Annual Report – 2013

Prepared for the California Cling Peach Advisory Board

Title:	*Management of brown rot, powdery mildew, and peach leaf curl diseases of peach in California*
Status:	Third-Year of Four
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SUMMARY OF RESEARCH ACCOMPLISHMENTS DURING 2013

We continued our research on major preharvest (foliar) and postharvest diseases of cling peach in California including leaf curl, brown rot blossom blight and fruit rot, and powdery mildew. We focused on the management of these diseases with new fungicides and biological treatments.

1. Peach leaf curl incidence was low in the spring of 2013. Still, our efficacy trial indicated that Ziram, used at the 6 lb or 8 lb rate, was the best treatment. Chlorothalonil (e.g., Bravo) was also highly effective and this fungicide represents another valuable component of a leaf curl management program and an alternative to copper fungicides.
2. Brown rot blossom blight incidence was low in 2013 – Efficacy data was obtained on cv. Fay Elberta at UC Davis; however, no data could be obtained in our field trials on two peach cultivars at Kearney Agricultural Research and Extension (KARE) Center. At UC Davis, two new biological treatments and several fungicides were evaluated. The plant extract Fracture (previously Problad) and the biocontrol Botector showed efficacy and significantly reduced the natural incidence of blossom blight from that of the control, similar to some of the fungicides. Using conventional fungicides, the lowest levels of disease were obtained with the fungicide Quash (FRAC group 3) and the pre-mixtures Inspire Super (FG 3/9 difenoconazole+ cyprodonil), Quadris Top (FG 7/11 difenoconazole + azoxystrobin), Luna Sensation (FG 7/11 fluopyram + trifloxystrobin), and Pristine (FG 7/11 boscalid + pyraclostrobin). Blossoms of Fay Elberta peach were used in laboratory tests and demonstrated excellent pre- and post-infection activity of all fungicides included whereas the incidence of infections by the two biological treatments was reduced by 20-40% as compared to the control (91-100% infection).
3. Preharvest fungicide applications were evaluated for the management of postharvest brown rot decay on three peach varieties in two orchards. In the UC Davis trial on cv. Fay Elberta where 1-day and 7-day PHI evaluations were done, the most effective fungicides at both timings included the new FG 7 Fontelis (penthiopyrad), Quash, and the pre-mixtures Luna Sensation, Inspire Super, Merivon (FG 7/11 fluxapyroxad + pyraclostrobin), and Pristine. Ph-D (polyoxin-D) showed intermediate efficacy in the 1-day application, but was only slightly effective in the 7-day application, indicating the rapid breakdown of this compound. In the two peach trials at KARE with 7-day PHI treatments, Merivon was consistently among the best treatments, however, several other compounds including Quash, Indar, Luna Sensation, and Custodia (FG 3/11 tebuconazole + azoxystrobin) also performed very well on both cultivars.
4. Evaluation of brown rot blossom blight susceptibility among peach genotypes in the UC Davis breeding program continued with 24 new and previously evaluated genotypes. The Bolinha accession had an intermediate amount of stamen infections. Disease incidence for several genotypes was statistically lower than that for Bolinha.
5. In powdery mildew management in a field trial with low disease pressure (4.5% disease incidence on fruit of control trees), most treatments reduced the disease similarly including DMI (FG 3), SDHI (FG 7), polyoxin-D (FG 33), SDHI/QoI (FG 7/11), DMI/QoI (FG 3/11), DMI/AP (3/9) fungicides. Several

rotations were also very effective including a Rovral/Fracture mixture/rotation program (using the 24-fl oz rate of Fracture), as well as Luna Sensation/Serenade Optimum and Mettle/Rezist programs. No powdery mildew was observed when Merivon was used by itself. The Merivon-Vivando mixture was also very effective. Vivando is a powdery mildew-specific compound. Its use in mixtures is an anti-resistance strategy because most other powdery mildew fungicides are also used for brown rot management, potentially resulting in multiple exposures of pathogen populations to a single FRAC group. In general, FRAC Group 7 fungicides are excellent against powdery mildew.

6. In baseline sensitivity studies for *M. fructicola*, the sensitivity range for tetraconazole among 32 isolates was determined to be 0.005 to 0.038 ppm (mean 0.017 ppm), for polyoxin-D 0.08 to 3.6 ppm (mean 1.34 ppm). Ranges for the SDHIs boscalid, fluxapyroxad, penthiopyrad, and fluopyram were 0.024 to 0.386 ppm (mean 0.118 ppm), 0.004 to 0.050 ppm (mean 0.019 ppm), 0.004 to 0.076 ppm (mean 0.023 ppm), and 0.004 to 0.132 ppm (mean 0.021 ppm), respectively.
7. Information on fungicide performance will be incorporated into the UCIPM website – Fungicide Efficacy Tables (http://www.ipm.ucdavis.edu/PDF/PMG/fungicideefficacytiming.pdf).

INTRODUCTION

Brown rot caused by the fungal pathogens *Monilinia fructicola* and *M. laxa* is the most important disease of stone fruit in California. The blossom blight stage of the disease cycle continues to be critical in the epidemiology of the disease. Primary inoculum in the form of ascospores produced from apothecia (*M. fructicola*) and conidia from mummified fruit or twig cankers (*M. fructicola* and *M. laxa*) infects blossoms to start the annual disease cycle. Subsequently, diseased blossoms supply secondary inoculum (i.e., conidia) for fruit infections in the current growing season. Fruit rots do not cause devastating losses in most years due to the dry California climate but occasionally under wet conditions entire crops can be lost. Thus, a considerable effort has been made to increase the amount of fungicides available with different modes of action and to develop peach selections less susceptible to brown rot to reduce blossom blights and fruit rots. Thus, the first part of this proposal will focus on management of brown rot blossom blight and fruit decay.

Because currently fungicide treatments are the most effective and consistent method for brown rot control, we have been evaluating the efficacy of new fungicides over the past years. With the introduction of several new fungicides of different chemistries and classes as compared to previously registered materials, and with the advent of EPA-classified reduced-risk pesticides, there has been an outpouring of new fungicides. Therefore, there is a need for more research on the management of foliar and fruit diseases of cling peach with these new chemistries if multiple registrations are to be obtained on the crop. Specifically, research is necessary for determining the efficacy, as well as the preventative and post-infection activity and the persistence of residues of the several new modes of action that belong to new classes recognized by the Fungicide Resistance Action Committee (FRAC) and designated as distinct FRAC groups (FGs) of fungicides. These include the strobilurins or QoIs (FG 11), DMIs (FG 3), anilinopyrimidines (FG 9), hydroxyanilides (FG 17), polyoxins (FG 19), and SDHIs (FG 7 - fluopyram, fluxapyroxad, penthiopyrad, and boscalid). We are evaluating these materials to determine their performance in respect to consistency of use, spectrum or activity, and anti-resistance characteristics. All this information is needed to design management programs that are highly effective under different environmental conditions (i.e., low to high rainfall)and that help to prevent the development of fungicide-resistant populations of the pathogens. In 2011/12, we initiated toxicity and efficacy studies with new SDHI fungicides and we plan to continue this work in 2013.

Most of the new materials are being launched as pre-mixtures and these also need to be evaluated. In laboratory and field studies on blossom blight and fruit rot in 2011/12, Adament, Quadris Top - FG 3/11; Inspire Super - FG 3/9; Luna Sensation, Merivon, Pristine, and Q8Y78 - FG 7/11 were highly effective as pre- and post-infection treatments. Because the use of AP fungicides during the summer months is limited and DMI fungicides are extensively used for the management of several peach diseases over the season (blossom blight and fruit rot, powdery mildew, rust), goals of our research are to develop alternative chemistries and new pre-mixtures that reduce the risk for resistance developing in pathogen populations. Ideally, any one fungicide class should only be used once or twice per season to prevent the development of pathogen resistance. The new products in the SDHI (FRAC 7) group have activity against brown rot and powdery mildew and thus, this is exciting new rotation chemistry to the AP (FG 9) and DMI (FG 3) fungicides.

An additional goal is to evaluate natural products as organic alternative treatments. Although previously evaluated natural products such as Actinovate and Regalia were inconsistent, new products may prove to be more consistent in reducing blossom blight and powdery mildew. In 2012 we identified Problad as a new plant extract product with activity against brown rot blossom blight and powdery mildew. In 2010, we identified polyoxin-D as a potential new organic material. In Sept. 2012, the EPA has given this fungicide an "exempt" registration status and the material has been submitted to OMRI for organic approval. These changes in the registration will allow higher rates to be tested in an effort to increase the spectrum of activity and to improve the consistency of the fungicide against peach diseases. Ph-D is the best potential organic fungicide that we have ever evaluated and subsequently it should be developed for both conventional and the organic production segments of the cling peach industry. Therefore we plan to continue our research in 2013 on the development of polyoxin-D and Problad for managing foliar diseases of cling peach.

Another objective of our cling peach research project is the development of fungicide baseline sensitivity data (reference points) and population monitoring of *M. fructicola* and *M. laxa* for their sensitivity to fungicides after they have been used. In previous years we have developed baseline data for FRAC 9 (e.g., cyprodonil) and FRAC 3 (e.g., propiconazole) and have evaluated fungicide sensitivity in *Monilinia* spp. populations from locations where treatments did not provide adequate disease control. Baseline data for new SDHI fungicides (e.g., fluxapyroxad, fluopyram, boscalid) that will be introduced in the near future or introduced for the 2013 season (e.g., penthiopyrad) on stone fruit need to be developed.

In evaluations of natural host resistance in cling peach, we identified promising new genetic lines almond and wild almond parental lineages of the breeding program of Dr. Tom Gradziel. Although we are using standardized laboratory methods, levels of susceptibility were highly variable over the years indicating that susceptibility is dependent on environmental conditions during flower development through regulation of genes involved in susceptibility. This indicates that these evaluations need to be done over multiple years. In 2013, we again will collaborate with Dr. Gradziel and focus on advanced breeding lines. The identification of less susceptible parental and progeny lines will be critical in the discovery of molecular markers (e.g., major genes or more likely quantitative trait loci or QTLs) that are associated with host susceptibility. These markers then can be used in further breeding programs and they ultimately may reveal the mechanism of resistance. We also will continue to develop assays for the evaluation of blossom and fruit susceptibility to brown rot. A field method would be ideal but this has proven difficult to standardize for both blossom and fruit evaluations of genotypes in the breeding program where limited trees are available. The critical time for inoculations of blossoms is the popcorn stage, whereas for fruit, it is 3-4 weeks before harvest because harvested fruit are essentially processed immediately (1-2 days).

Peach leaf curl has been an ongoing disease problem in peach production and serious outbreaks occurred in recent years. Because the use of copper in agriculture is currently being reviewed by EPA and the cost of copper fungicides is increasing, alternative treatments, including new formulations of copper materials that allow lower application rates. Thiram was also effective in previous studies but regulatory concerns may limit registration in CA. Currently we are working on obtaining: 1) a supplemental label for lower rates of ziram; 2) A new labeled rate of 6 pts/A of chlorothalonil to provide consistent efficacy similar to ziram; and 3) a higher usage rate (e.g., 48 oz/A) of dodine for more consistent control of peach leaf curl. Additionally, new copper formulations and rates as well as combination treatments of these products need to be continued to be evaluated.

In epidemiological studies on powdery mildew, several species of *Podosphaera* have been shown to occur on peach in California: *P. (Sphaerotheca) pannosa*, *P. tridactyla*, and *P. leucotricha*. Thus, as in other powdery mildews where the sexual stage of the pathogen is present, management strategies that include pre-bloom sulfur treatments to reduce the overwintering sexual structures (chasmothecia), bloom applications of fungicides that are effective against mildew and brown rot, and post-bloom fungicide applications to protect fruit through the pit hardening stage of development need to be evaluated.

Because of the inconsistent occurrence and low incidence of the disease in some years, we again plan to evaluate new fungicides such as the recently registered (i.e., 2010) product Quintec (quinoxyfen) and the new material Vivando (metrafenone) that has been accepted into the IR-4 program in 2010. Vivando, represents a new class of fungicide (benzophenones) that is also only effective against PM fungi, similar to quinoxyfen, and may be prone to resistance. Thus, other materials such as Quash (metconazole) and the pre-mixtures Luna Sensation, Quadris Top representing different classes of registered fungicides (DMIs and QoIs) need to be evaluated for the management of this disease. In our 2010-12 field trials, we identified the SDHI fungicides as a highly effective group similar to the DMI fungicides. Additionally, the natural product Problad was shown to be very effective. With changes in the registration of polyoxin-D, both Problad and polyoxin-D should be evaluated with other potential organic materials in 2013.

OJECTIVES

I. Management of brown rot.

A) Efficacy and timing of representative compounds from each of four classes of fungicides: QoIs, APs, DMIs (e.g., Quash, Topguard, Mettle), and SDHIs (e.g., fluopyram, fluxapyroxad, penthiopyrad), potentially organic treatments such as Ph-D, Oso, and Problad, as well as selected pre-mixtures (e.g., Adamant, Quadris Top, Inspire Super, Pristine, Luna Sensation, Merivon, and Q8Y78).
   - Pre- and post-infection efficacy will be studied for both blossoms and fruit.

B) Baseline sensitivities of brown rot fungi to new classes of fungicides.

C) Natural host resistance of new peach genotypes to blossom blight and fruit decay
   - Flower assays will be done using our standard laboratory procedure with detached pink bud blossoms
   - Fruit assays will be done using standard laboratory methods

II. Management of peach leaf curl

A) Evaluate lower rates ziram, higher rates of chlorothalonil (Bravo) and dodine (Syllit), and new copper formulations, as well as tank mixtures of these products.

II. Etiology and management of powdery mildew on cling peach and other stone fruits.

A) Collection of powdery mildew isolates from peach in California and identification of the causal pathogen(s).

B) Efficacy of new powdery mildew fungicides (e.g., quinoxyfen, metrafenone, metconazole, fluopyram, fluxapyroxad, penthiopyrad, and pre-mixtures), potentially organic treatments such as Problad and polyoxin-D, as well as currently registered products, and their use in anti-resistance rotation and mixture programs.

PROCEDURES

Evaluation of fungicides for management of peach leaf curl. In a trial on the management of peach leaf curl caused by *Taphrina deformans* on Fay Elberta peach at UC Davis, selected rates of ziram, copper materials (i.e., Kocide 3000, Badge X2), dodine (Syllit), or chlorothalonil (Bravo) were applied in combination with 3.5% Omni oil on Dec. 12, 2011 and Jan. 21, 2013. In addition, Syllit/Kocide and Bravo/Badge tank mixtures were also evaluated. Rates are indicated in Fig. 1. Applications were done using an air-blast sprayer at 100 gal/A. Trees were evaluated for disease on April 2013. For this, the number of infected shoots for a total of 100 shoots for each single-tree replication was determined.

Evaluation of fungicides for management of brown rot blossom blight and preharvest fruit decay. Trials were established to evaluate fungicides for control of brown rot blossom blight and fruit rot on the following cultivars and locations: Fay Elberta peach at the UC Davis orchard; July Flame, Summer Flare, and Ryan Sun peach, and Summer Fire nectarine at the Kearney Agricultural Research and Extension Center (KARE) in Parlier, CA. Fungicides that were applied to trees using an air-blast sprayer calibrated for 100 gal/A included to trees include cyprodinil (Vangard 75WP), pyrimethanil (Scala 600SC), penthiopyrad (Fontelis), tetraconazole (Mettle), fenbuconazole (Enable) flutriafol (Topguard), and metconazole (Quash), and pre-mixtures (FG 3/9 –Inspire Super; FG 3/11 - Quadris Top; FG 7/11 - Pristine, Luna Sensation, Merivon). Natural products such as Fracture, Botector, and polyoxin-D will also be included. Randomized sub-plots of four single-tree replications for each treatment were used. Applications of each fungicide were done at 50-70% bloom on Fay Elberta, 45% bloom (Summer Fire), 60% bloom (Summer Flare), 40% bloom (July Flame), or

16% bloom (Ryan Sun). Incidence of brown rot blossom blight was recorded in April 2013. For this, 200 blossoms were evaluated for blight for each of the four single-tree replications per treatment.

Laboratory studies were done with cv. Fay Elberta peach blossoms obtained from the UC Davis, Plant Pathology field station. For this, pink bud blossoms were collected, allowed to open in the laboratory, and either inoculated with a conidial suspension of *M. fructicola* (20K conidia/ml) and then treated after 24 h with fungicides or natural products using a hand sprayer (post-infection activity), or treated and then inoculated after 24 h (pre-infection activity). See Fig. 3 for a list of fungicides evaluated. Three replications of 7 blossoms were used for each fungicide. The incidence of stamen infection was determined for each blossom after 3 to 5 days at 20 C.

For fruit rot studies at UC Davis, treatments were applied to Fay Elberta peach at 1- and 7-day PHI. In the KARE trials, treatments were applied to July Flame, Summer Flare, Summer Fire, and Ryan Sun at 7-day PHI. Four single-tree replications for each treatment were randomized in four complete blocks. Fungicides evaluated are indicated in Figs. 4-6. Four boxes of 24 to 48 fruit each were harvested for each treatment (one per single-tree replication). Fruit were harvested in commercial boxes, spray-inoculated with *M. fructicola* (20,000 spores/ml), and incubated for 7-10 days at 20-25C, >95% RH. The incidence of fruit infection was expressed as a percentage of infected fruit per total fruit incubated for each replication.

Evaluation of baseline sensitivities of* M. fructicola *isolates against SDHI fungicides. Thirty-nine isolates of *M. fructicola* from our fungal collection obtained between 1992 and 2005 were cultured on V8 agar, and conidia were used in spiral gradient dilution assays with boscalid, fluopyram, fluxapyroxad, and penthiopyrad. EC_{50} values were determined for mycelial growth after 3 days of incubation of the fungicide-amended plates as described previously. Data were summarized graphically.

Host susceptibility of F1- progeny of Bolinha peach and other selections to brown rot blossom blight and fruit decay. Blossoms of advanced breeding lines with almond and wild almond parental lineages were evaluated and compared to industry (e.g., Dr. Davis) and internal standards (e.g., Bolinha) this year. Genotypes as suggested by Dr. Gradziel (*see* Fig. 7) were collected at popcorn stage in the spring of 2013. Due to the environmental conditions and simultaneous flowering of many accessions in 2013, blossoms could only be sampled once. Blossoms were allowed to open in the laboratory, placed in a container with a layer of wet vermiculite, spray-inoculated with a conidial suspension of *M. fructicola* (2×10^4 spores/ml) and incubated for 4-5 days at 20 C. The incidence of stamen infections was assessed for 7-8 blossoms per each of four replications.

Efficacy of fungicides for management of powdery mildew of cling peach. A trial on the management of powdery mildew caused by *Podosphaera pannosa* was established in a commercial cv. Carson orchard in Butte Co. Four single-fungicides, six pre-mixtures, and six rotation programs were evaluated (see Fig. 8). In three of the rotation programs the natural products Fracture and Serenade Optimum were mixed and rotated with conventional fungicides. Applications were done on March 12 (full bloom), March 27 (2 weeks after petal fall), and April 17, 2013 (4 weeks after petal fall). Disease was evaluated on May 7, 2013. For this, 100 fruit of each of the four single-tree replications were rated for disease and the incidence was expressed as a percentage of infected fruit.

Statistical analysis of data. Data for disease incidence (percentage data) were arcsin transformed before analysis. Data were analyzed using analysis of variance and least significant difference (LSD) mean separation procedures of SAS 9.3.

RESULTS AND DISCUSSION

Evaluation of fungicides for management of peach leaf curl. In a trial on cv. Fay Elberta peach on the management of peach leaf curl, the efficacy of two applications of selected fungicides during dormancy and late dormancy was evaluated. Under low disease pressure, all treatments significantly reduced the incidence of disease (Fig. 1). Ziram, used at the 6 lb or 8 lb rate, was the best treatment. Chlorothalonil (e.g., Bravo) was also highly effective and this fungicide represents another valuable component of a leaf curl management program and an alternative to copper fungicides. Syllit was similarly effective to copper (Kocide 3000 or Badge). Tank mixtures of Syllit/Kocide 3000 or Badge/Bravo using lower rates of copper were similar to treatments with copper alone. Ziram, chlorothalonil, and dodine are currently registered for use in CA. Thus, several options are available for growers to manage the disease.

Efficacy of fungicides for management of blossom blight. For brown rot blossom blight management, trials were done on peach cultivars at KARE and UC Davis. With low rainfall and warm temperatures during March 2013 at UC KARE, disease incidence was very low on untreated control trees and no data could be obtained. At the UC Davis plot, blossom blight incidence was 6.6% in the untreated control and was significantly reduced by all treatments (Fig. 2). A single application of the biologicals Fracture and Botector significantly reduced blossom blight to 2%; whereas an organic formulation of polyoxin-D resulted in 1.8% disease. Several new fungicides such as Mettle (FG 3 – tetraconazole), Topguard (FG 3 – flutriafol), and Fontelis (FG 7 - penthiopyrad) also were effective. Mettle and Topguard had an activity similar to the biologicals. The best treatments among the single-treatments were Quash and Fontelis (Fig. 2).

The pre-mixtures reduced the disease incidence to the lowest levels with 1% or lower incidence. Among these, Quadris Top, A13703N, Luna Sensation, Inpire Super, and Pristine had $\leq$0.6% blight. Overall, the pre-mixtures had improved efficacy and have built-in resistance management with both active ingredients inhibitory to the brown rot pathogens. Additionally, all of the pre-mixtures evaluated are also effective against *Botrytis cinerea* (the green fruit rot pathogen) and powdery mildew and thus, provide protection against multiple diseases.

Blossoms of Fay Elberta peach were used in laboratory tests and demonstrated excellent pre- and post-infection activity of all conventional fungicides evaluated (Fig. 3). Stamen infection of the untreated control blossoms was 91.6% to 100% in the post- and pre-infection activity assays, respectively. Most fungicides resulted in less than 10% disease. The biologicals that showed good efficacy in the field had only low to moderate efficacy under these highly conducive experimental conditions. Among the biologicals, the organic formulation of polyoxin-D was the most effective with approximately 45% of the stamens diseased (Fig. 3). Still, the biologicals Botector and Fracture showed activity in these laboratory assays.

Efficacy of preharvest fungicides for management of fruit decays. In the trial at UC Davis on Fay Elberta all of the fungicides, including polyoxin-D, reduced the incidence of brown rot in the 1-day PHI application and there were significant differences among most of the treatments (Fig. 4). CHA-1323 and Mettle were numerically the least effective at the rates evaluated; whereas Fontelis, Luna Sensation, Pristine, and Merivon were the most effective. All treatments were less effective when applied 7 days before harvest. The best treatments were the pre-mixtures, the DMI fungicide Quash, and the SDHI Fontelis (Fig. 4). In previous years, two applications within ten days of harvest provided more consistent control. The addition of non-ionic surfactants for some of the treatments was requested by the registrants and helped to stabilize the tank-mixtures and kept the formulations in suspension using high-agitation sprayers.

At KARE, 7-day PHI applications were done. Most treatments significantly reduced the incidence of brown rot after inoculation on four peach and nectarine cultivars. Similar to the Fay Elberta study, most effective among the single-active ingredient treatments were Quash and Fontelis, but also Indar on all cultivars (Figs. 5, 6). Although very effective, Fontelis has a high risk for resistance development and should be used in a mixture with propiconazole or tebuconazole (FG 3) with a minimal additional expense when generic materials are used. The 3/11 and 7/11 pre-mixtures were also very effective on all cultivars. Merivon, Custodia, and Luna Sensation were the most consistent with a high efficacy.

Polyoxin-D was not approved as an organic fungicide in 2013 for stone fruit and other crops but will be reconsidered when additional information is provided to the National Organic Standards Board (NOSB). The US-EPA has designated this fungicide as exempt from tolerance (i.e., no MRL requirement). In our 2013 field studies on brown rot fruit decay, polyoxin-D had little or no efficacy when applied using a single application and thus, should be evaluated using a two-spray application program (within 7 days of harvest). We plan to conduct additional research on this product in 2014 for several reasons: 1) the material was inconsistently effective; 2) the EPA gave exempt status for fungicide residues and thus higher rates can now be evaluated; and 3) the material was submitted to NOSB as a future organic treatment. Two formulations (Ph-D, Oso) of the fungicide that are provided by two registrants (Arysta, Certis) will need to be evaluated. We consider this compound as mainly a contact material with moderate persistence. Thus, multiple applications close to harvest should prove to be consistent and effective.

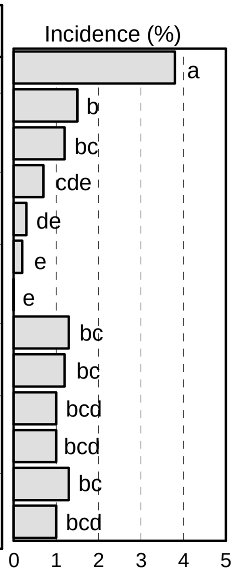
Evaluation of baseline sensitivities of* M. fructicola *isolates against SDHI fungicides. Baseline sensitivities against FG 7 SDHI fungicides were developed as part of our ongoing research on resistance monitoring and management. The evaluated fungicides belong to three subclasses of the SDHIs, fluxapyroxad and penthiopyrad being in the same sub-class, with boscalid and fluopyram in two other separate sub-groups. A range of sensitivities was found for each fungicide, with boscalid having a wider range and higher inhibitory values than the other three compounds (Fig. 7). Of interest is one isolate (isolate 2542) that showed high EC_{50} values for boscalid and fluopyram, and was also in the high-EC_{50} range for the other two fungicides. Cross-resistance between some of the sub-classes is considered low, but our data indicate that cross resistance does exist and that the risk for resistance development against SDHIs is high.

Host susceptibility of F1- progeny of Bolinha peach and other selections to brown rot blossom blight. Evaluation of brown rot blossom blight susceptibility among peach genotypes in the UC Davis breeding program of Dr. Tom Gradziel continued with 24 advanced breeding lines. Genotypes evaluated had parents with almond and wild almond lineage and these were compared to industry (e.g., Dr. Davis) and internal standards (e.g., Bolinha). Disease incidence of several genotypes was statistically lower than that of Bolinha (Fig. 8). These included one extra late and one extra early accession that soon will be released. As in previous years, we found that some lines were consistent but other inconsistent in their susceptibility. This may be due to environmental conditions that pre-dispose the host to infections by the pathogen but it may also be due to the genetics of blossom susceptibility because all of the advanced lines were from an orchard in the Wolfskill facility and were grown under the same horticultural practices. Perhaps some genotypes need different horticultural practices and we cannot screen for resistance using uniform farming practices. We are currently discussing this with Dr. Gradziel.

Evaluation of fungicides for management of powdery mildew. In the powdery mildew trial in Butte Co., we evaluated single-fungicides, new pre-mixtures, as well as the natural products Fracture and Serenade Optimum in mixture-rotation programs with conventional fungicides. Disease pressure in the test plot was low with an incidence of 4.3% in the untreated control. All of the conventional fungicides including the single-active ingredient treatments Fontelis and CHA-1323, six pre-mixtures, and one rotation were highly effective (Fig. 9). Polyoxin-D (Ph-D) and the mixture-rotation program of Rovral and Fracture with Fracture used at the 32-fl oz rate were similarly effective. Interestingly, the lower rate of Fracture was much less effective. The Luna Sensation-Serenade Optimum rotation also reduced powdery mildew on fruit to low levels; but in this rotation Serenade Optimum was only used in the third application. Still, the use of Ph-D, Fracture, or Serenade, all of which are exempt from tolerance, demonstrates the principle that softer chemistries can be integrated into a management program. This is done to 1) reduce the total pesticide load on the crop for conventional growers; 2) to have additional active ingredients effective against powdery mildew; and 3) as an anti-resistance management strategy of rotating materials and ultimately using only one mode of action (i.e., FRAC Group) per season. Fracture used under the name Problad was also very effective in our 2012 trials. For organic growers, these trials indicate that ‘softer chemistries’ are being developed and that perhaps organic certification of Ph-D and Fracture with the already organically approved Serenade Optimum and elemental sulfur (wettable sulfur or sulfur dust) will give organic growers additional options for the management of powdery mildew.

Fig. 1. Efficacy of fungicide treatments applied during dormancy against peach leaf curl of Fay Elberta peaches in a field trial at UC Davis

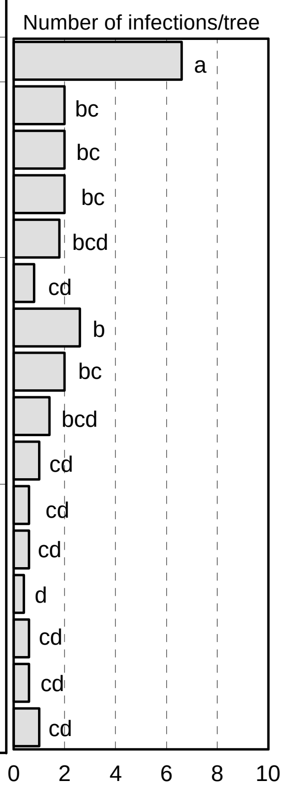
Treatment*	Rate (/A)	Oil (%)	12-12-12	1-21-13
Control	---	---	---	---
Syllit 65WG	24 oz	3.5	@	@
Syllit 65WG	32 oz	3.5	@	@
Bravo Weather-Stick	4 pt	3.5	@	@
Bravo Weather-Stick	6 pt	3.5	@	@
Ziram 76DF	6 lb	3.5	@	@
Ziram 76DF	8 lb	3.5	@	@
Badge X2	5 lb	3.5	@	@
Badge X2	7 lb	3.5	@	@
Kocide 3000	5 lb	3.5	@	@
Kocide 3000	7 lb	3.5	@	@
Syllit + Kocide 3000	24 oz + 3.5 lb	3.5	@	@
Badge X2 + Bravo WS	3.5 lb + 3 pt	3.5	@	@



Treatments were applied in the field in combination with a spray oil (3.5% Omni oil) using an air-blast sprayer (100 gal/A). Disease evaluation was done on in April 2013. For this, the number of infected shoots for a total of 100 shoots for each replication was determined.

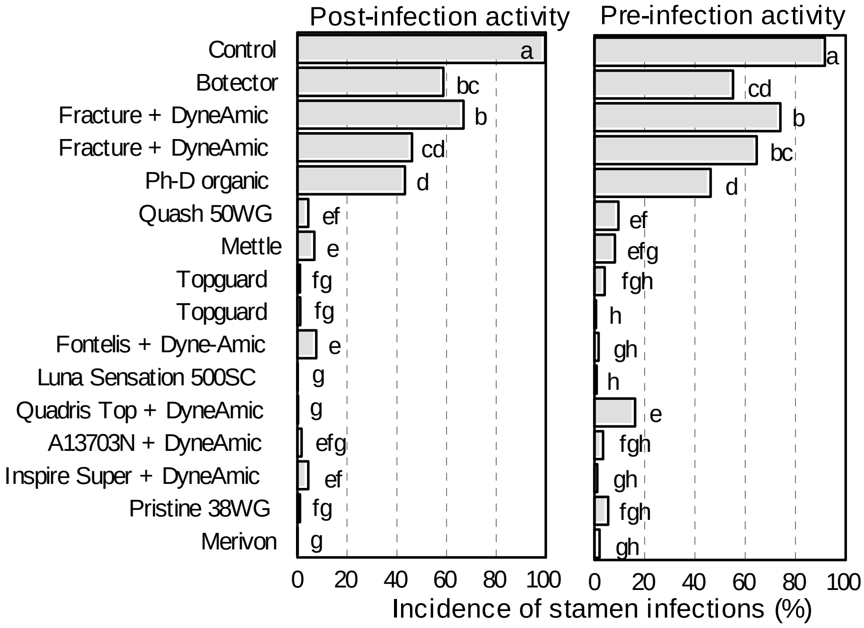
Fig. 2. Evaluation of new fungicides against brown rot blossom blight of Fay Elberta peach at UC Davis

Treatment*	Rate/A	50-70% bloom
Control	---	---
Botector	10 oz	@
Fracture + DyneAmic	24 + 16 fl oz	@
Fracture + DyneAmic	30 + 16 fl oz	@
Ph-D organic	12 oz	@
Quash 50WG	3.0 oz	@
Mettle	8 fl oz	@
TopGuard	3.5 fl oz	@
TopGuard	7 fl oz	@
Fontelis + NIS	14 fl oz	@
Luna Sensation 500SC	5 fl oz	@
Quadris Top + DyneAmic	14 + 16 fl oz	@
A13703N + DyneAmic	14 + 16 fl oz	@
Inspire Super + DyneAmic	20 + 16 fl oz	@
Pristine 38WG	14.5 oz	@
Merivon	5.5 fl oz	@



Treatments were applied on 3-7-13 using an air-blast sprayer at a rate of 100 gal/A. Evaluation was done in late April 2013.

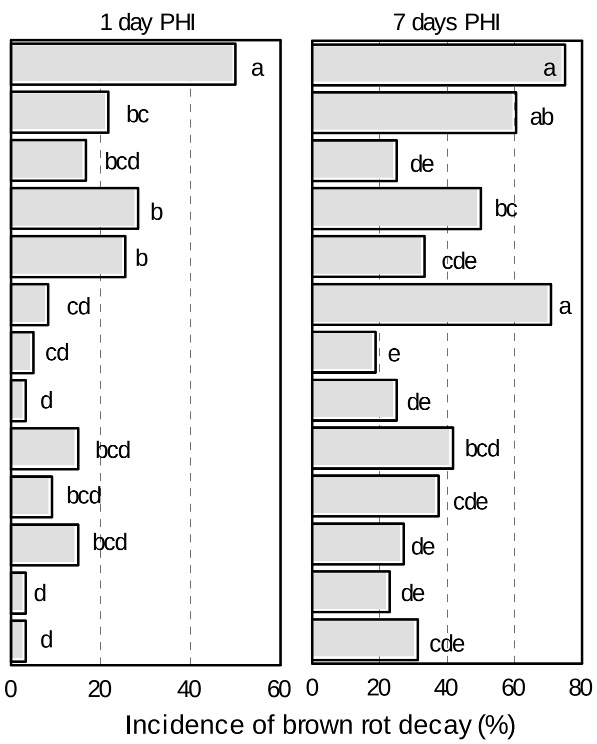
Fig. 3. Evaluation of the pre- and post-infection activity of new fungicides against brown rot blossom blight of Fay Elberta peach in the laboratory



Blossoms at popcorn stage were collected in the field and allowed to open in the laboratory. Blossoms were then either treated using an air-nozzle sprayer 24 h before (pre-infection activity) or after (post-infection activity) inoculation with conidia of *M. fructicola* 20,000 conidia/ml). Blossoms were incubated at 20C for 4-5 days and were then evaluated for stamen infections.

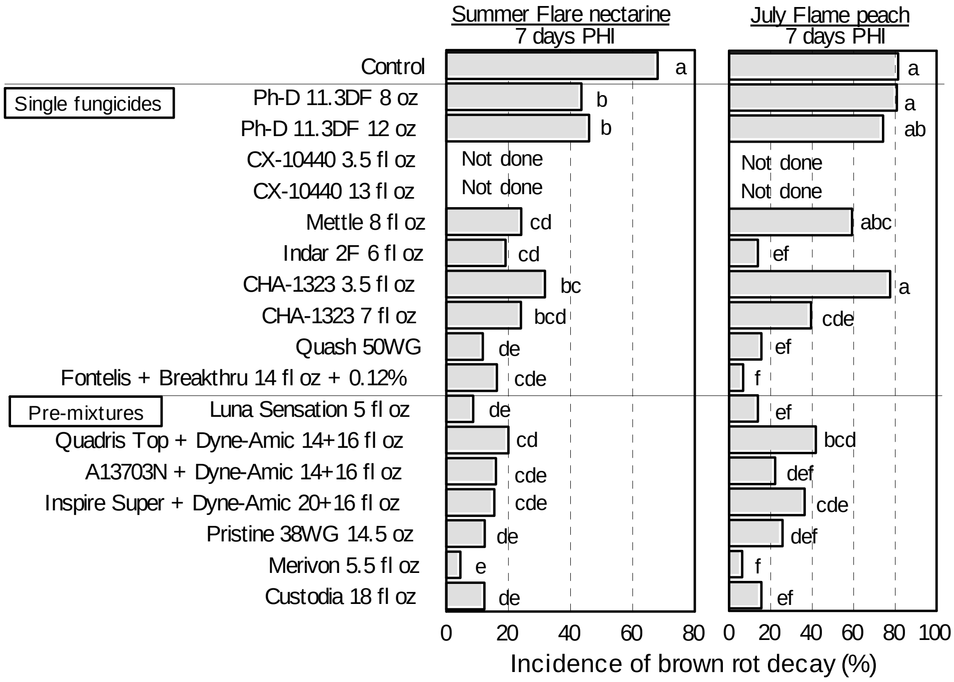
Fig. 4. Efficacy of 7-day PHI fungicide applications for management of postharvest brown rot of Fay Elberta peach at UC Davis 2013

Fungicide	Rate(/A)
Control	---
Ph-D 11.3DF	12 oz
Quash 50WG	10 oz
Mettle	8 fl oz
CHA-1323	3.5 fl oz
CHA-1323	7 fl oz
Fontelis + Breakthru	14 fl oz
Luna Sensation 500SC	5 fl oz
Quadris Top + Dyne-Amic	14 + 16 fl oz
A13703N + Dyne-Amic	14 + 16 fl oz
Inspire Super + Dyne-Amic	20 + 16 fl oz
Pristine 38WG	14.5 oz
Merivon	5.5 fl oz



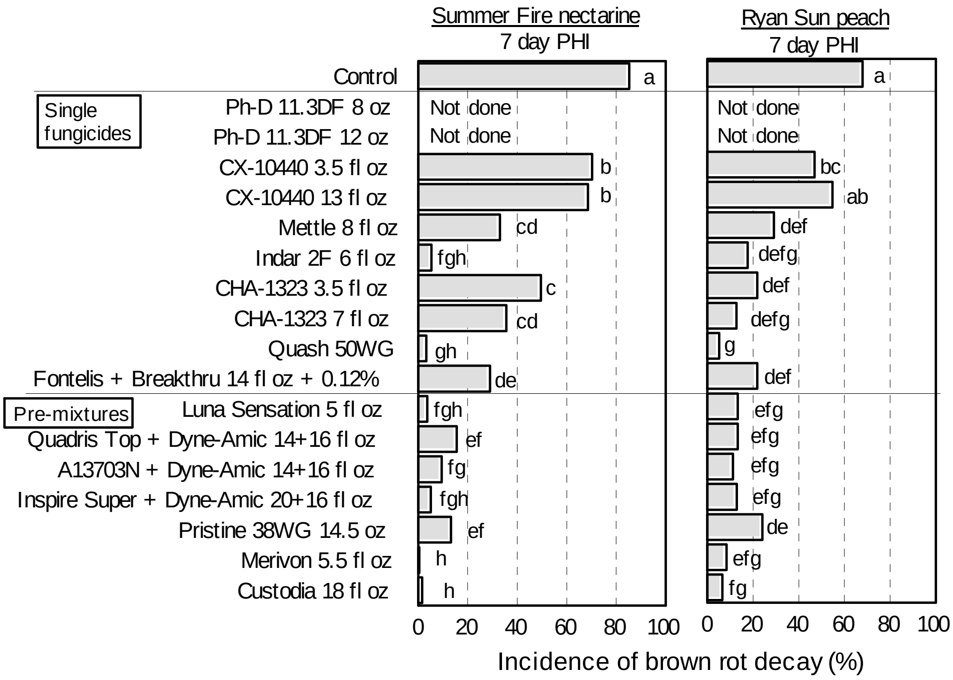
Treatments were applied on 7-11-13 using an air-blast sprayer (100 gal/A). Fruit were harvested, spray-inoculated with *M. fructicola* (20,000 spores/ml) and incubated for 10 days at 20-25C C. Breakthru and Dyne-Amic are non-ionic organosilicone surfactants.

Fig. 5. Efficacy of preharvest fungicide treatments for management of brown rot of peach at the Kearney Agricultural Research and Extension Center



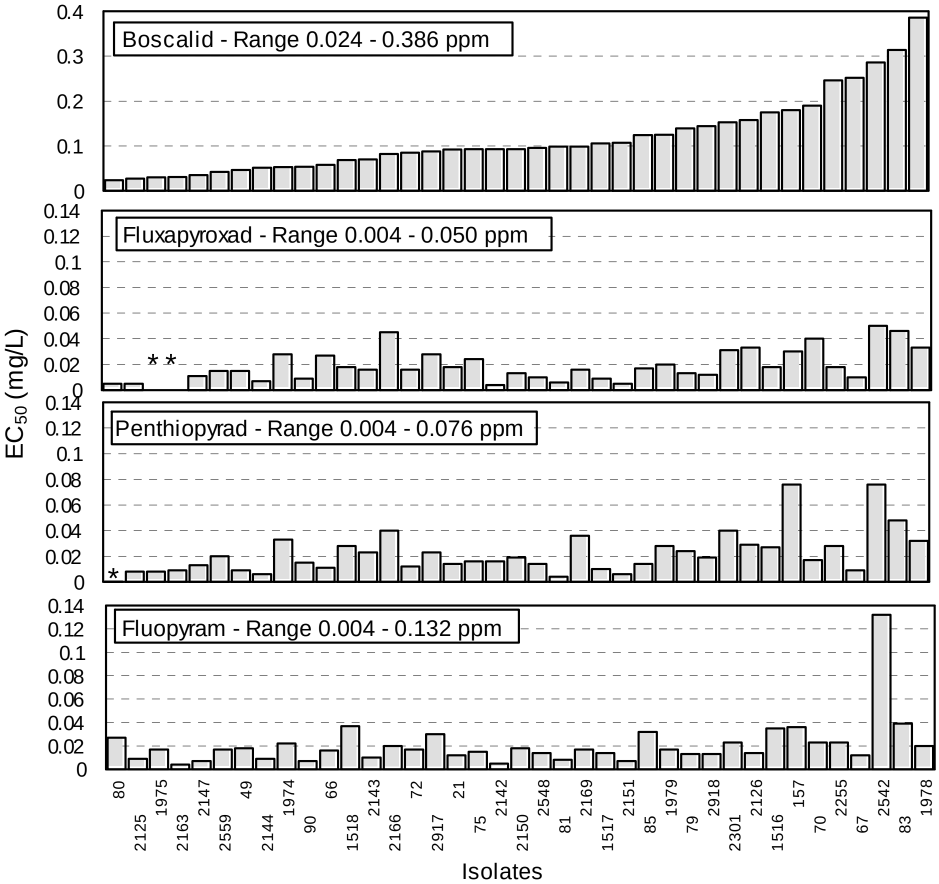
Treatments were applied on 6-20-13 to Summer Flare and July Flame using an air-blast sprayer (100 gal/A). Fruit were harvested and stored for 7 days at 1C. Fruit were then non-wound spray-inoculated with *Monilinia fructicola* (20,000 spores/ml) and incubated for 5-7 days at 20C.

Fig. 6. Efficacy of preharvest fungicide treatments for management of brown rot of peach at the Kearney Agricultural Research and Extension Center



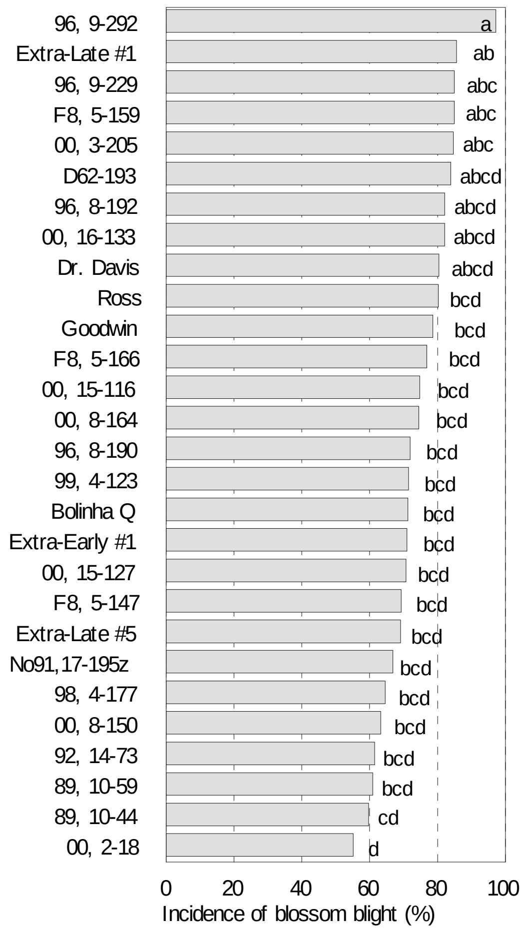
Treatments were applied on 7-24-13 to Summer Fire and on 8-7-13 to Ryan Sun using an air-blast sprayer (100 gal/A). Fruit were harvested and stored for 7 days at 1C. Fruit were then non-wound spray-inoculated with *Monilinia fructicola* (20,000 spores/ml) and incubated for 5-7 days at 20C.

Fig. 7. *In vitro* sensitivity of isolates of *Monilinia fructicola* collected from stone fruit crops in California between 1992 and 2005 to four SDHI fungicides



In vitro sensitivities for mycelial growth were determined using the spiral gradient dilution method.
Isolates are in the same order in each of the graphs. *

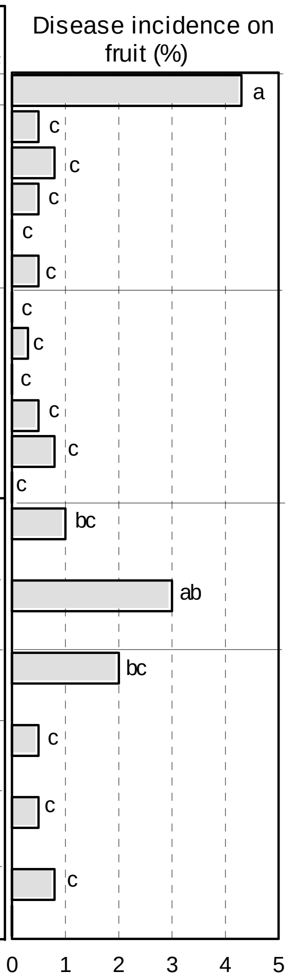
Fig. 8. Host susceptibility of standard and advanced peach genotypes with almond and wild-almond lineage to brown rot blossom blight



Blossoms at pink bud stage were collected, allowed to open in the laboratory, and inoculated with conidia of *Monilinia fructicola* (10^4 conidia/ml). Blossoms were evaluated for stamen infection after 5-6 days of incubation at 20C.

Fig. 9. Efficacy of fungicide treatments for management of powdery mildew of cv. Carson peach in Butte Co.

Program	Treatment*	Rate	3-12 FB	3-27 2 wk after PF	4-17 4 wk after PF
---	Control	---	---	---	---
Single treatments	Ph-D + NF-P	6 oz + 8 fl oz	@	@	@
	Ph-D + NF-P	12 oz + 8 fl oz	@	@	@
	CHA-1323	3.5 fl oz	@	@	@
	CHA-1323	7 fl oz	@	@	@
	Fontelis	20 fl oz	@	@	@
Pre-mixtures	Luna Sensation	5 fl oz	@	@	@
	Quadris Top + Dyne-Amic	14 + 14 fl oz	@	@	@
	A13703N + Dyne-Amic	14 + 14 fl oz	@	@	@
	Inspire Super + Dyne-Amic	20 fl oz	@	@	@
	Pristine 38WG	14.4 oz	@	@	@
	Merivon	5.5 fl oz	@	@	@
Rotations	Rovral + NF-P	24 fl oz + 8 fl oz	@	---	---
	Fracture	32 fl oz	@	@	@
	Rovral + NF-P	24 fl oz + 8 fl oz	@	---	---
	Fracture	24 fl oz	@	@	@
	Iprodione + NF-P	12 oz + 8 fl oz	@	---	---
	Quintec	7 fl oz	@	@	@
	Luna Sensation	5 fl oz	@	@	---
	Serenade Optimum	16 oz	---	---	@
	Merivon	5 fl oz	@	@	@
	Vivando + NF-P	15.4 + 8 fl oz	@	@	@
	Mettle	10 fl oz	@	---	---
	Resist	16 fl oz	@	@	@



Treatments were applied using an air-blast sprayer at a rate of 100 gal/A. N-P=Nu-Film P surfactant. Evaluation was done on 5-7-13. For this, fruit on each of the 4 single-tree replications were evaluated for the presence of powdery mildew. Values followed by the same number are not significantly different based on analysis of variance and LSD mean separation procedures (*P*> 0.05).