Annual Report - 2020

Prepared for the California Cling Peach Advisory Board

Title:	*Management of brown rot, bacterial blast/canker, and peach leaf curl diseases of peach in California*
Status:	Fifth of Six Years
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SUMMARY OF RESEARCH ACCOMPLISHMENTS DURING 2020

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 field trials at UC-KARE, single applications at 30% bloom to 'July Flame' at 25% bloom to 'Ryan Sun' were highly effective. On 'July Flame', Cevya and Luna Sensation and on 'Ryan Sun', Cevya, Miravis Prime, Merivon and the organics Dart and Ecoswing were highly effective providing 100% control. Still, Merivon, Luna Experience, the experimental UC-2, and the organics performed well and significantly reduced the incidence of disease on both cultivars. 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. New products such as Cevya, GWN 10570, Fervent, Miravis Top (-Duo), Miravis Prime, and UC-2 were similar in performance to registered standards (e.g., Quash, Luna Sensation, Quadris Top).
2. Preharvest fungicide applications were evaluated for the management of **postharvest brown rot decay** on three peach cultivars in four orchards. On 'Fay Elberta' peach with 5-day PHI applications, Merivon and Merivon+Serifel reduced the incidence of brown rot to the lowest levels followed by Cevya and the experimental UC-2. Luna Sensation, Miravis Top (-Duo) and Quash+Velum One also performed well. The biocontrol Serifel, the plant extract Ecoswing and the numbered organic compound GWN 10474 were not as effective as the conventional products but significantly reduced brown rot from that of the control. At UC-KARE, conventional fungicides applied 7-day or 14- and 7-day preharvest applications on July Flame and Ryan Sun, respectively, were most effective in reducing brown rot of fruit. Ecoswing, Howler, and GWN 10474 were not effective. Merivon and UC-2 were the most effective reducing decay to 4.8% to 11% as compared to >64% in the controls of both cultivars.
3. Evaluation of brown rot **blossom blight susceptibility among peach genotypes** of the UC Davis breeding program of Dr. Tom Gradziel was not done in March due to COVID-19 shutdowns at the University of California that limited collaborative research.
4. In two trials on the management of peach leaf curl at UC Davis, dormant treatments were applied once in December 2019 or in rotation – one in December and one in February 2020. Highly effective treatments that reduced the disease to very low levels included Cuprofix at 10 lb/A, MasterCop at 6 pts, Bravo at 6 pts, Ziram at 6 lb, as well as Bravo-Ziram, Bravo-Cuprofix, and Cuprofix-Ziram mixture treatments using reduced rates of both mixture partners. A rotation of Botector and Cuprofix, both organic treatments, was effective or very effective in the two studies.
5. In studies on **bacterial blast and canker**, flowers or small branches were treated with kasugamycin, oxytetracycline, or new antimicrobials and were inoculated with *Pseudomonas syringae* pv. *syringae*, however, very little disease developed on Fay Elberta peach. On sweet cherry, the food preservative Nisin mixed with Manniplex Zinc and the organic ET91, significantly reduced the incidence of blast from 9.3% in the control to $\leq$2.8%; whereas Kasumin, Mycoshield, and BacStop reduced the disease by >50%. The full registration of kasugamycin on peach is expected in April 2021, whereas oxytetracycline is federally registered and potentially will be registered on peach in California in 2021.

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 that are currently registered. Other new products are also becoming available including Cevya (formerly UC-1; mefentrifluconazole, FC 3), 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 Inspire Super (FC 3/9), Luna Experience (FC 3/7), Quadris Top, Xiphosin (FC 3/11), Luna Sensation, Merivon, and Pristine (FC 7/11), as well as experimentals such as FC 3/33, UC-2, Miravis Top (-Duo), and Miravis Prime. Single mode of action fungicides like Kenja (FC 7) may also be mixed with FC 3 or FC 11 compounds.

We are also continuing our evaluations of the FC 19 bio-fungicide polyoxin-D, biological controls, naturally occurring acids, and other natural products. These latter include extracts of *Swinglea glutinosa* (Ecoswing), essential oils (BacStop, ET91), natural acids (capric and caprylic acids – Dart), and the biological agents *Pseudomonas chlororaphis* (Howler) and *Bacillus amyloliquefaciens* (Serifel). In 2020, we evaluated Serifel, Dart, and EcoSwing. 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 2020 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. New products are being registered, and baselines need to be established for non-exposed populations to compare populations after fungicide usage in the future.

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. Comparisons of genotypes were done 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 help in the development of molecular markers that can assist in breeding. Evaluations were suspended in 2020 due to COVID-19 restrictions prohibiting collaborative in-person efforts.

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 expected lower annual amounts permitted, we evaluated alternative treatments over the past several years, including new formulations of copper with lower metallic copper equivalent (MCE) as compared to high MCE products, mixtures with other modes of action, and lower application rates of each mixture component. Chlorothalonil, ziram, and dodine by themselves or in mixtures with copper at reduced rates were highly effective and consistent in their performance. Evaluation of new biological rotation programs are ongoing.

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 bud and flower death, as well as 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 the antibiotics kasugamycin and oxytetracycline. Kasugamycin is not used in animal or human medicine. The California registration on pome fruit, walnut, and sweet cherry was approved in January 2018. Full registration petitions for almond and peach are under review with a PRIA date of April 2021. 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 2020, no or very little disease was obtained on cv. Fay Elberta peach due to lack of favorable environmental conditions. Trials on sweet cherry and prune demonstrated high efficacy of the two antibiotics, new biologicals, and food preservatives. The latter compounds potentially can be registered as biopesticides that are exempt from residue tolerances.

OBJECTIVES

I. Management of brown rot

- A) Evaluate the efficacy of new fungicides (e.g., pydiflumetofen, pyraziflumid, mefentrifluconazole, V-424, V-449, EXP-19A), pre-mixtures (Fervent, Viathon, F4406-1, EXP-AD, -AF, UC-2), biofungicides (e.g., EXP-13, 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, biologicals (Blossom Protect), 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) Conventioanl bactericides – kasugamycin and oxytetracycline combined with adjuvants.
- B) Biocontrols – Dart, Serenade ASO, and Blossom Protect
- C) New bactericides – nisin, and ε-poly-L-lysine

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 (UC-KARE) in Parlier, CA. A single application of each treatment (see Fig. 1) was made at 30% full bloom to ‘July Flame’ and at 25% 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 2-26-20 and allowed to open in the laboratory. Fungicides evaluated are indicated in Fig. 2. 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' 7 days PHI and to 'Ryan Sun' peach 14+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 used in 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. We attempted to access the genotypes of the breeding program of Dr. Gradziel, however, COVID restrictions prevented in-person collaborative research. We will work with Dr. Gradziel in an effort to summarize genotype susceptibility to brown rot blossom blight as compared to commercial genotypes of cling peach.

II. Management of peach leaf curl

Single applications in combination with 2% Omni spray oil (see Fig. 5) in two experimental 'Fay Elberta' orchards at UC Davis were done as dormant treatments on Dec. 23, 2019, using an air-blast sprayer at 100 gal/A. A biological rotational program was also evaluated with two applications one on Dec. 23, 2019 and a second on Feb 15, 2020. 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 on 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 2019, 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 kasugamycin (Kasumin), oxytetracycline (a new formulation of Mycoshield), ε-poly-L-lysine, nisin, an experimental antimicrobial (TDA-NC-1), and products containing essential oils (BacStop and ET91). In April 2020, 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 (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* (2×10^8 cfu/ml) by hand-spraying. Inoculated branches were covered with white plastic bags for 18 h. Disease was evaluated after approximately 2 weeks. Similar studies were done on sweet cherry and prune.

RESULTS AND DISCUSSION

I. Management of Brown Rot

Efficacy of fungicides for management of blossom blight. At UC-KARE, disease incidence on 'July Flame' and 'Ryan Sun' peach was between 1.3% and 2.3% on blossoms of untreated control trees. Most treatments evaluated significantly reduced the incidence from that of the control and there were significant differences among treatments (Fig. 1). On 'July Flame', Cevya and Luna Sensation, and on 'Ryan Sun', Cevya, Miravis Prime, Merivon, and the organics Dart and EcoSwing were highly effective providing 100% control. Still, Merivon, Luna Experience, the experimental UC-2, and the organics performed well and significantly reduced the incidence of disease on both cultivars. Thus, a single application at approximately 25 to 30% bloom was effective in reducing the disease to zero levels for several treatments. The organic treatments Dart and EcoSwing were consistently effective on both cultivars and performed similar to most conventional fungicides under low disease pressure. Therefore, these treatments will be evaluated again in 2021.

Blossoms of 'Fay Elberta' were used in laboratory tests with registered and experimental fungicides. All treatments evaluated demonstrated excellent contact action as pre-infection treatments and local systemic activity as post-infection treatments and significantly reduced stamen infection from that of the untreated control (Fig. 2). New products such as Cevya, GWN 10570, Fervent, Miravis Top (-Duo), Miravis Prime, and UC-2 were similar in performance to registered standards (e.g., Quash, Luna Sensation, Quadris Top).

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 organic and conventional single and pre-mixture treatments significantly reduced the incidence of brown rot to less than 34% in the first trial and 30% in the second trial after non-wound spray inoculation as compared to the untreated control with 57.3% or 72.9% in the two trials, respectively (Fig. 3A,B). Merivon+Serifel reduced the incidence of brown rot to the lowest levels (9.4%) followed by Merivon, Cevya and the experimental UC-2 (all with 11.5% disease incidence). Luna Sensation, Miravis Top (-Duo) and Quash+Velum One also performed well with 15.6%, 17.7%, and 21.9% respectively. The biocontrol Serifel, the plant extract EcoSwing, and the numbered organic compound GWN 10474 also significantly reduced brown rot to 28%, 30%, or 34%, respectively, as compared with the control that had 57.3% incidence.

At UC-KARE, 7-day or 7- and 14-day PHI applications with conventional fungicides on July Flame or Ryan Sun peach, respectively, were effective in reducing brown rot of fruit after inoculation, and there were significant differences among treatments (Fig. 4). Ecoswing, Howler, and GWN 10474 were not effective and resulted in disease incidence levels similar to the untreated controls with between 63.9% and 79.5% brown rot incidence. Merivon and UC-2 were the most effective reducing decay to 4.8% to 11%. Quadris Top, Miravis Top, Miravis Prime, Luna products, and Cevya were less effective and performed all similar on both cultivars. EXP-19A (representing a new mode of action) was the least effective on July Flame but was comparable to the other less effective fungicides indicated for Ryan Sun. In last year's study, EXP-19A was also the least effective fungicide treatment on both peach cultivars.

In summary, we are continuing to evaluate a range of fungicides representing different modes of action and that demonstrate different levels of efficacy. This information will help identify fungicides with high performance 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 codes (e.g., FC 3), as well as new FRAC codes such as EXP-19A. Therefore, mixture and rotation programs should be followed for bloom and preharvest applications to prevent over-use of any one FRAC code 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, resistance management is being practiced. Identification of fungicides with different FRAC codes effective on brown rot as well as powdery mildew and gray mold will help 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. Two applications also ensure good coverage and high residue levels at harvest when many infections occur on 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. fructicola *to new fungicides. Isolates of *M. fructicola* were used to determine inhibitory concentrations of a new FRAC Code fungicide EXP-19A (FC 21) for mycelial growth using the spiral gradient dilution method. We are currently doing the assay with a SC formulation that will be available for stone fruits. This work is ongoing due to COVID-19 delays in personnel laboratory time allocations.

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 of the UC Davis breeding program of Dr. Tom Gradziel was not done in March due to COVID-19 shutdowns at the University of California that limited collaborative research.

Management of peach leaf curl

Two studies were conducted in winter 2019/spring 2020 on 'Fay Elberta' at UC Davis with similar results. All conventional fungicide treatments applied in combination with 2% Omni spray oil as single applications in late-December significantly reduced peach leaf curl as compared to the untreated control. Disease levels in the untreated control were moderate with 21.2 (Orchard 1) or 28.4 (Orchard 2) shoots with leaf infections/tree (Fig. 6). Cuprofix+Ziram and Bravo+Ziram (with individual components at reduced rates in each mixture) reduced the disease to zero levels. 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. A biological rotational program was also evaluated with one application of Botector on Dec. 23, 2019, and a second one with either MasterCop or Cuprofix (both OMRI certified) on Feb 15, 2020. The rotation with Cuprofix at 5 lb/A reduced the disease to 5.6% incidence, similar to a Cuprofix treatment at 10 lb/A.

Ziram, chlorothalonil, and also dodine (not evaluated in 2020) 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 evaluations of different products and rates, but Ziram, high rates of Bravo, and mixtures of these products have been the most effective treatments evaluated. The rotation of Botector and Cuprofix provides another option for organic growers. These three fungicides, the biocontrol, and new formulations of copper are currently registered for use in California. Thus, several options are available for conventional and organic 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 2020. 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 2020/21 season. Still, enough efficacy data has been generated for kasugamycin (i.e., Kasumin) and oxytetracycline (Fig. 6) to request the registration of the two antibiotics on peach and almond to the EPA for registration through the IR-4 program. The PRIA date for these commodities is currently April 2021. Kasumin and Fireline/Mycoshield are two of the few chemicals available 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 including 2020, kasugamycin was among the most effective and consistent treatments against bacterial blast. 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. New products such as ET91 and Nisin/ManniPlex Zn also showed high efficacy and potentially represent biopesticides and as such will be exempt from residue tolerances. Similar to practices instituted with fungicides, mixtures or rotations of different modes of action or FRAC codes are an effective usage strategy to prevent the selection of resistant populations of the pathogens targeted.

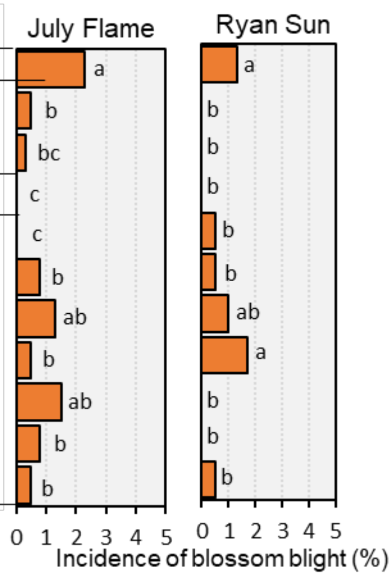
Table 1: Fungicides, bactericides, and biologicals used in 2020 studies*.

Pesticide	FRAC group	Trade name	Active ingredient
Fungicides			
Single Ais	M1	Cuprofix	copper
	M1	MasterCop	copper
	M3	Ziram	ziram
	M5	Bravo WeatherStik	chlorothalonil
	3	Cevya	mefentrifluconazole
	3	Quash	metconazole
	7	Velum-1	fluopyram
	19	Ph-D	polyoxin-D
	24	Kasumin	kasugamycin
	41	Mycoshield	oxytetracycline
Premixtures	3 + 7	Luna Experience	tebuconazole + fluopyram
	3 + 7	Fervent	tebuconazole + isofetamid
	3 + 7	Miravis Top, Miravis Duo	pydiflumetofen/difenoconazole
	3 + 11	Quadris Top	difenoconazole + azoxystrobin
	3 + 12	Miravis Prime	pydiflumetofen/fludioxonil
	7 + 11	Luna Sensation	fluopyram + trifloxystrobin
	7 + 11	Merivon	fluxapyroxad + pyraclostrobin
Experimentals	not discolsed	EXP-19A	not disclosed
	not discolsed	GWN 10570	not disclosed
	not discolsed	TDA-NC-1	not disclosed
	not discolsed	UC-2	not disclosed
Biopesticides	Food preservative	Nisin	nisin
	Food preservative	Poly-L-lysine	Ɛ-poly-L-lysine
Biologicals	Yeast	Botector	*Aureobasidium pullulans* strains DSM 14940-41
	Essential oil	BacStop	Clove, Rosemary, Peppermint Oils, etc.
	Organic acids	Dart	Capric/caprylic acids
	Plant extract	EcoSwing	*Swinglea glutinosa*
	Essential oil	ET91	not disclosed
	EXP-O	GWN 10474	not disclosed
	Bacterium	Howler	*Pseudomonas chlororaphis* strain AFS009
	Bacterium	Serifel	*Bacillus amyloliquefaciens* strain MBI600
Fertilizer	Zinc	Manni-Plex ZN	zinc fertilizer

* - 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 2020

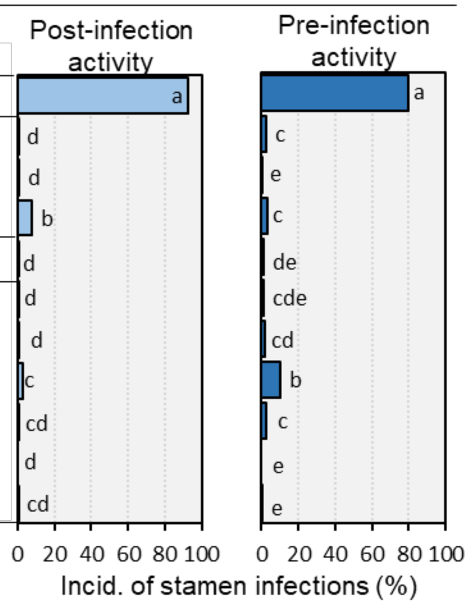
Program	Treatment	Rate/A
---	Control	—
Biologicals	Dart	0.25%
	EcoSwing	32 fl oz
Single	Cevya	4 fl oz
Pre-mixtures	Luna Sensation	7.8 fl oz
	Luna Experience	8 fl oz
	Quadris Top	14 fl oz
	Miravis Top	13.7 fl oz
	Miravis Prime	9.1 fl oz
	Merivon	5.5 fl oz
	UC-2	7 fl oz



Treatments were applied to July Flame peach at 30% bloom on 2-27-20 and to Ryan Sun Peach at 25% bloom on 3-3-20 using an air-blast sprayer (100 gal/A). Eight hours of overhead sprinkler irrigation was applied two days after the sprays. Disease was evaluated in mid-April 2020.

Fig. 2. Efficacy of pre- and post-infection treatments for management of brown rot blossom blight of Fay Elberta peach in the laboratory 2020

	Fungicide*	Rate
---	Control	---
Single	Quash	3 oz
	Cevya	5 fl oz
	GWN 10570	10 fl oz
Mixture	Quash liquid + Ph-D	3 fl oz + 6.2 oz
Pre-mixtures	Luna Sensation	7.8 fl oz
	Quadris Top	14 fl oz
	Miravis Top	13.7 fl oz
	Miravis Prime	9.1 fl oz
	Fervent	15 fl oz
	UC-2	7 fl oz

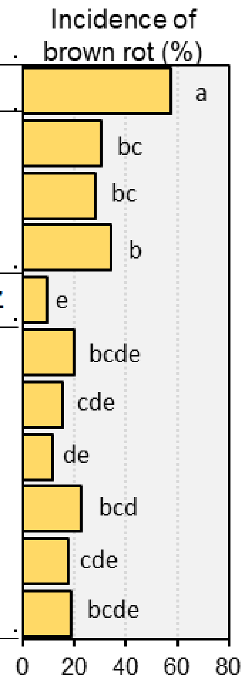


For evaluation of the pre-infection activity, closed blossoms were collected in the field on 2-26-20, allowed to open, treated in the laboratory using a hand sprayer, air-dried, and inoculated with a spore suspension of *M. fructicola* (20 K/ml). For post-infection activity, blossoms were inoculated, incubated at 22 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 2020

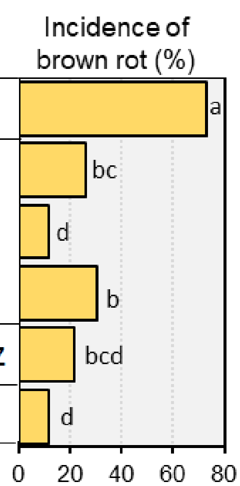
A.

Program	Treatment	Rate/A
—	Control	—
Biologicals	Serifel	8 oz
	GWN 10474	35 oz
	EcoSwing	32 fl oz
Mixture	Merivon + Serifel	5.5 fl oz + 8 oz
Pre-mixtures	Luna Experience	8 fl oz
	Luna Sensation	7.8 fl oz
	Merivon	6.5 fl oz
	Quadris Top	14 fl oz
	Miravis Top	13.7 fl oz
	Miravis Prime	9.1 fl oz



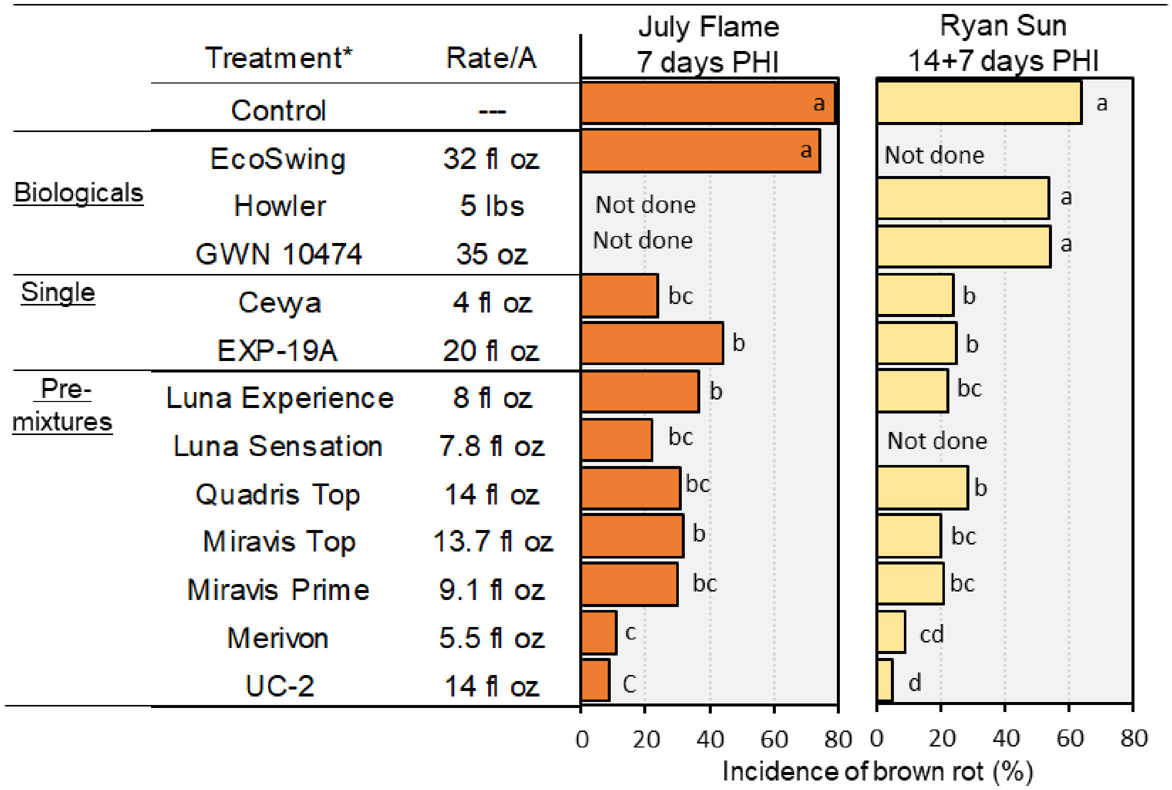
B.

Program	Treatment	Rate/A
---	Control	---
Single fungicides	Quash Liquid	3 fl oz
	Cevya	5 fl oz
	GWN 10570	7 fl oz
Mixture	Quash + Velum	3 + 6 fl oz
Pre-mixtures	UC-2	7 fl oz



Treatments were applied on 7-17-20 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 2020

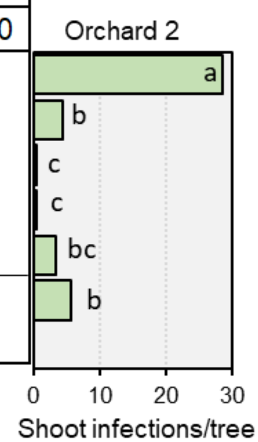


Treatments were applied in the field on 6-30 (July Flame) or on 8-13, 8-20-20 (Ryan Sun) using an air-blast sprayer at 100 gal/A. Fruit were harvested (48 fruit from each of four single-tree replications), spray-inoculated with *M. fructicola* (20,000 spores/ml) and incubated for 7 days at 20C.

Fig. 5. Efficacy of fungicide treatments for management of peach leaf curl of Fay Elberta peach at UC Davis 2019/20

	Treatment*	Rate (/A)	Oil	Applications 12-23-19	Applications 2-15-20
	Control	---	---	---	---
	Bravo	4 pt	2%	@	---
	Ziram 76DF	6 lb	2%	@	---
	MasterCop	6 pt	2%	@	---
	MasterCop + Ziram	4 pt + 4 lb	2%	@	---
	Bravo + Ziram	3 pt + 4 pt	2%	@	---
	Bravo + MasterCop	3 pt + 4 pt	2%	@	---
Rotation	Botector	10 oz	2%	@	---
	MasterCop	6 pt		---	@

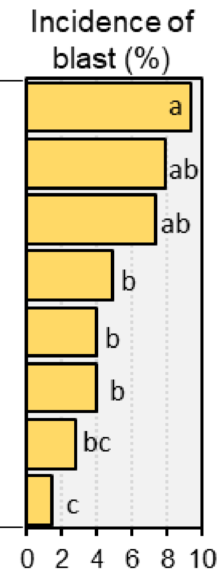
	Treatment*	Rate (/A)	Oil	Applications 1-3-20	Applications 2-15-20
	Control	---	---	---	---
	Cuprofix	10 lb	2%	@	---
	Cuprofix + Ziram	5 lb + 4 lb	2%	@	---
	Bravo + Ziram	3 pt + 4 lb	2%	@	---
	Bravo + Cuprofix	3 pt + 5 lb	2%	@	---
Rotation	Botector	10 oz	2%	@	---
	Cuprofix	5 lb	2%	---	@



Treatments were applied in the field 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 2020. For this, the number of infections per tree was determined.

Fig. 6. Efficacy of bactericides on bacterial blast of Coral cherry flowers in small-scale field studies at UC Davis 2020*

Treatment	Rate/A
Control	---
TDA-NC-1	20 oz
Poly-L-lysine + Manni-Plex Zn	3.5 oz + 32 fl oz
BacStop	64 fl oz
Mycoshield new	8 oz
Kasumin 2L	64 fl oz
ET91	0.5%
Nisin + Manni-Plex Zn	13.5 oz + 32 fl oz



* - Coral Cherry data are presented because the disease did not develop on all inoculations on Fay Elberta peach.

** - The stamens of flower clusters were cut off with scissors, and flowers were treated to run-off using a hand sprayer on 3-25-20. After air-drying, flowers were spray-inoculated with *Pseudomonas syringae* (10^8 cfu/ml) and bagged overnight.

*** - Disease was evaluated after 6 days based on the presence of dark, wilted flowers with brown peduncles.