Annual Report - 2019

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:	Forth-Year of Five
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SUMMARY OF RESEARCH ACCOMPLISHMENTS DURING 2019

We continued our research on major diseases of flowers, leaves, and fruit of cling peach in California, including brown rot blossom blight and fruit rot, leaf curl, and bacterial blast and canker.

1. **Brown rot blossom blight.** In a field trial at KARE in the high-rainfall spring of 2019, single applications at 55% bloom to 'July Flame' were often more effective than those applied at 20% bloom to 'Ryan Sun'. On 'July Flame', Merivon+Serifel, Luna Sensation, as well as the experimentals EXP-AD, and UC-2 had numerically the lowest disease, whereas on 'Ryan Sun', only the experimental EXP-AF was highly effective. The biocontrol Serifel and the capric/caprylic acid mixture Dart performed very well on both peach cultivars with similar efficacy as the best fungicides. In laboratory tests with 'Fay Elberta' flowers, all fungicides tested demonstrated contact action as pre-infection treatments and local systemic activity as post-infection treatments.
2. Preharvest fungicide applications were evaluated for the management of **postharvest brown rot decay** on three peach cultivars in three orchards. On 'Fay Elberta' peach with 5-day PHI applications, Luna Experience and Merivon reduced the incidence of brown rot to the lowest levels followed by Cevya and the experimentals EXP-AF, UC-2, EXP-19A, as well as Luna Sensation and Merivon+Serifel. The biocontrol Serifel and the plant extract Ecoswing were not effective. At KARE, 6- or 7-day PHI applications with fungicides were mostly effective in reducing brown rot of fruit after inoculation, and there were few significant differences among treatments. Serifel and Dart were not effective on 'July Flame'. Dart and Ecoswing significantly reduced the incidence of brown rot on cv. 'Ryan Sun' but they were significantly less effective than conventional fungicides.
3. Evaluation of brown rot **blossom blight susceptibility among peach genotypes** of the UC Davis breeding program of Dr. Tom Gradziel continued with 20 new or previously evaluated genotypes. When comparing data for the last 5 years of studies to the highly susceptible cv. Goodwin, 14 genotypes had numerically or significantly lower disease in four or five of the five study years. Thus, some of the newer genotypes that are primarily bred for other fruit characteristics also have the potential to be less sensitive to brown rot blossom blight.
4. In two trials on the management of peach leaf curl at UC Davis, dormant treatments were applied once in December 2018. Highly effective treatments that reduced the disease to very low levels included Champ at 16 lb/A, Bravo, Ziram, as well as Bravo-Ziram, Bravo-Champ, and Champ-Ziram mixture treatments using reduced rates of both mixture partners.
5. In studies on **bacterial blast and canker**, flowers or small branches were treated with kasugamycin, oxytetracycline or selected new antimicrobials and were inoculated with *Pseudomonas syringae* pv. *syringae*, however, very little disease developed. Still, the registration of kasugamycin on peach was submitted to the EPA by the IR-4 program for full federal registration. Oxytetracycline is federally registered on peach and potentially the bactericide will be registered on peach in California.

INTRODUCTION

In California, **brown rot** is caused by the fungal pathogens *Monilinia fructicola* and *M. laxa* and is the most important disease of stone fruits. Ascospores produced from apothecia (*M. fructicola*) and conidia from mummified fruit or twig cankers (*M. fructicola* and *M. laxa*) infect blossoms to start the annual disease cycle. Diseased flowers supply fresh inoculum (i.e., conidia) for in-season fruit infections and thus, management of blossom blight is critical in preventing fruit rot. Fruit rots do not cause major losses in most years due to the dry California summer climate. Occasional rains in spring and summer, however, can cause quiescent infections of fruit and fruit decay epidemics that may result in significant losses.

Considerable effort has been made to have highly effective fungicides with different modes of action available and to develop peach cultivars that are less susceptible to brown rot. Currently, properly timed treatments with these materials are the most effective method to control brown rot blossom blight and fruit rot. We evaluated and helped register many of these fungicides of different FRAC codes (FCs) representing different modes of action including iprodione (Rovral, FC 2); propiconazole (Tilt, Bumper), fenbuconazole (Indar), tebuconazole (Tebucon), metconazole (Quash), and flutriafol (Rhyme, FC 3); penthiopyrad (Fontelis) and isofetamid (Kenja) (both FC 7); pyrimethanil (Scala) and cyprodinil (Vangard, FC 9); azoxystrobin (Abound) and trifloxystrobin (Gem, FC 11); fenhexamid (Elevate, FC 17); and polyoxin-D (Ph-D, Oso, FC 19). Still, other new products are becoming available including Cevya (formerly UC-1; mefentrifluconazole, FC 3), as well as pyraziflumid and pydiflumetofen (both FC 7). These materials are being evaluated to determine their effectiveness, optimal rates, potential combinations with other fungicides, and resistance potential in California. Pre-mixtures that combine these active ingredients also provide excellent control, consistency, a wider spectrum of activity, and resistance management because they have two modes of action. Products available include FC 3/9, FC 3/7, FC 3/11, and FC 7/11, as well as experimentals such as FC 3/33, UC-2, EXP-AD, EXP-AF, and isofetamid (FC 7) mixed with FC 3 or FC 11 compounds.

We are also continuing our evaluations of the FC 19 bio-fungicide polyoxin-D, biological controls, and natural products. These latter groups include extracts of *Lupinus alba*, *Aureobasidium pullulans*, and *Bacillus subtilis*. In 2019, we evaluated Serifel (*Bacillus amyloliquifaciens*), Dart (a mixture of capric and caprylic acids), and Ecoswing (a plant extract of *Swinglea glutinosa*). These compounds demonstrated moderate to good brown rot blossom blight control. Many have exempt status in the United States and are certified by the Organic Materials Review Institute (OMRI) for use in organic production of stone fruits including peach. In 2018, a formulation of polyoxin-D gained organic approval because it is a fermentation product. Rotation programs need to be designed even for biocontrols to prevent the overuse of any one mode of action. Fungicides and biologicals evaluated in 2019 studies are listed in Table 1.

Another objective of our cling peach research is the development of fungicide baseline sensitivity data (as reference points for the detection of resistance) for *M. fructicola* and *M. laxa*. In previous years, this was done for FC 3 (e.g., propiconazole, tebuconazole, metconazole, mefentrifluconazole), FC 7 (fluopyram, fluxapyroxad, penthiopyrad, pydiflumetofen, isofetamid, and pyraziflumid), FC 9 (e.g., cyprodinil), and FC 19 (polyoxin-D) products.

In evaluations of **natural host resistance** in cling peach, we are identifying in cooperation with Dr. Tom Gradziel new genotypes derived from cultivated cling peach and wild almond parental lineages that are less susceptible to blossom blight. Susceptibility to blossom blight is controlled to some extent by host genes, and environmental conditions during flower development may regulate these genes. In recent years, we focused on advanced breeding lines, including Early, Extra Late, and Compact lines. Evaluations were done in the laboratory where multiple genotypes can be evaluated under the same environmental conditions (although flowers develop in the field under different environments every year). Comparisons of genotypes were done over in the last several years to identify annual consistency among genotypes in their susceptibility to blossom blight. Several genotypes showed reduced susceptibility to blossom blight as compared to standard commercial cultivars in 4 or 5 years of five annual evaluations done. The identification of less susceptible genetic lines will also help in the development of molecular markers that can assist in breeding.

Peach leaf curl outbreaks are associated with high rainfall in the winter and early spring and can significantly reduce production if left unmanaged. The disease can be effectively managed by fungicide programs that we helped develop for California conditions. Because the use of copper in agriculture is currently under review by EPA with the intention to lower annual amounts permitted, we evaluated alternative treatments over the past several years, including new formulations of copper, mixtures with other modes of action, and lower application rates of each mixture component. Chlorothalonil, ziram, and dodine in mixtures with copper or by themselves provide consistent efficacy.

Several species of *Podosphaera* cause **powdery mildew** on peach in California: *P. (Sphaerotheca) pannosa*, *P. tridactyla*, and *P. leucotricha*. Thus, as with other powdery mildews where the sexual stage of the pathogen is present, management strategies need to include integrated use of fungicides. Because the same fungicides are generally active against brown rot and powdery mildew, rotational programs against both need to be developed from bloom to the pit-hardening stage. The occurrence of powdery mildew has been inconsistent and often at low incidence in recent years. In our efficacy trials, the incidence of disease on untreated trees was less than 1% over numerous years. Thus, we suspended these studies until orchards with consistent disease can be identified. We previously identified FC 7 SDHI fungicides and premixtures (FC 7/11, 3/11, and 3/7 as highly effective against powdery mildew. 'Biologicals' such as *Lupinus alba, Aureobasidium pullulans,* and *Bacillus subtilis* provided intermediate but inconsistent efficacy.

Bacterial blast and canker of peach and other stone fruit crops are caused mainly by the bacterium *Pseudomonas syringae* pv. *syringae*, and are other important diseases where new management strategies are needed. Blossom blast develops after cold injury, causing flower and bud death and spots on leaves and fruit. The disease is more commonly found on early-blooming varieties that experience cooler, wet environments in the spring. Bacterial canker causes dieback from infection of pruning wounds and other injuries. The disease weakens trees, and in severe cases, trees may die. Copious amounts of amber-colored gum may exude from trunk and bark cankers. Copper resistance in the pathogen is widespread in California and currently, no effective treatment alternatives are available.

Based on our efforts, advances have been made in bacterial disease control with the identification and development of kasugamycin. This bactericide is not used in animal or human medicine. The California registration on pome fruit, walnut, and sweet cherry was approved in January 2018. IR-4 and the registrant UPL have submitted full registration petitions for almond and peach. In our studies, bacterial blast and canker were effectively reduced in inoculation and natural incidence trials. However, in our bactericide evaluations on cling peach in 2018 and 2019, no or very little disease was obtained due to lack of favorable environmental conditions.

OBJECTIVES

I. Management of brown rot
   - A) Evaluate the efficacy of new fungicides (e.g., pydiflumetofen, pyraziflumid, mefentrifluconazole, V-424, V-449), pre-mixtures (Fervent, Viathon, F4406-1, EXP-AD, -AF, UC-2), biofungicides (e.g., polyoxin-D) and biocontrols (Botector, Fracture, Serenade ASO) representing different modes of action for brown rot blossom blight and fruit rot in laboratory and field trials.
     - Pre- and post-infection efficacy will be studied for both blossoms and fruit.
   - B) Baseline sensitivities of brown rot fungi to new fungicides.
   - C) Natural host resistance of new peach genotypes to blossom blight and fruit decay
     - Flower assays using detached blossoms collected at pink bud stage.
     - Fruit assays using standard laboratory methods if sufficient fruit are available.

II. Management of peach leaf curl
   - A) Evaluate combinations of chlorothalonil (Bravo), ziram, dodine (Syllit) and new copper formulations in tank mixtures of these products.

III. Evaluate the efficacy of new treatments against bacterial canker in twig inoculation studies.
   - A) New bactericides – ZTD, nisin, and Ɛ-poly-L-lysine
   - B) Antibiotics – kasugamycin and oxytetracycline combined with adjuvants.
   - C) Biocontrols - Serenade ASO and Blossom Protect

PLANS AND PROCEDURES

I. Management of brown rot

Evaluation of fungicides for management of brown rot blossom blight and fruit rot. Trials were established to evaluate fungicides for control of brown rot blossom blight on ‘July Flame’ and ‘Ryan Sun’ peach at the Kearney Agricultural Research and Extension Center (KARE) in Parlier, CA. A single application of each treatment (see Fig. 1) was made at 55% full bloom to ‘July Flame’ and at 20% bloom to ‘Ryan Sun’ using an air-blast sprayer calibrated for 100 gal/A. The pre- and post-infection activity of selected fungicides was evaluated in laboratory studies using ‘Fay Elberta’ peach flowers. Pink bud blossoms were collected on 3-19-19 and allowed to open in the laboratory. For pre-infection activity, blossoms were treated using an air-nozzle sprayer, allowed to air-dry, and were then inoculated with spores of *M. fructicola* (20K/ml). For post-infection activity, blossoms were first inoculated, incubated at 22C for 20 h, and then treated with selected fungicides using an air-nozzle sprayer. Three replications of eight flowers were used for each fungicide. Stamen infections were evaluated after 4-5 days of incubation at 20 C.

For fruit rot studies at UC Davis, fungicide treatments were applied 5 days before harvest (PHI) to ‘Fay Elberta’ peach. In the KARE trials, treatments were applied to ‘July Flame’ 6 days PHI and to ‘Ryan Sun’ peach 7 days PHI. Four single-tree replications for each treatment were randomized in complete blocks. Fungicides evaluated are indicated in Figs. 3 and 4. Twenty-four fruit were harvested from each replication in the UC Davis trial and 48 fruit in the KARE trials. Fruit were spray-inoculated with *M. fructicola* (20,000 spores/ml) and incubated for 5-10 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. Data were analyzed using analysis of variance and mean separation procedures of SAS 9.4.

Evaluation of natural host resistance of peach to blossom blight and fruit decay. Based on availability of advanced selections from the Dr. Gradziel breeding program, we continued to compare new genotypes with currently available commercial genotypes of cling peach for susceptibility to brown rot blossom blight. Blossoms at the pink bud stage were collected in the field, allowed to open in the laboratory, placed into crispers with wet vermiculite, and inoculated with conidia of *M. fructicola* using an air-nozzle sprayer. Incidence of stamen infections was evaluated after 4-6 days of incubation. Data were evaluated using analysis of variance and mean separation procedures of SAS version 9.4.

II. Management of peach leaf curl

Single applications in combination with 2% Omni spray oil (see Fig. 6) in two experimental ‘Fay Elberta’ orchards at UC Davis were done as dormant treatments on Dec. 13, 2018, using an air-blast sprayer at 100 gal/A. Six single-tree replications of each treatment were used. Trees were evaluated for disease in early May. For this, the number of leaf curl infections was determined for each tree. Data were evaluated using analysis of variance and mean separation procedures of SAS version 9.4.

IV. Management of bacterial canker and blast

In December of 2018, the bark of 2-year-old twigs of ‘Fay Elberta’ trees was puncture-wounded using a 12-gauge needle (3 wounds per twig). Wounds were sprayed with bactericides to run-off using a hand sprayer, allowed to air-dry, and spray-inoculated with a copper-resistant strain of *P. syringae* pv. *syringae* (2×10^8 cfu/ml). Treatments included oxytetracycline (Mycoshield), kasugamycin (Kasumin), ε-poly-L-lysine, nisin, and an experimental antimicrobial (NS1). In April, inoculated branches were sampled and evaluated for the severity of canker formation. Data were analyzed using analysis of variance and mean separation procedures of SAS 9.4. In blossom blast evaluations, flowers of flower clusters (eight single-branch replications on different trees for each treatment) were partially emasculated by cutting pistils, stamens, and part of the petals using scissors. Bactericide applications were made using a hand sprayer. After air-drying for 2 h, blossoms were inoculated with *P. syringae* (2×10^7 cfu/ml) by hand-spraying. Inoculated branches were covered with white plastic bags for 18 h. Disease was evaluated after approximately 2 weeks.

RESULTS AND DISCUSSION

I. Management of Brown Rot

Efficacy of fungicides for management of blossom blight. At KARE, disease incidence on 'July Flame' and 'Ryan Sun' peach was between 3% and 4% on blossoms of untreated control trees. All treatments evaluated significantly reduced the incidence from that of the control with few significant differences among treatments (Fig. 1). None of the treatments eliminated the disease, and few of the fungicides were highly effective. This can be explained by high rainfall that occurred in the spring of 2019 that may have removed fungicides residues from flower tissues. Treatments were often more effective on cv. 'July Flame' where they were applied at 55% bloom as compared with 'Ryan Sun' where applications were done at 20% bloom. Thus, under high rainfall conditions, an application at approximately 50% bloom or two applications at early and mid-bloom should be done. On 'July Flame', Merivon+Serifel, Luna Sensation, EXP-AD, and UC-2 had numerically the lowest disease, whereas on 'Ryan Sun', only EXP-AF was highly effective. The biocontrol Serifel and the organic acid mixture Dart performed very well on both peach cultivars with similar efficacy as the best fungicides. Therefore, these treatments will be evaluated again in 2020.

Blossoms of 'Fay Elberta' were used in laboratory tests with registered and experimental fungicides. All treatments evaluated demonstrated excellent pre- and post-infection activity significantly reducing stamen infection from that of the untreated control (Fig. 2). The new experimental EXP-19A was significantly less effective than the other fungicides. Thus, all fungicides demonstrated contact action as pre-infection treatments and local systemic activity as post-infection treatments.

Efficacy of preharvest fungicides for management of fruit decays. In a trial at UC Davis on 'Fay Elberta' peach, 5-day PHI applications with a range of single and pre-mixture fungicide treatments were mostly effective in reducing the incidence of brown rot after non-wound inoculation (Fig. 3). Luna Experience and Merivon reduced the incidence of brown rot to the lowest levels followed by Cevya and the experimentals EXP-AF, UC-2, EXP-19A, as well as Luna Sensation and Merivon+Serifel. In contrast to blossom blight, the biocontrol Serifel was not effective against brown rot fruit rot, and the plant extract Ecoswing also showed no significant difference from the control.

At KARE, 6- or 7-day PHI applications with fungicides again were mostly effective in reducing brown rot of fruit after inoculation, and there were few significant differences among treatments (Fig. 4). Quadris Top was less effective on July Flame than on Ryan Sun. In previous years, the fungicide premixture was highly efficacious on both varieties. The biologicals Serifel and Dart were not effective on 'July Flame'. Dart and Ecoswing significantly reduced the incidence of brown rot from the control on cv. 'Ryan Sun' but they were less effective than conventional fungicides.

In summary, we are continuing to develop numerous highly effective fungicides to ensure that growers have efficacious fungicides available for the management of brown rot blossom blight and fruit decay. The compounds include new active ingredients and new pre-mixtures that belong to currently available FRAC groups, as well as new FRAC groups such as EXP-13 and -19A. Therefore, mixture and rotation programs should be followed for bloom and preharvest applications to prevent over-use of any one FRAC group and any subsequent development of resistance. Overall, pre-mixtures have improved efficacy, are consistent, have a broader disease range, and have built-in resistance management if both active ingredients are inhibitory to the foliar and fruit pathogens of peach. FRAC codes should be rotated with every application, and as long as one FRAC code is different among premixtures or tank mixtures used in rotation, then resistance management is being practiced. All of the pre-mixtures evaluated are also effective against *Botrytis cinerea* (the green fruit rot and gray mold pathogen) and powdery mildew fungi and thus, provide protection against multiple diseases. Identification of SDHI (FRAC Code 7) fungicides for powdery mildew and gray mold will help to prevent overuse of DMI and QoI fungicides (FRAC Codes 3 and 11, respectively). Preharvest applications for brown rot are best done within 7 to 14 days of harvest. On later maturing fruit, a two-spray program (two sprays within 14 days of harvest) may be beneficial because of a higher disease pressure due to more quiescent infections and higher inoculum levels in the orchard later in the season. This also ensures good coverage and that high residue levels are still present at harvest when many of the infections occur on mature ripening fruit. The DMI (FC 3) fungicides still are the only materials that provide post-infection activity and should be used in resistance management programs (i.e. in combination with other fungicides. An additional benefit of preharvest applications with DMI or QoI fungicides is that they continue to have benefits into fall by reducing the incidence of rust. This ensures that a rust epidemic is less likely in the subsequent spring season.

In vitro sensitivity of* M. laxa *and* M. fructicola *to new fungicides. These studies are ongoing and will be reported on in the coming year. One fungicide, EXP-19A, was evaluated as an emulsified concentrate (i.e., EC) and the registrant wants the studies to be done using a soluble concentrate (i.e., SC). This formulation will be evaluated in 2020.

Host susceptibility of F1-progeny of Bolinha peach and other selections to brown rot blossom blight. Evaluations among 20 peach genotypes and cultivars the UC Davis breeding program for brown rot blossom blight susceptibility was continued in 2019. Most genotypes were also evaluated in 2015 - 2018. All were grown under the same horticultural practices at the Wolfskill facility and experienced the same environmental conditions. We collected blossoms in the popcorn stage and allowed them to open in the laboratory to minimize maturity differences of the flowers; but still, genetic characteristics affecting bloom date may also affect blossom susceptibility.

A range of susceptibilities was again found among genotypes. Dr. Davis, Goodwin; Compact #2, and 00, 15-116 (peach by almond #2 parentage) were among the most susceptible (57.7% to 71.9% disease incidence) (Fig. 5). Carson; 00,2-18 (Loadel by almond #1); 00,B-202; and 01,2-85 had the lowest disease with an incidence of 36.8% or less. When comparing results from the last five years, several genotypes showed consistency in their susceptibility of stamen infections. Cultivars Goodwin and Dr. Davis always were among the most susceptible. When compared to cv. Goodwin, 14 genotypes had numerically or significantly lower disease in four or five of the five study years (Fig. 5). Thus, some of the newer genotypes that are primarily bred for other favorable characteristics, also have the potential to be less sensitive to brown rot blossom blight. These data have been shared with Dr. Gradziel.

II. **Management of peach leaf curl**

Two studies were conducted in winter 2018/spring 2019 on ‘Fay Elberta’ at UC Davis with similar results. Disease levels in the untreated control were moderate with 20.5 (Orchard 1) and 27.6 (Orchard 2) shoot infections/tree (Fig. 6). All treatments applied as single applications in mid-December, except the 12-lb rate of Champ in orchard 1, were highly effective and reduced the number of shoot infections/tree to 1.8 or less. Highly effective treatments included Champ at 16 lb/A, Bravo, Ziram, as well as Bravo-Ziram, Bravo-Champ, and Champ-Ziram mixture treatments using reduced rates of both mixture partners. Mixtures of these broad-spectrum fungicides reduce the risk of resistance, and the lower rates minimize the risk of environmental contamination, thus ensuring that regulatory issues do not restrict their usage in the future.

Ziram, chlorothalonil, and also dodine (not evaluated in 2019) represent valuable components of a leaf curl management program and are alternatives to copper fungicides. With increased EPA regulation to reduce copper levels on most registered crops, identifying alternatives is important for the industry. Over several years of trials, the efficacy of copper has been inconsistent in our evaluation of different copper products and rates, but Ziram, high rates of Bravo, and mixtures of these products have been the most effective treatments evaluated. These three fungicides are currently registered for use in California. Thus, several options are available for growers to manage the disease.

IV. Management of bacterial canker

Treated, injured branches inoculated with a copper-resistant strain of the pathogen did not develop canker in the spring of 2019. The usually warm December of 2018 when the trials were initiated likely prevented the inoculations from being established. Similarly, no blossom blast developed in our studies although high concentrations of *P. syringae* inoculum were used. Bacterial canker and blast require cold injury for infection to occur. Studies with kasugamycin, oxytetracycline, and other experimental bactericides will be repeated in the 2019/20 season. Still, enough efficacy data has been generated for kasugamycin (i.e., Kasumin) to be submitted by IR-4 to the EPA for registration on peach and almond. The

PRIA date for these commodities is expected to be 12 to 18 months from January 2019. Kasumin is one of the few chemicals that have potential for bacterial canker and blast management. With widespread copper resistance in the bacterial pathogen *P. syringae* pv. *syringae* in California, new effective treatments are needed to manage bacterial canker and blast. These are important diseases of stone fruits that can impact production in seasons with favorable environmental conditions and can also have long-term effects on tree health. In our studies on sweet cherry over several years, kasugamycin was the most effective and consistent treatment against both phases of the disease. In California, kasugamycin was registered on pome fruits for the management of fire blight, on sweet cherry for bacterial canker and blast, and on walnut for walnut blight in the spring of 2018. The bactericide is federally registered on pome fruits since 2014. Oxytetracycline is federally registered on peach and in California on pome fruits. Potentially, this bactericide will be registered on peach in California. This will ensure that resistance management practices can be implemented because kasugamycin is FRAC Code 24 and oxytetracycline is FRAC Code 41; thus, they represent two different modes of action. Similar to practices instituted with fungicides, mixtures or rotations of different modes of action or FRAC Codes is an effective usage strategy to prevent the selection of resistant populations of the pathogens targeted.

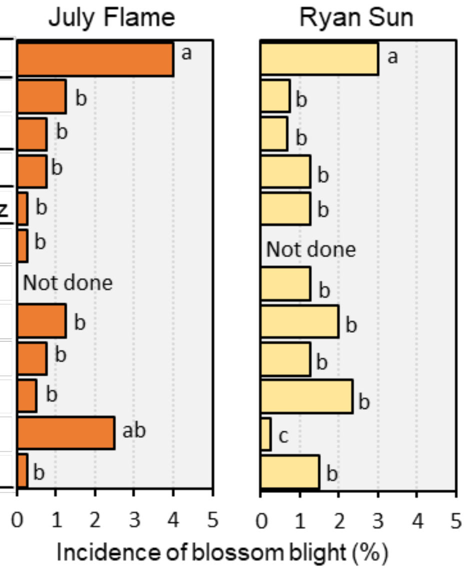
Table 1: Fungicides, bactericides, and biologicals used in 2019 studies*.

Pesticide	FRAC group	Trade name	Active ingredient
Fungicides			
Single active ingredients	M1	Champ	copper
	M3	Ziram	ziram
	M5	Bravo WeatherStik	chlorothalonil
	3	Cevya	mefentrifluconazole
	3	Quash	metconazole
	7	Fontelis	penthiopyrad
	7	Pyraziflumid	pyraziflumid
	7	Sercadis	fluxapyroxad
Premixtures	3 + 11	Quadris Top	difenoconazole + azoxystrobin
	7 + 3	Luna Experience	fluopyram + tebuconazole
	7 + 11	Luna Sensation	fluopyram + trifloxystrobin
	7 + 11	Merivon	fluxapyroxad + pyraclostrobin
Experimentals		EXP-19A	not disclosed
		EXP-AD	pydiflumetofen/not disclosed
		EXP-AF	pydiflumetofen/not disclosed
		F4406-3	not disclosed
		UC-2	not disclosed
		V-10424	not disclosed
		V-10484	not disclosed
Biologicals	Bacterium	Serifel	*Bacillus amyloliquefaciens* strain MBI600
	Organic acids	Dart	Capric/caprylic acids
	Plant extract	Ecoswing	*Swinglea glutinosa*

* - Alphabetical by trade name for each Fungicide Resistance Action Committee (FRAC) group or mode of action. Some fungicides were used with adjuvants such as Breakthru or DyneAmic.

Fig. 1. Efficacy of fungicide treatments for management of brown rot blossom blight of July Flame and Ryan Sun peach at KARE 2019

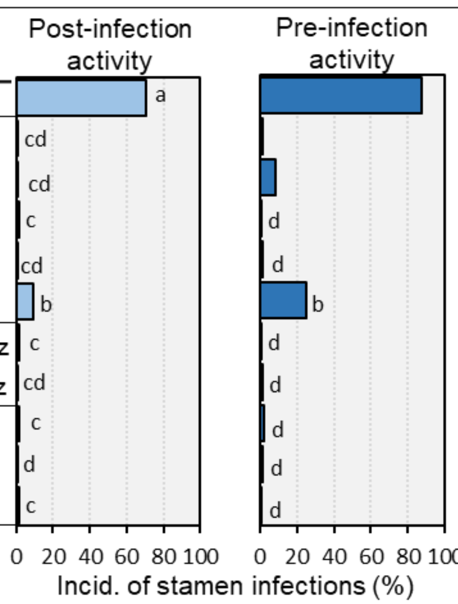
	Treatment	Rate	July Flame	Ryan Sun
	Control	---	a	a
Biological	Serifel	8 oz	b	b
	Dart	0.25%	b	b
Single	Cevya	4 fl oz	b	b
Mixtures	Merivon + Serifel	5.5 fl oz + 8 oz	b	b
Pre-mixtures	Luna Sensation	7.8 fl oz	b	Not done
	Luna Experience	8 fl oz	Not done	b
	Quadris Top	14 fl oz	b	b
	Merivon	5.5 fl oz	b	b
	EXP-AD	13.7 fl oz	b	b
	EXP-AF	9.1 fl oz	ab	c
	UC-2	7 fl oz	b	b



Treatments were applied to July Flame peach at 55% bloom on 3-9-19 and to Ryan Sun Peach at 20% bloom on 3-13-19 using an air-blast sprayer (100 gal/A). 8 hours of overhead sprinkler irrigation was applied two days after the sprays. Disease was evaluated in mid-April 2019.

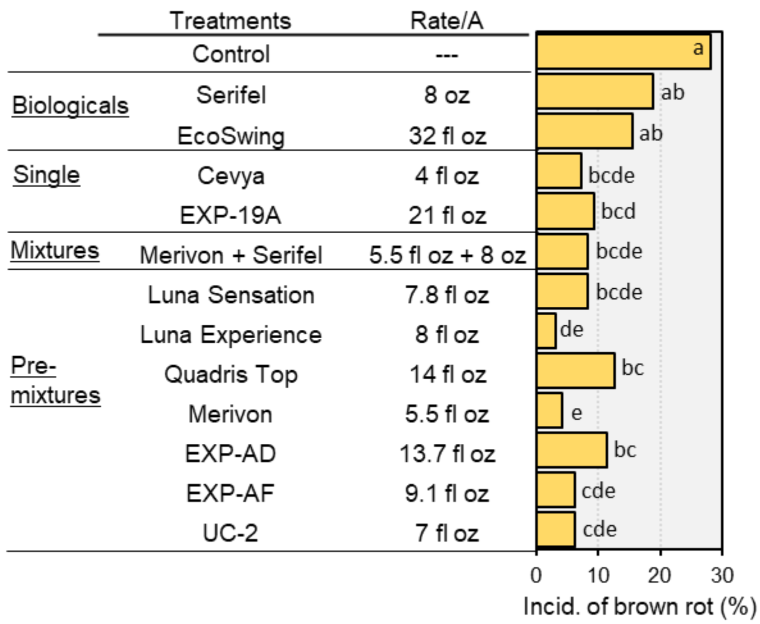
Fig. 2. Efficacy of pre-infection treatments for management of brown rot blossom blight of Fay Elberta peach in the laboratory 2019

	Treatments	Rate/A	Post-infection activity	Pre-infection activity
	Control	---	a	
Single	Cevya	4 fl oz	cd	
	Pyraziflumid	3.1 fl oz	cd	
	Fontelis	20 fl oz	c	d
	V-10424	3 fl oz	cd	d
	EXP-19A	21 fl oz	b	b
Mixtures	Quash + Sercadis	2.5 + 3.5 fl oz	c	d
	Quash + V-10484	2.5 + 3.75 oz	cd	d
Pre-mixtures	EXP-AD	13.7 fl oz	c	d
	EXP-AF	9.1 fl oz	d	d
	F4406-3	6 fl oz	c	d



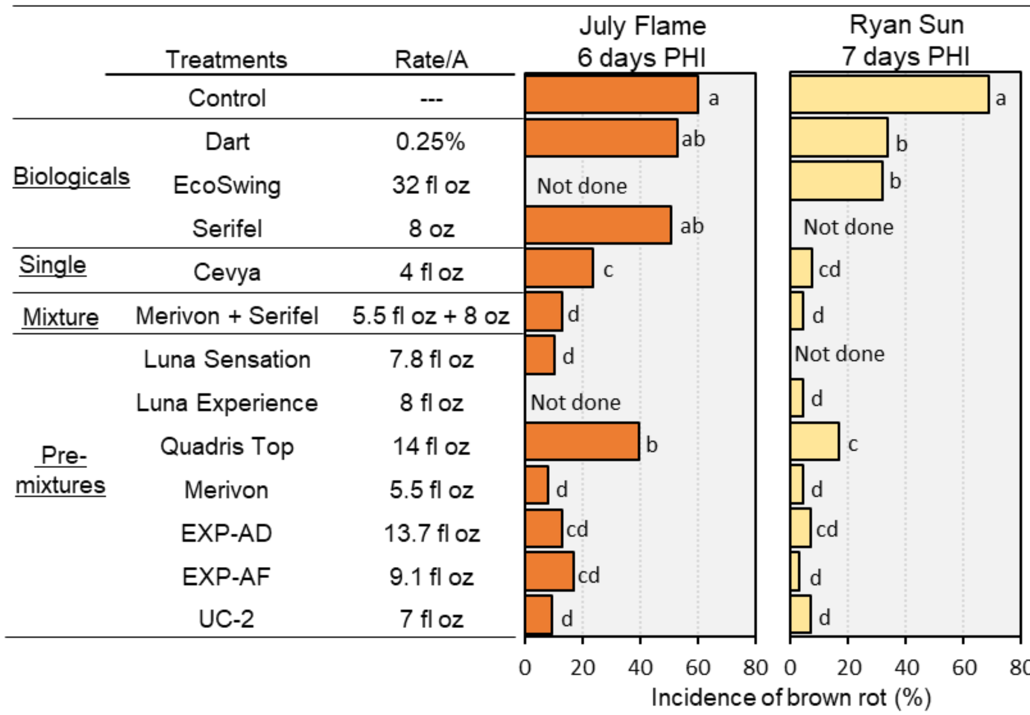
For evaluation of the pre-infection activity, closed blossoms were collected in the field on 3-19-19, allowed to open, treated in the laboratory using a hand sprayer, air-dried, and inoculated with a spore suspension of *M. fructicola* (20 K/ml). For post-infection activity, blossoms were inoculated, incubated at 20 C, and treated after 17 h. Blossoms were evaluated for stamen infections after 4-5 days of incubation at 20 C.

Fig. 3. Efficacy of 5-day PHI preharvest treatments for management of postharvest brown rot of Fay Elberta peach in a field trial at UC Davis 2019



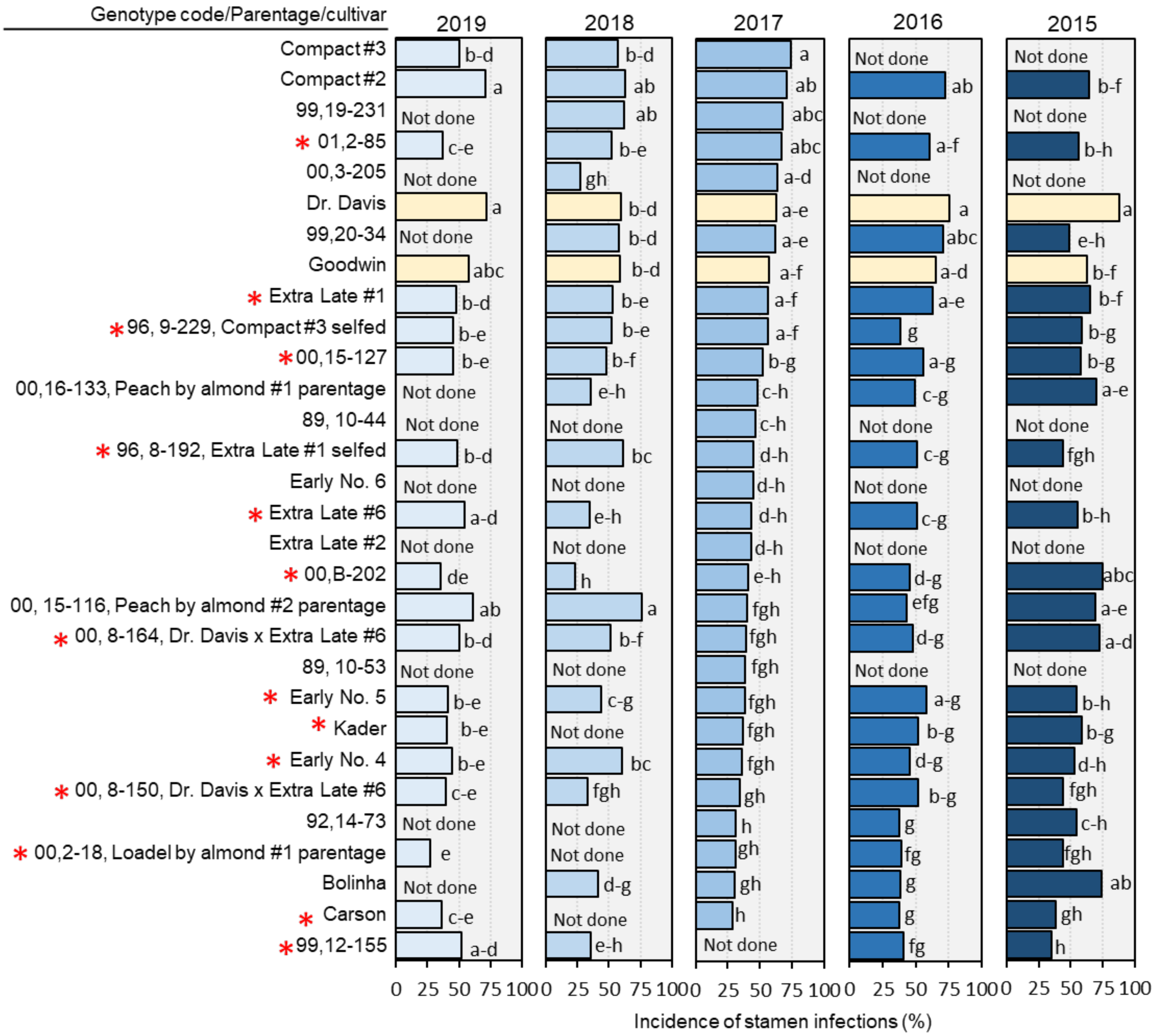
Treatments were applied on 7-20-19 using an air-blast sprayer (100 gal/A). NIS = non-ionic surfactant. Fruit were harvested (24 fruit from each of four single-tree replication), spray-inoculated with *M. fructicola* (20,000 spores/ml) and incubated for 8 days at 20-25C.

Fig. 4. Efficacy of preharvest treatments for management of postharvest brown rot of July Flame and Ryan Sun peach in field trials at KARE 2019



Treatments were applied in the field on 7-4 (July Flame) or on 8-14-19 (Ryan Sun) using an air-blast sprayer at 100 gal/A. Fruit were harvested (48 fruit from each of four single-tree replications), spray-inoculated with *M. fructicola* (20,000 spores/ml) and incubated for 7 days at 20C.

Fig. 5. Host susceptibility of standard and advanced cling peach genotypes with almond and wild almond parentage to brown rot blossom blight 2015 - 2019



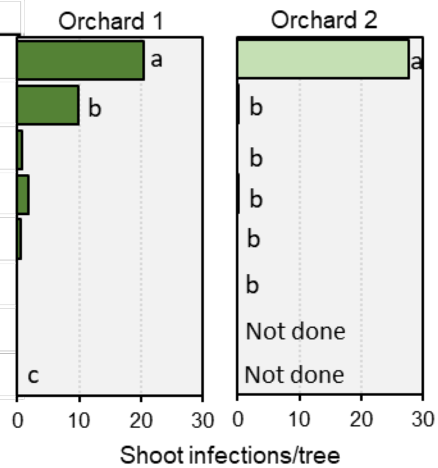
Closed blossoms were collected in the field, allowed to open, and inoculated with conidia of *M. fructicola* (20K/ml). Blossoms were evaluated for stamen infections after 5-6 days of incubation at 20C.

* Genotypes with numerically or significantly lower disease as compared to cv. Goodwin in 4 or 5 years of the 5 years of evaluation.

Fig. 6. Efficacy of fungicide treatments for management of peach leaf curl of Fay Elberta at UC Davis 2018/19

Applications Dec 13, 2018

Treatment*	Rate (/A)	Oil
Control	---	---
Champ	12 lb	2%
Champ	16 lb	2%
Bravo Weather-Stick	4 pt	2%
Bravo + Champ	3 pt + 8 lb	2%
Ziram 76DF	6 lb	2%
Champ + Ziram	8 lb + 4 lb	2%
Bravo + Ziram	3 pt + 4 lb	2%



Treatments were applied in the field on Dec. 13, 2018 using an air-blast sprayer (100 gal/A) in combination with a spray oil (2% Omni oil). Six single-tree replications were used for each treatment. Disease evaluation was done in the spring of 2019. For this, the number of infections per tree was determined.