cde	41.7	bc	0.6	bc	87.9	a	2.6	a
	A13703N + Dyne-Amic	14 fl oz + 16 fl oz	@	@	@	@	2.8	de	46.3	bc	0.7	bc	90.6	a	2.8	a
	Inspire Super + Dyne-Amic	20 fl oz + 16 fl oz	@	@	@	@	2.8	de	34.9	c	0.5	c	84.6	a	2.6	a
	Merivon	5 fl oz	@	@	@	@	6.3	cde	40.4	bc	0.6	bc	15.6	g	0.3	h
	Merivon	6 fl oz	@	@	@	@	6.0	cde	37.8	bc	0.5	c	35.8	cde	0.7	efg
Rotations	Scala	18 fl oz	@	--	--	--	5.7	cde	44.6	bc	0.8	bc	35.0	cde	0.8	defg
	Luna Sensation	5 fl oz	--	@	--	--										
	Ziram	8 lb	--	--	@	@										
	Scala	18 fl oz	@	--	--	--	5.8	cde	54.1	ab	0.9	ab	26.8	ef	0.6	fgh
	Luna Sensation	5 fl oz	--	@	--	--										
	Ziram	8 lb	--	--	@	@										
	Serenade Optimum	16 fl oz	--	--	@	@										
	Scala	18 fl oz	@	--	--	--	7.3	cde	35.2	c	0.5	c	42.8	cd	1.1	cd
	Luna Sensation	5 fl oz	--	@	--	--										
	Serenade Optimum	16 fl oz	--	--	@	@										
	Indar 2F + surf	6 fl oz + 0.125%	@	@	--	--	12.7	bcd	43.3	bc	0.6	bc	22.0	fg	0.5	gh
	Dithane	6 lb	--	@	--	--										
	Dithane + surf	6 lb + 0.125%	--	--	@	@										

* 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 May 2, 2013 for each of six single-tree replication.

*** Shot hole was evaluated on May 1, 2013. Disease incidence was based on the presence of shot hole lesions on 25 terminal leaf clusters with 5-8 leaves per cluster for each of six single-tree replications. Disease severity was based on a rating from 0, to 1 (1 lesion/cluster), to 2 (2-3 lesions/cluster), to 3 (>3 lesions/cluster).

**** Gray mold was evaluated on flower petals that were collected after the full bloom spray 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 areas 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 2. Efficacy of fungicide programs for management of brown rot, shot hole, and gray mold of cv. Sonora almonds at UC Davis 2013.

			Application*			Average number of Brown rot strikes/tree**		Shot hole *** Lesions/leaf cluster		Gray mold****			
Program	Fungicide*	Product Rate (/A)	PB 2-2	FB 2-27	PF 3-12	No.	LSD^	No.	LSD	Inc. (%)	LSD	Severity	LSD
---	Control	---	---	---	---	5.3	a	5.7	a	63.4	a	1.1	cd
Single	Fracture + NIS	30 fl oz + 0.25%	@	@	@	1.8	b	2.4	de	66.3	ab	1.7	ab
	Rovral + Oil	1 pt + 1.5% oil	@	@	@	0.3	bc	3.6	bc	33.4	defg	0.6	efg
	IKF-5411	13.7 fl oz	@	@	@	0.8	bc	2.0	de	19.7	gh	0.4	fg
	IKF-5411	17.1 fl oz	@	@	@	0.0	c	2.1	de	17.9	gh	0.3	fg
	Meteor + Oil	1 pt + 1.5% oil	@	@	@	0.3	bc	3.9	b	53.0	abc	1.8	a
	Fontelis	20 fl oz	@	@	@	0.3	bc	2.4	de	24.4	fgh	0.4	fg
Mixtures	IKF-5411	6 fl oz	@	@	@	0.3	bc	1.8	de	42.4	cdef	0.9	de
and rotation	IB18111	3.8 fl oz	@	@	@								
	IKF-5411	6 fl oz	@	@	@	0.3	bc	2.1	de	44.8	cde	1.1	cd
	IB18121	12 fl oz	@	@	@								
	IKF-5411	6 fl oz	@	@	@	0.0	c	1.9	de	11.6	h	0.1	g
	IB18220	8 fl oz	@	@	@								
	Syllit	1.5 lb	@	@	@	0.0	c	1.8	de	50.4	bcd	1.1	cd
	Tebucon	4 oz	@	@	---								
	Syllit	2 lb	@	@	@	0.0	c	1.5	e	37.7	cdef	0.9	de
	Tebucon	4 oz	@	@	---								
	Syllit	1.5 lb	@	@	@	0.3	bc	2.1	de	31.3	efg	0.6	ef
	Tebucon	6 oz	@	@	@								
	Rovral + Oil	1 pt + 1.5% oil	@	---	@	0.0	c	2.7	cd	46.3	cde	1.0	cde
	Fracture + NIS	30 fl oz + 0.25%	---	@	---								
	Meteor	1 pt + 1.5% oil	@	---	---	0.3	bc	2.1	de	50.1	bcd	1.3	bc
	Topsin-M	1.5 lb	---	@	---								
	KFD 167-01	5 lb	---	---	@								
	Topsin-M	1.5 lb	@	@	---	0.5	bc	2.1	de	20.4	gh	0.4	fg
	Meteor	1 pt + 1.5% oil	@	@	---								
	Manzate	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 May 2, 2013 for each of six single-tree replication.

*** Shot hole was evaluated on May 1, 2013. Disease incidence was based on the presence of shot hole lesions on 25 terminal leaf clusters with 5-8 leaves per cluster for each of six single-tree replications. Disease severity was based on a rating from 0, to 1 (1 lesion/cluster), to 2 (2-3 lesions/cluster), to 3 (>3 lesions/cluster).

**** Gray mold was evaluated on flower petals that were collected after the full bloom spray 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 areas 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 at Kearney Ag Center with a single full bloom application, an average of 11.4 strikes was observed on cv. Wood Colony control trees. Fungicide treatments reduced the disease to between 2.2 (i.e., Merivon) and 6.6 (i.e., Topguard) strikes. On cv. Sonora with 5.4 strikes per tree in the control, treatments reduced the brown rot blossom blight to between 0.4 (i.e., Topguard) and 4.8 (i.e., Ph-D) strikes per tree. Thus, the performance of Topguard was inconsistent among trials ranging from highly effective to intermediate to not very effective.

Most of the field treatments (biologicals, 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 hours before or after inoculation, respectively). Overall, the biologicals Fracture, Serenade Optimum, and Botector were the least effective, but blossom blight generally was still reduced by more than 70%. Additionally, Ph-D was similarly effective as most of the fungicides. Polyoxin-D was recently granted exempt status in the United States by the Environmental protection Agency (EPA). Efforts are being continued to determine if a polyoxin-D formulation can be registered as an organic fungicide through the National Organic Standards Board. The goal is to have an effective fungicide for the almond industry that meets OMRI (Organic Materials Review Institute) standards.

No new reports on treatment failures of fungicides against brown rot occurred in 2013. In 2012, we confirmed that approximately 20% of *Monilinia laxa* isolates in one orchard were resistant to FRAC Group 9 fungicides (e.g., cyprodonil and pyrimethanil).

The efficacy of field fungicide treatments against gray mold was evaluated in a blossom petal assay on cvs. Drake, Sonora, and Butte. The lowest levels of disease occurred on cv. Drake using Merivon, Luna Experience, and a rotation of Indar and Dithane (**Table 1**). The new almond registration of Syllit in combination with a tebuconazole product was also effective in reducing gray mold. On cv. Sonora, the numbered compound IKF-5411 and Fontelis, as well as a mixture of IKF-5411 with another numbered compound (i.e., IB 18220) were most effective (**Table 2**). On cv. Butte, where no brown rot occurred in 2013, a rotation/mixture program of Tebucon and Thymol and the high rate of Ph-D reduced gray mold to the lowest levels (data not presented).

Shot hole management – 2013 Research. The incidence of shot hole was very low in 2013. No disease occurred on fruit in our experimental orchards, but there was a low level of disease on leaves. Still, efficacy data could be obtained. On cv. Drake, Inspire Super and a rotation of Scala, Luna Sensation, and Serenade Optimum resulted in the lowest disease levels (**Table 1**). On cv. Sonora, the Syllit-Tebucon mixture/rotation program showed the lowest amount of disease (**Table 2**). In both orchards, however, most of the other fungicides tested also significantly reduced shot hole incidence from that of the controls.

These results indicate that many excellent choices are available for management of these springtime diseases. Performance of some fungicides has been variable over the years. Multi-year field evaluations, however, can be good indicators of a fungicide's success in practical disease management. Syllit will be registered and available in the 2014 spring season and shows efficacy against several springtime diseases. Our data also indicate that biologicals can have a role in effective rotation programs when disease pressure is not very high as in 2013.

Hull rot management – 2012 Research. Studies on the management of hull rot were conducted in orchards with *Rhizopus stolonifer, Monilinia fructicola,* or both pathogens as the causal agents. Hull rot caused by *R. stolonifer* could be reduced to low levels with a single application of either one of several fungicide classes during early hull split. Thus, in a trial in Colusa County, hull rot was reduced from 11.7 strikes in a standardized 30-sec evaluation (approximately 100 spurs evaluated) to as low as 2.3 strikes by using Luna Sensation (**Table 3**). Previously we had concluded that single early hull split applications were as effective as two applications. Hull rot caused by *Monilinia* species was much less effectively reduced using a similar spectrum of treatments and the same timing. Thus, in a trial in Fresno County, the disease was only reduced from 24 strikes per tree in the control to 13.5 strikes by Luna Sensation (**Table 4**). This was the best treatment evaluated in this trial (**Table 4**).

Table 3. Efficacy of fungicide treatments for management of hull rot of cv. Nonpareil almond caused mainly by *Rhizopus stolonifer* - Colusa County 2012.

No.	Treatment	Product Rate/A	No. of hull rot strikes/30-sec count	LSD***
1	Control	-----	11.7	a
2	Quadris Top	14 fl oz	5.7	b
3	Inspire Super + Surf.	20 fl oz	4.5	bc
4	Merivon	6.8 fl oz	4.2	bc
5	Ph-D 11.2DF	6.2 oz	4.0	bc
6	Topguard	14 fl oz	3.5	bc
7	YT669	12 fl oz	3.2	bc
8	Ph-D + Topguard	6.2 oz + 14 fl oz	3.2	bc
9	Luna Experience	8 fl oz	3.2	bc
10	Q8478	24 fl oz	3.2	bc
11	Luna Sensation	5 fl oz	2.3	c

* Treatments were applied on July 6, 2012 (early suture split) using an air-blast sprayer at a rate of 100 gal/A.

** Evaluations for disease were done on August 27, 2012 and the number of hull rot twig strike was counted for 30 sec for the 4 single-tree replications.

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

Table 4. Efficacy of fungicide treatments for management of hull rot of cv. Nonpareil almond caused mainly by *Monilinia fructicola* - Fresno County 2012 .

No.	Treatment	Rate/A	No. of hull rot strikes/tree	LSD***
1	Control		24.0	a
2	Q8Y78	20 fl oz	19.5	ab
3	Quadris Top	14 fl oz	19.0	ab
4	Ph-D 11.2DF	6.2 oz	18.8	ab
5	Merivon	6.8 fl oz	15.0	b
6	Quash	3.5 oz	14.5	b
7	Fontelis	20 fl oz	14.5	b
8	Luna Sensation	5 fl oz	13.5	b

* Treatments were applied on July 12, 2012 (ca. 10% hull split) using an air-blast sprayer at a rate of 100 gal/A.

** Evaluations for disease were done on August 31, 2012 and the number of hull rot twig strikes was counted for 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.

Table 5. Efficacy of selected timings of Luna Experience for management of hull rot of cv. Nonpariel almond caused by equal proportion of *Monilinia fructicola* and *Rhizopus stolonifer* – Stanislaus County 2012.

Timing No.	Application 4-4	4-25	6-6	7-13	No. of hull rot strikes/30-sec count	LSD***
1	---	---	---	---	25.2	ab
6	---	---	---	@	29.7	a
2	@	---	---	---	16.2	bc
3	---	@	---	---	15.3	bc
4	---	---	@	---	8.7	c
5	@	@	@	---	7.8	c

* Treatments were applied on July 12, 2012 (ca. 10% hull split) using an air-blast sprayer at a rate of 100 gal/A.

** Evaluations for disease were done on August 31, 2012 and the number of hull rot twig strikes was counted for 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.

In another plot in Stanislaus County where hull rot was determined to be caused by both pathogens, different application timings were evaluated. We found that the early-June timing was most critical, indicating that *M. fructicola* infects the developing almond fruit at an earlier stage than does *R. stolonifer* (**Table 5**). These studies are being repeated in 2013.

In summary, progress has been made over the last few years in understanding hull rot development and its management. Fungicides can be very effective when hull rot is mainly caused by *R. stolonifer* but disease reduction has never been to zero levels. Therefore, as with management of other diseases, integrated programs need to be followed. For hull rot, this includes that hull split should be induced simultaneously with proper deficit irrigation and should proceed as quickly as possible to shorten the highly susceptible period.

Develop baseline sensitivities of fungal pathogen populations against new fungicides and determine potential shifts in fungicide sensitivity - 2012/2013 Research. Baseline sensitivities were determined for several SDHI (FRAC 7) fungicides against *M. laxa* and *M. fructicola* that were collected between the early 1990s and 2005. For boscalid, EC_{50} values ranged from 0.015 to 0.105 ppm and from 0.024 to 0.386 ppm; for fluxapyroxad, values ranged from 0.002 to 0.013 ppm and from 0.004 to 0.050 ppm; for penthiopyrad, values ranged from 0.003 to 0.017 ppm and from 0.004 to 0.076 ppm; and for fluopyram, values ranged from 0.006 to 0.034 ppm and from 0.004 to 0.132 ppm for the two species, respectively. Thus, among these pathogen isolates, that were collected before the widespread use of SDHI fungicides, a wide range of sensitivities was found and a few isolates were quite insensitive. This emphasizes the use of resistance management strategies to prevent the spread and proliferation of the naturally occurring less sensitive isolates.

Studies on new diseases - 2012/2013 Research. Occurrences of the new powdery mildew-like disease of almond were not reported in 2012 and 2013 and further isolations of the causal pathogen could not be done. Previously the fungus *Acremonium* sp. was consistently isolated from sampled fruit and Koch's postulates still need to be done.

In the spring of 2013 in the central growing areas of the state, serious outbreaks of a new disease of developing fruit were reported. The disease was most serious on cv. Fritz but also was observed on cvs. Nonpareil, Padre, and others. Symptoms included lesions penetrating into the mesocarp and profuse gumming. These symptoms were originally thought by PCAs to be caused by insect feeding. No fungi were isolated from samples. However, a yellow bacterium was recovered from the samples by us and others and was identified as *Xanthomonas arboricola*. Using specific PCR primers, we further identified the pathogen as *X. arboricola* pv. *pruni* that is commonly causing bacterial spot on stone fruits in the eastern United States at locations with high temperatures and wetness.